

I INTRODUCTION



THE CASE OF RICHARD CABOT

Paul Dudley White, the distinguished cardiologist, wrote of Richard Cabot after his death:

In every generation there are restless souls who cannot be made to fit the common mold. A few of these are valuable in keeping their communities and professions in a ferment by their constant challenge to the existing order of man's thought and action. But when, in addition to possessing these attributes, a rare individual is endowed with the divine fire and makes important contributions to the pioneering progress of humanity, then indeed we recognize a great leader. In the thick of the fray such recognition comes slowly but as soon as the smoke of the battle clears the acclaim is universal. (1939)

Born into an old Bostonian family in 1868, Cabot was graduated from Harvard College in 1889 with a major in philosophy, his father's pursuit. After considering a career in the Unitarian ministry, he chose medicine and was graduated from Harvard Medical School in 1892 at age 24. His senior thesis was on "The Medical Bearing of Mind-Care," a study of healing by Christian Science.

During his internship at Massachusetts General Hospital, Cabot published a paper entitled "Leucocytosis as an Element in the Prognosis of Pneumonia" (see White, 1939), in which he described the elevated white blood cell count in pyogenic infections. Cabot spent the following year in hematologic research. His studies of blood culminated in his first book, *A Guide to the Clinical Examination of the Blood*, which was published in 1896 and went through five editions. In its preface he wrote, "the first book of its kind, so far as I am aware." Despite a busy private practice and service to outpatients at Massachusetts General Hospital, Cabot published a monograph, *The Serum Diagnosis of Disease*, in 1899, and

another, *Physical Diagnosis of Diseases of the Chest*, in 1901. He expanded the latter book to include the rest of the body, writing twelve editions from 1901 to 1938. His book, *Differential Diagnosis*, published in 1938, went through seven editions. He emphasized errors of omission and commission in clinical diagnosis.

Cabot devoted much time to clinical research, gathering data from a large number of cases and then applying statistical analysis. He sought facts. After examining autopsy reports of 3000 cases, Cabot wrote in 1912 a controversial paper in which he pointed out “a goodly number of ‘classic’ time-honored mistakes in diagnosis.” In response to a Chicago physician who criticized his pessimism, Cabot wrote:

When he has had three thousand clinical diagnoses criticized at autopsy by an independent and unprejudiced pathologist who makes full bacteriologic and histologic examinations of every case, he will find, I believe, that the facts are not less unpleasant than I have stated them to be. He will know that his most scrupulous and careful examination of the precordia often fails to reveal acute pericarditis when it is present; that his examination of the urine will not always distinguish either acute or chronic nephritis from other conditions resembling them, and that mitral stenosis and aortic stenosis are sometimes overlooked by the best diagnosticians. (1913)

Cabot’s paper on “The Four Common Types of Heart Disease” appeared in 1914 and is a landmark in medical history. For the first time, heart disease was classified according to its cause, which was a revolutionary point of view. He reported that 93% of 600 cases of heart disease were of either rheumatic, atherosclerotic, syphilitic, or nephritic etiology. Paul Dudley White (1939) described Cabot as the greatest contributor to cardiology in his generation.

After Walter B. Cannon introduced the idea of case teaching in medicine in 1900, Cabot became its most ardent advocate. His *Exercises in Differential Diagnosis*, published in 1902, consisted of 43 case summaries, each ending with the questions “Diagnosis? Prognosis? Treatment?” Cabot stressed the importance of deciding on a diagnosis and writing it down. He believed that “after the student has learned to open his eyes and see, he must learn to shut them and think” (1908). He considered the case method superior to other methods of teaching medicine. Wrote Cabot,

By using this method a single teacher can keep a large class of students actively busy. They are not merely listening or watching; they are doing the work of construction themselves. In lectures or large amphitheatre clinics the whole class is managed by one teacher, but the teacher does the work and hence the student’s gain is relatively slight. (1908)

Cabot believed strongly in student participation, that the case method of teaching succeeds when the students are called on by name, that “only if no one in the class knows the answer should the teacher give it himself; for the process of answering serves to fix the fact in the student’s mind and he should never be deprived of this benefit” (1908). The clinicopathologic conference, or CPC, was originated by Cabot in 1910, a result of his emphasis on the case study and the confirmation of a diagnosis by autopsy. His regular conference was held at Massachusetts General Hospital, a record of which was edited by him and published in the *Boston Medical and Surgical Journal* (now the *New England Journal of Medicine*) from 1924 to 1935.

Apart from his medical activities, Cabot gave much attention to social services, which he founded at Massachusetts General Hospital in 1905. His book, *Social Service and the Art of Healing*, appeared in 1909. Cabot's lifelong interest in ethics resulted in several books on the subject, and in 1919 at age 51, he was appointed professor of social ethics in addition to professor of clinical medicine. He was working on a philosophical treatise called "Creation" when he died in Boston in 1939.

—CHARLES STEWART ROBERTS

REFERENCES

Cabot RC. Case teaching in medicine. Boston: D.C. Heath, 1908.

Cabot RC. Diagnostic pitfalls identified during a study of three thousand autopsies. JAMA 1912;59:2295-98.

Cabot RC. Letter. JAMA 1913;60:145.

White PD. Richard Clarke Cabot 1868-1939. New Engl J Med 1939;220:1049-52.

1

The Origins of the History and Physical Examination

H. KENNETH WALKER

Each of us should strive "to rise above the routines of the daily ward round and to see in every patient an opportunity not only to serve mankind in the best tradition of medical excellence, but to add to the store of medical knowledge."

—A. MCGEE HARVEY (1973)

Ten individuals are responsible for the development of modern physical diagnosis: Hippocrates, Vesalius, Morgagni, Sydenham, Auenbrugger, Corvisart, Laennec, Louis, Mueller, and Osler. Their accomplishments form a "golden thread [that runs] throughout the history of the world, consecutive and continuous, the work of the best men in successive ages" (Moxon, quoted by William Osler). The pool of information presented in this book has been created by the scholarship of these ten men. They were physicians going about the daily practice of medicine. The story of their achievements serves to stimulate the spirit of inquiry in each of us and underscores the obligation we have to add to this pool of knowledge. This chapter traces the historical evolution of modern clinical diagnosis. Knowledge of this evolution provides the student with a foundation upon which to build mastery of the art and science of diagnosis.

Seven crucial developments over the past 3000 years shaped physical diagnosis as we know it today. Hippocrates and his colleagues laid the foundations by establishing medicine as a profession and by declaring that it has a rational basis. The second development was the resumption of the dissection of human bodies for educational purposes, beginning in the thirteenth century in Italy. Vesalius was thereby able to publish an accurate human anatomy text in 1543, and Morgagni to establish morbid anatomy, or pathology, as a discipline in 1761. The third development was Sydenham's definition of disease between 1666 and 1683, leading to the nosological concept of disease. The actual beginnings of physical diagnosis occurred with the discovery of percussion by Auenbrugger in 1760, and its dissemination by Corvisart in 1808. Laennec invented the stethoscope in 1816, beginning a century of explosive development in physical diagnosis. The French School, exemplified by Pierre Louis, synthesized the previous developments and put physical diagnosis on a secure footing at the bedside and in the autopsy room during the period 1800 until 1850. The German School, epitomized by Johannes Mueller, laid the foundation for experimental laboratory science from 1830 until 1900. These six developments were applied to medical education by William Osler in the medical clinic at Johns Hopkins University in 1893, thereby revolutionizing medical education and the practice of medicine in America and the Western world. Table 1.1 summarizes these developments.

There were a number of important developments in addition to the seven crucial ones outlined above: the model of bedside teaching developed by Boerhaave at Leyden about 1700; the development of precision instruments such as the thermometer, microscope, ophthalmoscope, kymograph,

and sphygmomanometer; and the discovery of the x-ray. The urban migration in Europe in the late 1700s and early 1800s, coupled with the development of the French hospital system, made available to physicians a concentration of human illness never seen before. The ascendance of the German and American university had a profound influence on medicine. Once again, the genius of William Osler wove all these threads into the fabric that established clinical diagnosis and medical education as it exists today.

Hippocrates: A Rational Profession 460–370 B.C.

Physical diagnosis had its origins in Grecian medicine. Clinical medicine flourished before the Greeks, especially in Egypt, Crete, and Babylonia, and undoubtedly the Greeks were influenced by these earlier physicians. But writings from these countries did not become part of the mainstream of Western civilization, as did those of the Greeks. Table 1.2 contains two quotations that illustrate the level of medicine practiced by the Greeks. They took a careful history and practiced direct auscultation. They were masters of observation: their descriptions of patients could fit modern texts without much change.

Greek medicine flourished early. Homer in the *Iliad* (ca 1200 B.C.) described 141 wounds and used 150 anatomic terms. Hippocrates (ca 460–370 B.C.) lived during the Golden Age of Greece. His contemporaries included Plato, Socrates, Aeschylus, Sophocles, Euripides, Aristophanes, and Pericles. Medicine "became in his hands an art, a science, a profession" (Major, 1954). The Hippocratic writings are probably a collection from a number of individuals, including the master, from the period during which he was the dominant medical figure. They were collected after the death of Hippocrates and stored in Alexandria. From there, they were disseminated to all parts of the civilized world. The surviving collection contains 42 clinical cases, the likes of which are not encountered again for 1700 years. These cases demonstrate a high level of medicine that included a careful history, inspection, palpation, direct auscultation, and examination of the sputum and urine.

An enduring contribution of the Hippocratic school was the conviction that disease is natural and not divine. Consider the remarks about epilepsy: "It is thus with regard to the disease called Sacred: It appears to me to be no wise more divine nor more sacred than other diseases, but has a natural cause from which it originates like other affec-

Table 1.1
Crucial Developments in the History of Physical Diagnosis

Date	Person	Development
ca. 400 B.C.	Hippocrates	Medicine as a profession; disease natural, not divine
ca. A.D. 1300		Dissection of human bodies resumes
1543	Vesalius	<i>Fabrica</i> published; first accurate anatomy text
ca. 1670	Sydenham	Nosology of disease
1761	Morgagni	<i>De Sedibus</i> published. Pathology begins
1761	Auenbrugger	Percussion discovered
1808	Corvisart	Popularization of percussion
1816	Laennec	Stethoscope
1800–1850	Louis	French School
1830–1900	Mueller	German School
1893	Osler	Medical clinic at Johns Hopkins

tions” (Delp and Manning, 1981). This was a major conceptual leap. Natural phenomena can be studied and their course predicted. This concept was a necessary prerequisite to the development of physical diagnosis.

The Greeks did not develop an accurate knowledge of human anatomy and pathology. Dissection of human bodies did not occur except for a brief time at Alexandria in the third century B.C. The Greeks had no concept of nosology. They felt that disease was caused by an imbalance of the four humors of the body: blood, yellow bile, black bile, and phlegm. Developments on these three fronts—anatomy, pathology, and the nosology of disease—did not begin to occur until the thirteenth century.

The next great Greek physician after Hippocrates was Galen (ca A.D. 130–201), who was born in Pergamum. He spent most of his professional life in Rome, becoming physician to the Emperor Marcus Aurelius. He was a prolific author. Many of his works have been lost; the surviving ones fill twenty-two volumes. He studied and wrote extensively about anatomy based upon pigs and monkeys. He was the first experimental physiologist. He supplemented his findings by speculation. His written work was accepted as the ultimate truth until the time of Vesalius. This enshrinement of knowledge, much of which was incorrect, hampered medical progress for the next 1500 years.

Vesalius: Establishment of an Accurate Anatomy, 1543

Andreas Vesalius founded modern anatomy with the publication of *De Humanis Corporis Fabrica* (On the Structure of the Human Body) in June 1543. His book was based upon personal dissection of human bodies. This represented a remarkable departure from the zoological anatomy of Galen. The accomplishments of Vesalius were possible because of the resumption of the dissection of human bodies that began in the thirteenth century.

Human dissection was rare before the thirteenth century. The Egyptians knew the body organs, but only after extracting them through tiny incisions made for the purposes of embalming. There is continuing controversy about human dissection during the Hippocratic period. A knowledge of anatomy, except the skeleton, is scanty in the Corpus Hippocraticum. The consensus is that human dissection was

Table 1.2
Quotations Illustrating the Level of Greek Medicine

One should pay attention to the first day the patient felt weak; one should inquire why and when it began. These are the key points to keep in mind. After these questions have been cautiously considered, one should ask the patient how his head feels, or if he has any pain or if he feels heavy. . . . In regard to the chest, one should ask the patient if he has pain there and if he has a slight cough, with pain in the abdomen when he coughs (Littre's Translation of Hippocrates, 2, 436–40: *Regimen in Acute Disease*. Appendix #9).

Source: Quoted by Siegel, RE. Clinical observation in Hippocrates: an essay on the evolution of the diagnostic art. J Mount Sinai Hosp 1964;31, 285–86.

not practiced during the Hippocratic period, either because of reverence for the human body or belief in a life after death that required an intact body.

Dissection for the purpose of acquiring a knowledge of the human body probably originated in Alexandria, Egypt, in the fourth century B.C., 100 years after Hippocrates. Herophilus studied the nervous system and gastrointestinal tract, describing the cerebrum, cerebellum, meninges, fourth ventricle of the brain, duodenum, and the eye. He counted the pulse with a water-clock, and analyzed the rate and rhythm. Erasistratus (ca 310–250 B.C.) described the aortic and pulmonic valves and the chordae tendineae of the heart. He clearly saw that the heart was a pump, although he had the direction of circulation backward.

The practice of human dissection in antiquity was confined largely to Alexandria. Some dissection apparently occurred in Rome until the second century A.D., but it must have been sparse. Galen (A.D. 129–200) said Alexandria, where he had studied, was the only place where anatomy could be learned. There is no good evidence that Galen himself practiced human dissection.

Human dissection began again in the thirteenth century in Bologna, one of the great medieval universities, and has continued uninterrupted through the present time. Several occurrences during the early thirteenth century set the stage for the lifting of the taboo against disturbing the human body. Emperor Frederic II issued an imperial decree in 1238 authorizing the performance of public “anatomies” on the bodies of executed criminals for teaching purposes. Legend has it that Frederick II also had the stomachs of two of his subjects opened in order to determine if digestion was enhanced by exercise or by rest. Another sign of the relaxation of the concept of the sanctity of the human body during the thirteenth century was the practice of dismembering the bodies of the Crusaders and boiling the parts so that the bones could be returned to their families in Europe for burial. A more specific reason for the resumption of human dissection probably had to do with the legal scholars at the University of Bologna, which was famous for its law school. The scholars were concerned to know the causes of deaths for legal reasons.

Mondino of Bologna (ca 1270–1326) was the predecessor of Vesalius in the founding of anatomy. In 1316 he wrote his *Anothomia*, the first text exclusively on anatomy. It was based on his own dissection of humans. This book was published at Padua in 1487 and went through 39 separate editions and translations. It was an unillustrated manual or handbook of dissection and not a formal anatomic text. His method was to begin with the abdominal viscera, then go to the chest and neck. The book ends with the opening of

the skull. The manual was a student favorite and was widely used. Mondino's anatomic work was continued by his students, and dissection became more popular. A public dissection occurred at Padua in 1341. Public dissections were decreed at the University of Montpellier in 1366, at Venice in 1368, and at Florence in 1388. In Padua an anatomic theater was erected in 1445. These events set the stage for Vesalius in the sixteenth century.

Vesalius was born in Brussels in 1514–1515, the son of a Flemish family that had been in medicine for many generations. He was said to be interested in anatomy even as a youth, dissecting mice, rats, dogs, and cats. He studied anatomy in Paris under Sylvius, a famous scholar who declared Galen was infallible. In 1537 he went to Padua, where he received his medical degree. For the next 5 years he worked prodigiously as professor of medicine and surgery, breaking tradition by personally performing all the dissections. At the end of these 5 years, he published his *Fabrica*. He was 28.

The *Fabrica* was sumptuously illustrated by Titian's pupil Jan Kalkar, who was the first to attain what Choulant calls the true anatomic norm, that is, a picture at once scientifically exact and artistically beautiful, summing up, as in a composite photograph, the innumerable peculiarities and minor variations in structures encountered in dissection. The splendid wood-cuts representing majestic skeletons and flagged figures, dwarfing a background of landscape, set the fashion for over a century and were copied and imitated by a long line of anatomic illustrators. . . . (Garrison, 1929, p. 219)

Vesalius provided the accurate anatomic base upon which physical diagnosis could be built. In the words of Major (1954, p. 404):

Few men in medical history have dominated their subject or their epoch as did Andreas Vesalius. The history of anatomy is divided into three periods: the pre-Vesalian Period, the Vesalian Period, and the post-Vesalian Period—a tribute to the genius of this great anatomist.

Sydenham: The Nosology of Disease, 1666

Nosology is the branch of medicine that deals with the concept, definition, classification, and nomenclature of disease. The historic development of nosology was fundamental to the evolution of diagnosis. A concept essential to modern medicine is that a particular disease can cause manifestations that can be quite different from one individual to another. The definition of what constitutes a disease began with Thomas Sydenham in seventeenth-century England. Sydenham (1624–1689) was born at Wynford Eagle in Dorset. He obtained his bachelor of medicine from Oxford in 1648. He was a captain in the cavalry during Oliver Cromwell's campaign in Scotland against Charles II. When the Restoration came in 1660 and Charles II became king, Sydenham had no political future "and he had no resource other than a serious devotion to the practice of medicine, an event with important benefits to all succeeding generations of physicians" (Harvey, 1973). He began practicing medicine in London in 1663, after having a lot of trouble passing the examination of the Royal College of Physicians.

The London of Sydenham's day was notable for the occurrence of one murderous epidemic after another (Faber, 1923). An epidemic of an acute infectious disease such as

smallpox or cholera, which struck thousands suddenly and left just as swiftly, provided the ideal setting for the development of modern nosologic concepts: a great many previously healthy individuals were suddenly afflicted by what was clearly the same illness, which at the same time varied in its manifestations from one person to another. An idea of the magnitude of these epidemics can be gotten from population estimates: in 1665 the plague killed about 100,000 of 600,000 inhabitants. The plague stopped by 1667, but in that year smallpox killed 1300, cholera 2000, phthisis 3000, and only 1000 died of old age (Faber, 1923). These figures, although of questionable exactness, nevertheless depict accurately the effects of these diseases.

In contrast to his contemporaries, Sydenham thought it was possible, albeit difficult, to construct an accurate picture of each disease:

And, in truth, it is my opinion that the principal reason of our yet being destitute of an accurate history of diseases, proceeds from a general supposition that diseases are no more than the confused and irregular operations of disordered and debilitated nature, and consequently that it is a fruitless labor to endeavor to give a just description of them. . . . [The symptoms] observed by Socrates in his illness may generally be applied to any other person afflicted with the same disease, in the same manner as the general marks of plants justly run through the same plants of every kind. Thus, for instance, whoever describes a violet exactly as to its colour, taste, smell, form, and other properties, will find the description agrees in most particulars, with all the violets in the universe. (Faber, 1923, pp. 8–9)

Sydenham laid down four principles that he felt to be important (Faber):

- All diseases should be classified in species, just as botanists do plants.
- Hypotheses and philosophical speculations should be eschewed in favor of an objective description of each disease, described with the same accuracy as when an artist paints a portrait.
- The manifestations that are constant in each patient with a particular disease should be distinguished from other phenomena that could be due to the age, constitution, or treatment of the patient.
- The season of the year in which the disease occurs should be noted because some diseases "follow the season as surely as many birds and plants."

Sydenham's first book was on fever: *Methodus Curandi Febres* (1666). His most prominent work is *Tractatus de Podagra et Hydrope* (1683). In it he separated gout (from which he suffered) from the entities that had been called rheumatism. Sydenham stressed personal independent observation. He "first gave clinical observation its place of honor as a scientific method—one which for those who cultivate it effectively is still today a basic asset of the complete physician" (Harvey, 1973, p. 124).

The next physician interested in the classification of diseases was Sauvages. In 1731 he published a book in which he grouped diseases in classes, orders, and genera, just as the biologists were doing with plants and animals. This book came to the attention of Linnaeus, who published his *Systema Naturae* in 1735. The two men carried on a lifelong correspondence. Sauvages published his principal work in 1763, *Nosologia methodica sistens morborum classes, genera et species*. He

described 2400 diseases, divided into 10 classes and 40 orders. In the preface he discussed principles for classifying disease, choosing symptoms as the basis for his scheme. This led to many difficulties, given the nature of medical knowledge at the time. There were 18 kinds of angina, 19 types of asthma, 19 species of dysphagia, 13 different species of anorexia, etc. This work had much influence upon contemporary medicine; detailed nosologies following his system appeared in various countries. These nosologies, however, did not appreciably influence the practice of medicine. The differences between the nosologists of the eighteenth century and Sydenham is that they merely catalogued and arranged symptoms, while he characterized diseases. Sydenham delineated each disease by its manifestations and clinical course. Succeeding nosologists classified symptoms. The distinction between symptom and disease was not appreciated.

The next advance was the development of the discipline of pathologic anatomy by Morgagni, which is described below. Morgagni established the concept of whole organs being diseased. Philippe Pinel of Paris published his *Nosologie philosophique* in 1798. This book stressed the importance of arriving at the typical picture of a disease, ignoring the varying picture in each individual patient. He characterized 2700 diseases and divided them into classes, orders, genera, and species. He grouped diseases that involved a particular tissue together, such as all diseases of the mucous membranes. This was an entirely new concept. Previous authors had arranged disorders according to anatomic location: heart, lungs, etc. Bichat expanded upon this idea and showed how disease of each type of tissue could give rise to two different kinds of symptoms. One group of symptoms is dependent upon the particular tissue involved, and the other group is caused by dysfunction of the affected organ. Laennec, who was greatly influenced by Bichat, produced a revolution in nosography with the publication of his book on auscultation (see below). Laennec wove symptoms, signs, and pathologic findings into a series of classic diseases, many of which he was the first to describe: emphysema, bronchiectasis, pneumothorax. His great achievement was to take many different conditions grouped under the name phthisis and show that they were all different stages of one disease, tuberculosis. He "demonstrated that the process usually begins in the apex of the lung, and that various anatomical changes may be demonstrated by means of stethoscopy, and finally he conceived and described tuberculosis of the lungs as a special disease differing from all other disease processes" (Faber 1923). Modern nosology begins with Laennec.

Morgagni: The Foundation of Pathologic Anatomy, 1761

Morbid anatomy had its origins alongside descriptive anatomy. The first known forensic autopsy was done in 1302 in Bologna, which is also where Mondino started descriptive anatomy (Klemperer, 1957). The body of an individual named Azzolino was examined because the authorities felt his death was suspicious. "Visceral congestion" was found, and the authorities investigated no further. The great descriptive anatomists of the time all were quite interested in morbid anatomy. The bodies of executed criminals were dissected for teaching purposes (*anatomia publica*), and the bodies of individuals who died of disease were also examined (*anatomia privata*). Vesalius inquired carefully into the

history of the bodies he dissected, and planned to publish his records, but apparently they were lost or destroyed.

Many of the great physicians and anatomists of the 1500s and early 1600s strongly advocated autopsies as a means of furthering clinical medicine. Johannes Schenck von Grafenberg (1534–1576) collected pathologic reports of preceding years, as well as his own experiences, into seven volumes. His book had a classified index and a collection of aphorisms designed to arouse interest in pathology. Wilhelm Fabry von Hilden, a physician in Bern, wrote a book in which he called attention to what had been learned from autopsies. He noted Germany was behind France and Italy in medicine because fewer autopsies were performed in Germany. The public apparently was willing to support autopsies, and, in fact, often requested that they be done on relatives in order to determine the cause of death. The situation in the British colonies of North America mirrored that of Europe. Cotton Mather in Boston described congenital rectal atresia in an autopsy done on his own son. In Copenhagen, Bartholin was given permission by the authorities to perform autopsies on patients who died in the public hospitals. Bartholin gave in detail methods by which permission for autopsies could be obtained as well as other techniques for gaining the information: looking through a previously existing surgical incision; inspecting bodies while they were being embalmed. He recommended that deception could be used, but he advocated caution and tact (Klemperer, 1957).

Theophil Bonetus (1618–1689) was Morgagni's predecessor as the founder of pathologic anatomy. He was a physician who gave up practice in Geneva at the age of 50 because of deafness, and spent the rest of his life writing medical books. He collected 3000 cases and published in 1679 the *Sepulchretum*. The full title reads as follows: "Repository of anatomy practiced on corpses deceased of disease, which reports the histories and observations of all alterations of the human body and reveals the hidden causes. Indeed, anatomy deserves to be called the foundation of real pathology and of proper treatment of disease, even the inspiration of old and recent medicine." The book was designed to contain each recognizable disease known up to that time, with a description of the clinical features followed by the autopsy findings. This book was highly influential and gave great impetus to pathologic anatomy.

Lancisi of Rome made important contributions to pathology with the publication of *De Subitaneis Mortibus* in 1707. His book contained autopsies on the cases of sudden death in Rome in 1706. The stimulus for his work was the panic of the Roman populace over the large number of sudden deaths in that year. The clinical and anatomic descriptions are detailed, with every effort made to correlate the two. The observations were precise—for example, exact measurements of body organs were given. The causes of unexpected death included cerebral hemorrhage and hypertrophied hearts; valvular vegetations were described clearly. Lancisi's book illustrates the trend toward making clinicoanatomic correlations.

Hermann Boerhaave (1668–1738) of Leyden was largely responsible for correlating autopsy results with what was found at the bedside. He was one of the great consulting clinicians of his time—his reputation extended even to China, and he was regularly consulted by emperors. Students from all of Europe sought his teaching and in turn became the leading physicians of the eighteenth century. Bedside teaching of clinical medicine had begun at Padua, and was brought to Leyden by Heurnius. Boerhaave made bedside teaching

an art form. He was given two wards in an old hospital for the purpose of teaching students, one with six beds for men and the other with six beds for women. "On twelve beds half the physicians of Europe were trained!" (Sigerist, 1951). Boerhaave made daily rounds with his students, reviewing the history, inspecting the patient, examining the urine. The patient was not examined to any extent, since percussion and auscultation had not been discovered. Boerhaave made his students attend the autopsy on each patient who died. He felt postmortem examinations were essential: "In spite of the most detailed description of all disease phenomena one does not know anything of the cause until one has opened the body." He continues (in his introduction to one of his books) to say he will try to give an accurate picture of his observations in order that in subsequent similar cases the disease can be diagnosed early and cured.

Giovanni Battista Morgagni established pathology as it is known today with the publication of his monumental work *De sedibus et causis morborum* (The Seats and Causes of Diseases) in 1761. Morgagni was born in 1682 and received his medical degree from Bologna. In 1715, on the recommendation of Lancisi, he was appointed professor of anatomy at Padua, filling the chair held previously by Vesalius. He became a popular teacher, with many foreign students coming to Padua just to attend his lectures. His fame as a scholar and pathologist was such that Samuel Johnson, upon being asked by Boswell if he believed the tale that a scorpion surrounded by a ring of fire will withdraw to the center and commit suicide, answered: "I will believe it if the autopsy was performed by Dr. Morgagni" (Klemperer, 1957).

He started out to write *De sedibus* in order to update Bonet's *Sepulchretum*, correct it, and add to it his own material. His book

. . . remains one of the imperishable books of medical literature. Many authors previously had recorded the results of autopsy findings in an attempt to explain the cause of death. But here, for the first time we find a vast array of pathological findings, well arranged and indexed, each preceded by a minute history of the disease, the symptoms present, the treatment employed, and finally a discussion of the relationship between the clinical picture and the autopsy findings. Morgagni's knowledge of the literature of the subject is apparent on every page, where he discusses previous articles on the subject and meticulously gives each author due credit for his own observations. He often begins with Aristotle and reviews the entire literature down to his own time.

The number of pathological states described by Morgagni, many of them for the first time, is enormous. He described syphilitic aneurysms, acute yellow atrophy of the liver, pneumonia with consolidation of the lungs, meningitis due to acute otitis, hyperostosis frontalis, cancer of the stomach. . . . (Major, 1954, p. 587)

De sedibus was published when Morgagni was 79; it was the fruit of 60 years of devoted work. As Virchow said, he introduced the "anatomical concept" into medicine. His work profoundly influenced the next century of medicine.

Auenbrugger: The Discovery of Percussion, 1761

Modern physical diagnosis began with the discovery of percussion by Leopold Auenbrugger in 1761 and its popularization by Jean Corvisart in 1808. The concept of anatomic

localization of disease in the living patient originated with the discovery of percussion, was given powerful impetus by Laennec's stethoscope in 1816, and became firmly entrenched with the discovery of x-rays by Röntgen in 1895.

Before Auenbrugger, physicians could not discover the location of internal disease during the life of the patient. Diagnostic methods, as illustrated by Boerhaave, were confined to the history, inspection at the bedside, taking the pulse, and scrutinizing the excretions of the patient. The stage for the "in vivo autopsy" was set by the contributions of Vesalius and Sydenham. Clinical knowledge had grown by slow accretion over the centuries since Galen by the efforts of the Arabs, by Boerhaave and his students, and by other great clinicians. The beginnings of modern physiology had occurred with the demonstration of the circulation by William Harvey (1628). Morgagni had established pathologic anatomy and correlated autopsy findings with the clinical history. But Morgagni's contributions had little value in the face of the inability of the physician to ascertain the state of diseased organs inside the patient during life. Auenbrugger conferred this ability upon the physician; he "opened up the world of the ear as a clinical instrument. Clinical observation, though never blind, had been deaf."

Leopold Auenbrugger (1722–1809) was born in Graz, the son of an innkeeper. Legend has it that his discovery of percussion was based upon observing his father tap wine casks in order to ascertain the amount of wine present in the cask. He studied medicine in Vienna under van Swieten, whom he revered. Gerhard van Swieten was Boerhaave's favorite student, and brought the latter's insistence upon bedside teaching and the importance of the autopsy to Vienna, creating what was known as the Old Vienna School. Upon graduation, Auenbrugger became physician to the Spanish Hospital in Vienna. Although initially founded as the hospital for citizens of Spain, Italy, and Holland, at the time of Auenbrugger it was mostly a hospital for soldiers. The discovery of percussion occurred during his years at this hospital.

Auenbrugger published his *New Invention by Means of Percussing the Human Thorax for Detecting Signs of Obscure Disease of the Interior of the Chest* in 1761. This 95-page book was based upon seven years' experience with working out the principles of percussion at the Spanish Hospital. The book was published on New Year's Eve, 1760. It begins as follows:

I here present the reader with a new sign which I have discovered for detecting diseases of the chest. This consists in percussion of the human thorax, whereby, according to the character of the particular sounds thence elicited, an opinion is formed of the internal state of that cavity. In making public my discoveries respecting this matter, I have been actuated neither by an itch for writing, nor a fondness for speculation, but by the desire of submitting to my brethren the fruits of seven years' observation and reflection. (Keele, 1963, p. 44)

Auenbrugger recommended that percussion be carried out with the physician's hand gloved with unpolished leather or that the patient's chest be covered by a tight-fitting shirt. The patient was struck with the points of the extended fingers held close together. This is known as direct, or immediate, percussion. The normal note "resembles the stifled sound of a drum covered with a thick woollen cloth or other envelope." "If a sonorous region of the chest appears, on percussion, entirely destitute of the natural sounds—that

is, if it yields only a sound like that of a fleshy limb when struck—disease exists in that region.” He injected fluid into the chests of cadavers and studied the percussion notes produced. He percussed during inspiration, during expiration, and at the end of a full inspiration. He distinguished four percussion notes (Jarcho, 1959): normal, tympanic, dullness, and flatness. The percussion notes associated with various thoracic diseases were outlined. He also listed diseases that could not be discovered by percussion. He described cardiac dullness to percussion, thereby outlining the position of the heart in the chest.

Auenbrugger's book received unfavorable and even hostile reviews. It was apparently little noticed until Maximilian Stoll became the leader of the Old Vienna School and used percussion in the clinics. One of Stoll's pupils, Josef Eyerel, wrote a paper on percussion that by chance was noticed by the French clinician Corvisart, who was stimulated to obtain a copy of *Inventum Novum*.

Jean Nicolas Corvisart (1755–1821) was France's greatest clinician during his time. He was born in the small village of Dricourt in Champagne. He received his degree in Paris in 1785. He was a hard worker and inspiring teacher, and by 1797 he was professor of practical medicine in the Collège de France, the highest teaching honor in France. He was deeply interested in diseases of the heart, publishing in 1806 a remarkable book on cardiac disease. He classified heart disease by anatomic structure (muscle, valves, endocardium, etc.), used the term “organic lesion,” and distinguished between hypertrophy and dilation (Major, 1954). His fame and ability were such that he became Napoleon Bonaparte's physician.

Corvisart recognized the value of Auenbrugger's work and set about testing it on the wards. His technique differed from Auenbrugger: he used the palmar surfaces of the closely approximated and extended fingers. After twenty years' experience with percussion, he published his findings in 1808, together with an unabridged translation of *Inventum Novum*. Corvisart chose as the motto of his translation *Resonvere Cavae Cavernae*: “the hollow cavities resounded” (Buck, 1933). This comes from the second book of Virgil's *Aeneid*, where Laocoon threw his spear at the wooden horse, with the result as described. The great prestige of Corvisart immediately established percussion as an important physical diagnosis tool. His revival of Auenbrugger's discovery and the latter's resulting fame occurred just a year before Auenbrugger's death.

The next name in percussion is that of Pierre Adolphe Piorry (1794–1879), who invented the pleximeter. He was born in Poitiers and received his medical degree in Paris in 1816, studying under Corvisart. Piorry worshipped Laennec and desired to contribute something equally important to medicine. The idea of the pleximeter is said to have come to him once when, scratching himself due to pruritus, he noted the sound made by the scratching. He scratched over a coin, and noted the louder sound thereby produced. He went on to design a small plate, which he placed between the percussing finger and the skin. He called this plate a pleximeter (from the Greek words “to strike” and “to measure”). He felt this had the advantages of diminishing the pain to the patient as well as improving the quality of sound. His plate was ivory, 5 cm in diameter. Piorry used his fingers to strike the pleximeter. English and American visitors started using the fingers of the left hand as the pleximeter, and Wintrich later introduced the percussion hammer (Bedford, 1971). The hammer was later adopted for use as the

reflex hammer (see below). The technique introduced by Piorry is known as mediate percussion—that is, something is between the finger and the skin.

A familiar and characteristic sight at his clinical demonstrations at the Pitié was Piorry sitting on a high stool, which was moved from bed to bed, and by careful pleximetry he mapped out the patient's organs on the skin, using coloured crayons, so that the patient's torso ended up looking like a geographical map (Gueniot, 1927). He tried to convince observers that every organ had a special percussion sound, and he played on his pleximeter like a virtuoso on a musical instrument. He came to be known as the “medical Paganini” (Ebstein, 1911). There were many anecdotes, no doubt fictitious, related about him, such as that he paid a visit to the Royal Palace in the Tuilleries and demanded to see the King, but was told that the monarch was not in his reception room. Piorry then decided to percuss the closed door with his pleximeter, detected a certain dull sound and diagnosed the presence of the King in his chamber! (Monpart, 1902) (Sakula, 1979, p. 578)

Laennec: The Stethoscope, 1816

The significance of the development of the stethoscope was not merely that the sounds of the heart could be heard clearly for the first time:

Laennec did more than discover auscultation, much more. It was he who first sought and found the confirmation of the clinical diagnosis at the autopsy table and united pathological anatomy and clinical medicine by an inseparable bond. Morgagni had raised the question, what changes are produced by the disease? Laennec went further and asked by what symptoms or signs are these changes to be recognized during life? In answering this question Laennec created local diagnosis (Naunyn). (Pratt, 1935, p. 204)

Laennec not only “united pathological anatomy and clinical medicine by an inseparable bond,” but he singlehandedly created a new discipline in medicine. Laennec had a mind that had been prepared for the discovery of “mediate” auscultation (immediate auscultation is the listening to the body directly; mediate is listening to the body through another object, such as the stethoscope):

Laennec's *De l'auscultation médiate* was the product of three years of the most intensive work with his new stethoscope and, also, of more than 18 years of close study of problems in pathology and clinical medicine. It is far more than a manual for the stethoscope. It is, also, a treatise on diseases of the lung and of the heart, a mine of information on the clinical aspects of pulmonary and cardiac disease, with an accurate description of the pathological anatomy of these conditions. Laennec heard with his stethoscope sounds never before heard or described and for which no terms existed in medical literature. He was the creator of a large number of words now currently employed in physical diagnosis, such as rales, bronchophony, pectoriloquy and egophony. His book, unlike Auenbrugger's *Inventum Novum*, did not wait 47 years for recognition. It was immediately accepted as an epoch-making work, and auscultation was soon used in medical clinics throughout the world. (Major, 1954, p. 662)

He was born at Quimper, France, in 1781. On the death of his mother, Laennec at age eight went to live with an uncle who was a physician in Nantes. He began studying medicine under this uncle at age 14. In 1801 he went to Paris and continued studying medicine under Corvisart, receiving his degree in 1804. He was fascinated by pathology. Laennec and his friend Bayle became assistants to Dupuytren, who was working on pathologic anatomy. Laennec gained a reputation as an excellent pathologist as well as being an excellent clinician. This interest led to the writing of several papers on pathology.

He invented the stethoscope in 1816. His friend Lejumeau de Kergaradec wrote of the discovery:

The author told me himself, the great discovery which has immortalized his name was due to chance. . . . One day walking in the court of the Louvre, he saw some children, who, with their ears glued to the two ends of some long pieces of wood which transmitted the sound of the little blows of the pins, struck at the opposite end. . . . He conceived instantly the thought of applying this to the study of diseases of the heart. On the morrow, at his clinic at the Necker Hospital, he took a sheet of paper, rolled it up, tied it with a string, making a central canal which he then placed on a diseased heart. This was the first stethoscope. (Major, 1954, pp. 661–62)

He apparently first used it on a fat young lady in whom direct auscultation yielded no useful information. Laennec had used direct auscultation for some years previously: "Bayle was the first whom I saw employ it, when we followed the service of Corvisart together." Another comment about direct auscultation: "As inconvenient for the physician as for the patient, distaste alone renders it almost impracticable in the hospital; it cannot even be proposed to most women and in most of them the volume of the breast is a physical obstacle to its use" (Laennec as quoted by McKusick, 1958, pp. 6–7).

Laennec made his discovery in 1816. The next three years were years of intense work, as he perfected his technique at the Necker Hospital. In 1819 he published *De l'auscultation médiate* (On Mediate Auscultation). He named the stethoscope for the Greek words meaning "to explore the chest." The book contains the symptoms, signs, clinical course, and pathologic findings of a variety of diseases: pulmonary edema, pneumonia, tuberculosis, emphysema, pneumothorax, pleural effusion. The descriptions are compelling—for example, the sound he called egophony:

It appears as if a kind of silvery voice, of a sharper and shriller tone than that of a patient, was vibrating on the surface of the lungs, sounding more like the echo of the voice than the voice itself. . . . It has, moreover, another character, so constant as to lead me to derive from it the appellation of the phenomenon—I mean a trembling or bleating sound like the voice of a goat, a character which is the more striking because the key or tone of it approaches that of this animal's voice. [Further egophony is likened] to the nasal intonations of the juggler speaking in the character of Punch. (Middleton, 1924, p. 436)

Laennec experimented with various stethoscope designs, turning them all on the lathe himself. He finally settled on one 45 cm long, 4 cm in diameter, with a plug that fitted into it when listening to the heart. The instrument was made more portable by fashioning it in two pieces. Each purchaser

of his book was presented with a stethoscope. Thayer maintained that at the time of Laennec's death from tuberculosis in 1826 every stethoscope then in existence had been made by him.

Students from all over the world flocked to study under Laennec and to learn how to auscultate, returning to their countries with stethoscopes. Laennec obviously had tuberculosis during this period, but worked indefatigably:

A good account of his work is given by C.J.B. Williams (1884) who visited Paris in 1825–26. Laennec demonstrated the signs obtained by auscultation in the wards from 10 A.M. to noon, always speaking in Latin at the bedside, after which he either gave a lecture in French or attended a postmortem examination to correlate the anatomical findings with the signs which had been elicited by auscultation. Williams took notes of the lectures and made sketches of Laennec whom he described as a frail-looking man of small stature who often became exhausted by his hospital duties. Laennec's own account of his life in Paris was given in a letter to a colleague which was published by Thayer (1920). Rising at 7:30 A.M., he gave consultations while dressing, then visited the Necker Hospital, and rarely had time to return home for lunch before setting out on his visits which lasted until 5:30 P.M., after which he took an early dinner and then set out on another round of visits until 10 P.M., eventually retiring to bed at 11 P.M. (Bedford 1972, p. 1194)

Public acceptance of the stethoscope was such that within a decade physicians felt they must use the stethoscope or else jeopardize their reputation. Changes in the design of the stethoscope appeared gradually. The first stethoscope that was not rigid was built by Nicholas Comins, an Edinburgh physician, in 1829. Monaural instruments that were completely flexible appeared in the 1830s. The first satisfactory binaural stethoscopes appeared in the 1850s. The fully flexible binaural stethoscope became generally used in the 1890s. The diaphragm was added in the early 1900s.

Pierre Louis: The French School, 1800–1850

Paris was the mecca of the medical world from 1800 to 1850. Modern medicine began to emerge in France during this fifty-year period. The leading clinicians of Paris were individuals such as Corvisart and Laennec. The list of luminaries included the surgeon Dupuytren (1777–1834); the great pathologist Bichat (1771–1802), who succeeded to Morgagni's mantle; the pioneering psychiatrist Pinel (1755–1826); the gastroenterologist Broussais (1772–1838); Pierre Louis; and others. The Parisian medical community was the shining light that attracted physicians from all over the world, just as they were to go to Germany starting in the 1850s. In the decade from 1830 alone, 222 American physicians visited Paris for further study (Jones, 1973). Medicine in the United States was influenced profoundly by what has come to be known as the French School.

The remarkable accomplishments of the French physicians did not come about by accident. For one thing, the physicians and medicine did not exist in isolation. Paris was a center of great activity from 1770 to 1800 in mathematics, physics, chemistry, and biology. Progress in the physical sciences carried over into other areas, such as medicine.

Another vital development was the rise of the hospital; this did not occur until the nineteenth century. Greek phy-

sicians focused upon the individual sickbed. Libraries were the focus of medicine during the Middle Ages. The bedside was the center of attention during the seventeenth century, as Boerhaave taught in his 12-bed ward at Leyden. The nineteenth century was the century of the hospital. The tens of thousands of peasants who streamed into the capitals of Europe with the coming of the Industrial Revolution became sick with a host of acute infectious and chronic diseases. Tuberculosis and typhoid fever were especially prevalent, and attracted the interest of physicians and lay-people alike during this period. The émigrés from the farms to the cities were without urban roots or families, and consequently, when they became ill, the hospital was the only place to go. The wards of the overcrowded hospitals provided clinical material in unprecedented quantity to the physicians of the period. Physicians could apply for the type of cases they wanted to see. Whereas Boerhaave's clinic had 12 beds, Bouillaud boasted of having seen 25,000 cases in 5 years (Ackerknecht, 1968). In 1830 Paris had 30 hospitals containing 20,000 patients. The Hôtel-Dieu alone had 1000 beds. There were 5000 medical students. The political climate was favorable: Napoleon liked and encouraged physicians. Corvisart, the most influential physician of the period, was Napoleon's personal physician.

Pierre-Charles Alexandre Louis (1787–1872) epitomized the best of French medicine during this period. Louis was an inspiring teacher and masterful clinician. He was the favorite of the American students who visited Paris during this time, and exerted an extraordinary influence upon medicine along the Eastern seaboard in the United States. Oliver Wendell Holmes, Sr., who studied under him: “[He is] the object of our reverence, I might almost say idolatry.” He was born in Aix, and received his medical degree in Paris in 1813, at the age of 27. He went to Russia with a family friend and settled in Odessa to practice medicine. William Osler describes what happened next:

In the last year of his stay in Odessa he was very much disturbed by the high rate of mortality in children with diphtheria, and this appears to have determined him to abandon for a time the practice of medicine and to devote himself to study. With this object in view he returned to Paris and for six months attended the practice at the Children's Hospital. Among the younger physicians in Paris he found an old fellow-pupil, Chomel, physician to La Charité, who offered him opportunities for work in his wards. Louis at this time was thirty-four years of age. Here for six years uninterruptedly he set himself to work to study disease in the wards and in the post-mortem room. At first he appears to have occupied the position simply as a voluntary assistant and friend of Chomel, but subsequently he became his chef-de-clinique, and during this period he occupied a room in the entresol of the hospital. He was a voluminous note-taker and collected in this time an enormous number of important facts.

This remarkable feature in Louis' life has scarcely been dwelt upon sufficiently. I know of no other parallel instance in the history of medicine. It is worth reading the brief extract from Dr. Cowan's introduction to his translation of the work on Phthisis. “He entered the hospital of La Charité as a clinical clerk, under his friend, Professor Chomel. For nearly seven years, including the flower of his bodily and mental powers (from the age of thirty-three to forty), he consecrated the whole of his time and talents to rigorous, impartial observation. All private practice was relinquished, and he allowed no considerations of personal emolument to interfere with the resolution he had formed. . . . From this moment may

be dated the presence of that strong impression of the necessity of exact observation by which the school of Paris has been since so distinguished. . . . (Osler, 1897, p. 162)

Louis can be called the first full-time clinical investigator, based on the five methods of approach that he employed (Harvey, 1973):

- Every effort was made to discover the previous state of health of a patient: his age, occupation, residence, family history, manner of living.
- The present illness was sought in detail: its initial and subsequent symptoms, the chronological order of occurrence, other symptoms.
- The manifestations of the disease were sought in the patient's statements and in the physician's examination.
- A careful record was made of the clinical manifestations during the course of the illness.
- If the patient died, an autopsy was obtained and a meticulous record was made of the findings.

Louis established the systematic approach to the clinical case that is in use today. This approach is given in detail below, when Martinet's contributions are described. Louis was one of the first to apply statistics to the study of medicine. His early concern for cures, based on his experiences in Odessa, caused him to turn his attention to therapeutics. It occurred to him to list each case in numerical order, and to compare the group receiving a certain therapy against the group that did not. He used this method to demonstrate that blood-letting, which was quite popular in France at that time, was of uncertain value in treating pneumonia. There were any number of critics of this “numerical method.” Louis' reply was that “in the difference between exactitude and vagueness, lies the difference between truth and error.”

Johannes Mueller: The German School, 1830–1900

By the 1840s the preeminence of French medicine began to decline. A basic reason for this appears to be that the French did not investigate the causes of disease. Their strength was observation; they distrusted experimental laboratory investigation (Ludmerer, 1985). Hospital medicine, with its complete dependence upon two techniques—clinical observation and the autopsy—had achieved its maximum potential. In order for clinical diagnosis to progress further, the causes and mechanisms of diseases had to be investigated. These investigations depended upon progress in the fundamental medical and biological sciences: biochemistry, pathology, physiology, experimental pathology, bacteriology, pharmacology. The mainstream development of modern medicine shifted to Germany, where the focus was upon the use of experimental methods to unravel the mysteries of medicine:

Even though the amount of new medical knowledge uncovered by the laboratory approach was still small and no major therapeutic innovations had yet been developed using experimental techniques, the successes of German medical science in the mid-nineteenth century created great excitement. For the first time the causes of diseases were being explained. This allowed an epistemological shift of revolutionary proportions. It became clear to

knowledgeable physicians that experimental methods could be applied to the study of disease and therapeutics as well as to the study of the healthy state. Scientific information no longer constituted curious knowledge, irrelevant and diverting to the ordinary practitioner, but now began to represent the core of what a modern doctor needed to know. (Ludmerer, 1985, p. 31)

This shift in the destination of students of medicine is illustrated by the numbers: about 15,000 American physicians went to Germany, Switzerland, or Austria to study between 1870 and 1914. Most of this migration occurred between the end of the Civil War and 1900 (Bonner, 1963).

Germany's rise to scientific preeminence was made possible by the nature of the German university. There were 20 or more universities throughout the country, and nothing like them existed outside Germany. Science, including medicine, existed side by side with all other disciplines. By way of contrast, in England medicine was centered in the London hospital schools, separate from the universities. The organization of the German university was ideally suited for furthering scientific research, including medical research. The German university had freedom, flexible organization, well-provided laboratories, and a free-flowing spirit of inquiry, all of which allowed Germany to become the undisputed center of scientific medicine (Ludmerer, 1985). Germany had achieved preeminence in other areas: the social sciences, philosophy, linguistics, literary criticism. This was in startling contrast to the Germany of the eighteenth century, where higher learning was dominated by a philosophic system termed *Naturphilosophie*, a romantic philosophy of nature characterized by extensive speculations on the essence of life and disease.

Johannes Mueller and his students were central figures in the ascendancy of German scientific medicine. Mueller (1801–1858) received his degree at Koblenz and studied under Rudolphi, who convinced him that the future was in the experimental method. Mueller was professor of anatomy and physiology at Bonn until the death of Rudolphi, when he returned to Berlin as professor of anatomy, pathology, and physiology. He was both an eminent scientist and an inspiring teacher. He authored over 200 monographs and articles, and made important contributions in biology, embryology, comparative anatomy, physiology, chemistry, psychology, and pathology. Between 1833 and 1840 he published *Handbuch der Physiologie des Menschen*; every statement in it was said to have been checked by Mueller's own experiments.

Mueller was the first of his line, his pupils bringing great honor to their master as well as to themselves. Among them were Schwann, Henle, du Bois-Reymond, Virchow and Helmholtz, each a great man in his own right, who had a powerful influence upon the later course of German and of world medicine, the germ of whose work we usually find in some earlier experiment, thought, or stimulus of which Mueller was the father. (Major, 1954, p. 790)

Vienna was also a great medical center in the second half of the nineteenth century. Three men were the nucleus of the New Vienna School, which was the successor to the "Old" Vienna School of Auenbrugger's time. Rokitansky (1804–1878) was one of the most productive pathologists of all time: during the 48 years of his career he and his assistants performed 59,786 autopsies! (Major, 1954). His *Handbuch der pathologischen Anatomie* (1842) was a gold mine

of new pathological information. Josef Skoda (1805–1881) attained legendary skill in physical diagnosis. He published *Abhandlung ueber Perkussion und Auskultation* in 1839. "Medicine appeared to him as a chaos, a dismal swamp, out of which rose up only two islands with a rich soil: pathological anatomy and physical diagnosis" (Kussmaul, quoted by Major, 1954). Hebra (1816–1880) and his pupil Kaposi were the first dermatologists. Hebra published a book in 1846 that aspired to the classification of skin diseases on the basis of pathologic anatomy; for the first time pathology was linked to dermatologic lesions. Semmelweis was also in Vienna at this time, and in 1847 promulgated the decree that physicians who attended women in labor must first wash their hands in a solution of calcium chloride—the first application of antisepsis in the history of medicine.

Helmholtz: The Ophthalmoscope, 1850

The eye is a dark chamber, and its entrance, the pupil, appears black because the eye's dark purple lining absorbs all of the light that reaches it.

—C. W. RUCKER (1971)

This was the view of the eye that prevailed throughout history until 1823. At that time, John Purkinje, professor of physiology at Breslau, Germany, described the "beautiful orange glow" reflected from the pupil when light was thrown into it from the right angle.

In 1847 the Viennese physiologist Ernst Brucke described the same phenomenon:

A short time ago in the evening as I was standing between the chandelier and the door in the auditorium of this university, I saw a young man whose pupils were illuminated with a bright red light as he turned to close the door through which he had just passed. This at once reminded me that several persons had written accounts of such illumination of the eyes. . . .

If one wishes to see this reflex in human eyes clearly he should proceed in the following manner: Take the usual oil lamp with its cylindrical wick and the glass chimney, as it is generally employed, but with the glass-shade with its metal ring removed, and regulate the wick in such fashion that it burns with a short, intense flame. Then set the lamp close to you, but place the subject 8 to 10 feet away, sitting in such manner that his eyes are at the same height as is the flame. Cover the flame with a shade, bring your eyes at the same level with it and look sharply towards the eyes of the subject. If he then looks with widely opened lids towards the darkness adjacent to the lamp, or if he slowly moves his eyes to and from, then the pupils will be illuminated with a reddish light, while the iris, in contrast, will appear slightly greenish. (Rucker, 1971, pp. 12–13)

Brucke was almost at the point of inventing the ophthalmoscope, as Helmholtz wrote later: "Brucke himself was but a hair's breadth away from the invention of the ophthalmoscope. He had only failed to ask himself what optical image was formed by the rays reflected from the luminous eye. Had it occurred to him, he was the man to answer it just as quickly as I did and to invent the ophthalmoscope" (quoted by Rucker, 1971, p. 13).

Hermann von Helmholtz (1821–1894) invented the ophthalmoscope. He was a precocious child, and early showed great linguistic and mathematical ability. He wished to study physics, but studied medicine because the family's financial resources were limited. He came under the influence of Johannes Mueller. Helmholtz had this to say of Mueller:

I recall my student days and the impression made upon us by a man like Johannes Mueller, the physiologist. When one feels himself in contact with a man of the first order, the entire scale of his intellectual conception is modified for life; contact with such a man is perhaps the most interesting thing life has to offer. (Major, 1954, p. 804)

Helmholtz received his medical degree in 1842; his thesis described the anatomic connection between nerve cells and nerves. An important early work in 1847 was one of the great scientific papers of the nineteenth century: *On the conservation of energy*. He demonstrated mathematically that all forms of energy can be transformed from one form to another, but energy cannot be created or destroyed.

In 1849 Helmholtz was appointed professor of physiology and pathology at the University of Königsberg. In this position he devoted time to teaching the physiology of the sense organs, especially the eye. A central problem was why the pupil was black under usual conditions, and under other conditions was brilliant red and emitted light. This was the problem, not the examination of the back of the eye. The discovery of the ophthalmoscope was a by-product of the solution of the emitted light problem. Helmholtz found that the emitted light was simply reflected light. But he went one step further than his predecessors, and analyzed how the emitted rays formed optical images (Rucker, 1971). He perceived he could obtain an optical image of the eye fundus by devising an instrument that would allow his own eye to be placed in line with the light rays entering and leaving the eye. He used three plates of glass, which acted as a mirror to reflect light, but were still transparent enough to see through. The first ophthalmoscope was composed of microscopic cover glasses and pieces of cardboard glued together. At the age of 29 he became the first individual to see the retina in all its anatomic details: "Years later, he said that had he not been theoretically convinced that it must succeed he would not have persevered" (Rucker, 1971). The announcement was made in a paper presented by his friend Du Bois-Reymond, another student of Mueller, to the Berlin Physical Society on December 6, 1850. This paper was not published and was lost. However, on December 17, 1850, Helmholtz wrote a letter to his father as follows:

I have made a discovery during my lectures on the Physiology of the Sense-organs, which may be of the utmost importance in ophthalmology. It was so obvious, requiring, moreover, no knowledge beyond the optics I learned at the Gymnasium, that it seems almost ludicrous that I and others should have been so slow as not to see it. It is, namely, a combination of glasses, by means of which it is possible to see the dark background of the eye, through the pupil, without employing any dazzling light, and to obtain a view of all the elements of the retina at once, more exactly than one can see the external parts of the eye without magnification, because the transparent media of the eye act like a lens with magnifying power of twenty. The blood vessels are displayed in the neatest way, with the branching arteries and veins, the entrance

of the optic nerve into the eye, &c. Till now a whole series of most important eye-diseases, known collectively as black cataract, have been terra incognita, because the changes in the eye were practically unknown, both during life, and, generally speaking, after death. My discovery makes the minute investigation of the internal structures of the eye a possibility. I have announced this very precious egg of Columbus to the Physical Society at Berlin, as my property, and am now having an improved and more convenient instrument constructed to replace my pasteboard affair. I shall examine as many patients as possible with the chief oculist here, and then publish the matter. (Rucker, 1971, pp. 23–25)

Helmholtz called his new instrument "Augenspiegel." This was the name of an instrument in use in Germany for some time that consisted of a lens and a mirror for reflecting the light. The instrument was used for examining the coats and adnexa of the eye. This instrument was known in England as an "eye speculum," in Holland as "oogspiegel," and in France as "ophthalmoscope." The word ophthalmoscope was used to describe Helmholtz's instrument in the medical literature for the first time in 1852 by Maressal de Marsilly of Calais, France (Rucker, 1971). The indirect method of ophthalmoscopy was invented by Ruete in 1852.

Practicing physicians did not appreciate the benefit of the ophthalmoscope to any degree. Clifford Allbutt wrote in 1871: "The number of physicians who are working with the ophthalmoscope today in England may, I believe, be counted on the fingers of one hand." Allbutt did much to change this with his book *On the Use of the Ophthalmoscope in Diseases of the Nervous System and the Kidneys*, published in 1871.

Karl Wunderlich: The Thermometer, 1871

Thermoscopes, which indicate a change in temperature, have existed in one form or another since antiquity. Thermometers, which measure the change on a scale, are a relatively recent development. For many years it was believed that body temperatures vary depending upon the climate. The first problem posed in *De Logistica Medica*, a European book on medical mathematics, in 1578, was: "To find the natural degree of temperature of each man, as determined by his age, the time of year, the elevation of the pole [that is, the latitude] and other influences" (Boorstin, 1985). Galileo invented a device that he called a "scherzino" (a little joke), which used alcohol to measure changes in the temperature of the air (Major, 1954). Sanctorius (1561–1636), a colleague of Galileo at the University of Padua, is given credit for introducing the thermoscope into medicine, although his work had little or no influence at the time. The goal of Sanctorius, following the dictates of Hippocrates, was to determine if there was a change in the patient's temperature, thereby giving prognostic information. He modified Galileo's thermoscope for use with a patient: "The patient grasps the bulb, or breathes upon it into a hood, or takes the bulb into his mouth, so that we can tell if the patient be better or worse, so as not to be led astray in knowledge of prognosis or cure."

Considerable progress was made in Florence in developing instruments for measuring temperature. At the Accademia del Cimento, founded in 1657, thermoscopes were sealed off from the atmospheric pressure, perhaps justifying for the first time the word "thermometer." There was no universally agreed upon scale for the measurement, how-

ever, and no consensus regarding a substance to use; while the Florentines used alcohol, Isaac Newton used linseed oil.

Boerhaave is said to have suggested to Fahrenheit that mercury would be suitable for the fluid. Fahrenheit experimented with various scales before settling upon ice and boiling water as the two fixed points; by 1710 he had determined that axillary temperature is 96 degrees (Keele, 1963). Boerhaave used it as a research instrument on his 12 beds at Leyden. Anton de Haen, one of Boerhaave's pupils who became a leader of the Old Vienna School, introduced thermometry into the practice and teaching of medicine, according to Wunderlich. De Haen left the thermometer in for 7½ minutes, and then added 1 or 2 degrees Fahrenheit to the registered temperature. "He was aware of the morning remission and evening exacerbation of temperatures; of the rise of temperature during the febrile rigor; of the persistence of fever-temperatures after intermittent fevers have apparently been cured; and of the discrepancies between pulse and temperature in some patients and in certain diseases" (Wunderlich, 1871). However, de Haen's work with temperature was neglected after his death.

Celsius in 1742 divided the scale into 100 degrees, taking zero as the boiling point of water, and 100 as the melting point of ice; this was inverted by Christin a year later. Clinical thermometers were well known by the 1750s. By 1777 John Hunter was writing (to Jenner) that the temperature under the human tongue was 97 degrees in all countries. Ludwig Traube in Berlin in 1850 suggested to Wunderlich a systematic study of temperatures in human beings.

Carl August Wunderlich (1815–1877) was professor of medicine at Leipzig. In 1871 he published *Medical Thermometry and Human Temperature*, in which he had assembled information on 25,000 patients. The classic temperature patterns of many diseases, such as typhoid, were depicted. From the preface:

For the last sixteen years my attention has been uninterruptedly directed to the course pursued by the temperature in diseases of various kinds. I have gradually brought together a mass of notes which comprises many thousand complete cases of thermometric observations of diseases, and millions of separate readings of the temperature. The more my observations multiplied the more firm my conviction was of the value of this method of investigation. And though theoretical questions as to human temperature and kindred subjects must not be overlooked, my purpose has been to prepare from these notes a practical book.

A knowledge of the course of temperature in disease is indispensable to medical practitioners.

Because: all the phenomena of the sick are deserving of study. The temperature may be determined with a nicety which is common to few other phenomena. The temperature can neither be feigned nor falsified. We may conclude the presence of some disturbance in the economy from the mere fact of altered temperature. . . .

Wunderlich's book established the fundamental importance of the measurement of temperature in clinical medicine.

Erb and Westphal: The Reflex Hammer, 1875

Clinicians had described a number of neurologic reflexes before 1875: the pupillary light reflex; absence of a blink reflex in Bell's palsy; the grasp reflex; flexion of a spastic leg upon stroking the sole. These were generally accounted

to be protective in nature. In 1875 William Erb reported for the first time on the elicitation and significance of the deep tendon reflexes using a reflex hammer:

Slightly flexed at the hip and knee, the leg is held fast while all its muscles are relaxed and, with a finger or percussion hammer, a very light and elastic tap is delivered (exactly as in very light and elastic percussion of the chest or in testing for fluid in the abdomen) to the region of the ligamentum patellae. Each tap is followed by a contraction of the quadriceps, immediate like lightning, unmistakable, visible, palpable, and apparently reflex: manifestly and often quite strongly is the shank set in motion. It is extraordinarily difficult to suppress this reflex by a voluntary effort. . . . (Schiller, 1967, p. 75)

Erb had been testing this reflex for some years, finding it of diagnostic significance in diseases of the spinal cord: "much more exquisitely brisk in many patients with diseases of the spinal cord." Ankle clonus had been described previously by Charcot in spinal cord disease, but Erb made it clear that his reflex was different. His paper was titled "On the Tendon Reflexes in Health and in Diseases of the Spinal Cord."

In the same issue of the *Archiv für Psychiatrie und Nervenkrankheiten* there appeared another paper dealing with the same reflex, written by the editor of the journal, Carl Westphal. Westphal had an explanatory footnote at the bottom of the first page. He had been astonished to receive a paper from Erb dealing with the same facts that he himself was about to publish. He, too, had been testing the reflex for several years, and his observations agreed with those of Erb. He had gotten Erb's permission for the two papers to appear side by side:

Erb and Westphal had hit upon the unique spot in the body where scientific purity and simplicity reign because only two neurons are involved in the reflex. They had struck a source of untapped knowledge—knowledge that previous generations of physiologists would have found useless. The source turned into "a sea of names and claims," a flood of reflexes. . . . (Schiller, 1967, p. 82)

The hammer used to elicit the reflex had been developed for percussing the chest. The idea for the percussion hammer apparently came from Gerhard van Swieten, of the Old Vienna School. Van Swieten in turn credited the idea to a Swiss physician of the preceding century, Johann Jacob Wepfer (1620–1695). Wepfer got the idea from cowherdsmen who diagnosed echinococcal and cysticeroid cysts of the brain by systematically hitting the animal's head with a mallet, and trephining any area that resonated (Schiller, 1967). The story thus comes full circle: an instrument initially used for neurological diagnosis in cows and sheep was used in chest diseases in humans and then again in neurology.

Gowers termed the reflex the "knee jerk" in 1879, and for decades it was the only reflex that was tested routinely. In Gowers's text of 1886 he listed the ankle jerk, but made no mention of its absence in sciatica. The jaw jerk was described by Beevor in 1885.

Just as the numbers of reflexes grew exponentially, so did the instruments used for eliciting the tendon jerks as well as percussing the chest. Gowers used his stethoscope to elicit them. J. Madison Taylor had invented the triangular hammer, so widely used today, by 1890. In the mecca of neurology, Queen Square in London, around 1925 a Miss

Wintle "hit upon the happy device of fitting a ring pessary to a solid brass wheel, and mounting this upon a stick of bamboo. The result was a heavy, springy, and completely painless hammer . . ." (Critchley, quoted in Schiller, 1967).

Riva Rocci: The Sphygmomanometer, 1896

The first measurement of blood pressure was by the Reverend Stephen Hales in about 1733. Hales was a clergyman, educated at Cambridge, with an enduring interest in science. He is considered the founder of plant physiology, as well as the father of hemodynamics. His measurement of the blood pressure was the first major advance in circulatory physiology since Harvey's demonstration of the circulation of blood. Hales was led to his experiments by his interest in the forces that lead to muscular contraction. The wisdom of the time was that the force of the blood during systole caused a dilation of the vessels, which caused the contraction. After he "read the unsatisfactory Conjectures of several [writers] about the Cause of muscular Motion [it occurred to me] that by fixing Tubes to the Arteries of live Animals, I might find pretty nearly, whether the Blood by its meer hydraulick Energy, could have a sufficient Force, by dilating the Fibres of the acting Muscles, and thereby shortening their Lengths, to produce the great Effects of muscular Motion" (quoted in Cohen, 1976, p. 99). He tied a horse on its back, and laid open the crural artery, and then:

I inserted into it [the artery] a brass pipe whose bore was 1/6th inch in diameter; and to that by means of another brass pipe which was fitly adapted to it I fixed a glass tube of nearly the same diameter which was 9 ft. in length. Then, tying the ligature on the artery the blood rose in the tube 8 ft. 3 inches perpendicular above the level of the left ventricle of the heart. (Quoted in Keele, 1963, p. 75)

The jugular pressure he found to be 12 inches when the horse was quiet and 52 inches when it struggled. He estimated human blood pressure to be 7.5 feet, which is fairly close. Hales also calculated the mean velocity of the blood in the aorta, the velocity of the systolic output, and the diastolic pressure.

Hales gratified his scientific passion while serving as the rector of the Church of St. Mary's-in-the-Meadows at Teddington. His close friends, including the poet Alexander Pope, observed that Hales looked upon wicked individuals without indignation, "not from want of discernment or sensibility; but he used to consider them only as those experiments, which, upon trial, he found could never be applied to any useful purpose, and which he therefore calmly and dispassionately laid aside." One surmises that scientific detachment pervaded the entirety of Reverend Hales's life. Johannes Mueller (see above) remarked that the discovery of blood pressure "was even more important than discovery of the circulation of the blood."

One hundred years later (1828), Poiseuille substituted a mercury manometer for Hales's glass tube (Keele, 1963). Potassium carbonate was used as an anticoagulant. Ludwig added a float recorder and kymograph in 1847, thus making possible physiological experiments involving the blood pressure.

Measuring arterial pressure directly was obviously unsuitable clinically. Vierordt in 1855 attempted to measure blood pressure by determining the weight necessary to ob-

literate the radial pulse (Keele, 1963). Ritter von Basch used a water-filled rubber bulb attached to a manometer (1881), and later an aneroid barometer. Potain used air in the arm band, and attached the aneroid barometer. In 1896 Riva Rocci published the method in use today of employing a rubber air-filled bladder and a mercury manometer.

The Clinical History

The Greeks were aware of the necessity of a clinical history, as illustrated by the quotation from Hippocrates at the beginning of this chapter. Rufus (or Ruphos) of Ephesus wrote what is apparently the first formal document solely about the history: *On the Interrogation of the Patient*. Very little is known about Rufus. He lived around A.D. 100. Galen spoke admiringly of him. He is thought to have studied and practiced in Rome, although this is not certain. He wrote a number of other books that were esteemed by his contemporaries and later Arabian physicians: *On the Names of Various Parts of the Body*; *Treatise on the Pulse*; *Treatise on Diseases of the Kidneys and of the Bladder*. His statements about the history are really remarkable:

It is important to ask questions of patients because with the help of these questions one will know more exactly some of the things that concern the disease and one will treat the disease better. One should start by interrogating the patient himself. One will learn just how sane or troubled the patient is and the degree of strength or weakness of the patient. One will obtain a certain notion of the disease process and of the body site affected. One can conclude that the spirit and mind are in good shape if the patient responds in a suitable manner with a faithful memory. . . . It is a sign of delirium if you ask one question of the patient and he replies with another, or forgets what he is saying when he talks. . . . The physician will interrogate the patient first, and then question the relatives and friends, especially if he cannot learn from the patient himself. . . . It is important at the beginning to find out precisely when the disease process began. . . . You will ask about the rapidity and manifestations of the disease—whether the damaging phenomena develop rapidly, or on the contrary arrive and progress slowly. . . . Ask if the disease has been present in the same patient previously. . . . I believe it is important to be informed of the nature of the disease in each individual patient, because we are not all formed in the same fashion, but we differ markedly from one another in many respects. (Quoted in R. D'Ephèse, 1879)

Rufus cites a contemporary who feels it is completely unnecessary for the physician to question the patient. Rufus feels this is in error: "The physician will be instructed and wiser about the patient if he interrogates the patient." Rufus writes at length about what to him are important aspects of the history: nourishment; habits; season of the year when the disease began; sleep habits; content of dreams; medications and regimens the patient has been subjected to; a full characterization of the location and nature of pains; types of food eaten and location of water drunk by the patient. In short, Rufus demonstrates an approach to history taking that is truly extraordinary for his time.

The modern view of the history probably began with the French School of Corvisart, Laennec, Louis, and Andral (Keele, 1963). They are responsible, as nearly as can be told, for what might be termed the modern clinical method.

Boerhaave exemplified the best up until the time of the French; as noted previously, he made rounds with his students on 12 beds each day, questioning and inspecting the patient, examining the urine and feces, and going to the autopsy table if the patient died. The next great step was that of the French School, exemplified by Martinet. Louis Martinet (1795–1875) in 1827 published *A Manual of Pathology containing the symptoms, diagnosis and Morbid Characters of Diseases, together with an exposition of the different Methods of Examination applicable to the affections of the Head, Chest, and Abdomen*. In his preface Martinet states that he intends his book as a clinical guide, containing “a brief statement of the necessary requisites for the proper conduct of clinical pursuits.”

Martinet’s clinical examination scheme fills seventy-four pages of this small book. Martinet begins his book with an “Exposition of the Various Methods of Examination Used in Medicine.” Selected quotations:

It is at the bedside of the patient that the observer must study disease; there he will see it in its true character, stripped of those false shades by which it is so frequently disguised in books.

The physician should be calm and conciliating, should hear with attention the communications which his patients make, should put his questions to them with mildness, listen kindly to their complaints, and never fail to demonstrate an active interest in their welfare.

In drawing up a case, it should always be recollected that it is done with the view to convey to others an exact representation of the facts which we have observed. . . . The report of a case should be like the copy of a picture.

The leading symptoms, particularly those which serve to establish the diagnosis, should first be noted down, ranged according to their importance, reference always being made, as far as can be done, to the order of their appearance.

It may, however, be sometimes useful to note the absence of any particular symptoms, which usually exist in similar cases, lest the omission may be attributed to negligence or forgetfulness on the part of the observer, and so discredit be cast on the facts he has detailed.

The observations should be transcribed immediately after the visit, in a book kept for the purpose, as being the only means of ensuring correctness in the statements.

When commencing to take down a case, first note the name, sex, age, and occupation of the patient; this should be done according to the form above given. In some cases it becomes necessary to state the country or district from which the patient comes, and the diseases which prevail there.

The acute and chronic forms of disease require a plan of examination and narration altogether different. Everything connected with the previous history should be known, and stated fully in chronic cases; it is the only means of throwing any light on the obscurity which so generally surrounds them. But in acute cases this is far less necessary. (Martinet, from Quain’s translation, 1827)

Martinet’s history begins with taking the full history as applicable to all diseases; he then uses special methods for the “three great cavities” of the body—the brain, chest, and abdomen (Keele, 1963). After the history comes the physical examination. The stethoscope is used before percussion on

the chest. Inspection, percussion, palpation, and auscultation are used systematically for the chest, head, and abdomen. Rectal examination is performed to detect prostatic enlargement. The skin, muscles, nerves, mucous and synovial membranes, lymphatics, and veins are noted specifically.

Martinet’s remarks could fit with ease into a modern physical diagnosis book. His scheme illustrates the clinical method as developed by the great clinicians of the French School.

An interesting contrast to Martinet’s methods are those of Peter Latham at St. Bartholomew’s Hospital. He writes, in 1836: “The patient being placed before me, I ask him no question until I have learned everything worthy of remark which my own eyes can inform me of . . .” (from Keele, 1963, p. 55).

Comments in the literature about history taking are quite sparse for the next century. G. L. Engel has this to say about the meagerness of the historical record:

I am not particularly bothered that the record is as sparse as it is. . . . Eliciting historical accounts of the experiences of others as a means of gaining knowledge is, of course, as old as man. It is also quintessentially human and is after all one of the ways we learn from early childhood on, that is, from the stories that others have to tell about that which is not known or is unfamiliar to us. It is for this reason, I suspect, that the process of “history taking” has not until very recently been thought of as anything that needed to be taught or even studied, much less as a scientific method. Yet, if science, and being scientific, represent man’s most persistent effort to extend and organize knowledge by reasoned efforts that ultimately depend on evidence that can be consensually validated, as Charles Odegaard has said, then “history-taking” (or interviewing) does qualify as a scientific method. Even Rufus of Ephesus appeared to know that intuitively. Thus, he recommends asking questions in order that physicians “know more exactly some of the things that concern the disease”; a suitable manner of patient response is “with a faithful memory”; he recommends verification by questioning relatives and friends; advises that the physician “find out precisely.” Therein is captured the essence of science in the human realm of history-taking, a perspective disregarded in this era dominated by the biomedical model. (Engel, personal communication, 1988)

Stoeckle and Billings have surveyed the history of the medical interview in the United States since the beginning of the twentieth century. Inferences about the history can be obtained from hospital records. Examples from Richard Cabot’s *Case Teaching in Medicine* (1905) illustrate detailed histories, with one or two lines regarding the patient’s social circumstances (Stoeckle and Billings, 1987). From 1900 to the 1940s in the United States, as well as elsewhere, there were no instructional texts on history taking. Teaching was by senior physicians acting as role models at the bedside. With rare exceptions, there were no verbatim accounts of the history, and students themselves were rarely if ever actually observed or critiqued doing a history. Didactic material on what to ask was found, albeit sparsely, in physical diagnosis texts and manuals on the physical examination. Questions given as examples were highly specific: “Have you ever had tuberculosis?” There was circumscribed attention to social circumstances.

After Martinet, the next real advance in history taking came with the publication of *The Clinical Interview* by Felix

Deutsch and William Murphy in 1954. The book was based in part upon reviewing transcribed tapes of psychiatric resident interviews of patients over a period of 16 years. The *process* of the interview received detailed attention:

If the examiner allows [the patient] to talk without asking leading questions or answering his questions, the patient will usually give a detailed account of his complaints and ideas about his illness. Having exhausted his ideas and recollections regarding his organic disturbances, he will stop and wait to be asked a question. The examiner waits until he feels that the patient will not continue spontaneously, and he then repeats one of the points in the patient's last sentence in an interrogative form. Usually the therapist repeats one of the somatic complaints last mentioned, being careful to use the same wording as the patient. The patient then as a rule gives new information centering around his symptoms and is stimulated to further associations. (P. 20)

Deutsch and Murphy termed this method associative anamnesis, or associative exploration. Medical students began to be taught this method, notably beginning with the course in Clinical Methods designed and used at the University of Rochester by Morgan and Engel. Their text introduced the method to other medical schools (see Morgan and Engel, 1969).

The Rochester course and text represent a landmark in history taking and in the approach to the patient. The book is the first text on clinical skills that approaches the history and interviewing differently from what had been so long a tradition of neglect. The biopsychosocial concept, as articulated by Engel (1977), has now become the standard approach to the history.

Clinical Methods in the United States

The spread and refinement of the history and physical examination in the United States followed the development of medical education. This development has been the subject of a recent book by Ludmerer. The outline below follows his excellent account.

The Civil War pointed up with brutal clarity the deficiencies of American physicians. One estimate is that 110,000 Union soldiers died from wounds and 225,000 from disease; 50,000 Confederate soldiers died from wounds and 150,000 from disease! Percussion was performed by only a small portion of physicians. Very few used the thermometer. Stethoscopes were rarely used. Large doses of laxatives and emetics were given for therapy. The U.S. government finally required that each physician entering the army or navy pass a compulsory examination: barely 25% passed.

The U.S. physician of this time was a product of the medical education system of several dozen proprietary and a few university schools. Admission requirements consisted of one question: Can the applicant pay the fees? Instruction was almost totally didactic; anatomy was taught without benefit of dissection. The faculty of a typical proprietary school was composed of six to eight professors. The pervasive spirit was commercialism, with the teachers sharing the spoils of what was left of student tuition after expenses were paid. There were some bright spots. Alternatives and supplements available included apprenticeship, being a house pupil in a hospital, additional work during the summer by extramural non-degree-granting schools, and by going to Europe—especially France—as has been described above.

There was a profound skepticism toward medical science and experimentation among American physicians from 1800 until the last half of the century. This reflected the influence of the French School. The laboratory sciences were distrusted. In 1832 American physicians who had studied in France founded the Society for Medical Observation. By way of contrast, American physicians influenced by study in Germany founded in 1908 the American Society for Clinical Investigation. This attitude against research profoundly influenced medical education until beyond the Civil War. It is illustrated by the fact that at no medical school in the 1860s did research constitute a part of a faculty member's responsibilities (Ludmerer, 1985). The faculty lectured and administrated on the school's time, and saw private patients on their own time.

An extraordinary change occurred between 1850 and 1890: American physicians journeyed to Germany for their postgraduate education. As noted earlier, 15,000 went between 1870 and 1914. The physicians who went to Germany had to have significant means: a spartan living cost \$900 a year. Consequently they were young, male, from the East Coast, and the upper strata of society (Ludmerer, 1985). They took one of two paths. They gained practical experience in the newly developing specialties of ophthalmology, dermatology, laryngology, obstetrics, and surgery, and then came home to go into private practice. This group—estimated to be some 10,000 of the number cited above—mostly went to Vienna, where the New Vienna School provided exceptional clinical opportunities. A smaller group went to study the fundamental medical sciences. These people came back to America and became the leaders in American medicine until well in the 1940s: William Welch, Franklin Mall, Henry Bowditch, etc. When these individuals returned, they were frustrated beyond measure because America simply had nothing comparable to the German university.

A development that fortunately paralleled the return from Germany of these individuals was the emergence of the American university between 1865 and 1890. "After the Civil War, the old-fashioned college evolved into the modern university. At the root of this transformation was the astounding growth of information that occurred in all scholarly fields" (Ludmerer, 1985). Professional schools, including medicine, moved into the universities. The presidents of these universities, for a variety of reasons, vigorously promoted the welfare of their medical schools. "To university leaders, research and teaching in medicine carried a special imperative, for such work offered the hope of better diagnosis and treatment of disease" (Ludmerer, 1985).

Between 1871 and 1893 these two forces, the German-trained physicians and ascendance of the university, acted to produce a profound change in American medical education at four universities: Harvard, Pennsylvania, Michigan, and Johns Hopkins.

At Harvard, Charles Eliot became president in 1870. He was a chemist who had worked in the laboratory and spent time abroad in Germany. He felt deeply the need to teach science with laboratories. He had a poor view of medical education: "The ignorance and general incompetency of the average graduate of American Medical Schools, at the time he receives the degree which turns him loose upon the community, is something horrible to contemplate." His strong views on the need to reform medical education met with resistance and hostility on the part of the older faculty.

In November 1869, Eliot took the unprecedented step of assuming the chair at a meeting of the medical faculty, a seat he did not relinquish for the next forty years. No

other event more dramatically symbolized the desire of the modern university to take charge of medical education. With the support of his faculty allies, Eliot tried to push through his ideas of reforming the medical school. For a year, as the two factions locked horns, the faculty was torn with strife. This was no conflict between elite and ordinary physicians but a civil war within the ranks of the elite. A deep chasm divided those with French from those with German views of medical science, providing a microcosm of the conflict besetting the elite medical community throughout America. (Ludmerer, 1985, p. 50)

Eliot pushed through his ideas successfully, and in 1871 appointed Henry Bowditch, just back from Ludwig's laboratory in Germany, as the faculty member in physiology. Bowditch was the first medical professor in America to be full-time in teaching and research. The laboratory became the seat for teaching a greatly expanded basic science curriculum. This focus upon the laboratory fostered a new educational philosophy: "the primary goal of medical education, in the eyes of the Harvard faculty, was not to provide students an encyclopedic knowledge of facts but to foster the student's ability to think critically, to solve problems, to acquire new information, to keep up with the changing times. This could best be done in the laboratory rather than in the lecture hall" (Ludmerer, 1985, p. 52).

The University of Pennsylvania medical school underwent similar reforms in 1877, followed closely by the University of Michigan. The reforms in these three schools set the stage for the most extraordinary development of all: the opening of the Johns Hopkins Medical School in 1893. This new medical school embodied astonishing innovations from its inception: strict admission requirements for students; two years of rigorous basic science training with plentiful laboratory experience; two years of clinical experience at the hospital bedside; a faculty chosen solely for their teaching and research ability; a view that research was one of its high priorities.

The acquisition of William Osler as professor and head of medicine at the Johns Hopkins Medical School was of the highest importance in the development of medical education and the foundation of clinical work as a science in the United States. In this one man there was a confluence of all the forces described earlier in this chapter: an appreciation of the importance of the laboratory and research; a reverence for the clinical greats who had laid the foundations of physical diagnosis—Auenbrugger, Laennec, Louis; a solid foundation in pathology. "His training and historical interest had given him the knowledge and perspective to incorporate in one medical educational setting all that the heritage of medicine had slowly and painfully evolved up to that time" (Harvey, 1973).

The medical clinic instructional model that Osler put into effect revolutionized medical teaching in the art and science of diagnosis and patient care. There were three aspects to the clinic. There was a live-in resident staff with graded experience: from the new graduate to more senior residents of several years' experience. Instruction in methods of history taking and physical diagnosis was emphasized to a degree not seen since Louis. Medical students became actual members of the patient care team, taking histories, doing physicals, doing the laboratory work, and making rounds with the residents and faculty. Thus evolved the medical clerkship, which was extended to surgery, obstetrics and gynecology. This clerkship did for the clinical students what laboratory work did for the scientists.

Table 1.3
Biographical Vignettes of Individuals in the Sections of This Book

Section	Vignette
1. Introduction	The Case of Richard Cabot
2. Cardiovascular	Herrick and Heart Disease
3. Pulmonary	Trudeau at Lake Saranac
4. Neurological	Weir Mitchell of Philadelphia
5. Autonomic Nervous System	Cannon of Harvard
6. Gastrointestinal	William Beaumont: The Man and the Opportunity
7. Skin	Goldberger and the Mal de la Rosa
8. Eye	The Doctors Friedenwald
9. ENT	The Controversial Horace Green
10. Endocrine	Fuller Albright
11. Hematopoietic	The Castle Approach
12. Musculoskeletal	Hench at the Mayo Clinic
13. Female Genitalia	The Collaboration of Kelly and Broedel
14. Genitourinary	On the Autobiography of Hugh Young
15. Psychiatric	The Interpersonal Theory of Harry Stack Sullivan
16. General	Osler and the Case Study
17. Special Groups	Engel and the Concept of Disease

"From the proprietary schools of the Civil War to the Johns Hopkins Medical School of 1893, the teaching of medicine had changed dramatically" (Ludmerer, 1985). Three basic changes had occurred: the curriculum was more rigorous; many new subjects were added; the student became an active participant rather than a passive observer.

The biographical vignettes beginning each section of this book take up where this chapter leaves off. These vignettes present individuals who have made seminal contributions to clinical diagnosis in the United States. They are listed in Table 1.3.

Conclusion

This chapter has traced the stages in the knowledge and forces that have shaped the modern history and physical examination. As stated in the beginning, this has been a story of scholarship largely achieved by physicians going about the daily work of delivering patient care. They serve to stimulate us "to rise above the routines of the daily ward round . . ."

References

- Ackerknecht EH. A short history of medicine. New York: Ronald Press, 1968.
- Albert DM, Miller WH. Jan Purkinje and the ophthalmoscope. *Am J Ophthal* 1973;76:494-99.
- Allbutt TC. On the use of the ophthalmoscope in diseases of the nervous system and the kidneys. *Rhode Island Med J* 1960;43:107-11.
- Andrews JL, Badger TL. Lung sounds through the ages. *JAMA* 1979;241:2625-30.
- Balfour GW. On the evolution of cardiac diagnosis from Harvey's days till now. *Edinburgh Med J* 1887;32:1065-81.

- Bedford DE. Auenbrugger's contribution to cardiology; history of percussion of the heart. *Br Heart J* 1971;33:817-21.
- Bedford DE. Cardiology in the days of Laennec. *Br Heart J* 1972;34:1193-98.
- Benison S. Celebration and history: the centenary of Robert Koch's discovery of the tubercle bacillus. *Bull Hist Med* 1982;56:157-59.
- Bonner T. American doctors and German universities: a chapter in international intellectual relations, 1870-1914. Lincoln: University of Nebraska Press, 1963.
- Boorstin DJ. The discoverers. New York: Vintage Books, 1985.
- Buck RW. Physical diagnosis prior to Auenbrugger. *N Eng J Med* 1933;209:239-41.
- Buzzi A. Piorry on percussion of the heart. *Am J Cardiol* 1960;5:703-5.
- Chamberlain EN, Ogilvie C. The foundations of our art. In: *Symptoms and signs in clinical medicine*. 9th ed. Chicago: John Wright & Sons, 1974.
- Cohen IB, Stephen Hales. *Sci Am* 1976;234(5):98-107.
- Copeland DD. Concepts of disease and diagnosis. In: *Perspectives in biology and medicine*. Chicago: University of Chicago Press, 1976/77;20:528-38.
- Davis AB. Life Insurance and the physical examination: a chapter in the rise of American medical technology. *Bull Hist Med* 1981;55:392-406.
- Delp MH, Manning RT. Major's physical diagnosis. 9th ed. WB Saunders, 1981:1-11.
- d'Ephèse R. De l'interrogatoire des malades. In: *Oeuvres de Rufus d'Ephèse*. Paris: Imprimerie Nationale, 1879:196-218.
- Deutsch F, Murphy WF. The application of psychoanalytic concepts to resident training and the technique of the therapeutic interview. In: *The clinical interview*. New York: International Universities Press, 1955;1:14-30.
- Engel GL. The need for a new medical model: a challenge for biomedicine. *Science* 1977;196:129-36.
- Engle RL. Medical diagnosis: present, past, and future. *Arch Intern Med* 1963;112:520-29.
- Faber KH. *Nosography in modern internal medicine*. New York: Paul B. Hoeber, 1923.
- Feinstein AR. An analysis of diagnostic reasoning, I. The domains and disorders of clinical macrobiology. *Yale J Biol Med* 1973;46:212-32.
- Fye WB. Why a physiologist?—the case of Henry P. Bowditch. *Bull Hist Med* 1982;56:19-29.
- Garrison FH. *An introduction to the history of medicine*. 4th ed. Philadelphia: WB Saunders, 1929.
- Gordon BL. *Medicine throughout antiquity*. Philadelphia: FA Davis, 1949.
- Graham D. The teaching of physical diagnosis. *Bull Assoc Am Med Coll* 1928;3:115-19.
- Granville JM. Percussion as a therapeutic agent in nervous diseases. *Br Med J* March 11, 1882:339-40.
- Harvey AM. Our medical heritage: some examples of creative scholarship. *Phar Alpha Omega Alpha* 1973;36:122-28.
- Herrick JB. Some features of present day diagnosis. *JAMA* 1938;111:981-86.
- Herrick JB. Modern diagnosis. *JAMA* 1929;92:518-22.
- Holmes FL. *Claude Bernard and animal chemistry: the emergence of a scientist*. Harvard: University Press Cambridge, 1974.
- Jarcho S. Observations on the history of physical diagnosis: Hippocrates, Auenbrugger, Laennec. *J Intern Coll Surg* 1959;31:717-25.
- Jarcho S. Morgagni, Vicarius, and the difficulty of clinical diagnosis. In: Stevenson LG, Multhauf RB, eds. *Medicine science and culture, historical essays in honor of Owsei Temkin*. Baltimore: Johns Hopkins University Press, 1968:87-95.
- Jarcho S. Jacob Bigelow on physical diagnosis (1839). *Am J Cardiol* 1969;23:446-52.
- Jarcho S. Experiments on heart valves (1908) by Harvey Cushing and JRB Branch. *Am J Cardiol* 1975;36:506-8.
- Jones R.M. American doctors and the Parisian medical world, 1830-1840. *Bull Hist Med* 1973;47:40-65 177-204.
- Kampmeier RH. *Medicine as an art: the history and physical examination*. *So Med J* 1982;75:203-10.
- Keele KD. *The evolution of clinical methods in medicine*. Springfield: Charles C Thomas, 1963.
- Keele KD. Uses and abuses of medical history. *Br Med J* 1966;2:1251-54.
- Keele KD. The application of the physics of sound to 19th century cardiology: with particular reference to the part played by CJB Williams and James Hope. *Clio Medica* 1973;8:191-221.
- Keys TE, Rucker CW. The atlases of ophthalmoscopy: a bibliography 1850-1960. *Am J Ophthal* 1960;49:881-94.
- King LS. Signs and symptoms. *JAMA* 1968;206:1063-65.
- Klemperer P. Pathologic anatomy at the end of the eighteenth century. *J Mount Sinai Hosp* 1957;24:589-603.
- Korns HM. A brief history of physical diagnosis. *Ann Med Hist* 1939;1:50-67.
- Lebensohn JE. *An anthology of ophthalmic classics*. Baltimore: Williams and Wilkins, 1969.
- Liddell EGT. *The discovery of reflexes*. Oxford: Clarendon Press, 1960.
- Llewelyn DEH, Anderson J. The historical development of the concepts of diagnosis and prognosis and their relationship to probabilistic inference. *Med Info* 1980;5(4):267-80.
- Ludmerer KM. *Learning to heal: the development of American medical education*. New York: Basic Books, 1985.
- Major RH. *Physical diagnosis*. In: *Physical diagnosis*. Philadelphia: WB Saunders, 1937:17-28.
- Major RH. *A history of medicine*. Springfield: Charles C Thomas, 1954.
- Major RH, Delp MH. *Physical diagnosis*. 6th ed. Philadelphia: WB Saunders, 1962:1-8.
- Major RH. Physical diagnosis in antiquity. *J Kansas Med Soc* 1962;63:497-99.
- Mark HH. The first ophthalmoscope? Adolph Kussmaul 1845. *Arch Ophthalmol* 1970;84:520-21.
- Martinet L. *Manual of pathology*. Translated with notes and Additions by Jones Quain. 2nd ed. London: W Simpkin and R Marshall, 1827.
- McHenry LC. *Garrison's history of neurology*. Springfield: Charles C Thomas, 1969:347-52.
- McKusick VA. *Cardiovascular sound in health and disease*. Baltimore: Williams and Wilkins, 1958:1-51.
- Middleton WS. A biographic history of physical diagnosis. *Ann Med Hist* 1924;6:426-52.
- Morgan WL, Engel GL. *The clinical approach to the patient*. Philadelphia: WB Saunders, 1969.
- Musher DM, Dominguez EA, Bar-Sela A, Edouard Sequin and the social power of thermometry. *N Engl J Med* 1987;316(2):115-16.
- Newman C. Physical signs in the London hospitals. *Med Hist* 1958;2:195-201.
- Newman C. Diagnostic investigation before Laennec. *Med Hist* 1960;4:322-29.
- Numbers RL, ed. *The education of American physicians historical essays*. Berkeley: University of California Press, 1980.
- Osler W. Influence of Louis on American medicine. *Johns Hopkins Hosp Bull* 1897;8:161-67.
- Osler W. *The evolution of modern medicine*. New Haven: Yale University Press, 1921.
- Parrino TA. The art and science of percussion. *Hosp Prac* 1987;22:25-36.
- The past and present school of Paris. *Boston Med Surg J* 1866-1867;75:389-90.
- Pearlman JT, Pearlman SJ, Engreen FE. Early efforts to view the human fundus. *Doc Ophthalmol* 1973;34:317-25.
- Platt FW, McMath JC. Clinical hypocompetence: the interview. *Ann Intern Med* 1979;91:898-902.

- Pratt JH. The development of physical diagnosis. *N Engl J Med* 1935;213:639-44.
- Reiser SJ. The medical influence of the stethoscope. *Sci Am* 1979;240:148-50,153-56.
- Riese W. The structure of Galen's diagnostic reasoning. *Bull New York Acad Med* 1968;44:778-91.
- Robertson WE. Physical diagnosis from the time of Rontgen. *Ann Med Hist* 1934;6:255-63.
- Rosenberg CE. Social class and medical care in nineteenth-century America: the rise and fall of the dispensary. *J Hist Med Alli Sci* 1974;29:32-54.
- Rucker CW. A history of the ophthalmoscope. Rochester, Minn: Whiting Printers and Stationers, 1971.
- Ryle JA. The training and use of the senses in clinical work. *Guy's Hosp Gaz* 1933;47:421-27.
- Sakula A. Pierre Adolphe Piorry (1794-1879): pioneer of percussion and pleximetry. *Thorax* 1979;34:575-81.
- Schiller F. The reflex hammer. *Med Hist* 1967;11:75-85.
- Segall HN. Evolution of graphic symbols for cardiovascular sounds and murmurs. *Br Heart J* 1962;24:1-10.
- Segall HN. How Korotkoff the surgeon discovered the auscultatory method of measuring arterial pressure. *Ann Intern Med* 1975;83:561-62.
- Shryock RH. The development of modern medicine. New York: Knopf, 1947.
- Siegel RE. Clinical observation in Hippocrates: an essay on the evolution of the diagnostic art. *J Mount Sinai Hosp* 1964;31:285-303.
- Seigerist HE. A history of medicine. New York: Oxford University Press 1951;1.
- Siegerist HE. On percussion of the chest. *Bull Inst Hist Med* 1936;4:21-25.
- Singer CJ. A short history of medicine. New York: Oxford University Press, 1928.
- Smith DC. Austin Flint and auscultation in America. *J Hist Med Alli Sci* 1978;33:129-49.
- Stoeckle JD, Billings JA. A history of history-taking: the medical interview. *J Gen Intern Med* 1987;2:119-27.
- Talbott JH, Louis, PCA. (1787-1872): A biographical history of medicine. New York: Grune and Stratton, 19xx.
- Welch WH. Papers and addresses. Vol. 3. Baltimore: Johns Hopkins University Press, 1920.
- Wunderlich CA. Medical thermometry and human temperature. New York: William Wood, 1871.
- Zebrowski A. A new magnifying glass for otoscopy. *Ann Otol Rhinol Laryngol* 1923;32:453-55.