Surgical Pathology in the Era of the Civil War

The Remarkable Life and Accomplishments of Joseph Janvier Woodward, MD

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• Joseph Janvier Woodward was an assistant surgeon in the US Army during the Civil War, coauthored the definitive works on the mortality and morbidity of that war, attended at the autopsy of President Lincoln, and attended President Garfield after he was shot. He revolutionized the field of photomicroscopy and was one of the first pathologists to use aniline dyes as tissue stains. Yet despite the occasional biographical sketch every few decades, he is largely unknown today. Herein, we review his contributions to surgical pathology and medicine and present modern-day photomicrographs of 140-year-old slides from Woodward's original collection.

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James Janvier Woodward (1833–1884) was born in Philadelphia, Pa, where he remained for medical school at the University of Pennsylvania (1853).

He was the published author of several papers related to microscopic studies and a founding member of the Pathological Society of Philadelphia in 1857.[1] Following the outbreak of the Civil War, Woodward (Figure 1) volunteered for the US Army. Initially, he served as an assistant surgeon and brevet major, participating in several battles, including the first Battle at Bull Run.[2] In June 1862, Woodward was assigned to the Office of the Surgeon General to prepare the medical section of the *Medical and Surgical History of the War of the Rebellion* (*MSHWR*). His duties included acquiring gross pathologic specimens to document medical conditions suffered by American soldiers along with the case history. Two years later, he was given control of the Medical and Microscopical Sections of the Army Medical Museum (currently the Armed Forces Institute of Pathology) and the Office of the Surgeon General Records and Pension Division, where he remained for the rest of his career.[1,3] In addition to collecting specimens for the museum's archive, he coauthored the definitive medical history of the Civil War in the 6-volume 1870 publication of the *MSHWR*.[4] Woodward's technique using aniline dyes for staining thin sections of tissue, along with his pioneering work in photomicroscopy, helped prepare the groundwork for modern surgical pathology.[3,5]

THE MEDICAL AND SURGICAL HISTORY OF THE WAR OF THE REBELLION

More Americans (Confederate and Union) died in the Civil War than any other conflict in American history. Following the end of hostilities, Woodward was commissioned to coauthor the medical section of the *MSHWR*. This work is acknowledged to be the first major academic medical accomplishment in the United States.[6] In the medical section of the *MSHWR*, Woodward's meticulous insight and attention to detail are evident in the description, organization, and tabulation of diseases found in soldiers of the Civil War.[7] The monthly records of sickness and mortality submitted by more than 200 hospitals and the medical directors of 8 armies were painstakingly compiled, and the troops were stratified based on active versus volunteer, ''colored'' versus white, officers versus enlisted men, and American versus foreign born. The total number of Union deaths from the commencement to the close of the Civil War was tabulated at 304 369, with 186 216 deaths resulting from disease and the remainder from trauma and other causes.[4]

''Camp diarrhea,'' dysentery, and ''camp fevers'' are listed as the most frequent causes of nontraumatic death; they resulted from overcrowding, poor hygiene, and malnutrition. Woodward noted the severity in the *MSHWR*, commenting: ''These disorders occurred with more frequency and produced more sickness and mortality than any other form of disease. . . . Soon no army could move without leaving behind it a host of victims.'' In fact, the adage that a soldier needed ''guts'' arose during this era.[6,8] For example, in 1862, the ''monthly mortality from diarrhea and dysentery among the white troops'' reached its maximum of 128 per 1000 soldiers during July, which correlated with General George McClellan's disastrous Peninsula Campaign. By the end of the war, Woodward observed, 1 soldier died for every 30 cases of acute diarrhea or dysentery. In unusually clear and explicit writing for the era, Woodward details the effect of region and season on the cases of dysentery, microscopic analysis of the stools, postmortem gross and microscopic appearance of the bowel, treatment of the condition, and known associated complications. These gross and microscopic descriptions and pictures were intended to remove independent-observer variability and create images that could be reproduced and studied for future reference comparison

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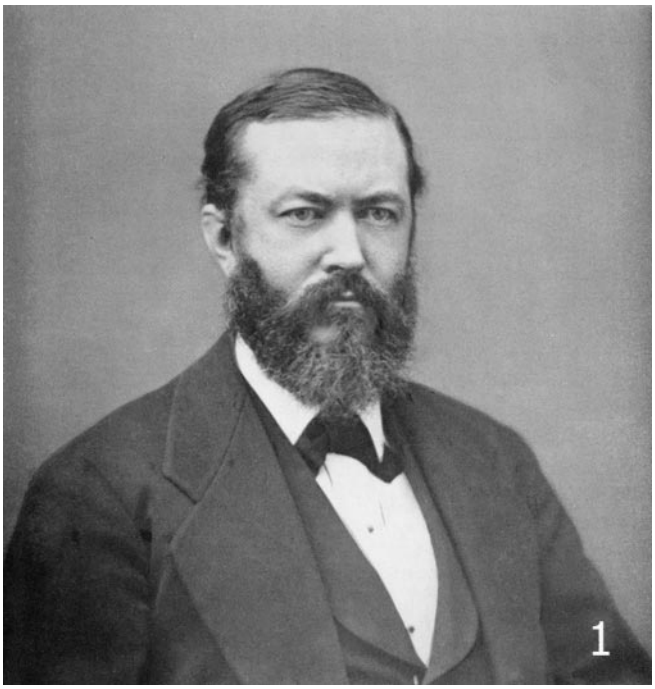

Figure 1. *Dr James Janvier Woodward (1833–1884).*

and diagnostic purposes. It was hoped that the accurate descriptions would facilitate etiologic subclassification of the various types of gastrointestinal diseases and lead to a better understanding of prevention and treatment.

WOODWARD AND PHOTOMICROSCOPY

A major strength of the *MSHWR* is the inclusion of photomicrographs of histologic specimens. To accomplish this, Woodward needed to first develop new histologic and photomicroscopic techniques. In contrast to modern-day pathologists, Woodward cut the tissue and mounted his own slides. Woodward and Dr Edward Curtis used a straight razor or small knife[9] to manually cut histologic

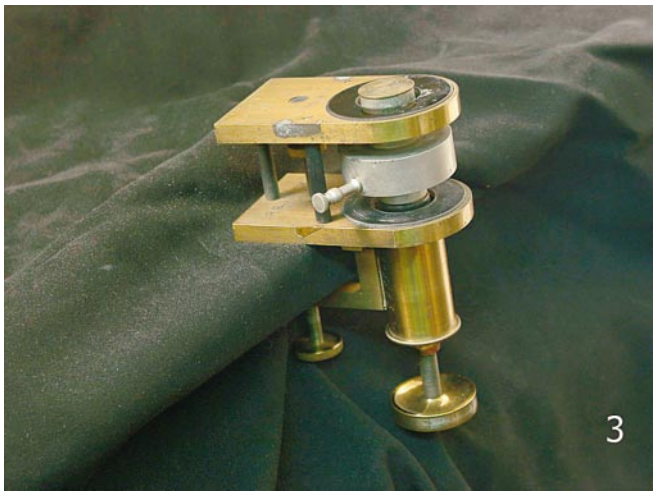

Figure 3. *Freezing microtome manufactured by R & J Beck, circa 1865, used by Woodward at the Army Medical Museum (Washington, DC).*

sections (Figure 2) from frozen tissue mounted on the microtome, which served as a guide to ensure thin sections. The tissue was then immobilized in either cork or wax and the tissue section mounted onto a glass slide using gum, glycerin, Venetian turpentine, and/or Canada balsam. The latter medium was preferred because it had a good refractive index (1.524) and adhesive qualities.

In this era, natural dyes were used to stain tissue sections. However, Woodward was not satisfied with the dyes because they were unstable and did not provide enough contrast. Through experimentation, he popularized in America the use of synthetic red and yellow aniline dyes developed in Europe.[4] Eosin, a synthetic aniline dye, is now routinely used in all anatomic pathology labs.

Woodward's inspiration for photography came from the physicist Lewis M. Rutherfurd, who had invented a telescope that could be used for astronomic photography. Woodward met in May 1865 with Rutherfurd, who ad-

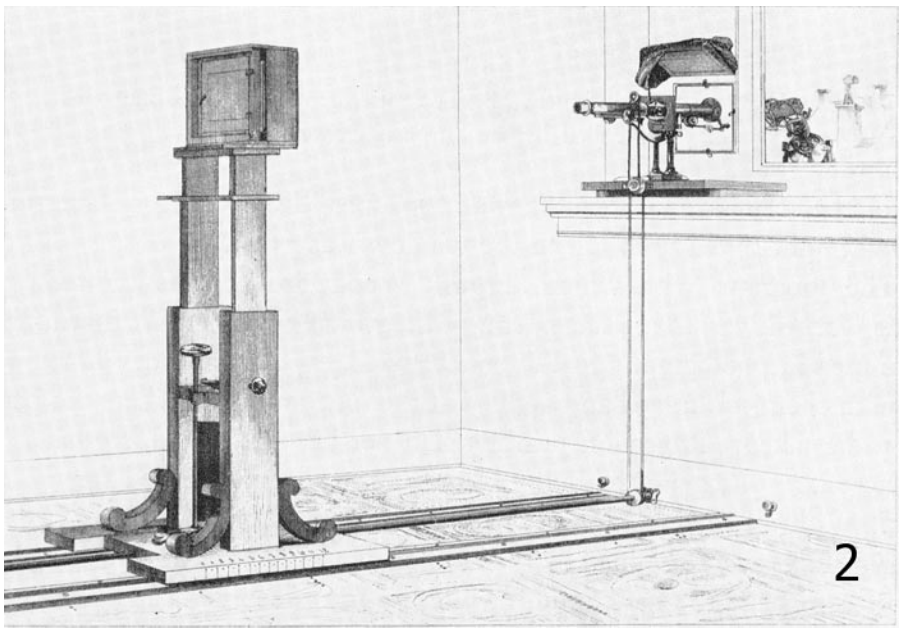

Figure 2. *Drawing of the photomicroscopy apparatus designed and used by Woodward.*

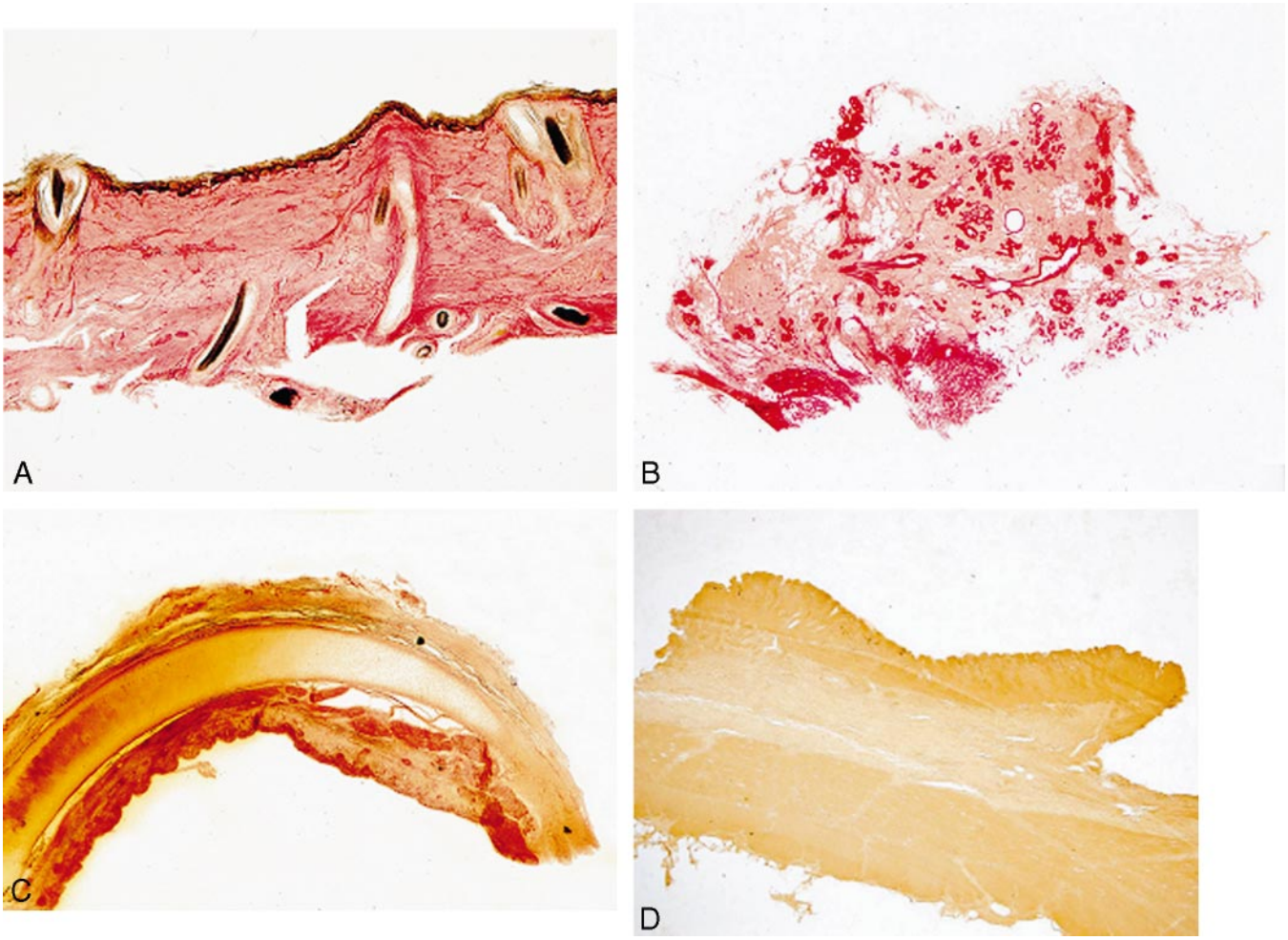

Figure 4. *Modern-day photomicrographs of (A) skin labeled as ''Negro skin'' (red aniline, original magnification ×32), (B) breast tissue labeled as ''mamma carcinoma'' (red aniline, original magnification ×8), (C) trachea labeled ''diphtheria'' (red aniline, original magnification ×32), and (D) large bowel labeled as ''chronic diarrhea'' (yellow aniline, original magnification ×8).*

vised him how to convert a microscope into a camera.[2,3,10,11] Woodward, with Curtis, then created the apparatus. Illumination came from sunlight reflected by a heliostat placed outside of a window on the fourth floor of the Ford Theatre building, location of the Army Medical Museum. The light passed through a copper ammoniosulfate solution light filter before passing through the specimen, which was mounted on a sideways Zentmeyer Grand American Microscope. The image was projected through the microscope, the eyepiece of which had been replaced by a concave lens, onto a movable plate holder situated approximately 9 feet away (Figure 3).[2] In *Circular No. 6: Reports on the Extent and Nature of the Materials Available for the Preparation of a Medical and Surgical History of the Rebellion,* published in 1865, Woodward described how he intended to use the photomicrographs to illustrate cases in the proposed medical section of the *MSHWR*. Because photolithography provided inadequate detail, Woodward had museum artist Hermann Faber make detailed drawings of the images that were used to generate the steel engravings that ultimately illustrated the *MSHWR*. Approximately 7500 copies of *Circular No. 6* were published.[3,11,12] To overcome the unpredictable sunlight source, Woodward later pioneered the use of artificial light sources, using both magnesium and electric lights.[5] Artificial light not only allowed nighttime experiments but also allowed greater magnification.[3]

Woodward's collection of glass slides is currently archived at the National Museum of Health and Medicine at the Armed Forces Institute of Pathology in Washington, DC. These slides are remarkably well preserved and provide a fascinating view of 19th-century pathology. One example demonstrates a section labeled ''Negro skin'' (Figure 4, A) and is noteworthy for the superb histologic technique. Although Woodward authored the sections on the ''colored'' Union troops in the *MSHWR*, one can only speculate about whether this specimen was derived from an autopsy or amputation from one of these soldiers. An example of a tumor is labeled ''carcinoma of the mamma gland'' (Figure 4, B) and stained with red aniline. The lesion consists of normal breast tissue highlighted by paler-staining stroma and vibrant red glands. In the lower portion of the slide, a dense infiltrating population of cells consistent with carcinoma is present. Figure 4, C, shows a section of trachea taken from a patient with diphtheria. The section beautifully illustrates the classic tracheobronchitis, demonstrating transmural acute inflammation and an adherent necrotic mucosal pseudomembrane containing sloughed respiratory epithelium. This specimen was procured at autopsy. Figure 4, D, demonstrates a section

of colon taken from a soldier with ''chronic diarrhea'' and stained with yellow aniline dye. The presence of flask-shaped ulceration present in the mucosa raises the interesting differential diagnosis of infectious colitis (eg, amoebic colitis, *Salmonella* or *Yersinia*) versus inflammatory bowel disease.

WOODWARD AND AMERICAN PATHOLOGY

Woodward's interest in pathology began during his tenure at the University of Pennsylvania, where he was known as a superb teacher of microscopic technique.[13] He was a well-respected gross anatomist; he attended the postmortem autopsy of President Abraham Lincoln and was one of the physicians for President James Garfield after he had been shot. In 1882, he was the first active-duty US Army physician elected president of the American Medical Association. Woodward can arguably be considered as one of the first American academic surgical pathologists who invented novel techniques and lectured widely on the controversial theories of the day. Woodward is also considered to be one of the first pathologists in the United States, particularly in the military setting, to use the microscope as a tool for diagnosis of disease.

Woodward's lecture entitled ''On the Structure of Cancerous Tumours and the Mode in Which Adjacent Parts Are Invaded,'' given at the first of the renowned Toner's lecture series at the Smithsonian Institution,[5,14] probably represents one of the first surgical pathology slide presentations. He projected lantern slides of his photomicrographs to illustrate the current theories on the origins of cancerous cells.[9]

Woodward consistently displayed a conservative approach to novel theories of disease pathogenesis. In 1870, Woodward observed a photomicrograph from the stomach of a mare with gastroenteritis demonstrating a white blood cell undergoing diapedesis from a small vein. Julius Cohnheim, an assistant to Virchow, had previously proposed that leukocyte diapedesis was essential for the development of inflammation.[15] In his summary of this photomicrograph, Woodward asked, ''Do these little moveable masses of protoplasm furnish the germs for the elements of new formations?''[15] He further counseled caution in accepting the view that the ''amoeboid movement'' from the interior of the vein constituted the ''essence of the inflammatory process.'' The past century of research has validated that leukocyte diapedesis is one of the initial steps in the process of inflammation.

A ''talmud'' of 19th-century medicine, the *MSHWR* incorporated many of the theories of the day, including, notably, the contagion theory:

> Is dysentery contagious? Does the dysenteric subject generate in his intestinal mucous membrane, or elsewhere, a virus capable of causing the disease in others? . . . It would be easy to multiply the authorities in favor of the contagion of dysentery. . . . Others, more conservative, held with Zimmermann that dysentery is contagious or non-contagious according to the circumstances.

One of his original slides from a patient with dysentery is remarkable in its preservation for more than 140 years (Figure 4, D). Amazingly, the differential diagnosis today remains contagious (infectious) versus noncontagious (inflammatory).

Based on the data available to him, Woodward appears to have supported theories that cancer arose from migrating leukocytes. He rejected Rudolf Virchow's *Omnis cellula e cellula* theory that all cells arose from preexisting cells.[9,13] Woodward's incorrect views were more a result of primitive experimental data rather than a reflection of his intellect. Both views were later discredited.

PERSPECTIVE

The rapid advances in pathology at the turn of the 20th century have largely overshadowed the impressive work of Joseph Janvier Woodward. Yet, Woodward's career of university physician, Army surgeon, museum curator, anatomic pathologist, and photomicroscopist is quite extraordinary even by today's standards. Ralph Waldo Emerson wrote, ''Progress is the activity of today and the assurance of tomorrow.'' It seems fitting that a contemporary of Joseph Janvier Woodward, MD, captured the innovative nature that was embodied by this pioneering pathologist.

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