INHOMOGENEITY OF THE TIMING OF LUNG SOUNDS IN PATIENTS WITH CHRONIC OBSTRUCTIVE LUNG DISEASE

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PURPOSE
To determine if time based parameters of lung sounds differed in patients with chronic obstructive lung disease (COPD) as compared to normal subjects.

MATERIALS AND METHODS
COPD Patients were selected from the practice of pulmonary specialists as well as from inpatients with a clinical diagnosis of COPD. The normals were volunteers who had no history of lung disease. COPD (n=62, age: 70±11) and normal (n=42, age: 71±9) subjects entered into this study were examined with a 16-channel lung sound analyzer (Stethographic Model STG180D). For ease of application 14 microphones were incorporated into a foam backpack as shown here.

The backpack was covered with a custom made disposable interface intended to transmit sounds but to prevent transmission of pathogens to the backpack. The backpack was positioned on a stretcher or a plastic reclining chair and subjects were instructed to lie on the backpack with their back toward the backpack. One microphone was used to record tracheal sound and one microphone was used to record heart sounds. The entire STG System unit was mounted on a small utility cart for convenient use in patient rooms. Twenty second samples of data were collected during deeper than normal breathing.

EXAMPLES OF TYPICAL RESULTS

NORMAL

COPD

The figure above compares sounds obtained from a normal subject and a patient with COPD. Vertical lines mark the start and the end of inspiratory sound recorded at the trachea. Arrows indicate the start and the end of the inspiratory sound at channel 1. Notice that in the normal subject the inspiratory sound starts and ends at almost the same time at all the chest sites as well as the trachea. In other words inspiratory sound is homogeneous among chest sites and the trachea. In COPD inspiratory lung sounds at the chest sites tend to start earlier than the inspiratory sound at the trachea. In addition, inspiratory lung sounds at the chest sites tend to end later than the inspiratory sound at the trachea.

To quantify inhomogeneity phenomena the lung sounds from 14 channels were band pass filtered between 50Hz and 400Hz. The tracheal sound was band pass filtered between 500Hz and 3000Hz. A running average of the absolute value of the time amplitude signal for each microphone was calculated. The start of inspiration at every location including trachea was defined as the time when the signal just exceeded 20% of its maximum level. The end of inspiration was defined as the time when the signal just dropped below 20% of its maximum value. The thin green line under each channel waveform indicates the duration of inspiration at that channel as automatically identified by the STG software.

In addition, the time of the start of inspiration at the trachea was subtracted from the time of the start of inspiration at each chest wall site. Similarly the time of the end of inspiration at the trachea was subtracted from the time of the end of inspiration at each chest wall site. The means of 14 time differences for the start and end was expressed in percent of the duration of the inspiration at the trachea to calculate the start of inspiration inhomogeneity (SI) and the end of inspiration inhomogeneity (EI) respectively.

DISCUSSION
• The fact that acoustic energy appears over the chest wall before it appears at the trachea in COPD patients suggests that decreased elastic recoil is present in these patients.
• The fact that the start of the inspiratory sound varies from site to site suggests that elastic recoil also varies from site to site.
• We studied the relationship of adventitious sounds to the inhomogeneity and found little correlation.
• A larger number of subjects should be examined to clarify the relationship of this inhomogeneity to pulmonary function and its correlation to measurements of regional ventilation should be studied.

CONCLUSION
The results of this preliminary study appear to show that acoustic phenomenon of inspiratory sound inhomogeneity that can be measured by computer differ in patients with COPD as compared to normals.