Postoperative Pulmonary Complications: Then And Now

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In his publication reprinted from the inaugural issue of the Journal of the Bowman Gray School of Medicine, Dr. Kenneth Cheek provided a seminal review of major postoperative pulmonary problems.[1] Fundamental principles outlined in his report have been validated and remain relevant to current practice. While Dr. Cheek emphasized the importance of atelectasis, pneumonia, and pulmonary embolism, a broader spectrum of concerns has emerged, culminating in new opportunities to enhance care. Technologic progress has provided readily available physiologic information, as pulse oximetry and arterial blood gas analysis reveal hypoxemic and hypoventilatory respiratory failure and guide their management. Unprecedented imaging resources such as computed chest tomography and diagnostic ultrasound have detailed anatomic correlates of functional respiratory derangements.

Although their precise frequency varies with diagnostic criteria, patient populations, and procedure-related factors, postoperative respiratory problems are common (e.g., incidence ranges 2 to 9% for nonthoracic, 8 to 39% thoracic procedures) and have important morbidity, mortality, and impact upon the duration and cost of care.[2-4] These have been included in major quality enhancement efforts of the American College of Surgeons and American Society of Anesthesiologists (ASA), as novel interactions of patient factors and surgical procedural details produce myriad clinical presentations. Enhanced awareness of predispositions and implementation of effective prevention strategies individualized for each patient is paramount. "Classic" patient-related risk factors[5-8] have included advanced age, ASA Class of II or greater, functional dependence, hypoalbuminemia, current cigarette smoking, and the presence of chronic obstructive pulmonary disease or congestive heart failure. Procedure-related factors include the duration of surgery (> three hours), abdominal surgery (as emphasized by Dr. Cheek), thoracic surgery, neurosurgery, head and neck surgery, vascular surgery including aortic aneurysm repair, emergency operations, need for general anesthesia, and nonselective nasogastric tube placement. Prediction rules and computerized tools have incorporated such data to develop more accurate personalized risk estimates of post-operative complications, contributing to essential elements of informed consent. Surgical advances including minimally invasive techniques (i.e. laparoscopy, thoracoscopy) have been key developments as older, more vulnerable patients with multiple comorbidities require surgery. Minimization of risk to whatever extent possible and patient preparation is key, but clarification of the need for and optimum approach to preoperative testing remains necessary. [4-12] Smoking cessation and optimizing treatment of preexisting lung disease are among general recommendations. General use of pulmonary function testing or chest radiography is not advocated, but may be helpful in patients with prior COPD or asthma. While more complex physiologic measures (e.g. cardiopulmonary exercise testing) are available widely, simple observations such as a "cough test" (e.g. whether voluntary cough triggers a paroxysm) and stair climbing (e.g. three flight threshold) retain worthwhile predictive values.[8, 13, 14] The most convincing benefits of preoperative pulmonary rehabilitation programs and inspiratory muscle training occur among high-risk patients undergoing cardiovascular and lung resection procedures[10-12] but the ideal protocol has yet to be defined.

Postoperative respiratory failure is characterized by impaired pulmonary gas exchange, causes high mortality, is probably under-estimated and often leads to prolonged mechanical ventilation, intensive care unit stays, and their synergistic hazards.[2, 3] In one experience, hypoxemic respiratory failure epitomized by the acute respiratory distress syndrome (ARDS) developed in 7.5% of 1,562 at-risk patients, and was associated with sepsis, high risk aortic, vascular and cardiac surgery, emergency procedures, cirrhosis, admission

location other than home, tachypnea, and hypoxemia.[2] Risk-reduction strategies have addressed intraoperative ventilatory and anesthetic management (e.g. use of neuraxial or regional techniques, complete reversal of neuromuscular blockade), parsimonious fluid administration and transfusions, use of less intrusive surgical approaches, shorter procedure duration, avoidance of residual curarization and prevention of surgical site and pulmonary infection. Ventilator treatment has been modified to limit lung injury from barotrauma, volutrauma, and atelectotrauma. Low tidal volume ventilation, associated with improved survival in patients with ARDS, has been associated with improved outcomes when used intraoperatively in patients undergoing abdominal surgery.[15, 16] The value of intraoperative positive end-expiratory pressure (PEEP) is under investigation.[17, 18]

Vigorous efforts to optimize postoperative analgesia while avoiding respiratory depression from over-use of opiates and benzodiazepines are priorities.[19] Recently, sedative premedication with lorazepam compared with placebo or no premedication did not improve the self-reported patient experience, but was associated with prolonged time to extubation and a lower rate of early cognitive recovery[20]. Respiratory care principles defined in other critically ill populations have been extrapolated successfully to postoperative management (e.g., use of noninvasive mask ventilation and lung recruitment techniques, protocolized daily interruption of sedation and liberation from mechanical ventilation using spontaneous breathing trials). The high prevalence and independent lethal impact of delirium applies to postoperative patients [21] as delirium may be a cause or consequence of respiratory compromise. Recognition of obstructive sleep apnea is another newly appreciated priority in preoperative assessment and post-operative care, including the use of continuous positive airway pressure (CPAP).[22] Clinical research at Wake Forest has underscored the value of "lung protective" ventilation, spontaneous breathing trials, and early mobility in mechanically ventilated patients.

Notwithstanding major technologic advances, simple, nonintrusive measures outlined by Dr. Cheek have retained their importance. Early mobilization of the postoperative patient is essential to recruit dependent lung zones and limit atelectasis, and maximizing upright posture (including the still under-used bedside chair) is a key intervention to minimize aspiration risks. Failure to mobilize patients occurs often and has been associated with worsened outcome.[23] While it might be intuitive that routine use of nonpharmacologic airway clearance and lung expansion modalities such as deep breathing, directed cough, postural drainage incentive spirometry and CPAP would benefit nearly all patients, their precise impact remains unclear.[24-30] Cochrane reviews underscore the paucity of data to define optimum roles of these commonly employed treatments, highlighting major opportunities for setting-specific clinical investigation. Not surprisingly, there is extraordinary variability among opinions and practices of clinicians. Heterogeneous patients and surgical procedures present formidable barriers to implement appropriately powered investigations of these modalities. Often the deleterious impact of respiratory complications and relative safety of these measures favor their use despite this suboptimum database.

Atelectasis has been included among time-honored causes of postoperative fever, but most evidence suggests this impression is inaccurate.[31] Its precise temporal relationship to development of infectious pneumonia is unclear and accurate differentiation of these conditions remains challenging. The latter high-risk problem is caused increasingly by virulent multi-drug resistant nosocomial pathogens, reflecting selection pressures of modern antibiotic use in progressively vulnerable patients. Selective use of serologic markers and cultures, occasionally including bronchoalveolar lavage, may have valuable diagnostic roles, and well-established preventive strategies have become essential elements of care.[9, 32]

As underscored by Dr. Cheek, the insidious threat of potentially lethal pulmonary embolism remains a universal postoperative concern. Despite established efficacy of deep vein thrombosis (DVT) prophylaxis, consistent application of validated approaches requires reinforcement. Although most patients with DVT and pulmonary embolism are treated effectively with anticoagulation (including new drugs with improved safety profiles), carefully selected patients may benefit from inferior vena cava (IVC) interruption using novel devices when anticoagulation is unsuccessful, unfeasible, or unsafe. This strategy has been supported by a low grade of evidence [33-37], considerable practice variation exists, and

adherence to guidelines appears low. Some patients with massive pulmonary embolism and continued DVT with major clot burden might benefit, as IVC filter use has been associated with lower mortality.[38-41] Differing appraisals among clinicians about the threat posed by an additional superimposed embolus accentuate the controversy. It is in this context that new data presented by Drs. Potti and Golwyn, [33] in the current Journal illustrates the edifying role of clinical research. In their retrospective review of retrieval rates of removable IVC filters, the authors confirm variable use of these devices, a low frequency of filter removal, and important system-based practices. By identifying patient and physician characteristics associated with non-retrieval, they target areas for future interventions which might enhance clinician performance. Their balanced commentary about risks and benefits of IVC filters also prioritizes increased awareness among practitioners other than those involved directly with device placement, in a true multidisciplinary approach to care. The need for strict monitoring of retrievable filters, especially in trauma patients and in those who receive filters for prophylaxis, is an important observation. Implicit in their message is the principle that the technical feasibility of the procedure and the well-intentioned goal to protect the patient alone do not justify its use. As retrievable IVC filters are placed with increased frequency, [37, 42] their availability contributes to a lower physician threshold to place them: the promise of retrieving the filter might increase clinicians' likelihood to use this device, but short-term benefit might be negated by the real-world failure to remove it.

Despite the seven-decade interval between reports in this Journal,[1, 33] they have noteworthy similarities: each focuses upon the patient, an enhanced appreciation of risks, and the singular importance of prevention in optimizing care. Major technologic progress regarding the spectrum of and predispositions to postoperative respiratory problems has clarified their pathophysiology and improved recognition, monitoring, diagnosis, and treatment. Assuring that simple, universally available bedside information is used optimally remains essential to assessing the patient's respiratory status. As noted by Tysinger in the current Journal,[43] respiratory rate has high predictive values, but measurement of this vital sign is too often unperformed, inaccurate, or underappreciated. Thus multiple challenges and opportunities to enhance care remain, and will continue to require an evidence-based approach incorporating personalized risk:benefit considerations informed by clinical research. Just as some of the treatment modalities outlined by Dr. Cheek have been reaffirmed or displaced by current options (which require yet further study), the endurance of our present approaches will be interesting to observe over time as better options evolve with technologic progress and alterations of clinical practice. In all of these developments, the patient must remain central.

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