Prevention and Treatment of Postoperative Atelectasis

Can It and Will It Be Adequately Studied?

Pulmonary atelectasis is the most common postoperative respiratory complication encountered today, and considerable time and resources are being directed toward its evaluation and management. Treatment modalities which are commonly employed for the prevention or treatment of atelectasis include voluntary deep breathing, incentive spirometry, intermittent positive pressure breathing (IPPB), chest physical therapy, bronchoscopy, aerosol therapy, and more recently, intermittent continuous positive airway pressure (CPAP) by mask. Studies which have attempted to compare or evaluate therapeutic techniques have generally added more confusion than enlightenment because of faulty design and failure to consider the mechanisms, clinical relevance, and natural history of the disorder.

In most patients, the development of postoperative atelectasis is attributable to the absence of periodic deep breaths. This occurs in association with a reduction in lung volumes and expiratory flow rates. Absence of periodic lung expansion also results in decreased surfactant activity which contributes to a reduction in functional residual capacity and to early airway closure. In patients undergoing open heart surgery, the frequent occurrence of lower lobe atelectasis appears to correlate best with phrenic nerve and diaphragm dysfunction. Because of differences in the mechanism of atelectasis, it may be impossible to compare results of therapy in open heart surgery with other abdominal or thoracic procedures.

The natural history of postoperative atelectasis is that spontaneous improvement occurs as periodic deep breathing returns and lung volumes and flow rates increase. Most postoperative atelectasis is not clinically significant and requires no specific therapy. The devotion of extension time and resources to the study of transient and clinically irrelevant postoperative atelectasis is not likely to serve any useful purpose.

Up to 90 percent of patients undergoing open heart surgery will develop roentgenographic evidence of lower lobe atelectasis, usually on the left, but only a small fraction of these patients experience a true clinical complication that justifies specific treatment. Therefore, any study which uses patients with postoperative atelectasis following open heart surgery as a target group must define the clinical relevance of the disease in the group or subgroup of patients studied and must be designed to distinguish the natural course of improvement from the response attributable to the treatment modality. Finally, it is very likely that favorable or unfavorable results of therapy in patients with open heart surgery cannot be translated to other surgical patients because of differences in the pathophysiology of the disease.

It is critical in the design of any study of postoperative atelectasis that results of prophylactic treatment to prevent atelectasis be clearly separated from treatment of atelectasis once it has occurred. Although there are known risk factors for the development of postoperative complications, it is extremely difficult to apply these factors to any individual patient. Any patient who is willing or able to take deep breaths and who has an inspiratory capacity that exceeds 1 L, usually needs no other lung expansion procedure for preoperative or postoperative prophylaxis. Incentive spirometry is useful to document the size of the breath, and therefore, these devices should be designed to measure volume with reasonable accuracy.

A major question in the management of postoperative atelectasis is how to determine the most appropriate therapy for those patients who develop clinically significant atelectasis despite the appropriate use of spontaneous deep breathing maneuvers or in association with an inability or unwillingness to breathe deeply. "Clinically significant atelectasis" usually means atelectasis which is persistent or progressive and which is associated with significant hypoxemia, increased work of breathing or other identifiable distress to the patient. The majority of patients who develop symptomatic atelectasis are unable or unwilling to perform spontaneous deep breathing maneuvers; and, in fact, those persons who can adequately perform spontaneous deep breathing maneuvers represent an entirely different subgroup for study. The bottom line is that lung volumes, such as tidal volume, inspiratory capacity, or vital capacity, must be monitored, both to identify and establish study groups and to evaluate results of therapy. Without attention to the measurement of inspired volumes, no investigation can ever answer the questions which relate to which...
deep breathing modalities are necessary or effective in managing postoperative atelectasis. Such measurements are also important in prescribing the best possible therapy for each patient; however, a recent national survey indicates that lung volume measurements are being made in only 21 percent of hospitals where lung expansion maneuvers are being ordered for the management of postoperative atelectasis. 6

There is currently an increasing interest in the use of intermittent CPAP by mask to possibly prevent or treat postoperative atelectasis. This approach to therapy is based on periodically increasing FRC rather than increasing inspiratory capacity. It has the advantage that patient cooperation is not necessary, though sometimes there may be lack of patient acceptance. It is impossible to say at this time whether or not intermittently increasing FRC is as effective as periodic deep breathing in treating atelectasis, but there is certainly no evidence that CPAP is necessary or useful prophylactically in patients who can voluntarily take deep breaths. Intermittent CPAP has the potential for abuse, and if not properly studied, it could be considerably misused in the future. Recent data indicate that intermittent CPAP is now being used in approximately one-fourth of all United States hospitals where major surgery is performed. 6

A final plea to investigators and to anyone reviewing research protocols for the study of postoperative atelectasis is to clearly define the study groups by: (1) separating prophylactic from therapeutic procedures, (2) focusing on patients with clinically significant atelectasis rather than transient and self-limiting dysfunction, and (3) measuring inspired volumes to identify and classify patients according to their ability to perform deep breathing maneuvers. Lung expansion maneuvers must be provided frequently enough to be effective, initially as often as every one to two hours during the waking hours. Any treatment that is given less frequently is not likely to be adequate for reexpansion of refractory atelectasis. Documentation of CPAP pressures, duration, and frequency of use and changes in FRC or vital capacity are necessary in studies which include CPAP as a means of treating atelectasis. Because of the multiple variables, both in patient groups and in treatment modalities, it appears that definitive data can best be obtained with well-designed multicenter clinical trials. At the present time, there is no specific answer to the very important question of when and how to best treat patients with postoperative pulmonary atelectasis.

Walter J. O'Donohue, Jr., M.D., F.C.C.P.
Omaha

Division of Pulmonary Medicine, Creighton University School of Medicine.
Reprint requests: Dr. O'Donohue, Creighton University Health Center, 601 North 30th Street, Omaha 68131

References


Least PEEP: Primum Non Nocere

There is considerable controversy regarding the proper level of positive end-expiratory pressure (PEEP) to use for patients with the adult respiratory distress syndrome (ARDS). Some authors suggest the best PEEP level is that which produces the greatest oxygen transport. 1 Others suggest that PEEP should be increased until the shunt is reduced below 15 percent, 2,3 the arterial-to-end-tidal carbon dioxide gradient is lowest, 4 the mixed venous oxygen tension falls, 5 or the minimal fraction of inspired oxygen is reached. 6 Since no clinical studies have compared the effects of PEEP adjustment using these various endpoints, choosing between these approaches is difficult. Recently, some new adverse effects of PEEP have been described. When added to the well-known complications of PEEP, an additional approach to PEEP adjustment is suggested.

Positive end-expiratory pressure is known to decrease shunt and improve midrange ventilation-to-perfusion homogeneity. However, with PEEP greater than 10 cm H2O, high ventilation-to-perfusion areas can develop and dead space can increase, despite a reduction in shunt. 7,8 This would result in less efficient gas exchange and require minute ventilation to increase in order to maintain a constant CO2 elimination.

Contrary to earlier reports, PEEP has been found to increase lung water. 9,10 This effect may result from a PEEP-induced decrease in the extra-alveolar interstitial hydrostatic pressure which would raise the transmural pressure and transvascular fluid flux across these vessels. 11,13

Positive end-expiratory pressure is known to reduce cardiac output primarily by increasing intrathoracic