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the William P. Didusch CENTER FOR Urologic History

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“Education is the most powerful weapon which you can use to change the world.”

Nelson Mandela (1918-2013)

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Preface

In this book, which accompanies the History Exhibit at the Annual Meeting of the American Urological Association in Las Vegas, Nevada, April 26-28, 2025, we describe what we, the authors, believe are the important milestones in the development of urologic education, beginning with ancient times and continuing to what we believe the future holds. We will begin with a few definitions:

> ***"Education"*** – the process of receiving or giving systematic instruction, especially in a school or university. An enlightening experience involving the transmission of knowledge, skills, and character traits, the act or process of imparting or acquiring general knowledge, developing the powers of reasoning and judgment, and generally of preparing oneself or others intellectually for a mature life.
>
> ***"History"*** – the study of past events and written accounts of these events (providing a sense of where we have come from and our heritage, and allowing us to understand our place in society and the forces that shape it); the study of change over time. We believe that one's own beliefs and interpretations define history. This explains why we often hear it said that "historians agree" or "historians disagree." This helps us understand how historical events or persons can be described so differently by different people or at different times.

Hence, we attempt to review the impact of our most distant past and the evolution of medical education, which has led specifically to our primary concern in this book - urologic education. As such, we will review the dramatic changes in educational practice from tutorial interactions and apprenticeships to the formation of schools and professional organizations primarily.

We recognize that we write this book from the perspective of Western, and especially North American, history. We recognize that the described historical developments have, in many cases, occurred in different ways in different areas of our world and that these differences may be related to the historical and cultural differences between our North American experience and those of other world populations.

Herein, we review what we believe have been the most important developments in urologic education and the preparation of urologists for the effective practice of our specialty, including the use of virtual simulation and the advent of new educational tools that will likely define our future. At the same time, we hope to address some of the shortcomings of our educational efforts to date, including the need for efforts to more effectively educate women and those underrepresented in medicine.

Finally, I want to thank all the authors for their tireless efforts and to recognize the important contributions of AUA staff working with the *William P. Didusch Center for Urologic History*; without these efforts, the creation of this historical exhibit and related book would not have been possible.

Robert Flanigan, MD

Exhibit Curator

Cast of Thoth, Egyptian Deity of Medicine. Wellcome Collection

Milestones in Urologic Education: Ancient Times

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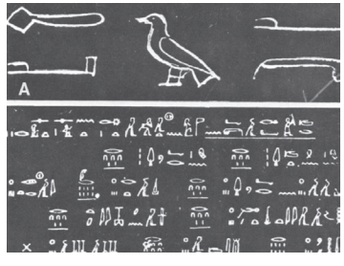
Russell S. Terry, MD
Ron Rabinowitz, MD

Introduction

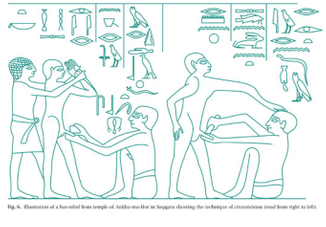
The study and treatment of urological disorders, while advanced today, traces its origins back to the earliest civilizations. Medical science and education in ancient times developed organically as a combination of empirical observations, religious rituals, and surgical practices. Urology as a distinct specialty appears to have emerged alongside general medical practices in multiple different civilizations. This evolution of urology as its own subspeciality was accelerated by the early recognition of the diagnostic value of urine in the diagnosis and treatment of various ailments (1), the high prevalence of morbidity of urological disorders in ancient civilizations (2,3), and the anatomical complexity and high surgical risk associated with surgical intervention of the urinary tract (4). Despite numerous barriers to the advancement of medical science in these early days of civilization, ancient physicians made significant strides in the diagnosis and treatment of urinary conditions and were ultimately successful in promulgating this knowledge across cultures and millennia to form the foundation of many urological principles and practices which are still used today.



Hieroglyphic script of haematuria associated with schistosomiasis in Kahun papyrus. Wellcome Collection

Egypt

Ancient Egypt stands as one of the earliest civilizations to document medical practices, including urologic conditions. The Egyptians kept detailed records of their medical knowledge in the form of *papyri*. Through these documents modern scholars have gained an understanding of ancient urologic practices. The most notable of these documents are the Edwin Smith and Ebers Papyri. These texts, which date back to the 16th century BCE, provide the earliest known references to surgical care and specifically urological diseases, including urinary retention, hematuria, and bladder stones. The Ebers Papyrus, for example, contains over 700 medical prescriptions, with nearly 7% focused on urological conditions. Treatments included herbal remedies, dietary recommendations, and the use of mystical incantations to drive out disease-causing spirits. The Edwin Smith Papyrus focuses on surgical care—mostly traumatic injuries—and it provides rational, clinical observations in a case-based format. Together, these papyri reflect an empirical



Circumcision scene from the tomb of Ankh-ma-Hor Saqqara (Sakkara), Egypt, 2,500– 3,000 BC. Wellcome Collection

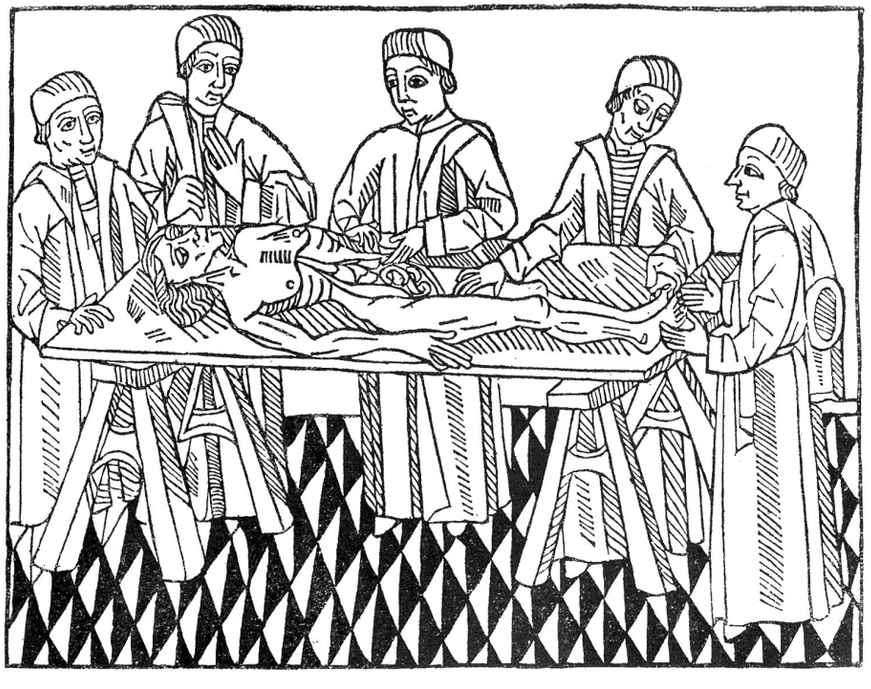
approach to medicine, where diagnosis and treatment were based on careful observation, and meticulous details were recorded.

The roles of physicians and priests were often intertwined in Ancient Egypt. Early medical education took place within specialized temples called *Houses of Life*, where male children of the upper class received general education and became literate. Following that, around perhaps the age of ten, the future physicians would assume an apprenticeship model whereby they would study medicine from an adult family member (5).

Greece

Greek medicine, particularly through the teachings of Hippocrates (circa 460-370 BCE) and his followers, played a pivotal role in the early understanding of urology. Although the advancement of medical science and education was bottlenecked due to cultural prohibitions against human dissection, Greek physicians made significant contributions to diagnostic methods, particularly through observation and classification of diseases (6). The Greek paradigm represented a significant shift toward empirical observation and natural, as opposed to supernatural, explanations for diseases.

The *Corpus Hippocraticum*, a body of texts attributed to Hippocrates, contains many references to urology, highlighting the importance of urine as a diagnostic tool. Hippocrates famously stated that "no other system or organ of the human body gives



Five Men at a Dissection Table, 1482. Wellcome Collection

us so much diagnostic information by its excretion as does the urinary tract," recognizing the wealth of information that could be gleaned from examining urine (7). In terms of urologic surgery, Hippocrates recognized the high risk of bladder surgery due to its associated morbidity and mortality. He advised against performing such procedures unless the physician was highly experienced, laying the groundwork for urology to emerge as a specialized field. This principle is famously memorialized in the Hippocratic Oath, wherein oath-takers are admonished to "not cut for the stone," but rather to refer those procedures to physicians who specialize in performing them.

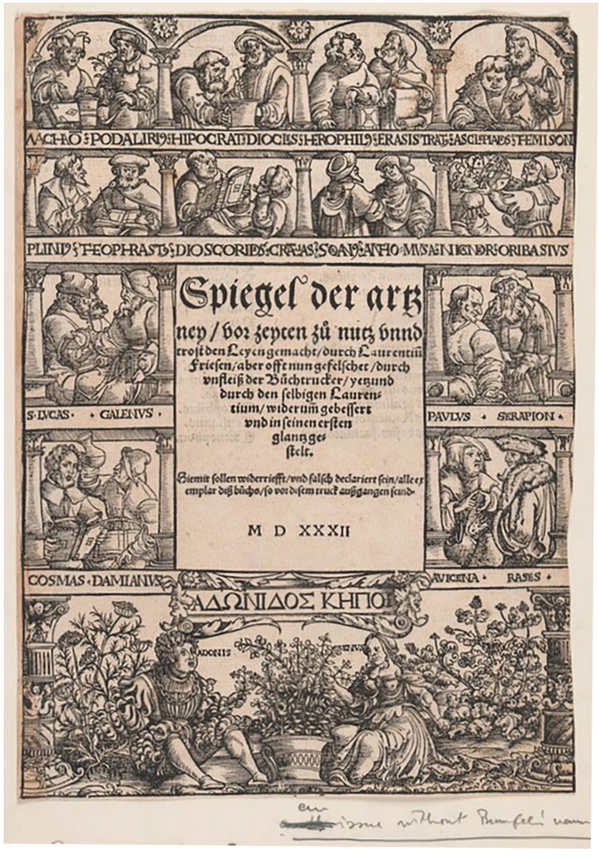
Anatomical knowledge in Greece saw significant advancement with the work of the physicians Herophilos (335-280 BCE) and Erasistratus (304-250 BCE) in Alexandria during the 3rd century BCE. These scholars performed dissections and vivisections of criminals, which provided them with a detailed understanding of the anatomy of the urinary system. This new knowledge significantly augmented the empirical, evidence-based Hippocratic paradigm which was already dominant in Greek medicine. Thereafter, Alexandria served as a hub of knowledge and medical training, attracting students and scholars from across the ancient world.

Early Greek medical education was centered at the temples of Asclepius, where priests facilitated healing through dream interpretation and rituals. Later, during the Hippocratic era, formal medical schools were founded in Greece that educated physicians using the *rational school of thought*. Following the rise of Alexandria as a renowned center of culture and learning, many physicians travelled there for advanced study in anatomy and physiology (8). Apprenticeships also played an important role in training beyond the confines of formal medical schools.

Rome

Ancient Roman medicine made a lasting impact on medical education through two major works: *De Medicina* (9) by Celsus (25 BCE-50 CE) and the collected writings of Galen (129-216 CE). While Roman medicine borrowed heavily from Greek knowledge, *De Medicina* was remarkable for its encyclopedic comprehensiveness—eight total books covering all aspects of medical knowledge including diet, pharmacology, and surgery—and for the fact that it was written in Latin, which enhanced its transmission and accessibility throughout the world in subsequent centuries.

The most prominent Roman figure of this era was Galen of Pergamon, whose contributions to anatomy, physiology, and urology shaped medical thinking for centuries. Galen's education began in the Greek temples of Asclepius and continued through apprenticeships in Alexandria and beyond. He emphasized a combination of theoretical knowledge and practical experience, advocating for direct observation and anatomic dissection as essential tools for learning. To circumvent cultural barriers restricting human dissection, Galen performed extensive studies of animal anatomy which he then applied to human medicine, albeit with some inaccuracies. He also spent time as a physician to gladiators, during which he gained extensive practical knowledge of surgery and anatomy. Galen's works, originally written in Greek, were widely adopted by the Byzantines, from there were translated into Arabic where they



Ancient herbalists and scholars of medicinal lore. Woodcut, 1532. Wellcome Collection

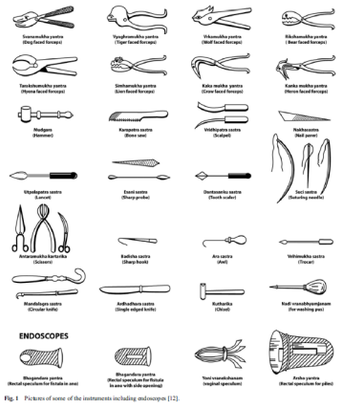
formed a cornerstone of ancient Arabic medicine, and ultimately returned to western medicine via Latin translations several hundred years later (10).

India

Evolving separately and in parallel to western medicine, ancient India produced one of the most sophisticated and detailed surgical texts from the ancient world: the *Sushruta Samhita* (circa 600 BCE). Attributed at least partially to the legendary Indian surgeon Sushruta, this text contained encyclopedic knowledge about anatomy, medical treatments, and surgical procedures and instrumentation. Sushruta even described in the text the details about how each of the 125 listed surgical instruments should be manufactured and maintained, including 28 varieties of urethral catheters and sounds.

Unlike in the Greek and Roman traditions, the dissection of human cadavers was not forbidden in India. Sushruta therefore emphasized the importance of dissection for the development of anatomical expertise. He also described several different early

"simulation models" (fruits, vegetables) that could be adequately used by students to learn and practice basic surgical skills. In the *Samhita*, Sushruta also documented stringent trainee selection criteria, an ethics oath, and an elaborate initiation ritual marking passage into medical apprenticeship.



Page from Sushruta's Samhitá, translator Bhishagratna, Kunja Lal, 1963.

Conclusion

The foundation of urologic knowledge and education during ancient times was a complex interplay of empirical observation, religion, and practical experience. Apprenticeship training was nearly ubiquitous across cultures. The use of human cadaveric dissection varied based on cultures and customs, but was typically limited, and this may have significantly slowed the speed of medical progress through the ages. The adoption of written records and shifts toward empirical, observation-based paradigms focused on understanding "natural" cases of disease (as opposed to super-natural). This greatly enhanced the ability of the field to progress and move forward. Practicing urologists today certainly benefit from the work done by our ancient predecessors.

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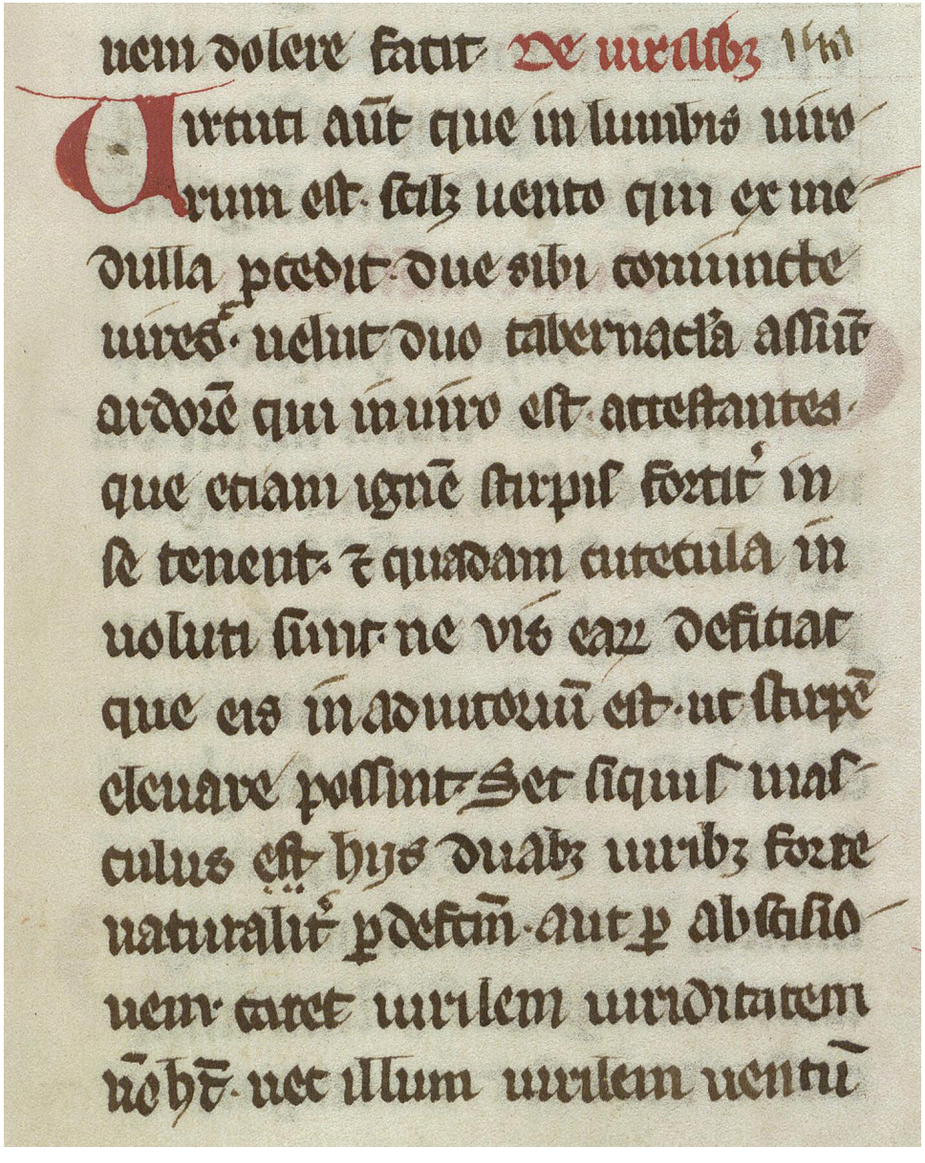

Figure 1. "On the Testicles". Hildegard of Bingen was a brilliant musician, philosopher, and health care provider in early 11th century Germany. Some of her medical writings were compiled in *Causes and Cure*s and include her theories on sex and anatomy, urinary difficulties and their treatment, "why there are two kidneys", and the above section, "devirilibs" or a section "on the testicles". The text reads: "For a strength in a man's loins, namely the wind which proceeds from the marrow, two testicles are present, like two tabernacles, attesting to the heat which is in the man; indeed they firmly hold the fire of the penis. They are enveloped in certain membrane lest their power fail, this assists them in *raising up the penis."* (Hildegard of Bingen, *Causes and Cures*, the complete English translation of *Hildegardis Causae et Curae*, translated from the Latin by Priscilla Throop, page 100, Medieval MS, Charlotte Vermont, 2006.)

Beacons of Light: Urologic Education in the Dark Ages

Dinora Murota,
John Phillips, MD

Introduction

A 'medieval education' may seem like an oxymoron, but physicians in the Dark Ages were less 'in the dark' than you may think. Centers for teaching included Chang'an (now Xi'an, China), the world's first formal medical school in the 7th century, Montpellier, France and its famed dissection laboratory, and the internationally renowned school at Salerno, Italy, which admitted medical students of any background or gender. Still, there was no easy exchange of ideas after the fall of Rome. Widespread print media did not exist, and scholars were wholly dependent on hand-written Arabic translations of works by the Greek scholar Galen, which perceived natural processes through archaic, 'inductive' thinking rather than the hypothesis-based deductive method associated with modern medicine. The medieval medical world was one of 'why' rather than of 'how' (1). Anatomic dissections were done merely to confirm what had been passed down from Galen rather than to test hypotheses and discover what was unknown (2).

The first AUA President, Ramon Guiteras (1858-1917), wrote that the medieval period was "a period of decadence of surgery when this art was relegated to the barbers while medicine was for the most part in the hands of the monks who disdained surgical operations" (3). Medieval European society adjusted to the downfall of Rome over several centuries and evolved into smaller spheres of fortified decentralization. Peoples' lives became dependent on strong, regional protectors ranging from feudal Lords to ecclesiastical sovereigns. The rise of city-states, international commerce, and enclosed urban spaces increased population densities but without public health works or sanitation. The population density of 14th century Paris, not even the largest city in Europe at the time, was 60,000 person/km^2, or triple today's rate. Pestilence and plague, including the Black Death, were constant, fearful reminders of mortality to the medieval mind. While there was an urgency to treat these and other common debilitating diseases, there was no understanding of their causes. The education of medical practitioners thus focused on what their patients needed, with few educational methods to learn more. Urology as a specialty did not exist in the Middle Ages, but urologic diseases, and the suffering they caused, certainly did. The predecessors of our current methods of urologic training and education may be found scattered in the shadows of that period. This chapter is devoted to their path into modern times.

What is so 'medieval' about the Medieval Age? The term "medieval" literally means "between ages," referring to the long period between the gradual fall of Rome and the crescendo of the Renaissance. Thus, the medieval period is generally regarded by historians as occurring between 500-1500 CE, almost wholly in reference to the history of Western Europe, and is itself divided into Early and High Periods, loosely termed the "*Dark Ages*" and the "*Late Period*." There were some persons of

Figure 2. Uroscopy wheel from *Epiphanic Medicorum* by Ulrich Pinder, 1506, of Nördlingen, Germany, depicting various colors of urine within flasks or 'matulas' and their Latin descriptions. The figure suggests that the green-smocked gentleman has brought a matula of urine to the physician who is now tasked with interpreting the urine's color, smell, and taste to diagnose the offending malady. To help, urologic educators provided the wheel to match the color of urine with the supposed standardized interpretation of the color, starting from the top or '12 o'clock' position, as follows:

1. Albus color ut aqua fontis - White as well water (i.e. clear)
2. Glaucus color ut cornu lucidum - Light blue/green/grey as lucid horn
3. Lacteus color ut serum lactis - Milky as whey of milk
4. Caropos color ut vellus cameli - Bluish-grey as camel skin
5. Subpallidus color ut succus carnis semicoctus non remisse - Slightly pale as a not-reduced juice of meat
6. Remissus pallidus ut succus carnis semicoctus remissi - Reduced pale as reduced juice of meat
7. Subcitrinus ut pomi subcitrini non remissus - Pale yellow as of a not reduced lemon
8. Citrinus color ut pomi citrini remissi - Yellow as of a reduced lemon
9. Subruffus color ut aurum remissum - Slightly ruddy as an alloy of gold
10. Ruffus ut aurum purum intensum - Ruddy as pure intense gold
11. Subrubicundus color ut crocus occidentalis - slightly red as western saffron
12. Rubeus ut crocus orientalis - Red as oriental saffron
13. Subrubicundus ut flamma ignis remissa - Slightly red as a lowered flame of fire
14. Rubicundus ut flamma ignis non remissa - Red as a flame of fire not lowered
15. Inops color ut epatis animalis - Wine-red as of animal liver
16. Kyanos color ut vinum bene nigrum - Deep blue as very dark wine
17. Viridis color ut caulis viridis - Green as green cabbage
18. Lividus color ut plumbum - Livid as lead
19. Niger ut incaustum - Black as ink
20. Niger ut cornu bene nigrum - Black as very dark horn

brilliance during this time, and they were often revered and celebrated by their students in a kind of hagiography and subculture of fanaticism. Hurriedly transcribed texts from lectures at schools of learning would be copied by hand and then recopied by students and scribes. These would then be translated into many languages in fragments and often with errors, so that the original authors, their teachings, clinics, patients, remedies, or surgeries cannot be confirmed with academic veracity. Nevertheless, the Medieval Age still shares many of the features of our current medical educational methods devoted to a hands-on, bedside approach to urologic diseases, a reliance on urologically active drugs, and nascent urologic surgery.

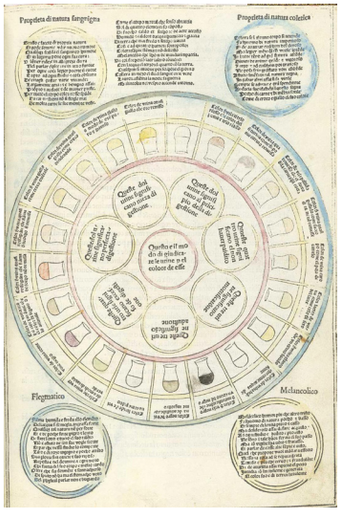

Figure 3. Uroscopy wheel and the four humors. Like Figure 1, the above woodcut displays the typical uroscopy wheel thought to be from a Venetian publication from 1491. The original text, *Fasciculus di Medicina*, was eventually owned by Johannes de Ketham, from whom the work is now known as the 'de Ketham'. There are visual similarities to the later work by Pinder but here the illustrator also wishes to provide to the reader descriptions of the personality types and characteristics as determined by the four humors: Sanguine, Bilious or 'Colic', Phlegmatic, and Black Bilious or 'Melancholic'. These designs ascribe to the medieval thinking that diseases and biology had a structural order and relationship akin to that of the movement of the celestial bodies.

Medical Education and Schools

Physicians and education in the medieval world changed little from what Aristotle had described in ancient Greece. Itinerant craftsmen, often illiterate and educated by practical experiences, taught their apprentices various herbal folk remedies and minor surgical skills. Learned laymen, however, obtained medical knowledge and, where required, a kind of acknowledged licensure, by studying medicine with other arts like Latin, theology, rhetoric, music, and poetry. Finally, there were the 'master' physicians who were trained in the few but famous university settings that dotted the world. 'Masters' had access to a sort of pedagogy, including lectures, medical writing, and dissections (4). The few texts available for learning were handwritten and often confined to the religious communities of monasteries, whose monks busily and lavishly transcribed the Arabic medical texts of Hunayn ibn Ishaq (809-873 CE) and Abū Bakr Muḥammad ibn Zakariyyāʾ al-Rāzī (865-925 CE) into Latin. Such texts were not available to the larger public. Constantine, the 'African' (c. 1020-1087 CE), a major figure at this time, was thought to have been the first to translate the extant writings of contemporary Arabic and Greek medical works into Latin. Constantine's translations were almost the sole source of anatomic knowledge in Europe for two centuries. The Mediterranean coastal cities, primed for commerce, enjoyed the exchange of intercultural ideas about medicine and nature that were lacking in the protectorates of middle Europe.

Few cities were as important in medical education as Salerno, Italy, where an important medical school began in the 11th century. It was in Salerno that Constantine

translated his first texts, and where medicine was taught in familiar disciplines like hygiene and surgery. In general, education was open to both genders. The famed 'Trota of Salerno' (c. 1040s-1097 CE) devoted her life to the care of women and wrote the earliest texts on female medical care which came to be known as the *Trotula* (although, like Homer, Trota in reality may have been many authors). Her efforts, and the efforts of her students who transcribed her teachings, appeared to be directed towards male physicians to improve their awareness of the unique anatomy and medical problems of their female patients. The most famous of the *Trotula*, which likely represented a small part of Trota's entire opus, is the *Practica secundum Trotam*, only rediscovered in 1995. The *Trotula* focuses on the care of gynecologic problems, such as dysmenorrhea, pelvic floor prolapse, obstetrical emergencies, and pelvic pain, but the works also cover testicular tumors, paraphimosis, bladder stone, and general urinary obstruction. In one text, Trota writes on urinary strain:

> *Both men and women suffer strangury. For men, we should proceed thus. We place cooked watercress on the pubic area and we put the patient in a decoction of the same. Women, indeed labor from this same affliction for whom we make a fumigation of Horsemint, catmint and pennyroyal. For both men and women, we should make a steam bath and place them in a water in which juniper, catmint, fleabane and horsemint, laurel leaves, pennyroyal, wormwood, and mugwort have been boiled and in the bath we give to them uncompounded hemlock. And thus the patient is freed even if she/he has a bladder stone because so long as it is not yet solidified, the patients purge through their urine as if little grains of sand were coming out. (5)*

Figure 4. From *Tractatus de Herbis*, around 1440, illustrating the modern concept that certain plant-derived pharmacologically active agents may alleviate a specific medical condition. The challenge to the medieval practitioner, however, was one of reproducibility. The plant has few standardized botanical descriptors, information on how the berries or gum is prepared, and, ultimately, for what urologic condition other than "for the man who has difficulty with passing the urine". (British Library, Sloan MS 4016.)

The use of these texts, while rudimentary and based solely on empiricism and Greek humoral medicine, does speak for a systematic method of urologic teaching that would be part of the more formal curriculum at Bologna (1088), Paris (1150), and Montpelier (1289). Gilles de Corbeil (1140-1224), a member of the Parisian school, wrote an important work on the critical nature of the pulse and of the color, diseases, and contents of urine in his 12th century text "*Carmina Medica*", a 355-line Latin poem based on his bedside observations and exams (6).

A major advance in urologic education was Holy Roman Emperor Frederick II's (1194-1250 CE) royal proclamation that cadaver-based gross anatomy be included in the curriculum of Sicilian medical schools as early as 1240. Slowly, the early medieval anatomists–such as at Salerno–using Galenic animal dis-

Figure 5. From Chirurgia, c 1180, the revolutionary medieval surgical text by the Italian Rogerius Frigardi (of Salerno), in which a visual table of contents is provided for the practitioner who will find details of operations for (top left to bottom right): malignant tumors of the breast, mastitis, penile laceration, penile malignancy, an unknown penile condition, and scrotal swelling due to hernia. (From the original text, Public Domain, British Library, Sloane MS 1977, folio 7v.)

sections, and the Arabists, who used texts instead of anatomic dissections themselves, were replaced by what we would identify as "*modern anatomy*." It was probably Mondino de Luzzi (1270-1326) and his 1316 magnum opus, *Anathomia corporis humani*, that most closely approached our modern concept of urologic dissection and demonstrated the anatomic changes associated with a bladder stone, 200 years before the more famous and modern works by Andreas Vesalius (7).

Monasteries and Hospices

Religious institutions were critically linked to medical care and education. While some medieval clerics viewed disease and plague as a sort of divine punishment, many monasteries and houses of worship were built to care for the sick. Paris' *Hotel Dieu* and the *Hospice de Beaune* provided philanthropic medical care without interruption for 500 years. Often the only places the poor and middle class could afford, such hospitals were staffed by nuns and monks who saw medical care as a form of

pious servitude. Several abbeys and orders arose throughout Europe expressly to care for the itinerant ill, pilgrims, and Crusaders on either leg of their journey. In 1198, Pope Innocent III was said to have begun the public health movement to ensure that nearly every city had a religious hospital throughout 12th-century Europe. In fact, one could argue that the sole advance of medieval medicine that persists today is the development of the hospital as a dedicated structure for the sick (8).

Figure 6. Operation for scrotal hernia in the head down (i.e. Trendelenberg) position, as per Rolandus Parmensis, a student of Rogerio, in his 13th century text *Medicina e Chirurgia*. (Courtesy, Biblioteca Casanatense, Rome Manuscript 1382 c.24V.)

Hildegard of Bingen (1098-1179), a polymath nun from the German Rhineland, wrote *Causae et Curae*, the textbook used by monastery-based caregivers, or *infirmaria*, for centuries (Figure 1). The work describes the interplay of religion, fate, and a medieval understanding of the world in managing diseases, including those of the urinary tract. Some of her concepts displayed an almost modernistic view of the interplay of various parts of the body towards a single function, as in this passage on erectile dysfunction:

> *For strength in a man's loin, namely the wind which proceeds from the marrow, two testicles are present, like two tabernacles, attesting to the heat which is in the man; indeed, they firmly hold the fire of the penis. They are enveloped in a certain membrane, lest their power fail. This assists them in raising up the penis. If any man lacks these two testicles, either by a natural defect or through castration, he does not have manly vital forces nor that virile wind which raises the penis to its strength. The penis is not able to become erect for the 'ploughing' of the woman as if it were soil. The penis lacks the wind of its powers, which ought to strengthen on its journey, a child. In the same way, a plow lacking its iron plowshare, is unable to dig the earth. (9)*

Uroscopy

The foundation for medical education in both the classroom and at the bedside may have been an examination of bodily fluids. Urine, stool, phlegm, and blood had been attractive media for study since the Egyptians, were championed by Hippocrates and the Greeks, and eventually became a basis for medical evaluation in the Dark Ages. Urine, in particular, was easily obtained in quantity and could be compared from patient to patient. More than 1,000 years after Galen, medieval uroscopists still sought to view the world through the balanced four 'humors' which Galen had proposed as the basis of normal health. Unbalanced humors allowed all diseases to occur. It followed, then, that people themselves tended to be of four personality types as they would be influenced by a predominant humor at any one time: sanguine, choleric,

phlegmatic, and melancholic (10). The practice of uroscopy was documented as early as practitioners could examine urine in a glass container. For medieval physicians, uroscopy was the basis for almost all diagnostic exercises and most tried to explain the cause of disease and the unbalanced humors in what they deemed a nearly "*divine fluid*" (11). The role of uroscopy in medical care was so critical that Cassiodorus wrote that "for a skilled physician, the pulsing of the veins reveals [to his fingers] the patient's ailment just as the appearance of urine indicates it to his eyes" (12). A kind of medieval interpretive pseudo-science evolved around the examination of urine. Its color, sediment, temperature, and even taste were used by the practitioner to divine any number of internal problems. The interpretation of the color of urine itself was famously preserved in the 1491 printing of the *Fasciculus Medicinae* by the Venetian brothers Johannes and Gregorius de Gregoriis and in the 1506 woodcuts by Ulrich Pinder (died c. 1519 CE) in his *Epiphanie Medicorum* (Figure 2). The glass container, the matula, was so widely used by medieval doctors that the flask became a symbol of the field, just as the stethoscope did for 20th-century medicine. For the first 80 years following its first publication, the cover of the *Journal of Urology*® displayed an 18th-century physician performing uroscopy, demonstrating that the examination of urine's color maintained popularity for centuries. However, uroscopy was wholly subjective, had no basis in physiology, and its teaching was a memorization of rules that made sense only to the medieval mind. Despite having no formal training in medicine, John Crophill (1322-1383) compiled a well-known methodology for uroscopy published in the 1400s. Female pioneers in uroscopy included Gueraula de Codines (1275-1340), who received a license to practice medicine in 14th-century Spain, and Jacqueline Felice, who practiced in 14th-century Paris. An unlearned, unlicensed, and often unpaid uroscopist, Felice so enraged the male medical establishment that she was banned through an infamous formal trial in 1322 and threatened with excommunication (13).

Drugs and Pharmacy

Few texts on botany and drugs were as influential in the medieval world as the *Canon of Medicine* by Avicenna in the early 11th century. Avicenna, or Ibn Sina (died 1037 CE), was a Persian physician-philosopher who published the handwritten work in Arabic in five books, largely based on his interpretation of Galen's theories of the four humors. Two of these books, the *Materia Medica* (book two) and book three on organ-based diseases, influenced practitioners for centuries and were some of the most important works translated into Latin for European consumption by Gerard of Cremona (1114-1187 CE). The development of drugs and their uses in Avicenna's *Canon* foreshadowed modern concepts such as pre-therapeutic testing, preparation quality,

Figure 7. Operation for bladder stone in the 'enhanced' lithotomy position, according to Celsus, and as described by Rogerius' student and scholar Rolandus Parmensis. (From *Medicina et Churgica*, printed 1201-1300, Manuscript number 1382 c.25R, Courtesy, Biblioteca Casanatense, Rome.)

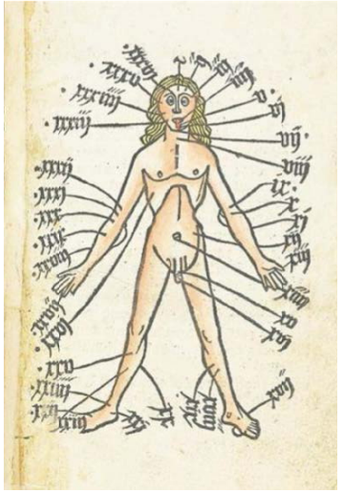

Figure 8. Bloodletting Man or 'Venenmännchen'. From the "German Almanac" by Hans Schönsperger the Elder, of Augsburg (1481-1520). Here, the illustrator has numbered which areas of the body should be used for bloodletting during which months and astrology signs, from numbers 1 - 36. A review of the original medieval text by the authors, however, indicates that the corresponding key to the numbering, especially for areas 15 and 16, the testes and penis, have been lost. (Harris Brisbane Dick Fund, 1926, Metropolitan Museum of Art, Public Domain, New York.)

and reproducibility. The effect of a particular drug, whether it be through drying or moisturizing, cooling or heating, was exploited to treat those diseases thought to occur through the same mechanism. Silicate of lime, for example, was considered a 'lithotriptic' drug as it "strikes against the petrified humor or substance (e.g. kidney stone), crushes it, and reduces it to small pieces" (14).

The teaching of *Materia Medica* in medieval society followed the simplistic tenets of Galen's imbalance of humors for centuries. Remedies designed to restore humoral balance were based on tradition, folklore, and a perceived effect of herbs and animal parts based on their appearance, smell, or taste. Rabbit brain, mixed with wine, appears to be a medieval Welsh approach to urinary obstruction or incontinence, while woodruff (a plant) and wine was a treatment for hematuria (15). However, the lack of standardized botanical and pharmacological methods, variation, and sheer chicanery produced a confusing array of approaches that further stymied medical care and education in the Dark Ages. In response, several medieval works were published to properly catalog the contemporary herbarium of medicines, including the *Tacuinum Sanitatis (Maintenance of Health)*. This marvelously illustrated book was largely based on the 11th-century Persian work, *Taqwīm as-Siḥḥa*, by the Arabic physician, Ibn Butlan (1001-1063 CE), who included guidelines for proper hygiene, diet, and domestic life. Here, readers could learn of the risks and benefits of commonly found herbs and vegetables, including chestnuts, gherkins, and cucumbers, which he notes can aid urination.

Sex itself was often cited for its health benefits to "preserve the species and calm the senses irritated by spermatic vapors" while those who had "cold and dry breath and are impotent" were warned to abstain from intercourse. Another work of the late Middle Ages was the *Tractatus de Herbis* which allowed practitioners to match the picture of an available herb with their supposed therapeutic benefit. The *Tractatus* thus permitted physicians of many regions, and consequently limited by language, to approach what could be a standardized, although non-scientific, approach to disease. Hyppurius (field horsetail) is quite clearly shown to be a cure for urinary and menstrual problems and an aphrodisiac, or at least that is suggested by an accompanying drawing of a couple mingling on a bench. An illustration from a 1440 printing pairs the image of a medieval gentleman urinating in a pot with two plants bearing paired, simple leaves and clusters of berries (Figure 4). The suggestion would be that the

plant, if identified and prepared properly, would thus provide the hoped-for benefit on urinary function.

Another aspect of medieval medicine, again derived from Galen, took on a strongly religious element in the so-called *Doctrine of Signatures* by early Renaissance physicians like Paracelsus. It was sometimes believed God caused disease but also provided the cure through designs in nature. Thus, medieval physicians were taught to use eyebright flowers to cure eye diseases and skullcap seeds for headaches. The mandrake sometimes resembles an anthropomorphic body of either gender and was long sought for the cure of infertility, impotence, and vitality.

One of the challenges of medieval scholarship is the lack of standardized anatomic, surgical, or, in some cases, botanical classifications of living processes. The description of an herb used for bladder stones in Persia, for example, may be misidentified as a similar-appearing but different herb in Europe or Asia. The same would be true in the preparation of drugs and compounds. Riddle et al., for example, evaluated two monastic recipes from the 9th century designed to improve the complaints related to the slowing of the urinary stream. The medieval recipes called for herbs that would stimulate diuresis, since knowledge of any underlying obstructive cause was lacking. The most common herb used for this purpose was aloe but, Riddle found, at widely differing doses, sometimes at several orders of magnitude, leading to preparative versions that might weaken an already tenuous rationale (16,17).

Surgery

The teaching of surgery in the Middle Ages was hindered by the lack of investigative science, effective anesthesia, aseptic technique, and a means of regulating its practitioners. Monastic medicine shunned surgical approaches to disease and may have hampered advances in the acute care of the wounded or injured for centuries. Still, medical texts do survive that were designed to provide practitioners with at least some approaches for common conditions including disorders of the skin, limb infections, and trauma. These works are also a testament to the diseases from which most people in this time routinely suffered including sexually transmitted diseases, communicable diseases, and accidents. One of the most important texts was a collection of lecture notes of a Rogerio Frugardi (1140-1195 CE) of Parma from his time at medical schools in Northern Italy (Figure 5). This work, known as the *Rogerino* and entitled *Practica Cirurgica*, appeared around 1200 CE. It was compiled, revised, and edited by Guido of Arezzo the Younger with help from many of Rogerio's students and elaborated upon by another of Rogerio's disciples, Rolando Parmensis, who merged his own additions into the text, creating a new and more popular edition (Figure 6). Textbooks at this time were not made from one source but often edited and transcribed by many others, with mistakes, misprints, and mispunctuation so that generations of subsequent scholars and practitioners inherited medieval errors.

In the text and wonderfully colored plates that have survived time, the *Rogerino* describes lithotomy in the Trendelenburg position, urinary catheterization, and operating for a bladder stone. Rogerio's (or Roland's) assessment of intestinal hernia demonstrates at least an awareness of the risk and danger inherent in the operation:

*If the intestines descend into the scrotum, first restore them to their proper place. If this cannot be done easily, clyster or purge, then apply mollifacients and replace the intestines as we have said. Having an assistant place a finger on the rupture while the physician cuts into the thin skin above the testicle (*pelliculum supra testiculum*). Having extracted the testicle [*from the peritoneum*], scrape the inguinal canal even to the top with an instrument (*giova*). If there is 'wind' in the canal, decompress internally (*remittatur interius*). Suture the top of the inguinal canal well with thread and bind with thread, leaving it, detached at each end it hangs inside and outside the suture. Placing the patient on a plank, burn the inguinal canal with cauteries three times, up to the thread. Then apply tow and egg and put the patient to bed for nine days, applying egg and oil as we have said. When the heat and thread are gone from the wound, after nine days, foment with water in which bears' paws (*branca ursina, an herb*), vitriol, absinth, etc. have been cooked. (18)*

Rogerio was no less specific with his operation for a bladder stone derived from the early Greek surgeon Celsus. The *Rogerino* describes the teaching of the operation for bladder stones in a manuscript from 1300, suggesting that this method had certainly been in practice since the second century. Celsus himself believed that the operation was too dangerous to perform on anyone other than a child, likely due to the troublesome bleeding encountered in those patients with a prostate gland. It was Rolando, rather than Rogerio himself, who appeared to expand Celsus' operation for stone to the adult population:

If there is a stone in the bladder, make sure of it as follows – have a strong person sit on a bench, his feet on a stool, and the patient sits on his lap, legs bound to the neck with bandage or steadied on the shoulders of the assistants. The physician stands before the patient and inserts fingers of his right hand into the anus, pressing with his left fist above the patient's pubic bones. With his fingers engaging the bladder from above, let him work over all of it. If he finds a hard firm pellet, it is a stone. Thus you will find what is impeding urination. If you want to extract the stone, precede it with light diet and fast for two days before hand. On the third day, having done everything beforehand to find whether there is a stone in the bladder, locate the stone, bring it to the neck of the bladder. There at the entrance, with two fingers above the anus, and incise lengthwise with an instrument and extract the stone (19, Figure 7).

Bloodletting

Bloodletting was commonly used in ancient Greece and Rome as a method to restore the imbalance of one or more of the four humors. This reliance on bloodletting was inherited by medieval practitioners without question, like all things Greek and Roman, but medieval physicians also depended on the seasons of the year to make clinical decisions about when and where bloodletting should occur. A prevailing philosophy throughout medieval Europe was that the heavens and its stars influenced health and, therefore, the dysregulation of the body's humors could be linked to some celestial event. Any attempt at re-balancing humors, therefore, had to take into account a

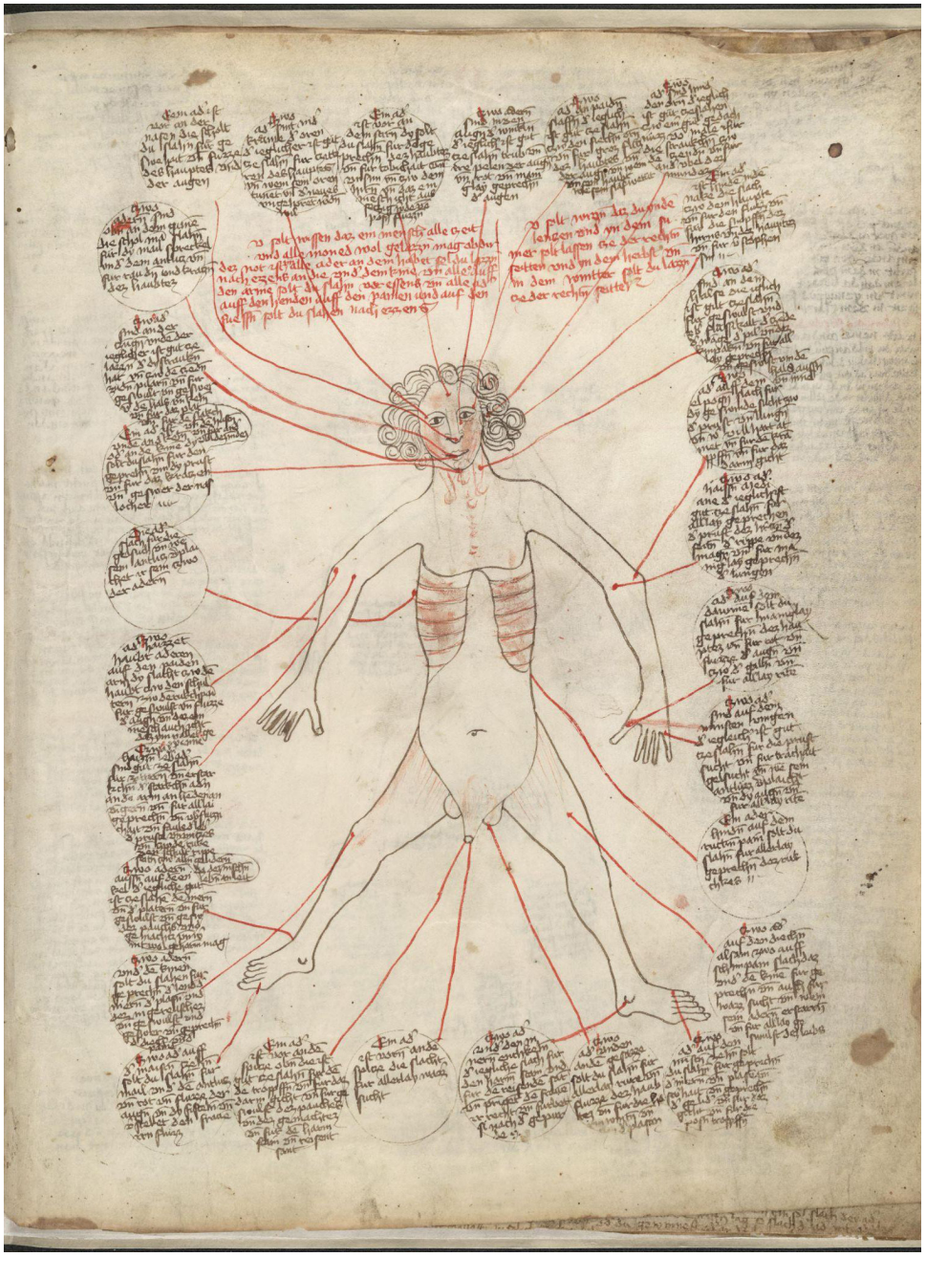

Figure 9. Bloodletting man, circa 1410, South Germany, illustrating preferred sites for venous incision including the diseases to be relieved with them. Unlike Figure 3, this version identified sites of puncture according to the disease to be treated, often reflecting the medieval thinking of drawing away unbalanced humors from the site of disease. (Lessing J. Rosenwald Collection, *Iatromathematisches Hausbuch*, Aderlassmann, Library of Congress, Ms. No. 4.)

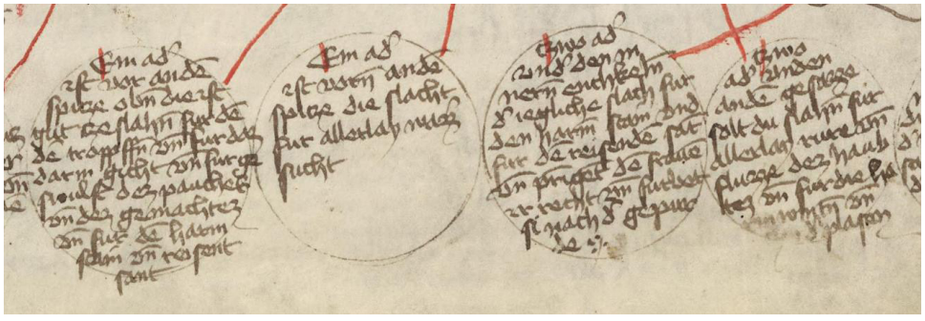

Figure 10. Phlebotomy of the genitalia. Magnified image of Figure 4, showing the instructional circles corresponding to bloodletting sites in the genitalia. Translations, from the old German, moving from far left circle to right: *A vein is on top at the front of the tip which is good to open against dropsy and against bowel arthritis and against a swelling of the belly and of the genitalia and against urine stones and painful / inflamed sand* (tiny urinary stones)"; *"Open the vein at the front of the tip* (of the penis) *for any form of dropsy"; "Two veins under the inner ankles, each of these open against the urinary tract stones and against the painful sand, they provide the women with their right and purge them after having given birth"* and far right circle, *"two veins low at the backside, these you should open against any form of rapid discharge* (diarrhea) *and rheumatism and against painful urine discharge* (strangury) *and towards the bladder.* (Translations courtesy of Rebecca Schleuß & Henrike Lähnemann, Oxford University.)

complex pseudo-science of astrological calculations and schedules. Bloodletting was viewed as a critical surgical technique to reestablish homeostasis, but it could only be performed during specific seasonal windows and religious observations (20).

Printed copies of sites for venous laceration were somewhat prevalent in the Middle Ages and were accompanied by instructions detailing what ailments would improve by bloodletting from each puncture site and, more importantly, when in the year such punctures should and should not be performed. So-called *Bloodletting Man* appears very similar to prevalent pictures of *Zodiac Man*, modern names given to these illustrations designed to educate and help the practitioner coordinate care throughout the solar cycles (Figure 8). It may be noted that the locations on the body for bloodletting appear arranged in a kind of radial algorithm beginning with venipuncture sites in the head and moving down the left side of the body to include the midline structures of the scrotum and penis, before moving on to the right side of the body to complete the circle. The spleen was thought to be associated with "cool" blood, so left-sided phlebotomy was favored for the cooler months; the warming effect of the liver, it followed, meant that bloodletting on the right side of the body was deferred to the warmer months.

Important to medieval phlebotomists was their concept of 'revulsion' in which blood could be diverted away from the source of the disease, thus relieving the malady. Renal diseases, such as stones (*reisent sant*) and renal abscess (*apostenata der nieren*), painful urination, and *geswulst der gemacht* or scrotal/testicular swelling were all urologic ailments that phlebotomy, in specific months and zodiac signs, might heal (21).

A major advance in medical education was the use of indicator lines whereby text is linked with an arrow to various parts of an illustration, a graphic method now

standardized today but revolutionary in the 1400s. In Figure 9, and translated from middle German for this chapter by Drs. Rebecca Schleuß and Henrike Lähnemann of Oxford University, an early 15th-century phlebotomist used indicator lines to connect surgical instructions and diseases to various parts of the body where the surgeon would make phlebotomy incisions. No part of the body appears to be excluded. The penis, scrotum, and buttocks appear to be targets for bloodletting for a variety of diseases, including those of the urinary tract, ascribing to the revulsion theory. Printed on animal parchment, artistic space would have been at a premium, and instructions within each circle might require shorthand or abbreviations, adding to the challenges of the translator. For example, the original middle or 'old' German:

> *Ein ad' ist uor an de' spice ob'n die is gut cze slah'n fur de troppff'n vn' fur daz darm gicht vn' fur geswulst dez pauches vn' dez gemachtez vn' fur de' harm stain vn' reisent sant.*

would be, in 'normalized' German:

> *Ein Ader ist vor an den Spitzen oben, die ist gut zu slahen für den Tropfen und für daz Darmgicht und für Geschwulst dez Bauches und des Gemächtez und für den Harnstein und reisent Sant.*

The English, thus, reveals a 1410 bloodletting approach for clinically significant nephrolithiasis as:

> *A vein is on top at the front of the tip* (of the penis) *which is good to open against dropsy, against bowel inflammation, against a swelling of the belly and of the backside, and against urine stones and painful sand.*

An indicator line in Figure 9 appears to point to the left testicle as well, but its translation reveals some of the challenges facing the artist using a two-dimensional diagram to illustrate a three-dimensional patient. The instructions pertain not to the left testicle but to the anal area:

> *Two veins* (are here) *low at the backside. These you should open against any form of rapid discharge* (probably diarrhea) *and rheumatism and against painful urine discharge and towards the bladder.*

It may be presumed that the reader would thus need to search the patient in hopes of finding the target vein in the backside that could be lanced to obtain the desired clinical results.

Summary

There is a large body of evidence that medieval practitioners recognized and tried to alleviate suffering from urologic disease. The popularity and veneration of successful teachers, medical schools, and celebrated texts point to the desire to learn from whatever source was available to them.

The medieval period, however, was also plagued by a devotion to archaic and useless methods of thinking about disease which today we may view as naive and ignorant of scientific principles. Countless hours may have been frittered away at copying and promulgating nonsensical astrological rules and properties of patient care into

incredibly detailed and artistically elegant texts that, in the best of hands, may have been as good as placebos. In some cases, bloodletting in painful and urologically sensitive areas, random uses of potentially dangerous plants, and unregulated and unwise surgical adventures were likely far worse than providing no care at all. Still, there were some beacons of light in the Dark Ages who were at least thinking about urologic education in a way that shares features of present-day medicine. Uroscopy tables and diagrams of celestial patterns and how they predict urinary disease are, in a way, a form of primitive nomograms. Teachers like Trota of Salerno, Hildegard of Bingen, Rogerio of Palermo, or Mondino of Bologna were immortalized in the few texts that were widely circulated, translated, and used for centuries to train doctors and surgeons throughout the Western world prior to the arrival of Vesalius. The teaching of uroscopy–using color-coded graphics of urine contained in glass matulas–could be viewed as a kind of standardized method to explain disease. Our contemporary minds might consider many medieval medical concepts as bordering on the ridiculous, but uroscopy remained popular well into the 20th century. Indeed, urinary color and clarity are still included in most modern urinalyses, and the 'uroscopy' of light, moderate, and heavy hematuria in continuous bladder irrigation, for example, carries significant clinical impact. Medieval medicine existed centuries before urology arose as a specialty but through rare texts, drawings, and educational schools, there was a flicker of urologic light in the Dark Ages.

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Theatrum Orbis Terrarum

From Cartography to Surgery: The Development of the Urologic Surgical Atlas

Sutchin R. Patel, MD
Ronald Rabinowitz, MD

Atlas, in Greek mythology, was a Titan condemned by Zeus to hold up the heavens for eternity. The Flemish geographer Gerard Mercator (1512-1594) was the first to use the term 'Atlas' as the title of a bound collection of maps (Figure 1). His *Atlas Sive Cosmographicae Meditationes de Fabrica Mundi et Fabricate Figura (Atlas or cosmographical meditations upon the creation of the universe and the universe as created)* was first published the year after his death (Figure 2). This defined the atlas as a collection of maps, bound in one or more volumes, whether or not augmented with text. Although individual maps had been drawn for millennia, it was the Flemish cosmographer Abraham Ortel (Ortelius) (1527-1598) who is credited with producing the first Atlas (Figure 3). In 1570, he published *Theatrum Orbis Terrarum (Theatre of the World)*, a book of a uniform collection of similar sized map sheets bound together with sustaining text. There were four versions of the first edition, and, at the time, it was the most expensive book ever printed. It continued to be published for 14 years after Ortelius's death, totaling 7,300 copies in 31 editions.

Figure 1: Flemish geographer Gerard Mercator (1512-1594). Wellcome Collection

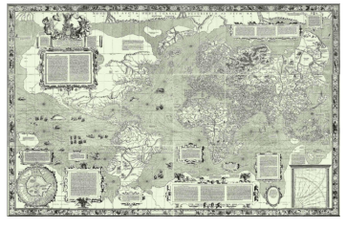

Figure 2: *Atlas Sive Cosmographicae Meditationes de Fabrica Mundi et Fabricate Figura.* Wikimedia

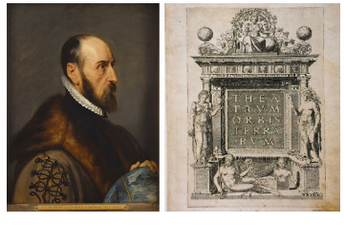

Figure 3: Abraham Ortelius (1512-1598). Wellcome Collection

Medical illustration created for instruction first appeared in Hellenic Alexandria during the 4th century BCE. Progress accelerated during the Renaissance with Leonardo da Vinci (1452-1519), the first medical illustrator in the contemporary sense (Figure 4). Da Vinci combined a scientific understanding of anatomy with great artistic skill. Andreas Vesalius (1514-1564) began his medical career by authoring and publishing his seven-volume *De Corpus Fabrica Humani (On the Fabric of the Human Body)*, the most well-known book of anatomy ever published (Figure 5). In the 19th century, new printing techniques allowed illustrators to work in a variety of media. Color printing was refined and became practical, helping usher in color atlases of pathology and colorful anatomy books for the public.

At the end of the 19th century Max Brödel (1870-1941) would single-handedly create and define the profession of medical illustration (Figure 6). He was hired at The Johns

Hopkins Hospital in 1894, where he illustrated an operative textbook of gynecology for Howard A. Kelly. Despite his many medical illustrations, Brödel's most significant legacy was the creation of the first school of medical illustration, the Department of Art as Applied to Medicine at Johns Hopkins University in 1911.

Figure 4: Leonardo da Vinci (1452-1519)

The evolution of anatomic and medical illustration played a large role in the eventual development of the surgical atlas. Surgical atlases, which would serve as teaching road maps to perform surgery, evolved from anatomy atlases and early textbooks of surgery.

One of the first surgical atlases published was *Traité complet de l'anatomie de l'homme (The Complete Atlas of Human Anatomy and Surgery)* by Jean-Baptiste Marc Bourgery (1797-1849), a French physician and anatomist (Figure 7). Bourgery began work on his atlas in 1830 with illustrator Nicolas Henri Jacob. The first volumes were published in 1831, but the entire work took nearly 20 years to complete (1854). Bourgery would write:

> *Because the technology of lithography today makes it possible to publish a substantial number of illustrated works without incurring too high costs, physicians would greatly benefit if they were given all the work involved in anatomy. However, to extract the most significant benefit from this kind of work, the medical expertise presented therein must not only be up-to-date but also presented in all its areas of application. ... First of all, the newly designed illustrations of such a work must be drawn from nature. (Vol 1, pp 1-2).*

Dr. Robert M. Zollinger (1903-1992), Dr. Elliot C. Cutler, (1888-1947) and illustrator Mildred Codding (1902-1991) first published *Atlas of Surgical Operations* in 1939 (Figure 8). The target audience of the Atlas of Surgical Operations was not only practicing surgeons and trainees, but also general practitioners who were still performing operations, despite the establishment of the American Board of Surgery certification in 1937. The atlas was inspired by the popular animal laboratory courses that had been organized by Drs. Cutler and Zollinger. The clarity of Codding's illustrations and the purposeful use of a distinctly large format with text facing the drawings made the book easy to read.

Incidentally, Drs. Zollinger, Cutler and Mildred Codding were all connected by their relationships to Dr. Harvey Cushing (1869-1939). Dr. Cutler trained under Dr. Cushing at the Peter Bent Brigham Hospital and served with him overseas during World War I. Dr. Zollinger was one of Dr. Cushing's last interns in Boston. In 1932, Dr. Cutler succeeded Dr. Cushing as chief of surgery and Moseley Professor at Harvard in Boston, MA. Codding attended Wellesley College, MA (1924) and after receiving a master's degree from Columbia University in New York, NY, she became a medical illustrator, studying under Max Brödel at The Johns Hopkins School of Medicine. There she became acquainted with Dr. Cushing, Brödel's longtime friend and colleague. Harvey

Cushing was a good artist in his own right and, despite the growing popularity of photography, he felt medical illustrations could still be a superior teaching medium.

The creation of surgical atlases has, in recent times, led us to question who the models for the anatomical illustrations were. Eduard Pernkopf (1888-1955), an ardent Nazi, created an anatomy atlas *(Pernkopf Topographic Anatomy of Man)* before and during World War II (Figure 9). His colleagues described him as an "ardent" National Socialist who, from 1938, wore a Nazi uniform to work every day (Figure 10). When he was made Dean of the medical school at the University of Vienna, he dismissed all the Jewish members of the faculty, including three Nobel laureates. In 1939, a new Third Reich law ensured the bodies of all executed prisoners were immediately sent to the nearest department of anatomy for research and teaching purposes. Dr. Sabine Hildebrandt from Harvard Medical School said that at least half of the 800 images in the atlas came from political prisoners including gay men, lesbians, gypsies, political dissidents and Jews. Significant questions have been raised about the ethics of using an atlas that illustrated dissections of cadavers that came from the bodies of hundreds of people murdered by the Nazis. Critics say the book is tainted by its dark past and scientists have grappled with the ethics involved in its use. Rabbi Jospeh Polak, a Holocaust survivor and professor of health law, believed the book to be a "moral enigma" because it was derived from "real evil, but can be used in the service of good." It was only in the 1990s that students and academics began to question who the people in the atlas were and, after its history was revealed, the atlas went out of publication in 1994.

Many of the first urology textbooks had sections describing early urological surgery. *Young's Practice of Urology* by Hugh Hampton Young and David M. Davis (1926) had chapters on the operation of the Kidney, Ureter, Bladder, Prostate, Seminal Vesicles, Scrotum and Scrotal Contents, Urethra, and Penis (Volume 2, Chapters 14-21, Figure 11). The text had over 1000 illustrations by William P. Didusch.

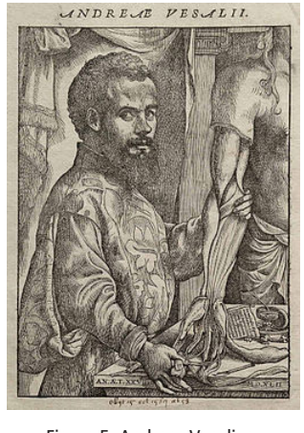

Figure 5: Andreas Vesalius (1514-1564)

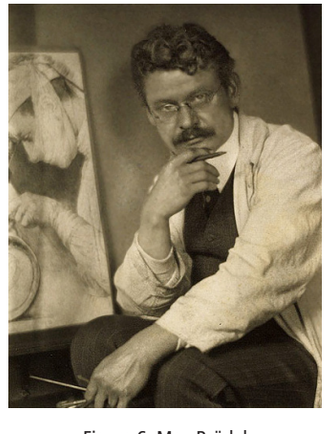

Figure 6: Max Brödel (1870-1941)

Figure 7: Jean-Baptiste Marc Bourgery (1797-1849)

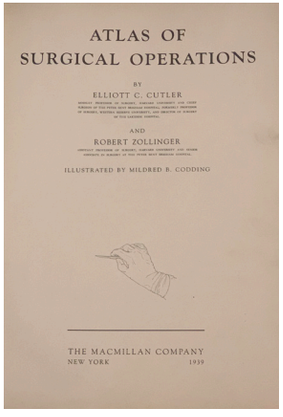

Figure 8: Zollinger Frontispiece

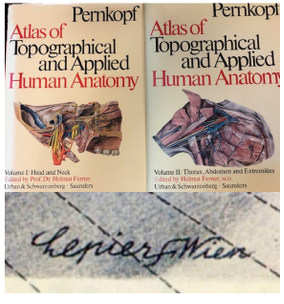

Figure 9 and 10: Pernkopf Atlas and Signature

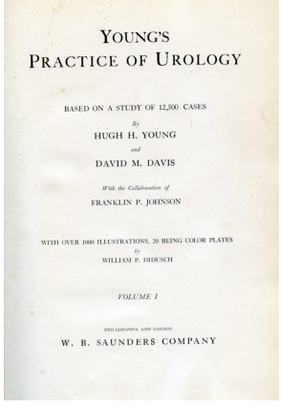

Figure 11: Young's Practice of Urology

William P. Didusch (1895-1981) studied under Max Brödel at the newly created medical art school at The Johns Hopkins Hospital (Figure 12). He became the medical illustrator for Hugh Hampton Young, MD, at Hopkins in 1915 and remained in the field of urology for his entire life. Didusch illustrated Dr. Young's major work, *The Practice of Urology,* the *Clinical Urology* textbook by Lowsley and Kirwin, *Transurethral Prostatectomy* by Nesbit and *A Retropubic Prostatectomy* by Beneventi. Didusch became the foremost illustrator of American urology.

Short surgical handbooks such as *Surgical Urology: Handbook of Operative Surgery* by Rubin H. Flocks and David Culp (1954) were the next evolution of educational tools used to help teach urological operations. Frank Hinman, Jr.'s *Atlas of Urologic Surgery* (1989) and *Atlas of Pediatric Urologic Surgery* (1994), both illustrated by Paul Stempen, served to become one of the most widely used atlases in urology (Figure 13). In the preface to the first edition of his atlas, Hinman wrote, "soon after completing residency training, I began to record with sketches and brief notations the techniques I was learning and teaching the residents… I intended to put together a 'how-to' atlas, modeled after that of my fourth-year surgery teachers, Cutler and Zollinger" (Figure 14). In describing the construction of his atlas he wrote, "I reviewed my sketches and post-operative notes made over the last 35 years. Current and classic publications were then consulted to be sure that each important step of every operation was covered… I described the operation step by step, just as I would tell you how to do it at the operating table, **cut here, suture here**. I hope the user won't take offense at this approach."

With changes in medical technology, surgical atlases have evolved to include atlases of cystoscopy (*Kystophotographischer Atlas* was the first atlas of cystoscopy published by Maximilian Carl-Friedrich Nitze (1848-1906) in 1894) and atlases of laparoscopic and robotic surgery (Figure 15). The next evolution in surgical teaching occurred with the creation of video libraries of surgeries often accompanied by narration.

Surgical atlases have served as teaching tools helping generations of surgeons prepare for the operation at hand. The evolution of these atlases reflects the dynamic relationship between technology, art and medicine.

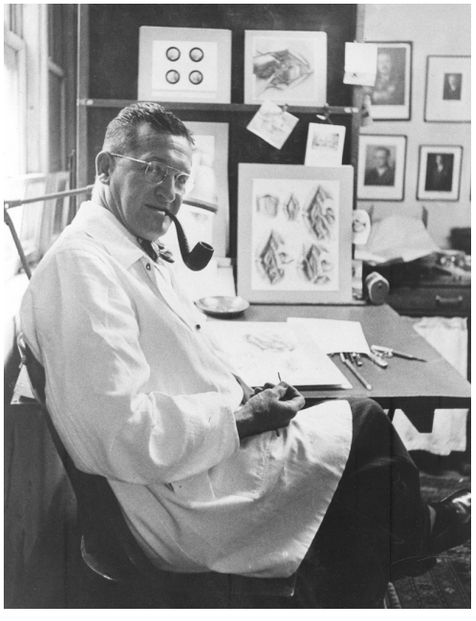

Figure 12: William P. Didusch

Figure 13: Frank Hinman Jr.

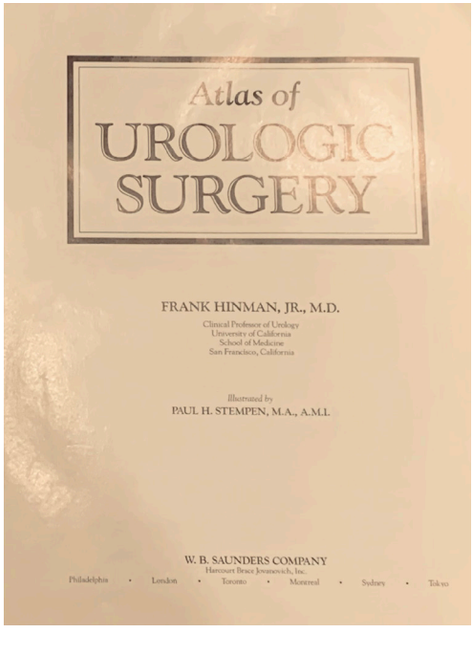

Figure 14: Hinman Atlas Frontispiece

Figure 15: Max Nitze (1848-1906)

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Figure Legend

Figure 1. Gerardus Mercator (1512-1594) [Wikimedia Commons] (left) and Title Page with Atlas supporting Globe in 1610 Edition of Mercator Atlas published by Jodocus Hondius (right)

Figure 2. Mercator's 1569 Map of the World [Wikimedia Commons]

Figure 3. Abraham Ortelius by Peter Paul Rubens [Wikimedia Commons] (left) and Title Page of 1570 Ortelius Atlas

Figure 4. Leonardo Da Vinci Self Portrait [Wikimedia Commons]

Figure 5. Andreas Vesalius from Fabrica De Corpus Humani [Wikimedia Commons]

Figure 6. Photograph of Max Brödel by Doris Ulmann

Figure 7. Jean-Baptiste Marc Bourgery (1797-1849) [Wikimedia Commons]

Figure 8. Atlas of Surgical Operations 1st Edition Frontispiece (1939) [Photograph by Sutchin Patel]

Figure 9. Pernkopf Atlas [Photograph by Ronald Rabinowitz]

Figure 10. Signature of Erich Lepier with Swastika in middle in Pernkopf Atlas

Figure 11. Hugh Hampton Young's Practice of Urology (1926) [Courtesy of the William P. Didusch Center of Urologic History]

Figure 12. William P. Didusch [Courtesy of the William P. Didusch Center of Urologic History]

Figure 13. Frank Hinman Jr. (1915-2011) [Courtesy of the William P. Didusch Center of Urologic History]

Figure 14. Hinman's Atlas of Urologic Surgery 1st Edition Frontispiece with Illustration of Frank Hinman Jr. working with Paul Stempen illustrating the text on inside cover [Photograph by Sutchin Patel]

Figure 15. Maximilian Carl-Friedrich Nitze (1848-1946) [Courtesy of the William P. Didusch Center of Urologic History]

Flayed cadaver holding his skin. Juan Valverde de Amusco, Anatomia del Corpo Humano, 1559
National Library of Medicine

The Dead Teaching the Living: A History of Corpses in Surgical Education

Connor Hartzell, MD
Jennifer B. Gordetsky, MD

Introduction

The evolution of medical and surgical education is intricately connected to the study of anatomy, which has traditionally relied on the study of the deceased. The study of human anatomy is ancient with classic examples dating back to the teachings of Galen. With the rise of universities in Europe in the Middle Ages came the organized study of anatomy. Medical knowledge regarding the structure and function of the human body saw its first advance in hundreds of years. The principle behind anatomic studies was basic and permeates to modern times: studying the normal appearance of the human body could allow for understanding of normal function and studying the abnormal could allow for understanding of the pathology of disease. Over time, physicians came to utilize dissections as a critical tool in medical and surgical education. Cadavers along with autopsies helped physicians connect gross physical findings to normal function and to the cause of disease. However, the study of human anatomy historically relied on being able to have subjects to study. The acquisition and dissection of human remains met with strong resistance at different times throughout history. There has been both the acknowledgement of the benefit of studying deceased human subjects, as well as ethical concerns and social backlash. In modern times, the use of cadavers in medical and surgical education continues to hold value. Herein, we explore the history of using human remains in medical education as it relates to the evolution of medicine and surgery in Europe and America.

Results

The study of human anatomy dates back to the 11th century when a school of medicine based on common sense and observation emerged in Salerno, giving rise to a new era of medicine in Europe (1). The development of universities in the 13th century, such as the School of Bologna, brought a renewal of the study of anatomy and medical knowledge regarding the structure and function of the human body. The principle behind anatomic studies was basic and permeates to modern times: studying the normal appearance of the human body allows for the understanding of normal function and studying the abnormal allows for the understanding of the pathology of disease. Thus, dating back to the Middle Ages in Bologna, cases of homicide underwent autopsy by doctors from the university (1). In 1543, Andreas Vesalius published the first complete textbook of human anatomy *De Humani Corporis Fabrica* (1,2). But, dissections were not common even well into the 16th century. At Montpellier between 1552 and 1557, only 11 dissections were documented (3). It was simply challenging to acquire subjects. Physician Felix Plater records three body-snatching expeditions in his autobiography (3). Similarly, Vesalius and his students procured bodies by stealing human remains from the gallows and cemeteries of Paris

Bartolomeo Eustachi, Tabulae Anatomicae, 1714 Anatomical theater dissection; a surgeon examines the cadaver; several men observing. Wikimedia

(1). Anatomical studies continued into the 16th century, with famous seminars occurring at places like Leyden University and Padua. The study of anatomy and experimental medicine led to William Harvey's (1578-1657) landmark discoveries regarding the circulatory system (2). It was also the study of anatomy that created the platform for the advancement of surgery. John Hunter (1728-1793), a famous anatomist and surgeon, used anatomic experimentation and dissection to improve surgical techniques (1, 4). Through the 1800s, medical education in Europe continued to advance by knowledge and experience gained through anatomic dissections and autopsies in renowned institutions in Paris, London, and Edinburgh. As medical schools opened in America—Philadelphia in 1765 and New York in 1768 —the tradition of anatomical studies in medical education was brought from Europe's medical institutions to the New World. Dr. William Welch, who became Chief Pathologist at The Johns Hopkins Hospital in 1885 (1), taught scientific medicine and experimental research. Both students and house surgeons attended Welch's autopsies. His seminars became part of the core curriculum at Hopkins and influenced medical education standards at other institutions in America.

Although physicians came to use dissections as a critical tool in medical and surgical education, the acquisition and dissection of human remains met with strong resistance throughout history. During the Crusades, the Church was positioned against human dissection. In 1300, Pope Boniface VIII issued a proclamation against cutting up dead bodies (1). This did not stop dissections and autopsies from occurring in European schools of medicine in the Middle Ages and Renaissance, but it came with

risks. Michael Servetus (1509-1553), a Spanish physician and anatomist, was buried alive in Geneva with his own books (1). In the New World, William Shippen, MD, (1712-1801), Professor of Anatomy at Philadelphia's College of Physick, was accused of grave robbing and attacked by a mob for showing specimens from human dissections (1). On April 13, 1788, a riot broke out when a dissection by Dr. Richard Bayle was witnessed in the laboratory of the Hospital Society in New York (2). The anatomical collection was burned by the angry citizens, and seven people died in the riot. This led to a change in New York state law to allow executed persons to be legally dissected. Still, anatomic specimens remained difficult to obtain throughout the 19th century (2). Graverobbing remained so common that grave watchers were hired to protect the bodies of the recently deceased. More nefarious methods also occurred. William Hare and William Burke murdered 16 people in 1828 and sold their cadavers to Robert Knox in Edinburgh, Scotland (2). The heads had all been removed to try to hide their identities as murder victims. Burke was executed by hanging and then dissected. His skeleton was placed on display at Edinburgh Anatomical Museum.

Americans' distaste for modifying the dead persisted until the Civil War. It took many days to return fallen soldiers to their families. Maintaining them in an acceptable state required embalming, a relatively new technology. Following his assassination, President Abraham Lincoln's corpse was autopsied, embalmed, and sent on a multi-week tour through the Union (5). In his book *The Sacred Remains: American Attitudes Towards Death 1799-1883*, historian Gary Laderman writes, "In the span of roughly five years, embalming was transformed from a practice almost exclusive to the emerging professional medical field—peripheral to the public arena and resisted by northern Protestants—to an accepted, highly visible, and desired treatment for the dead." Embalming radically changed Americans' views on death and laid the groundwork for dissection programs.

At the turn of the century, medical science was advancing rapidly, and the demand to train physicians rose dramatically. With this, came a need of cadavers for gross anatomy and surgical education. In the first half of the century, medical schools acquired many unclaimed bodies from prisons, state asylums, and those who were buried at the cost of the state (6, 7). Willful donation was not common until the 1950s. By then, the funeral home industry was well established and very profitable. Upon discovering how expensive modern funerals were, many families chose instead to donate their loved ones' bodies to science. Once the public became more accepting of body donation, medical schools formed willed donor programs. By the midcentury, the modern channels used to acquire bodies had formed, and today, most cadavers in the United States are obtained through donation. The latter half of the 20th century would see the development of the ethico-legal landscape of cadaver acquisition (6).

In the 1950s, there was increasing interest in the therapeutic value of bodies, especially surrounding the burgeoning field of organ transplantation. Complicating the matter was the commercial interest that came along with the advancement in organ transplantation. The patchwork of state statutes and common law regulating body donation was underprepared to adequately regulate the use of corpses. Standardized rules were needed to prevent unsavory use of cadavers, preserve the sanctity of the

Figure 1: Vanderbilt University School of Medicine Medical Gross Anatomy Lab.
Picture provided with permission by Dr. Anna Edmondson

body, and fulfill the wishes of the deceased (8). This came to a head with the first successful heart transplantation in 1967 (9). Physicians, lawmakers, and the public quickly realized the value of organs in the perimortem state. A concerted effort to govern their use was quickly undertaken and resulted in the passing of the Uniform Anatomical Gift Act (UAGA) of 1968 by the American Bar Association (8). The UAGA provided legislation that states could use to allay the concerns surrounding anatomic gifts, including whole body donation. It was rapidly adopted by all 50 states and the District of Columbia. The main points of the UAGA are to 1) establish a right to donate; 2) designate who can authorize and receive anatomic gifts; 3) describe how the gifts are authorized and revoked; and 4) describe for what purpose the gifts can be made (10). Amendments were made in 1987 and 2006, although they were not as widely adopted (8).

In present times, around 12,000 cadavers are donated each year to American educational institutions (11). A recent study surveyed 72 university-affiliated body donation programs across 38 states. Most have existed between 5-120 years. Annually, programs each receive an average of 408 donation applications (range 5-5000), of which an average of 172 are accepted (range 5-1500). Of registered donors, 86.5% are white, 6.5% are black or African American, 3% are Asian, 2.5% are Hispanic, 0.5% are Native Hawaiian or Pacific Islander, 0.2% are American Indian or Alaskan Native, and 0.9% are of another race. Most programs have minimum age and maximum body mass index requirements, and most cover the costs associated with donation (11). At these authors' institution, Vanderbilt University Medical Center, the Anatomical Donation Program (VUMC ADP) is built exclusively on self-donated bodies from the state of Tennessee. Participants of sound mind and body must willingly agree to donate their bodies before they pass. Next-of-kin and/or guardians cannot authorize the donation of their relatives' bodies, unlike 48% of other donation programs (11).

Approximately 15% of donors will participate in undergraduate medical gross anatomy (Figure 1) while the remainder take part in postgraduate training courses that practice surgical procedures, intubation, and more. When their service is complete, the donors are cremated and returned to the families. An annual memorial service honors them.

Discussion

A real cadaver will always be invaluable to medical education. Indeed, the modern understanding of hypertension is rooted in autopsy findings of concomitant cardiomegaly and renal artery stenosis (12). Autopsy studies are crucial to resident physician training programs. Photography of genitourinary organs in autopsy cases is a standard practice at our institution (Figure 2) to document gross evidence of anatomical abnormalities. In addition to showing gross pathology, the anatomy laboratory also allows the showcasing of normal anatomic variation between bodies that simulations cannot. Moreover, bodies teach some physical skills that models and textbooks cannot, such as the tactile feedback crucial to the development of surgical and procedural skills. For example, in a 2018 study examining the effectiveness of training urology residents on fresh-frozen cadavers in robotic surgery, participants (N=22) scored their median overall improvement following the training as a 5 on a Likert scale (interquartile range (IQR) of 4-5; where 1 was "very poor" and 5 was "excellent"). Notably, when asked if using a cadaver was superior to a simulation, nearly all residents answered, "absolutely yes" (median 5; IQR 5-5; where 1 was "not at all" and 5 was "absolutely yes") (13). A 2015 study surveyed urologic trainees and new attendings (N=81) in cadaver use for training in a wide variety of non-robotic urologic procedures and surgeries (14). Participants rated cadavers as the best training model (mean 4.26 on Likert scale of 1 – 5, where 1 was least and 5 was most recommended) compared to live animal simulations, animal tissue, bench-top models, and virtual reality. Cadaver tissue quality, evaluated by ease of manipulation, definition of tissue layers, and dissection ability, was ranked highly. Importantly, all participants (mean = 4.38) and their overseeing faculty (N = 27, mean = 4.29) agreed that incorporating cadaver training into residency was quite feasible (14). Lastly, exposure to cadavers early in medical school helps students develop the respect and professionalism skills needed to compassionately care for patients. This is possible, in part, due to American society's deep reverence for the dead (5).

The UAGA was adopted with the understanding that the use of bodies for medical education need not interfere with the sanctity of the deceased. It intended to simplify the process of donating one's body, and thereby encourage it, without encroaching on those who were not interested (10). Foundational to this was a robust provision of consent, either by the person donating or by a next-of-kin. The UAGA paved the way for the establishment of modern willed donor programs at most American medical schools today.

A major criticism of the UAGA was that it did not address the controversies of unclaimed bodies (8). Unclaimed bodies are those not accepted by a next-of-kin for burial or cremation and put into the care of the state. They cannot, by definition, give

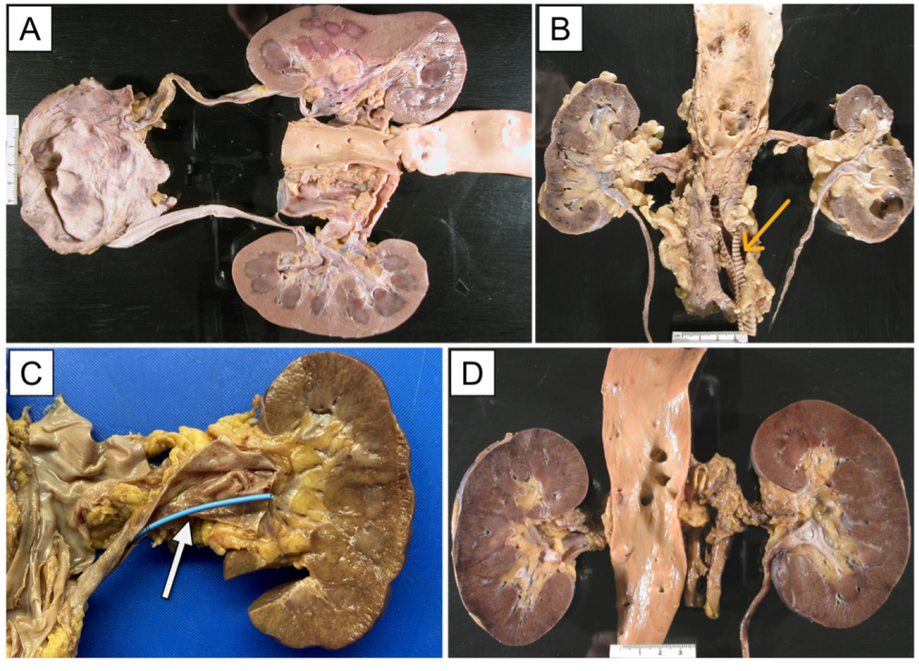

Figure 2: Genitourinary organs photographed during autopsy studies. A) This formalin-fixed collecting system demonstrates renal cortical pallor and mild cystic wall hemorrhage. B) An aortic graft is present in this specimen (see arrow), which also features moderate aortic atherosclerosis, right renal atrophy, cyst, and hydroureter. C) This specimen shows a ureteral stent emerging into the renal pelvis (gray arrow). Two sections for histopathologic analysis have been taken. D) The aortic wall of this specimen is without atherosclerotic change. The renal corticomedullary junction is poorly defined.

consent for their use in medical education. Nevertheless, most states these days permit their use, and some medical schools accept donations of unclaimed bodies (15). One recent study even found that use of unclaimed bodies is increasing in Texas medical schools (16). Proponents suggest that their use in students' learning outweighs the moral concern of lacking consent (15). Finding issue with using unclaimed bodies is, perhaps, in part, a Western cultural custom, as some countries like Qatar rely exclusively on unclaimed bodies for anatomy courses (17). To this day, major disagreements over the use of unclaimed bodies in medical education persist.

The subject of payment for bodies was not addressed until the 1987 revision of the UAGA (18). It prohibited the sale or purchase of body parts for the purposes of therapy or transplantation. Thirteen states adopted the revision, and Congress later prohibited the interstate sale of body parts for these purposes (8). This prevented the creation of a market for transplantable human organs. Otherwise, there is little federal law on the sale of human remains, and only a handful of states explicitly prohibit it (19). The consequences of the lack of regulation can be seen in the recent body-part-selling scandal by the morgue manager of an American medical school. He

was charged in federal court with illegal interstate transport of stolen goods, rather than the sale of human remains (20).

While much progress has been made in the ethical use of bodies, parts of the practice arguably remain in a gray area. For example, the widow of a recently deceased donor learned that after his body was donated to the Biological Resource Center in Phoenix, Arizona, it was sold to the Department of Defense for explosives testing (21). Zealley *et al.* studied 110 body donation forms from educational institutions in 46 states and found that while 77% stated that bodies may be used for research, only 2% listed examples of the research. Only 46% stated that bodies may be transferred to an outside institution if a greater need exists. The authors argue that donation forms should be more detailed and suggests they follow recommendations published by anatomical societies like the American Association of Clinical Anatomists (22). To resolve some of the ambiguity surrounding body use, a bipartisan bill was introduced to Congress in June 2023. It requires entities that acquire and sell bodies for a profit to register with the Department of Health and Human Services. It proposes enhanced tracking of donated bodies with record keeping, labeling, packaging, and disposition requirements as well as greater transparency over how the bodies are used (23). As of December 2024, this bill has yet to be voted on by the legislature.

To maintain the highest ethical and legal standards, the VUMC ADP has strict protocols for accepting bodies for donation. Donors are solicited through word-of-mouth, community presentations, and media on celebration-of-life events. Most professions and socioeconomic classes are represented, with approximately 15% coming from teaching and medical careers. The donors themselves must have provided consent at least 30 days before passing and must have passed within Tennessee. After embalming, cadavers are kept at VUMC for three to 36 months while they participate

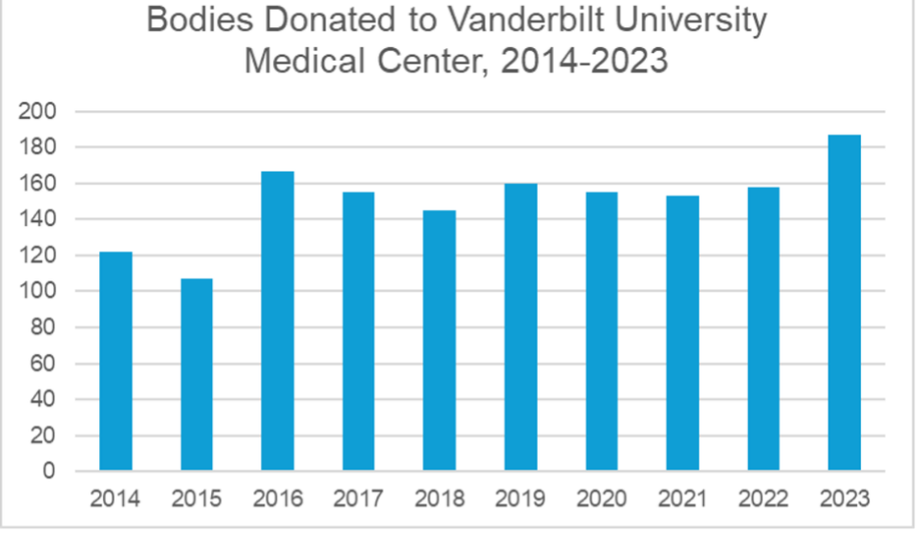

Figure 3: Bodies donated to Vanderbilt University Medical Center's Anatomic Donation Program, 2014-2023

in classes before being cremated and either returned to the next-of-kin or buried in a VUMC-owned plot. In the last decade, the yearly donation number has increased from 122 to 187 (Figure 3). An internal audit conducted following the previously mentioned body-part-selling incident revealed no significant findings of concern. Importantly, available historical records dating back to 1925 did not note any purchases of bodies.

Looking to the future, one question to consider is how new technologies will integrate with the use of bodies in medical education. The coronavirus 2019 (COVID-19) pandemic prompted many schools to teach anatomy using new tools such as virtual and augmented reality, high quality plastic models, and more (24). Some schools, such as New York University's Long Island campus have moved to a completely electronic curriculum (25). Because they do not use cadavers, these methods simplify many of the ethical and legal challenges described previously. However, it is unknown if these methods provide the same educational quality as donated bodies. There is data suggesting that virtual learning is non-inferior; however, it was acquired during the tumult of COVID-19 and was likely affected by confounders (26). Moreover, virtual models cannot provide the tactile feedback that cadavers can. They cannot act as a student's "first patient" and teach lessons of respect and reverence for the dead. These are crucial in developing humanistic and empathetic physicians.

The tradition of using bodies in medical education is rich and has evolved from nefarious beginnings to an ethical modern era that strives for accountability. With the introduction of new and exciting technologies and progress in the moral-legal realm, the future of corpses in medical education is bright.

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Muscle Man wax figure, Felice Fontana, 1767/1800. Vienna, Josephinum, Collections of the Medical University of Vienna

Education in Wax and Models: Roots in the History of Urology

Friedrich Moll, MD

Wax has been used since ancient times by Egyptians, Greeks, Etruscans and Romans to create religious figurines (*votives*). The closing days of the Roman Saturnalia were known as *sigillaria*, due to the custom of making, towards the end of the festival, presents of wax models of fruits and waxen statuettes which were fashioned by the Sigillarii, skilled practitioners of this art (1). These devotional objects were made from white Smyrna or Venice wax mixed with Chinese or plant waxes, mastic (Greek: μαστίχαm a resin from Pistacia lentiscus, known as tears of Chios) (2), tallow, turpentine, and different fats to increase the melting point and elasticity. Once melted, the wax was mixed with finely ground and pre-filtered pigments of body-part-specific color dissolved in turpentine. Layers of wax were then poured into a plaster cast previously moistened with warm water and soft soap to facilitate the detachment of the cured wax. Often the mixture of an individual sculptor could not be traced back.

Up to now, research studies on urologic wax models are lacking either due to underrepresentation in academic collections (in the United States, for example, in Boston, Chicago, New Orleans, Philadelphia, Washington) (3) with the exception of sexually transmitted diseases (STDs), or little interest in other fields of cultural studies (e g. folklore studies concerning the question of "dime museums", "anatomy museums" or "panopticons"). These institutions served educational purposes for the general public by providing entertainment and education ("edutainment") and were accessible to larger parts of society than elite museums. The institutions brought together components of natural history and art museums, freak shows and performances. Health and sexuality were always part of the topics displayed (4,5).

So-called *moulages (casts or impressions)* were long used as aids in medical education, and were in common use in Europe and the US between 1850 and 1950, when they were produced in great numbers by specialized sculptors, such as Jules Baretta, Paris (1824-1923), Marcus Sommer, Sonnenberg (1845-1899), Friedrich Ziegler (1850-1920), Auguste Kaltschmidt, Bonn (1873-?), Hermann Hessling, Bonn (1876-1944), Alfons Kröner, Breslau (?-1937), Otto Vogelbacher, Freiburg (1869-1943), Fritz Kolbow, Berlin (1873-1946), Lotte Volger, Zuerich (1883-1956), Adolf Fleischmann 1892-1968, Zürich (6) and later on by companies as *Deutsches Hygienemuseum-Dresden*, SomSo or others (7).

These days, we can find a renaissance in using these tools at universities in Europe and the United States, where they have survived (8). Moulages passed from local use to international acceptance when medical specialties and scientific communication increased, and today when we learn again about the advantages of these special museum artifacts and specimens in teaching (9).

The origin of making moulages goes back to *anatomica plastica*, the modelling of the normal organs and structures of the human body in wax. Written in 1552 and printed

in 1714, the *Tabulae anatomicae* of Bartolomeo Eustachius prompted Pope Benedict XIV (1675-1758) to create a Museum of Anatomy in Bologna for which sculptor Ercole Lelli (1702-1766) constructed eight anatomic models of the whole human body. It was in Italy where this art of "ceroplastic" came into greater use in science and art to produce anatomical models in the 17th and 18th century.

As early as 1672, the Dutch biologist Jan Swammerdam (1737-1680) demonstrated his method for injecting wax into the veins of corpses in order to preserve the blood vessel system.

The Rise and Popularization of the Art

Felice Fontana (1730-1805), founder of the Florentine Museum of Physics and Natural History *(Reale Museo di Fisica e Storia Naturale)*, inaugurated and helped make cadaveric specimens into wax models for teaching anatomy to physicians and the general public. This combined several traditions: medical illustration, the modelling of religious icons in wax and the production of colored wax busts (10,11). There was close collaboration between anatomists, who performed careful dissections following the drawings of anatomical treatises, and modelers who then produced the wax specimens (Figure 1).

Enthused by these Florentine wax models commissioned by his brother (the Grand Duke of Tuscany and later Emperor Leopold II from 1847-1792), Joseph II (1741-1790) of Austria ordered a total of 1,192 models at a price of 30,000 Guilders (12) for the newly founded academy in Vienna *(Römische Kaiserliche Josephinische Medicinische-Chirurgische Academie Wien)* later called *the Josephinum*. The creators of the anatomical models were artistically talented anatomists, physiologists and historians of science, working under the direction of Paolo Mascagni (1752-1815), who was also famed for his research into the lymphatic system (13). Within the collection there are also some rare artifacts depicting the penis (14).

One of the first artists (called *mouleur*) dedicated to models relevance in urology and the connected topic of STDs was Franz Heinrich Martens (1778-1805), private lecturer at the University of Jena. According to German writer Johann Wolfgang Goethe, Martens could create "exceptional pathologic curiosities, especially syphilitic ailments in coloured wax with high precision" (15,16,17). The idea for a Berlin school of medical wax modelling was first proposed by Goethe, who had visited the anatomical wax collections in Florence and believed that students of medicine could learn more from recreating the human form than from cutting open dead bodies. He wrote:

Construction is more instructive than destruction, building more than separating, bringing what is dead to life more than further killing what has already been killed.

(Wilhelm Meister's Travels, 18,19)

From the beginning of the nineteenth century, wax models and moulages were used in the evolving medical specialties such as dermatology and urology, providing a new model of visualization in natural sciences.

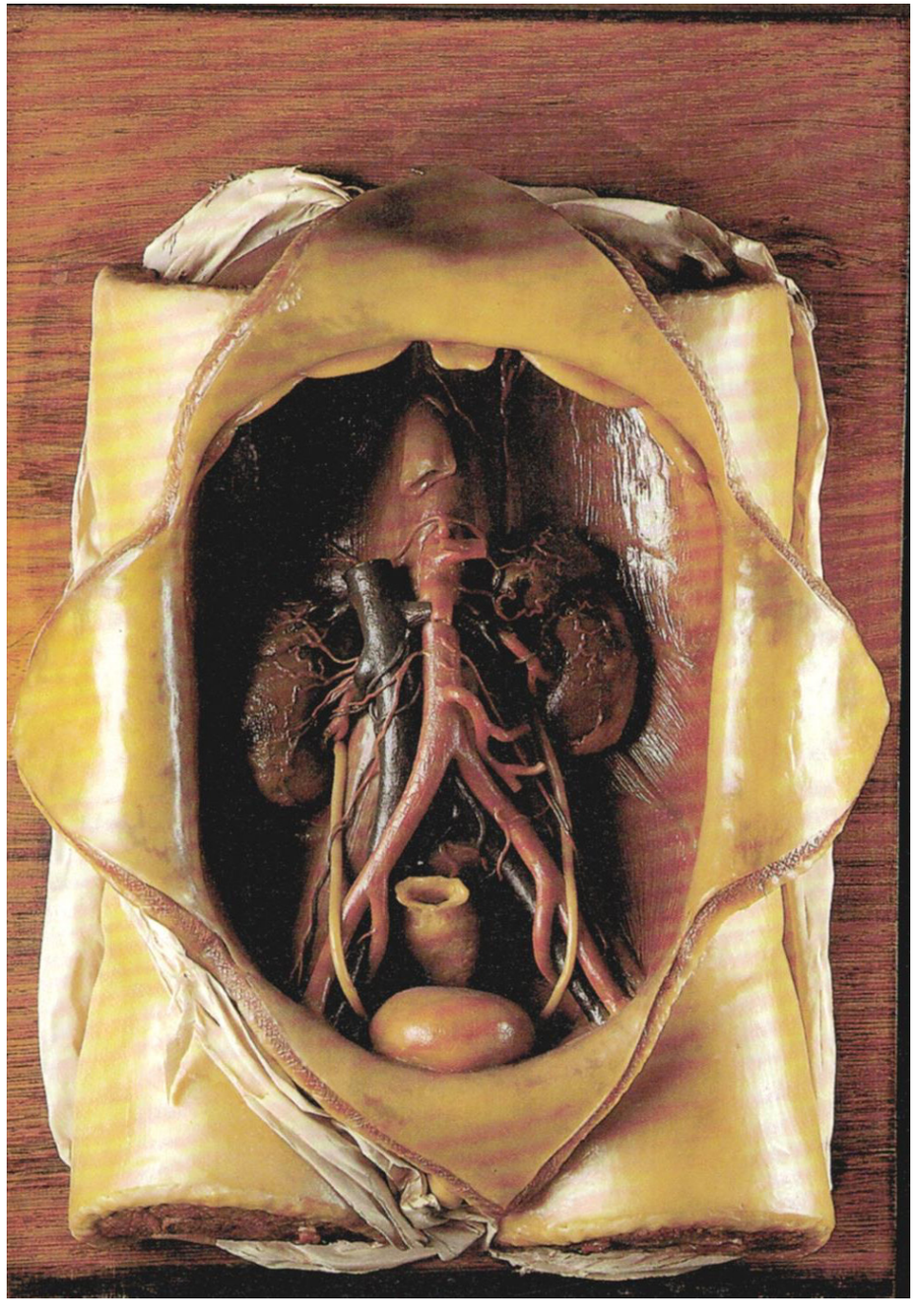

Figure 1: La Specola: Specimen of the kidneys from: Frieß P, Witzgall S 2000 La Specola Anatomy in Wax in Contrast with Images of Modern Medicine. Deutsches Museum, Bonn Repro Moll-Keyn, with permission.

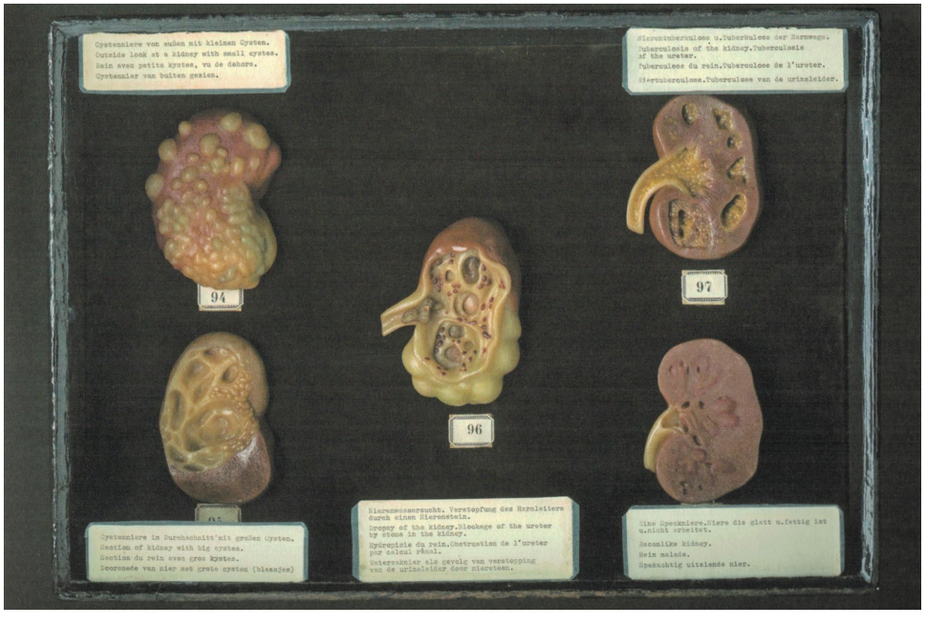

Figure 2: Kidney diseases, Emil Kotschi, c. 1880. Repro Moll-Keyn, with permission

From the mid-19th century, pathology gained major acceptance in medicine to outline separate steps of one disease. These models illustrate this to the general public. Display from Hoppe Panopticon. Deutsches Hygienemuseum Dresden, from Lang J, Radtke J Wagner C 2015 Zwischen Aufklärung und Sensation. Eine Chronologie zum Anatomischen Wachskabinett des Deutschen Hygiene- Museums, Dresden in: Ein anatomisches Wachskabinett und die Kunst Blicke Körper. Wallstein, Göttingen p. 129.

The moulage collection at the Hôpital St. Louis in Paris, one of the first clinics for skin diseases in Europe, was another place where these objects were used in urologic education. Under the direction of Charles Lailler (1882-1898), Jules Baretta (1834-1923), who had originally sold artificial wax fruits in his own studio, produced over 3,000 moulages of unusual and typical skin and venereal diseases.

In England, Joseph Towne (1808-1879) is known for manufacturing over 1,000 dermatological, pathological and anatomical wax models during his 53 years at Guy's Hospital in London.

The first International Congress for Dermatology and Syphilology in 1889 at the Hôpital St. Louis in Paris impressed specialists from all over Europe and overseas with an extraordinary exhibition such that moulage collections were subsequently set up at many clinics from Europe to the US, South America, Russia and Japan (20,21). In the early 20th century, wax moulages were one of the main teaching resources in dermatology, urology and venereology. They provide a true representation of pathologically altered parts of the body and areas of the skin, but also give insight into the body to understand important steps of a procedure which requires a three dimensional aid to visualize. (Figures 2, 3, 4, 5, 6).

Information of the Public by Deterrence

These objects in urology had two functions. For physicians, they were a three-dimensional art piece of visualization. They helped physicians understand ailments, which were difficult to display with woodcuts or black and white photos. For laypersons, they could be used for informational campaigns about sex, its consequences and treatment options. But, the second function in so-called anatomy museums, dime museums or panopticons played a big role all over the world. Dime museums were popular at the end of the 19th century in the United States. Designed as centers for entertainment and moral education for the working class population (lowbrow), the museums were distinctly different from upper middle class cultural events (highbrow). In Baltimore, Maryland, Peale's Museum is credited as one of the first serious museums in the country (22,23,24,25,26). From Sarti's and Kahn's institution (27) in London up to Hoppe, Zeiler, Castan, in Germany, or Binda - Bondardo (28) in Switzerland or Barnum in the States, many such entrepreneurs and institutions could be found all over the world. As Sappol (2008) pointed out, "The anatomical museum was not just a transgressor of public morality, it was a notorious, flagrant transgressor, a public institution devoted to the display of things that should not be displayed." For urology, this meant that the cabinet marked "For men only!" or "For women only!" was sometimes the only place people could get information about the private parts, sexuality or birth control.

Doctors and public health officials claimed that the spread of sexually transmitted infections would only be halted when the public knew about the consequences and means of prevention. Education campaigns tended to exploit society's disgust of this unsightly infection. Physicians and historians have argued that this approach did not solve the problem of STDs, but added to the fear of the diseases, and the stigma and discrimination towards its sufferers. (Figure 7).

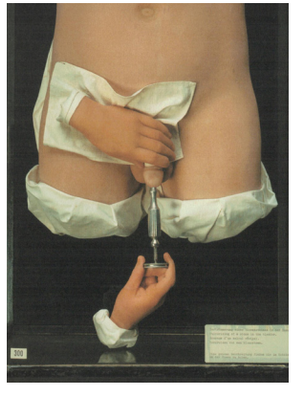

Figure 3: Lithotripsy by Heurteloup. Moulage. Christies 9289, The William Bonardo Collection of Wax Models 13.12.2001. Repro Moll-Keyn, with permission.

Figure 4: The first minimal invasive procedure in medicine and urology. "Blind" lithotripsy was quickly popularized. Display from Hoppe Panopticon. Deutsches Hygienemuseum Dresden aus: Lang J, Radtke J Wagner C 2015 Zwischen Aufklärung und Sensation Eine Chronologie zum Anatomischen Wachskabinett des Deutschen Hygiene- Museums, Dresden in: Ein anatomisches Wachskabinett und die Kunst Blicke Körper. Wallstein, Göttingen p. 140. Repro Moll-Keyn, with permission.

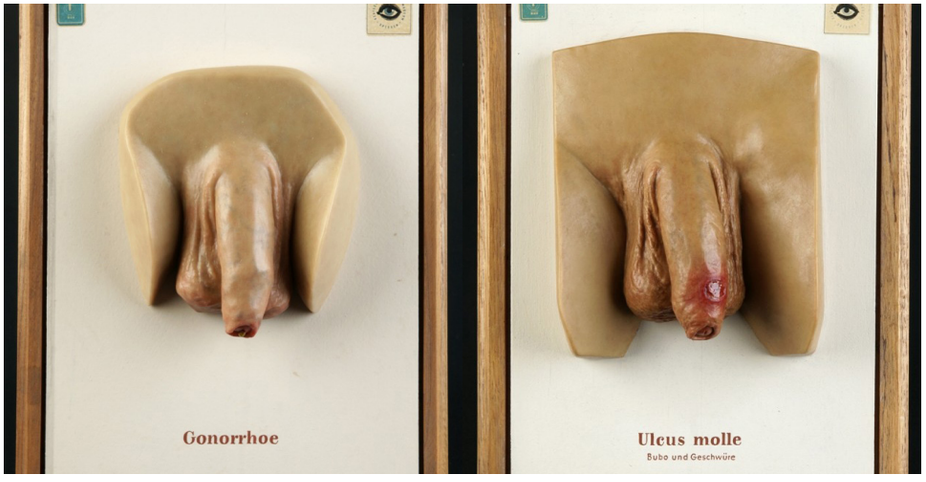

Figure 5: Moulage "Male Gonorrhoa" produced for over 70 years by "Deutsches Hygienemuseum" Dresden/Saxony for educational purposes and sold all over the world. Circa 1950. This was a big income of currency for the former GDR until 1990. b "Ulcus molle". These objects can be found in many collections all over the world. Repro Moll-Keyn, with permission.

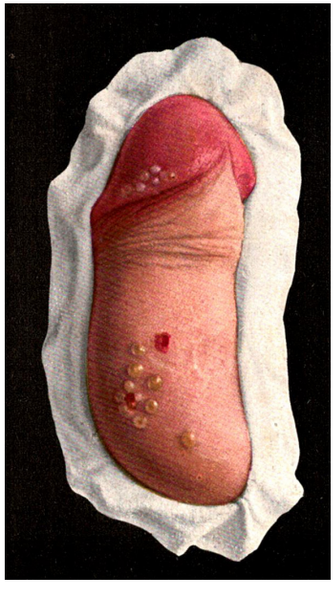

Figure 6: "Herpes genitalis", mouleur Jules Baretta (1824-1923), Paris from: Jacobi-Zieler 1934 Lehrbuch und Atlas der Haut- und Geschlechtskrankheiten Vol 2 .Fig 163, templ 92. Urban & Schwarzenberg, Berlin. Repro Moll-Keyn, with permission.

Figure 7: Exhibition case of one of the last European panopticons "Sexual Life and its dolorous consequences concerning sexuality". Moulages probably by Kröner, Breslau. With courtesy to Dominik Schmitz, Bedburg, pardox-sideshows.com, Germany, photo Moll-Keyn, with permission. "Be aware that the short time of pleasure scams you out from health and happiness." One eyewitness of the time wrote: "By low nerved persons it happens that they had to leave the hall at once" (29).

Some moulages, especially those by Adolf (1820-1898) and Friedrich Ziegler (1850-1920) of Dresden, Saxony, who produced many objects in embryology, enforced the medicalization of gender identity as binary during the first half of the 20th century, a point now under discussion on several aspects (30,31) (Figure 8).

Figure 8: Adolf Ziegler (1820-1898) Modellreihe zur Entwicklung der äußeren Geschlechtsteile des Menschen "Die Serie nach Professor Ecker zeigt die Entwicklung der äußeren Geschlechtsorgane des Menschen."(Development of the external genital organs of the human embryo). University of Heidelberg online (http://www.universitaetssammlungen.de/modell/949)

The Decline of the Objects and a Renaissance

The introduction of photography and more elaborate printing techniques—especially in color at lower prices c. 1900—made the moulages and the mouleurs' ability to reproduce clinically important aspects redundant. They became less useful within the academic collections, and many of the pieces were melted down or neglected. A large part of the legacy inventory of moulages survived poorly due to natural ageing, but also to past usage and unfavourable storage conditions, as well to as a lack of expert knowledge about preservation options. Also, much knowledge of preservation was lost after World War II. Apart from few exceptions, most mouleurs did not permit access to their techniques by successors or the public (32).

By the 1970s, moulages had all but lost their pre-eminent position as teaching and visual aids to depict dermatological and venereal diseases. However, within the history of culture studies, there was a turning point towards a more object-based research that gave increased interest and focus on medical museums and their objects. This led to a research project of several national and international institutions to give recommendations for preserving the "dying moulages" (33,34,35).

Now at many universities, the objects find new interest worldwide in education and research (36,37). Public attitudes to educational displays of anatomical specimens rose again all over Europe when temporary exhibitions of plastinated anatomical specimens came to London or other bigger European cities as Cologne or Mannheim and Berlin or as far as Japan. In 11 months, according to organizer Gunther von Hagens, the Body Worlds exhibition in London (2002) attracted over 840,000 visitors. Comments from the medical professionals were generally negative, though not necessarily representative of their members' own views. The show "Body Worlds" has attracted more than 56 million visitors in over 160 cities across the Americas, Asia, Australasia, Europe and South-Africa since 1995 (38,39,40,41).

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A woman distilling medication at home, from the frontispiece of "The Accomplished Ladies Rich Closet of Rarities", 1691. Library of Congress

1500–1900: From Early Modern Apprentices to Modern Medical Students

Barbara Chubak, MD
David Bloom, MD

After the Middle Ages, society and its health care were increasingly medicalized, with professional institutions and their associated regulations supplanting the more informal care provided by knowledgeable family, friends, and "ministers of health" (Figure 1 a,b). In cities, doctors were ubiquitous and faced competition from surgeons, apothecaries, and midwives. Their power grew as more areas of life fell under medical control, with authoritative practitioners managing birth, death, and much of life in between.

The early modern period (called the *Renaissance* in Italy) featured a revival of Greco-Roman humanism and interest in the works of Galen, including his anatomic works. Physicians who learned medicine in universities grappled with the tension between theory and practice: Galenic medicine encouraged a patient-centered consideration of disease etiology, but lectures and books for medical practice (called *Practica*) enforced rote memorization of a head-to-toe list of symptoms and their treatment. With rare exceptions, surgery was taught by apprenticeship, organized through local guilds or colleges of surgeons and barber-surgeons.

Physician Andreas Vesalius was revolutionary for establishing a detailed knowledge of anatomy as fundamental to medicine as well as surgery, and for translating the Scientific Revolution to health care by arguing that medical knowledge should be generated empirically (based on experience and observation). However, he dogmatically perceived anatomy through the lens of Galenic physiology, as exemplified by his genital dissections that reinforced a perception that the female reproductive parts are an inversion of the male (Figure 2). Surgeons, who generally lacked Latin and favored craft tradition, made readier

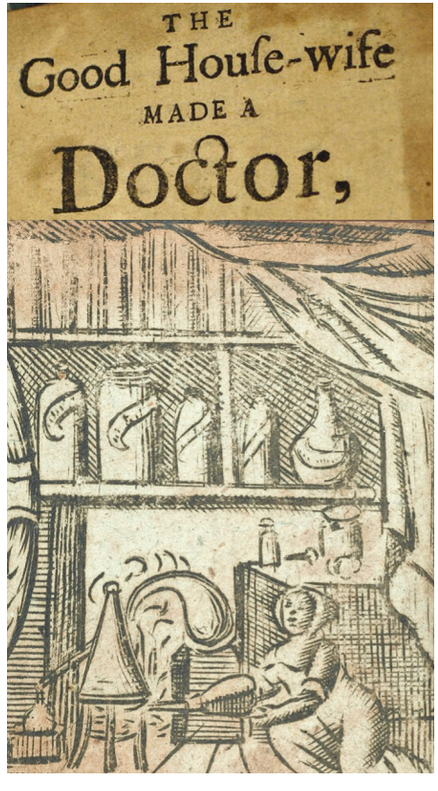
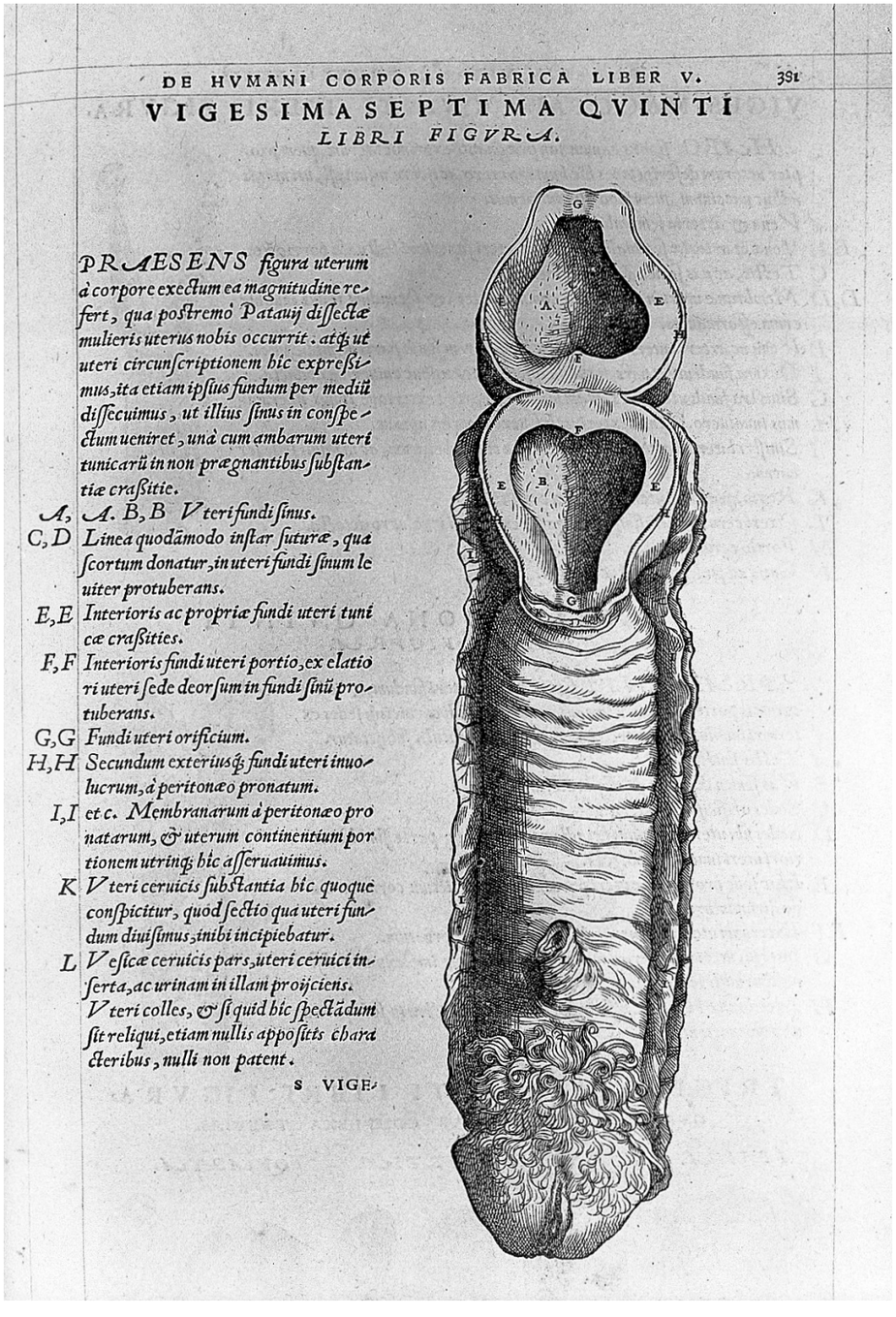


Figure 1a: Frontispiece from "The Good House-wife made Doctor," a manual of household remedies and medical treatments (1698)

Figure 1b: A woman distilling medication at home, from the Frontispiece of "The Accomplished Ladies Rich Closet of Rarities…" (1691). Library of Congress



DE HVMANI CORPORIS FABRICA LIBER V. 391

VIGESIMA SEPTIMA QVINTI LIBRI FIGVRA.

PRAESENS figura uterum à corpore exectum ea magnitudine refert, qua postremò Patauij dissectæ mulieris uterus nobis occurrit. atq; ut uteri circunscriptionem hic expressimus, ita etiam ipsius fundum per mediũ dissecuimus, ut illius sinus in conspectum ueniret, unà cum ambarum uteri tunicarũ in non prægnantibus substantiæ crassitie.

A, A. B, B Uteri fundi sinus.

C, D Linea quodãmodo instar suturæ, qua scortum donatur, in uteri fundi sinum leuiter protuberans.

E, E Interioris ac propriæ fundi uteri tunicæ crassities.

F, F Interioris fundi uteri portio, ex elatiori uteri sede deorsum in fundi sinũ protuberans.

G, G Fundi uteri orificium.

H, H Secundum exterius q; fundi uteri inuolucrum, à peritonæo pronatum.

I, I et c. Membranarum à peritonæo pronatarum, & uterum continentium portionem utring; hic asseruauimus.

K Uteri ceruicis substantia hic quoque conspicitur, quod sectio qua uteri fundum diuisimus, inibi incipiebatur.

L Uesicæ ceruicis pars, uteri ceruici inserta, ac urinam in illam proijciens.

Uteri colles, & si quid hic spectãdum sit reliqui, etiam nullis appositis characteribus, nulli non patent.

s VIGE-

Figure 2: Image of the uterus as inverted penis, from Vesalius, De Humani Corporis Fabrica (Basle, 1543)

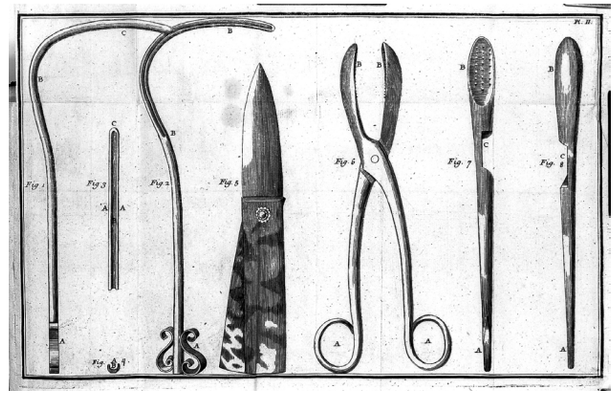


Figure 3: Tools used for the proprietary Colot surgery for bladder stone, from Traite de l'Operation de la Taille (1727). The Colot family of French barber-surgeon lithotomists developed a technique for lateral perineal lithotomy in the mid-1500s, which they passed on through 8 generations and did not reveal until Francois Colot (d. 1706) published it posthumously.

Figure 4: Care for patients with syphilis, from the frontispiece of *A Malafranczos morbo gallorum proeservatio ac cura* by Bathrolomaeus Steber (Vienna, 1498)

progress through empirical knowledge, but often kept it secret to maintain a competitive advantage in the medical marketplace (Figure 3).

Venereal diseases, especially "the pox" or syphilis, were among the predominant medical problems of the period. After its introduction to Europe in the 1490s, syphilis ran rampant through the continent, its colonies and trade partners. By the later 16th century, its virulence had diminished but its prevalence increased, and venereology joined cutting for bladder stones as part of the bread-and-butter of surgical practice. The vast scope of health care need created by the pox pandemic and the powerful sociocultural impact of sexually transmitted diseases also encouraged involvement by physicians, establishing genital health care as a field requiring both medical and surgical expertise (Figure 4).

In the 17th and 18th century, medicine evolved away from the Classical *balance of humors*, incorporating chemistry and physics to understand the body as a mechanical device composed of interconnected and manipulable parts. This body concept, along with the Enlightenment-era enthusiasm for hands-on experiential learning, further narrowed the divide between physicians and surgeons. The urban growth of infectious diseases and other illnesses prompted the reform of existing hospitals from places of shelter into spaces for health care, and new medical hospitals were sponsored by governments and private philanthropy to accommodate the sick-poor in both the old and new worlds (Figure 5).

These medical hospitals became centers of learning for student physicians and surgeons alike, providing ample learning opportunities in the form of living patients to care for and dead bodies to dissect. In the 19th century, education followed the "Paris Medicine" model, characterized by detailed observation of patients, followed by

autopsy to identify the characteristic lesions that correspond to their pre-mortem presentation, and statistical analysis to determine the efficacy of particular treatments. Consequently, the pursuit of clinical research and experimentation became woven into the fabric of medical education, and American doctors who traveled abroad brought this influence home to their own students (Figure 6).

Figure 5: Pennsylvania Hospital, circa 1832, as illustrated by John Caspar Wild. This was the American colonies' first general medical hospital, established in 1751 to provide care for sick-poor of Philadelphia. Its staff helped found the University of Pennsylvania College of Medicine in 1765.

By the later 1800s, medical education took place in schools of various types. Within Germany and the Austro-Hungarian Empire, medical schools existed within the structure of universities, which encouraged interdisciplinary collaboration, specialization of expertise, and the inclusion of laboratory-bench research. In France and Britain, schools were often directly affiliated with hospitals and more clinically oriented in research and mission. In America, the scene was dominated by stand-alone proprietary schools, which varied in quality of teaching, value for tuition money, and ideological orientation. Inconsistency was the rule, with regulatory requirements for medical practice differing between states and "regular" medicine competing with homeopathy and other popular medical sects for market share and professional authority (Figure 7).

Americans who were exposed to the European models of medical learning brought that influence home with them, inculcating the values of scientific medicine and specialist expertise into their own universities and hospitals. The Johns Hopkins University, established in 1876, mimicked the German model, which was held up as the ideal form of medical education by Abraham Flexner in his revolutionary report of 1910 that led to the closure of over half of American medical schools in following years. One deleterious consequence of the Flexner Report was the closure of all but two African-American medical schools: Howard and Meharry Medical Colleges. American surgeons with an interest in urologic health care embraced specialization, joining together as the *American Association of Genitourinary Surgeons* in 1887. From 1890-1892, the organization was renamed the *American Association of Andrology and Syphilology*, reflecting the field's foundation in venereal disease, but the stigma of this association and interest in a broader scope of practice led to a return to its original name.

Figure 6: Paris Medicine. Dittrick Museum

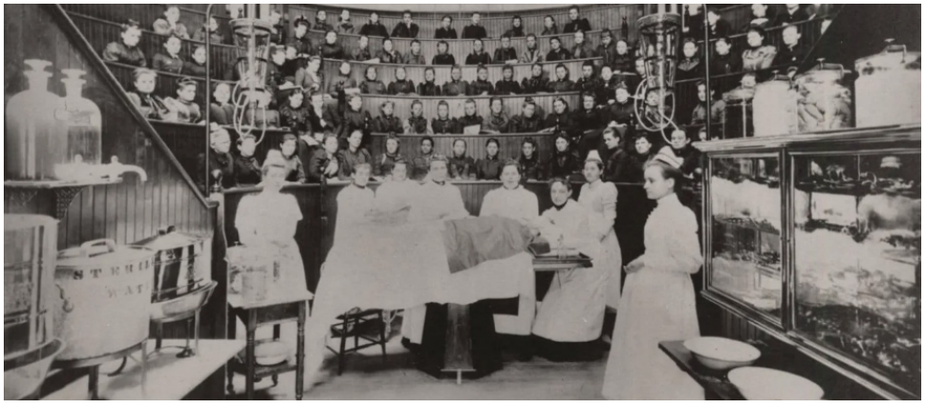


Figure 7: The laissez-faire nature of American medical education created opportunities for women and minority groups to access learning from which they otherwise might have been excluded, often in the face of much resistance. When students from the Women's Medical College of Pennsylvania were granted permission to purchase tickets and attend a clinical medicine lecture at Pennsylvania Hospital in 1869, they met with verbal and physical abuse from the male students so extreme that it made the national news. The New York Citizen and Round Table newspaper wondered at the "Wild Women determined to witness the carving and cutting of the masculine form divine."

The specialty nomenclature evolved further at the turn of the 20th century, when the older terminology of "genito-urinary surgery" was largely replaced by "urology." This shift began in Paris in the 1890s, when Felix Guyon was appointed "Professeur d'Urologie" and renamed his department at the Necker Hospital the "Service d'Urologie." "Urology" was introduced to American medicine by Dr. Ramon Guiteras (Figure 8) and gained popularity through the establishment of the AUA. Because it does not explicitly specify its surgical origin, urology is implicitly relevant to both the surgical and non-surgical sides of the medical profession, and empowered to incorporate and contribute the best from both.

Figure 8: Dr. Ramon Guiteras, c. 1880-1890. AUA Didusch Archives

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Dr. Russell Scott and initial Office of Education staff, 1978. AUA Didusch Archives

Urologic Organizations Standardize Training

Linda Dairiki Shortliffe, MD

Worst to Best: Creating Public Trust

In the early part of the 20th century after the Flexner Report (1910), "American medical education [began to evolve] from the worst in industrialized civilization to the very best … the marvel of the industrial world" (1).

While the Association of American Medical Colleges (AAMC) reformed medical schools, US medical practice lagged in medical knowledge of the time. Postgraduate medical training varied in content, supervision, and duration from weeks to years. Recognizing an oversight gap in postgraduate training, a physician-led group with members of four early boards (Dermatology, Obstetrics and Gynecology, Otolaryngology, Ophthalmology) met to consider a national system to improve training standards. In 1933, this group became the American Board of Medical Specialties (ABMS).

Winds of organization blew within urology as well, and in 1932 the AUA Executive Committee received a report from the Membership Committee noting "…a very intensive movement is going on throughout the country as to the standardization of specialists…." (2) and around the same time, the American Association of Genito-Urinary Surgeons (AAGUS) appointed a committee of three to study specialization in urology. In 1933, the AMA Section on Urology studied qualifications for specialization, and representatives from AUA, AAGUS, and AMA discussed forming a board of Urology "1) for the protection of patients from unprepared uncertified specialists in urology [and], 2) to raise the standards of education in the special field of urology…" (2).

The next year, the American Board of Urology (ABU) was founded as an autonomous organization with nine members, three from each of the three parent organizations: AUA, AAGUS, AMA (Figure 1). Currently, the ABU has 12 Trustees representing six urologic organizations (Figure 2). A larger joint AUA-ABU Examination Committee designs the objective written tests.

The ABU initiated *credentialing*: a process to include 1) graduation from an *approved* medical school, 2) an *approved* internship and a defined period of residency training or practice or an alternative of preceptorship training, 3) case reports, 4) letters for peer review to assess ethical behavior, and 5) *certification* consisting of qualifying and certifying examinations. The examinations evolved from free-form to standardized objective written tests, including pathology and radiology, and an oral examination with standard questions. Perhaps most important, "unacceptable or illegal behavior" risked revocation of certification (2).

Figure 1: Founding Trustees of the American Board of Urology. The American Urological Association Centennial History. 1902-2002, Volume II, pp. 745-756.

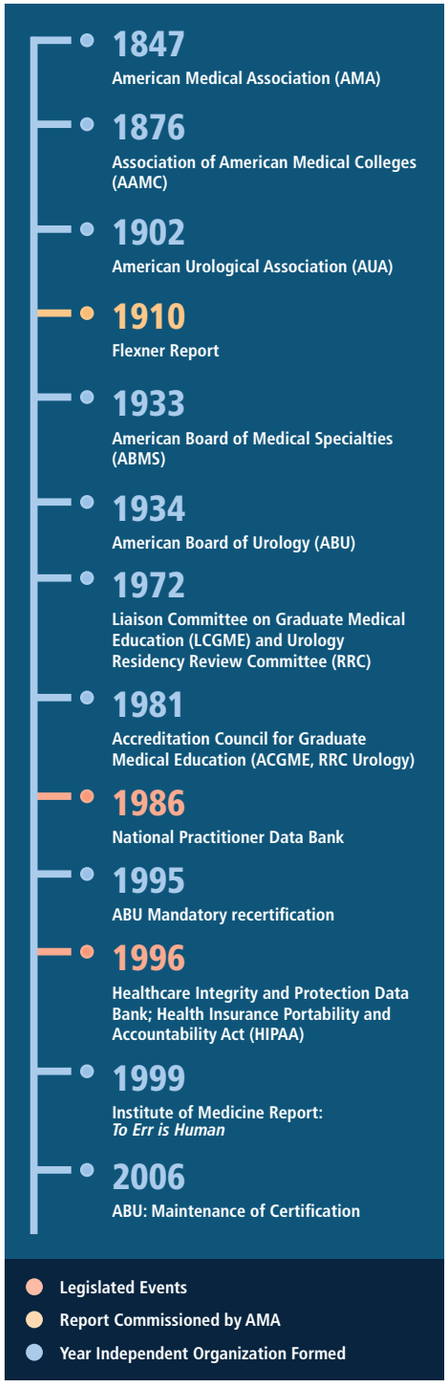
The postgraduate training process (residencies) lacked oversight, however. In 1972, cooperating organizations

formed the Liaison Committee for Graduate Medical Education (LCGME, later becoming the Accreditation Council for Graduate Medical Education, ACGME) to accredit specialty residencies with Residency Review Committees in specialties (RRC, Urology). In 2007, a standardized core curriculum was proposed after a group of stakeholders, representatives of the AUA, ABU, RRC, AACU, and ACGME, met to discuss the future of Urologic Residency Training.

Preserving Public Trust: Organizational Accountabilities

Forming the ABU as an autonomous certifying organization was part of assuring the public that a urologist fulfilled credentialing requirements and was certified by examination. With rapid advances, medical knowledge is a moving target, and the adoption of new knowledge by practitioners varies from early adoption to lack of adoption. New technologies enabled the tracking of medical outcomes, and the federal government started tracking physicians with the National Practitioner's Databank (1986) and the HIPAA Data Bank (1996). However, an Institute of Medicine Report: *To Err is Human* (1999) exposed medical errors from outmoded knowledge, tests, and management. These events prompted progress in two areas: 1) measures to ensure continuous education and 2) increased sub-specialization.

The ABMS adopted "recertification" for its member boards; the ABU adopted voluntary (1981) and then mandatory (1995) recertification with time-limited certificates to confirm evidence of continuing education. In 2006, this ABU process evolved to "maintenance of certification" (MOC), including a pass-fail examination to complete the recertification process. After an ABU Town Hall in 2017, a program to assess longitudinal learning with continued urologic certification (CUC) without certificate expiration was developed.



With the growth of more diverse and subspecialized urologic practices, post-residency "fellowships" sprouted. Since their scope and requirements differed, training standardization followed different models. In 1989, pediatric urology submitted to the ACGME "Proposed Special Requirements for Programs in Pediatric Urology" with the ABU supporting accreditation without certification. In 2004, the ABMS approved Pediatric Urology as a subspecialty, and in 2006, the ABU approved a Pediatric Urology certification. In 2011, the ABMS approved certification for female pelvic medicine and surgery (Urogynecology and Reconstructive Pelvic Surgery) after a joint ABU and ABOG (American Board of Obstetrics and Gynecology) application.

With changes in medicine and practice, the ABU and other accountable organizations were established, often with controversy, to operate autonomously. While these organizations face future challenges from medicine spread through social media so often unpatrolled for misinformation, commercialism, abuse, artificial intelligence, and goals of private equity, the mission is the same:

> *"The mission of the American Board of Urology is to act for the benefit of the public by establishing and maintaining standards of certification for urologists, working with certified urologists to achieve lifelong learning to insure the delivery of high quality, safe and ethical urologic care." (The American Board of Urology)*

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Members of the AUA Core Curriculum and AUA*University*. Top Left: Robert C. Flanigan, Top Right: John Mulhall, Bottom Left: Elspeth McDougall, Bottom Right: Gopal Badlani

The AUA Core Curriculum and AUA*University*

Justin M. Refugia, MD
Gopal Badlani, MD

Tools for acquiring urological knowledge are continually evolving to meet the demands of today's learners. The tried-and-true guidance has been daily reading from urologic textbooks. Specifically, learners are directed to Campbell-Walsh-Wein Urology, colloquially referred to as the "Bible of Urology" (1). Presently, however, textbooks have been adapted to develop an abundance of more pragmatic resources for contemporary learners to learn urology. The rise of educational tools sparked significant debate within the specialty. The central tenet to these early debates was a shared question: how should urological education be delivered?

During a broad-based strategic planning meeting in April 2006, a group of stakeholders was convened and recommended that the American Urological Association (AUA) develop a core curriculum for urologists that would address cognitive and manipulative skills. In 2008, under the aegis of the AUA Board of Directors, the Urology Core Curriculum Steering Committee was established (Table 1). This first group was comprised of a broad constituency of authors and reviewers from the AUA, American Board of Urology (ABU) and sub-specialty urological organizations (2). First chaired by Dr. Robert C. Flanigan and then by Dr. John Mulhall, the Core Curriculum task force rallied the support of more than 160 authors to identify and define the scope of urology.

The first educational product from the group targeted the essentials in urology that every student should know before graduating from medical school. Foundations for core urology topics had previously been assessed by a large cohort survey of stakeholders in medical education (3). Two urologists, Drs. Price Kerfoot and Paul Turek, surveyed hundreds of residency directors from different medical disciplines as well as graduating medical students, and analyzed and published what these stakeholders believed all students needed to know about urology. Based on this research, an essential curriculum for all medical students was developed (4). The National Medical Student Core Curriculum (NMS-CC) debuted online in October 2008 for students to learn the core principles and practices in urology that are important for every practicing physician to know and apply throughout their medical careers, regardless of their career path (5,6).

The NMS-CC laid the foundation for the first iteration of the AUA's urology core curriculum (AUA-CC). Under guidance of then-AUA Secretary, Dr. Gopal Badlani (2011-15), the AUA Office of Education (chaired by Dr. Elspeth McDougall from 2009 to 2015) aimed for the AUA-CC to become the most comprehensive reference guide available to deliver quality urological care (7). Since its launch in 2010, the AUA-CC has been an online "living" and "evolving" resource that is kept current with frequent updates so users would be assured they are participating in a rich and growing educational program (8). The first version was comprised of 50 specialized sections collated from the most up-to-date and scientific resources available, including

clinical guidelines, textbooks, scientific articles, videos, simulations, interactive websites, and more. Thanks to generous expert contributors, the hallmark of the AUA-CC is the low cost of human effort to rapidly update and maintain on-demand accessibility to this content (Table 2). Since its release, all AUA members are given free access, allowing anyone who is a member around the world to enrich their urological education.

The next leap in education modalities during Gopal Badlani's term as AUA secretary was the release of the AUA*University* online platform in 2014. Through the AUA*University*, the omnibus of educational products was centralized into an easy-to-use format accessible from any web browser. Combined, the AUA*University* and Core Curriculum allowed the AUA to spread urologic education internationally. Gopal Badlani united eight nations through AUA International Educational Courses for resident members from Argentina, Brazil, China, Egypt, India, Japan, South Korea, Mexico, and Peru.

Then, building on themes of accessibility, the AUA*University* was adapted to mobile devices by developing numerous adjunctive mobile apps. The AUA*University* is now home to the AUA-CC, the Self-Assessment Study Program (SASP), the AUA Updates Series, AUA webcasts and podcasts, the Journal of Urology® Home Study, surgical videos, and numerous educational offerings with online or live learning courses (9).

2006
Origin of the AUA Urology Core Curriculum (AUA-CC) at a broad-based strategic planning meeting to define the ideal "future state" of urologic education

2008
Core Curriculum Task Force and Editorial Committee officially formed to determine content of the AUA-CC, Chair: Robert C. Flanigan, MD

2008
The National Medical Student Core Curriculum debuts to teach core principles and practices in urology important for every practicing physician to know and apply throughout their medical careers, regardless of their career path

2010
First iteration of the AUA-CC published online with 50 specialized sections

2014
AUA*University* web platform launched to house the AUA's breadth of educational products

2015
AUA-CC mobile app launched to provide AUA members on-demand access from their mobile devices

2022
AUA*University* revised to integrate AUA-CC, surgical video library, AUA Update Series, guidelines and policies, and more into one mobile app platform

2024
AUA-CC now contains 136 separate core curriculum topics across 22 subject areas, all updated since at least 2023

The AUA answered the question of "how should urological education be delivered?" with finesse. Presently, the AUA-CC is considered the new gold-standard for learning urology by resident trainees, owing to its 136 specialized sections across 22 subject areas that have all been updated within the past two years. As of 2023, the AUA-CC Editorial Committee is comprised of over 200 authors, 43 section editors, and 14 senior editors and senior consultants (10). Furthermore, in 2023 alone, the AUA-CC was accessed 207,269 times by 6,807 unique users including a substantial number of non-residents (10). From urology newcomers to seasoned attendings, each generation benefits from the generous contributions to these thriving works housed within the AUA*University* (9).

Table 1: Member & Organization(s)

Robert Flanigan (AUA)

Jan Baum (AUA)

Peter Carroll (AUA)

Ralph Clayman (ABU)

Roger Dmochowski (AUA Guidelines Committee)

John Forrest (ABU, AUA Guidelines Committee)

William Gee (AUA)

Stuart Howards (ABU)

Mike Koch (ABU, RRC, SUU)

Glenn Preminger (AUA)

Lawrence Ross (AUA)

Paul Schellhammer (AUA)

Michael Sheppard (AUA)

Linda Shortliffe (SUCPD)

Ian Thompson (RRC)

W. Bedford Waters (ABU)

AUA: American Urological Association, ABU: American Board of Urology, RRC: Residency Review Committee, SUU: Society of University Urologists, SUCPD: Society of Urology Chairpersons and Program Directors

Table 2: AUA-CC Chair Contributions

Dr. Robert Flanigan

(2010 – 2012)

- Inaugural AUA-CC chair
- Directed AUA-CC task force
- Developed original content outline

Dr. John Mulhall

(2012 – 2014)

- Team recruitment
- Coordination of online module development

Dr. Yair Lotan

(2015 – 2018)

- Oversaw alignment of AUA-CC content with ABU categories
- Pioneered the inclusion of presentation slides

Dr. Phillip Spiess

(2019 – 2022)

- Developed summary section for each chapter
- Integration of learning materials (e.g. AUA Updates and Guidelines, surgical videos)
- Further coordination of AUA-CC content with ABU Exam Committee

Dr. Alan Shindel

(2023 – present)

- Updating references from modules
- Formal letters of recognition for AUA-CC contributors
- External validity of cited evidence
- Coordination of AUA-CC materials with AUA Diversity, Equity and Inclusion Committee

AUA-CC: American Urological Association Core Curriculum, ABU: American Board of Urology. Compiled from "Shindel A. FROM THE AUA EDUCATION COUNCIL The AUA Core Curriculum: A Brief History. 2004."

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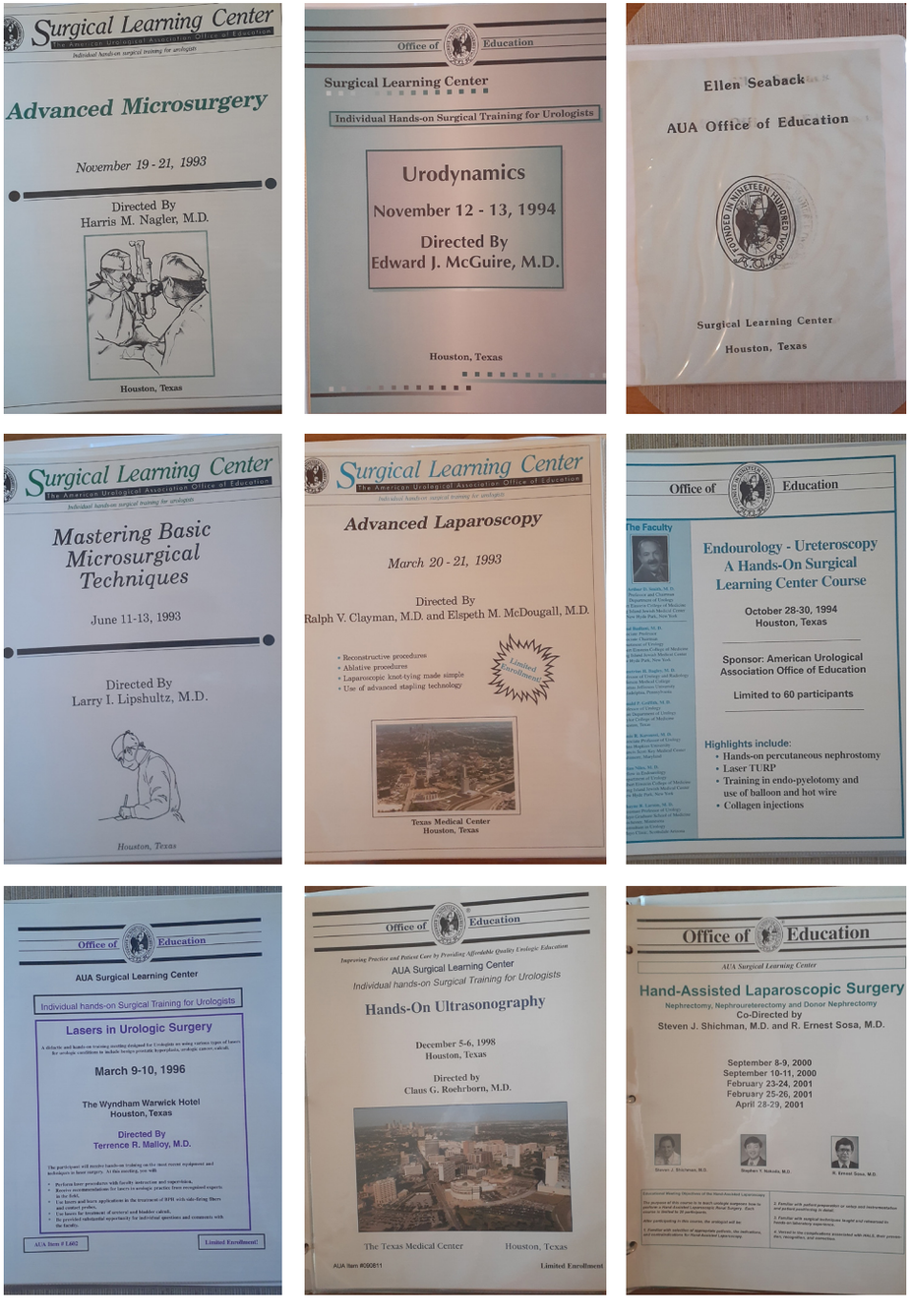


A few of the many AUA Office of Education brochures

Simulation in Urologic Education

Lauren H. Poniatowski, MD, MS
Elspeth M. McDougall, MD, FRCSC, MHPE
Robert M. Sweet, MD, MS, MAMSE

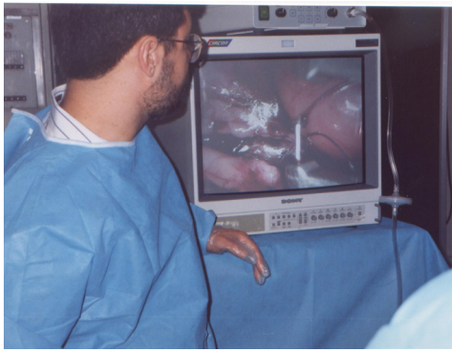
The field of urology has evolved to incorporate surgical simulation as a strategy to train surgeons of today and future generations. Urology has been a leader in the field of surgical simulation, often seen in parallel to the notable advancements in surgical technologies and techniques. Simulation is defined as *the imitation of a situation or process especially for the purpose of skills training* and provides an ideal educational and practice platform for the practicing urologist, trainee, or surgical team (1). The simulation environment has become a useful learning platform which allows for the replication of high risk-low frequency events as well as an opportunity for skills acquisition and maintenance for both technical and non-technical skills. In addition, it allows repetition and spaced learning where the focus is on the learner and there is no concern for patient safety. As such, it affords immediate feedback and re-practice with learned information from errors or complications experienced during training. This facilitates the surgeon to better acquire complex surgical skills and operative techniques (2,3). The AUA recognized the importance of simulation early on and

March 1993 Advanced Laparoscopy Course Faculty: (seated) D. Albala, J. Donovan,
(standing left to right) E.R. Sosa, W. Schuessler, R.V. Clayman, K. Kerbl, E.M. McDougall

1999 Advanced Laparoscopy Course at Texas Medical Center in Houston TX
Teaching laparoscopic nephrectomy in pig lab

Faculty Instructors: L. Kavoussi & S. Wolf

R.V. Clayman teaches D. Lightner



Faculty Instructor: L. Kavoussi

E. McDougall teaching laparoscopic nephrectomy

Ellen Seaback CMP, CAE, CHCP, AUA Office of Education

P McCue, Surgical Learning Ctr, Houston TX& D Ostrander, Barnes Hospital, St. Louis

incorporated it into its educational activities. As simulation technologies and educational techniques have advanced over the years, the approaches to incorporate simulation into AUA training have also evolved.

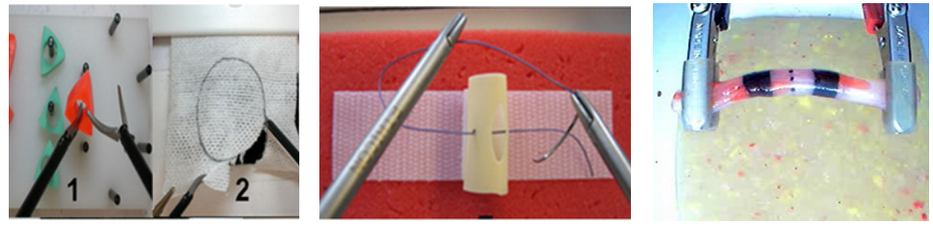
Edge Device by Simulab

Simulation-based training was first introduced by the AUA Office of Education as hands-on courses in the 1980s and 1990s with a variety of surgical techniques and diagnostic modalities presented.

These included, but were not limited to: hands-on courses for endourology, ureteroscopy, microsurgical techniques, laparoscopy, laser technologies, advanced imaging, urodynamics, stapling/continent diversion, ultrasonography, and hand-assisted laparoscopy. The majority of these courses were performed on a porcine model as the urinary tract anatomy was similar to humans. Other animal models included rat or bull testicles for microsurgical courses. The ultrasound hands-on courses increased in popularity at the AUA Annual Meeting beginning in 2010 and utilized live human volunteers.

The use of animal and cadaver models for robotic surgery training is limited by logistical, ethical, financial, and infection control issues. Alternatives to the use of live animals and cadavers has subsequently gained popularity (4). This shift has some advantages including fewer facilities requirements than live tissue, decrease in cost and absence of associated ethical issues. Virtual reality simulation, developed in the late 1990s, was introduced as a learning platform in hands-on ureteroscopy, percutaneous renal access, laparoscopic suturing, and knot tying courses in 2007 and 2009. By 2013, robotic surgery simulators were available and these were used in robotic skills training hands-on courses at the AUA Annual Meeting that year. The latest evolution in synthetic organ model training for robotic surgery has been driven by new 3D-printing technology (4). Validated and cost-effective, high-fidelity procedural models exist for robotic surgery training in urology.

Simulation technologies have continued to advance as has the relationship between simulation and education objectives supported by the AUA. One of the most significant contributions the AUA made to surgical simulation-based education was support and development of the Basic Laparoscopic Urologic Skills (BLUS) curriculum. This

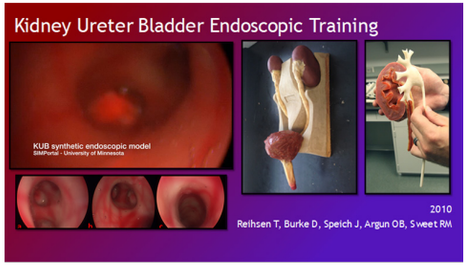


Edge Device performing Peg Transfer, Suture/Knot Tying, and Clip Applying Skill Tasks

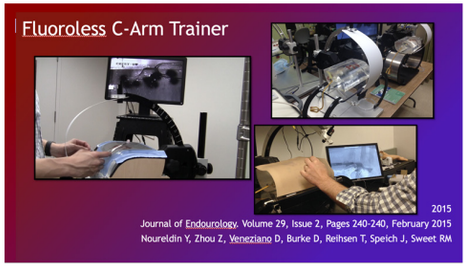
curriculum included the development and validity testing of a set of basic laparoscopic simulation tasks representing laparoscopic skills required by urologists. These four BLUS were created through extensive consideration and discussion by expert laparoscopic urologists, similar to the process by which the general surgery Fundamentals of Laparoscopic Surgery (FLS) were developed (5). The four BLUS skill tasks included: peg transfer, circle cut, suturing, and clip applying, and these were developed on a simulation-based platform called the EDGE device (SimuLab Corp., Seattle, WA) that allowed capturing metrics such as time, tool motion, and instrument force in real time (6).

In the BLUS research project, 117 BLUS study subjects were accrued at eight collaborative U.S. centers. All completed the four basic skill tasks including peg transfer, circle cutting, intra-corporeal suturing, and BLUS clip applying/cutting and video recording of these performances.

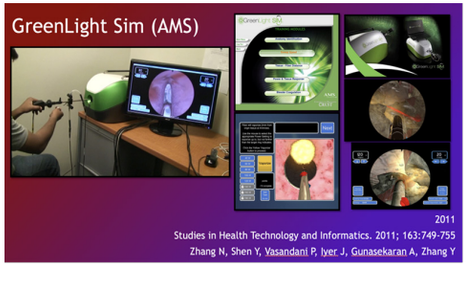
Typical demographics, such as the number of laparoscopic procedures performed or number of laparoscopic cases performed per week, failed to statistically discriminate skill level compared to task time metric. As a result, "true skill" was established via traditional demographic approach and blinded video review with the global operative assessment of laparoscopic skills (GOALS) survey tool (7). The BLUS peg transfer and suturing skill tasks showed good construct validity based on a consensus of established objective metrics and blinded video review by expert faculty.



Synthetic tissue analogues and virtual models have more recently become important in hands-on ureteroscopy and percutaneous renal access training. The Endoscopic Urinary Tract Model (CREST developed and Simagine Health, USA licensed) is an example.

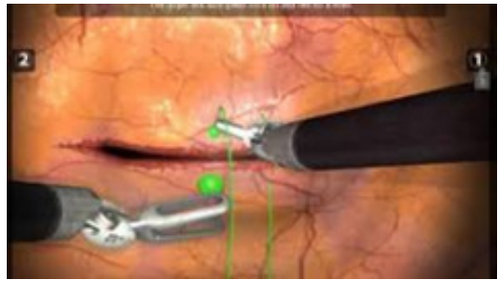


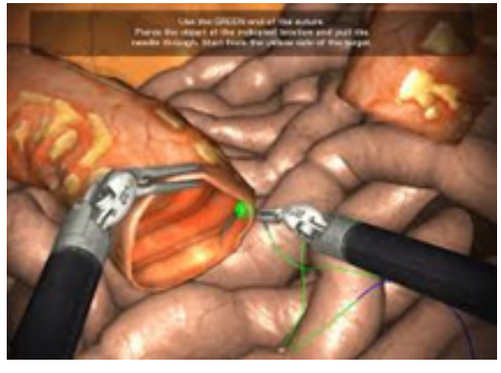
Fluoroless C-Arm Trainer used to teach hands-on PCNL using a camera mounted to a mini C-arm for needle insertion without need for fluoroscopy.



Virtual reality photovaporization of prostate simulator designed by CREST. Device company required surgeon to train on simulator before using the device clinically.

Novel strategies for assessing surgical skills have also been established. Crowd-sourcing assessment of technical skills (C-SATS) was developed to overcome limitations in demographics distinguishing level of laparoscopic expertise (8). This approach clearly demonstrated that a properly sized and qualified crowd can accurately sort video





The dV Trainer developed by Mimic Technologies and licensed to Intuitive Surgical is utilized by the company as prerequisite training for surgeons before the use of the clinical robotic device.

laparoscopic skills performance on par with faculty experts and is a rapid and efficient method of discriminating between passing/failing performances. GOALS video review (ground truth) correlated with task metrics.

Urology investigators have also been leaders in the advancement of surgical simulation technologies including high-fidelity models that have been used at AUA Hands-On Courses. The Center for Research in Education and Simulation Technologies (CREST) Endoscopic Urinary Tract Model (Simagine Health, USA) is an organosilicate model with realistic color mapping and physical properties that have been used for the AUA Hands-On Ureteroscopy course (9). A Fluoro-less C-Arm Trainer (CAT) was developed for training hands-on PCNL and included a kidney model embedded in silicone and a camera mounted to a mini C-arm for needle insertion without need for fluoroscopy. Imaging is simulated using a camera mounted to a mini C-arm for needle insertion, without the need for fluoroscopy (10,11).

The future of simulation in urology allows the learner to navigate a highly accurate simulation that responds to their actions. 3D printing has gained traction in the creation of high-fidelity simulator models that allow for a multitude of urologic education to be performed in the simulation setting, including renal anatomy as demonstrated at the University of Rochester (12). Simulator model materials have continued to evolve to better replicate the characteristics of tissues encountered in the clinical setting. Additionally, emphasis has been placed on objective means of technique assessment as well as incorporating metrics into simulation training.

MoHSES™ (Modular Healthcare Simulation and Education System) is an open-source simulation platform that utilizes a modular manikin and full body physiology engine (BioGears®) (13). With these sorts of simulation technologies, surgical or procedural interventions completed on a manikin will initiate the appropriate physiological response and increase the realism of the experience for learners.

Simulation-based surgical training is an example of how the AUA has been a significant leader in this important teaching strategy for more than 35 years.

Special thanks to Ellen Seaback, CMP, CAE, CHCP who assisted greatly in compiling information on the AUA Hands-on courses in the 1990s and provided photographs of the course hand-out brochures for some of these courses.

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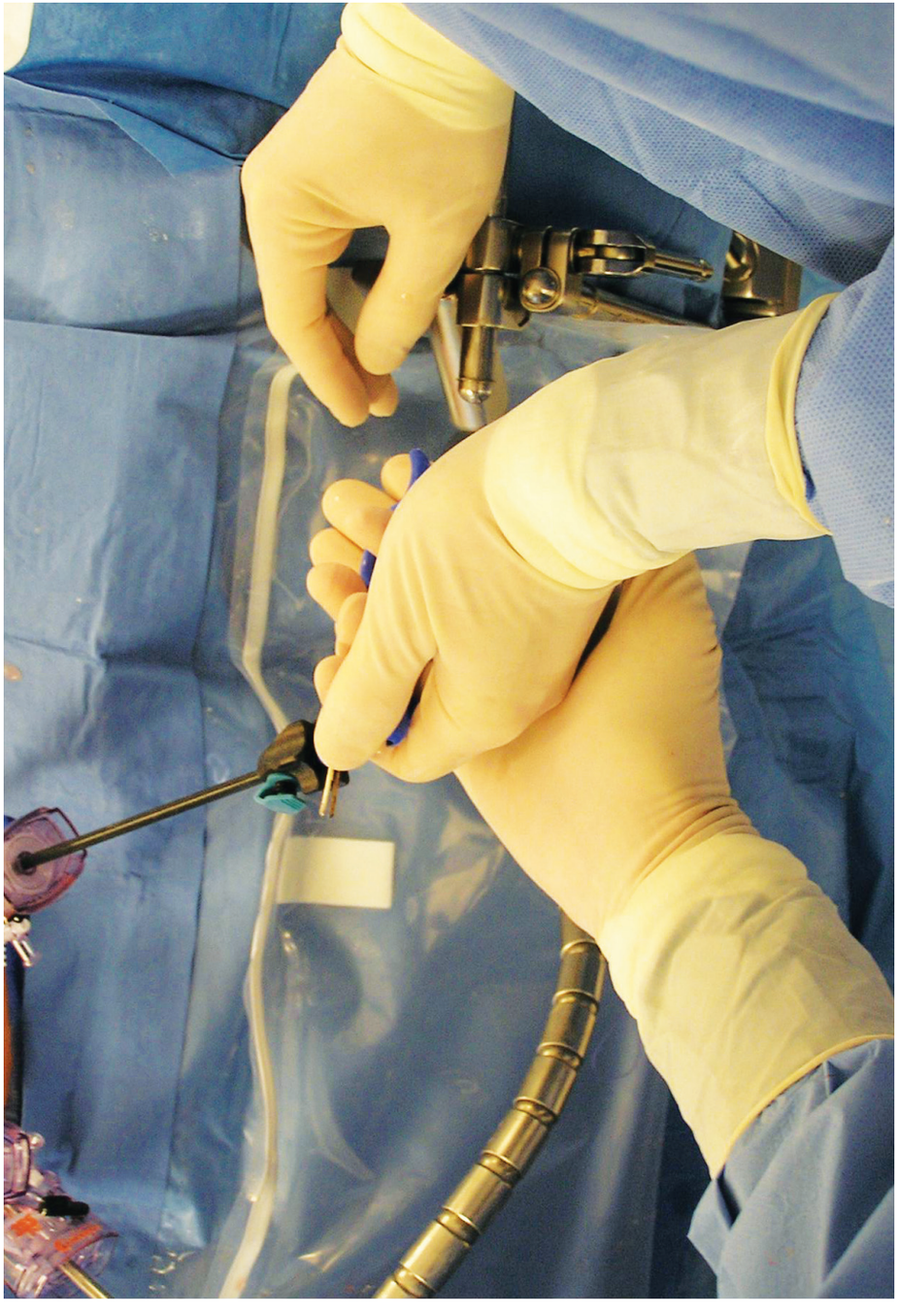


Lap Surgery Hands On 2008

The Future of Urologic Education: New Educational Tools

Victor W. Nitti, MD
Shelby Englert, CHCP

Urologic Education: A Vision for the Future

In 2018, the AUA Board of Directors charged the AUA Office of Education and the Education Council with developing a plan for educating our members into the future.

We immediately recognized two challenges that required a major restructuring of the AUA's educational processes and tools. The first challenge was the explosion of urologic information generated on a yearly basis. We discovered that the amount of medical information was doubling every 18 months. Second, the tools for learning and disseminating information were also changing. The landscape of how medical students, residents, young urologists, and advanced practice providers learn was very different than in decades and even centuries past.

It is no longer possible for a single person to know all there is to know in the field of urology. The new education process required a switch from emphasizing acquisition and recall of a large amount of information to adaptive learning (1). While there was still a requirement to educate on core urologic information in the traditional sense (e.g., concepts that can be tested to evaluate competency such as board exams), we also needed to create a system that allowed for easy access to information for adaptive, "on the spot" learning (2).

The 2019 AUA Office of Education vision statements are the starting point of the AUA educational offerings in 2025 and into the future.

A Vision for the Future:

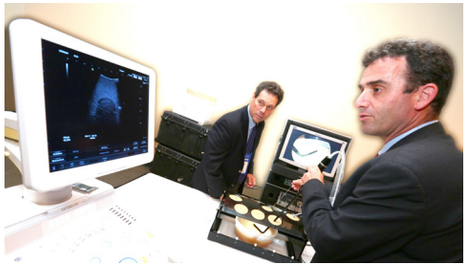
AUA Office of Education Vision Statements 2019 (and Beyond)

- As evidence and technology transform practice, we need more linkages between real-world evidence generation, guideline development, performance assessment, registry feedback, and physician learning.
- Physicians need practice-based learning and improvement that incorporates performance data, effective feedback strategies, and implementation approaches that can meaningfully drive improvement.
- We need to educate our members on how to manage constant change, engage in guided self-assessment, and adapt to the evolving needs of their patients and the health care system throughout their careers.
- We need to focus on enhancing physician learning to improve practice versus just fulfilling educational requirements set by the Boards, state licensing bodies and/or employers.

- New technology and digital strategies have the potential to transform how education is delivered and how care is assessed, delivered, and improved.

To work towards these vision statements, we identified three areas on which to focus: content, format, and access. First, we needed to decide on the content for educating urologists now and in the future. The core principles of urology are obvious, but some emerging areas are critical for the practicing urologist: big data and AI, genomics, telemedicine, health systems sciences, cutting edge technologies and new pharmaceutical agents.

Second, we needed to determine the best structure or format for that content. Times had changed. With available resources, personalized learning rather than structured education that is the same for everyone became our goal. We sought to develop an educational program that encourages lifelong physician learning with an emphasis on how to apply and analyze data and information rather than simply data acquisition. We sought to apply new educational formats that were popular outside of urology: podcasts, surgical videos, micro-learning, etc.



Hands-on ultrasound at the 2012 AUA Annual Meeting

Third, we needed to provide easy access to the content. This required a restructuring of our website, mobile app strategy, development of a YouTube channel, and integration of AUA educational materials across multiple platforms. In a short period of time, the AUA Office of Education was able to pivot and now offers a plethora of educational opportunities for a diverse membership in multiple formats.

AUA Education Today

The above strategy led to a major re-vamping of the AUA Office of Education offerings through the AUA*University*. The variety of offerings allow for traditional learning as well as self-paced and spaced learning and include:

- The AUA Core Curriculum - a dynamic curriculum with each section updated yearly, with inclusion of surgical videos designed specifically for the Core Curriculum
- AUA Live Learning Courses with a focus on case-based discussions
- The AUA*University* Clinical Podcast
- AUA*University* On-demand Webcasts
- AUA*University* YouTube Channel
- AUA*University* Surgical Video Library
- The AUA Self-Assessment Study Program (SASP) Mobile App
- AUA Update Series print, online and audiobook versions

Of all these offerings, the AUA*University* mobile app is the one that brings everything together. Busy physicians and health care workers need information at the ready, and the AUA*University* mobile app brings together all the AUA's clinical information, providing an environment for our members to be self-directed, critically thinking, expert workplace learners. This sets the stage for the continued evolution of educational offerings that reflect how each new set of residents learn.

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AI Prompted Image of Alan Turing, Midjourney AI, prompted by Netha Hussain

The Role of AI In Urologic Education

Craig Niederberger, MD, FACS

More and more we hear of "artificial intelligence" (AI). There seems to be a great deal of hype around it nowadays. But what does the term mean, and is there a role for it in education? We urologists are technophiles who have found uses for all sorts of innovations: lasers, microscopes, robots, just to name a few. We are defined by our love for technology. It is certain that we will adopt artificial intelligence methods in urology and in its education, and we've already begun.

Much attention has focused lately on "large language models", or LLMs, as they create textual content that appears to be very human. Early on, one of the great pioneers of computer science, Alan Turing, proposed a test that would demonstrate if a machine were intelligent. In Turing's test, a human evaluator, another human, and a machine would be separated and not visible to each other. They would communicate by typing. If the evaluator could not reliably state which was the other human and which was the machine, the machine would have passed the intelligence test.

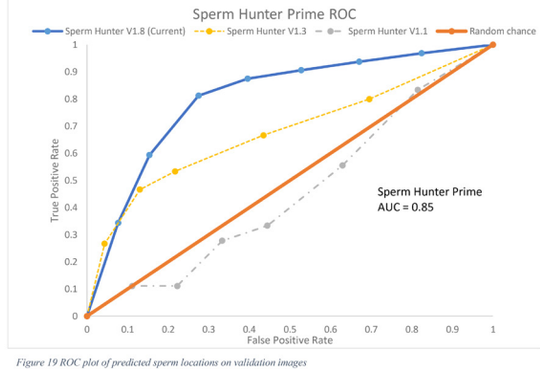

Figure 19 ROC plot of predicted sperm locations on validation images

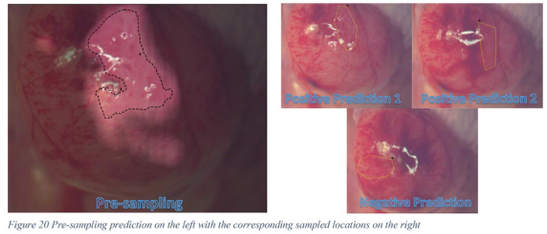

Figure 20 Pre-sampling prediction on the left with the corresponding sampled locations on the right

Figure 1: Demonstrates receiver operating characteristic curves models, including the final model with area under the curve at a satisfactory 0.85 and sample training images.

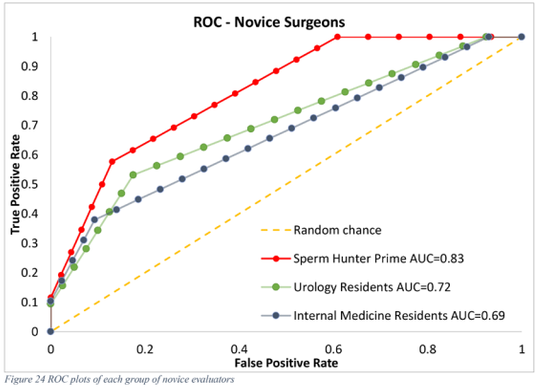

Figure 24 ROC plots of each group of novice evaluators

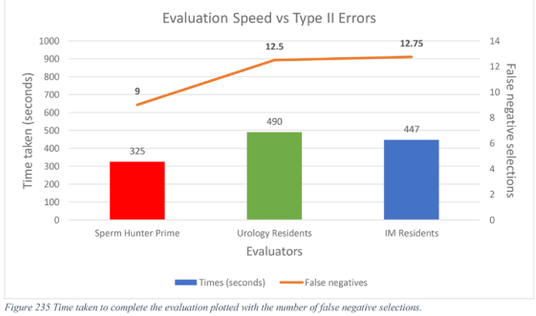

Figure 235 Time taken to complete the evaluation plotted with the number of false negative selections.

Figure 2: Demonstrates performance compared to urology and internal medicine residents, whom it outperforms in accuracy and speed. Here, a form of artificial intelligence can be used to teach surgery to urology residents.

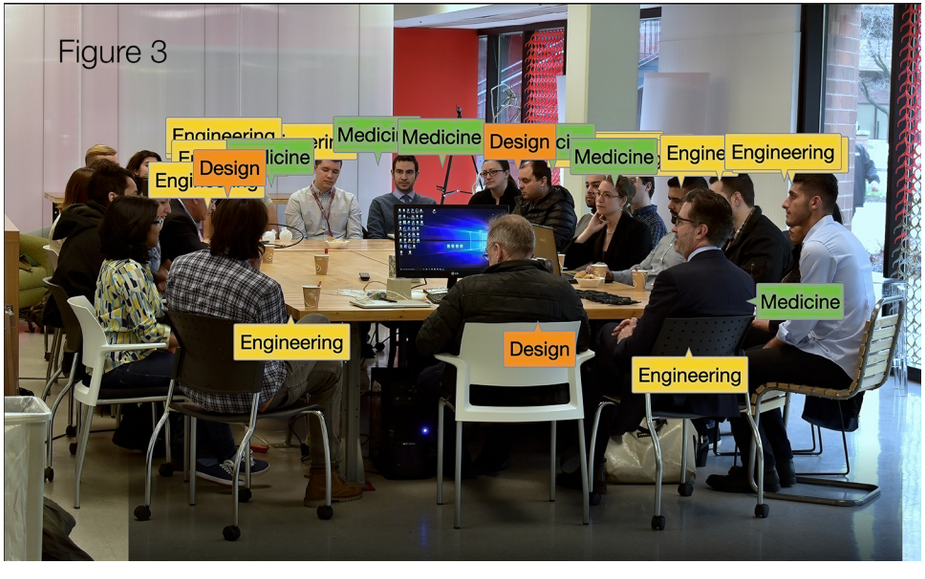

Figure 3: An ideal educational environment

There is a growing consensus that current LLMs can pass the Turing test. In early 2023, investigators reported that the LLM, ChatGPT, performed quite proficiently on the ACGME medical licensing exams (1). Of particular interest, ChatGPT could explain its answers well, demonstrating insight and a potential ability to assist in the medical educational process. I am personally uncertain of its current role in urological education, as when I've fed it easy factual questions, it tends to get them right, but when I've presented questions that require analysis and evaluation similar to the high taxonomy questions on formal urological exams, it often gets them very wrong.

However, artificial intelligence has taken another form through the years, that of modeling biological neural processes in order to solve complex problems. LLMs don't think like us; their architecture is completely different than that of the human brain. However, we can borrow from nature to address all sorts of challenges, as we humans evolved to be extraordinary pattern recognition systems. Neural networks mimic the physiology of biological neurons in computer hardware and software to tackle real world problems, and with the leaps and bounds that these computational resources have achieved in the past few decades, multiple layers of these neurons arrayed in specialized configurations in "convolutional neural networks" provide powerful tools for use in urological education.

As an example, a recent doctoral student completed his thesis on identification of testis tubules most likely to harbor sperm (2). He created an animal model of hypospermatogenesis and trained convolutional neural networks on a library of images generated from testis photographs with areas identified that contained sperm (2). Figure 1 demonstrates receiver operating characteristic curves models, including the final model with area under the curve at a satisfactory 0.85 and sample training images (2). Figure 2 demonstrates performance compared to urology and internal medicine residents, whom it outperforms in accuracy and speed. Here, a form of artificial intelligence can be used to teach surgery to urology residents.

Finally, it is very important to understand the context in which computational tools can be taught to the urologists who will use them and innovate with them. In the modern era, multiple disciplines including engineering, design, business, and of course, medicine, work together to create solutions for urological problems. We teach the process of innovation including artificial intelligence to learners such as medical students, residents, and fellows in a structured curriculum that includes all disciplines in an equal footing. Figure 3 demonstrates what that educational environment looks like.

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AUTHOR BIOGRAPHIES

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Dr. Gopal Badlani is a professor and vice-chair, Urology, at Wake Forest Baptist Medical Center in Winston-Salem, N.C. He is also the co-director of their Female Pelvic Medicine and Reconstructive Surgery Fellowship. He is the editor of several textbooks and has authored more than 200 publications and book chapters. Dr. Badlani is recognized as a world expert in the field of urinary incontinence and has been invited nationally and internationally as a visiting professor. He served a four-year term as Secretary of the AUA and was a member of the Advisory Council of the NIDDK.

David A. Bloom, MD

David A. Bloom was born, raised, and educated in Buffalo, New York, culminating with an MD from the University of Buffalo. He completed residencies in Surgery and Urology at UCLA as well as Pediatric Urology training in London England with Sir David Innes Williams. Bloom spent 4 years as staff urologist at Walter Reed Army Medical Center, rising to Lt. Col. He joined the University of Michigan where he became Jack Lapides Professor of Urology and served sequentially as Associate Dean for Faculty Affairs and then Chair of the Department of Urology.

Barbara Chubak, MD

Dr. Barbara Chubak did her urology residency at Montefiore Medical Center in the Bronx, NY. She completed a Fellowship in Bioethics at the Cleveland Clinic and has Master's degrees in Bioethics from Case Western Reserve University and in the History of Medicine from Johns Hopkins University, where she also received her Medical Doctorate. Her research interests combine these various disciplines, with a particular focus on the historic and contemporary psychosocial impact of male sexual dysfunction and its treatment.

Dr. Chubak has a long history of working with the William P. Didusch Center for Urologic History, contributing to several exhibits, most recently 2023 Battlefield Urology and 2024 Ins and Outs of Sexual Health. She is a member of the AUA History Committee and won the AUA Earl Nation Retrospectroscope Award in 2013 for her paper on "The Orthopedic Origin of Popular Male Circumcision in America."

Shelby Englert, CHCP

Shelby Englert, CHCP serves as the Vice President of Education for the American Urological Association. In this role, she provide leadership to the AUA Office of Education, AUA International Programs, AUA's Institute for Leadership and Business and AUA Research Education. Strategically, her focus is on the future of education, ensuring that the AUA offers the most relevant content in engaging formats that are the most accessible to the busy physician. Part of this effort includes the development of new digital products including educational apps, podcasts, and a YouTube channel to engage our learners. Ms. Englert has served as both an ACCME Accreditation Review Committee member and an ACPE Commissioner. Additionally, she volunteers on the Finance Committee for the Alliance for Continuing Education in the Health Professions and has held volunteer leadership positions within the Council for Medical Specialty Societies.

Robert C. Flanigan, MD, FACS

Robert C. Flanigan, MD, FACS, is currently a Professor of Urology at Loyola University Chicago, Stritch School of Medicine. Previously, he served as the Albert J. Speh Jr. and Claire R. Speh Professor and Chair of the Department of Urology at Loyola University for 32 years. He graduated from Case Western Reserve University (CWRU) School of Medicine before completing his residencies in urology and general surgery at CWRU Affiliated Hospitals in 1978 and becoming board certified in both urology and general surgery.

After residency, he served in the U.S. Air Force for two years and was awarded the Air Force Commendation Medal. He then began his academic career at the University of Kentucky before accepting a position at Loyola University Chicago. Dr. Flanigan has been continuously involved in basic, translational and clinical research. His primary research interests have been in the area of urologic oncology, especially renal and prostate carcinoma. His research work with cytoreductive nephrectomy dramatically changed practice patterns in advanced renal cancer. In 2011, he received the Distinguished Contribution Award from the Society of Basic Urologic Research.

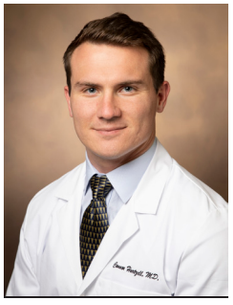
Dr. Flanigan has also made over 450 contributions to medical literature. Dr. Flanigan has served as President of the North Central Section of the American Urological Association (AUA), the American Board of Urology, the American Association of Genitourinary Surgeons, the Society of Urologic Oncology, the Society of University Urologists, the Society of Pelvic Surgeons, and was founder and first President of the Society of Urologic Chairpersons and Program Directors. In 2011, he completed a five year term as AUA Secretary, during which he directed the development of the first Core Curriculum for Urology and initiated the Global Philanthropic Committee. In 2011, the

AUA created the Robert C. Flanigan Education Award to be presented every three years to an individual that makes exemplary contributions to the educational goals of the AUA. In 2017, he was awarded the AUA's highest honor, the Ramon Guiteras Award, for outstanding contribution to the art and science of urology. He has also received the Ferdinand Valentine Medal from the New York Academy of Medicine, the Huggins Medal from the Society of Urologic Oncology and the first Distinguished Service Award from the Chicago Urological Society.

Jennifer B. Gordetsky, MD

Jennifer B. Gordetsky, MD, is a Professor in the Department of Pathology, Microbiology and Immunology and the Department of Urology at Vanderbilt University Medical Center (VUMC) in Nashville, TN, where she specializes in genitourinary pathology. Dr. Gordetsky currently serves as Director of the Division of Anatomic Pathology for Vanderbilt Medical Laboratories. In 2005, she received a medical doctorate from the Medical College of Wisconsin and was accepted into a urology residency at the University of Rochester Medical Center (URMC). In 2009, Dr. Gordetsky entered a residency in Anatomic Pathology at URMC. She became board certified in Anatomic Pathology in 2012, which was followed by a fellowship in general surgical pathology at URMC and a fellowship in GU surgical pathology at The Johns Hopkins Hospital.

Since the completion of her training, Dr. Gordetsky has been actively involved in oncologic research and medical education. She served for nine years as a medical school course director, teaching pathophysiology of the reproductive systems. During this time, she received awards for Best Educator, Best Organ Module, and the Dean's Award for Excellence in Teaching. In 2019, Dr. Gordetsky established the first GU pathology fellowship at VUMC. To date, she has more than 160 scientific publications in peer-reviewed literature and multiple book chapters to her credit. In 2021, she was presented with the Arthur Purdy Stout Society of Pathology Annual Prize and in 2024 with the William P. Didusch Art & History Award from the American Urological Association. Dr. Gordetsky has been a member of the United States and Canadian Academy of Pathology (USCAP) since 2014. Over the last 10 years, she has consistently presented abstracts at USCAP annual meetings and has been an invited speaker at companion society meetings. In addition, she has served on the Abstract Review Committee, the Education Committee, and is currently Chair of the Subcommittee for Unique Live Course Offerings. Dr. Gordetsky has been an invited speaker nationally and internationally in the field of GU pathology.



Connor Hartzell, MD

Dr. Connor Hartzell is a third-year pathology resident at Vanderbilt University Medical Center. He was born in Panama City, Florida, and grew up in the United States and Germany. He always enjoyed watching history programs with his dad. Dr. Hartzell attended the University of Florida where he majored in Microbiology and Cell Science and minored in Philosophy. There he became interested in adventure trekking, leading him to summit Kilimanjaro just after graduation. He earned his MD from Temple University Lewis Katz School of Medicine in Philadelphia. He led the medical school's tutoring program and helped plan the anatomy body donor celebration. In residency, he authored several peer-reviewed papers and was selected as a Kinney Scholar by the Association for Academic Pathology. He will pursue academic hematopathology with plans to research post-transplant lymphoproliferative disorders in xenotransplant recipients. In his spare time, Dr. Hartzell enjoys cooking with his fiancée, exercising, and reading/watching science fiction.

Elspeth M. McDougall, MD, FRCSC, MHPE

Dr. McDougall is internationally recognized for her laboratory and clinical research in urologic laparoscopic surgery and for teaching courses on fundamental and advanced endourological, laparoscopic, and robotic surgery techniques.

Dr. McDougall completed her medical and Family Practice residency training at the University of Calgary. She completed her urology residency training at the University of Ottawa in Canada and then undertook a fellowship in endourology and extracorporeal shock wave lithotripsy (ESWL) with Dr. Ralph Clayman in 1987 at Washington University School of Medicine in St. Louis, Missouri. Following her fellowship training in 1988, she practiced private practice urology at St Vincent's Hospital in Vancouver and the Richmond General Hospital in Richmond, BC for two and a half years. She joined the faculty at Washington University Medical School in 1991, where she spent nine years in academic urology including clinical practice in endourology, clinical translational research to develop new surgical techniques in laparoscopic urology, taught health care professionals in the minimally invasive techniques of endourology and laparoscopic urology, within the institution, nationally and internationally. Subsequently, she developed the Endourology/Laparoscopic Urology Program at Vanderbilt University in Nashville, Tennessee during her tenure there as Professor of Urologic Surgery from 1999 to 2001. In 2002 she became Professor of Urology at the University of California, Irvine where she developed the ongoing, five-day mini-residency training program in minimally invasive urologic surgery, including robotic urologic surgery, for post-graduate urologists. In addition, she served as the Director of the Surgical Education Center and Associate Dean of

Simulation and Medical Education, during which time she helped create a robust multidisciplinary and integrated health professional education program at UC Irvine. Dr. McDougall joined the University of British Columbia, Department of Urologic Sciences as Professor in February 2013 and served as the Provincial Coordinator for Health Simulation Education for the Faculty of Medicine at UBC. On her retirement in June 2019, she was awarded Professor Emeritus status and continued to serve on the Department of Urologic Sciences' Competency Committee for the residency training program.

She is a Fellow of the Royal College of Surgeons of Canada (Urology) and certified with the American Board of Urology. Dr. McDougall has published close to 300 peer-reviewed journal articles and numerous book chapters. She is the co-editor of two textbooks on laparoscopic surgery. In 2008, Dr. McDougall successfully completed a Masters in Health Profession Education from the University of Illinois at Chicago.

Dr. McDougall has been chairperson of the AUA Laparoscopy Committee and coordinated the Ad Hoc Surgical Simulation Group with the American Urological Association. She served as Chair of the American Urological Association Office of Education from 2009 to 2015. In this leadership role she oversaw all aspects of the educational programs and activities of the AUA. She was on the editorial boards of the Journal of Endourology and the Journal of the Society of Laparoendoscopic Surgeons. She is Past President of the Society of Laparoendoscopic Surgeons and was awarded the Excel Award by this multidisciplinary surgical society in 2007. She was an elected member to the prestigious American Association of Genitourinary Surgeons. In 2017, she received the AUA Presidential Citation for outstanding contributions to education and innovative learning methods in urology and the Endourological Society Lifetime Vision & Achievement Award for her significant and lasting contributions to the field of endourology. She now enjoys her retirement in the interior of British Columbia.

Friedrich H. Moll, MD

Dr. Friedrich H. Moll is a distinguished urologist and medical historian with extensive expertise in urology, medical ethics, and the history of medicine. He earned his medical degree from RWTH Aachen in 1986, followed by board certification in urology in 1991 and a doctorate in 2019. Dr. Moll has held key positions at Cologne Medical Center and has been affiliated with leading institutions such as the Institute for the History, Theory, and Ethics of Medicine in Düsseldorf.

As an expert in the history of urology, he has contributed significantly to academic research, serving as chairman of the working group on history at the Academy of German Urologists and curator of the German Association of Urology's Museum, Library, and Archives since 2008. He has authored over 300 peer-reviewed publications, 21 handbook chapters, and 8 books on the history of urology. Dr. Moll is an active member of numerous national and international scientific societies, including the German Urological Association, the American Urological Association, and the European Association of Urology. He has been a valued member of the AUA History Committee and has collaborated on exhibits and presentations with The William P. Didusch Center for Urologic History for over 20 years. He won the prestigious William P. Didusch Art and History Award in 2017 for outstanding contributions to the history of urology, especially the history of endoscopy, the transfer of science and knowledge between Europe and North America and the fate of German urologists under national socialism.

Dinora Murota

Dinora Murota is a fourth-year medical student at New York Medical College. Originally from Berkeley, California, she earned her undergraduate degree in Comparative Literature from Washington University in St. Louis. Her medical interests are centered on urology, with a focus on reconstructive and gender-affirming surgery.

Craig Niederberger, MD

As a professor of urology and bioengineering, Dr. Niederberger oversees undergraduate and graduate engineering and medical students, urology residents and fellows at the University of Illinois at Chicago's (UIC) Innovation Center, an intercollege research and design lab. Dr. Niederberger's students work on the surgical user interface, helping surgeons more accurately see, feel and operate. Dr. Niederberger is a co-founder of the surgical device company NexHand.

Dr. Craig Niederberger is Clarence C. Saelhof Professor and Head of the Department of Urology in the College of Medicine at the University of Illinois at Chicago, and holds a joint appointment as Professor in the Department of Bioengineering in the College of Engineering. He is Co-Editor in Chief of Fertility and Sterility and a prior section editor for the Journal of Urology®. He is a primary editor of the fourth edition of Infertility in the Male and An Introduction to Male Reproductive Medicine. He served as general program chair for the American Society for Reproductive Medicine's annual meeting in Atlanta in 2009 and has served as president of the Society for the Study of Male Reproduction within the American Urological Association and as president of the Society for Male Reproduction and Urology within the American Society for Reproductive Medicine.

Victor W. Nitti, MD

Victor W. Nitti, MD, is Professor of Urology and Obstetrics and Gynecology and the Shlomo Raz Chair in Urology as well as the Chief of the Division of Urogynecology and Pelvic Reconstructive Surgery (URPS) and is the fellowship director for that ACGME accredited program at the David Geffen School of Medicine at UCLA.

Dr. Nitti is a graduate of the University of Rochester and Rutgers New Jersey Medical School. He completed urology residency at SUNY Downstate in Brooklyn, NY and a fellowship in female urology, neurourology and reconstructive urology at UCLA. Dr. Nitti served on the faculty at SUNY Brooklyn and NYU before joining the faculty of UCLA.

He is an authority in urodynamic techniques, medical and surgical therapies for urinary incontinence, pelvic organ prolapse, female pelvic reconstructive surgery and voiding dysfunction. He has authored over 200 peer-reviewed articles and 80 book chapters. He is the editor of two textbooks: Practical Urodynamics and Vaginal Surgery for the Urologist. He has presented his research at national and international meetings and has been invited as a visiting professor and participated in postgraduate courses throughout the world. In 2015 he was the recipient of the AUA's Victor Politano Award for expertise and contributions in urodynamics, medical and surgical therapies for urinary incontinence, female pelvic reconstruction and voiding dysfunction. In 2020, he received the Society for Urodynamics, Female Pelvic Medicine and Urogenital Reconstruction (SUFU) Lifetime Achievement Award.

Dr. Nitti is a Fellow of the American College of Surgeons (ACS) and the American Board of Urology (ABU) and a member of the American Urological Association (AUA), the Society for Urodynamics, Female Pelvic Medicine and Urogenital Reconstruction (SUFU), The American Urogynecologic Society (AUGS), the International Continence Society (ICS) and International Consultation on Incontinence (ICI). He is a past president of SUFU (2010-2012) and the SUFU Foundation (2017-2023). He served on the board of directors for the New York Section of the American Urological Association and was the organization's Secretary from 2017-2018. Dr. Nitti held the position of Chair, American Urological Association Office of Education from 2015-2021. He is a member of the American Association of Genitourinary Surgeons (AAGUS) and served on the AAGUS Council. Dr. Nitti served on the combined FPMRS Committee of the American Board of Obstetrics and Gynecology/American Board of Urology. Dr. Nitti has served on the editorial boards of Neurourology and Urodynamics, the Journal of Female Pelvic Medicine and Reconstructive Surgery, and the International Urogynecology Journal.

Sutchin R. Patel, MD, FACS

Dr. Patel is an Adjunct Assistant Professor at the University of Wisconsin Department of Urology. Dr. Patel has been actively involved with the William P. Didusch Center for Urologic History since 2011. He has served on the AUA History Committee and is currently on the Editorial Board for the International Journal of Urologic History, the Board of Governors for the American Osler Society, and a member of the Endourological Society History Committee. Dr. Patel was a recipient of the AUA Earl Nation Retrospectroscope Award in 2011 for his paper, "Standing On The Shoulders Of Giants: Teaching The History Of Urology", and received the William P. Didusch Art and History Award for important contributions to the understanding and appreciation of the history of urology.

John L Phillips MD, FACS

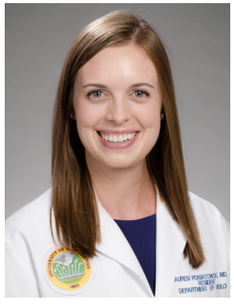
Dr. Phillips was raised in Tarrytown, NY amongst the hamlets and vales made famous in the stories of Washington Irving. He graduated from Sleepy Hollow High School and then Wesleyan University with BAs in biology and classics. He received a Howard Hughes research grant while a medical student at Yale University researching cytokine biology in bone remodeling before his urologic training at Yale-New Haven Hospital. Translational research still beckoned, however, and he completed a two-year fellowship, at the dawn of genomics and robotic surgery, at the National Cancer Institute/National Institutes of Health where he was also Program Director for the urology residency at National Naval Medical Center. He returned to his roots in New York thereafter and established a practice in robotics, urologic oncology, and clinical trials.

Dr. Phillips was in the 2008-2009 Leadership Program of the AUA and served on the Executive Committee of the New York Section of the AUA and of the Valentine Committee of the New York Academy of Medicine. With a primary focus on residency training, he has served as Program Director at Westchester Medical Center and New York Medical College since 2008 and as the department's Executive Vice Chair since 2022.

Dr. Phillips' interest in history may have stemmed from the lore of Washington Irving promulgated through his grammar school curriculum but which parlayed easily into a great interest in medical history. He was president of the Nathan Smith Society while at Yale Medical School, a voluntary organization dedicated to the history of New Haven and Connecticut's innovative thinkers in health care since colonial times. Yale was the site of copious high altitude research during World War II led by John P Fulton which inspired Dr. Phillips to complete a book, The Bends, on the history of compressed air and its diseases, published by Yale University Press in 1998. The success

of the AUA History Forum but the absence of a publishing venue for award-winning papers led to his creation, with Dr. Akhil Saji of USC, of the International Journal of Urologic History (www.ijuh.org), entering its 5th year in 2023.

He lives in Sleepy Hollow, NY, with his wife, Katherine, having raised 3 children there, and now helping with their 1st grandchild, Sophia, the 6th generation inhabitant of those leafy climes.



Lauren Poniatowski, MD, MS

Dr. Poniatowski graduated from the University of Minnesota with a Master's degree in Biomedical Engineering. She attended Medical School at the University of Minnesota and went on to urology residency at the University of Washington. She is currently a pediatric urology fellow at Seattle Children's Hospital. Dr. Poniatowski's research interests include applications of biomedical engineering in surgical simulation in pediatric urology.

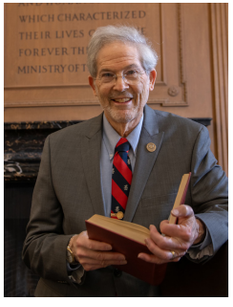
Glenn Michael Preminger, MD

Glenn M. Preminger, MD, is the James F. Glenn, Distinguished Professor of Urologic Surgery and Director of the Comprehensive Kidney Stone Center at Duke University Medical Center, where he focuses on the minimally invasive management of urinary tract stones including SWL, percutaneous and ureteroscopic stone removal. He also directs the metabolic evaluation and preventative medical treatment offered at the Stone Center. Dr. Preminger has extensive experience in developing endoscopic instrumentation for minimally invasive urologic procedures and co-holds nine patents in SWL design. Dr. Preminger, along with Pei Zhong, Ph.D., established The Lithotripsy Laboratory, having been awarded over $10 million in research support from the NIH. Dr. Preminger has published more than 360 manuscripts, 100 book chapters and 10 books.

He has served as Co-Chairman of the 1st and 2nd International Consultations on Stone Disease, (2001 & 2007). He was Chairman of the AUA Nephrolithiasis Guidelines Panel (2002-2012), Co-Chairman of the joint AUA/EAU International Nephrolithiasis Guidelines Panel (2003-2012), Chair of the AUA Office of Education (2006–2009), Director of Education for the Endourological Society (2011-2017), and President of the Endourological Society (2020). He has served as SESAUA Secretary (2015-2018) and President (2019).

Honors include AUA Residents Committee Teaching Award (2008), International Urolithiasis Society Lifetime Achievement Award (2016), BAUS St. Paul's Medal (2013),

Endourological Society's Lifetime Achievement Award (2018), Endourological Society Honorary Membership (2021), AUA John K. Lattimer Lecturer (2021), AUA Ramon Guiteras Award (2022), AUA Urology Care Foundation Distinguished Scholar Alumnus Award (2022), Southeastern Section Representative to the AUA Board of Directors (2023-2025) and Secretary General of the American Association of Genitourinary Surgeons (2023-2028).



Ronald Rabinowitz, MD

Ronald Rabinowitz, MD, is Professor of Urology and Pediatrics, Chief of the Division of Pediatric Urology at the University of Rochester, and Historian Emeritus for the American Urological Association (AUA).

Born and raised in Pittsburgh, Dr. Rabinowitz earned his medical degree from the University of Pittsburgh. He completed his urology residency at the Hospitals of the University Health Center of Pittsburgh, including a year at the Children's Hospital of Pittsburgh. This was followed by a fellowship in pediatric urology at the Hospital for Sick Children, Toronto. He served two years on active duty in the United States Air Force as a pediatric and general surgeon.

Dr. Rabinowitz is an internationally renowned expert in pediatric urology and urologic history. He has served organized urology in numerous capacities for more than four decades. As a member of the AUA Board of Directors (2001-2005), he served as a member of the History sub-committee of the Strategic Long Range Planning Committee that was tasked with designing a role for the William P. Didusch Center for Urologic History in the new headquarters building. In this capacity, he recommended and participated in planning to spread the museum's displays throughout the building, as one sees today.

Nationally, Dr. Rabinowitz has served the Northeastern Section AUA as Secretary, President, and Historian; the American Academy of Pediatrics Section on Urology as Chair; and the American Board of Urology on the written examination committee and as an oral examiner.

The AUA has honored Dr. Rabinowitz with a Distinguished Service Award in 2013, the Lifetime Achievement Award in 2021, and the William P. Didusch Art and History Award in 2023.

Dr. Rabinowitz has continued to lecture and publish on topics related to urologic history. He has authored or co-authored over 250 scientific publications and textbook chapters (many pertaining to urologic history), edited a textbook on pediatric urology, and served on history publication committees. He has remained steadfastly committed to the preservation of urologic history and the William P. Didusch Center for Urologic History.

Justin M. Refugia, MD

Dr. Justin M. Refugia, a native of North Carolina, earned his Bachelor of Science in biology from Old Dominion University in Norfolk, Virginia. He subsequently obtained his Doctor of Medicine from Eastern Virginia Medical School, also in Norfolk. Dr. Refugia is currently completing his residency in Urology at Wake Forest University School of Medicine in Winston-Salem, North Carolina, with an anticipated graduation in 2025. Following his residency, he will further his specialization as a Society of Urologic Oncology Fellow at Duke University in Durham, North Carolina, from 2025 to 2027.

Linda Dairiki Shortliffe, MD

Linda Dairiki Shortliffe is the Stanley McCormick Memorial Professor Emerita and past Chair of Urology Stanford University. She was Department Chair of Urology at Stanford University, President and Trustee of the American Board of Urology, President of the American Association of Genitourinary Surgeons (AAGUS), a Hewlett Foundation Fellow at the Radcliffe Institute for Advanced Study at Harvard, a Stanford University Clayman Institute Faculty Fellow, and a Distinguished Expert on the California Council on Science & Technology.

She examined basic mechanisms of prostatitis, effects of pregnancy and sex hormones on the urinary tract, urinary tract infections, and genitourinary imaging and physiology. She is interested in advancing urologic scientific and medical education. Dr. Shortliffe was Chair of the National Institutes of Health (NIH) Bladder Research Program Review Group that published the HSS (US Health and Human Services) document that guided benign bladder research and federal funding for over a decade: Overcoming Bladder Disease: a Strategic Plan For Research, Deputy Chair of the NIH Consensus Panel on Impotence, a member of NIDDK Special Grants Chartered Review Committee, NIH Urology Strategic Planning Committee, and other NIH, NIDDK committees.

She was a recipient of the 2018 SWIU Jean Fourcroy Leadership Award, 2016 New York Academy of Medicine Ferdinand C. Valentine Medal, 2015 American Urological Association Distinguished Service Award, 2020 AUA Honorary Member, 2012 Distinguished Alumnae of Children's Hospital of Philadelphia in Pediatric Urology, 2008 Stanford University Asian Faculty Award, and included in Forty Careers in Medicine, Stanford University School of Medicine, 2000. She is included in the Stanford University oral history project (https://historicalsociety.stanford.edu/publications/shortliffe-linda-dairiki), 2019.

She received her AB cum laude in History and Science from Radcliffe/Harvard College, MD from Stanford University, general surgery, urologic and chief residency training

at Stanford University Medical Center, and pediatric urological training at Children's Hospital of Philadelphia.

Robert M. Sweet, MD, MS

Dr. Sweet practices urology, focusing on endourology, with a clinical emphasis on kidney stones and diseases of the prostate. He is the Medical Director for the UW Medicine Kidney Stone Center at Northwest Hospital, the Executive Director for the WWAMI Institute for Simulation in Healthcare and Executive Director for the Research in Education and Simulation Technologies.

Dr. Sweet received his medical degree (alpha omega alpha) from the University of Minnesota in 1997. After a urology residency at the University of Washington in 2003, he became Attending Physician/Acting Assistant Professor of Urology and held a 2-year Health Policy Scholarship focused on Simulation Sciences from the American Foundation for Urological Diseases (AFUD).

In 2004, Dr. Sweet co-founded the Institute for Surgical and Interventional Simulation (ISIS) at the University of Washington.

He is the principal investigator of numerous simulation research and development projects. Dr. Sweet has leadership positions in the area of simulation and education within the American College of Surgeons, the Endourological Society, and the American Urological Association. He is Past President of the Society of Laparoendoscopic Surgeons.

Russell Terry, MD

Dr. Russell Terry is an Assistant Professor of Urology at the University of Florida College of Medicine and the Malcom Randall VA Medical Center in Gainesville, FL. He completed his urology residency training at the University of Florida, followed by a two-year fellowship in Endourology, Metabolic Stone Disease, Laparoscopic and Robotic Surgery at Duke University Medical Center. During fellowship, he received an AUA Research Scholar Award to study the physics and optimization of new laser lithotripsy technologies for the treatment of kidney stones.

Dr. Terry's clinical focus at the University of Florida is the medical and surgical management of complex kidney stone disease. His VA practice is primarily prostate cancer and minimally invasive urologic oncology. His research interests include artificial intelligence, deep learning, medical imaging radiomics, laser lithotripsy, metabolic kidney stone disease, and the development and testing of novel medical devices.