

The invention of the stethoscope: A milestone in cardiology

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The heart was initially considered the seat of the emotions. The anatomy of the heart and blood vessels has been studied since antiquity, but it was only with the introduction of the notion of measurement into the scientific process that cardiology could begin in earnest.

The scientific use of measurement in cardiology can be dated back to the 19th century, well after the time of William Harvey (1578–1657), who in 1616 deduced that blood flows in a closed circuit pumped by the heart. This notion of a pump-like heart moving blood around the body was, like its predecessors, inspired by irrigation and therefore rather different from the ideas we are familiar with today. The connection between sounds and cardiac pulsations, for its part, was definitively established only in the 19th century.

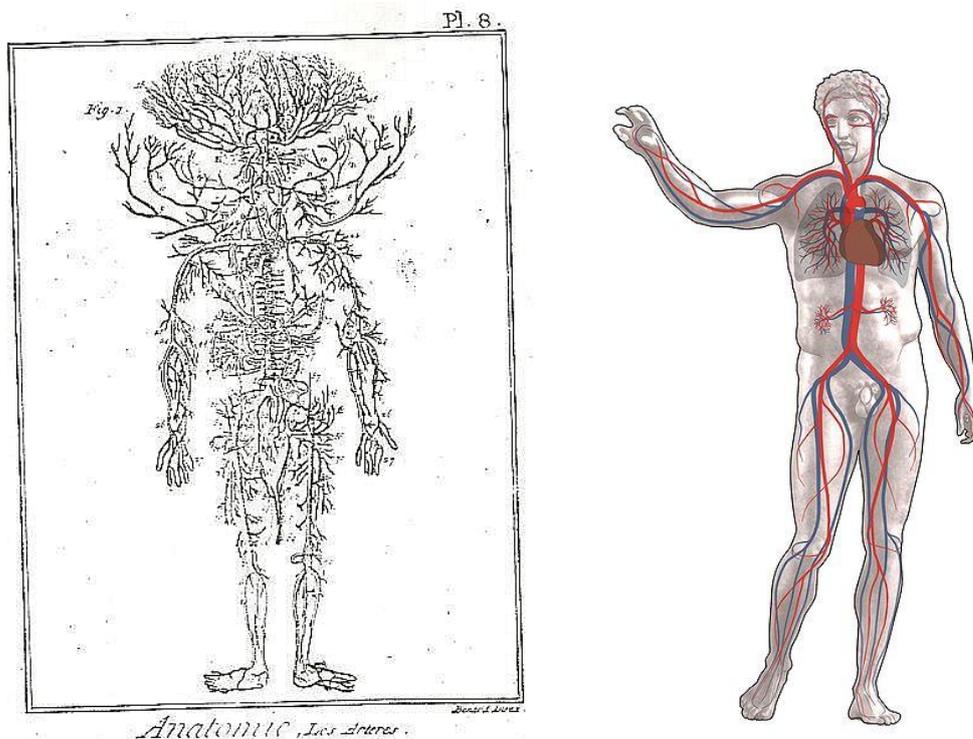


Figure 1: Diagram of blood flow in the human body. On the left, a plate from "Anatomy. The Arteries" taken from d'Alembert's Encyclop die. On the right, a modern diagram, WikiCommons. The arteries are shown in red, the veins in blue.

The practice of taking a patient's pulse gave way to that of listening to the heart beat when, in 1818, Laennec (Quimper, 1781–Douarnenez, 1826) invented a practical measuring instrument that he christened the *stethoscope*. The author's writings discussing his invention are worthy of commentary, not only so as to understand the author's chain of thought but also to see how a new medical technique was presented in the 19th century.

After presenting his invention at a session of the Academy of Sciences in 1818, the young doctor from the Hôpital Necker¹ published a detailed two-volume work: *Mediate auscultation, or Treatise on the diagnosis of lung and heart diseases based on this new exploratory instrument*.² Several revised editions of these works were published. The epigraph is from Hippocrates: "Exploration, in my view, accounts for much of the art", a statement that gives an idea of the heritage on which the Breton doctor drew.

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The preface³ to the first edition of 1819 is sober in tone, but Laennec's need to justify himself and convince his contemporaries of the practical benefit of the instrument is striking (p. xxv):

The main object of my work being to demonstrate the advantage of using the cylinder to distinguish various lesions to the lungs [...]

He seems most wary of the reactions of those familiar with cruder exploratory methods based on the Auenbrugger technique, i.e. percussion (p. xxxi):

*If I have sometimes taken issue with their way of seeing things, I hope that no one will mistake my motivation in doing so.*⁴

This highly innovative instrument is modestly presented at the end (§ 11–17) of a short introduction numbering 14 pages, while the illustrative plate and explanation are consigned to the end of the first volume of 456 pages. Laennec states in the first page of this introduction the importance of being able to listen to the heart:

1. This hospital, situated in the 7th arrondissement in Paris and originally known as the "Charitable Hospice of the Parishes of Saint-Sulpice and Gros Caillou", was founded in 1778 by Suzanne Necker, born Curchod, the wife of Jacques Necker, Finance minister under Louis XVI.

2. [Translator's note] This title was translated into English as *A treatise on the diseases of the chest, and on mediate auscultation* (trans. John Forbes, published by Thomas & George Underwood, 1839).

3. [Translator's note] This preface is not included in the English translation of 1839; page numbers refer to the French edition.

4. Indeed, Laennec pays homage to Corvisart (1755–1821), who popularised Auenbrugger's works in France. This homage to the emperor's doctor is noteworthy set as it is against the backdrop of the Restoration.

The heart, although structurally very robust, is exposed to very varied alterations [...] The increase in nutrition, and especially the dilation of this organ, are among the most common diseases.



Figure 2: Léopold Auenbrugger, an Austrian doctor (1722–1809), who invented the clinical examination of the thoracic and abdominal cavities by digital percussion. Immediate percussion consists in bending one's fingers and tapping them against an area of the body. Mediate percussion consists in tapping the middle finger of one hand, which is applied to the area of the body under examination, with the middle finger of the other.

Then, as in the preface, he justifies himself to supporters of the Auenbrugger percussion method and shows that he is aware of its limitations:

The results of percussion are furthermore equivocal when the absence of sound is confined to the lower right portion of the chest; they are often misleading when the chest is even slightly deformed.

An anecdote recounted on page 7 of the introduction⁵ is said to have inspired the design and use of the first instrument enabling doctors to listen to heart sounds at a distance. It is related in many publications on the history of cardiology:

In 1816, I was consulted by a young woman labouring under general symptoms of diseased heart, and in whose case percussion and the application of the hand were of little avail on account of the great degree of fatness. The other method just mentioned being rendered inadmissible by the age and sex of the patient, I happened to recollect a simple and well-known fact in acoustics, and fancied it might be turned to some use on the present occasion. The fact I allude to is the great distinctness with

5. [Translator's note] Of the first French edition.

*which we hear the scratch of a pin at one end of a piece of wood, on applying our ear to the other.*⁶ (p. 4)

Never in his scientific writings, however, would Laennec mention that he had received a musical education and played the flute. And yet this seems an important point to bear in mind, both as a source of inspiration for this listening technique and in the construction of the instrument, which he describes in the following terms:

I rolled a quire of paper into a kind of cylinder and applied one end of it to the region of the heart and the other to my ear, and was not a little surprised and pleased, to find that I could thereby perceive the action of the heart in a manner much more clear and distinct than I had ever been able to do by the immediate application⁷ of the ear. (p. 5)

The method employed in this first instrument would be used to construct other instruments made out of various materials, and which are described in the following two pages of Laennec's book. What is striking is both the precision with which Laennec describes the instruments – he clearly was not afraid of being copied – and his modesty – he does not shy away from mentioning his failures, so potential emulators do not waste their time:

The most dense bodies do not, as might have been expected from analogy, furnish the best materials for these instruments. [...] Bodies of a moderate density, such as paper, the lighter kinds of wood, or Indian cane, are those which I always found preferable to others. (p. 6)

Only on page 11 – and what's more, in a footnote – does Laennec suggest a name for the instrument: "stethoscope" (from the Greek *stethos*, chest or heart, and *skopos*, observer). In later editions, this term would be used throughout the text.

He then indicates the positions to be used in examinations, and gives a brief interpretation of sounds that may be heard, which he develops in later chapters of the first and second volumes. He also explains the dimensions of his instrument:

A greater diameter renders its exact application to certain parts of the chest, impracticable; greater length renders its retention in exact

6. [Translator's note] This passage and those quoted in the following pages are taken from the English translation of Laennec's work, which can be found at <https://archive.org/stream/treatiseondiseas1829laen>. Page numbers refer to this edition.

7. As with percussion (see Figure 2), immediate auscultation signifies "without a mediating instrument", i.e. using the ear alone. Mediate auscultation is carried out using an instrument, the stethoscope – hence the title of Laennec's work.

apposition more difficult, and when shorter, it [...] frequently obliges [the doctor] to assume an inconvenient posture [...]. (p. 7)

At the end of the introduction, he feels the need to evoke the percussion method:

The employment of this new method must not make us forget that of Auenbrugger; on the contrary, the latter acquires quite a fresh degree of value through the simultaneous employment of the former, and becomes applicable in many cases, wherein its solitary application is either useless or hurtful. It is by this combination of the two methods that we obtain certain indications of emphysema of the lungs, pneumo-thorax, and of the existence of liquid extravasations in the cavity of the pleura. (p. 7-8)

Such an abundance of caveats about a method in which Laennec had little confidence could be interpreted as a desire to appease his superiors, who praised and practised the percussion method. This interpretation is confirmed by the preface to the second edition, which puts even more emphasis on the listening techniques of the past.

On pulmonary diseases

The numerous chapters of the two volumes (thirteen chapters in volume I and thirty-nine in volume II) are studded with observations and interpretations of cardiac and pulmonary diseases that had been made possible by the stethoscope. The prose style is more discursive than that used to describe the instrument.

Laennec enumerates the pulmonary diseases that can be detected with his instrument. The chapter on pneumothorax is interesting because, in the absence of radiographic techniques, it is the dissymmetry of sounds heard through mediate examination (with a stethoscope) that allows the pneumothorax to be detected in the human body.

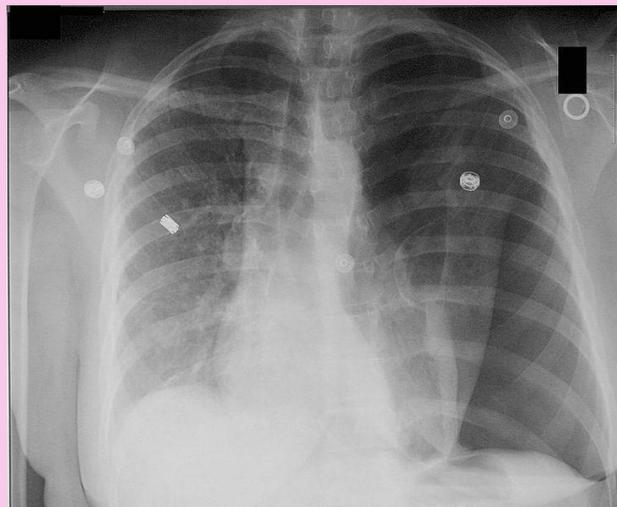


Figure 3: Radiographic image of a pneumothorax (in the right-hand side). (Image: WikiCommons; author: Medical Cases)

A pneumothorax is the formation of an air pocket outside the lung, which causes the lung to collapse. It can be spontaneous or traumatic (the result of a physical shock). An emphysema is the destruction of the walls of the pulmonary alveoli (which can be caused by tobacco and, in the past, was also caused by smoke in wood-heated houses). It causes respiratory problems and can provoke a pneumothorax.

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The introduction to the book, which presents the stethoscope to the medical community, ends with an invitation to learn how to use the instrument:

[...] it is only in an hospital that we can acquire, completely and certainly, the practice of this new art of observation [...]. (p. 8)

General practitioners are not forgotten, however, and the last line of the introduction was an early encouragement of cooperation between hospital and “private” physicians.



Figure 4: *On the left, Laennec of Necker Hospital examines a consumptive before his students (1816). A later commemorative painting by Théobald Chartran (1849–1907), displayed in the Great Staircase at the Sorbonne (the stethoscope can be seen in Laennec’s left hand). On the right, Laennec and the stethoscope, painting (c. 1960) by Robert A. Thom (1915–1979).*

Thanks to this publication, the young French doctor’s invention would quickly become well known and used throughout Europe, though not without some reservations. Within little time at all it would also be honed by other inventors, who introduced a supple cord and twin earpiece. Sound imaging techniques developed in the 20th century allowed for far greater precision but did not sideline the classic stethoscope in the doctor’s surgery. The cylinder is still

used to detect the sound of a foetus's heart in situations where ultrasounds are unsuitable.

As for the workings of the heart, Laennec remained attracted to the notion of a circle of sensorial receptivity, essentially the ears and the heart. It was not until later, with Claude Bernard's discoveries about the regulations, research into electric activity, and then observations of autopsy materials using 20th-century techniques, that the cardiac muscle would be better explored and understood. A further significant stage is currently underway, based on research into the genetic mechanisms intervening in the expression and regulation of the various contractile proteins of the cardiac muscle.

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Lastly, the presentation of this major innovation in medical examination is remarkably different from that used in contemporary science. It is admirable for its honesty and its manifest desire to convince. It could serve as an example, or at least as pause for thought, for young scientists of today, who are immersed and caught up in a very demanding publications culture – but never mention their experiments that have failed.

Laennec's presentation of the new instrument that was the stethoscope is clear, straightforward and pleasant to read. Like its author, it modestly informs the reader of the different stages in the discovery – and publication of the results – of this tool, which would revolutionise medical examinations.



(January 2012)

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Annex

Plates showing Laennec's diagrams / The modern-day stethoscope

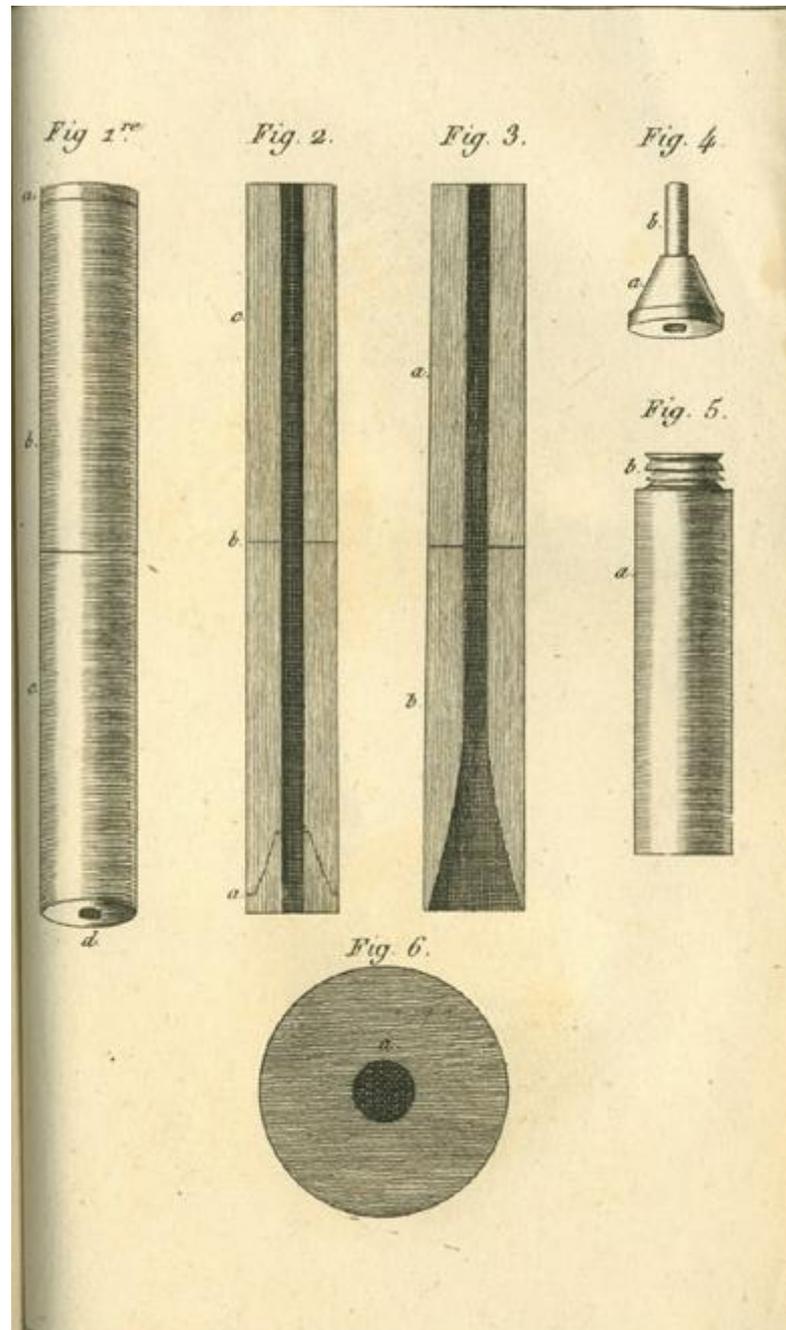


Figure 5: Diagrams of the stethoscope, plate 1 at the end of Laennec's first volume (on the following page: Laennec's captions accompanying these diagrams).

EXPLICATION DES PLANCHES.

PLANCHE PREMIERE.

FIGURE 1. Le cylindre, réduit au tiers de ses dimensions réelles. (Tom. 1, pag. 10.)

- a. L'obturateur ou en-bout.
- b. Le corps inférieur du stéthoscope.
- c. Le corps supérieur.
- d. L'extrémité auriculaire ou destinée à être appliquée contre l'oreille.

FIGURE 2. Coupe du stéthoscope dans le sens de sa longueur.

- a. L'obturateur ou en-bout.
- b. Point de réunion des deux corps du cylindre.
- c. Le corps supérieur.

FIGURE 3. Cette figure représente la même coupe, l'obturateur étant enlevé.

- a. Corps supérieur ou auriculaire.
- b. Corps inférieur ou pectoral.

FIGURE 4. L'obturateur ou en-bout.

- a. Le corps de l'obturateur, fait du même bois que le reste du stéthoscope.
- b. Petit tube de cuivre qui traverse l'en-bout et sert à le fixer dans le canal du stéthoscope.

FIGURE 5. Le corps inférieur du stéthoscope.

- a. Le corps du stéthoscope.

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Fig 6 diamètre réel du stéthoscope
a) diamètre du canal

Some confusion arises when Figure 2 is compared to Figure 1: the obturator (or stopper, labelled *a*) is shown at the bottom of Figures 2 and 3, but at the top of Figure 1.

Figure 5 shows the lower part of the stethoscope, which screws into the upper part. As Laennec notes (p. 7), the cylinder is "divided into two portions, [...] for the convenience of carriage": it can be unscrewed and disassembled.

The inner circle in Figure 6 (annotated *a*) shows the "diameter of the canal", the auditory canal that is shown in section in Figures 2 and 3.



Figure 6: Replica of Laennec's stethoscope (image from the site Medical Antiques Online, <http://www.antiquemed.com/>). It measured around 30 cm in length ("a foot long", notes Laennec on page 6).



Figure 7: On the left, the standard modern stethoscope (image from WikiCommons, author Luna04). It was the German American doctor David Littmann (1906–1981) who would develop the standard design for the instrument in the 1960s. The stopper, or chest-piece (Figure 4 above, on Plate 1) is similar, though today it is fitted with a membrane. The auditory conduit is no longer a cavity in a piece of wood, but a flexible rubber tube. **On the right, a modern foetal stethoscope.** This model is very similar to Laennec's and is still used today by some GPs and midwives; it is also sold to the general public (pregnant women) to "listen to your baby's heartbeat".