


6 Meduri GU, Chastre J. The standardization of bronchoscopic techniques for ventilator-associated pneumonia. Chest 1992; 102(5[suppl 1]):S575-S64S

**"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.
The investigators sampled respiratory sounds when airflow rates were 1.5 to 2.5 L/s. Such flow rates will generally be achieved during tidal breathing in healthy men, but are unlikely to be achieved in smaller individuals, such as young women and children, or in those with airway pathology that introduces flow limitation. Pasterkamp et al suggest, as one method of standardizing this parameter, that flow rates be normalized to body weight. Since tidal volume scales with body weight from infancy through adulthood and inspiratory time is approximately constant over the age span, flow rate will be constant when normalized to body weight. On the other hand, origins of sounds are sufficiently uncertain and the structures through which those sounds travel are sufficiently different between adults and infants that standardization of the input sound seems to be a better alternative than using naturally generated breath sounds.

Once standardization is achieved, what can we anticipate from lung sounds analysis? Based on the theoretical framework that altered structure (which affects function in definable ways) will perturb sound transmission in predictable ways, it should be possible to provide a quantitative analysis of underlying pathology. This analysis can be expected to identify the extent of replacement of normal structures with abnormal where the abnormalities affect compliance of airways and tissue around alveoli. The measured variables are likely to be regional power as a function of frequency and transmission times in various regions. The latter estimates might be aided by application of matrix analysis applied to signals obtained from a grid of sensors following introduction of a standard sound source at the airway opening. Here again, use of a standard sound input rather than naturally generated breathing sounds will be advantageous. What remains to be seen is the quantitative relationship between measured change in structure and altered intensity or time of transmission as a function of frequency as well as the spatial resolution of the method. Certainly the signal-to-noise ratios in the range of 25:1 or better, reported in the present study, offer hope of success.

Since the chief goal of signal processing of respiratory sounds is improved diagnosis, studies of model diseases in man and animals should progress in parallel with theoretical models as soon as standardization has been achieved.

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REFERENCE
1. Doyle AC. Adventures of Sherlock Holmes: adventure 1—a scandal in Bohemia. Strand Magazine 1891; 2(July):61-75

Aerodigestive Manifestations of Gastroesophageal Reflux
What We Don't Yet Know

A decade ago, I first became aware that gastroesophageal reflux (GER) disease could cause aerodigestive, particularly laryngopharyngeal, symptoms and complications in patients who denied having heartburn and regurgitation. Instead, these patients often complained of hoarseness, cervical dysphagia, globus pharyngeus, chronic throat clearing, and cough. It now seems clear that patients with laryngopharyngeal GER also may be prone to develop other respiratory conditions, including unexplained chronic cough, tracheitis, bronchitis, and asthma.

Interestingly, the issue of GER-related respiratory conditions has created a schism in the medical community: there are both proponents and opponents of the concept that GER disease may play a causal role in these conditions. This dichotomy appears to be due to the fact that we lack ideal diagnostic methods to define the mechanisms and patterns of GER in such cases. Fortunately, three things have changed in recent years: (1) ambulatory 24-h double-probe pH monitoring (pH-metry) is available; (2) omeprazole is available; and (3) as a result of these diagnostic/therapeutic tools, new data are beginning to confirm some previously controversial clinical observations:

1. In patients with aerodigestive manifestations of GER disease, reflux may be unassociated with esophagitis or its symptoms. (In a series of patients with chronic unexplained cough studied by diagnostic pH-metry, I reported that only 16 percent had heartburn more than once a week; however, 55 percent had abnormal pH-metry, and 83 percent responded to antireflux treatment.)

2. The pattern of GER disease in patients with pulmonary and laryngopharyngeal reflux is often chronic-intermittent, so that any and all currently employed diagnostic tests for GER sometimes may be falsely negative.

3. The tissue damage that results from GER is primarily due to the effects of pepsin, and 70 percent of peptic activity is maintained at pH 4.5. This may, in part, explain why the medical treatment failure rate with H2 blockers is much higher than expected in such patients.

4. With the current state of the art, one of the best diagnostic tests for GER-related aerodigestive conditions would be a therapeutic trial with omeprazole. Unfortunately, for this purpose, it must be prescribed in larger doses and for a longer period of time than recommended by the Food and Drug Administration.

All of this uncertainty poses a dilemma for the clinician: how to diagnose and manage patients with