BRONCHOPLEURAL FISTULA: A BRIEF REVIEW

by David Wheeler RRT, NPS

The most direct and functional definition of a bronchopleural fistula, (BPF), is to describe it as a communication involving both the pleural space and the bronchial tree. BPFs represent a complex management problem and are linked with increased morbidity and mortality. The most common manifestation of BPF is in the postoperative phase following any pulmonary resection. (The incidence of BPF has been reported from 1.5 to 28% after pulmonary resection). This most common manifestation is followed by lung necrosis, persistent spontaneous pneumothorax, chemotherapy or radiotherapy, (as a treatment for lung cancer) and tuberculosis.

The treatment of BPF includes a variety of surgical and medical procedures. The most recent advances and the greatest potential for treatment may be in the use of bronchoscopy with various glues, coils, and sealants. Bronchoscopic procedures may prove the dominant therapeutic direction in the near future, or serve as a temporary bridge until the patient's clinical status is improved. There is no strong consensus of optimal therapy and it seems that the current therapeutic options may be complementary. The mindful practitioner will understand that all therapeutic plans and treatment options should be individualized to the patient.

BPF is a life-threatening condition due to tension pneumothorax and/or asphyxiation secondary to massive pulmonary flooding

Patients at risk for the development of BPF include patients with ARDS, chest trauma, invasive chest procedures, debilitated patients, patients with pneumonia, lung abscess, COPD, bullous lung disease, spontaneous pneumothorax, and parenchymal abnormalities.

The preoperative issues related to the development of BPF are fever, steroid use, H influenzae in the sputum, elevated erythrocyte sedimentation rate, and anemia. While the postoperative factors are fever, steroid use, leukocytosis, tracheostomy, and bronchoscopy for secretion management or mucus plugging.

Additionally, both right-sided pneumonectomy and postoperative mechanical ventilation were identified as posing increased risk for BPF. An essential note is that the incidence of BPF is related to the type of closure used in any pneumonectomy, with an incidence of 1.8% with a manual suture, 5.0% with a stapling device. Postoperatively a BPF may be classified as acute, sub acute, and chronic. The acute form of BPF is typically related to stump dehiscence and necessitates early re-operation. The sub-acute and chronic forms are commonly associated with infection and immunocompromised or debilitated patients with various comorbidities.

The Acute BPF is a life-threatening condition due to tension pneumothorax or asphyxiation secondary to massive pulmonary flooding. The clinical presentation may be characterized by the sudden appearance of dyspnea, hypotension, subcutaneous emphysema and purulent cough. There may be an attendant acute tracheal shift. Again, an acute presentation generally requires a visit to the operating suite and should be treated as quickly as possible.

The Sub-acute presentation is rather insidious and is characterized by a general wasting, malaise, fever, and minimally productive cough. This chronic form of BPF may be associated with an infectious process and there may be co-attendant fibrosis of the pleural space and mediastinum.

Common diagnostic techniques employed to detect BPF include the instillation of methylene blue through the stump. If the chest tube becomes blue then…The essential CXR, MRI and CAT scans may be definitive or inconclusive yet they remain the mainstay of assessment tools for BPF.

Another assessment utilizes small metallic probes introduced through the working channel of the bronchoscope; and yet another analyzes changes in gas concentration in the pneumonectomy cavity after inhaling different concentrations of oxygen and N2O. Interventional bronchoscopic techniques are emerging as very reliable diagnostic and therapeutic tools in the management of BPF.

Indeed, bronchoscopic investigation is critical for both diagnostic and therapeutic interventional reasons. Bronchoscopic evaluation affords appropriate evaluation of the airways, endeavors to localize the fis-

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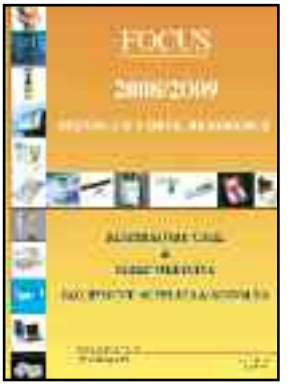

tula and exclude tuberculosis or infectious etiologies. Interventional bronchoscopic techniques offer the introduction of sealants or stents into the fistula providing a reasonable therapeutic solution.

The actively leaking BPF is an extremely challenging complication to ventilator management in acute respiratory failure. The crude mortality in these patients may be as high as 67%. The larger air larger the leak the higher the mortality.

Initial ventilator management focuses on decreasing the pressure gradient between airways and the pleural space. The mean airway pressure must be monitored and the clinical goal should be to keep it as low as possible.

Mechanical ventilation in patients with BPF must be goal directed and context driven. The patient will determine the type of ventilation strategy employed and the subsequent changes to mechanical ventilation. The mechanical ventilation of the patient with BPF is definitely a case for n=1 management.

Independent lung ventilation and High Frequency oscillation have been employed in the management of BPF and both are worthy of columns of their own. The current discussion will focus on the goals of mechanical ventilation. The primary goal of mechanical ventilation in BPF is reducing the airway pressure and therefore reducing fistula flow and loss of tidal volume.

The cogent practitioner will understand that "Volutrauma" is a more accurate term for describing the pathogenesis of pneumothorax as a complication of mechanical ventilation and that ventilator-induced lung damage is more likely to occur when pre-existing acute lung injury is present. The likelihood of developing VILI or VALI during mechanical ventilation can be minimized by avoiding alveolar stretch, overdistention and dynamic hyperinflation. The likelihood of developing a pneumothorax during mechanical ventilation can be minimized by avoiding alveolar overdistention and gas trapping.

I must emphasize that both independent lung ventilation and HFOV have some clinical utility in the ventilatory support of the patient with BPF, however the current thought is that one become more goal directed with these patients and work within the parameters of your individual practice model. The best method for avoiding the complications of mechanical ventilation is to wean patient completely if possible.

Should weaning prove unlikely then the following recommendations are essential in the ventilator management in patients with clinically significant BPF. Limit tidal volume to between 5-8 ml. / kg ideal body weight. Minimize inspiratory time and MAP if possible. Attempt to maintain an I:E of at least 1:3. Utilize relatively high, (70-100 LPM) inspiratory flow rate. In a MAP reduction strategy; minimize the amount of set PEEP and inspiratory pause time.

Mindful clinical practice would have us experiment with patient positioning. Given the nature of BPF it would make sense that oxygenation would be enhanced or reduced depending on the gravitational effect on the pulmonary capillary bed. Again, the primary goal of mechanical ventilation is to maintain patient stability and to wean from mechanical ventilation as soon as possible.

I must stress that selective intubation, double lumen ET-tubes, independent lung ventilation and HFOV all have enormous potential and should be utilized in a highly contextualized fashion. When in doubt, look at the patient. The mechanical ventilation strategy must be lung protecting and directed at enhancing the healing or repair of the BPF.

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The use of chest tubes in the management of BPF has both potential for benefit and complication. They include the loss of tidal volume, abnormal gas exchange, and asynchronous ventilator cycling. The mindful practitioner will note that the use of negative pressure to the chest tube may increase flow through the fistulous tract and interfere with closure and healing.

If a tension pneumothorax is detected then emergent drainage is required. In the case of pulmonary flooding and hemothorax airway management is the first priority followed by postural drainage with attention towards positioning the affected lung down. Should there be a major bronchial stump dehiscence then immediate re-suture and reinforcement are compulsory. Should the lung remain fully inflated suction pressure on pleural tubes should be minimized.

The area of current interest and rather thought-provoking innovation is in the discipline of interventional bronchoscopy. The therapeutic application of flexible bronchoscopy is gaining appreciation as both a diagnostic and therapeutic modality in patients manifesting BPF. The fiberoptic bronchoscope is used to visualize the track of a BPF associated with pneumonectomy or lobectomy. A more distal BPF requires the use of balloons to systematically occlude selected bronchial segments to locate the fistula. Once located a unique arsenal of sealant substances and stents have been utilized with a great deal of success.

Indeed, there have been a variety of sealing compounds applied directly to the fistula through the bronchoscope. The realization of this approach lies in the notion that most of the "leaks" are quite peripheral or alveolar. Some strongly suggests injecting "absolute ethanol" directly into the sub-mucosal layer of a fistula, under flexible bronchoscopy as a first-line therapy for patients with a postoperative BPF with an orifice < 3 mm in diameter. I can see the billboards now "Absolute and Chest Tubes".

In other interventional procedures a catheter is introduced through the working channel and positioned near the fistula; then acrylate glue is then injected through the catheter into the fistula. There have been water-soluble polyethylene glycol-based gels and sealants activated by a xenon-generated light used to seal BPFs.

The diagnosis and subsequent closure of small BPFs can be accomplished through interventional bronchoscopy and placement of fibrin sealant through the flexible bronchoscope. Interesting to note, that the fibrin glue is eventually reabsorbed, thus impeding foreign body inflammatory response.

Larger BPFs have been treated with the utilization of angiographic occlusion coils, when placed by the interventional brochoscopist accomplish the closure or clinical control of large parenchymal BPFs. The most utilized are the bronchial stents that have been extensively used for the management of esophageal-to-airway fistulas, Stents are also designated for the sealing of stump fistulas and the management of stump dehiscence.

Clearly the role of the interventional brochoscopist is expanding as is the notion of lung protective ventilation strategies. The contemporary clinical practice will employ a comprehensive and individualized therapeutic plan that is created for the unique needs of the patient. The overriding caveat must be to treat the lung gently.

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