

Intra-Operative Auscultation of Heart and Lungs Sounds: The Importance of Sound Transmission

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Introduction

Sometimes we put so much emphasis on electronic monitoring devices we forget that our own senses often detect things before a machine can. Seeing condensation in airway device or clear mask can serve to indicate the presence of ventilation before the signal has even reached the equipment. Sometimes the sense of smell can be the first thing to aid in the detection of a disconnected airway device or circuit. Similarly, in some situations listening for the presence of abnormal heart or airway sounds can help detect the onset of critical incidents quicker than electronic monitors. But in recent years the art of listening has changed in the practice of Anesthesia. Anesthesiologists and Anesthetists, although trained to evaluate for adequacy of ventilation and circulation through auscultation of heart and lung sounds, just don't listen like they used to.

Auscultation is an important and mandatory aspect of any physical examination of the patient's cardio-pulmonary system and similarly it should be used to monitor the patient perioperatively. The Esophageal Stethoscope provides a means to listen to the actual sounds from the patient as they are occurring - clear breath sounds and distinct heart sounds providing valuable information to the anesthesia provider. In fact, it is reported that almost one-third of anesthetists recorded critical incidents they were involved in were detected by stethoscope prior to any other means of detection (1). Esophageal Stethoscopes are useful in detecting critical incidents like obstruction of the endotracheal tube, bronchospasm, air embolus, myocardial depression, laryngospasm, airway obstruction, failure of IPPV/apnea, dysrhythmia and hypovolemia (1). These incidents are detected more readily when stethoscopes are used. Loeb (2) has reported that the response time to detect an abnormal value on an intraoperative monitor display and it was 61 seconds with 16% of the abnormal values not being recognized in 5 minutes. Whereas, Copper et al, (3) found the meantime between an event and detection with a stethoscope was 34 seconds. This suggests that changes in cardio-pulmonary function may be detected more readily with a stethoscope (1). Auscultation of heart and lung sounds during perioperative period is useful only if the Esophageal Stethoscope provides strong, clear transmission of the sounds to the

anesthesia provider. This study evaluates the sound transmission properties of several Esophageal Stethoscopes currently available in the market.

Methods

To evaluate the sound transmission properties of the Esophageal Stethoscopes in vitro study was performed. A system that simulates the heart and lung frequencies was used to test the sound transmission across the esophageal balloon for each manufacturer's esophageal stethoscopes. The system consisted of a sound source, microphone, an oscilloscope display and a sound box. The signal of specific frequency was generated by an audio generator. The signal was appropriately amplified and supplied to the sound box using a low frequency speaker. The signal from the sound box was picked up by an electronic microphone, properly amplified by a power amplifier and displayed on the oscilloscope. The amplitude of the signal (V) represents a sound intensity.

Prior to testing, the system was calibrated by placing the microphone inside of the chamber and adjusting the audio generator to a specific frequency and adjusting the power amplifiers to create a signal of 2.0V as displayed on the scope. After calibration, each esophageal stethoscope tested was suspended inside of the sound chamber without contacting the chamber. The microphone was connected to the Luer lock of the stethoscope and intensity of the signal as displayed on the oscilloscope was recorded for each sample. The test was performed at the following frequencies to cover the wide spectrum of frequencies for heart and lung sounds: 32, 64, 80, 120, 150, 180, 200, 280, 320 and 420Hz on ten samples from each manufacturer. For each manufacturer, results for each sample tested at each frequency were recorded and then averaged to provide the mean amplitude (Volts) per frequency. The system was calibrated at each frequency and calibration verified at the end of the test.

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Results

Ten samples of each manufacturer's esophageal stethoscope were tested at each frequency. Mean and standard deviation for signal amplitude (V) are presented in Table 1

TABLE 1. MEAN MEASURED AMPLITUDE (VOLTS)										
	32 Hz	64 Hz	80 Hz	120 Hz	150 Hz	180 Hz	200 Hz	280 Hz	320 Hz	420 Hz
Vital Signs	1.16 ± 0.51	1.20 ± 0.55	1.31 ± 0.60	2.05 ± 1.01	2.70 ± 1.47	4.77 ± 2.91	4.15 ± 1.66	2.30 ± 0.45	2.01 ± 0.61	2.10 ± 1.25
Starboard	1.68 ± 0.17	1.94 ± 0.02	2.11 ± 0.24	3.53 ± 0.67	5.42 ± 0.87	6.22 ± 1.19	4.78 ± 0.65	2.38 ± 0.28	2.13 ± 0.30	2.54 ± 0.71
Smiths	1.16 ± 0.26	1.24 ± 0.23	1.37 ± 0.28	2.15 ± 0.70	2.77 ± 0.83	3.83 ± 0.83	3.54 ± 0.82	1.85 ± 0.24	1.52 ± 0.31	1.48 ± 0.55
DeRoyal	1.00 ± 0.29	1.07 ± 0.34	1.13 ± 0.35	1.61 ± 0.63	2.00 ± 0.90	3.49 ± 1.79	4.05 ± 1.24	2.38 ± 0.25	2.10 ± 0.32	2.36 ± 0.81

The mean signal amplitude (volts) at each frequency for each manufacturer is shown in Figure 1.

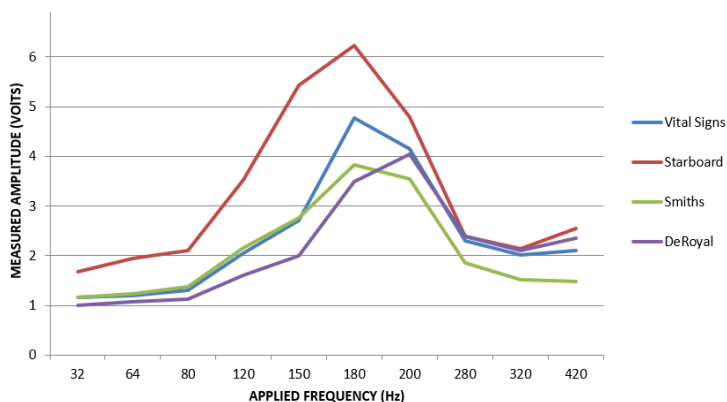


Figure 1. Measured Amplitude (Volts) at Various Frequencies

Conclusion

Esophageal Stethoscopes are a valuable minimally invasive and cost-effective adjunct method to monitor heart and lung function during general anesthesia procedures. Often, there use can detect critical events prior to other quantitative measures. The review of pertinent literature reveals that vigilant auscultation of

heart and lung sounds during surgical procedures requiring general anesthesia can detect abnormal conditions prior to detection by electronic monitoring, and therefore it is a useful tool for monitoring the patient and detecting critical incidents during general anesthesia(1,3,4,5). The sound quality of the device plays a paramount role in incident detection. This study found the sound quality of Esophageal Stethoscopes currently available varies considerably. The Starboard Medical Esophageal Stethoscope was found to provide the best sound transmission at all frequencies in this study.

References:

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