Surgical Infectious Diseases

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SURGICAL INFECTIOUS DISEASES

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Preface

INFECTION IS encountered by all surgeons and surgical specialists who, by the nature of their craft, invariably impair the first lines of host defense—the cutaneous or mucosal barrier—between the environmental microbe and the host's interior milieu. In the past surgeons made some of the most important contributions to the development of early antiseptic techniques and the environmental control of infection. With the standardization of these approaches and the advent of modern antibiotic therapy, however, surgeons as a group tended to lose interest in the study of infection. Progress in the understanding of its pathogenesis and treatment was given over to medical specialists in infectious diseases, who in turn tended to focus on systemic diseases caused by single organisms occurring in otherwise normal hosts.

For these reasons, there has not been a comprehensive textbook of surgical infections since Frank Meleney's *Clinical Aspects and Treatment of Surgical Infections*, published in 1949. Although there are several excellent medical reference-textbooks, their emphasis is on virology and single agent etiology. Surgeons tend to ignore these texts because surgical infections are regional infections caused by polymicrobial endogenous flora in hosts whose defenses are compromised.

This reference text is an attempt to gather together useful material on the pathogenesis, diagnosis, and treatment of infectious diseases for the library of both the mature surgeon and the surgeon in training. We hope that this compiled information will be used as a basis for further advances in the understanding of surgical infectious diseases.

We have divided this book into eight sections: history, surgical microbiology, host defenses, systemic response to infection, antimicrobial therapy, wound infections and their prevention, regional surgical infections, and special problems in surgical infection. The sections on surgical microbiology and antimicrobial therapy concentrate on those microorganisms that are most likely to cause infection in surgical patients.

We feel that the section on host defenses is particularly important because in the end it is the host's own defenses that rid the patient of infection. We predict that the field of host defenses, and how to improve them, will receive intensive investigation in the remaining years of this decade.

Because the surgeon is the physician who frequently deals with the septic patient, septic shock, and systemic organ failure in sepsis, we included a section on the physiologic and metabolic alterations occurring in the infection patient.

The final three sections deal with actual clinical problems. The section on wound infections discusses the epidemiology, causes, and prevention of wound infections. The section on regional surgical infection adopts the anatomic, regional approach because surgeons frequently think in these terms and clinically are usually presented with infections in a single region. This is not a how-to-do-it section.

Like all multi-authored books, style and clarity may vary from chapter to chapter, but we have exerted a strong editing hand in all chapters in an attempt to provide consistency. Therefore, any criticism should be reserved for us. We believe that the advantages of having experts write clearly about their areas of specialty far outweigh the potential consistency provided by a single-authored book.

This book could not have come into being without the help of several other individuals. We would like to thank Dr. John S. Najarian for his constant support and encouragement. We are especially grateful to Angela I. Henriksen for her creative editorial contribution during every stage of our book's development. We are also grateful to Carolyn M. Keene, Candy Swain, Carol A. Markwood (Gainesville), and Kathryn P. Anderson and Ann Marie Klapperich (Minneapolis) for typing the manuscripts.

R.L.S., R.J.H.

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PART I: HISTORY

CHAPTER 1
Surgical Infection and History

OWEN H. WANGENSTEEN, SARAH D. WANGENSTEEN, AND CHARLES F. KLINGER

THE mid-sixteenth century witnessed three significant events in the advance of medicine: Girolamo Fracastoro described the significance of direct contact in the propagation of infection (1546); Ambroise Paré demonstrated, conclusively, the superiority of instillation of turpentine, instead of burning-hot oil, into battle wounds (1545); and Andreas Vesalius' great and beautifully illustrated book, *On the Fabric of the Human Body,* appeared in print (1543). Perhaps never in medical history have three such important works appeared within so brief a period, and each was to leave an indelible imprint on medical progress.

For centuries before and more than three centuries after Fracastoro, the nature of infection remained an enigma. He conceived of seminaria (germs) as the provocative agents of infection. The microscope was more than a century away, as were the animalcules (bacteria) of Leeuwenhoek. The proof of the pathogenicity of bacteria awaited the methodology and the careful work of Robert Koch (1876–78). Robert Hooke's *Micrographia* (1665) marked the beginnings of microbiology, a science that has greatly enriched medicine in this romantic period, which witnessed a steady succession of contributions to medicine's advance. Jacob Henle (1840) directed notice to the role of bacteria in the origins of miasmas, and the imaginative research of the wide-ranging chemist Louis Pasteur, unhindered by the restrictive barriers of conventional scientific disciplines, helped solve the mysteries of many diseases of animals and man. The careful and systematic methodology of that greatest of microbiologists of the nineteenth century, Robert Koch, succeeded in separating and identifying bacteria by substituting use of solid culture media for broth. His demonstration of the life cycle of the anthrax bacillus was labeled by Cohnheim (April 1876) as the greatest discovery in microbiology up to that time. Koch's innovation of photographing bacteria rather than describing them also marked an important advance. Koch's postulates sketching the means of establishing the pathogenicity of bacteria as the causative agents of disease have found universal acceptance.

Samuel Johnson's *Dictionary of the English Language* (1755), consisting of two huge tomes that rapidly went through a second and third edition, contains the words contagion, contagious, infectious, infective, and infection. The contagious nature of many diseases had already been well established. Puerperal fever was believed to be contagious in nature until Ignacz Semmelweis (1847) demonstrated it was carried by the unclean hands of the accoucheur. Scrubbing the hands in warm soap and water with a nail brush, followed by a similar scrub in chlorine water (Dakin's solution of World War I), quickly decimated the mortality of that dreadful scourge. With general acceptance of the prophylactic surgical antisepsis of Semmelweis, puerperal fever has virtually disappeared. Bacteria is a post-Semmelweis word innovation of the mid-nineteenth century.

Semmelweis (March 1847) was led to his conclusion while studying the autopsy report on his friend Kolletschka, who died from sepsis after he had sustained a finger prick while performing an autopsy on a patient who had died of sepsis at Vienna's Allgemeines Krankenhaus. Semmelweis inferred that the lethal agents in puerperal fever were the unclean hands, instruments, and linen employed by accoucheurs. By mid-May 1847, Semmelweis had initiated a strict program at the Vienna hospital involving scrubbing of the hands in soap and warm water with a fingernail brush, followed by a similar scrub in Dakin's solution. Instruments to be employed in the delivery were also immersed in a solution of chlorine water. By June, Karl Haller, an adjunct director of the hospital, wrote: "A fresh breeze permeates the hospital atmosphere that augurs well for the future of obstetrics and surgery." Although Semmelweis, a direct and brusque man in dealing with associates, initially incurred the wrath and enmity of many professional colleagues, not many years after pub-

lication of his 1861 monograph, *Die Aetiologie, der Begriff und die Prophylaxis des Kindbettfiebers,* his antagonists capitulated to his views. Why the Vienna surgeons took no note of Semmelweis' significant innovation remains a mystery. Other than Haller, the first to take serious note thereof was Ferdinand von Hebra, who was originally intent on surgery but turned to dermatology. Actually, the first to employ Semmelweis' methods in elective abdominal surgery was the Freiburg gynecologist Alfred Hegar who, in 1876–77, reported 15 successive excisions of ovarian cysts without mortality, an operation that in the hands of well-known ovariotomists of that period commanded an operative mortality of 25 to 40 percent. Semmelweis' initial work (1847–49) antedated recognition and acceptance of the pathogenicity of bacteria by approximately four decades and the first publication of Lister (1867) by 20 years.

Placement of antiseptics into wounds is an ancient practice, featured in the parable of the Good Samaritan (Luke 10:34). Lister lent great impetus to surgery's advance by instilling varying concentrations of carbolic acid into the open wounds of compound fractures (1867), a practice he extended to other wounds and later to elective operations. Over great opposition in Britain and America, Listerian practices had found general adoption by the mid-1880s, to be supplanted shortly thereafter by the prophylactic surgical antisepsis of Semmelweis (1847). At the end of World War I, Alexander Fleming (1919) protested the placement of antiseptic agents into wounds, saying they did more harm to the tissues than to the bacteria. In later publications, Fleming described the bactericidal properties of lysozyme and of penicillium mold (1929), which led to the development of penicillin and other antibiotics.

Prior to the innovation of printing (ca 1450), the art and practice of surgery were taught to apprentices primarily by word of mouth and observation. Surgeons of that period were essentially an unlettered lot, disdained by physicians. Surgeons, despite their low status, did have the advantage of acquiring practical experience through their labors, while physicians in their teaching exercises devoted themselves solely to philosophic discussions of the disease they were called upon to treat, failing to employ patient demonstrations in their lectures to students. Jean Louis Petit (1710), an accomplished Paris surgeon, was among the first who declined to acknowledge the superiority of physicians.

Until the demonstration of the pathogenicity of bacteria by Koch (1876–78) and the acceptance of bacterial etiology of tissue infection, surgical management and avoidance of wound infection remained in a chaotic state. Erysipelas and "hospital gangrene" in wounds were commonplace. In the mid-1870s, Volkmann of Halle and Nussbaum of Munich informed university authorities that the frequency of these lethal complications was forcing them to close their surgical wards.

Methods of treating wounds were subjected to argument rather than trial. Very little note had been taken of the study of James Lind, the Haslar Hospital naval surgeon, who had taken 12 sailors with scurvy to sea (1747). They were divided into six groups, two in each, and fed a basic naval diet, with various additions for each group. At six days, the two sick sailors provided with two oranges and one lemon each day were already seaworthy. This was probably the first published, controlled, clinical study in medicine (1753).

Open wound management of amputations and "minute particulars" permitted a few surgeons to achieve results rarely excelled, even following the acceptance of prophylactic surgical antisepsis. Pouteau of Lyons (1760), in 120 instances of perineal lithotomy for the removal of vesical calculi, lost three patients, a hospital mortality of 2.5 percent. Pouteau stressed cleanliness and left the perineal wound open, permitting the urine to wash the wound.

Alexander Monro I of the Royal Infirmary in Edinburgh (1737, 1752) was able to report a hospital mortality for amputations of 8 percent; almost a century later (1843) in the same hospital the mortality was more than five times greater (49 percent), definitely suggesting that surgical cleanliness had deteriorated, giving way to speed in the performance of amputation, with neglect of "minute particulars."

SPONTANEOUS GENERATION

The belief in spontaneous generation was present throughout antiquity; Aristotle and Van Helmont firmly believed in it. The strongest advocate of the thesis of spontaneous generation in the eighteenth century was Needham (1713–81), and in the nineteenth, Pouchet (1800–72). The English neurologist Henry Bastian (1837–1915) entered the fray on their side in 1911. Spallanzani (1729–99) had, in the view of many scientists (1767, 1776), disproved the validity of the Needham thesis, but doubt persisted until Pasteur and Tyndall brought conclusive proof to bear on the invalidity of spontaneous generation.

PASTEUR'S IMPRINT

John Hughes Bennett (1868), fellow of the Royal Society of Edinburgh, professor of the Institutes of Medicine, and senior professor of clinical medicine at the University of Edinburgh, wrote a pamphlet entitled *On the Atmospheric Germ Theory and Origin of Infusoria.* The author challenged Pasteur's finding of the sterility of fluids subjected to boiling, including sealed bent tubes that precluded admission of air. In fact, Bennett was unable to confirm Pasteur's observations. He was apparently unaware of the work of Davaine on the multiplication and fission of bacteria (1860). Bennett's work also antedated the observations of Ferdinand Cohn (1876), who confirmed Davaine's earlier findings of the extraordinary rapidity of germination and propagation of bacteria.

John Farley (1977) critically analyzed the historic and philosophic background of spontaneous generation, and Aleksandr Oparin (1936) reviewed the history of the "Origin of Life" on the planet earth. Toncsik reviewed the entire history of experimentation on the theory of spontaneous generation from the time of Francesco Redi (1668) up through the work of Pasteur (1861), who, with the aid of Tyndall's studies on moteless air and discontinuous repetitive fractional sterilization (1877, 1881), dealt the death blow to the thesis of spontaneous generation.

Pasteur Vallery-Radot, a grandson of Pasteur, traced Pasteur's origins and successively enumerated his more important contributions. First came his work with crystals and their separation into tartrate and paratartrate. Pasteur's first work in the biologic field concerned fermentation; then spontaneous generation, in which area he made a very significant contribution; followed by studies of wine, vinegar, and beer; then silkworm disease. Pasteur was interested in the germ theory and its application to medicine and surgery, and began his research in 1873. In 1877, Pasteur addressed the problem of anthrax. He also studied cholera of chickens and prepared a vaccine for its prevention and treatment.

Louis Nicol (1974) stressed the role of Pasteur's keen interest in and knowledge of veterinary medicine in the progress of his work and discoveries. Nicol expanded on the role of Henri Bouley, the French apostle of veterinary medicine, and his relationship to Pasteur, whose contact with veterinary medicine over long years was intimate. Nicol's chatty monograph contains many letter exchanges between the principals, with considerable emphasis on rabies. The death of Bouley (1884) terminated the long collaboration between Pasteur and veterinary medicine, an influence extended by Nocard, a pupil of Bouley, and again through Nocard's friendship with Duclaux, Roux, and Chamberland.

Albert Delaunay summarized the growth and development of Pasteur's interest in microbiology. Casimir-Joseph Davaine (1812–82) was the first to recognize the pathogenicity of microbes. He wrote (1860) of the rapidity with which bacteria divide and reproduce themselves.

Delaunay described the birth of microbiology, tracing the development of knowledge of the pathogenicity of bacteria and viruses, natural and acquired immunity, the mechanisms of immunity, and the prevention and treatment of infectious diseases. Delaunay dealt at some length with Metchnikoff and phagocytosis.

The Dijon, Dole, and Arbois areas, the scenes of Pasteur's early life in the Jura section of eastern France, contain important memorabilia of Pasteur's development into a keen, mature, and creative scientist. A visit there can definitely be recommended to all students of Pasteur and his brilliant achievements. Pasteur spent the final years of a productive life at the Pasteur Institute in Paris in the company of many celebrated pupils including Roux, Duclaux, Chamberland, Metchnikoff, and others. A visit to the Pasteur Institute can be an experience that stirs the emotions and makes one appreciate Pasteur's durable contributions to human welfare.

THEORIES OF IMMUNITY

Élie Metchnikoff (1845–1916), a zoologist and embryologist by training, spent the final 25 years of his life at the Pasteur Institute. He is usually regarded as the founder of the phagocytic theory of immunity. He introduced a rose thorn into the transparent larvae of the starfish and noted hours later that the mobile cells of the larvae worked their way to the splinter. Metchnikoff noted that when the transparent crustacean daphnia was infected with a small parasitic fungus, a struggle ensued between the daphnia's mobile cells and the parasite. He observed also that in mammalian laboratory animals, white blood corpuscles engulfed bacteria. With the advice of Greek scholars, Metchnikoff called the phenomenon of engulfing and devouring organisms phagocytosis.

A long struggle ensued between proponents of the humoral theory and the proponents of Metchnikoff's cellular theory of immunity. Today, it is conceded that both have significant roles to play in immunity. Development of the cellular theory undoubtedly represents Metchnikoff's most important scientific contribution.

Metchnikoff expressed the belief and hope that man's useful life could be extended to 140 years. He thought that the absorptive capacity of the colon, which permits toxic substances to enter the blood, was the chief deterrent to the achievement of that objective. He entertained the idea that at some future date the colon could be safely removed by surgery to obviate this occurrence. Meanwhile, his attack on the problem was to alter the bacterial flora of the colon by the ingestion of lactic acid milk, of which yogurt is probably the current counterpart. Metchnikoff subsequently labeled intestinal microbes a significant cause of senility. He was an abstainer from alcohol and tobacco, which he regarded as important ancillary causes of arteriosclerosis and senility. Despite his long dietary reliance on lactic acid milk, Metchnikoff spent his final years as an invalid. He suffered almost daily from painful anginal and cardiac attacks, requiring narcotics for relief. He died at age 71, achieving only half the life expectancy of 140 years that he had projected for man. He quoted the Bible frequently in his writings but made no allusion to the admonition of verse 10 of Psalm 90: "The days of our years are threescore years and ten; and if by reason of strength they be fourscore years, yet is their strength labour and sorrow."

As related to freedom from taxation and other fiscal or religious obligations, immunity is a word of ancient origin. As applied to disease, it probably originated with Pasteur, who noted that there are some infections of man to which many laboratory animals are naturally immune. Acquired immunity and its mechanism of acquisition are not completely understood.

The original theory of the body's defense against bacterial invasion held to the humoral thesis that the blood plasma possessed great bactericidal qualities. Metchnikoff was primarily responsible for promulgating the cellular theory of immunity; allusion has already been made to his studies on phagocytosis in crustacean larvae. Denys and LeClef observed that removing the leukocytes from the blood resulted in a considerable reduction of the bactericidal property of the blood; the addition of leukocytes restored its antibacterial quality. They showed that washed leukocytes are deprived of their phagocytic activity. This activity is restored only when the leukocytes are again placed in blood serum or plasma, a circumstance indicating how interdependent the cellular and humoral theories of immunity are in action.

A succession of events characterized by chemotactic attraction of polymorphonuclear leukocytes, macrophages, and lymphocytes brings the bacteria to the leukocytes that have escaped by a process of diapedesis through the venules and capillary blood vessels in the area. The

bacteria become adherent to the wall of the leukocytes, which then ingest and digest the offenders. Bordet has shown that some bacteria, notably streptococcus, exude a substance that inhibits this sequence of events, thus interfering with and delaying phagocytosis. It is this repellent action of streptococci upon leukocytes that permits rapid spread of the ensuing cellulitic infection.

Jenner (1749–1823), a pupil of John Hunter, securely established the protective effect of cowpox vaccination against smallpox, an accomplishment that military leaders like Napoleon I greatly appreciated. The Jennerian program of vaccination prevented the decimation of armies. H. J. Parish has suggested that "smallpox may have preserved Canada for the British Empire." General Washington failed to take Quebec in 1776 because his army under Generals Richard Montgomery and Benedict Arnold had not been vaccinated, and losses from smallpox were great. Today, prophylactic vaccination has apparently eliminated smallpox throughout the world.

The humoral thesis of immunity undoubtedly had its origin in Jenner's great accomplishment, but scientific proof of the validity of the humoral thesis of immunity awaited the work of Nuttall (1888) and of Buchner (1889–90), who demonstrated that a cell-free serum has bactericidal activity.

MANAGEMENT OF CONTAMINATED WOUNDS

OPEN MANAGEMENT

The thirteenth century surgeon Theodoric (1205–96) held that wounds could heal without suppuration, a thesis that Henri de Mondeville (1260–1329) also supported. The erudite surgeon Guy de Chauliac (1298–1368) of Avignon favored open management of contaminated wounds; many surgical historians believed he thereby retarded surgery's advance, as much as six centuries according to Garrison (1922). A few pre-Listerian surgeons, notably von Kern of Vienna (1826), Liston (1841) of London's University College Hospital, and the German surgeon Burow (1859), employed open-wound management in amputation, with mortalities considerably lower than that of surgeons primarily closing wounds.

DEBRIDEMENT

In March 1917, before American entry into World War I, the Inter-Allied Surgical Conference of English–French Military Surgeons convened in Paris and resolved that all contaminated wounds should be subjected to debridement with excision of all dead tissue and left open. On April 26, 1943, in World War II, Surgeon General Norman Kirk of the American Army Medical Corps mandated debridement for all contaminated wounds, with open-wound management. Circular amputations without skin flaps were also mandated, leaving such wounds open, to be closed secondarily. Guy's (1363) wound practices of almost six centuries earlier finally found universal adoption in military circles, and soon thereafter in civilian surgery.

SURGICAL ACCOUNTABILITY

Before the acceptance of prophylactic surgical antisepsis, surgeons were reluctant to publish their operative and hospital mortalities, and understandably so, because of the frequency of serious wound infections that proved lethal. Florence Nightingale, who emerged from the Crimean War (1854–56) as a legendary hero, and who devoted the remainder of her long life to improving nursing and hospitals, had repeatedly urged on hospital authorities and surgeons the need to publish their hospital and operative mortalities. Yet very few went along with the suggestion. As late as 1875, Lawson Tait, a well-known Birmingham gynecologist and surgeon, urged the board of a large municipal hospital to publish the hospital and operative mortalities. The hospital's board of supervisors advised Tait that they did not elect to do so. Tait threatened to publish their letter of refusal in a widely read medical journal if they did not provide the data. The board capitulated and, said Tait, with the elapsing of a few years, the operative mortality of that hospital decreased by 50 percent.

Sir James Paget of London's Guy's Hospital related in *Lancet* (1862) that Sir Astley Cooper had visited a prominent Paris surgeon (undoubtedly Dominique Larrey) and had made hospital rounds with him approximately 20 years previously. Larrey had declared to Cooper that he had no mortality from amputation at the shoulder joint. When they visited the dead house together, there lay upon the autopsy table a fresh body upon which a recent disarticulation at the shoulder joint had been performed, a favorite operation of Larrey's. Larrey remarked that the patient died of pneumonia, not from the operation. "We must beware of such dishonesty," wrote Paget. He added, "I have as yet scarcely lost a case in true consequence of hernia, tracheotomy, or trephining . . . yet nearly half of all that I have operated on for hernia had died, and more than half after tracheotomy and nearly all after trephining. But these were deaths after operations; not because of them."

HOSPITAL REFORMERS

England's first great hospital and prison reformer was John Howard (1727–90), who on a vacation-bound ship to Lisbon in 1756 underwent imprisonment in Brest, France, at the hands of a French privateer. The misery of the imprisonment left an enduring impression on Howard. He was shocked to discover in 1773 the health conditions in his small county jail, and sought comparison with nearby institutions. Howard then began an investigation and self-appointed mission that was to occupy the remainder of his life and entail 50,000 miles of travel. He particularly criticized the environmental conditions of hospitalization, as well as diets in lazarettos and hospitals in many countries. At Hôtel Dieu in Paris, he found as many as five to six patients in a single bed, some of them dying. Howard's last journey took him to St. Petersburg (Leningrad), Moscow, and Cherson (Sevastopol), where he died of an infectious fever characterized by convulsions; he became the hero and martyr to a great cause. The Russian government

erected an impressive monument near the Black Sea to honor Howard's contribution to the health of the Russian people. Commented Edmund Burke, English statesman, "Howard's life was a voyage of discovery."

In Jacques Tenon (1724–1816), France had its first great sanitarian and hospital reformer. The eldest of 11 children of an impecunious surgeon in a village south of Paris, young Tenon went to Paris at age 17 to learn something of his father's profession. Witnessing surgery at Hôtel Dieu filled him with horror. He then joined the Danish anatomist, Jacques Winslow, at Jardin-du-Roi in Paris. When Winslow observed a heart preparation Tenon had made, he gave the young investigator a position on his staff. Quickly, Tenon learned to read Latin and Greek and received a degree in philosophy. After a tour as an army surgeon, he won the chair of surgery at the Paris Salpetrière. Later, he occupied the chair of pathology at the Royal Academy for many years. Tenon studied the conditions in hospitals in France and England, visiting hospitals in Oxford, Birmingham, Bristol, Plymouth, Exeter, Salisbury, Winchester, and Portsmouth, making a detailed inventory of the care of the sick, including diet, beds, attitude toward patients, hours and frequency of meals, and general care. He studied the water supply of hospitals, their amphitheaters, operating room suites, and hospital ventilation. His epochal report remains pertinent for hospital construction and bed assignments today. He studied hospital records and found that Hôtel Dieu in Paris had probably the highest mortality among hospitals. He recommended that surgical wards should not be near the postmortem rooms; that separate rooms be set aside for operations, for preparing patients for operations, and for postoperative care; he suggested too that obstetrical beds not be mingled with surgical beds in the wards.

THE IMPRINT OF A FEW PUBLIC SANITARIANS

Chadwick (1890), a young English attorney, abandoned the law to study systems of public health. He became a follower of Jeremy Bentham (1748–1832), the founder of utilitarianism—the greatest good to the greatest number—and an ardent champion of the cause of sanitation and betterment of public health. Chadwick was primarily responsible for passage of the act that established a board of public health in England (1848). His memorable *Report on the Sanitary Condition of the Labouring Population of Great Britain* was presented to the House of Lords in 1842. He found that the length of life was shorter among laborers than among the gentry and professional persons; he then made a serious plea to improve the living conditions of the poor. To this end, he spent the remainder of his long professional life attempting to reduce filth and the physical suffering of the poor, and to remedy the moral disorder prevalent among the lower classes of English society.

The year 1858 marked the period of the "Great Stink," owing to the pollution of the Thames by sewage, which was so bad that Parliament had to adjourn periodically; the unpleasant odor made work impossible. Ultimately, the sewage of London was dumped into the lower reaches of the Thames and washed out to sea.

John Simon (1816–1904), distinguished St. Thomas Hospital surgeon, abandoned the practice of surgery at age 32 to become the first medical officer of the city of London (1848). Simon had been broadly trained. He was the first in 1852 to do a successful ureterorectal anastomosis for urinary incontinence caused by congenital vesical ectopia. Simon regarded trial by jury, in court hearings in which professional experts from opposite sides vigorously supported their partisan interests, as "moral prostitution and subordination of science." Simon studied the medical literature for clues of the sources of hospital insalubrity, and he cited Semmelweis's contribution to the establishment of prophylactic surgical antisepsis; Lister's first publication on wound antisepsis (1867) was still 3 years away. It was obvious that Simon was more knowledgeable concerning the status of hospital sanitation than most men of his time.

The New York surgeon Stephen Smith (1823–1922), who remained active and healthy into his late nineties, devoted a good segment of his long professional life to questions of public health on a voluntary basis. With the help of William Cullen Bryant, editor of the *Evening News*, he threatened to expose an extensive and wealthy landowner, one of whose apartments was a fever nest and the source of an epidemic. The culprit immediately initiated corrective measures, which converted the long-neglected apartment complex into a safe place to live and also brought the owner high rents. Smith's stress on improving the public health brought about in legislative sessions the Metropolitan Health Bill (1865), which succeeded in ridding New York City of much of the filth in which many of its poor lived. In his story of his struggles to do away with rubbish heaps and filth, Smith alluded to the insistence of the Hebrew fathers on cleanliness in formulation of the Mosaic Sanitary Code.

SOME REGIONAL VARIETIES OF INFECTION

EMPYEMA

Toward the end of World War I and before the availability of the sulfonamides and penicillin, the pandemic of streptococcal pneumonia terminating in empyema commanded worldwide attention. The mortality was horrendous, reaching 90 percent according to some reports, owing in large measure to employment of early open drainage. The current practice then was to follow one of Hippocrates' rules concerning suppuration, that wherever collections of pus occur, they should be immediately evacuated. But physicians and surgeons continued to overlook the stricture that Hippocrates had advised and imposed upon suppuration in the pleural cavity: in the presence of serous exudation, open drainage, whether by an intercostal incision or a rib resection, should be delayed until the exudate, on aspiration, had become thickened by the presence of fibrin. It remained for the French surgeon C. E. Sédillot (1841) to recall the admonition of Hippocrates on this score. Yet despite Sédillot's advice, physicians and sur-

geons almost universally continued to establish early open drainage for all empyemas. Only in World War I did Evarts Graham and the chemist R. D. Bell redirect attention to the hazards of open drainage of the thoracic cavity in the presence of serous streptococcal empyemas. Fortunately, with the arrival of sulfanilamide (1935) and penicillin for army (1942) and civilian use (1944–45), empyema became rare.

SUBPHRENIC AND OTHER INTRAPERITONEAL ABSCESSES

Subphrenic abscesses occur as a consequence of a perforated tubular abdominal viscus, notably from perforation of a duodenal or gastric ulcer, the appendix, gallbladder, or colon; it may also occur as an iatrogenic complication following intra-abdominal surgery, in which a leak occurs as a sequel to imperfect techniques in operations upon the gastrointestinal tract. An infected hematoma from injury of the pancreas or spleen may also give rise to subphrenic abscess. An imperfect inversion of the duodenal stump attending Billroth II gastric resections has continued to be an occasional antecedent of subphrenic abscess.

A large pneumoperitoneum, attending perforation of a duodenal ulcer, indicates that the perforation is also large and leaking, a circumstance suggesting that digestion of the diaphragm with a resultant hole and extension of digestive juices into the thorax is a possibility. An accumulation of acid peptic juice immediately beneath the diaphragm can readily do this with the development of an empyema. Howard Beye reported that in a series of 337 patients with thoracic empyema, he had only once observed transversion of the diaphragm from above with resultant subphrenic abscess. To the contrary, in 31 patients with subphrenic abscess of abdominal origin, Beye noted thoracic complications in 23 instances (74 percent), usually empyema.

The Finnish surgeon Autio reported that in performing appendectomy he left 10 ml of an opaque sterile x-ray medium in the lateral gutter of the pericecal area. X-ray films were taken at intervals between 3 and 12 hours and again between 24 and 72 hours after the operation in a large number of patients. He noted wide dispersion of the opaque x-ray medium into the subhepatic and suprahepatic spaces, the pelvis, and even the left paracolic gutter.

Recognition of a left subphrenic abscess is relatively simple. With the patient in the steep Trendelenburg position on the x-ray table, a few ounces of swallowed barium will come to occupy the upper end of the gastric fundus. If there is a spatial separation of a centimeter or more between the diaphragm and the gastric fundus, a subphrenic collection of pus or blood is a possibility.

Recognition of a right subphrenic collection is not so easy; a high right diaphragm of limited mobility when viewed fluoroscopically, accompanied by fever and leukocytosis with a likely antecedent cause, points the way. Rarely is it possible to identify with certainty the presence of a subhepatic collection on the right side preoperatively. The important item in any abdominal collection of exudate is to detect its presence early and to provide dependent drainage. Antibiotics cannot reach or overcome an abscess; the only effective remedy is surgical drainage. The senior author (O. H. W.) was once partial to a technique of exploration of abscess-prone areas of the peritoneal cavity, using a long suction device patterned after a tonsillectomy sucker. The long handle is provided with a thumb release to interrupt suction during introduction of the instrument. A 4-cm incision is made beneath the lateral costal margin of that side of the abdomen where the collection is believed to be. The probing suction device is kept gently but firmly applied to the lateral abdominal wall, and in succession reaches the lateral gutter, the subhepatic and suprahepatic spaces, and finally the cul-de-sac. Dependent drainage through a short drainage tract, performed without risk of opening the pleural cavity, is the best technique in managing a subphrenic abscess. An inch of gravity drainage is the most effective force in evacuating an abscess. From the standpoint of dependent drainage, the classical posterior approach with paraspinal resection of a low-lying thoracic rib provides the most dependent drainage. The surgeon must be aware, however, that the parietal pleura descends to a level lower than the 12th rib. Before an incision is made in the diaphragm, it must be ascertained that the lung lying immediately below the pleura is not moving freely. In such an event, it is well to insert a gauze pack for a few days, extending out beyond the skin level, so that firm adhesions between the pleura and the lung will develop. When the diaphragm is incised a few days later, the pleural cavity itself will not be opened. The best assurance against opening the pleura is provided by the Nather-Ochsner approach; its shortcoming is the long tract, which often precludes dependent drainage.

Pelvic collections in the female are easily evacuated by a colpotomy incision. In the male, a dissection plane needs to be developed between the rectum and the bladder for evacuation of a pelvic collection. The paracolic gutters can be readily evacuated.

Hudspeth of the Bowman Gray School of Medicine has urged a more radical direct approach to intraperitoneal collections of exudate. In fact, he calls his operation "radical surgical debridement in the treatment of advanced generalized bacterial peritonitis"; he recorded a succession of 92 patients thus treated without hospital mortality, obviously a unique achievement, not readily duplicated without case selection. Effective evacuation of abscesses, with addition of appropriate antibiotics, is in the final analysis the critical measure of a successful surgical drainage procedure. How widely Hudspeth's success has been duplicated in the hands of other abdominal surgeons yet awaits confirmation. Halaz (1970) also favors the intraperitoneal approach and has provided some data to support this view.

A plea for early surgical intervention is definitely in order in cases of intraperitoneal infection. When the acutely obstructed appendix is excised before perforation, the risk to the patient is minimal. Over several years in the late 1930s, in the preantibiotic era, the mortality of perforated peptic ulcer in our University Hospitals was zero. All the physicians in Minnesota were then alert to the importance of early surgical intervention. Today, a sizable mortality is still being reported in many areas. Is the profession placing too much dependence on antibiotics? One may also ask, with justification, should there be