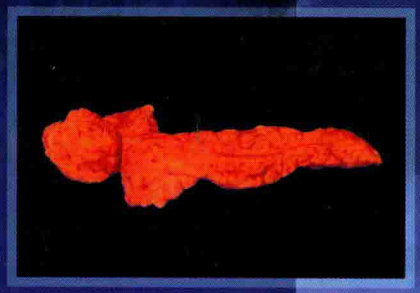
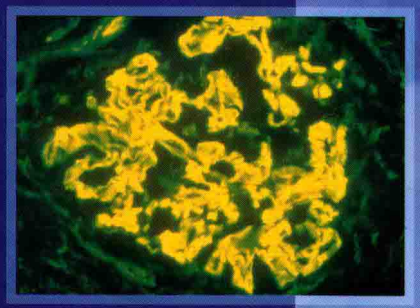
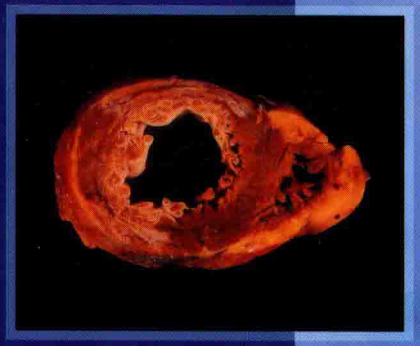
Autopsy Pathology

A MANUAL AND ATLAS

Finkbeiner
Ursell
Davis







Churchill
Livingstone

AUTOPSY PATHOLOGY

A MANUAL AND ATLAS

Walter E. Finkbeiner, MD, PhD
Professor and Vice Chair
Department of Pathology
University of California, San Francisco
Chief, Department of Pathology
San Francisco General Hospital
San Francisco, California

Philip C. Ursell, MD
Professor and Director, Pediatric Pathology
University of California, San Francisco
Director, Autopsy Service
Moffitt-Long Hospital
San Francisco, California

Richard L. Davis, MD
Professor Emeritus
Clinical Neuropathology
University of California, San Francisco
San Francisco, California

CHURCHILL LIVINGSTONE

An Imprint of Elsevier

CHURCHILL LIVINGSTONE
An Imprint of Elsevier

The Curtis Center
Independence Square West
Philadelphia, PA 19106

AUTOPSY PATHOLOGY: A MANUAL AND ATLAS ISBN 0-443-07676-6

Notice

Pathology is an ever-changing field. Standard safety precautions must be followed, but as new research and clinical experience broaden our knowledge, changes in treatment and drug therapy may become necessary or appropriate. Readers are advised to check the most current product information provided by the manufacturer of each drug to be administered to verify the recommended dose, the method and duration of administration, and contraindications. It is the responsibility of the treating physician, relying on experience and knowledge of the patient, to determine dosages and the best treatment for each individual patient. Neither the Publisher nor the author assumes any liability for any injury and/or damage to persons or property arising from this publication.

The Publisher

Library of Congress Cataloging-in-Publication Data

Finkbeiner, Walter E.
Autopsy pathology: a manual and atlas / Walter E. Finkbeiner, Philip C. Ursell, Richard L. Davis.—1st ed.
p. ; cm.
ISBN 0-443-07676-6
1. Autopsy—Handbooks, manuals, etc. 2. Autopsy—Atlases. I. Ursell, Philip C. II. Davis, Richard L. III. Title.
[DNLM: 1. Autopsy—methods. 2. Death Certificates. 3. Quality Control. QZ 35 F499a 2004]
RA1063.4 .F566 2004
616.07'59—dc21 2002038245

Editor-in-Chief: Richard Lampert
Acquisitions Editor: Natasha Andjelkovic
Developmental Editor: Danielle Burke
Project Manager: Linda Van Pelt

BS/CC

Printed in China.

Last digit is the print number: 9 8 7 6 5 4 3 2 1

AUTOPSY PATHOLOGY

To our teachers

Preface

The intent of this book is to provide a resource for those seeking to develop skills in autopsy procedures. With the exception of forensic autopsy, interest in postmortem examination has continued to wane. The intent of this book is not to provide a blueprint of how to return the autopsy to the center of the medical stage, a position it occupied at the beginning of the 20th century. Rather, it is intended to reaffirm the direct and indirect benefits of autopsy in the hope that it remains a vital part of integrated health care at the beginning of the 21st century. By performing skilled postmortem examinations, pathologists contribute to patients and their families, the medical community, and society at large. This book was written in that spirit.

The road to the completion of this book has taken several detours. It was originally conceived as an extension of the manual on autopsy pathology provided to pathology trainees at the University of California at San Francisco. It became clear quite early in the writing process that much more depth was required. Progress languished after I departed UCSF to join a sister institution. With vigor regained following my return to UCSF and the encouragement provided by an editor who took over a project that I had nearly abandoned, the book has finally been completed. I hope that both pathologists-in-training and those in practice will find it useful.

I must acknowledge and thank my able co-authors, Drs. Ursell and Davis. Dr. Ursell wrote the primary drafts of Chapters 5, 10, and 11 and made significant contributions to the others. Dr. Davis provided the book with a wealth of experience in neuropathology that has strengthened many sections of the work. Also, a number of people deserve public thanks for the help they provided toward the completion of this work. Autopsy assistants at UCSF (Mel Abulencia, David Chang, James Crabtree, Roman Karp), UC Davis (Sheryl Perryman), and the Sacramento County Coroner's Office (Kimberly Moody) provided assistance with procedures and photography. Several colleagues read and commented on chapters: Lois Kaye, JD, and Boyd Stephens, MD, each reviewed Chapter 2; Steven DeArmond, MD, and Jean Olson, MD, reviewed parts of Chapters 3 and 8, respectively. I am grateful for their insightful comments. Drs. Robert Anthony, Gregory Reiber, and Donald Hendrikson of Northern California Forensic Pathology provided some illustrations for Chapter 14 and introduced me to the world of forensic pathology during a year-long sabbatical. Dr. Claudia Greco, Dr. Stephany Fiore, and Eileen Anthony made contributions to Appendix A. Special thanks go to Kerry Willis of Churchill Livingstone for her support of the initial book proposal. Natasha Andjelkovic, our editor at Elsevier, provided the interest and support without which this book might have remained but files on a computer. To her, I am particularly indebted. The able editorial and production staff at Elsevier made valuable contributions at various stages of the project; these include Danielle Burke and Linda Van Pelt. I thank two wonderful teachers, Drs. Martha Warnock and William Margaretten, who introduced me to autopsy practice. Finally, for the love, patience, and support of my wife, Janet, during what for her most surely were some of the "for worse" periods alluded to years ago, I am genuinely grateful.

Walter E. Finkbeiner, MD, PhD

Contents

1 The Autopsy—Past and Present

"Despite the disparagement of the ignorant and the patronizing smiles of the sophisticated, the necropsy still moves along at its time-honored, steady pace, maintaining standards, contributing to knowledge and even, on occasion, stimulating the sluggard."

Edward A. Gall[1]

The Autopsy in Antiquity

The history of the autopsy is intimately connected with that of anatomy and medicine in general. According to the Egyptian historian Manetho, the king-physician Athotis (about 4000 BC) wrote books on medicine, the first of which contained some anatomic descriptions.[2] However, most scholars believe that early anatomic descriptions came primarily from the observations of animal anatomy made by early hunters, butchers, and cooks.[3,4] King and Meehan[5] in their excellent discourse on the origins of the autopsy trace human knowledge of anatomy to the practice of haruspicy, the inspection of animal entrails, particularly the liver, to predict the future. This form of divination was widespread in the ancient world, performed at least as early as the fourth century BC in Babylonia. Later, the ancient Hebrews contributed more practical observations. Following the Talmudic law "Thou shalt not eat anything that dyeth of itself," rabbis examined slaughtered animals for evidence of disease, especially in the lungs, meninges, and pericardium.[5]

Anatomic study of human disease evolved slowly, however. In ancient Egypt, there was considerable interest in the relationship of wounds and fractures to anatomy but little concern with the effects of nontraumatic disease. The embalmers of ancient Egypt removed the internal organs through small incisions, but their observations were neither recorded nor related to diseases. Egyptian records dating from the 17th (Edwin Smith Papyrus) and 16th (Papyrus Ebers) centuries BC dealt with surgical and medical diseases but related changes to magic rather than pathologic anatomy.[2] Similar beliefs were held by the Assyrians and Babylonians.[6] In ancient India, Susruta (ca. 600 BC) advocated human dissections, but despite relatively sophisticated contemporary surgical techniques, anatomic studies (with the exception of osteology) were rather limited.[7] Practice of medicine in China and Japan was based on philosophy and religion rather than science.[8,9] Dissection was forbidden, and until the arrival of western influences in the 18th century, anatomic knowledge remained largely speculative, based on rare dissected bodies.[2] The first recorded anatomic dissection of a human body in China occurred in 16 AD.[10] The first known dissection in Japan was in 456 AD when an autopsy done on the body of Princess Takukete following her suicide revealed fluid in the abdomen with a "stone."[11]

The humoral theories of disease that dominated ancient Greek medicine provided an atmosphere that discouraged investigation to correlate anatomy with disease. The Hippocratic physicians described external manifestations of disease—infections, abscesses, and ulcerating and even infiltrating cancers—but were content to observe human anatomy only through wounds. It is likely that no human dissections were performed in Greece until the third century BC.[12] Nevertheless, Aristotle (384-322 BC) inspired the study of animal anatomy and development. Aristotle's sphere of influence expanded following the battlefield success of his pupil, Alexander the Great. It was Alexander's able comrade Ptolemy of Macedonia who created the environment in which pathologic anatomy first flourished. Ptolemy established the great university and library in Alexandria at the mouth of the Nile River. For 4 centuries, Alexandria attracted the best students of medicine. Here, scholars dissected the human body at least throughout the third century BC.[5]

According to Pliny, Herophilos (335-280 BC) was the first who "searched into the cause of disease."[13] He performed dissections of humans and wrote a treatise on human anatomy. It was his contemporary Erasistratus

(ca. 310-250 BC), however, who broke from the humoral theories popular at the time and associated disease with changes in the organs.[4] He believed in two circulations, one that carried the nutritive substance "parenchyma" (blood) from the heart to the organs through the veins and one that carried air from the lungs through the arteries. Failure of an organ to digest the nutrient substance caused plethora or overfilling of the organ. Thus, he explained inflammation as overfilling of the veins with blood and fever as overfilling of the arteries with air. However, he correctly correlated excessive accumulation of fluid within the abdominal cavity with hardness of the liver. Although the great library of Alexandria was destroyed by the army of Julius Caesar in 48 BC, copies of some of the manuscripts had already made their way to Rome. Celsus (circa 30 BC-38 AD), a Roman patrician and not a physician, compiled much of the medical knowledge in his eight-volume *De Re Medicina*. Here are described the cardinal symptoms of inflammation ("rubor, tumor, dolor, calor, et functio laesa"), splenomegaly in what presumably were cases of malaria, and inflammation of the cecum in what later was understood as appendicitis, along with descriptions of clinical findings in what were certainly cases of rabies, meningitis, gout, hernia, gonorrhea, scrofula, and urinary calculi.[4,14]

The impressive compilation of Celsus was not influential on the physicians of the period, however, for it was unread and soon lost. Its impact came only in the Renaissance after it was discovered among stored documents in the church of St. Ambrose in Milan by Thomas of Sarzan (later Pope Nicholas V). The physicians of Rome followed the teachings of Galen (129-201 AD). Although Galen performed anatomic dissections on animals, including primates, and made many original observations, his theories on pathophysiology were worthless because they were based on the old humoral doctrine.[15] Unfortunately, his influence persisted until the late Middle Ages. Even during this generally unproductive period, however, there were some advances. In the Byzantine world, the physicians Oribasius (325-403), Aetius (502-575), Alexander of Tralles (525-605), and Paul of Aegina (625-690) preserved the teachings of others as well as their own through their writings. During this era, physical diagnosis and its basis in pathologic anatomy became more firmly rooted, and according to Procopius, as early as 543 physicians opened dead bodies searching for the cause of a plague epidemic in Byzantium.[16]

A small sect of Christians, probably of the Semitic or Aramean race, who eventually became known as the Nestorians, migrated from the Arabian peninsula into Syria.[17] At Edessa in Syria, the Nestorian bishop Rabboula had founded a hospital and medical school in 372 AD. Instruction was grounded in Hippocratic and Galenic teachings, and the faculty was composed of Christian and Jewish physicians. Opposed to the "heresy" of the Nestorian church, Emperor Zeno ordered the school closed in 489. The faculty fled to the town of Juní Shápúr in South Persia, a safe haven because it was administered by a Nestorian bishop. Neo-Platonist exiles from Athens arrived in 529. Instruction was given in Syriac, Greek, and Persian.[18] Scientific expeditions into India brought back the works of the great Indian doctors Susruta and Charaka (circa first century BC to circa first century AD), whose teachings were added to the Talmudic-influenced Greek medicine practiced at Juní Shápúr.[18]

Beginning in the seventh century, the Arabs pushed westward across Persia, Byzantine Asia Minor, Syria, Egypt, and northern Africa and into Spain until their advance was stopped at the Pyrenees at the battle of Poitiers by Charles Martel in 732. The Arabian armies spared Juní Shápúr from destruction, and its medical school soon became the center of medical teaching for the Islamic world until late in the ninth century, when Baghdad gained greater prominence. During the next 3 centuries, the most important works in medicine sprang from the Caliphate empire and included those of Arabic and Jewish physicians such as Rhazes (860-932), Avicenna (980-1037), and Avenzoar (1070-1162). However, the greatest advances were in pharmacology rather than pathology, for the Koran condemned dissection as mutilation of the dead.

In China, human dissections were performed occasionally during the Sung dynasty.[11] In 1045 AD, over a 2-day period, dissections of the bodies of 56 members of a band of rebels were recorded in an atlas. Between 1102 and 1106, Li Yee Siung, a government official, assembled physicians and artists to dissect a criminal and record the anatomic findings.

During this Arabic period, science was practically nonexistent in the developing European cultures. The collision of the two cultures would change that, however.[19] The Saracens, who arrived in Spain during the eighth century, intermittently raided and invaded Sicily and southern Italy and soon established colonies in the region. Jewish groups educated in Arabic thought also settled here. The town of Salerno on the Campanian coast, where a medical school had been founded as early as the ninth century, became the focal point. In 1076, the Normans

took Salerno. At the same time, the monk-physician Constantine the African (?-1087), who had traveled for nearly 4 decades through Mesopotamia, India, Ethiopia, and Egypt studying medicine, arrived at the Benedictine abbey of Monte Cassino near Salerno, where a hospital had been established as early as 539.[20] Here, he and his pupils began translating medical works from Arabic into Latin. The significance of the works was quickly appreciated by the physicians at the Salerno school. The influence of the medical school grew, and it received official state sanction from Frederick II in 1231. Flourishing well into the 13th century, it attracted students widely, and its courses of instruction were adopted by the great universities that existed in Naples, Bologna, Padua, Montpellier, and Paris.[21] At the University of Bologna, Taddeo di Alderotto (1206?-1295) apparently made dissections of the human body a regular part of university teaching, and his students, such as Mondino (1265-ca. 1326) and Mondeville (ca. 1250-1320), followed this example.[4]

The first law authorizing human dissection (1231) is credited to Frederick II (1194-1250), Holy Roman Emperor. During the 13th and 14th centuries, restriction against opening the human body after death eased (Fig. 1–1). According to Chiari, a physician of Cremona performed autopsies on victims of the plague of 1286.[13] The Pope apparently authorized opening of bodies during the "Black Death" (1347-1350) to determine the cause of the disease.[22] Autopsies were performed in Siena in 1348 and authorized at Montpellier (Fig. 1–2) around 1376.[23] However, initially, bodies were more likely opened for legal rather than educational purposes. Records indicate that William of Saliceto (about 1201-1280), a Bolognese surgeon, performed at least one medicolegal necropsy. Another early forensic autopsy was ordered by the court as part of the investigation of the death of Azzolino, an Italian nobleman who died suddenly in 1302, presumably from poisoning. Although the final judgment is unclear, the report describes an internal examination of the body.[4]

With the Renaissance, medicine and medical education were transformed. Public human dissections spread through the universities from Italy north across the Alps.[24] Professors sitting in raised chairs supervised assistants, commonly barber-surgeons, in formal dissections that lasted for several days and were attended by as many as 100 onlookers.[19] The long-held doctrines of Galen began to break down. Leonardo da Vinci (1452-1519) made drawings from some 30 human dissections.[25] Antonio Benivieni (ca. 1443-1502), a Florentine physician, requested permission from relatives to perform postmortem examinations in enigmatic cases (Fig. 1–3).[22] He kept careful case records, and these were published by

Figure 1–1. This miniature from a 13th century English manuscript did not have a caption but may represent an autopsy scene. (From MacKinney L: Medical Illustration in Medieval Manuscripts. London: Wellcome Historical Medical Library Publications, 1965; Bodleian Library, University of Oxford, MS. Ashmole 339, fol. 34r.)

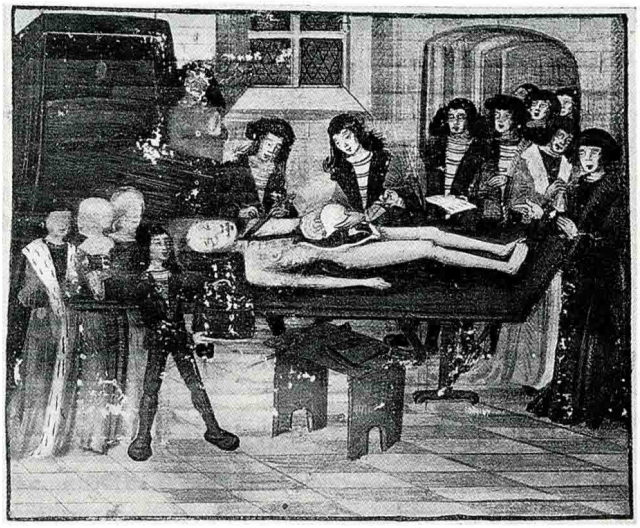


Figure 1–2. Miniature from the Guy de Chauliac manuscript *Chirurgia* (1363) depicting an anatomical dissection or autopsy at Montpellier. (From Holländer E: Die Medizin in der Klassischen Maleriei. Stuttgart, 1913.)

Figure 1–3. Antonio Benivieni (from a portrait). (From Benivieni A: De Regimine Sanitoatis Ad Laurentium Medicem. Belloni L [ed]. Torino: Societa Italiana Di Pathologia, 1951.)

his brother in 1507 as *The Hidden Causes of Disease*.[26] Included in the 111 short chapters of this treatise are descriptions of 20 postmortem examinations. However, Benivieni only incised rather than dissected the bodies, and the findings reported are superficial. The first recorded autopsy in North America was an examination of conjoined twins performed in 1533 in Santo Domingo. Authorized by the clergy, its goal was not to establish cause of death but rather to determine whether there were two souls or one.[22] The records of the second voyage (ca. 1536) of Jacques Cartier up the St. Lawrence River described an internal examination of a sailor who died of a strange disease (scurvy) in the hope of identifying its cause and preventing its spread to other members of the crew.[22] As early as 1576 in Mexico City, Francisco Hernandez and Alonzo Lopez performed limited postmortem examinations.

In the 16th century, Andreas Vesalius (1514-1564) from Brussels ushered in the modern era of studying anatomy. After completing his studies at Padua, he was appointed professor of surgery there and given the duty of conducting the public dissections. However, Vesalius did his own dissections using his students as assistants. Vesalius' pupils spread throughout Europe, advancing the anatomic concept of disease as they recognized the abnormal. In Germany, Johann Schenck von Grafenburg (1530-1598) performed postmortem examinations and recorded the findings as part of his practice as town physician for Freiburg and Strassbourg.[27] At the University of Paris, Jean Fernel (1497-1558) supplemented his studies of medicine, and particularly tuberculosis, with postmortem examinations.[27] His chapter on pathology in his book *Medicina* (1554) was the first treatise to consider the pathogenesis of disease and contained the first clear description of what Reginald Fitz would later identify as appendicitis.[28] Following an autopsy on a 7-year-old boy who died during the Paris diphtheria epidemic of 1576, Guillaume de Baillou (1538-1616) described the false membrane covering the airway that characterizes the disease.[29] A London physician, George Thomson (1619-1677), remained in that city during the Great Plague of 1665 and attempted to determine its cause through postmortem examinations.[30] In 1666 he published his studies in *Loimotomia, or The Pest Anatomized*, which included an engraving of an autopsy dissection of a plague victim as its frontispiece (Fig. 1–4).

With William Harvey's (1578-1657) description of the circulation in 1628, the stage was set for the physiologic interpretations of pathologic findings. A pathologic anatomy museum was established by Riva (1627-1677). Marcello Malpighi (1628-1694), Francis Glisson (1597-1677), and Franciscus Sylvius (1614-1672) were routinely performing autopsies. The findings of many of these autopsies were compiled by Theophile Bonet and published in 1769 as the *Sepulchretum sive Anatomica Practica*. However, he made no attempt to correlate pathologic findings with clinical symptoms except for occasional references to the humoral doctrine. In contrast, Giovanni Morgagni (1682-1771) was among the first to correlate clinical symptoms with organic changes (Fig. 1-5). His autopsy reports published in 1761 as *De Sedibus et Causis*

Figure 1–4. Frontispiece from *Loimotomia, or The Pest Anatomized*, by George Thomson.

Figure 1–5. Giovanni Battista Morgagni (from an engraving). (From Krumbhaar EB: Pathology. New York: Paul B Hoeber, 1937.)

Morborum per Anatomen Indagatis (The Seats and Causes of Diseases Investigated by Anatomy) numbered over 700 and included descriptions of coronary artery atherosclerosis, aneurysms, endocarditis, lobar pneumonia, hepatic cirrhosis, fatty liver, renal calculi, hydronephrosis related to ureteral stricture, and various cancers.[31] Although Bonet's *Sepulchretum* is largely forgotten, Morgagni's work stands as one of the most influential in the history of medicine, for it convinced the physicians of its day that advancement of medicine rests in sound clinical-pathologic correlation.[32]

In France, Marie-François-Xavier Bichat (1771-1802) was perhaps the first experimental pathophysiologist and, along with his countrymen Jean-Nicolas Corvisart (1755-1821) and Réné-Théophile-Hyacinthe Laënnec (1781-1826), advocated the correlation of pathologic findings with physical diagnosis (Fig. 1–6). Bichat's career, cut short by tuberculosis, was notable for another reason, however. By subjecting organs to heat, air, water, acids, alkalis, salts, and so forth, and without a microscope, he determined that organs were composed of tissues (from the French *tissu* or cloth). He distinguished 21 kinds of tissues. Furthermore, he recognized that disease weakened tissues and that this effect of disease was the same no matter what organ was affected.[13]

At roughly the same time, great strides were also made in Scotland and England. William Hunter (1718-1783) and John Hunter (1728-1793) established the first

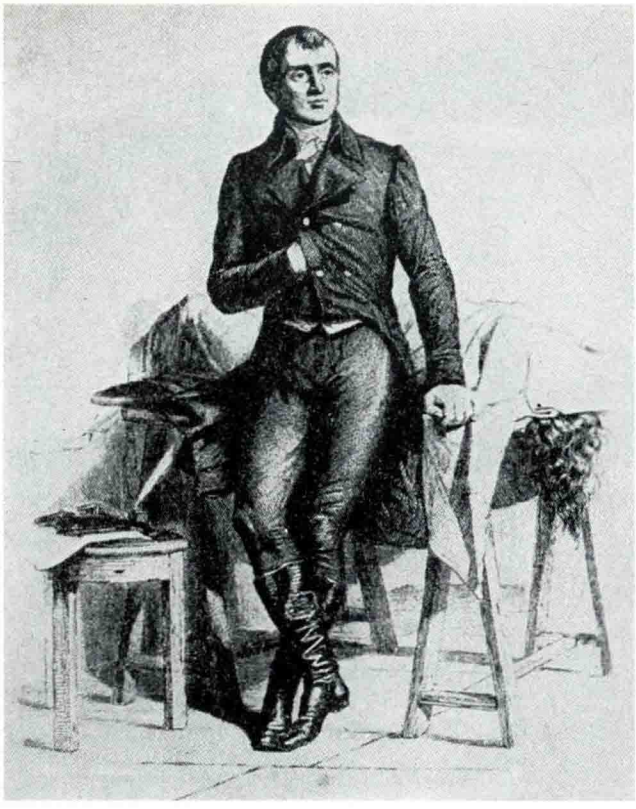


Figure 1–6. Marie-François-Xavier Bichat (from an engraving). (From Krumbhaar EB: Pathology. New York: Paul B Hoeber, 1937.)

Figure 1–7. Matthew Baillie (from an unfinished engraving). (From Krumbhaar EB: Pathology. New York: Paul B Hoeber, 1937.)

English museum for teaching of pathology. Matthew Baillie (1761-1823) published the first atlas of pathology in 1793; he described situs inversus, hydrosalpinx, dermoid ovarian cysts, and "hepatization" of the lungs in pneumonia and further clarified cirrhosis of the liver (Fig. 1–7).[33] Postmortem examinations were a regular event at Guy's Hospital in London, performed by the likes of Sir Astley Cooper (1768-1841), Richard Bright (1789-1859), Thomas Addison (1793-1860), and Thomas Hodgkin (1798-1866), who used their findings to advance the field of medicine.[15]

At the beginning of the 19th century, the wealth of information available from the autopsy was still largely untapped. Autopsies were usually confined to one organ, which was generally chosen by the clinician on the basis of medical judgment.[5] Autopsies begun without a specific direction were often concluded when the prosector, usually an untrained surgical assistant, determined the seat of disease, leaving many organs unexamined or at best given a cursory evaluation.

While this state of affairs persisted in Paris, Edinburgh, and London, there were new developments in Vienna and Berlin. At the Allgemeines Krankenhaus at Vienna, Karl Rokitansky (1804-1878) performed more than 30,000 autopsies (Fig. 1–8). Through the influence of the editions of his manual *Handbook of Pathological Anatomy*, the autopsy became an important and integral part of medicine during the first half of the 19th century. However, Rudolph Virchow (1821-1902), by applying microscopic examination to diseased tissues and recognizing cellular alterations, became known as the founder of modern pathology (Fig. 1–9). To be sure, Virchow stood upon the shoulders of the early histologists, his mentor Johannes Müller (1801-1858) and two previous students of Müller, Theodor Schwann (1810-1882) and particularly Jacob Henle (1809-1885). Nevertheless, it

Figure 1–8. Karl Rokitansky (from a photograph). (From Krumbhaar EB: Pathology. New York: Paul B Hoeber, 1937.)

Figure 1–9. Rudolph Virchow as a young professor. (From Krumbhaar EB: Pathology. New York: Paul B Hoeber, 1937.)

was the publication in 1858 of 20 of Virchow's lectures in *Cellular Pathology as Based Upon Physiological and Pathological Histology*[34,35] that ushered in the modern age of pathology.

To Rokitansky and Virchow, we can trace systematic examination of organs. In 1876, Virchow published a book on autopsy technique in which he introduced a detailed postmortem technique designed to identify abnormalities in organs and retain important anatomic relationships when necessary for demonstrations.[36] After examination of the organs and their relationships in situ, Virchow removed them one at a time. Following their removal, he performed further dissection outside the body. Moreover, he preserved regional organ relationships if indicated. This contrasts with the technique developed earlier by Rokitansky, as described by his student Chiari in a book first published in 1894.[37] Rokitansky examined and opened all organs in situ, preserving all abnormal relationships. Friedrich Albert von Zenker (1825-1898) developed a technique similar to Rokitansky's in that it emphasized preservation of topographic anatomy, and two of his students, Heller and Hauser, each described their own versions in publications.[22] In their modifications, physiologically related organs were removed together and connections were maintained unless the pathologic process could not be demonstrated. The first substantial American works on autopsy technique were published by Delafield in 1872[38] and Thomas in 1873.[39] Joined by coauthor Prudden in 1885[40] and eventually revised by Wood,[41] the Delafield work evolved into a complete textbook of pathology but continued to include a description of autopsy technique through numerous editions.

Books by Nauwerck,[42] Woodhead,[43] Hektoen,[44] Clarke,[45] Warthin,[46,47] Cattell,[48] Mallory,[49] Box,[50] Beattie,[51]

and Miller[52] described modifications of or improvements on the autopsy technique of Virchow. Versions based on all of these are in practice today. In France, Maurice LeTulle (1853-1929) described a technique based on en bloc removal of the thoracic and abdominal organs.[53] With variations, it remains a popular alternative to the organ-by-organ approach that descended from Virchow.

The Autopsy in the 20th Century

The first half of the 20th century saw, in addition to standardization of postmortem dissection procedures, improvements in tissue embedding, microtomy, and histochemistry. In North America, leaders of medicine, including Sir William Osler (1849-1919), stressed the importance of the autopsy in both undergraduate and postgraduate medical education (Fig. 1–10). As a student at McGill University, Osler was actively involved with autopsies. For his graduation thesis, which consisted of reports of 50 postmortem examinations and included 33 specimens, he received a special prize from the faculty. Following postgraduate study at University College in London (1872-1873), Osler spent 3 months in Berlin under Virchow and 5 months in Vienna, primarily with Rokitansky.[54,55] On his return to Montreal in 1874, Osler began a decade-long service at McGill University and its associated Montreal General Hospital, where he performed nearly 800 autopsies in addition to his clinical and teaching duties.[56] These cases formed the basis for numerous presentations and case reports and ultimately became the foundation of his textbook, *The Principles and Practice of Medicine* (1892).

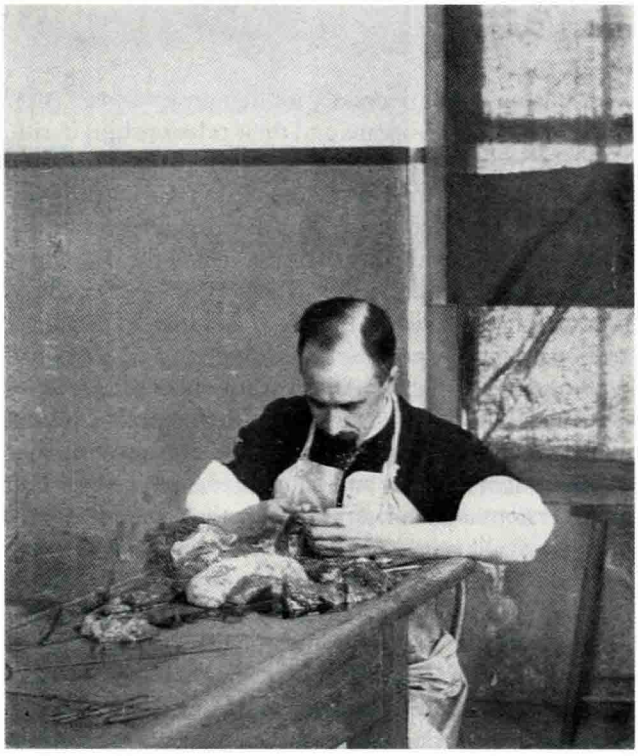


Figure 1–10. William Osler performing a postmortem dissection at the Blockley Mortuary, Philadelphia around 1886. (From the Sir William Osler Memorial Number, International Association of Medical Museums, Bulletin 9, 1926.)

Flexner's report on medical education in Canada and the United States advocated the autopsy as an important tool for ensuring hospital quality, and accrediting agencies defined acceptable autopsy rates.[57,58] In 1936, the newly formed American Board of Pathology began certifying pathologists. This raised the standards for the training of pathologists, and training centered largely around the autopsy table.[5] Forensic pathology burgeoned, became a subspecialty of pathology, and the medical examiner system began to replace the coroner system.[59] In the United States, the autopsy rate, which was about 12% in 1910,[60] climbed to about 50% by the late 1940s.[61]

In an editorial that appeared in the *Journal of the American Medical Association* in 1956, Starr[62] questioned the value of the "classical" autopsy. Although his premise generated a lively rebuttal, the fact remains that after a century, the autopsy was moving from its place in the center of the medical stage. Autopsy rates declined. In 1971, the Joint Commission for the Accreditation of Hospitals (JCAH) dropped its recommendation for a 20% to 25% autopsy rate in accredited hospitals.[63] Although the numbers of hospital autopsies were decreasing before this change in policy, the JCAH decision lent tacit acceptance to this state of affairs. Rigorous objections to the decision appeared in print[64-66] but failed to sway the policy makers.

Why was there such a precipitous drop in autopsy rate? At the height of autopsy activity, new demands diverted pathologists' attentions. The role of clinical pathologists grew as physicians relied on newer, more sophisticated laboratory tests. Operations and endoscopies increased surgical pathology specimen numbers and the demands on pathologists' time. The value of cytologic examinations in disease prevention and recognition led to their expanded use and consequently increased pathologists' workload. All of these endeavors provide direct remuneration for pathologists. In contrast, U.S. pathologists'

compensation for autopsy practice generally remains hidden in the hospital budget and daily room rate, where it is essentially considered overhead.[67] For the pathologist practicing in the community, the morgue became a place to avoid. At the medical schools, pathology departments invested in experimental pathologists, not autopsy prosectors. Too frequently, the inexperienced house officer was left on his or her own while performing a postmortem examination. A generation of pathologists was trained in an environment that devalued the autopsy.

The responsibility for the decline of the autopsy does not rest on the shoulders of pathologists alone. Clinicians, who along with hospitals and health care organizations are the prime "consumers" of the autopsy, have requested fewer. A number of reasons for this have been suggested, the following most frequently: (1) greater confidence in modern diagnostic techniques, (2) unwillingness to dwell on clinical "failures," (3) fear that autopsy results will increase malpractice risks, (4) difficulty in obtaining autopsy authorization from the grieving family, and (5) dissatisfaction with the quality or timeliness, or both, of autopsy reports.[68-70] The shift in care of patients from a general practitioner to multiple specialists and the concomitant lack of rapport between physician, patient, and family made it easier for relatives to refuse an autopsy request from a physician with whom they had no long-term relationship.[71] Families of the deceased have resisted autopsies for numerous reasons, including being poorly informed about the value of the autopsy, fear that they might be billed for the service, anxiety about delays in funeral arrangements, concern that the deceased had suffered enough, religious convictions, or cultural beliefs.[72-76] Although funeral directors often believe in the value of autopsies, delays in receiving the remains, increased difficulties in embalming, and concern of the family about possible disfigurement of their relatives after autopsy have led morticians to counsel families against authorizing autopsies.[77] Increasing numbers of patients with chronic diseases are dying outside the hospital—at home or in nursing homes or hospices—in sites where there is often little interest in postmortem examination.

Near the end of the 20th century, the autopsy rate including medical examiner-coroner cases in the United States fell below 10% and to nearly 5% if deaths caused by accidents, homicide, and suicide are excluded.[78] More alarming, the rate of postmortem examinations performed at some community hospitals is at or near 0%.[79] Also, the autopsy rates for certain groups (elderly people) and diseases (e.g., cerebrovascular) are particularly low.[80,81] From 1980 to 1984, the autopsy rate in New York State nursing homes was less than 1%, although 20% of all deaths in the state occurred in these institutions.[82] In fact, this represents the current situation nationwide, in which old age and death in a nursing home both have a statistically negative relationship with whether an autopsy is performed.[83] Similar data come from Australia,[84] Denmark,[85] Japan,[86] Sweden,[87] and the United Kingdom.[88]

Has the autopsy rate reached its nadir? If anything, health care cost containment policies will exert additional restraints. In the past, autopsy costs in the United States have been recovered through both insurance and Medicare part A reimbursements.[89] However, as payers switch to different methods such as capitation, cost recovery for autopsy services is essentially lost. The College of American Pathologists[90] has strongly advocated for a method of direct reimbursement for autopsy; however, its voice has fallen on deaf ears. Of note, a survey of Swedish citizens indicated that declining autopsy rates are apparently not a consequence of negative attitudes toward the procedure.[91] And in the United States, some entrepreneurs have found commercial success providing private autopsy services to a receptive public.

The Objectives of the Autopsy

Despite the decline in autopsy rates, the procedure still has its champions. The autopsy—its place in medicine, role in society, and future—has been the subject of numerous symposia,[92-100] editorials,[71,101-112] and books.[113,114] Proponents laud the autopsy for its role in establishing public trust in medicine. Detractors question the risk and cost-effectiveness of the autopsy. For others, the autopsy needs no justification—it remains a focal point for the integration of medical knowledge. Most would agree, however, that the autopsy benefits physicians, patients, and society and therein demonstrates its value. These benefits fall into seven broad categories.

Benefits to Physicians and Health Care Organizations. Two of the major objectives of the autopsy are the establishment of final diagnoses and determination, whenever possible, of the cause of death. Autopsy cases provide a unique opportunity for physicians to correlate their physical and laboratory findings with the pathologic changes of disease. In essence, the autopsy is a "gold standard" for evaluating the accuracy of diagnosis and the outcome of therapy. Through autopsy findings, pathologists alert hospital infection control committees of pos-

sible contagion. Thus, the autopsy provides critical data for medical quality assurance and, ultimately, quality improvement (see Chapter 13).

Autopsies may also reduce hospital and physician malpractice risk. Valaske[115] surveyed 183 hospitals and 39 malpractice liability companies and from their responses concluded that autopsies (1) eliminate suspicion, (2) provide reassurance to families, (3) substitute facts for conjecture, (4) construct a better defense, (5) reduce the number of claims, and (6) improve the quality of care. In a small, biased sample of autopsies performed after families filed a malpractice suit, postmortem findings clarified the cause of death in 10 of 15 cases, contributing to the resolution of conflicts and safety of future patients.[116]

One of the most overlooked benefits of the autopsy may be its contribution to accurate billing. Under the Diagnosis-Related Group (DRG) system of Medicare reimbursement, autopsy data increased allowable billing by 6.6%.[117]

Benefits to the Family of the Deceased. The therapeutic value of the autopsy for surviving family is often overlooked.[118] At autopsy, pathologists can identify or define hereditary or contagious diseases. This information not only provides the basis for genetic counseling but also may indicate preventive care for relatives. In a study of the value of autopsies performed in cases of death during the perinatal period, Faye-Petersen and colleagues[119] found that autopsy findings altered parental counseling or recurrence risk estimates in 26% of cases. Autopsies help families with the grieving process, especially by removing guilt on the part of the immediate family for believing that they may have contributed to death.[120,121] This is particularly true after sudden death. In the setting of a postautopsy conference, the clinician or pathologist can console the family by reporting the cause of death, provide information about the disease process, answer any lingering questions about the terminal events, and alleviate irrational guilt.[122,123] Finally, the autopsy provides accurate data for determination of insurance benefits or workers' compensation. McPhee and coauthors,[124] in a survey of family members who had consented to an autopsy of their relatives, found that 88% considered the postmortem examination beneficial. Reasons given in order of frequency included consolation through contributing to the advancement of medical knowledge, comfort in knowing the cause of death, reassurance that the therapy was complete and appropriate, identification of genetic or contagious diseases, and settlement of insurance claims.

Benefits to Public Health. The autopsy contributes to public health surveillance through detection of contagious diseases, identification of environmental hazards, and contribution of accurate vital statistics. Direct benefits accrue when an autopsy pathologist alerts public health officials about a communicable disease or an environmental hazard. Indirectly, the autopsy contributes to population health planning and disease prevention by providing reliable data. Unfortunately, as the autopsy rate declines, so does the accuracy of vital statistics. Numerous studies document serious discrepancies in the underlying cause of death as recorded on death certificates when determined clinically rather than from autopsies.[114,125-127] Major inaccuracies reach levels of approximately 30%.[125,128] The discordance crosses national boundaries,[125,129-131] diseases,[132-143] and age of the deceased[144] (although errors are magnified in the geriatric population).[145-147] Furthermore, because the practice of amending death certificates after autopsy is sporadic at best, mortality statistics based on these documents are probably too inaccurate for use. With this concern in mind, a committee of the College of American Pathologists proposed the creation of a National Autopsy Data Bank.[148,149] This has never been fully realized, but a publicly accessible autopsy database has been established on the Internet.[150]

Benefits to Medical Education. The majority of medical students,[151,152] house officers,[153,154] pathology residents,[153] physicians,[155,156] and nurses[157] agree on the usefulness of the autopsy in medical practice and education. However, surveys of medical students and faculty suggest that the educational value of the autopsy is not fully realized.[158,159] The autopsy aids in the education of students in medicine and other health-related disciplines by providing teaching material for anatomy, histology, and pathology. Direct exposure of medical students as participants offers opportunities not just in the instruction of pathology but also in that of anatomy.[160] In the arena of medical school education, the autopsy is a focal point for integration and correlation of basic and clinical medical knowledge.[161,162] Medical students and hospital residents and fellows learn from observing or discussing at conferences the postmortem findings of patients whom they treated. The autopsy also provides an opportunity for pathologists-in-training to improve their knowledge of normal and abnormal gross and microscopic anatomy.