Digital Stethoscope—Improved Auscultation at the Bedside

Barry Silverman, MD[a,b,*], and Michael Balk, MD[b]

Electronic stethoscopes convert acoustic sound waves to electrical signals which can then be amplified and processed for optimal listening. However, amplification of stethoscope contact artifacts, and component cutoffs has led to the question of whether they are an improvement in the bedside cardiac examination. In this study, a single observer compared an analog stethoscope with the Thinklabsone electronic stethoscope in a clinical setting to determine if there was a significant difference in the diagnostic utility of the devices. Two hundred and nine patients were examined and the electronic stethoscope was felt to have superior sound quality in 65% of patients. **(Am J Cardiol 2019;123:984−985)**

The first stethoscope was a monaural wooden tube introduced by Rene Laennec in 1816. The first significant innovation was the addition of a flexible tube described by Golding Bird in 1840. Arthur Leared introduced a binaural stethoscope (BS) in 1851, and George Philip Cammann designed a binaural stethoscope BS that used both ears for commercial production in 1852.[1] The design has not changed significantly to the present day with the most popular stethoscopes including the Littmann and Sprague-Rappaport variations with improved materials. These acoustic stethoscopes operate on the transmission of sound from the chest piece, via air-filled hollow tubes, to the listener's ears.

Electronic stethoscopes were first developed in the 1950s and 3M introduced their first clinical electronic stethoscope in 1995. Acoustic sound waves are converted to electrical signals which can then be amplified and processed for optimal listening.[2] However, amplification of stethoscope contact artifacts, and potential for sounds to be cut-off or less sharp past a conduction threshold has led to the question of whether they are an improvement in the bedside cardiac examination.

In this study, a single observer compared an analog stethoscope with the Thinklabsone electronic stethoscope (Figure 1) in a clinical setting to determine if there was a significant difference in the diagnostic utility of the devices.

Methods

A cardiologist with 47 years of experience in a general clinical practice, compared an analog BS with the Thinklabsone electronic stethoscope (DS) in 219 patients. Patients were asked if they would permit auscultation with an Allen Medical Instruments dual head acoustic stethoscope and a Thinklabsone electronic stethoscope to assess if there was any difference in the examination. The first 42 patients were examined with the ear pods provided with the Thinklabsone. In the rest of the patients, a Bose QuietComfort 25 Acoustic Noise Canceling Headphone was used.

Results

Of the 952 measurements in which audible sounds and murmurs were heard, the sound (pitch, clarity, and loudness) of the digital stethoscope was felt to be superior to the acoustic stethoscope in 65% and equal in 30% (Figure 2). Auscultation of the first and second heart sounds yielded similar results. In our cohort, the majority of patients did not have a murmur. However, in patients with murmurs (n = 78), the digital stethoscope was superior or equal in 96% of examinations and performed better with murmurs located at the base of the heart. During lung examination, the digital stethoscope was equal to or superior in 99% of cases. Overall the digital stethoscope was equal to or superior to the acoustic device in 95% of examinations.

Discussion

In a 1996 American Heart Association journal article, *Cardiac Auscultation: A Glorious Past − But Does it Have a Future?,* Morton E. Tavel felt the examination was still an important diagnostic tool.[3] Valentin Fuster commented in 2016 that he found the stethoscope to be a valuable diagnostic instrument in his daily practice of cardiology.[4] Very little has changed in the basic stethoscope construct and technology until the introduction of the electronic stethoscope. Unlike acoustic stethoscopes, which are all based on the same physics and movement of a diaphragm, transducers in electronic stethoscopes vary. The Thinklabs Rhythm ds32 uses what they call an electromagnetic diaphragm with a conductive inner surface to form a capacitive transducer. This diaphragm responds to sound waves, with changes in an electric field replacing changes in air pressure. It can be used with ear pods, headphones or wirelessly. Because the sounds are transmitted electronically and converted to a digital signal, an electronic stethoscope can provide noise reduction, signal enhancement, and both visual and audio output.

The DS is small and affordable (less than $500) and the volume can be adjusted. You can select different

[a]Northside Heart Northside Hospital, Atlanta, GA; and [b]Emory University School of Medicine, Atlanta, GA. Manuscript received November 22, 2018; revised manuscript received and accepted December 7, 2018.

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*Corresponding author: Tel: +0016786378701; fax: +0014042562526.
E-mail address: mssbds@gmail.com (B. Silverman).

Figure 1. Thinklabsone stethoscope.

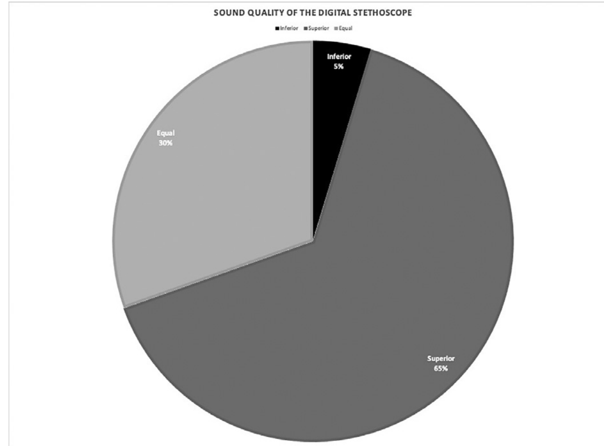

Figure 2. Sound quality of the digital sethoscope.

frequencies for lower-pitched cardiac tones and higher-pitched breath sounds. When a physician uses a BS, the ear piece needs to be firmly situated in the physician's ear canal and a good fit is the exception. The DS is more forgiving when using ear pods or headphones and this was especially true with the use of the Bose noise canceling headphones. We found that a DS, records clearer sounds through a patient's clothes, and the Korotkoff sounds are heard better with a DS when measuring manual blood pressures. BS requires the physician to stretch and lean over patients or maneuver around a hospital bed, which can place physicians in uncomfortably close proximity to the patient and frequently results in the displacement of the ear piece. Meanwhile, the DS enables the physician to have unencumbered movement during an exam. This includes maneuvering the microphone around the patient's body and under their clothes. This was important in the hospital where many patients could not be adequately exposed because they could not move, were intubated, or numerous tubes and IV lines made repositioning a hazard. Sound volume can be amplified for quiet heart tones and the use of noise cancelling headphones permitted better appreciation of heart and lung sounds even in the presence of ambient noise such as talking, hall noises, and TV sounds.

The advantages to this study are the comparison of real patients in a clinical setting by one physician. The limitations are that it is a subjective measurement of sound transmission and acoustic quality between the analog and digital instruments.

DS has teaching benefits, the sounds can be recorded and played on a smart phone or tablet. In addition, the sounds can be converted into a visual form which enhances the educational benefit. This eliminates the need for every individual physician to listen to the patient on rounds, and the recording can be shared with others as in telemedicine. Auscultation is an important diagnostic tool and the DS represents a significant advance—— a development that may alter what has been an icon of our profession.

Disclosures

The authors have no conflicts of interest.

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