IT IS IMPOSSIBLE to ignore the dramatic developments that have occurred in the diagnosis and treatment of heart disease in recent years.\(^1\) Borrowing heavily from the physical sciences, new diagnostic instruments have been invented that allow earlier and more precise identification of cardiac disease. Pharmacologic therapy of angina pectoris, dormant for nearly a century after the discovery that nitrates were effective in relieving this distressing symptom, has blossomed recently with the introduction of \(\beta\)-blockers, calcium antagonists, and long-acting nitroglycerin preparations. Surgical approaches to many forms of congenital and acquired heart disease have been developed. Julius Comroe asked, “How many patients who have undergone open heart surgery know of the tremendous efforts of many scientists through the years that provided the basic and practical knowledge which was essential for their successful operation?”\(^2\) Indeed, how many physicians appreciate the enormous amount of multidisciplinary basic and clinical research necessary for the development of the present state of cardiology and cardiac surgery? Many of our senior colleagues remember the practice of cardiology before cardiac catheterization, echocardiography, or nuclear cardiology, and before there was “CPR” or coronary care units. I will describe the practice of cardiology a century ago to emphasize the dramatic advances in this field that have occurred as a result of millions of hours of observation and experiment by countless physicians and basic and clinical scientists.

The medical context. The average life expectancy for Americans born in 1885 was about 45 years, and infections were the leading cause of morbidity and mortality. Tuberculosis was responsible for the greatest number of deaths, but other communicable diseases took tens of thousands of lives annually.\(^3\) Although significant advances in public health and sanitation had taken place since the 1850s, major obstacles remained, and many of the residents of the increasingly crowded cities were at great risk for contracting a potentially fatal infectious disease. In the cities wealthy patients received care in their homes or in the offices of private physicians and were admitted to a hospital only as a last resort. The urban working class and the poor received their care at dispensaries where one or two full-time employees, usually a resident physician and an apothecary, cared for dozens of patients a day.\(^4,5\) Hospitals had not yet become a major institution for the evaluation and treatment of the sick; this would soon change, however. Between 1875 and 1925 the number of hospitals in America rose dramatically from about 150 to nearly 7000.\(^6\)

In the mid 19th century several discoveries were made that had major implications for the diagnosis and treatment of disease. Perhaps the most dramatic of these was the discovery of anesthesia in 1846. Equally important was the recognition of the role of microorganisms in the causation of disease, and the introduction of antiseptic, and ultimately, aseptic techniques of surgery. With the microscopic demonstration of bacteria in the 1870s and 1880s and the continued research of Koch, Pasteur, Lister, and others, the remaining skeptics of the germ theory of disease were silenced.

The practitioners. What did Americans do when they became ill a century ago? As is true today, many cared for themselves using home medical guides or “family recipes” rather than seeking formal medical evaluation.\(^7\) For those who wanted to see a medical practitioner several options existed. Numerous medical sects thrived in America during the middle of the 19th century.\(^8\) In addition to “regular” physicians, patients could choose homeopaths, botanics, eclectics, hydropaths, electrotherapists, phrenologists, or other sectarians. The American Medical Association was founded in 1847 in large part to attempt to elevate the standards of medical education, but another goal was to protect the regular physicians from the growing influence of “irregular” practitioners. In 1885 there were approximately 4200 medical graduates, of whom 85% were

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regular physicians, 10% were homeopaths, and the remaining 5% were eclectics. There were about 87,000 physicians of various schools, which represented one practitioner for 575 Americans. In 1980 this ratio was approximately one physician for 485 Americans. Concern about the "doctor glut" is not new. Writing in 1882 an editor observed, "We are so often asked concerning professional prospects by young men starting out in practice that we offer this as a general answer. It does not make much difference where he settles. Every place is full."10

Contemporary practitioners could not help but be impressed by the discoveries and inventions of European physicians, surgeons, and biomedical scientists. Nor could they ignore the trend toward specialization. Graduates who could afford it attempted to improve their chances of success in practice by traveling to the medical centers of Europe, Germany in particular, where the developing specialties were taught in the large universities. A few medical schools and hospitals in America attempted to offer postgraduate training as well. The New York neurologist Edward Seguin claimed in 1880, "Of the many practical questions which present themselves to the minds of students of medicine, and even more forcibly to the minds of young graduates, few, I take it, are more interesting than the one: 'Shall I practice medicine in general, or become a specialist?'"11 In this era the specialties were confined primarily to surgical sub-specialties, dermatology, and neurology; cardiology did not exist as a distinct professional field. The debate about specialization continues despite the 1885 proclamation of the New York physician and medical editor, George Shrady, "Specialism is an established feature of modern medicine. . . . It is not an artificial addition to medicine, but a natural and inevitable development."12

The cardiac patient: history and cardiac physical examination. A century ago physicians relied heavily, as we do today, on the historical details of the present illness to determine the etiology and significance of a patient's complaints. However, they realized the difficulty of making an accurate diagnosis based on symptoms alone. Jacob DaCosta, a leading diagnostician, declared, "It is not easy to say what are and what are not the symptoms that belong to diseases of the heart."13 The invention of the stethoscope in 1819 by the French physician and pathologist Laennec signaled the birth of modern physical diagnosis. Indeed, it has been claimed recently that this instrument "transformed the practice of medicine in the 19th century, altering the physicians's picture of disease and his relation to the patient."16 Americans who studied in Paris during the middle third of the 19th century did much to popularize the use of the stethoscope in the United States. Austin Flint, "the American Laennec," was a strong advocate of auscultation and percussion. He published a popular textbook on cardiac physical diagnosis and the first monograph on heart disease written by an American.17 The correlation of murmurs and abnormal heart sounds auscultated during life with autopsy results had led to a rather sophisticated understanding of the significance of these physical findings. Moreover, attempts were made, with reasonable success, to explain auscultatory abnormalities on the basis of physical principles.18 Many cardiac conditions were "silent," however, and physicians of a century ago recognized their limited ability to diagnose nonvalvular diseases of the heart by physical examination.

Laboratory aids to diagnosis. Instruments designed to graphically record physiologic events became fundamental tools in physiologic laboratories during the second half of the 19th century, and some of these methods were applied to clinical practice. Carl Ludwig, the pioneering German physiologist, had invented the kymograph in 1847, and seven years later Karl Vierordt adapted this instrument to record the pulse in man. This "sphygmograph" enabled physicians and investigators to evaluate the character of the pulse objectively for the first time.19 These recording instruments were combined with catheterization techniques developed by German and French physiologists to record intracardiac pressures in experimental animals nearly a century before these procedures were attempted in humans.20 Another instrument "sometimes of considerable diagnostic value" was the cardiograph. This apparatus graphically recorded the apical impulse and was used primarily by physiologists to study the phases of the cardiac cycle. Clinical applications were recognized, however, and it was claimed, "By means of the cardiograph it is possible to clear up some obscure causes of cardiac disease, and to ascertain the exact relationship of murmurs (which it is difficult or impossible to 'time' in any other way) to the different periods of the cardiac cycle."21

Developments in the science of electricity were accompanied by growing interest in bioelectrical phenomena. By 1885 the electrical activity of the heart in intact animals had been recorded with a capillary electrometer. This instrument would be used by Augustus Waller in London two years later to record the first electrocardiogram in man.22 However, electrocardiography would not become practical until the work of Einthoven, Lewis, and others in the early 20th century.
X-rays were not discovered until 1895, so, in 1885, physicians did not have access to two of the most important diagnostic tests for detecting cardiac disease.  

Ischemic heart disease. Although there was little insight into the pathophysiology of ischemic heart disease a century ago, there was no lack of enthusiasm for proposing various forms of therapy for angina pectoris. In 1867, the British pharmacologist Lauder Brunton discovered that amyl nitrite administered during an attack of angina pectoris could abort the paroxysm or at least reduce its severity. William Murrell of London extended Brunton’s studies on nitrates and reported the value of nitroglycerin in the treatment of angina in 1879. Then, as now, enthusiasm for advances in therapeutics overshadowed the response to reports of new insights into the pathophysiology of disease processes. Some observers, however, recognized the critical role of basic research in the discovery of these “breakthroughs.” Referring to Brunton’s discovery of the efficacy of amyl nitrite in angina, a reviewer exclaimed in 1883, “In few maladies are the improvements in our therapeutical resources more conspicuous. In the use of the most effective remedy for the relief of the paroxysm, an admirable illustration is given of the remarkable value of the contributions made to therapeutics by physiological investigations.”

The introduction of nitrates did not totally replace older therapies for angina for several decades, however. In addition to advocating the use of amyl nitrate and hypodermic morphine for the treatment of angina, the prominent Philadelphia physician Jacob DaCosta recommended arsenic, strychnine, and cannabis indica (marijuana) for this condition. In 1885 empiric observation was the only means to assess the relative merits of the various therapeutic approaches to angina. It was nearly a century before it became possible to identify the existence of coronary artery lesions or evaluate their physiologic significance in the living patient.

Valvular heart disease. Diseases of the cardiac valves received great attention during the 19th century mainly because of the physician's ability to identify many valvular lesions with the stethoscope. It is likely that the prevalence of valvular heart disease was greater a century ago than today. Infectious diseases, notably streptococcal infections, could not be treated effectively in the preantibiotic era, and rheumatic heart disease was more common. Life expectancy was sufficiently short that degenerative diseases such as coronary artery disease and cancer were less prevalent. It was recognized by 1885 that valvular lesions could be congenital or acquired and that acute rheumatism often preceded the development of valvular heart disease in the older child or adult. The previous year Ernest Laseque had proclaimed, “Rheumatism is a disease which licks the joints . . . but it bites the heart.” Salicylates were first advocated for the treatment of acute rheumatism in 1876 by Thomas Maclagan, and the association of tonsillitis with this disease had been reported in 1880 by James Fowler.

Aortic valve disease was relatively easy to identify by careful auscultation. Alfred Loomis of New York claimed in 1885, “The treatment of aortic stenosis and of aortic regurgitation may be summed up under three heads — viz. rest, diet, and regimen. Rest is most important; it must be mental as well as physical; the appetite, emotions, and passions must be kept under perfect control. . . . The stomach also must have all the rest compatible with the most perfect nutrition . . . sugar, sweet vegetables, and animal fat must be sparingly indulged in. . . . The bowels should be gently moved once daily. That the cutaneous circulation may be active the body should be warmly clothed. Any prolonged exposure of the surface to cold is to be avoided.” If cardiac decompensation occurred, Loomis advocated the administration of digitalis, which had been introduced into medical practice a century earlier by William Withering. If syncope or vertigo supervened, Loomis suggested the administration of quinine and strychnine. “When the hepatic and gastric vessels are engorged,” he advised, “three or four leeches over the liver or epigastrium . . . will afford temporary relief.”

The British physician Hilton Fagge claimed, “The diagnosis of mitral disease is far from resting on so satisfactory a footing as that of aortic obstruction and regurgitation.” Byrom Bramwell considered mitral insufficiency “a very common condition” and recognized that it “may result from a lesion of any part of the mitral valve apparatus (sphincter muscle, basal ring, valve segments, chordae tendineae, or papillary muscles).” He appreciated the variable natural history of mitral insufficiency and claimed, “In some cases, it neither interferes with the comfort of the patient, nor shortens life.” It was well known, however, that this lesion could lead to progressive exertional dyspnea and ultimately to decompensation with anasarca (dropsy) and death. Bramwell advocated changes in life-style in the early stages of mitral insufficiency and claimed, “If the patient has been in the habit of following a laborious occupation he should be advised to give it up.”

Revealing concern for the patient’s emotional response to the physician’s prognostication, he warned that the
patient “should not be allowed to take too serious a view of his own condition . . . [and] the fact that the disease has little or no tendency to cause sudden death should be impressed upon the patient; many of the laity, when they are told that their hearts are not quite sound, jump to the conclusion that they are affected with a disease which may at any moment prove fatal, and to persons of a nervous and anxious disposition this idea is often a source of perpetual and terrible anxiety.” Alcohol, tobacco, tea, and coffee were to be used in a “strictly moderate” fashion, and mild exercise, a large amount of sleep, and fresh air were beneficial. Decompensation was treated with the same approach advocated for advanced aortic valve disease. Congestive heart failure was treated with digitalis, “by the internal administration of cardiac tonics and stimulants, diuretics and purgatives . . . [and] by local measures,” including the use of Southey’s trochars to physically drain fluid from edematous extremities.\textsuperscript{31} To reduce pulmonary and systemic venous congestion, Fagge advocated “the removal of a portion of the venous blood by venosection, leeches, or cupping.”\textsuperscript{29} Agents used as diuretics included squill (\textit{Urginea scillo}), juniper, broom (\textit{Sarothamnus scoparius}), cream of tartar, and copaiba.\textsuperscript{30}

Mitr al stenosis was recognized as a complication of rheumatic fever, although a congenital form was acknowledged. The risk of embolization in the setting of mitral stenosis was recognized. Although the risk of thrombus formation was appreciated, emboli were most often attributed to detachment of vegetations from the diseased valve leaflets. If embolism occurred, the British physician Ernest Sansom advocated “the maintenance of rest and tranquility of the heart. The blood should be rendered as fluid and non-coagulable as possible, and to this end alkaline salts of ammonia or soda may be administered.”\textsuperscript{31}

\textbf{Miscellaneous cardiac diseases.} Endocarditis was attracting a great deal of attention a century ago and was the subject of William Osler’s Gulstonian Lecture before the Royal College of Physicians of London in 1885. This disease had recently been attributed to microorganisms, and Osler commented that micrococci were invariably present in vegetations examined under the microscope. The predisposition of deformed valves for the development of endocarditis, the variable course of the illness, and the frequent predominance of systemic over cardiac symptoms were emphasized by Osler. He claimed, “Few diseases present greater difficulties in the way of diagnosis, difficulties which in many cases are practically insurmountable. . . . The protean character of the malady, the latency of the cardiac symptoms, and the close stimulation of other disorders, combine to render the detection peculiarly difficult.”\textsuperscript{32} In this preantibiotic era, infective endocarditis was invariably fatal, usually within a month of the onset of symptoms.

Cardiac arrhythmias were poorly understood in 1885 despite the long tradition of palpation of the pulse and the introduction of the sphygmmograph. There was growing awareness of the role of the heart in sudden death, however, and William Osler claimed, “The cases of very rapid death are almost always due to affections of the heart, or of the great vessels.”\textsuperscript{33} Austin Flint recognized the risk of sudden death in patients with angina pectoris and warned, “A person subject to paroxysms of angina must be considered as in more or less danger of sudden death with the recurrence of each paroxysm. The physician should be sufficiently impressed with . . . this fact.”\textsuperscript{34} Although the risk of sudden cardiac death was recognized, its mechanism was obscure in 1885. Flint’s explanation, “The immediate cause of sudden death in a paroxysm is probably an arrest of the heart’s action in diastole,” reflected contemporary attitudes regarding the pathophysiology of sudden cardiac death. In the late 1880s the Scottish physiologist John MacWilliam would propose that ventricular fibrillation was the usual mechanism of sudden cardiac death.\textsuperscript{35}

Chronic irregularity of the pulse had been associated with mitral valve disease since the early 19th century, but atrial fibrillation was not recognized as the most common mechanism of this physical finding until the 20th century.\textsuperscript{36} The identification of extrasystoles and attempts to understand their etiology and significance had to await the experiments and observations of Wenckebach, Mackenzie, and Lewis early in the present century. In 1885, palpitations were considered a functional disorder or “neurosis of the heart.” It was recognized that alcohol, coffee, tea, and tobacco predisposed to palpitations and that certain types of individuals were more prone to this symptom. “The individuals most frequently affected are young adults and persons beyond middle age; females; nervous subjects; and fat, flabby people, who live highly and are habitually dyspeptic.”\textsuperscript{37} Although the mechanisms of cardiac irregularities were not understood, empiric observations made since the 18th century led physicians to prescribe digitalis for palpitations.

Although there was no understanding of the mechanism of palpitations and their significance was debated, contemporary practitioners prescribed a wide variety of remedies. Oliver Wendell Holmes proclaimed in 1860 that, with the exception of opium,
anesthetics, and wine, “If the whole materia medica, as now used, could be sunk to the bottom of the sea, it would be all the better for mankind, — and all the worse for the fishes.” This blunt plea for therapeutic nihilism had little effect on practitioners who Holmes admitted were responding, in part, to the public, “which insists on being poisoned” and exerts immense pressure on the physician, “tending to force him to active treatment of some kind.”

A quarter of a century later, Frederick Roberts, a leading British practitioner, advocated a quiet calm environment for the treatment of an acute attack of palpitations as well as the administration of antispasmodics, sedatives, and stimulants “such as brandy, ether, ammonia, opium or morphia, hydrocyanic acid, bromide of potassium, tincture of henbane, musk, camphor, tincture of lavender, galbanum, or assafœtedia, as well as medicines which act upon the heart directly, especially digitalis.”

The treatment of palpitations was hardly scientific a century ago.

Many forms of congenital heart disease had been defined by 1885, due in large part to the detailed studies of European pathologists. A growing understanding of the origin of these anomalies had resulted from advances in embryology. Diagnosis during life was unusual, however, and rested upon the presence of certain characteristic murmurs and associated physical findings. Writing in 1891, Osler observed, “To the general practitioner congenital heart-disease has an extremely limited interest. A great majority of the cases are still-born, or do not survive many weeks or months. Instances which reach maturity are extremely rare. I do not call to mind more than one or two cases, in a some-what extended hospital practice, of subjects of congenital heart-disease in persons who had passed the age of puberty.”

Cardiac surgery. Although the introduction of anesthesia and antiseptic techniques led to important advances in surgical practice during the second half of the 19th century, surgery of the heart lagged because of problems posed by opening the thorax, to say nothing of opening the heart itself. By 1885, however, surgeons were experimenting on suturing wounds of the heart in experimental animals. The belief that this technique was incompatible with life was being dispelled by research. Nevertheless, it would be nearly a half century before there was a sustained effort directed at performing intracardiac surgery.

In 1885, the only “heart operation” performed in humans was pericardiocentesis, a procedure popularized in America by the innovative Philadelphia surgeon John Roberts. He concluded his 1880 monograph on the procedure by claiming, “Surely the record I have given supports the plea for the adoption of paracentesis of the pericardium into the family of accepted surgical procedures; surely it is noble to add three or four weeks to the life of a fellow-being. . . . Let the operation be palliative, if you will; but operate, and that before continuance of inflammation, maceration of the heart, and pressure of the distended sac have caused the tissues to assume pathological aspects of such a kind that a perfect return of function is impossible.”

The future. This review of the state of cardiology practice a century ago has revealed the limitations faced by practitioners when they attempted to diagnose and treat diseases of the heart. The development of “modern” cardiology and cardiovascular surgery depended on fundamental changes in the structure and philosophy of medical education and medical research. There was growing awareness of the importance of medical research among contemporary practitioners. In 1885, the New York ophthalmologist Henry Noyes observed, “During the year past, it has been permitted me to see many medical men and medical institutions in various parts of Europe. One gets a new impulse from such an opportunity, and one may be lifted to a wider horizon in the field of medicine. . . . The impression which, to me, has come uppermost, is that the line of advance must hereafter be through acute, exacting, and deep research.” He continued,

Our American physicians may be justly proud of their forwardness and energy in such efforts. The wonder is, that they do so much with the meagre facilities which are at their command. I pay willing tribute to men who sacrifice ease and health to pursuits of pure science; who must snatch time from bread-getting, who give public instruction, whose is the heroism of steadfastness and unshrinking labor, that they may contribute to the advance of scientific medicine. You will acquit me of any thought of belittling the achievements of aspirations of my brethren, if I venture to bring before you the need there is among us for better and more perfect methods of pursuing scientific medical research.

Pursuing a similar theme, another writer claimed,

The gulf between scientific and practical medicine is a wide one. The majority of the profession are practical men, while comparatively few have either the time or inclination to pursue the scientific aspects of medicine. . . . Unfortunately, there is a certain amount of antagonism between these two classes [of scientific and practical men]. The practical men are much too apt to sneer at the teachings of the scientist, instead of carefully considering the practice value of their scientific investigations. Were the busy, every-day physician to carefully read, ponder over, and practically deduce from the laborsious researches of the scientist, we would have a combination that would be very productive.

During the second half of the 19th century, the emphasis placed on scientific research in the universities
of Germany spread to Great Britain and finally to America. Philanthropic and ultimately governmental support of research led to the establishment of sophisticated research institutes and faculty positions in medical schools where original investigation was expected of the faculty members. This fostered scientific research and ultimately led to great improvements in patient care. The development of cardiology as a distinct medical specialty began during the middle third of the 20th century as diagnostic and therapeutic techniques became increasingly specialized and time consuming. The empiricism that characterized cardiology practice a century ago has given way to a specialty deeply rooted in the biomedical and physical sciences. The precious "art" of medicine has been solidly framed in science and the benefactors have been our patients.

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