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Research Article

Pediatric Home Mechanical Ventilation Emergency Responses for Home Caregivers and Nurses

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Abstract

Background and significance: It is estimated that 4800 children living in the USA are currently supported by mechanical ventilation at home. Despite advances in technology, the mortality rate of 21% remains high. Previous studies identified knowledge gap in the responses to emergencies in the home. Therefore, a training module focusing on the response to these emergencies is needed.

Purpose /aims of the study: Children's Hospital of Los Angeles (CHLA) approached regional home clinicians and formed an advisory panel to develop a training content for home mechanical ventilation (HMV) emergency management.

Methods: We surveyed 28 HMV clinicians in So. California asking them to recall HMV emergencies in the home settings. We gathered this advisory panel for a focus group via the modified Delfi method to develop the training content of responses to HMV emergencies.

Results: Ninety-two HMV emergency scenarios were recalled with 412 years of clinical experience on home HMV management. Data were categorized into 15 emergency situations. The expert panel deliberated on 1) the emergent situation 2) the immediate response 3) the possible causes and 4) pearls- the collective sharing of experiences on these encounters.

Conclusion: A training didactic tool for in-home caregivers and nurses of HMV children was developed. We hope that providing focused education, based on real world experience and wisdom, will help reduce accidental deaths in children on HMV.

INTRODUCTION

Children requiring home mechanical ventilation (HMV)" posed more challenges than the 9.4 million children in the United States with special health care needs [1, 2]. It is estimated that 4800 children living in the USA are currently supported by mechanical ventilation at home, and the prevalence of home mechanical ventilation for children is also similar in other developed nations [3]. However, despite advances in technology, readmissions and mortality remain high for these children [4-6]. The readmission rate for home mechanically ventilated children was reported at 40 % for the first year post initial discharge from the hospital, with the most common reasons being related to tracheostomy and respiratory issues [4]. A five-year mortality rate of 27.5 % and 21% were reported from two other studies [5, 6]. Many deaths were unexpected and from causes not directly related to their primary reason for chronic respiratory failure. Nearly 20% of these deaths were due to acute tracheostomy obstruction, tracheostomy accidents, and tracheal bleeding which required emergency action by the caregivers in the home [5].

How well are caregivers of children on HMV equipped to handle these in-home emergencies? Kun surveyed parents and in-home nurses of HMV children about their knowledge of home ventilators and emergency response [7]. She found that most caregivers incorrectly answered questions about the meaning of home ventilator alarms and response to emergency situations [7]. Nurses did not know more than parents, and the length of time a person cared for HMV children made no difference in their knowledge. Dougherty and Farre found similar deficiencies in caregiver knowledge [8,9]. The American Thoracic Society (ATS) strongly recommends that ongoing education to acquire, reinforce, and augment skills required for patient care be provided to both the family and professional caregivers of children requiring chronic home invasive ventilation [3,10]. However, being a solo practitioner in the home with primarily one patient, it is difficult to gain knowledge in emergency care. In-home nurses caring for pediatric HMV patients need and want training in emergency care to improve their knowledge and clinical skills [11]. Thus, a call for action in decreasing readmissions and accidental mortality of ventilator dependent children at home by focused training programs for home nurses is warranted [6].

We hypothesize that the development of a training module

for in-home caregivers and nurses of HMV children, focusing on responses to emergency situations will reduce accidental deaths. We believe there is untapped experience and wisdom in those caregivers that could be utilized to develop such an educational content based on real-life experience. Therefore, we convened a group of experienced caregivers and health care professionals, with experience caring for children on HMV, to educate us about real life emergency situations and to help us develop a training model with appropriate responses to these situations.

METHODS

An inter-professional workgroup (HMV Advisory Panel) of 28 individuals, who had expertise in the care of children on HMV, were invited to participate in a focus group. The clinicians were drawn from home ventilator and respiratory equipment manufacturers, home clinical Respiratory Care Practitioners (RCP), home health nursing agencies, clinicians from the Hospital HMV program, and three parents of HMV children. First, they completed a home emergency scenario survey on-line. Each participant was asked to recall up to eight emergency scenarios they had encountered in the home, and to recommend appropriate responses or management of each emergency scenario. The responses were complied, and a summary analysis of this survey was sent to each participant for review. On-line survey questions included tracheostomy and ventilator related emergency situations, with possible causes, appropriate responses, and shared experience on each scenario. We calculated the years of experience in working with HMV children in their respective professional discipline. Subsequently, the participants were invited back to meet as a group for a face to face focus discussion on the details of each emergency. The application of the modified Delphi Study tools was utilized to achieve consensus [12-14]. This discussion identified emergency scenarios, possible causes, recommended actions, and clinical "pearls".

The participation in this survey and focus group was totally voluntary. There was no financial obligation or remuneration to participate in this study. This study was approved by the Children's Hospital Los Angeles institutional review board.

RESULTS

Twenty-eight participants formed the HMV Advisory Panel; 9 lead RCPs from community vendors/manufacturer, 1 RCP from within the hospital, 9 nursing clinicians from home health agencies, 4 nurse specialists from the hospital, 2 pulmonologists, and 3 parents. They were the key stakeholders sharing their expertise on the subject. Collectively the participants had 412 years working with HMV children. Together they recalled 92 emergencies scenarios. These were then grouped into 15 major emergency scenario categories. During the focus group discussion, the group deliberated on the appropriate responses to each situation. They also included responses from the survey data that were more likely to be useful for that emergency scenario. The open discussion allowed collaborative recommendations that resulted in identifying some helpful suggestions from personal experience and observation. Consensus was reached with an open forum of discussion. The results of the eight-hour focus group discussion were structured into four areas: the emergency situations, the possible causes, the appropriate responses, and the pearls which were the result of collective brainstorming regarding what else could we offer on this topic. We structured the talking points into these four areas. The details of each emergency scenario are described in Table 1 and Table 2:

The HMV Advisory Panel made the following general observations, which should be considered for each emergency scenario. The response to individual emergencies is dependent upon:

- The child's medical condition.
- Familiarity with the child's baseline.
- Location of where it happens - home, school, during transport? Preparation for out of home situations is critical since our data noted 1/3 of the scenarios were outside the patient's home
- The type of help that is immediately available.
- The condition of the child at that moment.
- Your skill in HMV training.
- Whether driving to the ED or calling for ambulance transport is safe.
- Seeking emergency advance care when child has not returned to baseline.
- Calling for help if someone you know is available in the vicinity.
- Giving oxygen when desaturation is noted.
- Use of additional airway clearance therapy if deemed beneficial (for example for children with muscle weakness).

Being prepared before an emergency occurs was recommended to minimize the risks of an adverse outcome.

- Always have a resuscitation bag with you.
- Bag to mask ventilation is always an option.
- Remember the resuscitation bag is your backup ventilator.
- Always have the suctioning devices with you.
- Always have a spare tracheostomy tube for accidental decannulation or mucous obstruction and also a backup trach that is one size smaller in case the primary trach cannot be replaced.
- Call the respiratory vendor for mechanical problems when child is stable.
- Update your physician if needed.

The best way to address an emergent situation is to prevent it if all possible. In order to reduce the risk of an event, in-home caregivers and nurses should:

- Assess your own situation and determine risk factors frequently.
- Review and rehearse the possible emergency events.
- Take pictures of circuit and treatment set-up to assist

Table 1: Tracheostomy Related Emergencies.

Emergency	Possible Causes	Responses	Pearls
Mucous Plugging	• Dryness. - No water in the humidifier. - Humidifier temperature is set too low. - Humidity has "rained out" as water is in the tubing rather than remaining as water vapor that enters the lungs. • Infection with thick secretion. • Infrequent suctioning • Dehydration due to increased losses (diarrhea, emesis). • Hot weather. • Low humidity. • Exacerbated bleeding from the trachea.	• Suction the trach tube. • Change the trach tube. It is important to emphasize that the trach tube should be changed if the child does not improve with suctioning. • Assess the reason for the alarm. • Deliver aerosol treatment. • Provide manual ventilation if needed. • Resolve humidity problem. • Resolve dehydration problem.	• Mucous plugging is the most common cause of death with a trach patient. • Low humidity in breathing gas must be resolved. • Keep breathing circuit tubing warm and away from drafts. • Don't wait until vital sign changes before you suction. • Inline suctioning may not be adequate with thick mucus plugs. • Neuromuscular patients may require deeper suctioning. • Size 6 suction catheter may be too small to clear plugs. • Low threshold to change to a new tracheostomy tube.
Accidental decannulation	• Loose tie • Too many layers of gauze. • Unintended pulling of the circuit. • Excessive secretion within the stoma site may make the tube more slippery, causing decannulation.	• Re-insert the trach tube. • Secure the trach tube snugly.	• Pay attention to tubing and trach, especially during transport. • Never rely on only one alarm to detect this situation. HMV children should always use a patient monitor, such as a pulse oximeter, and not just ventilator alarms. • If a pulse oximeter is being used, the low oxygen saturation alert will go off. • Tailor alarm settings to fit ventilator, circuit setup type and trach tube size. If inspiratory volume monitoring is in use, this may result in low pressure/high volume alarms during pressure ventilation. If expiratory volume monitoring is in use, this may result in low volume alarms. • Be aware that the ventilator may not alarm if the end of the trach tube is buried within clothing or bedding or if the tube is of small caliber, the ventilator might not detect the change in the flow via a small trach tube.
Trach tube is disconnected from the circuit	• Slippery adaptor from secretions. • Child pulling on the circuit.	• Connect the tube to circuit. • Secure the trach tube snugly.	• Pay attention to tubing and trach, especially during transport. • Never rely on only one alarm to detect this situation. • If a pulse oximeter is being used, the low oxygen saturation alarm will go off. • Tailor alarm settings to fit ventilator, circuit setup type, and trach tube size. • If inspiratory volume monitoring is in use, this may result in low pressure/high volume alarms. • If expiratory volume monitoring is in use, this may result in low volume alarms.

Large volume of secretions	• The most common sign of infection (tracheitis) is an increase in secretions, needing frequent suctioning.	• Suction the trach tube. • Remove moisture from the circuit. • Change the circuit. • Increase oxygen if desaturation occurs. • Deliver aerosol treatment. If secretion is thick. • Assess additional signs and symptoms of infection.	• Ventilator alarms: high pressure, low minute volume. • This is a very common experience at home. Normally, increase in the frequency of airway clearance therapy for a few days is adequate. Other times, the secretions might present with foul odor, blood tinged, yellow, green or thick. Notify the provider to see if antibiotics are warranted.
Inability to suction through the trach tube.	• Trach tube is blocked by mucous plugs. • Trach tube is too short with the distal end against the tracheal wall, or it is too long and the end of the tube is too close to the carina. • Trach tube is ill-fitted. • Granulation tissue below the end of the tube. • Abnormal anatomy (tracheal shelf, severe scoliosis). • Knowing patient's volume baseline will help in determining a possible plug due to a much lower read out on the ventilator screen.	• Reposition the child and suction again.. • Change the trach tube if obstruction is suspected. • Manually ventilate if needed.	• If an inline suction catheter is used, switch to the open suctioning method when secretion is thick. • Instill a generous amount of normal saline through the trach if a mucous plug is suspected. • Be ready to change trach tube. • Make sure the trach size is correct: neonatal vs. pediatrics. • Reposition trach tube and attempt to suction again if positional tube is suspected. • Be ready to go to ED or call 911 for advanced management.
Bleeding from the trach	• Dryness. • Irritation from aggressive suctioning. • Infection. • Ill-positioned trach tube. • Granulation tissue beyond the end of the tube.	• Gently suction the trach tube. • Change the trach tube. • Call 911 if airway is still not patent. • Remove blood clots from the circuit.	• Distinguish between blood-tinged mucus vs. frank bleeding from the trach tube. • Bleeding non-stop necessitates ED visit. • Always change the trach tube because of possible coagulated blood occluding the trach tube. • If blood-tinged secretions are noted in the circuit, also change the circuit. • Seek advice of provider. • Cold normal saline drops to constrict blood vessels may be helpful. • May need urgent ENT evaluation. • For bleeding from dryness, a possible solution is to switch from a traditional home humidifier and vent circuit to a heated wire circuit with the ability to control the temperature. • Maintaining adequate room temperature may also be a factor in not receiving appropriate humidity from the vent humidifier. Example: If the room where the vent and humidifier are located is too cold, there will be a lot of condensation and water will rain out and collect in the vent circuit which results in low humidification delivered to the patient.

Table 2: Ventilator Related Emergencies.

Alarm	Possible Causes	Responses	Pearls
High Pressure	• Mucous plugging. • Bronchospasm. • Coughing and back pressure from patient. • Administering an in-line aerosol treatment with flow from outside of the ventilator. • Any possible obstruction in the circuit. • Kinked/bent tubing. • Moisture in the circuit causing obstruction. • Moisture in sensor area with the double lumen circuits. • Sticky exhalation valve.	• Assess the reason for the alarm. • Mucous plugging is the most frequent cause, but it must be addressed early. • Suction the trach tube. • Change the trach tube. • Remove moisture from the circuit. • Change the circuit. • Deliver aerosol treatment (if secretion is thick). • Temporarily increase oxygen if desaturation persists.	• Since mucous plugging is very common, suctioning and resolution of humidity problems are often needed. • In rooms that are cool, condensation is more likely. • Shake off excessive moisture accumulation at the monitoring sensor. • Use a drainage bag/water traps with the stationary ventilator to keep water from accumulating in the circuit. (Not needed for heated wire circuit.) • Remember: On certain ventilators, the alarm must be reset to clear the alarm screen; otherwise, it will continue to be displayed visually with no audible alarm. • Distention of the abdomen, constipation, or distended bowel decreases ventilation and can cause high pressure alarms.
Low Minute Volume	• Mucous plugging needing suctioning and resolution of humidity problem. • Excessive moisture in the circuit. • Low inspiratory volume alarms may be caused by missed triggering, mucous plugging, need for bronchodilator and/or suctioning, and decreased patient breathing. • Low exhaled minute volume alarms may be caused by leak, disconnection, missed triggering, mucous plugging, need for bronchodilator and/or suctioning, or decreased patient breathing.	• Assess the reason for the alarm. • Suction the trach tube. • Change the trach tube. • Deliver aerosol treatment. • Resolve humidity problems.	• This is the most frequently encountered alarm. Monitor the patient for suctioning needs before the alarm goes off.
Low Pressure	• Any leak or disconnection in the circuit or accessory components: humidifier, nebulizer, HME. • Trach decannulation. • Significant leak due to a small trach tube. • Mouth breathing.	• Assess the reason for the alarm. • Connect the tube to circuit. • Secure the trach tube snugly. • Look for any leaks in the circuit. Any connecting tubing to the circuit is a possible site for loose connection. • Ensure that the circuit is configured correctly, and fittings are tight. • Change the circuit.	• Frequent places of disconnection are the trach adapter, exhalation valve, and any tear in the circuit. • Remember: This is common when suctioning using an open suction catheter as the circuit needs to be disconnected temporarily but alarm must be reset to clear.

High Respiratory Rate	• Child: Could be sick (physiological change from baseline). • Airway patency is compromised. • Tidal volume may be low and alarm has caused back up ventilation which increases respiratory rate to compensate for presumed inadequate ventilation by providing more breaths. • Ventilator related problems – not delivering adequate volume. • Auto-triggering of ventilator due to trach or circuit leak or water sloshing in tubing.	• Assess the reason for the alarm. • Suction the trach tube. • Remove moisture from the circuit. • Tighten all fittings. • Reposition child to reduce trach tube leak. • Change the circuit. • Change the ventilator (if mechanical dysfunction is suspected). • Increase oxygen if desaturation persists.	• Is airway obstructed? • Is there an increase in trach tube or circuit leak causing auto-triggering of breaths? • If bias flow is adjustable, check bias flow setting. • Is there water in the circuit? • Is ventilator working? • What other physiological symptoms that suggest the child is becoming sick? • Pulse oximeter will also alarm if heart rate is beyond set limit/ desaturation occurs.
High Minute Volume	• Volume x Rate = Minute ventilation. • High inspiratory volume alarms may be caused by auto-triggering, increased patient respiratory rate, and leak. • High exhaled minute volume alarms may be caused by auto-triggering and increased patient respiratory rate. Not all ventilators have this feature.	• Assess the reason for the alarm. • Secure the trach tube snuggly. • Connect the tube to circuit. • Change the circuit. • Change the ventilator.	• Look for disconnection from head to toe. • Look for agitation. • Look for leaks that cause auto-triggering. • If bias flow is adjustable, check bias flow setting. • Assess for possible source of leak- trach tube size too small or child sleeps with mouth open.
Disconnect Alarm (circuit disconnect)	• Disconnection anywhere in the circuit. • Trach tube slipped out of the stoma. • Trach guard not securely tied. • Swivel adapter slipped out from trach tube. • Large leak from using a small size trach tube.	• Look for alarm reasons. • Connect the tube to circuit. • Secure the trach tube snugly.	• Inspect connection daily for tight connection. Should have extra circuit/duct tape on hand for temporary repair of tear in circuit if needed. • Set the disconnect alarm parameters correctly to reflect a true disconnect and not a natural leak.
Ventilator Disconnect	• Disconnection anywhere in the circuit. • Trach guard not securely tied. • Swivel adapter slipped out from trach tube • Ventilator: Disconnect alarm, Low pressure alarm, Low PEEP alarm.	• Assess the reason for the alarm. • Connect the tube to circuit. • Use backup ventilator if the problem can not be resolved.	• Pay attention to tubing and trach, especially during transport • Never rely on only one alarm to detect this situation. • Tailor alarm settings to fit ventilator and circuit setup type. • If inspiratory volume monitoring is in use, this may result in high volume alarms. • If expiratory volume monitoring is in use, this may result in low volume alarms.
Water in the Circuit	• Air is cooling in the circuit after it leaves the humidifier. Circuit is too cold. • Excessive condensation due to ambient environment – under the fan or cold room. (cooling the circuit tubing). • Head of bed (or position of the child) is below the ventilator. • Water trap not being used (cannot use water trap if heated wire is used).	• Assess the reason for the alarm. • Suction the trach tube. • Remove moisture from the circuit. • Change the circuit. • Resolve cold circuit problem that is causing water vapor from humidifier to "rain out" in the tubing.	• Use of humidifier during transport – may pour water into the circuit/ trach. • Avoid humidifier bottle for transport or short out of home activities for safety. • May moisten the trach tube with 3 drops of normal saline to prevent dryness. • Ventilator alarm: would alarm high pressure, and low minute volume. • High respiratory rate is also possible given the turbulence of the water, which could lead to auto-triggering and also high minute volume alarm.

Power Source Drained: Battery/ Oxygen	• Ventilator malfunction (an infrequent occurrence). • Obstruction of airflow to the ventilator. • No battery. • No power source to the ventilator. • No oxygen in the portable gas tank.	• Cover the patient connection during planned disconnect so that the ventilator is not ventilating the room (increased minute volume will drain the battery faster). • *MAKE CERTAIN* that the power main indicator lights up every time you plug into external power. If it doesn't light, the internal battery system is not charging. Check all connections and power sources! Ensure that the ventilator is not plugged into a strip or outlet controlled by a light switch. Call for support if you cannot get it to light up. • After running on battery for approximately 5 minutes, check the charge level. • Always carry your AC and DC power cords with you. Plug in to external power whenever possible. Plan ahead for emergencies. • Keep track of the internal battery's use time (time until Battery Low Alarm). Keeping a log will help you to know the average use time available (it will vary). • Use an external (AC or DC) power source whenever possible. • Always carry a manual resuscitator with you- Bag with appropriate size mask and connector for trach tube.	• Always maintain battery charge. • Battery left discharged/empty will dramatically shorten life of battery. • When ventilator is mobile and unplugged from charger, put in sleep mode to preserve battery life. (Screen will go dim and/or turn off, but ventilator will still function). • Avoid exposure to extreme heat/ sunlight (For example; left in the car). Extreme cold weather has similar effect on the battery.

others in checking or assembling equipment.

- Take a good inventory of all accessories used and keep extra on hand..
- Order medication and supplies on time.
- When in doubt-Consult!
- The BEST response to an emergency is to minimize the risk factors before it happens.

DISCUSSION

We developed an in-home emergency response training content for caregivers and nurses caring for children on HMV. Our educational material was based on real world experiences and wisdom of an interdisciplinary working group experienced in HMV home care. Many members of the panel were providers from within the hospital – respiratory care practitioners, nurses, and pulmonologists. Their experience is important even though they do not work in the home setting. Their role in the process reflects the initial preparation for home care, design of the training program and subsequent home care management in the outpatient settings on sick or emergency calls from our HMV population. Therefore, the recommended responses echoed a wealth of knowledge from all the stakeholders from both inside and outside the hospital setting. Using a survey and face-to-face focus group, their combined experience was used to identify common in-home emergencies situations and their most appropriate solutions. To our knowledge, a similar approach is not available to the general public. This additional emergency content deepens the knowledge of caregivers on emergency care. From our previous studies on the knowledge of our caregivers, this project addresses the knowledge gap [5, 7] identified in our earlier studies on tracheostomy and ventilator management.

Even though there are existing manufacturer's instruction manuals on the operation of the ventilator, many caregivers consider our educational material on ventilators alarms a good general reference due to its clarity and practicality. We stressed that it is not a replacement or substitute for the information contained in the ventilator manufacturer's instruction manual or the professional clinical judgement of their attending physician. But rather, the emergency scenarios offer a quick reference of how to respond in the home setting.

The face to face discussion generated robust awareness on the management of alarms and why they could be confusing to caregivers. For most ventilators, visual alarm indicators change from flashing to solidly lit when an alarm condition is resolved. However, there are exceptions when the ventilator visual indicators remain flashing when the alarm condition is resolved. In all cases the audible indicator stops when the alarm condition is resolved. There are also important differences in alarm setup and responses between ventilators and even between the different circuit types on the same ventilator. Since the type of ventilator and the way that ventilator is set up impacts how alarms work, it is vitally important to be aware of the type of breathing circuit setup in use and whether the volume alarms are related to inspiratory or expiratory volumes. An alarm is functioning only "if enabled" for all the alarms, except for Disconnection alarm. Anytime you have a disconnect, or a leak, you can have degradation of PEEP, which could lead to a low PEEP alarm and auto-triggering if the issue is not resolved in a pre-set number of breaths. Also note that for the same problem, such as mucous plugging, you could have an "Obstruction alarm" which is independent of the "High Pressure" alarm with some newer ventilators. Hence, the HMV emergency response of a patient and his/her ventilator alarm management needs to be customized to the type of ventilator used and the clinical risk associated with the medical condition.

Since our teaching module was created on a regional approach utilizing home and hospital clinicians from a major HMV program, we were able to gather valuable experience on the working of the functions and alarms of two to three major home ventilators that we used. We could focus on the management of uncuffed tracheostomy tubes, and the preference for pressure control ventilation. Hence, the training information is more pertinent than educational material from a program that might not have the same approach.

The assessment of an emergent situation requires a systematic approach to establish that the airway is patent, the ventilator is functioning and set properly, the ventilator accessories are intact, the environment they are in, and baseline changes of the child's medical condition. The responses of each emergency scenario are listed, not particularly in a step by step order. But rather, the responses represent an inventory of possible solutions. It is not helpful to mandate that the responses follow certain sequence as the emergency situations might have different presentations.

The focus group discussion was especially helpful in identifying the risk of draining the power source such as the internal battery, and how to prolong the longevity of the battery. This led to the observation that ventilator hardware malfunctions were rare events [15]. However, running out of battery power and oxygen supply were common events posing further risk to provide adequate ventilation to the patient. It is emphasized that caregivers and nurses should be sure batteries remain charged when possible and that there is adequate oxygen supply in order to avoid emergency situations.

There is no central data repository for home care providers to record emergencies for HMV children. We developed our content based on the collective experience of stakeholders in our region. In managing the HMV patient, the distinction of whether it is a tracheostomy issue, a ventilator malfunction, a major physiological change, or a knowledge deficit of a caregiver might be hard to describe. Some of these events in real life are multi-factorial, therefore the cause of an emergency needs to be assessed using the systematic approach to explore all possible problems.

LIMITATIONS

This training module is helpful to those clinicians and caregivers who use similar models of ventilators, uncuffed trach tube and pressure control mode. As many clinicians are using volume control, cuffed trach tube and a myriad of ventilators in the home, the educational information might not be extrapolated for their patients. Also, this educational module was developed by a single institution only. The recommendations were based on personal experience and not a randomized research study.

CONCLUSION

We have identified through a group of experts the most common types of tracheostomy and ventilator emergencies for HMV children in the home, and we developed a training module on emergency responses for caregivers. The clinicians offered the insight that when working with HMV children, one needs to anticipate the emergencies to include the concept of a ventilator management in a systematic manner. This includes the risk factors from the airway, the ventilator, the circuits, and supporting equipment like the battery and oxygen. Lastly, the underlining medical condition of the child and any major deviation from its baseline could pose an emergent situation must be included in the systematic assessment of the HMV emergency. We speculate that learning the risk factors and their proper responses in each scenario would mitigate harm in HMV management.

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