Minimizing the Risk of Bronchoscopy During Mechanical Ventilation

Pneumonia is an important cause of respiratory failure in immune-compromised patients. In addition, nosocomial pneumonia is commonly observed in patients undergoing mechanical ventilation for noninfectious respiratory failure. Accurate diagnosis and treatment of lower respiratory tract pathogens is crucial to a favorable outcome. In recent years, transbronchoscopically obtained specimens, including bronchoalveolar lavage (BAL) and protected-specimen-brush samples with routine or quantitative cultures, have been found useful in making a specific diagnosis in such cases.\(^\text{1-3}\) Performing these procedures may cause deterioration in gas exchange due to ventilation-perfusion mismatch caused by introduction of the bronchoscope, as well as to the creation of additional intrapulmonary shunting after BAL. Because increasing numbers of patients are undergoing these invasive procedures, it is important to establish the incidence and clinical importance of their complications.

In this issue of Chest, Papazian et al (see page 1548) describe the hemodynamic and gas exchange effects of obtaining consecutive protected-specimen-brush and BAL samples in 12 patients with respiratory failure. There were minimal effects on hemodynamic measurements, and modest decreases in oxygenation were observed. Previous studies involving larger numbers of critically ill intubated patients undergoing bronchoscopy with or without BAL also indicate that in most patients oxygenation was adversely affected to a modest degree; however, more pronounced reductions in oxygenation occurred in some patients.\(^\text{4,6}\) In our series of 99 consecutive BAL procedures, for example, widening of the alveolar to arterial oxygen gradient by more than 100 mm Hg, lasting up to 4 h after the test, was observed in 13 patients. Our data did not allow us to conclusively determine whether these decreases were directly related to the effects of BAL or were instead due to progression of the underlying disease process.

Careful prebronchoscopy screening must be performed to exclude patients judged to be at high risk for deleterious effects on gas exchange and hemodynamics.\(^\text{4,6}\) These include patients with hemodynamic instability despite large doses of inotropic-support agents, patients whose \(P_{\text{a}}\)O\(_2\) cannot be elevated above 60 to 70 mm Hg at an FIO\(_2\) of 1.0, and those with active bronchospasm. In addition to careful patient selection, the methods used to perform bronchoscopy are important to minimize risk. Bronchoscopy and related procedures should be completed in less than 5 to 7 min. Patients should be heavily sedated and, when necessary, paralyzed with neuromuscular blocking agents to eliminate agitation and cough during the procedure. Finally, the bronchoscope should be introduced via an airtight connector to preserve positive end-expiratory pressure and minimize leakage of inspired air.

It is important to recognize that despite all precautions a relatively small proportion of critically ill patients undergoing bronchoscopy will experience a prolonged and/or clinically significant reduction in oxygenation. At this point it is not clear whether this is directly due to shunting in the area of lavage, to more remote effects of BAL on global lung function due to release of cytokines and other mediators, or to progression of the underlying pulmonary condition independent of the procedure. Regardless, after bronchoscopy in critically ill mechanically ventilated patients, the FIO\(_2\) should be decreased slowly while monitoring oxygen saturation to ensure adequate oxygenation.

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References

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"You See but You Do Not Observe"

Physicians have traditionally relied on the use of trained eyes and ears for accurate medical diagnosis, skills that are no less important since the advent of technologic aids in evaluating structure and function. Yet, seeing and hearing are not enough. A visual or auditory image must be processed; compared to remembered images, searching for recognizable patterns; and, not finding them, interpreted in light of a base of knowledge of structure and function. When Holmes says, "My dear Watson, you see but you do not observe," it is very likely the echo of Sir Joseph Bell chiding the young Conan Doyle, a medical student at the University of Edinburgh, for missing another diagnosis. Observing is processing. It is the processing of visual and auditory images that is crucial, not simply seeing and hearing.

For over 185 years, physicians have been struggling to process the sounds emanating from the chest in order to better assess the alterations in structure and function of the patient. They have struggled even more to transmit their understanding of these sounds to naive, willing, but disbelieving students. Anyone who has tried to instruct students in the interpretation of lung sounds heard through the stethoscope remembers the frustration and hand waving. A picture is worth a thousand words, but the abstract nature of sound and smell compared to vision severely limits the transmission of appreciation of these sensations to another in any but the crudest form. Having struggled first with the unaided ear, then with a wooden cylinder, and more recently with a plastic diaphragm, even in a stereo configuration, physicians have either abandoned the stethoscope in favor of expensive technology or have sought better ways of listening. Some investigators have resorted to application of digital electronics to perform the processing, so that objective images can be shared.

The time has come to place lung sounds analysis on an objective scientific basis. To do so requires (1) standardization of procedures and processing, (2) development of testable theoretical models that account for acoustic behavior and interactions of relevant structures, and (3) experimental validation of theoretical models in physiologically and structurally quantifiable models of disease. Only then will the acoustic images that are generated accurately reflect structure and function so that they can be shared as objective evidence with colleagues and students for the welfare of patients. Pasterkamp et al, writing in this issue of Chest (see page 1518), are to be congratulated for leading the way in achieving the first goal, the standardization of acoustical measurements.

They have demonstrated, using sophisticated signal-processing techniques, that even after standardizing measurements for airflow rates and normalizing to background noise, there are important differences in sound spectra that depend on the choice of sensor, the subject, and the type of "window" used to smooth the data. There was even a substantial difference between two sensors of the same manufacturer.

Air-coupled sensors (microphones) and contact sensors had similar signal-to-noise ratios, but the former severely attenuated sounds about 600 Hz and would be inappropriate for analysis of sounds above this level, such as those from the trachea and possibly from peripheral airways. This problem is inherent in the design of an air-coupled sensor, probably resulting from damping of the higher frequencies in the air chamber. As one might have guessed, the sensor that performed the best at all frequencies up to 2,000 Hz was the most expensive and most fragile. Nevertheless, these results identify the need for minimum standards in sensors used for respiratory sounds analysis, standards that should include not only an optimal signal-to-noise ratio at all relevant frequencies but also robust design and affordable price. It should also be observed that free-field standardization, which is generally reported by the manufacturer, is insufficient characterization of a sensor that will be used directly or indirectly coupled to the chest wall.

One of their subjects exhibited a signal-to-noise ratio more than 50 percent better than those of the other two, a difference that reportedly could be readily appreciated as increased intensity heard with a stethoscope. This finding suggests that standardization of the intensity and frequency of sound input are important, so that such observed differences can be better related to structure rather than differences in sound generation. Further studies will be needed to determine whether sensor position should also be uniform.