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REVEALING THE BODY'S WHISPERS

How the Stethoscope Transformed Medicine

"Technological breakthrough" is a phrase that stirs visions of a complex invention having multiple parts that do something important. In medicine we think of artificial hearts, respirators, and imaging machines. But sometimes the material expression of a significant concept appears in a plain wrapper. No technology illustrates this more than a wooden tube with an opening down the center created in 1816 by the French physician René Laennec, which revolutionized diagnosis, altered the doctor's identity, transformed the experience of being a patient, and changed medicine forever. He called it the stethoscope.

The transformative power of this tube had as much to do with its effects on the relationship between doctor and patient as it did with the evidence of illness that it uncovered. In medicine, relationships and evidence are linked. How the facts about an illness are gathered and the nature of those facts critically affect how doctor and patient regard each other. The influence of technology on these connections is demonstrated by the story of the stethoscope's invention and use. But to set the stage for its coming, we need to explore earlier means used by doctors to investigate medical problems.

Before stethoscopes, the coin of evaluation was words – the doctor learned about an illness from the patient's story of the events and sensations marking its passage. Patient-driven narratives appear in early works of Western medicine, such as those written by Hippocrates and his disciples in ancient Greece more than two and a half millennia ago. One case begins: "Silenus lived on Broadway, near the place of Eualcidas. After over-exertion, drinking, and exercises at the wrong time he was attacked by fever. He began having pains in the loins, with heaviness in the head and tightness in the neck. From the bowels on the first

day there passed copious discharges of bilious matter, unmixed, frothy, and highly coloured. Urine black, with a black sediment; thirst; tongue dry; no sleep at night."[1] Most of the symptoms described in the case were felt or witnessed by the patient and transmitted to the doctor. The case report continued until the eleventh day of the illness, when Silenus died.

More than two thousand years later, in the seventeenth century, the narrative account of illness by patients was still the main way that the doctor obtained facts on which to base a diagnosis and suggest a remedy. It did not matter whether the narrative was given by the patient in person or sent by mail to the doctor for a written opinion. In fact, the practice of consultation by letter was widespread at the time, an index of the significance of the patient's narrative. A doctor of the period often consulted in this way was John Symcotts, an English physician with a large practice in Huntington and Bedfordshire and for many years physician to Oliver Cromwell and his family. He got the following request for help by mail:

Sir,

I have a great burning pain about the reins of my back, which strikes up to the top of my belly, and a wonderful ill scent arising from my stomach. I do desire your best advice. In my hankering for physic I have taken so much all ready and it has done me no good, and therefore I would desire you to send me no physic but some oil or some cooling thing, for I am very sore about my back that I cannot stand upright. The greatest pain of all is my left kidney.[2]

The focus of the stories is the illness as experienced by and depicted through the feelings and words of the patient. The patient as sufferer held center stage: the patient was the narrator of the illness as well as its victim, and the doctor's decisions about what was needed were largely determined by what the patient said. The doctor's success or failure with the remedies prescribed was also measured by the patient's view of their effects. The doctor was brought into the patient's life and world of remembrance. There the doctor resided throughout the illness, as so much hung on the patient's view.

This position was not always comfortable for doctors. For example, William Cullen, professor of medicine at schools in Glasgow and Edinburgh, wrote in his 1789 treatise on the classification of diseases that

he always preferred symptoms "perceived by the physician, rather than by the patient, yet the latter, however fallacious, are not wholly to be rejected."[3] Another well-known physician and professor of anatomy at Edinburgh, Alexander Monro, commented in an 1811 book that the story patients gave of their illnesses was flawed in several ways, such as "the imperfect manner in which patients describe their ailments, and the erroneous account which many physicians lead their patients to give of their situation, from taking up too hasty an opinion respecting the nature of the case."[4] Monro grasped the problem that physicians dependent on the story of patients faced: usually there was no good way to judge the accuracy of the patient's recollections. But he also recognized that, knowingly or unwittingly, doctors might influence the patient's narrative to reflect their own views about what was the matter.

Physicians like Cullen and Monro did have means of exploring illness other than accepting the patient's perspective: they could see and touch the body. When exploring the patient's outward appearance, doctors focused on facial expression, posture, gait, and the tongue. They looked also at matter generated from within, such as urine, stools, and gastric matter, and blood, when it was expelled from the body or deliberately let out for therapeutic purposes.

However, doctors exercised restraint in examining the body physically and limited their inquiries largely to evaluating the pulse, body heat, and tumorous outgrowths emerging at the surface of the skin. Physicians had eschewed deep probing with the hands or using instruments to examine the body ever since the study of medicine had been placed in universities in the thirteenth century. The university-trained physicians considered active manipulation of the body or use of instruments on it to be menial actions beneath their station as learned professionals and best left to healers of lower status. The training of physicians in these universities followed the same scholastic and text-driven approach to learning used to teach theology and law, the two other main branches of university education. So in this environment, theoretical exploration and discourse, not hands-on practical knowledge seeking, reigned supreme. This perspective determined the doctor's approach to practice. Accordingly, physicians mainly listened to stories of patients, inspected their appearance, and gently explored the body's surface to decide what was wrong.

The revolution that changed how doctors learned about illness and related to patients, and reversed their attitudes about actively exploring the body and using tools, began with and was vitally nourished by the study of the dead. Many controversies about how the body was put together and what its architecture really looked like were resolved with the appearance of the 1543 work on anatomy by Andreas Vesalius, *De humani corporis fabrica*, which for the first time gave doctors a detailed picture of every major part of the body.[5] The work facilitated the study of the normal composition of the body and, critically, spurred the investigation of structural changes created by disease in it through the emerging discipline of pathology.

The equivalent for pathology of Vesalius's work appeared two centuries later when Giovanni Battista Morgagni published in 1761 *The Seats and Causes of Diseases Investigated by Anatomy*.[6] Its title described its theme. Morgagni showed that the footprints of different illnesses could be recognized in characteristic disruptions they created in the body's inner architecture. Further, he demonstrated that these disruptions of structure, or lesions, directly caused the expressions of illness displayed in the living person called symptoms. Morgagni's work and ideas have defined the basic way physicians think about illness from the time of his book's publication to the present. This way of understanding disease is centered on one question: where is the disease? An anatomical view of illness requires locating its presence in some place in the body. As the title of Morgagni's work describes, diseases have seats in the body. Locate the seat and you explain both the origin of the illness and the reasons a patient has particular symptoms.

But the concept raised a fascinating problem for doctors. How to locate the lesions beneath the skin of a living patient without piercing it with a scalpel? What good was anatomical thinking without a dependable, noninvasive way of finding the lesions in patients? Clinicians began to appreciate that something more precise than the verbal accounts of patients or the outer survey of the body was needed to take full advantage of the new anatomical insights. From the publication of Morgagni's book, fifty-five years would pass before a generic solution to this problem appeared. The answer would emerge from what had started as an ordinary clinical consultation.

In 1816 a thirty-five-year-old French doctor, René Laennec, was consulted at the Necker Hospital in Paris by a young woman with

symptoms of heart disease. To probe her illness, Laennec thought of a technique first suggested by Hippocrates, who urged physicians to put their ear on their patient's chest to determine whether water (which would sound like boiling vinegar) or pus was present. This technique, called auscultation, had been largely ignored. However, Laennec and his medical colleague, Gaspard Bayle, occasionally used it, particularly to evaluate heartbeats. But it required doctors to move their head over the surface of the patient's body, a procedure not only cumbersome and unpleasant to both but also, when doctor and patient did not share a gender, embarrassing. At this time, respect for female modesty and bodily privacy required male medical attendants to refrain from modes of examination that trespassed on these mores. Because of this problem, Laennec rejected the use of auscultation on the patient he was examining. What, then, to do?

Searching for an answer, he recalled both a well-known fact of acoustics, sounds grow louder when they pass through solid bodies, and an example: when one end of a solid piece of wood is scratched, the noise can be heard at the other end. Could these insights lift him over the social and physical barriers of the Hippocratic approach to auscultation and provide new evidence about his patient's illness? Spying sheets of paper nearby, he rolled them tightly into a cylinder and put one end on the region over the patient's heart and his ear on the other end. He recalled being "not a little surprised and pleased, to find that I could thereby perceive the actions of the heart in a manner much more clear and distinct than I had ever been able to do by the immediate application of the ear. From this moment I imagined that the circumstance might furnish means for enabling us to ascertain the character; not only of the actions of the heart, but of every species of sound produced by the motion of all the thoracic viscera."[7]

Laennec vigorously explored the reach and limits of his invention. Seeking to refine its makeshift character, he created instruments with different sorts of composition and construction. He found that materials of moderate density like wood, paper, and Indian cane had the best properties for hearing sounds in the body. But he also discovered that the form of his spontaneously produced initial model was the best. Thus, his chosen design was a straight wooden tube about a foot long and an inch and a half in diameter that could be separated into two parts to enhance portability. To improve his invention's sound-conducting

Figure 1. A caricature of Laennec holding a caricature of the stethoscope. Anonymous wood cut, 1824. Courtesy of the National Library of Medicine.

properties, the center contained a bore, which began as a quarter-inch round opening at the doctor's end and continued unchanged down its length until it neared the patient's end, where it gradually flared to almost the full diameter of the tube. The interior space thus had the configuration of a musical instrument, like a trumpet. To ensure its proper application, Laennec advised physicians to locate the hand that grasped the instrument close to the patient's body and to hold it like a pen. He called the invention "simply the cylinder, sometimes the stethoscope," the latter (from the Greek words for "chest" and "I view") being the name that became popular (Figure 1).

With the stethoscope in hand, Laennec intensely studied patients at the Necker Hospital to explore the uncharted realm of heart and lung sounds. For each disease investigated, he examined two or three patients, comparing the accuracy of diagnosis using traditional spoken

and observed symptoms with that of the sounds he heard with his stethoscope. Confirmation of the diagnosis was made by an autopsy, which demonstrated the relation between the sounds and the characteristic structural changes wrought by disease in the tissues of the body.

An example of the power of the new diagnostic technique is Laennec's discovery of a sound that confirmed the presence of the most widespread illness of his time, tuberculosis. He made the discovery while examining a woman who had a slight fever and benign cough. "On applying the cylinder below the middle of the right clavicle, while she was speaking, her voice seemed to come directly from the chest, and to reach the ear through the central canal of the instrument. This peculiar phenomenon was confined to a space about an inch square, and was not discoverable in any other part of the chest."[8] Being ignorant of its cause, Laennec examined most of the patients in the hospital at the time. He found the sign in about twenty patients, most of whom were in the advanced stages of tuberculosis. Several of those patients, however, like the woman in whom he first discovered it, had no symptoms of tuberculosis and exhibited a general robustness that appeared to rule out its presence in them. But autopsy of patients exhibiting this sign confirmed its accuracy.

Laennec declared that the sign, which he called pectoriloquism, "announced the presence of this disease [tuberculosis] . . . long before any other symptom leads us to suspect its existence. I may add, that it is the only sign that can be regarded as certain." People who had the basic symptoms of tuberculosis – a cough producing blood and pus, shortness of breath, a fluctuating fever, emaciation – sometimes recovered contrary to all medical expectations. In contrast, sometimes almost all the typical symptoms of tuberculosis were absent in patients who died of it. The stethoscope, Laennec concluded, "will help us distinguish the cases which are quite beyond the resources of nature and art, from those which still leave us room to hope."[9]

Laennec worked for three years to describe the character of sounds produced in the chests of healthy and sick people. In 1819 he published his opus, which was translated into English in 1821 bearing the title *Treatise on Diseases of the Chest, and on Mediate Auscultation*. The book did far more than establish a new group of signs that physicians could use to diagnose illness. It reformulated the relationship between doctors and patients, through the use of an instrument that took the mantle of illness out of the hands of patients and placed it in the doctor's

orbit. As noted, physicians had grown uneasy with and skeptical about the data patients gave them about their illnesses. Doctors recognized that some patients exaggerated the severity of their symptoms while others minimized them. Patients also might not correctly remember the sequence of events that led to or caused their symptoms. Laennec, while discussing the diagnostic significance of discharges from the body, expresses this concern: "We must never trust to the reports of patients themselves or of their attendants, as we are almost always sure of being misled by their prejudice or ignorance."[10]

Such limitations evaporated when physicians could focus on the acoustic signs of illness detected through the stethoscope. These sounds could be linked by physical principles to the anatomical lesions that produced them, while the sensations that patients experienced as symptoms had no such direct links to changes inside the body. For example, the eminent French scientist François Magendie, while experimentally investigating pathological heart sounds, found one that was produced by impediments to the passage of blood through the heart. "At least in all the post mortem examinations which I have made of patients who have exhibited this stethoscopic symptom during life," he wrote, "I have always found the pathological change now described."[11]

Advocates of the stethoscope asserted that the connection between physical principles and the acoustic signs made them more dependable than all other symptoms of chest diseases. "In truth," wrote a doctor, "the exact state of the functions of the heart and lungs cannot be ascertained except by the ear."[12] The point was reinforced in a public challenge made by a critic of the stethoscope to an advocate. The contest required both to evaluate the same patient: one with and the other without the instrument. A verdict emerged when the patient died and was autopsied. The stethoscope's champion emerged the victor.[13]

The ability of doctors to find diseases began to outstrip their ability to treat them, an imbalance that raised this question: why work to accurately diagnose an illness when effective therapy didn't exist? The answer given at that time still remains cogent. Without the knowledge that technology produced, doctors often diagnosed their patients incorrectly and treated them for the wrong diseases. Further, knowledge of the true condition from which a patient suffered, if incurable, freed doctors to halt often-aggressive treatments directed at cure and to

replace them with therapies that relieved symptoms and supported and comforted the patient. The most certain guide to treatment was knowing, noted a doctor in 1836, "the situation and extent of disease."[14] At this time the stethoscope was the leading edge of such knowledge.

Despite its benefits, many doctors opposed the stethoscope. An important cause, and a factor that continues to influence the spread of a new technology in medicine, is the problem of learning its use. Several obstacles appeared, one of which was the doctor's hearing. Some practitioners insisted that to practice auscultation, "what musicians call 'a good ear' or a delicate appreciation of minute differences of sound, is an important if not essential qualification."[15] Others worried about the mental challenge of discriminating sounds that reached the ear: "The diversity of hues in a rainbow, are not harder to be remembered than the variety of sounds given out by different bodies under different circumstances. . . . Whoever aspires to be proficient with the stethoscope had better construct a gamut for himself. . . . It requires the greatest attention to avoid error. Its use can only be acquired by unremitting perseverance."[16] Laennec disputed this view. He asserted that physicians needed only to study several patients with a given illness to learn the sounds marking its presence. The consensus that emerged from this debate was that several weeks of use gave basic learning, and several months produced an educated ear.[17]

A second aspect of the learning issue that delayed the stethoscope's acceptance was an unwillingness of doctors to become students again. Even after allaying their doubts about its value, those who feared leaving the security of older learning and trying to achieve prominence with an innovation resisted the stethoscope. A doctor observed that when such colleagues spoke of having tried auscultation and found it "useless or unavailable, the just conclusion may be deduced, that the attempt was commenced in doubt, followed without interest, and relinquished in wisdom."[18]

Physicians also worried about becoming instrument users and thus associated in the public mind not only with the common trades but also with surgery. The previously noted entrance of medical studies into the university in the thirteenth century had led to a separation of

surgery from medicine. United before, the textual and philosophical focus of university education led doctors to abandon and look down upon the surgical discipline, whose practice was technological and manually based. Cast out from the universities, surgeons studied mainly through apprenticeship until the mid-nineteenth century, when surgery was once again made part of medicine. This reunion was advanced by successful efforts to make the stethoscope and other technologies that would follow it commonplace elements in the work of the doctor.

Ironically, however, zealous supporters erected the greatest barrier to the acceptance of auscultation. They ignored its limitations, touted it as a universal gateway to diagnostic certainty, and demeaned the value of older diagnostic measures. By raising the expectations of those who tried the stethoscope beyond its ability to meet them, the enthusiasts sowed disillusion and fostered rejection. "Auscultation has suffered in this way from its friends," wrote a doctor.[19] The Harvard Medical School professor Oliver Wendell Holmes parodied the overconfident stethoscopist in a ballad published in 1848 called "The Stethoscope Song."[20] The song tells the tale of a doctor who went to the stethoscope's Parisian birthplace to study the instrument and returned to America entranced and, ultimately, victimized by its messages:

There was a young man in Boston town
  He bought him a STETHOSCOPE nice and new,
All mounted and finished and polished down,
  With an ivory cap and a stopper too.

It happened a spider within did crawl,
  And spun him a web of ample size,
Wherein there chanced one day to fall
  A couple of very imprudent flies.

The first was a bottle-fly, big and blue,
  The second was smaller, and thin and long;
So there was a concert between the two,
  Like an octave flute and a tavern gong.

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There was an old lady had long been sick,
  And what was the matter none did know;
Her pulse was slow, though her tongue was quick;
  To her this knowing youth must go.

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