THE RELATIONSHIP OF LUNG SOUND AMPLITUDE AND DURATION TO VOLUME AND FLOW

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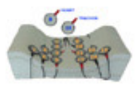
PURPOSE

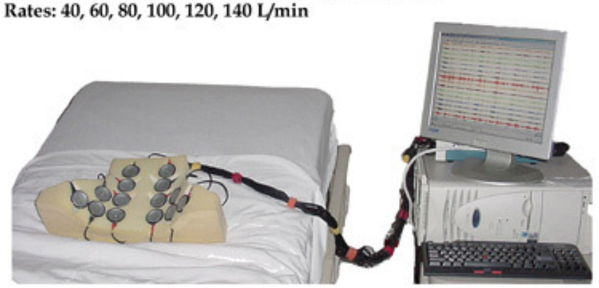
The purpose of this investigation was to determine whether variations in lung sound amplitude and duration measured over the chest wall reflected variations in tidal volume and flow rate delivered by a positive pressure ventilator.

METHODS

<> 16 channels: 14 over the posterior and lateral chest, 1 over the trachea, 1 over the heart.
<> Gentex microphones imbedded in stethoscope chest pieces.
<> Chest pieces imbedded in soft foam pad.
<> Subjects sitting upright in a chair.
<> Custom software (Stethographics, Inc).



<> Tidal volumes of 400, 800, AND 1200 cc's were respired
<> Flow Rates: 40, 60, 80, 100, 120, 140 L/min



SOUND AMPLITUDE MEASUREMENT

<> Acoustic power (Root mean square value i.e. RMS) was calculated automatically by the computer.
<> Acoustic energy was calculated by multiplying RMS values by the inspiratory time at the trachea.

<> *Caution*: RMS reflects all sounds including crackles, wheezes and artifacts. Therefore in this study only sounds free of crackles, wheezes and artifacts were analyzed.

RESULTS

<> RMS increased with increasing flow at each input tidal volume at the trachea and all chest sites.
<> At tidal volumes of 400 and 800 cc's (physiologic range), the relationship of RMS x time of inspiration to flow at each chest site was flat despite changes in flow.
<> RMS x time increased with increasing tidal volume.

EXPIRATORY RMS AND RMS x TIME

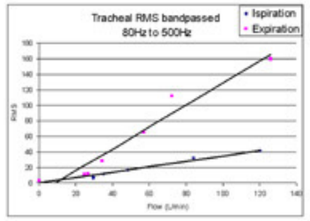
The RMS and RMS x TIME of the expiratory sound was unrelated to the input flow and volume (Data not shown).

RELATIONSHIP BETWEEN FLOW AND SOUND AMPLITUDE

SPONTANEOUS BREATHING

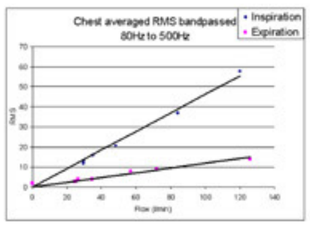
RELATIONSHIP BETWEEN FLOW AND RMS AT THE TRACHEA.

The subject was asked to breath freely at different flows. Note that expiratory sound is louder than inspiratory sound. Note the linear relationship between the RMS and the Flow.

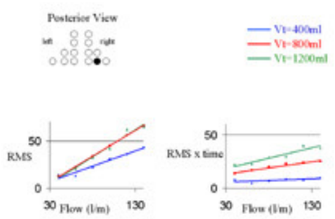


RELATIONSHIP BETWEEN FLOW AND RMS AVERAGED FROM 14 SITES ON THE CHEST.

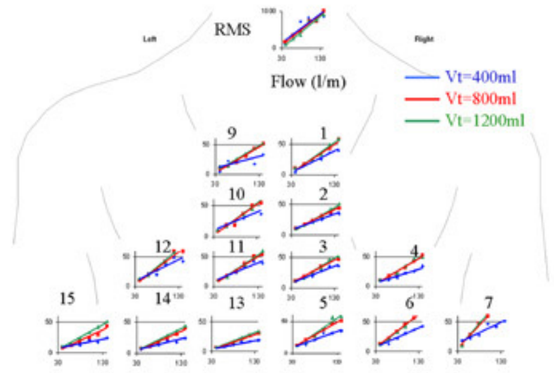
The subject was asked to breath freely at different flows. Note that the lung sounds are louder during inspiration. Note the linear relationship between the RMS and the Flow.

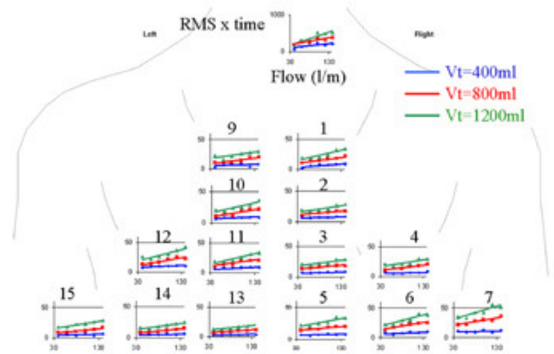


VENTILATED SUBJECTS



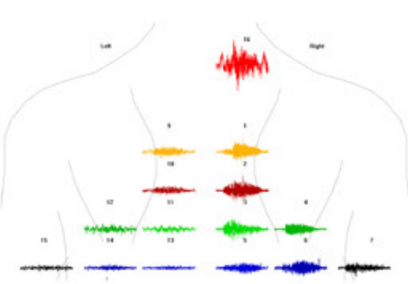
VENTILATED SUBJECTS *CONTINUED*





CLINICAL EXAMPLE

DECREASED LUNG SOUND AMPLITUDE IN A PATIENT WITH A BULLA



CONCLUSION

Lung sound analysis can provide information from sites over the chest that reflects changes in flow and volume delivered by a ventilator. Although these results are preliminary, they offer the promise of improved monitoring of patients on ventilators.