RELATIONSHIP OF ACOUSTIC WAVEFORMS TO MODE OF VENTILATION

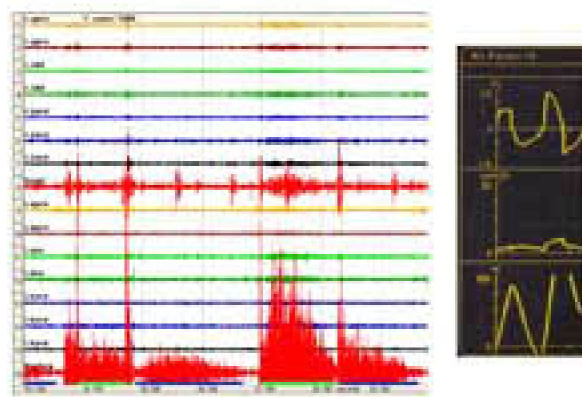
F. Davidson, A Wong-Tse, R. Murphy - Brigham & Women's/Faulkner Hospitals, Faulkner Hospital, Boston, MA.

BACKGROUND

An underlying objective of our work has been to determine whether lung sound monitoring could be used to help assess the adequacy of ventilation.

Previously we noted that flow input at the mouth by a ventilator correlated with acoustic RMS measured with a multichannel lung sound analyzer.

While recording lung sounds from a patient on a ventilator we observed that the pattern of the waveform of the sounds appeared to vary with the mode of ventilation that the patient was receiving, as noted in the following figure. We wondered if this was reproducible, and, if so, what was the mechanism of this phenomenon.



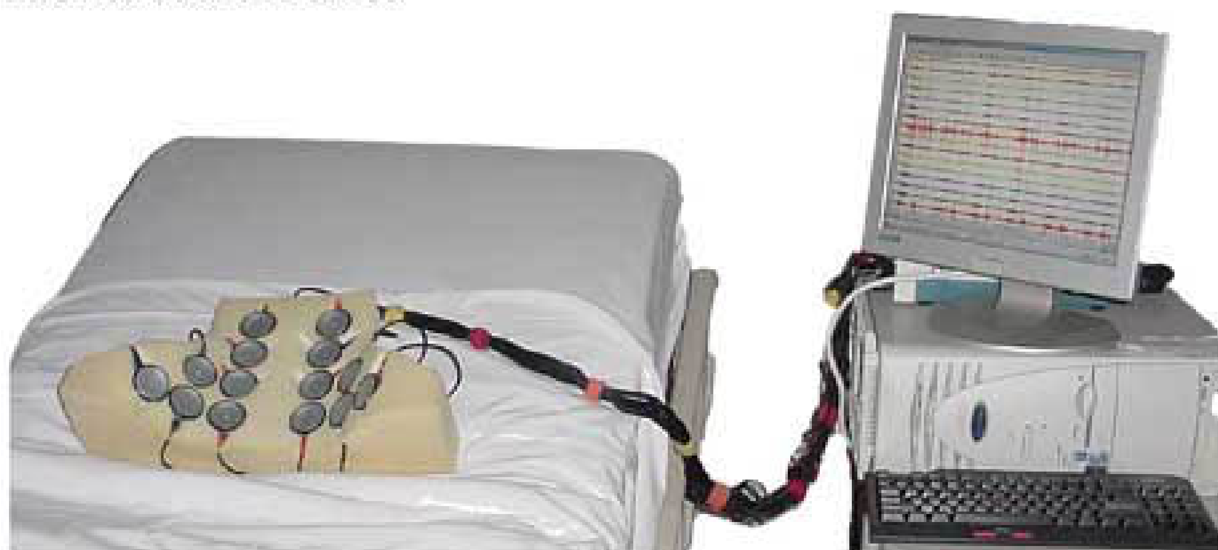
This figure shows the change in breath sounds and vent parameters that occured immediately upon changing from Volume Control to Pressure Support.

OBJECTIVE

To study the correlation of ventilatory modes to lung sound patterns.

METHODS

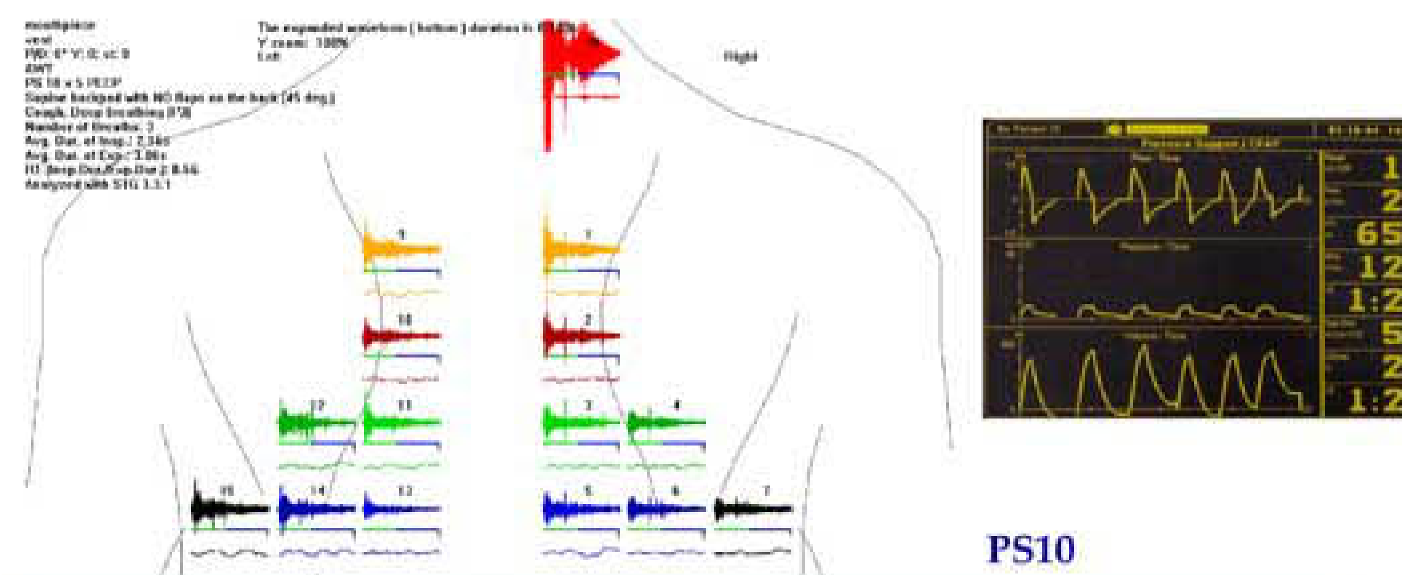
Healthy volunteers inspired from Siemens Servo ventilators via a mouthpiece in volume control, pressure support and pressure regulated-volume control modes. Lung sounds were recorded using a multichannel lung sound analyzer (STG16) over the trachea and at 14 sites over the chest.



RESULTS

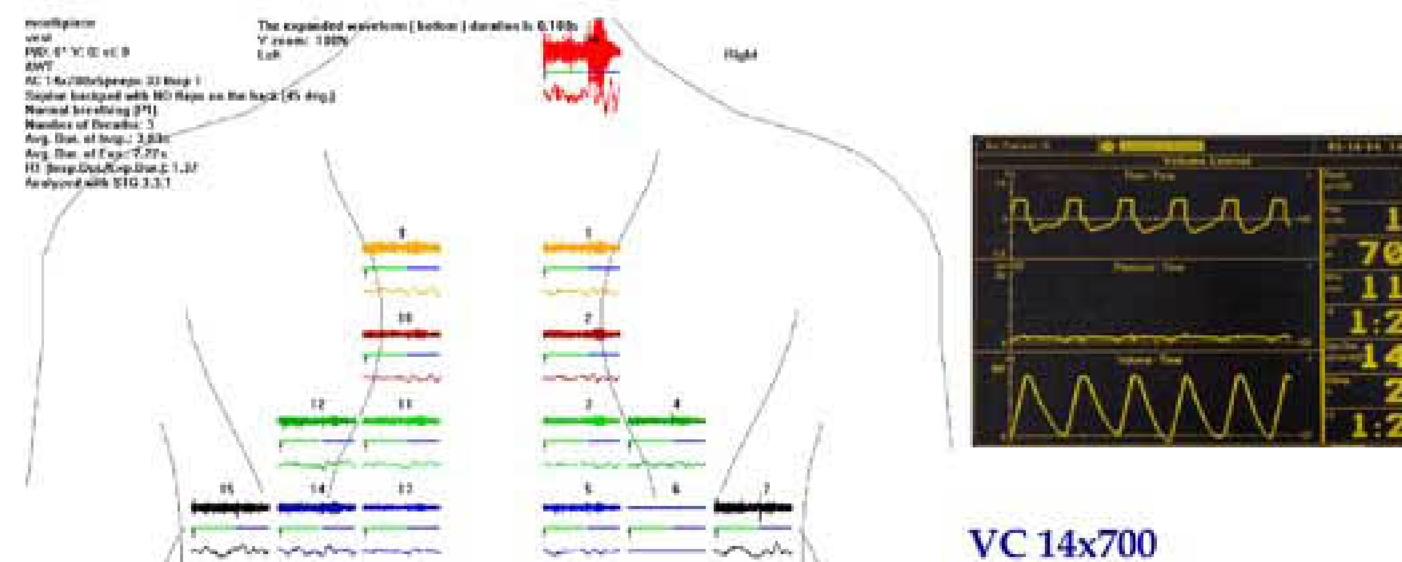
The following figures show the flow, pressure, and volume information as well as the simultaneously obtained acoustic data on a typical subject breathing from a ventilator in three different modes. The sound amplitude is lower when the subject was on PRVC than it was when the subject was on PS. It was lower still on VC.

PRESSURE SUPPORT



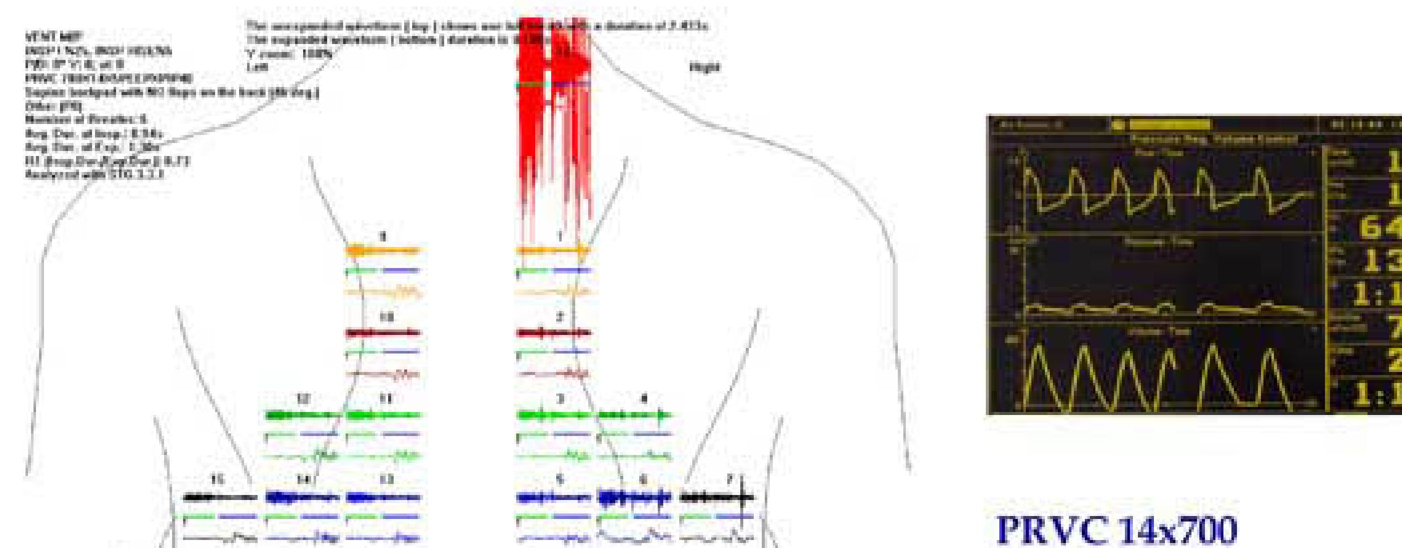
PS10

VOLUME CONTROL



VC 14x700

PRESSURE REGULATED VOLUME CONTROL



PRVC 14x700

INSPIRATORY SOUND AMPLITUDE VS. MODE

RIGHT			LEFT		
VC	PRVC	PS	VC	PRVC	PS
9	12	11	8	12	14

- -- STD%AV RANGED FROM 19 to 28%
- -- VC Ventilator settings 14x800, 1:3 RATIO, 50 LPM FLOW
- -- INSP T% 25 INSP RISE T% 5
- -- PEEP=5

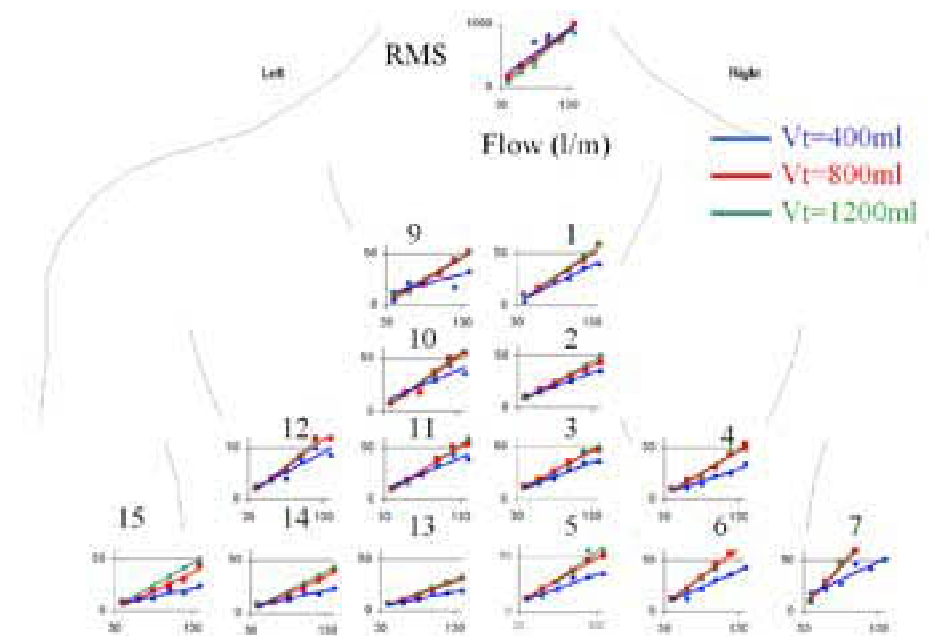
This figure shows the relationship of inspiratory sound amplitude (Acoustic RMS) to the mode of ventilation. PEEP was set at 5. Data is presented separately for the right and left hemithoraces. The ARMS was lower when the subject was breathing in the VC mode.

In summary, when breathing at volumes and flows determined by the subjects, the pressure support mode was associated with higher amplitude breath sounds than were seen when the subjects were breathing in the volume control mode.

Attempts were made to have the subjects breathe at similar flow rates during each mode of ventilation. They found it difficult to breathe at the low flow rates observed at VC when on either Pressure Support or PRVC.

We examined the relationship of the acoustic RMS to flow at varying lung volumes as seen in the following figure. It shows a close correlation between flow input at the mouth to acoustic RMS

Acoustic RMS vs. Flow



CONCLUSION

The different patterns of lung sounds observed when study subjects were switched from one mode of ventilation to another, appear to be due to differences in the flow rate delivered. The fact that the acoustic amplitude varies with flow, and that this can be detected at multiple chest sites simultaneously, suggests that lung sound analysis may be helpful in monitoring patients on ventilators.