COLLEGE of AMERICAN PATHOLOGISTS

ISSUES BRIEF

How Laboratory Technology and Techniques Are Revolutionizing Cancer Care

Lessons on how to use technology to improve the patient medical journey are playing out at Moffitt Cancer Center. A leader in precision medicine, the Tampa, Florida-based, National Cancer Institute-designated comprehensive cancer center is implementing laboratory and digital technologies, as well as specialized pathology techniques, to improve the accuracy and speed of diagnosis. When used appropriately, these technologies and techniques are also reducing costs and workload demands on busy pathologists.

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Marilyn Bui, M.D., Ph.D., FCAP, section head of bone and soft tissue pathology, Moffitt Cancer Center

Recognizing the promise of technology and science to radically improve patient care, Moffitt Cancer Center is working toward achieving three strategic goals by 2028:

Personalized Care Continuum

Lead in personalized care throughout the patient journey, which includes using genomic and genetic markers, (i.e., DNA alterations in tumors) to help determine a targeted treatment plan for each patient.

Digital Care & Discovery Accelerator

Lead in digital oncology advances, which involves using computational approaches (e.g., artificial intelligence [AI] and machine learning) to improve oncology care decisions.

Market Expansion

Expand reach to direct the care of more cancer patients, which includes adding additional outpatient clinics and serving as a reference laboratory for other health care organizations.

For all these goals, the cancer center's pathology department and clinical laboratories are uniquely positioned to take on leadership roles. "Traditionally, pathologists are physicians who provide the diagnosis," says Marilyn Bui, M.D., Ph.D., FCAP, section head of bone and soft tissue pathology. "But in the era of precision medicine, pathologists' functions are extended by providing prognostic and predictive information to guide clinical teams in managing patients effectively."

During a September 2019 College of American Pathologists-sponsored AHA webinar, Bui shared a number of examples of how Moffitt Cancer Center is using state-of-the-art laboratory techniques and technologies to ensure more accurate, faster, and less expensive diagnostic and prognostic information. These insights are invaluable to clinicians looking to identify the right therapies (e.g., targeted drugs and immunotherapy) to treat a patient's subtype and stage of cancer.

Robert J. Keenan, M.D., vice president of quality and chief medical officer, acknowledged that laboratory and digital technologies can be expensive, but points to the positive return on investment in terms of better patient outcomes and experience as well as improved safety, efficiencies, and fiscal returns. "If there are ways in which these technologies can also reduce costs, then so much the better," Keenan says.

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State-of-the-Art Laboratory Medicine

The following are some of the ways that Moffitt Cancer Center is using advanced techniques and technology in pathology to improve value.

Rapidly diagnosing sepsis. Nearly 270,000 Americans die from sepsis each year, according to the Centers for Disease Control and Prevention. The key to reducing mortality is a quicker and more accurate diagnosis. "Cutting down the turnaround time in reporting positive results to physicians ultimately results in faster treatment to the patient," Bui says.

The cancer center's antimicrobial stewardship program worked with clinicians and administrators to acquire three new laboratory instruments that have significantly speeded up sepsis diagnosis:

- An automated blood culture system rapidly grows and detects bacteria and requires less hands-on time of laboratory staff. A sepsis diagnosis is now available one-half to one day sooner than before.
- An antibiotic susceptibility testing instrument distinguishes between gram-negative and gram-positive bacteria in blood samples of sepsis patients so that the right antibiotic can be prescribed. The technology also provides results 25.5 minutes quicker per test than previous approaches.
- An automated mass spectrometry microbial identification system allows for rapid identification of numerous organisms. While the other two instruments are specific to bacteria, this system can identify bacteria, yeast, mold, nocardia, and microbacteria. The system has reduced test turnaround time by six to 48 hours and increased identification of the optimal antimicrobial therapy. It also has reduced costs from $3.50 per test to $0.30 per test.

Speeding up diagnosis during surgery. After taking a biopsy of cancerous or suspicious tissue, surgical oncologists often pause the operation until pathologists examine the specimen and provide key insights. "The clinical question is: 'Is this benign or malignant?' And, if it's malignant, [the surgeons] usually want to know what type [of cancer]," Bui says. "This is where pathologists really make an immediate impact."

Traditionally, many pathologists quick-freeze the biopsy sample before studying it under a microscope. While this technique, known as "frozen section," allows for a fairly rapid "yes" or "no" to the cancer question, it does not always provide enough specificity for the pathologist to determine the type of cancer.

Additionally, Bui uses more specific cytology techniques (i.e., the study of cells), including touch imprint, to rapidly identify the type of cancer. For instance, using these techniques, Bui was able to determine that a suspicious bone lesion on a 40-year-old woman was not only cancerous, but that the cancer was most likely a lymphoma.

Without this definitive diagnosis, the cancer team might have assumed the patient had breast cancer. But intraoperatively knowing it is possibly a lymphoma, the fresh tissue can be traced for a flow cytometry study, which confirmed the diagnosis with more speed and accuracy. Knowing the accurate diagnosis allows the team to take the appropriate next steps. "Now that it's lymphoma, it will be treated differently," Bui says. "The clinical team can refer the patient to the hematology-oncology service to have a port inserted to prepare for therapy because, in this case, there's no need for surgery. It's going to be medical treatment."

Bui stresses that state-of-the-art approaches are not always expensive. "In this case, we're using cytology, which doesn't cost [much]."

Targeting the right therapy. Many targeted cancer therapies are proven in clinical trials to be better than other therapies, but only if they are given to patients with cancers that harbor specific genetic mutations.

To help identify these mutations, Moffitt Cancer Center developed an assay, called the Moffitt STAR™ (Solid Tumor Actionable Result) panel, which allows pathologists to screen patient tumors for numerous genetic changes in 170 genes. This can be done in a single test using a relatively small amount of tissue.

The STAR panel also allows the cancer center to screen for more cancers in house versus having to send samples out for testing.

Alleviating the Pathologist Shortage

In addition to improving patient care, laboratory innovations and technologies are being touted as a strategy for alleviating the current shortage of pathologists. The United States saw a 17.53% decline in the number of pathologists between 2007 and 2017, according to a May 31 study in *JAMA Network Open*. During the same period, demand for pathology diagnostic consults rose by 41.73%.

The shortage does not look as though it will let up anytime soon. Between 2008 and 2017, the number of seniors applying for pathology positions dropped by 27.5%, according to a *Human Pathology* study.

Automated laboratory equipment, digital pathology, artificial intelligence, and other innovations promise to lessen hands-on time required of laboratory staff, which will ease workloads of busy pathologists. "We have to make up those shortages through a variety of means, including technologies," says Robert J. Keenan, M.D., vice president of quality and chief medical officer, Moffitt Cancer Center.

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Saving money on blood irradiation while improving safety. Some people receiving blood transfusions, including immunocompromised cancer patients, run the risk of developing a rare but often fatal complication called transfusion-associated graft versus host disease (TA-GVHD). To prevent TA-GVHD and save lives, clinical laboratories irradiate blood and blood products (i.e., exposing it to high-energy waves) before giving it to patients at risk for this disease.

Historically, Moffitt Cancer Center used a gamma blood irradiator machine to irradiate blood. However, the U.S. National Nuclear Regulatory Commission (NNRC) is encouraging health care organizations to replace gamma irradiators because these machines use cesium-137, a radioactive isotope that poses significant security and health concerns. Radiation contamination can occur if the equipment is mishandled or if terrorists get hold of the cesium-137 to make dirty bombs. Laboratories with gamma irradiators must meet cumbersome national safety requirements, including fingerprinting all staff members and installing motion detectors and tamper-proof detectors on the irradiator.

Working with clinical leaders, the blood bank at Moffitt Cancer Center recently replaced its unsafe gamma machine with a more efficient X-ray blood irradiator. The NNRC provided the hospital with a financial incentive to switch models and paid for the removal and disposal of the old gamma machine (at a cost of $100,000–$200,000). Rounding out the benefits, the new X-ray model irradiates more units of blood per run than the gamma model, saving the cancer center $28,000 a year. "That's a good example of the blood bank saving money for the hospital while keeping up with new regulatory requirements," Bui says.

Moving toward digital pathology and AI. Bui believes digital pathology will revolutionize laboratory medicine. Digital pathology is not just about scanning histopathological slides so they can be viewed digitally, she explains. "In addition to telepathology and image analysis, AI has the potential to combine different data sources, images, patient records, genomic information, radiologic images, and [more] to provide actionable information that helps the clinical team."

This is where AI comes in. Moffitt Cancer Center recently added a chief AI officer to determine how the health system can begin applying deep learning and AI to sort through various types of patient data and images to help improve cancer diagnosis and treatment.

This will be a game changer, Keenan believes. He points to sepsis as an example. "Sepsis is an incredibly important concern for us, not only because of the increasing susceptibility of our patients, but also the fact that those patients often don't manifest the typical signs and symptoms that other patients might," he says. "By using AI to help us predict earlier when patients may be developing sepsis, we'd be able to intervene and prevent [the patient] from getting severe sepsis and prevent mortality."

AI also can help pathologists improve their diagnostic accuracy, Bui says. In a 2016 report, an AI program had a 7.5% misdiagnosis rate when looking for

malignant breast cancer on digital slide images. In comparison, pathologists had a 3.5% error rate. However, when pathologists consulted the AI program while looking at digital slides, their misdiagnosis rate decreased to 0.5%, an 85% improvement.

Digital pathology should also help improve efficiencies and reduce the workload of pathologists. A study at the University of Pittsburgh Medical Center found that digital pathology made pathologists 12% to 13% more efficient.

A Multidisciplinary Approach

Moffitt Cancer Center is slated to achieve a 12% increase in pathology volume by the end of the hospital's FY 2019 compared with that of FY 2015. The adoption of advanced techniques and technologies is a major contributing factor to this growth.

So, too, is the multidisciplinary approach to care at Moffitt Cancer Center. Rather than being organized by specialty departments as are many hospitals (e.g., oncology and orthopedics), Moffitt Cancer Center is made up of interdisciplinary teams that focus on specific cancer types (e.g., endocrine tumors and neuro-oncology). Each team includes pathologists and radiologists who specialize in that specific type of cancer, as well as surgical oncologists, medical oncologists, and radiation oncologists. "We put our heads together to give the best possible [diagnostic] report on a particular patient," says Bui.

Pathologists also sit on various hospital committees, which allows them to further partner with senior leaders and front-line clinicians to advance patient-centered, precision medicine. For instance, Bui is the medical staff president at Moffitt by election. "Pathologists traditionally are not ones that have been at the forefront of medical staff leadership in many cases," Keenan says. "But the importance of pathologists in what we do here at Moffitt is reflected in the fact that people like her serve on these various hospital committees."

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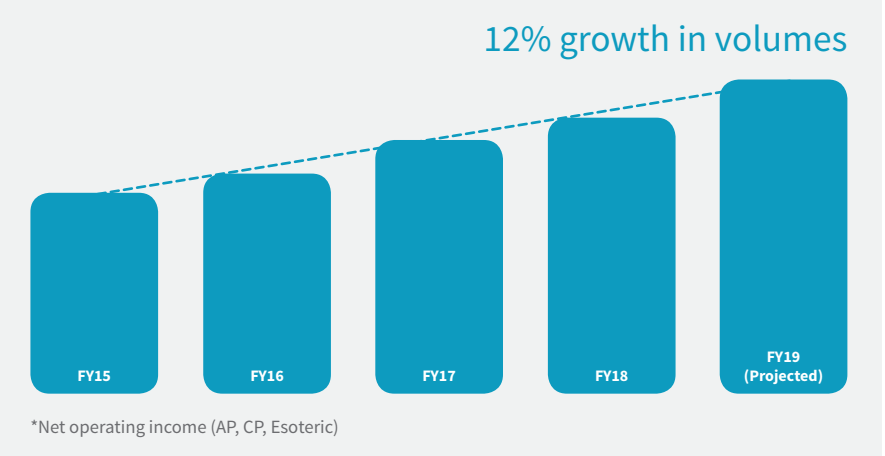
Moffitt Cancer Center Pathology Services NOI*



Key Takeaways

1	Close partnerships among pathologists, hospital administrators, and other clinicians is key to effective, patient-centered precision medicine.
2	While advanced laboratory equipment and technologies can be expensive, they often produce a positive long-term return on investment in terms of lower total costs, improved efficiencies, and better patient outcomes.
3	By leveraging and developing emerging technologies like digital pathology and artificial intelligence, pathologists will be more fully able to diagnose disease and work with clinicians in more accurately guiding treatment.

About the College of American Pathologists

As the world's largest organization of board-certified pathologists and leading provider of laboratory accreditation and proficiency testing programs, the College of American Pathologists (CAP) serves patients, pathologists, and the public by fostering and advocating excellence in the practice of pathology and laboratory medicine worldwide.

College of American Pathologists
325 Waukegan Road
Northfield, IL 60093-2750
Phone: 800-323-4040
cap.org