The Promising Future of Public Health

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By

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All my love to Laure, Stella, Ari, Amalia and Adam
for nurturing our family ties.

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PREFACE

As it evolved over time, medicine was primarily concerned with public health. The famous physicians of antiquity prescribed foods, habits, exposures, sins, and divinities as the critical agencies of health and disease. Their recommendations usually ended after the demise of a nation's leader, though some became permanent fixtures in the culture of certain societies. Kashrut, the ancient religious laws of Judaism, governed the diet, circumcision, quarantine, and personal hygiene regulations of the Israelites for thousands of years, while the vegetarian preferences of Hindus, Jains, and Buddhists are maintained to this very day.

Clinical medicine for individual patients slowly emerged during the past few centuries, as epidemiologically alert physicians began to notice diseases arising in patients eating certain foods or otherwise exposed to substances or conditions proven to be harmful through periodic observations of family members, the community, or the era's medicine men. When a sufficient number of consistent observations had been assembled, they became part of the records, teachings, and clinical practices of the time. In this fashion, the medical schools began to recognize etiologic factors of disease, which were disseminated throughout Europe and beyond. Since the mid-1800s, medical research has developed rapidly, as investigators and then comprehensive research institutes probed disease epidemics, began to understand the functions and malfunctions of human health and disease, and devised a myriad of techniques to detect their risk factors.

Early in this era, the anatomy and physiology of human beings, as well as their functions and malfunctions, were the principal subjects of concern. But, as investigators with PhD degrees in basic medical science multiplied, animal-based studies became the dominant experimental model, as the relative simplicity and lower cost of laboratory animal investigations outweighed all other considerations. Whether the animal species chosen for the study of a specific human disease was sufficiently homologous to Homo sapiens to justify its use was sometimes, but not invariably, considered.

Since then, physicians with epidemiological skills became the biomedical researchers undertaking the relatively complex human studies to test hypothesized risk factors for given diseases. The majority of such physicians, including myself, were associated with public health schools and preventive medicine departments in medical schools. But, over the past 30 years or so, the ground under their feet has been disrupted. Public health and medical schools have essentially eliminated entrance requirements for master and PhD degrees, so that the majority of matriculants in their programs are now seriously lacking knowledge of human health and disease, as well as the basic medical sciences. A small minority has been trained to undertake classical epidemiologic studies in humans, but most researchers now utilize computers with Big Data capabilities that make the critical analytical decisions for them. Graduates of public health programs these days generally end up in office jobs of government agencies, and would be unprepared to participate meaningfully in the design, conduct, or analysis of epidemiologically based human studies.

The urgency of publishing this volume is intensified because public health schools are now being established on college campuses remote from any medical school or hospital, strongly suggesting that, in the minds of many, public health need no longer continue as a significant branch of medicine. Epidemiological reasoning and research on human disease will be permanently impaired if this view gains wider support.

This book is not a standard textbook on public health, of which many have been published. Rather, it is designed to offer the reader a multidisciplinary view of epidemiology and the diverse fields of public health and medicine in which it can be applied. Chapter 1 describes the development of medicine from its faith-based origins to modern science. This is followed by a detailed discussion in Chapter 2 of the flowering of epidemiology as the fundamental process of applying scientific reasoning to clinical observations in human biomedical research.

Sixteen studies conducted by the author while at Harvard, Johns Hopkins, and the University of Maryland Schools of Medicine and Public Health are presented next. These demonstrate the wide diversity of investigations in disease that are possible using traditional epidemiological methodologies, as well as other ventures designed to assist physicians in their clinical practice. Chapters 3 to 9 were undertaken during what many regard as a ‘Golden Age of Medicine and Public Health,’ a period when thousands of papers were published, in which researchers carefully reviewed the existing literature on human disease, proposed specific risk factors in living subjects, and critically discussed the results of the study. These efforts were largely completed during the earlier years of this era, when government regulations were modest and risk factor investigations as potential causes of human disease were plentiful. The reader should glean from these chapters a fuller understanding of the epidemiological relationships between clinical diseases and their putative risk factors, as well as the captivating spirit of engaging in such endeavors.

Chapter 10 describes our Department of Public Health at the University of Maryland developing a uniquely rapid-reporting statewide cancer registry system while Chapter 11 focuses on our innovative training program in medical informatics to prepare the faculty and students for exploiting the enhanced capabilities of modern computing. The classic epidemiological approach to the COVID-19 pandemic is addressed in Chapter 12, an objective comparison of the costs and quality of medical care by dermatologists and family physicians is fully described in Chapter 13 and the details concerning our automated clinical information system for physicians in practice are presented in Chapter 14. These studies were developed during a later period when government regulations were maximal, epidemiological studies in humans had declined, and public health schools were emphasizing ancillary subjects rather than the pathogenesis of human disease. My duties as department chairman had greatly increased so that I proceeded with a multiplicity of projects without much concern for immediate publication. The readers of this section will come to better understand how well designed epidemiological investigations can address many of the long-ignored conundrums in public health and medicine. Such an array of data has never, to our knowledge, been made available to the medical community and the general public.

After detailing the many contributions of epidemiological reasoning in human studies of disease, the book concludes with Chapter 19 entitled "Assuring a Promising Future for Public Health." It is here that the urgent need to reconfigure the public health education of physicians and nurses is emphasized. By having the medical and public health schools add a graduate-level, degree-granting, and autonomous Clinical Public Health (CPH) department for physicians and nurses with a strong background in clinical medicine, such departments could eventually become each school's center for clinically oriented teaching and research on human disease. The CPH departments would become the primary pathway to prepare physicians and registered nurses for leadership roles in public health education, clinical practice, and epidemiology-based research on human disease.

It is essential that the CPH departments be physically separate from the ancillary departments that cater to the needs of students lacking a clinical or health background. All students desiring to expand their knowledge of health economics, healthcare policy, environmental health, hospital administration, genetics, and other ancillary subjects can attend such lectures, but the core courses on agent/host/environment epidemiology and human disease must be based in the CPH department, and the bulk of the students' time each day should be spent in the company of CPH faculty and students. This intense exposure to colleagues and faculty engaged in public health education and research will enrich the program immensely and benefit all participants.

After decades of relatively low productivity, the medical and public health schools will once again regain their leadership in public health, emboldened to resume their unique roles in advancing knowledge and training for public health practitioners to the benefit of mankind. The world at large will rejoice to see hundreds of young physicians and nurses attracted each year to programs designed to prepare them for careers in public health education, practice, and research on the causes of human disease, disability, and prevention.

Chapter 19 concludes with an outline of the steps necessary to establish CPH departments, including unique educational programs to assure their success, both academic and financial. Included in the chapter is a sampling of notable ventures that differ greatly from traditional offerings of Public Health Departments, and which will contribute substantially to the program's educational and financial viability.

I am very grateful to a number of my colleagues, including former students and academic colleagues who were among the pioneers of their generation in public health, and who agreed to read or comment on the book. Included in this number are: Prof. Rainer Frentzel-Beyme, MD MHS, University of Bremen; Prof. Joseph W. Burnett, MD, University of Maryland; Prof. Manning Feinlieb, MD, DrPH, NHLBI; Prof. Arnold Krieger, PhD, University of Maryland; Prof. Lewis Kuller, MD, DrPH, University of Pittsburgh; Prof. Ruey-Shiung Lin, MD, MHS, National Taiwan University; Dr. Kiyohiko Mabuchi, MD, MHS, Radiation Epidemiology Branch, NIH; Dean Phillip Pizzo, MD, Stanford University; University Prof. Roger W. Sherwin, MB BChir, University of Maryland; and Prof. Frank E. Speizer, MD, Harvard Medical School. Prof. Laure Aurelian Kessler, my wife, dearest friend, and colleague, provided unbounded support to complete this vital task, including her virological, immunological, and epidemiological commentary on the HSV-2 virus and its associated roles in human diseases. Sincere thanks are due Rebecca Gladders, Senior Commissioning Editor, Amanda Millar and Sophie Edminson of Cambridge Scholars Publishing for their valuable assistance.

THE PAST

Chapter One Summary

Medicine Evolves from Faith to Science

For most of recorded history, people relied on gods and medicine men to diagnose and treat their illnesses. The first medical schools were established 18 centuries after the Hippocratic Oath began urging caregivers and their students to obey basic moral principles in their clinical practice. Until modern times, tribal groups accepted certain vegetables, fruits, and animal products as being healthful on the basis of observations by community leaders and others, using their senses of taste and smell and the physical consequences of ingestion. Foods with laxative, medicinal, or poisonous effects were similarly accepted or rejected for thousands of years.

In the absence of science-based knowledge, the core principles of systematic sanitation practiced by the Israelites defended them against infectious disease long before the appearance of science-based medicine. The faith-based laws of Kashrut, such as washing the hands before meals, certain food practices, bodily cleansing after contact with discharges from themselves or others, and circumcision, were adopted by the world's Muslims around 600 AD and by millions of other non-Jews in today's Western-oriented countries.

After analytical and microscopic studies began to challenge the ancient, but stagnant, views of Galen, Ramazzini undertook the first epidemiological investigations of diseases in workers exposed to a variety of toxic substances. By the mid-1800s, medical science had advanced remarkably in formulating germ theories of disease, Koch's postulates to prove that microbes are causes of specific illnesses, vaccine development, and technical breakthroughs like stethoscopes and X-rays to study vascular circulation and a host of other human conditions.

This chapter highlights the prodigious discoveries of a number of bioscientists who accelerated the evolution of medicine from faith to true science. Vesalius disproved many of Galen's anatomical theories, Harvey clarified the roles of the heart, lungs, and blood vessels, and Malpighi discovered the basic roles of the skin and blood vessels, while van Leeuwenhoek and Kohler dominated the development of microscopy.

Ramazzini's research, though flawed, called attention to risk factors that exist in many diseases and need to have their causative roles investigated. The work of John Shaw Billings led to the Hollerith card and, from there, to the giant computer industry of today.

While all of these medical and technical developments represent spectacular advances in the science of medicine, the remarkable achievements in epidemiology attracted far less attention. This paradox may be related to the fact that clinicians use microscopes, stethoscopes, and X-rays daily in their clinical practice, but read about epidemiological studies only in their leisure.

CHAPTER ONE

MEDICINE EVOLVES FROM FAITH TO SCIENCE

For most of recorded history, people relied on gods and medicine men to diagnose and treat their diseases. The first medical schools were not established until 18 centuries after promulgation of the Hippocratic Oath on the ethics of caregivers, after which systematic observations began to be made and theories on health and disease were formulated.

Until modern times, many tribal groups around the world came to accept certain vegetables, fruits, and animal products as being healthful on the basis of observations by medicine men, community leaders, and others, using their senses of taste and smell and the physical consequences of ingestion, ranging from gastrointestinal upsets and allergies to severe infections and death. Foods with laxative, medicinal, or toxic effects were similarly identified and accepted or rejected for use in an essentially unscientific fashion for thousands of years, until the gradual emergence of medicine as a systematic approach to organizing random medical observations into a scientific discipline. The ancient cultural practices of India and China, with particular reference to animals approved or rejected as food, have been incorporated into the religious practices of different segments of their populations, with vegetarian diets mandated by Hinduism, Jainism, and Buddhism.

An exceptional prototype of sanitary health recommendations dating from the second millennium BC was reiterated throughout the Hebrew Bible and Talmud, and maintained for over 3,000 years. These religion-based health and behavioral practices of Kashrut were adhered to over this extraordinary length of time because they proved to be sufficiently effective in warding off disease and maintaining health. The hygienic practices included washing the hands before meals, bodily cleansing in fresh water after contacting discharges from themselves or others, burying human waste, and a variety of food practices.

In the absence of science-based knowledge, the core principles of systematic sanitation practiced by the Israelites defended them against infectious disease eons before the development of Pasteur's explanations of infectious diseases and their prevention. Related health laws required burning the clothes of leprosy victims, quarantining patients with a variety of infectious diseases, and frequent washing of patients and their clothing. Circumcision was another major, and still somewhat controversial, Hebraic health practice, which was adopted by the world's Muslims around 600 AD and millions of other non-Jews in today's Western-oriented countries. The benefits of this procedure—such as a reduced risk of phimosis in men and of cervical cancer in their wives and sexual contacts—have been attested to in many studies. Over its multiple-century history, Kashrut involved adherence to dietary laws by most Jews until modern times. This forbade the intake of swine, a major source of trichinosis, and certain seafood, and encouraged diets based on fruits, vegetables, and kosher meats. The extent to which these dietary laws affect health and disease remains indeterminate, although the continued practice of Kashrut over millennia makes it worthy of continued study.

After the initial appearance of anatomical and microscopical studies challenging the stagnant views of Galen of Pergamon (130–210 AD), Bernardino Ramazzini undertook pioneering epidemiological investigations of diseases in workers of the late 1600s who were exposed to chemicals, dust, metals, and other toxic substances. His research, though technically flawed, was the first to demonstrate how one might compare exposure to disease risk factors among workers in specific occupations with their counterparts in the general population.

By the mid-1800s, medical science had advanced sufficiently to formulate germ theories of disease, Koch's postulates to prove that microbes are the causes of specific illnesses, the development of vaccines, and technical breakthroughs like stethoscopes and X-rays to investigate the vascular circulation and a host of other clinical conditions. The Library of the Surgeon General, established to study the medical outcomes of the Civil War, led to a method of storing vast amounts of medical information on Hollerith cards, an important precursor of the modern computer. And, late in the 19th century, following the brilliant work of Robert Koch, Louis Pasteur, Marie Curie, and other bioscientists, research institutes devoted to biomedical education and research were established at major medical schools in Europe and the United States.

The Hippocratic Oath, an ancient ethical code to promote beneficence and non-maleficence among all practitioners of medicine and their students, was promulgated by a Greek physician, possibly Hippocrates, about 1,500 years before the first medical schools were organized in Italy and France, demonstrating the significance of health and disease to the public long before medical science had begun to evolve.

MEDICAL SCHOOLS BEGIN WITH GROSS ANATOMY

During the Renaissance, knowledge of human and animal anatomy gradually began to be acquired through dissections, often conducted secretly on cadavers secured outside the law, in Italy and other Western European countries. These studies eventually led to the development of the first subject matter of modern medicine, viz. anatomy, beginning with gross anatomy based on cadaver research and direct examination of patients, living and dead. Paramount among the early anatomists was one of the world's great geniuses, Leonardo da Vinci. This remarkable observer of nature and life in the late 15th to early 16th centuries achieved world renown for his extraordinary art and unusual scientific brilliance, both medical and physical. The painter of the *Mona Lisa* and the *Last Supper* was also the most talented anatomist of his time, drawing and commenting on many aspects of human anatomy, dissection, and comparative anatomy.

Medical schools began to be established in the early 13th century, by which time European society was concurring that sufficient knowledge had been amassed to justify the inclusion of medicine in its universities. Physician training was inaugurated in Salerno and Montpellier at the universities of Bologna and Padua, in the early 1200s. The emphasis was on the recently accumulated anatomical details of the human body, derived largely from human dissection, as well as formal critiques of the thousand-year-old observations of Galen of Pergamon, which had barely been modified during this millennium. It is not surprising that the central focus of the newly established medical schools was human anatomy and the structures and functions presumed, though not validated, of the organs of the body. There was little objective evidence from any other source, except clinical observation of patients over the course of their diseases.

Among his contemporaries, Andreas Vesalius, a Belgian, was universally regarded as the founder of modern human anatomy. He devoted much of his career to disproving many of Galen's anatomical theories, fomenting antagonism from the orthodox "scientific world" that `regarded opposition to Galen as blasphemous. Vesalius discovered, for example, that many of Galen's observations were based on ape, rather than human, anatomy, and that the lower human jaw was a single bone rather than two, as in animals. But Vesalius also perpetuated errors; for example, though he fairly accurately described the anatomy of the brain, he continued to teach that the heart and ventricles were the main sites of brain function. His teaching methods also generated controversy, as they involved anatomical dissections with the active participation of students, rather than simple acceptance and regurgitation of the 1,400-year-old views of Galen.

While several centuries of anatomical observations and debates finally led to a resolution of some major questions regarding human anatomy, other advances in medicine were also occurring during the Renaissance. Among the most significant were the clinical observations on blood circulation proposed by William Harvey, an English physician who studied medicine at Padua and spent most of his life as Physician in Charge at St. Bartholomew's Hospital in London during the 1600s. Married, but childless, he lived a modest life, examining patients and lecturing extensively but also occupying politically important positions in later life to the British monarchy and the College of Physicians. His brief but very influential text, "De Motu Cordis," conflicted with many teachings of Galen but came much closer to clarifying the true functioning of the heart, lungs, and blood vessels in animals and man.

However, two major facts eluded him: first, he could never demonstrate his hypothesized blood vessels (capillaries) that would have proven the single circuit of blood circulation; and, second, he could never explain why the heart should circulate blood (i.e. the role of oxygen).

One of the first notable microscopists seeking to expand medical knowledge beyond that revealed by gross anatomy was Marcello Malpighi. After earning his medical degree at Bologna in 1653, he devoted the rest of his life to the gross pathology of hundreds of autopsies and their correlation with the signs and symptoms of disease appearing prior to death. His microscopic observations of the human body often contradicted the still dominant views of Galen and his unscientific, but still popular, medical beliefs.

Malpighi made fundamental discoveries concerning many internal organs as well as the skin and red blood cells. He also provided the missing link in William Harvey's theory of a single circuit of blood circulation by describing the pulmonary capillaries that connect the small veins to the small arteries in the bloodstream. But, as is true for many brilliant scholars throughout the history of medicine and science, many of his conclusions concerning cell and organ function were erroneous.

In the late 1600s, Antonie van Leeuwenhoek, a Dutch draper, developed an interest in lens making and microscopes in order to study the microscopic world. Beginning with lice, bees, and mold, his studies eventually led to visualization of bacteria, spermatozoa, and cell vacuoles, inter alia. The development of microscopes led to major advances in anatomy and promising ideas about blood, the arterial and venous circulatory systems, the heart, the lungs, and other bodily systems. It eventually led to a fuller understanding of microbes, beginning with various bacterial species, as the bearers of disease. While Malpighi was the pioneering gross pathologist of his era, it was Rudolph Virchow 50 years later who focused attention on manifestations of disease at the cellular level and is credited with being the father of microscopic pathology.

The next great development in microscopy did not occur until late in the 19th century when August Kohler developed a new technique for sample illumination (Kohler illumination), which eventually led to phase contrast microscopy, permitting the imaging of colorless and transparent samples, and, later on, to the electron microscope that discerned objects as small as the diameter of an atom in the early 1930s. Other microscopic tools for research and medical care were developed more recently, including transmission and scanning electron microscopes, which produce three-dimensional images of objects down to the atomic level, as well as fluorescence and confocal microscopy.

ADVENT OF EPIDEMIOLOGY

Late in the mid-17th century, by which time some of the basic elements of scientific observation and experimentation had been established, Bernadino Ramazzini, a medical school professor in Modena and Padua, initiated the first systematic study of the health of workers and tradesmen, suggesting the possible disease-causing capabilities of chemicals, dust, metals and other occupational exposures. But his famous book, written before any fundamental knowledge of infectious agents, genetics, chemicals or other agents of disease or disability had been demonstrated, was a revolutionary but futile effort to identify actual diagnostic or preventive criteria for disease. His text, like many written by brilliant scholars before medical science had sufficiently advanced, was a lengthy narrative offering an unsubstantiated view of the diseases most characteristic of workers in a variety of occupations, including “Jewishness”! Ramazzini’s research, though fatally flawed scientifically, was the first to demonstrate how one might compare the quantitative and qualitative aspects of associations between exposure to risk factors (e.g. a specific chemical, metal or dust) in specific occupations as compared to the same associations in the general (largely unexposed) population of similar age.

Ramazzini’s approach, though lacking the elements of modern biomedical science, represented an early and pioneering development in classical epidemiological thinking. He systematically searched for risk factors in patients with specific diseases that might play a role in their pathogenesis and compared their prevalence with people in the general population. In modern epidemiology, this process is accelerated: patients with a given disease are identified, their symptoms, complications, and outcomes are observed, and comparisons are made with the general population.

Domenico Rigoni-Stern was an Italian surgeon in Verona who was actively interested in the epidemiological distribution of human disease. He undertook a statistical analysis of cancer incidence and mortality based on data from Verona between 1760 and 1839. Despite a number of arithmetic and medical errors, the data revealed that more women than men died from tumors and that, among women, neoplasms of the breast and uterus were the most common. He also suggested that cancer incidence increases with age and dwelling in urban areas, and unmarried people are most susceptible to it.

The outbreak of a cholera epidemic in 1854 attracted the attention of an English physician, John Snow, an early supporter of the germ theory of disease. He lived near Soho, London, and suspected that a contaminated water pipe near the intersection of Broad Street and Cambridge Street was the source. He amassed patient data from hospital and public records on whether the victims drank from the pump and concluded that this was the origin of the outbreak. He brought his epidemiological data to the town's officials, the pump was immobilized, and the cholera epidemic ended. His was a remarkable demonstration of clinical epidemiology in action.

Modern medicine arose in the 19th century with great advances in chemistry and bacteriology, but was also accelerated by technical developments including the introduction of the stethoscope for auscultation of lung and heart sounds by Rene Laennec in 1816, and Edward Jenner's discovery of vaccination, i.e. inoculation of cowpox virus to build immunity against the deadly scourge of the related smallpox virus.

The Hungarian physician Ignaz Semmelweis dramatically reduced childbed fever and daringly insulted many physicians of his day in the mid-1800s by suggesting that they wash their hands before undertaking obstetrical procedures, and by recommending antiseptic and aseptic operating rooms. Believing that puerperal fever was caused by "infective material," he required doctors at his hospital to wash their hands in a chlorinated solution before attending patients, and thus reduced the mortality rate for new mothers from 18% to 2%. But it was not until the germ theory of disease was proven, 25 years later, that his theory was finally accepted.

Joseph Lister, a Scottish surgeon, read about Pasteur's research showing how wine spoiled because of microorganisms in the air. This convinced him, in the mid-1800s, that similar organisms also caused the infections that killed up to half of his patients after successful surgery. By cleaning surgical wounds and instruments with carbolic acid mists, he reduced the death rate from 46% to 15%. His widely publicized success revolutionized the use of aseptic and antiseptic measures in surgery. The germ theory of disease began to clarify disease etiology and rationalize methods for controlling infectious disease. It also stimulated the development of public health measures such as quarantine and sanitary treatments of toilet and garbage collection, as had been mandated to the Israelites three millennia earlier. Overall nutrition also began to improve health in the Western world, as did the national economies despite totalitarian governments and dreadful wars.

COMPUTER SCIENCE EXPEDITED BY WARFARE

The US Civil War served as a major training ground for the treatment of wounds and accidents that kill or incapacitate many more soldiers than actual battles, and led to more effective methods for the treatment of infectious diseases. Surgical techniques, nursing care, hospital organization, and even biomedical research all benefited, even in the absence of antibiotics that had not yet been developed. World Wars I and II advanced the treatment of massive injuries and control of infections rampant under battlefield conditions. Greatly improved types of prosthetic limbs, plastic surgery, and cosmetic surgery were introduced, and experience was gained with the first widespread use of antibacterial agents such as the sulfa drugs in World War I. Shortly thereafter, a major advance in the care of the wounded with tetanus immunization was achieved, and treatments with penicillin, the sulfa drugs, and DDT as an insecticide against malaria vectors were all found to be highly effective.

A senior surgeon in the Civil War, John Shaw Billings, founded the Library of the Surgeon General, now the National Library of Medicine, initially to deal with the enormous amount of statistical data collected by the Sanitary Commission during and after the Civil War. His objective was to store the information and develop methods to access it rapidly while searching mechanically for data patterns. Billings and his associate, Herman Hollerith, discovered how to turn facts into numbers, and punch the numbers onto cardboard cards that could be sorted and counted by machine. The punch card and counter-sorter system that dominated statistical data manipulation until the 1970s became the International Business Machines (IBM) Corporation in 1911.

Care of the insane was largely a family responsibility, rather than a medical or community problem, until the 19th century. In that era, lunacy was seen less as a medical disease than a mental and moral one, and the recommended treatment was largely persuasion and internal restraint rather than coercion. "Moral treatment" centers were built throughout Europe and America and medico-psychological journals emphasizing this viewpoint were published, but, by the end of the century, optimism that asylums could treat insanity declined and the public began to view the insane as suffering from specific causes, including heredity. The German physician Emil Kraepelin introduced new categories of mental illness often based on behavior, such as shell shock in soldiers. In the 1930s, a variety of controversial practices were introduced (electroshock, insulin, lobotomy, etc.), and in the 1950s new psychiatric drugs, such as chlorpromazine, began to be produced in the biomedical laboratories.