LOCALIZATION AND 3-DIMENSIONAL DISPLAY OF LUNG SOUNDS
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BACKGROUND
A principal advantage of lung auscultation is that regional information on pathophysiology is obtained. Abnormal sounds may be heard over localized areas of pneumonia and unilateral decreases in sound intensity are observed in pneumothorax, pleural effusions and bronchial obstruction.

The precise location of origin of lung sounds, however, is not well understood. Accordingly, we devised a method for detecting their location. The rationale for this effort is the belief that a more exact knowledge of their site of production would aid in the correlation of the sounds with normal and pathophysiologic processes that produce them and thus enhance their use in noninvasive diagnosis of pulmonary disorders.

PURPOSE
To examine the relationship of the origin of lung sounds to disease processes in the lung.

MATERIALS AND METHODS
We utilized a 16 channel lung sound analyzer (Stethographs, Model STC16012) to detect and display lung sounds in 3 dimensions. The device uses arrival time differences of sound at the microphones to calculate the location of origin of the sounds.

A soft foam pad with acoustic chest pieces imbedded in it was placed on the backs of the subjects while they were lying in the supine position.

LOCALIZATION

This figure shows that crackling sounds are transmitted through the chest. Consider the most prominent crackle on channel 6 in the center of the expanded waveform (indicated by a long thick arrow). One can recognize crackles at channels 3, 4, 5, and 7 that occur at the same time (indicated by long thin arrows). These crackles are related. They likely represent the same event of airway opening.

We say that these crackles form a family of crackles, the crackle with the highest deflection (at channel 6) called the mother crackle and the corresponding deflections at other channels are called daughter crackles. In this patient the crackle was transmitted throughout a considerable area on the chest. As a rule of the thumb crackles in patients with CHF are transmitted over an area about the size of the palm.

RESULTS
Sound origin as detected by the STC correlated with chest X-ray and CT analysis in patients with focal tumors, bronchietatitis, and pneumonia. The noise of a suction catheter in the right main stem bronchus was also accurately localized by STC.

APPLICATIONS
Potential applications include:
▷ Determination of site of suction catheters, site of mucus plugging.
▷ Location of pneumonia.
▷ Improving knowledge about the mechanism of normal and abnormal lung sound origin.

CONCLUSION
3D displays of lung sounds correlate with chest X-ray and CT in certain lung conditions. This provides a noninvasive means of examining the nature and course of these conditions.