scope to my patients' chests, but I do so often simply out of habit. But when I teach physical diagnosis, I exhort my students to learn it well. As Mr. Abbott taught me, you never know when the physical exam will hold the vital clue.

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The Stethoscope and the Art of Listening

Howard Markel, M.D., Ph.D.

Many physicians cling to Asclepios's staff as the quintessential insignia of our craft, no doubt debating endlessly whether it should have one or two ascending snakes. Some doctors cherish instead the symbolism of the white coats they don daily, which impart a hygienic air. Still others tightly clutch their beaten black-leather doctor's bags, once indispensable accessories for bygone house calls.

But with all due respect to these and a host of other treasured tokens, I contend that the stethoscope best symbolizes the practice of medicine. Whether absentmindedly worn around the neck like an amulet or coiled gunslinger-style in the pocket, ever ready for the quick draw, the stethoscope is much more than a tool that allows us to eavesdrop on the workings of the body. Indeed, it embodies the essence of doctoring: using science and technology in concert with the human skill of listening to determine what ails a patient.

Many doctors will gladly bore you with the details of their first stethoscope, and I feel compelled to make a disclosure of sorts. Mine was actually a "gift" from one of the pharmaceutical-industry representatives who clogged the corridors of my medical school during the 1980s, routinely tempting medical students with coveted freebies that are now strictly and deservedly prohibited. Just before graduating, however, I did the honorable thing and purchased a top-of-the-line doctor's stethoscope, with all the bells and diaphragms, which I still own. Alas, I do not use it much these days, but I still cling to the clinical conceit that I can distinguish between a diastolic murmur and a split second heart sound.

Long before Hippocrates (ca. 460–380 B.C.) taught his disciples the importance of listening to breath sounds, references to its usefulness appeared in the Ebers papyrus (ca. 1500 B.C.) and the Hindu Vedas (ca. 1500–1200 B.C.). Nevertheless, it was not until the early 19th century that physicians began to explore in a systematic way the precise clinical meanings of both breath and heart sounds by correlating data gathered during patient examinations with what was ultimately discovered on the autopsy table.[1]

This was the period when Paris reigned as the international center for all things medical. Drawing from a system of hospitals affording limitless access to what was then referred to as "clinical material," the Paris medical school boasted a talented faculty that represented the vanguard of medicine.

One of the brightest stars in this firmament was the man credited with creating the stethoscope, René Théophile Hyacinthe Laënnec (1781–1826). Long before he assumed the position of chief of service at the teeming Necker Hospital in 1816, Laënnec became adept at a technique called percussion, which involves striking the chest with one's fingertips in search of pathologic processes. Leopold Auenbrugger, the physician-in-chief of Vienna's Holy Trinity Hospital, first described the method in his 1761 treatise *Inventum novum*, but it was largely ignored until 1808, when Laënnec's professor and Napoleon's favorite physician, Jean-Nicolas Corvisart, translated Auenbrugger's text into French and began teaching it to his students and colleagues.

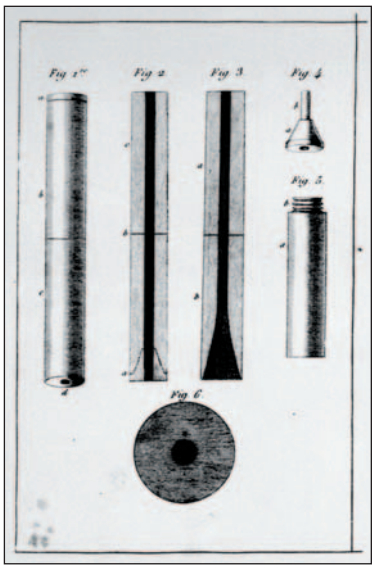
Yet neither percussion nor the time-honored technique of listen-

ing to breath sounds by placing an ear against a patient's chest satisfied Laënnec's demand for diagnostic precision. He was especially critical of physicians' inability to hear muffled sounds emerging from the chest of an obese person, and he balked at what he described as the "disgusting" hygiene of his patients, many of whom were unwashed or lice-ridden.

We do know that one day in the fall of 1816, Laënnec was scheduled to examine a young woman who had been "laboring under general symptoms of diseased heart."[2] He was running late, according to the most charming version of the tale, and so took a shortcut through the courtyard of the Louvre, where a group of laughing children playing atop a pile of old timber caught his attention. Laënnec became especially entranced by a pair of youngsters toying with a long, narrow wooden beam. While one child held the beam to his ear, the other tapped nails against the opposite end; all had a jolly good time transmitting sound.[3] Whether or not this instructive event ever occurred, Laënnec would later record that his invention was inspired by the science of acoustics and, in particular, the fact that sound is "conveyed through certain solid bodies, as when we hear the scratch of a pin at one end of a piece of wood, on applying our ear to the other."[2]

Fortunately, all can agree that what eventually transpired was one of the great "Eureka!" moments in the history of medicine. On entering his patient's room, Laënnec asked for a quire of paper and rolled it into a cylinder. Placing it against the patient's chest, the doctor was amazed to find how well he could "perceive the action of the heart in a manner much more clear and distinct than [he had] ever been able to do by the immediate application of the ear."[2]

Between 1816 and 1819, Laënnec experimented with a series of hollow tubes that he fashioned out of cedar or ebony, arriving at a model approximately 1 ft in length and 1.5 in. in diameter, with a 1/4-in. central channel. He would name his invention the stethoscope, derived from the Greek *stethos*, meaning chest, and *skopein*, meaning to observe.



A superb flautist who often used music to console himself during his own long and ultimately losing battle against tuberculosis, Laënnec pursued his studies with a vigor that belied the frailty of his frame. He became the first physician to distinguish reliably among bronchiectasis, emphysema, pneumothorax, lung abscess, hemorrhagic pleurisy, and pulmonary infarcts. He also opened the door to our modern understanding of cardiac maladies by describing their associated heart sounds and various murmurs.[4]

Initially, his magnum opus, *De l'Auscultation Médiate*, published in 1819, caused hardly a stir in the medical world — even at the price of 13 francs, with a stethoscope thrown in for an extra 3 francs. By the late 1820s, however, the book had been reprinted and translated into other languages and had managed to triumph over poor publicity and distribution. This success, combined with the gradual acceptance of the stethoscope by practicing physicians, allowed Laënnec to revolutionize clinical medicine.[5]

Although historians of medical technology consider the golden age of the stethoscope to have run from the publication of Laënnec's treatise to the death of Sir William Osler in 1919, the tool continues to be of great clinical value to those who take the time to learn how to use it. But as with all technological advances, its days were numbered from the start. To be sure, the stethoscope has not yet achieved quaintness, like the medieval physician's urine flask, but it is safe to assume that it, too, will someday be relegated to a museum shelf.

Yet even the stethoscope's predicted obsolescence is instructive and cautionary. After all, its creation initiated an irreversible trend in medicine by physically separating diagnosing physicians from their patients, albeit only by the length of a hollow tube. Today, with our advanced capabilities for noninvasive imaging and a host of other techniques that afford stunningly accurate glimpses into the human body, that distance has grown exponentially. Perhaps, then, as a reminder of how separation can alter the enduring

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task of physicians — listening to our patients — we ought to hang on to our stethoscopes a bit longer than practical usefulness dictates.

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FOCUS ON RESEARCH

Stroke and Neurovascular Protection

Gregory J. del Zoppo, M.D.

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Neurons are extremely sensitive cells, whose function, like that of all cells, can be influenced by changes in their environment. Using pumps to regulate the internal and external electrolyte milieu, neurons keep toxic calcium ions outside the cell but allow the cell membrane to transmit signals electrically. If changes in the environment damage the membranes or if the energy-driven pumps fail, calcium ions can enter the neuron and permanently disable it. Local oxygen deprivation, such as that which occurs during ischemic stroke, can lead rapidly to transient or permanent injury of neurons by affecting the cells' energy requirements, pump function, membrane integrity, or immediate environment.

For many years, biomedical researchers have hoped that agents could be developed for the treatment of stroke that would prevent the influx of calcium by blocking the regulated pores and ion channels, preserving membrane integrity, or inhibiting the cell pathways that lead to cell injury or death. Many such agents have been shown to decrease injury to cultured neurons or particularly sensitive neurons from the hippocampus of rodents in experimental models of ischemic stroke. Many of these "neuroprotectant" agents have been further tested in prospective clinical trials involving patients with ischemic stroke. The notion has been that giving patients such agents within hours after the onset of symptoms could preserve the function of neurons and reduce the extent of injury to the brain tissue or allow time for reperfusion strategies, such as the use of recombinant tissue plasminogen activator, to work. Most such agents, however, have failed to show any beneficial activity in patients with stroke.

The disappointing results of this line of research reflect our still insufficient understanding of the evolution of ischemic injury in the brain. They are also partially attributable to unforeseen limitations in how the modulation of channel properties in ischemic neurons might translate into tissue protection; problems with the design or conduct of clinical trials, including delay in treatment; and the complexity of cerebral ischemia in both experimental models and humans.

A general assessment of the causes of the failure of neuroprotectants to realize their promise in the clinic points to the complexity of postischemic brain injuries. Ischemia initiates inflammation, increases microvascular permeability (which produces tissue edema), and causes local hemorrhage, in addition to having direct effects on cells. Ischemic stroke has such effects because it is really a vascular disorder affecting neuronal function. Because neurons constitute less than 5 percent of the cells in cerebral gray matter, ischemia affects not only neurons but also astrocytes and other glial cells that support the neurons, the axons of neurons that relay their signals to other cells, and the microvessels that supply oxygen and nutrients to them. Neurons and microvessels respond equally rapidly to the ischemic insult.[1]

These observations have led recently to a shift in perspective from a focus on the neurons alone to a focus on the complex of neurons, the microvessels that supply them, and the supportive cells (astrocytes, other glial cells, and resident inflammatory cells). This