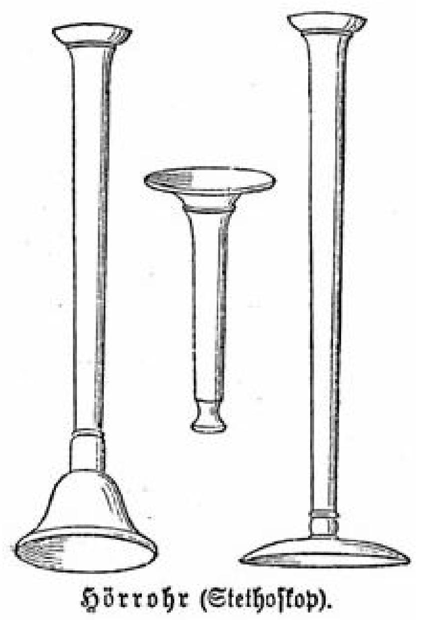
Stethoscope

Modern stethoscope.

The **stethoscope** (from Greek **στηθοσκόπιο**, of *στήθος, stéthos - chest* and *σκοπή, skopé - examination*) is an acoustic medical device for auscultation, or listening to the internal sounds of an animal body. It is often used to listen to lung and heart sounds. It is also used to listen to intestines and blood flow in arteries and veins. In combination with a sphygmomanometer, it is commonly used for measurements of blood pressure. Less commonly, "mechanic's stethoscopes" are used to listen to internal sounds made by machines, such as diagnosing a malfunctioning automobile engine by listening to the sounds of its internal parts. Stethoscopes can also be used to check scientific vacuum chambers for leaks, and for various other small-scale acoustic monitoring tasks. A stethoscope that intensifies auscultatory sounds is called **phonendoscope**.

History



Early stethoscopes.

The stethoscope was invented in France in 1816 by René Laennec at the Necker-Enfants Malades Hospital in Paris.[1] It consisted of a wooden tube and was monaural. His device was similar to the common ear trumpet, a historical form of hearing aid; indeed, his invention was almost indistinguishable in structure and function from the trumpet, which was commonly called a "microphone". In 1851, Arthur Leared invented a binaural stethoscope, and in 1852 George Cammann perfected the design of the instrument for commercial production, which has become the standard ever since. Cammann also authored a major treatise on diagnosis by auscultation, which the refined binaural stethoscope made possible. By 1873, there were descriptions of a differential stethoscope that could connect to slightly different locations to create a slight stereo effect, though this did not become a standard tool in clinical practice.

Rappaport and Sprague designed a new stethoscope in the 1940s, which became the standard by which other stethoscopes are measured, consisting of two sides, one of which is used for the respiratory system, the other is used for the cardiovascular system. The Rappaport-Sprague was later made by Hewlett-Packard. HP's medical products division was spun off as part of Agilent Technologies, Inc., where it became Agilent Healthcare. Agilent Healthcare was purchased by Philips which became Philips Medical Systems, before the walnut-boxed, $300, original Rappaport-Sprague stethoscope was finally abandoned ca. 2004, along with Philips' brand (manufactured by Andromed, of Montreal, Canada) electronic stethoscope model. Today there are still cardiologists who consider the original Rappaport-Sprague to be the finest acoustic stethoscope. Rappaport-Sprague copies made in China currently retail for about US$20.00. The Rappaport-Sprague model stethoscope was heavy and short (18–24 in (46–61 cm)) with an antiquated appearance recognizable by their two large independent latex rubber tubes connecting an exposed-leaf-spring-joined-pair of opposing "f"-shaped chrome-plated brass binaural ear tubes with a dual-head chest piece.

Several other minor refinements were made to stethoscopes, until in the early 1960s Dr. David Littmann, a Harvard Medical School professor, created a new stethoscope that was lighter than previous models and had improved acoustics.[2] In the late 1970s, 3M-Littmann introduced the tunable diaphragm: a very hard (G-10) glass-epoxy resin diaphragm member with an overmolded silicone flexible acoustic surround which permitted increased excursion of the diaphragm member in a "z"-axis with respect to the plane of the sound collecting area. The left shift to a lower resonant frequency increases the volume of some low frequency sounds due to the longer waves propagated by the increased excursion of the hard diaphragm member suspended in the concentric accountic surround. Conversely, restricting excursion of the diaphragm by pressing the stethoscope diaphragm surface firmly against the anatomical area overlying the physiological sounds of interest, the acoustic surround could also be used to dampen excursion of the diaphragm in response to "z"-axis pressure against a concentric fret. This raises the frequency bias by shortening the wavelength to auscultate a higher range of physiological sounds. 3-M Littmann is also credited with a collapsible mold frame for sludge molding a single column bifurcating stethoscope tube[3] with an internal septum dividing the single column stethoscope tube into discrete left and right binaural channels (AKA "cardiology tubing"; including a covered, or internal leaf spring-binaural ear tube connector).

In 1999, Richard Deslauriers patented the first external noise reducing stethoscope, the DRG Puretone. It featured two parallel lumens containing two steel coils which dissipated infiltrating noise as inaudible heat energy. The steel coil "insulation" added .30 lb to each stethoscope. In 2005, DRG's diagnostics division was acquired by TRIMLINE Medical Products.[4] Between 1998-2007 Marc Werblud, a disabled paramedic/medical student created a lightweight 32" long acoustic noise cancelling stethoscope which improved sound quality, and reduced neck strain. The acoustic properties of the specific materials used to make stethoscope components were first tested to determine their 'resident frequency'. The results of individual acoustical component materials tests revealed how their collective interactions determine the instrument's dominant tonal character and frequency response of the stethoscope, yielding several high fidelity and acoustic noise cancelling stethoscope models. Some models weighed as little as 133 grams (4.7 oz); half the weight of common cardiology stethoscopes from the 1960s and 1970s. The new models also included a unique set of stethoscope diaphragms which increased frequency response, and could be sanitarily changed for each patient.

Current practice

Stethoscopes are often considered as a symbol of the doctor's profession, as doctors are often seen or depicted with a stethoscope hanging around their neck.


A German physician listens to a patient's lower lung regions with a stethoscope applied to his back.

Types of stethoscopes

Acoustic

Acoustic stethoscope.

Acoustic stethoscopes are familiar to most people, and operate on the transmission of sound from the chest piece, via air-filled hollow tubes, to the listener's ears. The chestpiece usually consists of two sides that can be placed against the patient for sensing sound — a diaphragm (plastic disc) or bell (hollow cup). If the diaphragm is placed on the patient, body sounds vibrate the diaphragm, creating acoustic pressure waves which travel up the tubing to the listener's ears. If the bell is placed on the patient, the vibrations of the skin directly produce acoustic pressure waves traveling up to the listener's ears. The bell transmits low frequency sounds, while the diaphragm transmits higher frequency sounds. This 2-sided stethoscope was invented by Rappaport and Sprague in the early part of the 20th century. One problem with acoustic stethoscopes was that the sound level is extremely low. This problem was surmounted in 1999 with the invention of the stratified continuous (inner) lumen, and the kinetic acoustic mechanism in 2002. Acoustic stethoscopes are the most commonly used. A recent independent review evaluated 12 common acoustic stethoscopes on the basis of loudness, clarity, and ergonomics. They did acoustic laboratory testing and recorded heart sounds on volunteers. The results are listed by brand and model.[5]

Electronic

An electronic stethoscope (or **stethophone**) overcomes the low sound levels by electronically amplifying body sounds. However, amplification of stethoscope contact artifacts, and component cutoffs (frequency response thresholds of electronic stethoscope microphones, pre-amps, amps, and speakers) limit electronically amplified stethoscopes' overall utility by amplifying mid-range sounds, while simultaneously attenuating high- and low-frequency range sounds. Currently, a number of companies offer electronic stethoscopes. Electronic stethoscopes require conversion of acoustic sound waves to electrical signals which can then be amplified and processed for optimal listening. Unlike acoustic stethoscopes, which are all based on the same physics, transducers in electronic stethoscopes vary widely. The simplest and least effective method of sound detection is achieved by placing a microphone in the chestpiece. This method suffers from ambient noise interference and has fallen out of favor. Another method, used in Welch-Allyn's Meditron stethoscope, comprises placement of a piezoelectric crystal at the head of a metal shaft, the bottom of the shaft making contact with a diaphragm. 3M also uses a piezo-electric crystal placed within foam behind a thick rubber-like diaphragm. Thinklabs' Rhythm 32 inventor, Clive Smith uses an Electromagnetic Diaphragm with a conductive inner surface to form a capacitive sensor. This diaphragm responds to sound waves identically to a conventional acoustic stethoscope, with changes in an electric field replacing changes in air pressure. This preserves the sound of an acoustic stethoscope with the benefits of amplification.

Because the sounds are transmitted electronically, an electronic stethoscope can be a wireless device, can be a recording device, and can provide noise reduction, signal enhancement, and both visual and audio output. Around 2001, Stethographics introduced PC-based software which enabled a phonocardiograph, graphic representation of cardiologic and pulmonologic sounds to be generated, and interpreted according to related algorithms. All of these features are helpful for purposes of telemedicine (remote diagnosis) and teaching.

Recording stethoscopes

Some electronic stethoscopes feature direct audio output that can be used with an external recording device, such as a laptop or MP3 recorder. The same connection can be used to listen to the previously-recorded auscultation through the stethoscope headphones, allowing for more detailed study for general research as well as evaluation and consultation regarding a particular patient's condition and telemedicine, or remote diagnosis.

Fetal stethoscope

A **fetal stethoscope** or **fetoscope** is an acoustic stethoscope shaped like a listening trumpet. It is placed against the abdomen of a pregnant woman to listen to the heart sounds of the fetus. The fetal stethoscope is also known as a **Pinard's stethoscope** or a **pinard**, after French obstetrician Adolphe Pinard (1844–1934).

Maintenance

The flexible vinyl, rubber, and plastic parts of stethoscopes should be kept away from solvents, including alcohol and soap. Solvents can have detrimental effects, including accelerating the natural aging process by dissolving the plasticizers that keep these parts flexible and looking new. In addition, when they are manufactured stethoscopes with two-sided chestpieces are lubricated where the chestpiece rotates around the stem and need to be re-lubricated periodically, just like any other machine. If these moving parts are not lubricated, they grind together and ruin the fine tolerances required for the proper acoustic performance of the stethoscope. Cleaning the stethoscope will also remove lubricants, making periodic lubrication essential. Most lubricants must be kept away from rubber, vinyl, and plastic parts.

Only products that have been tested to be safe and effective for cleaning stethoscopes and similar medical instruments should be used.

See also

- Doppler fetal monitor

External links

- The Auscultation Assistant [6], - "provides heart sounds, heart murmurs, and breath sounds in order to help medical students and others improve their physical diagnosis skills"
- BBC: Smart stethoscope for detecting kidney stones [7]
- museum of historic medical artifacts [8]
- Phisick [9] Pictures and information about antique stethoscopes
- Demonstrations: Heart Sounds & Murmurs [10] University of Washington School of Medicine

References

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