CRACKLE POLARITY IS INFLUENCED BY RESPIRATORY PHASE
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BACKGROUND
Crackles are intermittent explosive sounds that are associated with a number of pulmonary disorders including Interstitial Pulmonary Fibrosis (IPF), Congestive Heart Failure (CHF), and Pneumonia (Pn).
The mechanism underlying crackle generation is poorly understood. The working assumption is that sudden airway opening is responsible for inspiratory crackles and airway closing is responsible for expiratory crackles.
Fredberg and Holford postulated that crackles were due to a stress relaxation quadrupole associated with sudden airway opening and closing. Their model predicted that the polarity of expiratory crackles would be the reverse of inspiratory crackles.

PURPOSE
The goal of this research was to examine systematically the relationship between crackle polarity and respiratory phase to test the hypothesis of Fredberg and Holford.

METHODS
Patients with pneumonia, congestive heart failure, and interstitial fibrosis (n=165) were examined using a multichannel lung sound analyzer (Sishtographics Model 1602).
Crackles were defined in accordance with accepted criteria. Inspiratory and expiratory crackles were counted separately.
To be accepted into the study either the inspiratory or the expiratory crackle count had to be greater than 2 crackles per breath.
Eighty five patients with Pn, 58 with CHF, and 22 with IPF were included in this study.
Crackle polarity was defined positive if the largest deflection was upward. Crackle polarity was defined negative if the largest deflection was downward. (See Figure 1.)

RESULTS
[Table 1. Crackle polarity as a function of respiratory phase]

CONCLUSION
[Table 1. Crackle polarity as a function of respiratory phase]

REFERENCES

Fig. 1. A shows a sound waveform recorded from a patient with pneumonia in the retrocardiac region. The acoustic sensor was located on the left posterior chest over the area of infiltration. The waveform shows one full breath. Crackles are marked by 'c'. Note that during inspiration crackles are superimposed on normal vesicular lung sounds.
Fig. 1B. In this figure, the sections between the long arrows are time-expanded to show the details of the crackle waveforms. The largest deflections in the inspiratory crackles are upward (triangles, Fig.1B left, positive polarity), while the largest deflections in the expiratory crackles are downward (triangles, Fig.1B right, negative polarity). In this patient, all inspiratory crackles (total of 11 crackles or 2.8 inspiratory crackles per breath) had positive polarity, and all expiratory crackles (total of 5 crackles or 1.38 expiratory crackles per breath) had negative polarity.