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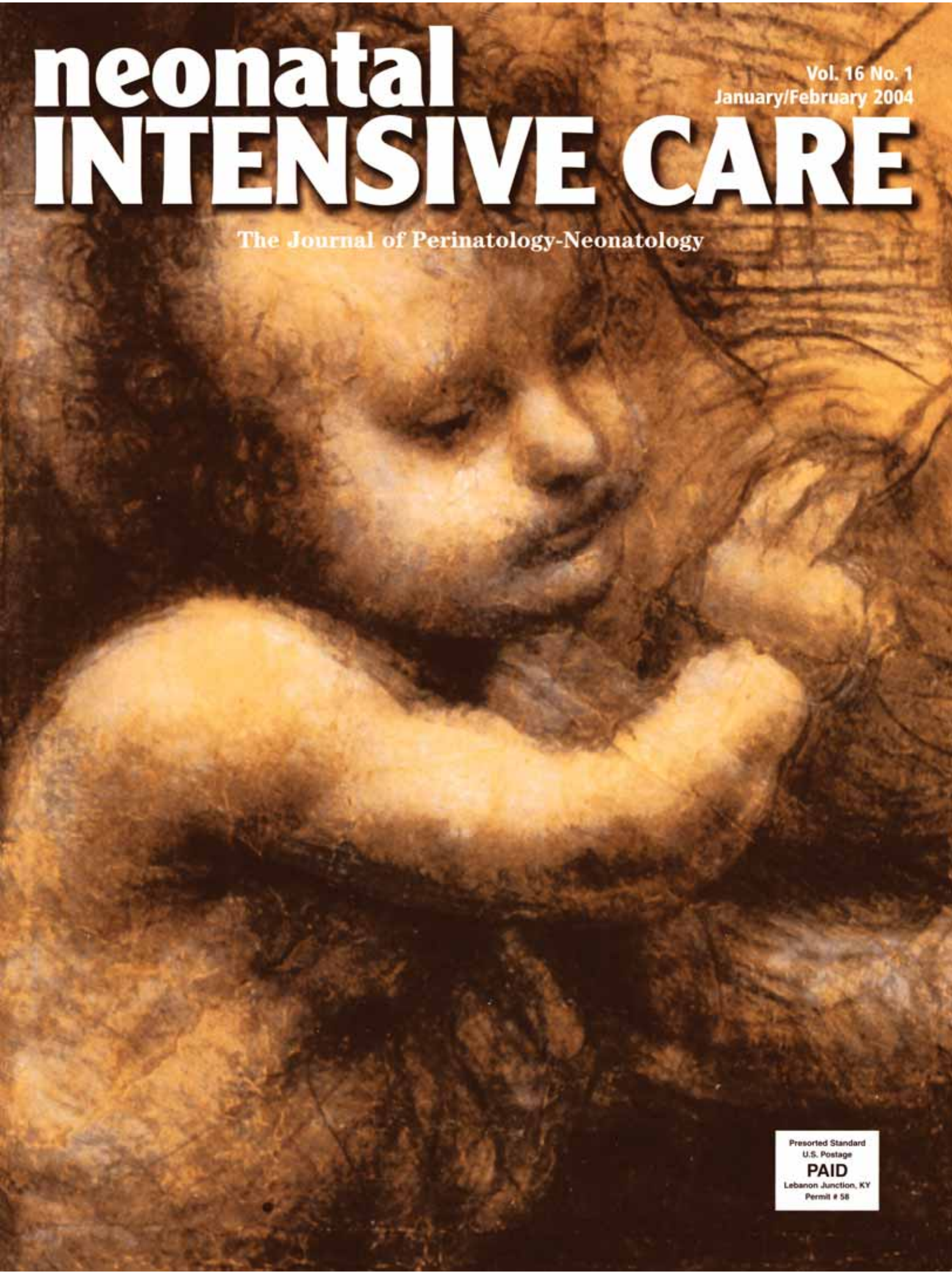

Problems Caused By Tracheostomy Tube Placement

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Although a tracheostomy tube placement is a medical necessity for many neonates, there are several physiological functions that are altered with tracheostomy placement that can be restored within hours by utilizing the Passy-Muir Tracheostomy and Ventilator Speaking Valve (PMV) in the NICU.

Due to the placement of the tracheostomy tube below the level of the vocal folds, inspiration and expiration through the tube bypass the vocal folds, which causes aphonia, the inability to create voice. Speech and language development, which begins at birth with crying, is delayed the moment the tracheotomy is performed. The bonding process for parents and care providers is severely impacted by this lack of communication.

This lack of airflow through the upper airway decreases the sense of smell and taste, which may contribute to feeding difficulties for many of these neonates. Despite the medical necessity for the tracheostomy tube, swallowing function is impacted by a combination of several factors which may result in aspiration.[1-7] The first contributing factor, the lack of airflow in the upper airway, decreases sensation in the oropharynx. Sasaki, et al demonstrated with animal models that intrinsic muscle activity is adversely affected by the loss of airflow through the larynx.[8] Eibling and Gross report that this lack of sensation contributes to lack of coordination and decreased transit time of the swallow.[9] In addition, it is this lack of sensation that contributes to the pooling of the secretions and formula in the back of the throat. The second factor, the presence of the tracheostomy tube in the trachea, can impede laryngeal excursion which is necessary for the epiglottis to flap back and protect the airway. Tethering of the larynx, which can be caused by an inflated cuff, or the presence of the trach tube itself, is often cited as the source of the swallowing problem and the primary cause of dysphagia and aspiration in the tracheostomy patients.[10] Third, the lack of the pressure of airflow beneath the level of the vocal folds does not stimulate the baroreceptors which signal the vocal folds to close. With the vocal folds in the open position, and the second protective mechanism, the epiglottis, unable to protect the airway, the neonate is void of his natural protective barriers, and is highly susceptible to aspiration and subsequent aspiration pneumonia.

The open tracheostomy tube, combined with the open vocal cords are the contributing factors to lack of subglottic air pressure, pressure beneath the level of the vocal folds. This lack of subglottic pressure diminishes the ability to cough and mobilize secretions and eliminates Positive End Expiratory Pressure (PEEP). Eibling and Gross report that subglottic air pressure during swallowing is required for an efficient swallow.[9] The absences of these pressures and impaired swallow can lead to an increased risk for infections, aspiration pneumonia and the potential for atelectasis. The combination of these risk factors ultimately leads to longer placement of the tracheostomy tube and increased length of time on the ventilator due to the multiple complications that may occur. This in turn equates into increased costs for the healthcare facility and the patient.

EARLY INTERVENTION WITH THE PASSY-MUIR VALVE

The Passy-Muir Valve has been used on infants on a ventilator as young as five days old. Engleman and Turnage-Carrier found that of 29 children trialed with the PMV at Texas Children's Hospital in Houston, Texas, 24 (83%) tolerated the PMV and 75% of those children produced vocalization on the first trial.[1] The closed position "no leak" design of the PMV is unique in that it closes spontaneously at the end of inhalation and does not allow any airflow back out through the valve. This reintroduction of airflow and pressure from the PMV restores the natural physiology of the patient and reduces the complications which may arise from the placement of the tracheostomy tube.

PHYSIOLOGICAL BENEFITS

The restoration of speech is essential for normal language development. The tracheostomized child is now able to request a desired activity or object, obtain information from the social surroundings, display displeasure, gain relief from an undesirable situation, and acknowledge the presence of others.[12] Restoration of communication for tracheostomized infants can diminish exposure to other developmental interferences to language developments such as: repeated and extended periods of hospitalization, neurologic insults, prematurity, inconsistent primary caregivers, poor growth and muscle strength, lack of normal feeding experiences, and a high incidence of otitis media and ambient noise exposure that can affect hearing.[13] The communicating neonate is now capable of bonding with parents and siblings through crying, cooing and babbling.

The restoration of airflow through the upper airway restores the sense of smell and sense of taste, which can led to an improved appetite. Overall nutritional intake is imperative, especially for the ventilator dependent neonate. The restoration of airflow restores sensation to the oropharynx, allowing the neonate to sense any pooled secretions or material that would otherwise be aspirated. The pressure of the airflow beneath the level of the vocal folds allows the vocal folds to remain in a closed position. In conjunction with placement of the closed position PMV on the trach tube, restoration of subglottic pressure has been reported by Gross and Eibling to significantly improve the swallowing efficiency and decrease the risk of aspiration for patients utilizing the valve.[9] Similarly, Dettelbach et al used the PMV to occlude the tracheostomy tubes of 11 patients who were known to aspirate and unable to tolerate capping or decannulation. It was concluded that aspiration was reduced or eliminated in all cases with at least one food consistency provided.[14] Stachler et al completed a similar investigation using a thin liquid. Scintigraphic evidence quantified that occlusion of the tracheostomy tube during the swallow with a PMV significantly reduced the amount of aspiration as compared to the open condition with the same patient.[15] Elpern et al used a mixed group of tracheostomy patients to compare occurrences of aspiration with and without use of the PMV using videofluoroscopic swallowing examination. They found that aspiration was significantly less frequent with the PMV as compared to the same patients when not utilizing the PMV.[6] Therefore, with placement of the PMV, the combination of 1) the ability to elevate the larynx so that the epiglottis may flap back to protect the airway, 2) the restoration of airflow to provide increased sensation, 3) vocal fold closure, and 4) the restoration of subglottic pressure all contribute to a more efficient swallow and decrease in aspiration for the neonate. Decreased risk of aspiration may prevent further surgical intervention for swallowing complications such as gastrostomy tube or jejunostomy tube placement.

The improved subglottic pressure also allows for sufficient pressure to generate a more efficient cough, to improve mobilization of secretions. Lichtman et al verified previous studies which found that use of the PMV resulted in decreased secretions due to the restoration of airflow in the nasal passages, and with a more forceful cough, that the secretions may be elevated to the oropharynx and subsequently expectorated or swallowed. They report that the "continued clearing of secretions from the lower airway while wearing the speaking valve would reduce the requirement for suctioning through the tracheal lumen."[16] Reduced suctioning needs would provide an opportunity to reduce the overall complications of suctioning such as trauma and the incidence of infection introduced by passing the suction catheter through the tracheostomy tube. These researchers also concluded that due to the restoration of normal pressures, that wearing the PMV may also have beneficial effects on arterial oxygenation due to the restoration of physiologic PEEP.[16]

WEANING AND DECANNULATION

Early intervention with use of the PMV provides the neonate with the opportunity to utilize his expiratory muscles while on the ventilator by breathing past the trach tube, past his own natural anatomy and out his mouth and nose. This allows for strengthening of the respiratory musculature, which promotes the decannulation and weaning process. Light et al found that tracheostomized patients utilizing the PMV were able to be decannulated five days sooner than the control group who were not using the valve.[17] Frey and Wood reported on overall improvement in oxygen saturation levels, a 56% greater tolerance for weaning attempts, which eventually led to independent breathing for 33% of the patients included in this study.[18] Expedited weaning from the ventilator with the PMV promotes decreased days in the ICU for the neonates, decreased length of stay in an acute care facility and ultimately, transfer of this patient from the hospital to home setting. This translates into a significant cost savings for the healthcare facility and the patient's family.

QUALITY OF LIFE

The physiological benefits of communication, improved swallow and decreased aspiration, improved cough, improved oxygenation and restoration of PEEP, and improved weaning and decannulation times allow for a cost effective treatment and overall improvement in the quality of life for the tracheostomotized and ventilator dependent neonate. Ultimately, the question is not why would you want to utilize the PMV for a neonate on a ventilator, but why are you not using the PMV as prevention from the several complications that occur as a result of the tracheostomy tube for your patient.

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