

Postoperative Ventilatory Care*

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Postoperative ventilatory care implies that some significant percentage of surgical patients cannot breathe adequately in the postsurgical state and need to be appropriately assisted in order to do so. It further implies that there may be some difficulty in or complication resulting from such care. Both implications are correct.

However, if we are to deal effectively with this problem, that is, if we are to correct some defect in a physiologic fashion, we must understand how postoperative ventilatory mechanisms and physiology are upset.

While many forces, both pre- and intra-operative, come to bear on the immediate postoperative ventilatory status of the patient, the common denominator in virtually all instances is hypoventilation. Unfortunately, for the patient's sake, this physiologic abnormality occurs at a time when normal protective reflexes and a fully alert state of consciousness are wanting. For some hours, or even days, the patient exists in a physiologic "twilight zone"—neither surgically anesthetized nor fully capable of protecting himself from his environment.

What causes this hypoventilation? Obviously, many factors related to both the anesthesia and the surgery are responsible.

Every known general anesthetic, barbiturate, narcotic, sedative, and tranquilizer is a central nervous system depressant, and in sufficient dose will depress ventilation. Muscle relaxants, which frequently produce a greater effect in the immediate postoperative period than we think they do, impair ventilation by their action. In addition, anesthesia even of relatively brief duration, predisposes toward the development of diffuse, generalized micro-

atelectasis. A series of blood gas analysis routinely performed on young, healthy women immediately following elective uncomplicated D&C will soon convince even the most skeptical that something is amiss in the efficiency of breathing. Arterial oxygen tension in these circumstances is almost invariably depressed, even when the PCO_2 is normal. Now, add to this array of abnormalities the fact that some anesthetics produce a degree of metabolic acidemia, and that this in turn will adversely affect the metabolism and pharmacologic reversal of certain relaxants. The stage is now set for a potential disaster.

Next come the adverse effects of surgery. The immediate postoperative effects on pulmonary functions of elective upper abdominal surgery are typical. The patient is in pain; he splints; he typically breathes rapidly, but shallowly. He either cannot or will not take a deep breath, and therefore, cannot cough effectively. Secretions tend to accumulate, and we have another reason to develop atelectasis.

The upper abdominal procedure is more depressant to the postoperative vital capacity than the lower abdominal operation. Non-abdominal (and non-thoracic) procedures are not associated with any significant change in pulmonary function related to the surgery per se.

The type of anesthesia, whether conduction or general, has considerably less influence on the adequacy of postoperative coughing ability than does the anatomic site of surgery. Upper abdominal operations are in fact slightly more debilitating in this regard than are intrathoracic procedures, so long as actual lung tissue is not excised.

The highest incidence of postoperative pulmonary complications occurs in elderly patients, as might be expected. Even though these data are 25 years old, the situation has not changed markedly as far as the upper-age groups are concerned. Postoperative pulmonary complications are also more

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likely to occur in obese patients, in chronic cigarette smokers, and (although not agreed upon by all investigators) seem to increase as the duration of anesthesia and surgery increase. Needless to say, the existence of significant preexisting pulmonary disease raises the probability of postoperative problems.

Preoperative abnormalities in vital capacity and the FEV₁ are related to the operative risk. When the preoperative vital capacity is less than 80% of the predicted, or when the FEV₁ is less than 60% of the total vital capacity, or especially when both of these abnormalities coexist, the risk of surgery and anesthesia, particularly surgery of the upper abdomen, increases tremendously.

Let us consider an example which is not unusual and, indeed, is being seen more and more frequently by those of us with a busy clinical practice. A 50-year-old, 210-pound male, who has smoked a pack and a half of cigarettes a day for 25 years comes in for elective vagotomy and pyloroplasty. After three hours of nitrous oxide, oxygen, halothane, and curare relaxation he arrives in the recovery ward. His tidal volume is 350 ml, his vital capacity is 600 ml, his PaO₂ is 53, his PaCO₂ is 49, and his pH is 7.29.

Let us be sure that we delineate the problem accurately: The question is not, "Will this patient develop significant hypoventilation and, finally, respiratory failure?" The question is, "When?" He is already seriously hypoventilating, is hypoxemic, and is developing a respiratory acidemia. He is overweight and probably has significant chronic bronchitis. All too frequently, we see this patient who becomes febrile within 24 hours of surgery and develops pneumonia. His hospitalization is prolonged, his convalescence complicated, and he has inherited an increased risk of mortality. He has joined that ever growing group of patients who share the most common of all postoperative problems—pulmonary complications.

Knowing that anesthesia may impair ventilation, knowing that surgery adds insult on top of injury to the breathing mechanism, and knowing that preexisting lung disease adds two strikes before surgery is even contemplated, one cannot escape the clear indication for prophylaxis. Indeed, the hallmark of postoperative ventilatory care is preoperative pulmonary preparation. It is now clearly demonstrated that appropriate pre-, intra- and postoperative care of patients with chronic pulmonary

disease can result in morbidity and mortality rates similar to those in patients with no pulmonary disease, treated in the usual fashion, that is, largely ignoring the pulmonary system unless complications occur.

Preoperative pulmonary preparation requires that someone, usually the operating surgeon or the initial referring physician, be aware that the patient has some respiratory difficulty, either potential or existent, and that this difficulty poses a threat to his postsurgical survival. With this in mind, the following preoperative program is suggested:

Which diseases or symptoms should concern us?

- a) Acute respiratory infection obviously should be eliminated prior to elective surgery. In the emergency case we have to go ahead with anesthesia and surgery, and this is acceptable, but it increases the risk for the patient. Otherwise elective surgery should be postponed.
- b) Chronic bronchitis—a history of cigarette smoking, cough with production of sputum, especially purulent sputum, is enough to make the diagnosis of this disease.
- c) Emphysema—this disease cannot be cured or even reversed to any great extent, but it is often associated with considerable bronchial spasm and/or infection, both of which should be eliminated or decreased in severity prior to anesthesia.
- d) Asthma—we are concerned here with the patient who is actually wheezing with dyspnea. These patients should be rendered symptom-free prior to elective surgery if at all possible.
- e) Bronchiectasis—these patients always produce sputum. They must be able to cough and hopefully should not get superinfection.
- f) Dyspnea as a symptom should never be ignored. Its origin may be either respiratory or cardiovascular. The system which is responsible for its genesis should be determined and evaluated as to the actual diseases present. This is obviously easier said than done, but in the presence of uncompensated heart failure, vigorous diuresis is a relatively benign yet fairly effective way to improve this situation.

How do you diagnose these diseases? The points in physical and clinical diagnosis are not needed in this discussion as they are no doubt

well appreciated by all of us. What is needed, I think, is one simple reminder. We must consider smouldering, lingering, or occult pulmonary disease in each patient we contemplate sending to surgery. We must suspect it and look for it, otherwise somebody will develop a serious pulmonary complication or perhaps die in the postoperative period—somebody who would otherwise return to some years of further productive life. The presence of cough with yellowish or greenish sputum regardless of how scant in quantity, means pulmonary infection, bronchitis probably, but perhaps bronchiectasis.

"All that wheezes is not asthma," is sound albeit aged advice. On the other hand, wheezing should suggest asthma since this disease cannot exist without this sign.

Obstructive airways disease carries greater postoperative morbidity than does restrictive disease due to the limited ability of effective coughing. A quick, fairly reliable, and quite unsophisticated qualitative appraisal of airway obstruction is the match test. The one-second and 0.5-second FEV₁, or timed vital capacity, is obviously more accurate. A point to remember is this: Severe emphysema and bronchitis can exist in the presence of a normal chest x-ray and with no increase in anterior-posterior diameter of the chest. Do not rely on these signs as the tip-off to the presence of pulmonary disease.

The relationship of pulmonary function tests and arterial blood gases to postoperative prognosis. Pulmonary function studies such as vital capacity, timed vital capacity, and maximum mid-expiratory flow rate are sensitive but not specific tests (they may be abnormal in all who do poorly postoperatively, but they also may be abnormal in those who do well). The PaCO₂ is quite specific but not particularly sensitive as it invariably predicts postoperative difficulty if elevated preoperatively. But the patients with this abnormal test in the preoperative period are very few of all those who are operated upon. Both the pulmonary function test plus the blood gas analysis and the response of both of these to preoperative respiratory preparation are the best indication of the postoperative course and the patient's tolerance of surgery and anesthesia.

How do we prepare the patient for surgery? Once the diagnosis of pulmonary disease is made and some quantification of this function is achieved, our entire efforts are aimed toward one simple goal—getting the patient in as good a shape as possible before surgery. Regardless of the severity

of his pulmonary disease we should be satisfied that he can be improved no further before elective surgery and anesthesia is undertaken. This includes:

- a) the eradication of acute infection
- b) the control of chronic infection
- c) the relief of bronchial spasm
- d) an improvement in the sputum clearance and bronchial drainage
- e) the reversal of uncompensated congestive heart failure on the basis of cor pulmonale, if such is present.
- f) all steps to improve muscular power for coughing and deep breathing (nutrition, electrolytes, and humidification of airway)
- g) a familiarization with inhalation therapy equipment likely to be used in the postoperative period, ventilators, etc.
- h) a familiarization with chest physiotherapy techniques for effective coughing, sputum production, and exercises.

Even if all this produces little detectable improvement in the patient, we have the advantage of knowing that his disease is largely irreversible and that his tolerance for extensive surgery and prolonged anesthesia will be minimal.

What is the best anesthetic technique or agent?

It has been repeatedly demonstrated that the drug used or the technique employed in producing anesthesia for such patients is of considerably less importance than is the skill with which the particular drug or technique is applied. In other words, the anesthetic is not what is important, it is the anesthesiologist.

What are the details of postoperative care?

This is a continuation of the preoperative regime, that is:

- a) awareness of the possibility of complications and actively looking for them.
- b) maintenance of adequate alveolar ventilation (as determined by arterial blood gases) without excessive energy expenditure (measurement of tidal volume, vital capacity, minute ventilation, and frequency of ventilation).
- c) maintenance of an unobstructed airway. An endotracheal tube may be used in these circumstances if needed.
- d) meticulous STERILE tracheobronchial suction as necessary.
- e) *effective* humidification—both in the airway and parenterally.

- f) frequent chest physiotherapy to help in coughing, deep breathing, and secretion removal.
- g) establishment of assisted ventilation if pulmonary function tests and arterial blood gases deteriorate beyond a certain point, or if one has reason to *think* that they will deteriorate beyond a certain point, that is, a PaCO_2 above 50, a PaO_2 below 200 on 100% oxygen, a tidal volume less than 3 ml per kg, a vital capacity less than 10 ml per kg, or a respiratory frequency of greater

than 35 per minutes in adults.

If the possibility of preoperative pulmonary disease is suspected; if it is diligently sought for; if a degree of functional impairment as well as pathologic diagnosis is established; and if the patient is rendered as symptom-free as possible with respect to infection, sputum clearance, ability to cough, and freedom from bronchial spasm, he will tolerate his surgery and anesthesia as well as modern medical care can allow him to. And if postoperative ventilatory care is necessary, it will be anticipated and utilized appropriately.