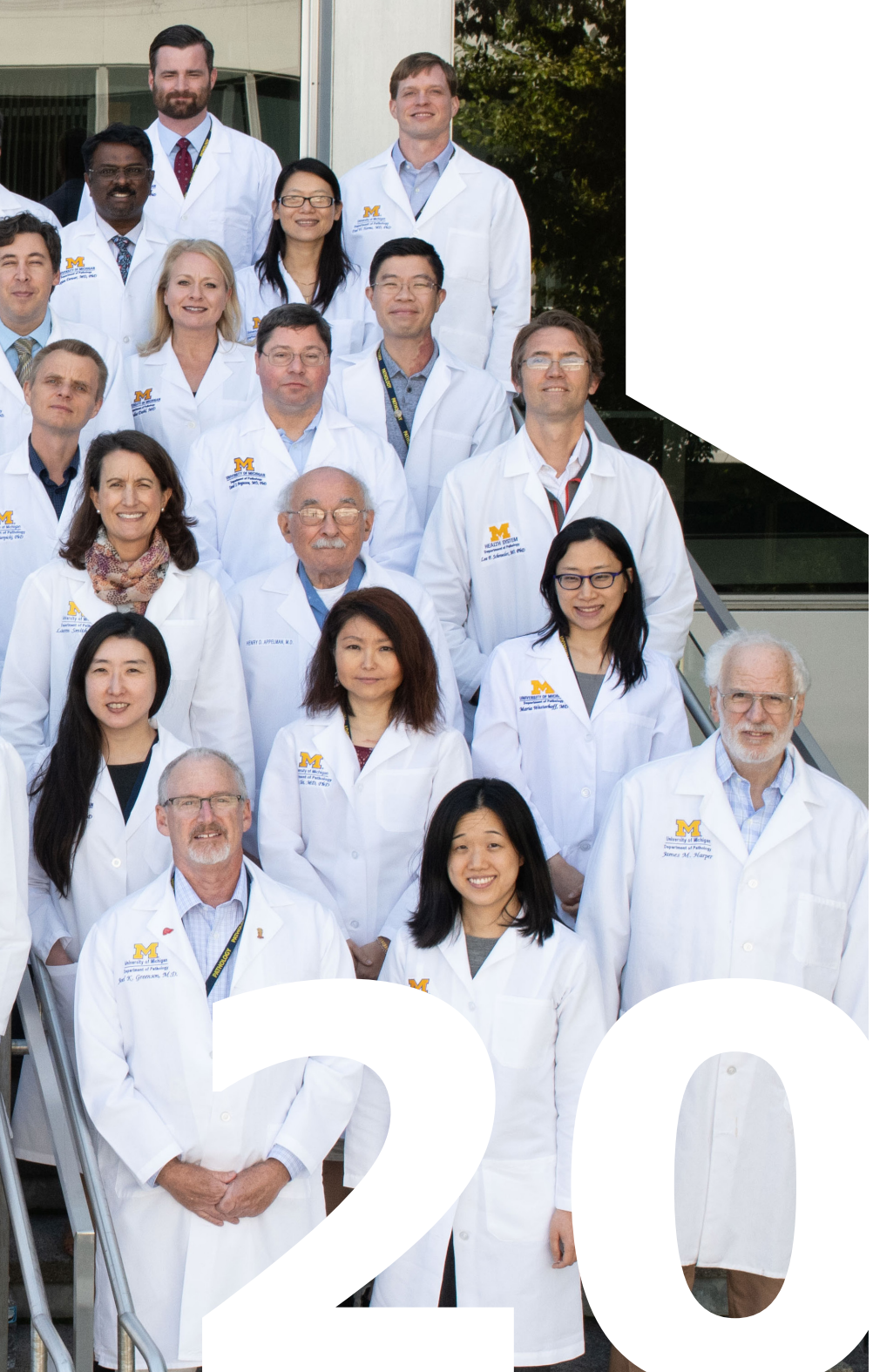
Annual Report

2018

Department of **Pathology**

MICHIGAN MEDICINE
UNIVERSITY OF MICHIGAN



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Message **From the Chair**

Preparing for the Future reflects the theme for the Department of Pathology in fiscal year 2018 (FY 18). We took a long, hard look at our Department and conducted numerous studies to find efficiencies through streamlining workflow and investing in new equipment and facilities to ensure we are poised to provide the healthcare of the future for our patients.

Using Lean Facility Design processes, we set out to envision what the future of healthcare would look like and how we could best be poised to step into that future as we prepared to relocate our clinical laboratories from a variety of sites across Ann Arbor to four adjacent buildings on the University of Michigan's North Campus Research Complex. Eliminating any possible waste was a key feature. How could we minimize the steps needed to complete tasks? What is the ideal workflow? Where should each clinical laboratory unit be located and how could we build in redundancy in case of equipment failure, so our patients receive the best possible care? How will healthcare change in the future and how can we incorporate flexibility to adapt to this unknown future? These processes began in 2013 and at the end of FY 18, we were putting the final touches on our new space, ready to move in at the beginning of FY 19!

Key features in our new space design included:

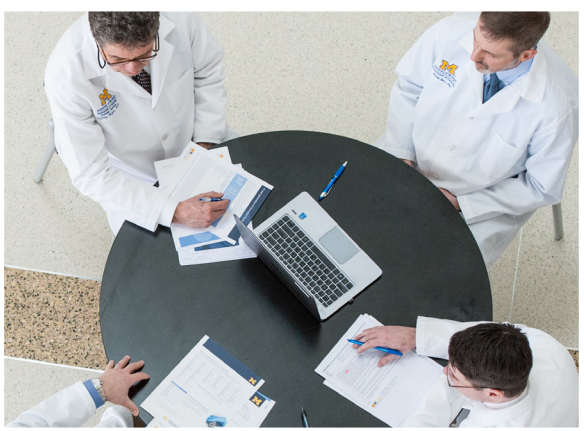
- co-locating all of our faculty into neighborhoods surrounded by welcoming collaborative space to encourage the sharing of ideas;
- creating a large sign-out space with several multi-headed microscopes located in glass-walled rooms with monitors to display slides, enhancing resident and fellow teaching;
- positioning resident and fellow office space close to the faculty and the sign-out space and just down the hall from the education office to enhance their educational experience;
- using reconfigurable walls for all of our office and conference room space, to allow for flexibility in the future;
- consolidating six molecular diagnostic laboratories into one large laboratory to enhance workflows, create equipment redundancies, and enable consultations between the laboratories;
- installing an automated microbiology line by BD Kiestra™;
- making generous use of natural lighting with full wall-sized windows to enhance our faculty and staff's work environment;
- Using advanced technology to enable our pathologists to work remotely with those at the hospital, including use of robotic microscopes, video conferencing, digital imaging of cases, and a new specimen tracking system to ensure specimens can always be located quickly.

While all of this planning, design and construction was taking place, we never let down on our core missions! We experienced a 3.3% year-over-year growth in the number of billable tests processed, generating a 5.6% increase in gross revenues and a 4.2% increase in net patient revenues. Our research mission saw 53 awards granted from the NIH and was ranked 8th in the nation in NIH funding, 2nd in the nation in R01 funding. Total sponsored research spending totaled $33.4 million. The Department was home to 200 faculty, 1,123 staff, 26 PhD students, 22 Clinical Fellows, 58 Postdoctoral Fellows, 26 Residents, and 17 student temporary employees.

In this year's report, we will tell the story of our Department's trifold mission of patient care, research and education, along with the supporting efforts of our quality team, administration, and informatics. I hope you will enjoy the journey with us as we are *Preparing for the Future.*

Charles A. Parkos, MD, PhD

Carl V. Weller Professor and Chair



Development

The Department of Pathology at the University of Michigan is most grateful to our alumni, faculty and staff, and friends who have made a gift to our programs in education, research and patient care. In FY 18, The Department of Pathology received over $2.5 million in donations from foundations, trusts, former faculty and trainees, and others. If you would like to be a part of our future and wish to talk more about making a gift or including the department in your estate planning, please contact:

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PEOPLE

200 Faculty

- **50** / Instructional
- **78** / Clinical
- **36** / Research
- **36** / Supplemental

1123 Staff

- **17** / Student Temps

EDUCATION

118 Trainees

- **26** / Residents
- **11** / Clinical Fellows
- **58** / Postdoctoral Fellows
- **23** / MCP Graduate Students
- **17** / Medical School Instructors
- **40** / Graduate Student Mentors

MISSIONS / RESEARCH & CLINICAL

$73.7M
MS Annual Expense Budget

$131.8M
UMHS Annual Expense Budget

Ranked
#8 **In Funding**
Received by NIH in 2017

Received
53 **Awards** from NIH in 2017

$33.4M
Sponsored Spending in 2017

3.3% ↑
Growth in Billable Tests

Research Space Occupies
61,293SQFT
$322 DC/SF
$131 IDC/SF

Outpatient Phlebotomy in all Health Centers

OTHER

Partnerships

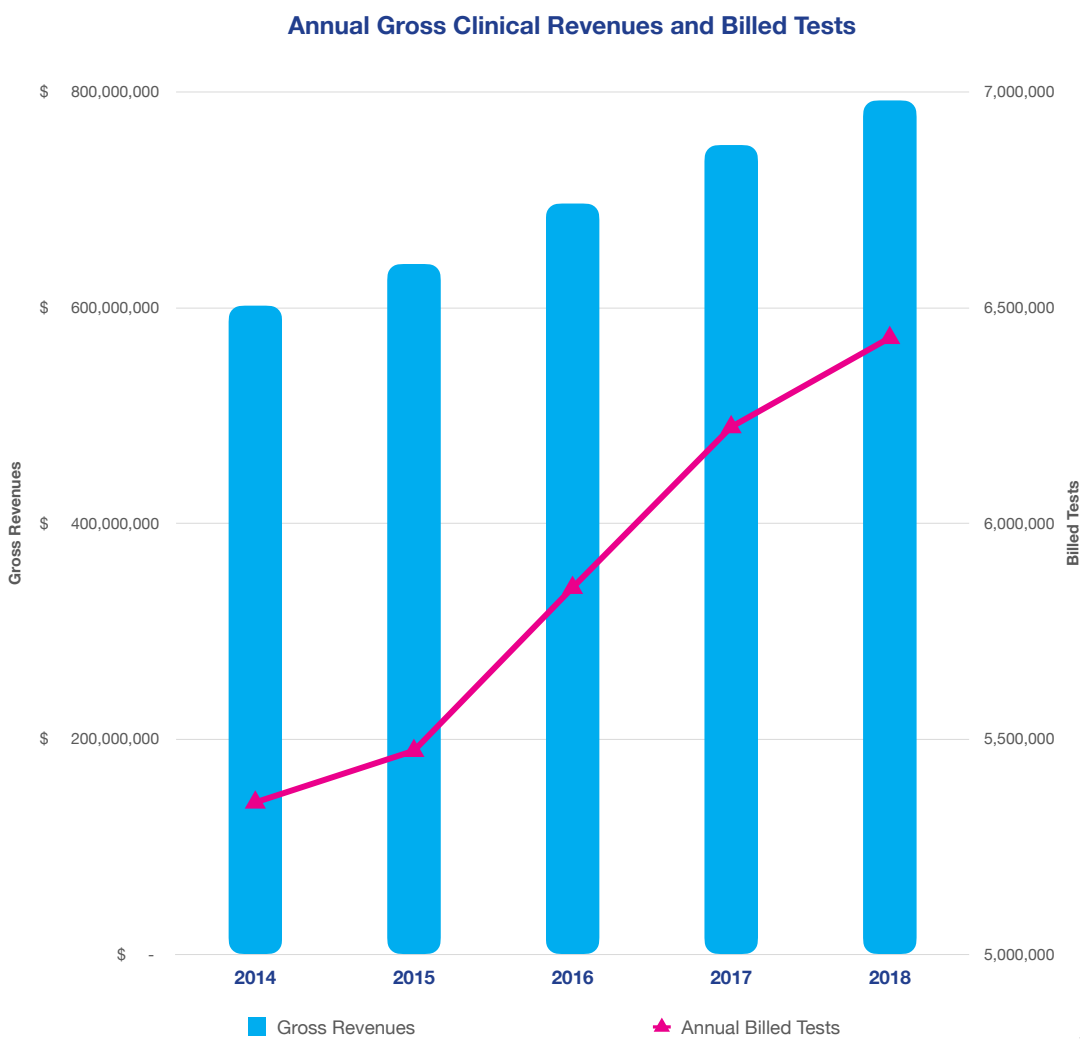
M-Labs – Primary Reference Lab, Mid-Michigan Metro Health and national presence in molecular/genetic testing, totaling 48 million in gross charges; Ann Arbor Veterans Administration Hospital Laboratories

Clinical **Mission**

The Department of Pathology's primary mission is to serve the patients seen at Michigan Medicine, its affiliates and satellite sites, as well as patients being served by other medical centers who need our expertise to guide their care. During fiscal year 2018, our clinical laboratories processed 6,430,066 billable tests, generating $792,194,490 in gross revenues/$20,089,169 in net patient revenues, representing an increase of 3.32% in billable tests processed, 5.55% in gross revenues, and 4.2% in net patient revenues over fiscal year 2017. When looking back five years, our growth in billable tests processed and gross revenues have been 20.12% and 31.65% respectively.

Sustained growth requires increased personnel, equipment, and facilities. Over time, as we outgrew the University Hospital facilities, our laboratories became scattered across Ann Arbor leading to inefficiencies and duplication of equipment and staffing. For the past six years, the Department of Pathology has engaged in a plan to relocate our non-stat clinical laboratories to the North Campus Research Complex while renovating the hospital laboratories to improve on-site patient care. Fiscal year 2018 saw the culmination of the planning, building, and equipping of our new laboratory space with laboratory relocations scheduled for the summer of 2018.

The clinical laboratories are divided into four primary divisions: Anatomic Pathology, Clinical Pathology, Molecular Pathology, and MLabs.



Anatomic Pathology

David Lucas, MD

Director of Anatomic Pathology,
Bone and Soft Tissue Pathology

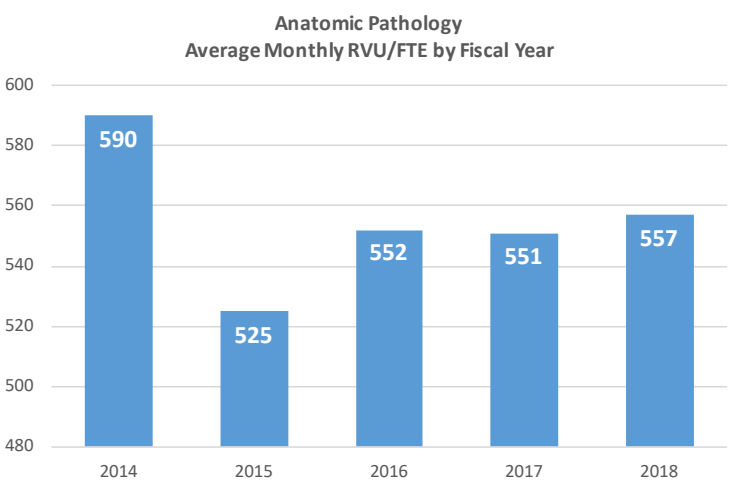
Jonathan McHugh, MD
Co-Director, Surgical Pathology
Director, Head and Neck /
Oral-Maxillofacial Pathology

Lakshmi Priya Kunju, MD
Co-Director, Surgical Pathology
Director, Genitourinary Pathology
Director, General Surgical
Pathology

Celina Kleer, MD
Co-Director, Breast Pathology

Anatomic Pathology deals with testing of tissues and solid tumors as well as autopsies and forensics. Anatomic Pathology realized a 4.58% year-over-year growth from a total of 148,915 to 149,339 cases. The five-year growth rate showed an 18.31% increase. Over this same five-year time period, AP staffing increased by 28% from 29.8 FTEs to 38.16 FTEs. On average, each FTE faculty member in Anatomic Pathology provides 557 RVUs/ month.

The AP Service is comprised of several units, including Surgical Pathology, Cytopathology, Dermatopathology, Autopsy and Forensic Pathology, Pediatric/Perinatal Pathology, Frozen Sections, Ophthalmic Pathology, Renal Pathology, Neuropathology, and the AP Consultation Service.



Surgical Pathology

Case volume for Surgical Pathology, including consultations from all general and all subspecialty services, was 114,656, which represents a 0.33% year-over-year increase and a 33% 5-year increase.

General Surgical Pathology

The General Surgical Pathology section encompasses a general sign-out service and four subspecialty services contained within this category: Gastrointestinal (GI), Genitourinary (GU), Gynecologic (Gyn), and Breast Pathology. Frozen section coverage at University Hospital, C.S. Mott Children's Hospital, Rogel Cancer Center, Frankel Cardiovascular Center, East Ann Arbor Medical Center, and Brighton Center for Subspecialty Care also fall within this section. Our General Surgical Pathologists signed out 50,483 in-house cases in FY 18.

Bone and Soft Tissue Pathology

Bone and Soft Tissue Pathology is focused on the diagnosis and study of diseases of the bone and surrounding soft tissues. These cases are not tracked separately from general surgical pathology cases. However, the Bone & Soft Tissue consult cases experienced an 11.9% increase in case volume with 1,112 cases in FY 18 and a 61.6% increase over the past five years.

Breast Pathology

Breast Pathology is a subspecialty of surgical pathology with expertise in the interpretation of breast lesions from various specimen types, including needle core biopsy, lumpectomy, and mastectomy specimens. In FY 18, the Breast Pathology service processed 2,479 cases, representing a 7% increase over FY 17.

Cardiovascular Pathology

Cardiovascular pathology examines the heart and blood vessels to determine the diseases of these organs, whether congenital or acquired in life. Cases may be to diagnose a living patient or to establish a cause of death in a deceased patient. These cases are not tracked separately from general surgical pathology and autopsy cases.

Dermatopathology

Dermatopathology focuses on the study of cutaneous diseases at a microscopic and molecular level. While the Dermatopathology service experienced an overall 5.8% decrease in cases in FY 18, the in-house service grew by 3.8%. In FY 17, MLabs generated a much higher-than-average volume of cases, resulting in the year-over-year decrease in overall Dermatopathology cases. In FY 18 the case volume through MLabs decreased by 22%, but remained significantly higher than prior years. The 5-year total case volume for our Dermatopathology service grew by 18.8% in spite of the decrease seen in FY 17.

Endocrine Pathology

Endocrine Pathology is the study of diseases of the endocrine system, including the thyroid, parathyroid, pituitary, endocrine pancreas, and adrenal glands. In-house cases are included in the general surgical pathology cases and are not tracked separately. However, this service completed 407 consult cases in FY 18, a slight decrease from FY 17, but a 66.8% increase over the past five years.

Frozen Section/Intraoperative Consultations

Also known as cryosections, this procedure is used to perform rapid microscopic analysis of a specimen, most often used in oncological surgery to diagnose a tumor or to ensure tumor excisions are complete and the margins are clear. This prevents patients from having to undergo surgery a second time if the excision was not otherwise complete. The Frozen Section service performed 3,647 rapid analyses in FY 18, an increase of 3% over the prior year and 7% over the past five years.

Gastrointestinal/Hepatobiliary Pathology

Gastrointestinal Pathology (GI) is a subspecialty of surgical pathology which deals with the diagnosis and characterization of neoplastic and non-neoplastic diseases of the digestive tract and accessory organs, such as the pancreas, gall bladder, and liver. A change in accessioning methodology, combining upper and lower endoscopies into a single accession rather than as two separate cases, as previously done, resulted in an artificially reduced case volume of 23,115 cases (down 3%). GI Pathology case volumes have grown by 28% over the past five years.

General Surgical Pathology/"Room 1"

General Surgical Pathology (also known as "Room 1" service) sign-out handles biopsy and surgical resection specimens not covered by the other subspecialty areas. In FY 18, 13,839 general specimens were processed, an increase of 2% over the prior year. This service experienced a 23% growth over the past five years.

Genitourinary Pathology

Genitourinary Pathology (GU) is a subspecialty of surgical pathology which deals with the diagnosis and characterization of neoplastic and non-neoplastic diseases of the urinary tract, male genital tract, and testes, excluding medical disorders of the kidneys, which falls under renal pathology. The GU service processed 3,734 cases in FY 18, up 10% over the prior year. This service's volume has grown by 57% over the past five years.

Gynecologic Pathology

Gynecologic Pathology (GYN) is the subspecialty that deals with the study and diagnosis of disease involving the female genital tract. The GYN service processed 7,216 cases in FY 18, a 4% increase over the prior year. This represents a 20% growth over the past five years.

Head and Neck Pathology/Oral-Maxillofacial Pathology

Head and Neck Pathology covers neoplastic diseases of the thyroid and endocrine system, salivary gland neoplasms, and squamous lesions found in the head and neck. Oral-Maxillofacial Pathology is concerned with the diagnosis and study of diseases affecting the oral and maxillofacial region and is sometimes considered to be a specialty of dentistry and pathology. In-house cases are not separately tracked and are included in surgical pathology case numbers. Consult cases amounted to 622 cases, a 19.3% increase over FY 17 and a 55.5% increase over the past five years.

Andrew Sciallis, MD
Co-Director, Breast Pathology

David Gordon, MD
Director, Cardiac Pathology

Douglas Fullen, MD
Director, Dermatopathology

Thomas Giordano, MD, PhD
Director, Endocrine Pathology

Laura Lamps, MD
Director, Gastrointestinal Pathology

Kathleen Cho, MD
Director, Gynecologic Pathology

Andrew Lieberman, MD, PhD
Director of Neuropathology

Victor Elner, MD, PhD
Professor of Ophthalmology

Raja Rabah, MD
Director, Pediatric Pathology

Jeffrey Myers, MD
Director, Pulmonary/Thoracic Pathology

Paul Killen, MD, PhD
Director, Electron Microscopy Laboratory

Judy Pang, MD
Director, Cytopathology

Jeffrey Jentzen, MD, PhD
Director, Autopsy & Forensic Pathology

Neural and Neuromuscular Pathology

Neuropathology is a branch of pathology that focuses on the diagnosis of diseases of the nervous system and striated muscle. As a low-volume service, the Neuropathology case volume percentage numbers are subject to significant changes simply due to chance. While FY 18 saw overall lower volumes (1,213 cases) than any of the prior five years, the 9% decrease may not be indicative of a true downturn in the service, which varies significantly year-over-year.

Ophthalmic Pathology

Ophthalmic Pathology, which studies and diagnoses diseases of the eye, continues to be primarily a 1-person service led by Dr. Victor Elner, with support from surgical, hemato-, dermato-, and neuropathology consultants. This low volume service has seen modest growth, likely due to chance, over the past five years.

Pediatric and Perinatal Pathology

This medical subspecialty is focused on diseases affecting the placenta, fetus, infant, and child and is broadly categorized into surgical pathology cases and performing of autopsies and placental examinations. Pediatric surgical pathology case volume reflects a 1.8% increase, which slightly under-represents the volume as compared to prior years. This is due to the high volume of GI biopsies for which upper- and lower-endoscopic biopsies were combined in FY 18 into a single accession rather than considered as separate cases. All areas of Pediatric and Perinatal Pathology experienced year-over-year growth with an average of 7.0% and 26.4% growth as compared to FY 17 and FY 14.

Pulmonary/Thoracic Pathology

Pulmonary Pathology is a subspecialty of surgical pathology which deals with the diagnosis and characterization of neoplastic and non-neoplastic diseases of the lungs, pleura, and thoracic cavity. In-house cases are not tracked separately from other surgical pathology cases. However, among consult cases, Pulmonary Pathology evaluated 2,413 cases, which represents a 3.6% increase over FY 17 and a 37.9% increase over the past five years.

Renal Pathology

The Renal Pathology service focuses on the diagnosis and characterization of medical diseases (non-tumor) of the kidneys. This low-volume service has remained relatively consistent through the past five years.

Cytopathology

Cytopathology is a branch of pathology that studies and diagnoses diseases on a cellular level. Our cytopathology service has remained relatively stable over the past five years with 33,352 cases processed in FY 18.

Gynecologic and Non-Gynecologic Cytopathology

Gynecologic pap smears represent the bulk of the cytopathology cases, with 22,999 pap smears analyzed in FY 18, a 1% decrease as compared to FY 17 and a 1% increase as compared to the prior five years. There were 7,402 non-gynecologic cytopathology cases in FY 18, an 11% increase over FY 17, but a 3% decrease as compared to the past five years.

Fine Needle Aspiration

Fine needle aspirations (FNAs) are conducted to determine whether a tumor is malignant or benign prior to excision. In FY 18, 2,951 FNAs were conducted, a 2% decrease over FY 17, but a 2% increase as compared to the prior five years.

Rapid Onsite Evaluation

Our cytopathologists perform rapid on-site evaluations at multiple clinics and procedure rooms throughout Michigan Medicine. This enables rapid diagnostics for patients while they are still at the medical center, eliminating the need for some follow-up visits.

Autopsy and Forensic Pathology

University Hospital autopsies and forensic pathology autopsies and examinations represent major activities within Anatomic Pathology. We currently employ 7 fellowship-trained forensic pathologists who handle forensic cases from Wayne, Monroe, Washtenaw, and Livingston Counties. All Michigan Medicine adult and pediatric autopsies as well as all forensic cases from Washtenaw and Livingston Counties are performed in the University Hospital morgue. Wayne and Monroe County forensic cases are performed at the Wayne County Medical Examiner's Office (WCMEO) in Detroit.

FY 18 saw a 1% increase in the number of forensic autopsies performed, with a 7% increase over the past five years. Last year, there were 2,417 full autopsies and 3,226 total examinations, representing a 3% and a 2% increase over the prior year, but a 21% and 19% increase over the past five years.

Due to a national shortage of fellowship-trained forensic pathologists, coupled with increasing forensic autopsy case volumes due to the opioid crisis in America, we have been challenged with filling open faculty positions for the past two years. We recently employed an academic physician recruitment service, Merritt-Hawkins, with promising early results.

Adult Hospital Autopsy

Autopsies for adult patients who die at the University Hospital are provided by the autopsy pathology service. In FY 18, 218 autopsies were performed, an increase of 15% over the prior year, representing a substantial jump in autopsies with the prior years of FY 14-FY 17 remaining relatively stable.

Pediatric Autopsy

Children who die at the University Hospital may be autopsied to determine the cause of death. In FY 18, 43 pediatric autopsies were performed, no change from the prior year. Due to low volumes, the 16% growth over the past five years is likely due to chance as opposed to reflecting any real change.

Fetal Examination

Examination of fetal remains are often conducted to determine why a fetus did not survive, which can provide medical insight for future family planning for the parents as well as a sense of closure for them. In FY 18, 215 fetal exams were completed, up 21% over FY 17 and 71% over the past five years.

Anatomic Pathology Consultation Service

Our extramural AP consultation practice continued to grow with 15,502 cases (highest volume services shown on ***pg 12***), representing a 7% year-over-year increase from FY 17. The rare and challenging cases represented in this service challenge our faculty to continue to develop their expertise and expose our trainees to cases otherwise rarely seen. This bolsters our reputation at the regional and national levels, leads to research projects, drives revenue, and enhances patient recruitment to Michigan Medicine.

Case Volume

	FY 14	FY 15	FY 16	FY 17	FY 18	1-Yr	5-Yr
Washtenaw / Livingston	365	327	359	407	412	1%	7%
UH (Adult)	188	183	168	189	218	15%	16%
UH (Peds)	37	31	41	43	43	0%	16%
Grand Total	**590**	**541**	**570**	**639**	**673**	**5%**	**12%**

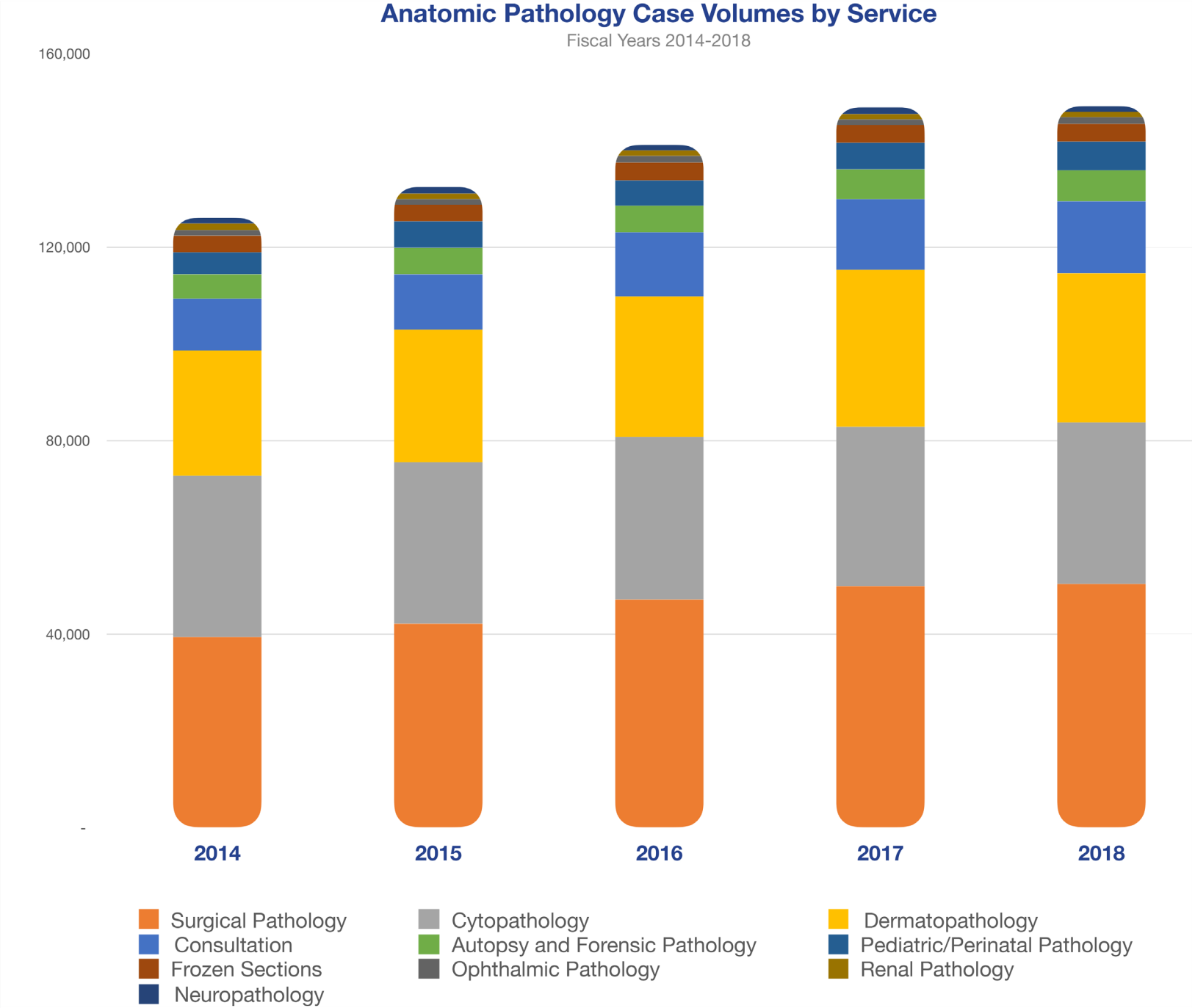
Table: *Autopsy and Forensics Total Examinations at UH, Washtenaw and Livingston Counties;*

Wayne County ME Office Case Volumes

	FY 13	FY 14	FY 15	FY 16	FY 17	1-Yr	5-Yr
Full Autopsies	1904	2242	2053	2359	2417	3%	21%
Total Exams	**2638**	**2921**	**2822**	**3226**	**3272**	**2%**	**19%**

Table: *Wayne County ME Office Case Volumes.*

See pg. 68 *of the Appendix to see all Anatomic Pathology Case Volumes 2014-2018.*


Anatomic Pathology Case Volumes by Service
Fiscal Years 2014-2018
160,000
120,000
80,000
40,000
-
2014
2015
2016
2017
2018
Surgical Pathology
Consultation
Frozen Sections
Neuropathology
Cytopathology
Autopsy and Forensic Pathology
Ophthalmic Pathology
Dermatopathology
Pediatric/Perinatal Pathology
Renal Pathology

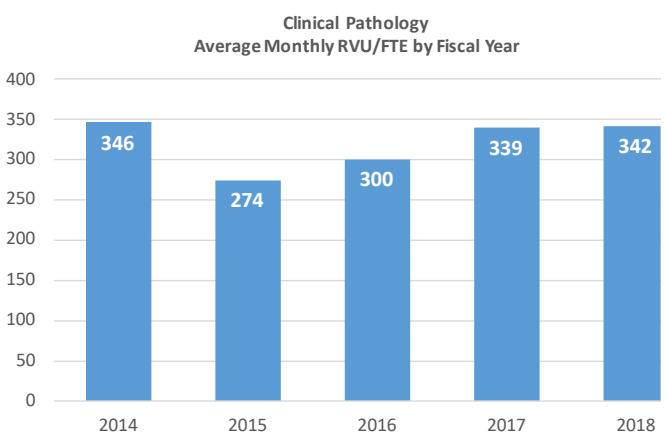

BIOHAZARD

Clinical Pathology

Riccardo Valdez, MD
Director of Clinical Pathology

Clinical Pathology encompasses the testing of blood, urine, and other bodily fluids to diagnose diseases and infections. In FY 18, Clinical Pathology processed 5,994,782 billed tests, and $713,359,864 in gross revenues, representing a 4.4% and 5.9% year-over-year growth, respectively. As compared to 2014, the division experienced a 20.8% growth in billed tests and 30.6% growth in gross revenues. Our clinical pathologists average 342 RVUs per month, with staffing levels essentially unchanged at 11.58 FTEs in FY 18 as compared to 11.83 in FY 17. *(See Chart of Billed Test Volumes on **pg. 68** of the Appendix)*

The Division of Clinical Pathology includes multiple clinical laboratories including: Clinical Chemistry, Clinical Immunology, Clinical Microbiology, Coagulation – Routine and Special, Cytogenetics, Flow Cytometry, Hematology, Hematopathology, Histocompatibility, Molecular and Genomic Pathology, Phlebotomy – inpatient and outpatient, Transfusion Medicine, and Virology.



Donald Giacherio, PhD
Director, Chemical Pathology

Clinical Chemistry

The majority of the tests run in Clinical Pathology are conducted in the Clinical Chemistry laboratory. These include tests such as cholesterol screening, drug testing, allergy testing, and Troponin T testing for chest-pain patients, among many others.

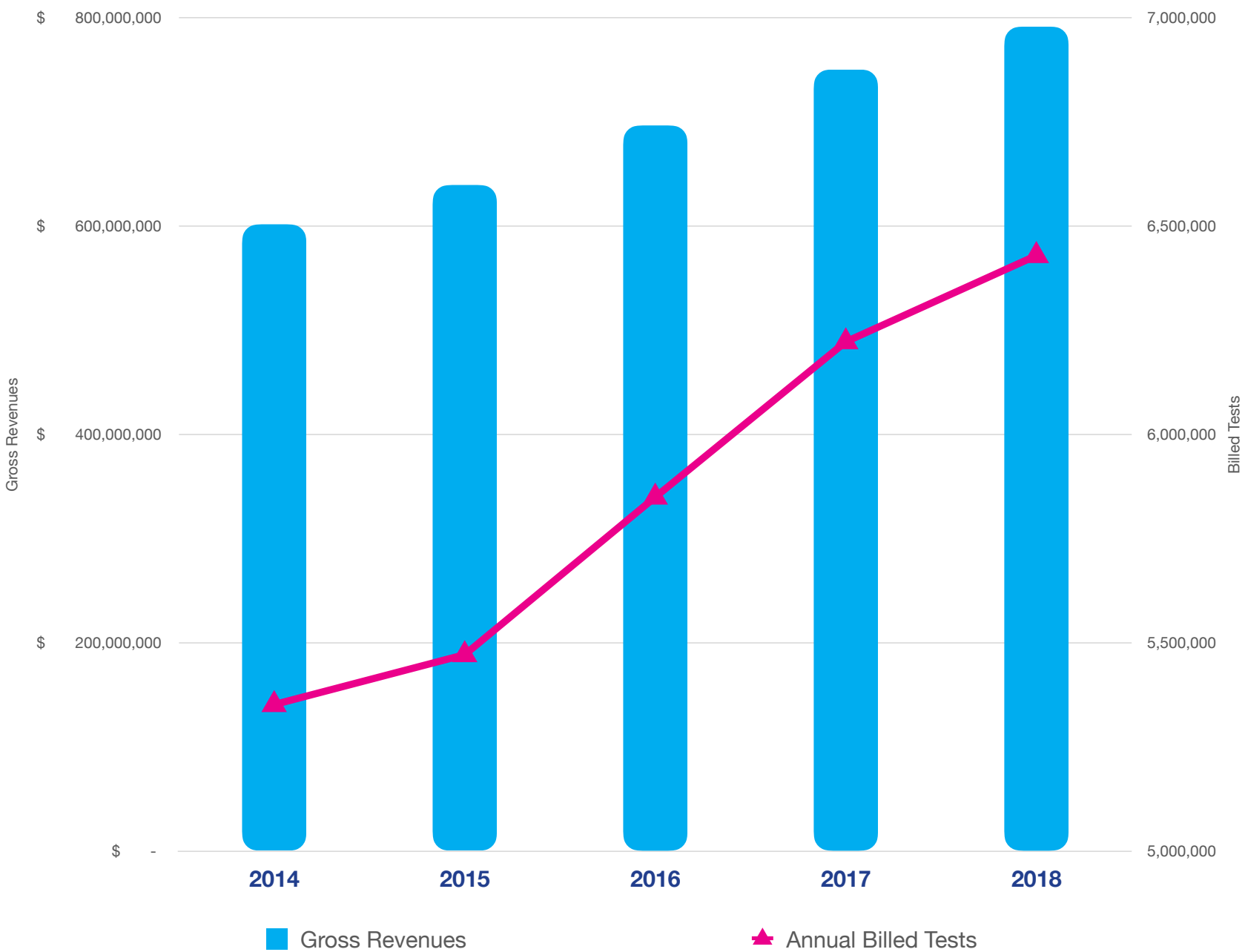
Clinical Chemistry saw a 3.9% increase in billed test volumes as compared to FY 17 and a 30% increase over five years, as compared to FY 14, processing 3,640,160 tests. Of these, 82% were chemical pathology tests and 12% were special chemistry tests.

To provide the best patient care, the Clinical Chemistry laboratory upgraded their equipment, adding two new Roche Cobas® e411 immunoassay analyzers to enable Troponin T testing for chest-pain patients, an Optilite analyzer to more efficiently process immunology testing, and an Integra 400 chemistry analyzer to support the growing complexity of infusion center patients being seen at our Northville location.

In addition, several new tests were brought on-line in the laboratory, in addition to the Troponin T, including:

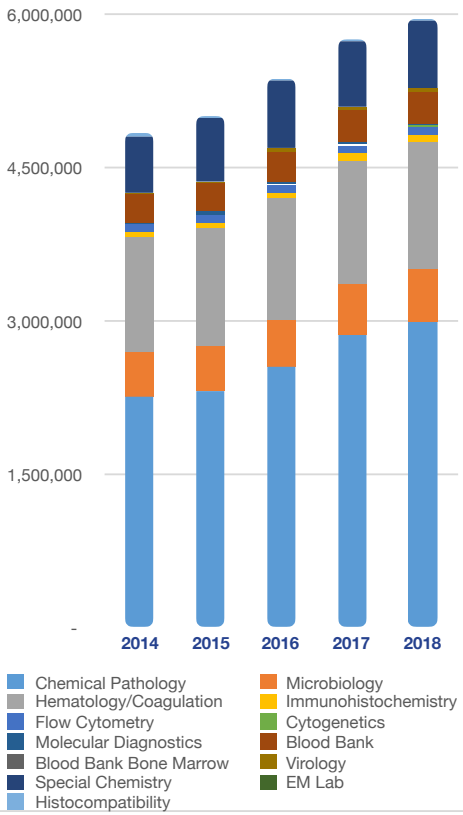
- toxicology testing for Vitamin A and E in serum, which is estimated to reduce costs by $40,000 annually.
- toxicology confirmatory testing for opiates and benzodiazepines on a Waters Vion Q-tof high resolution LC-Mass Spectrometer system to identify parent drugs and metabolites. This test will provide the results physicians need when looking for opioid abuse and diversion.
- multiple allergy profiles to meet the needs of Mid-Michigan Health System.

Annual Gross Clinical Revenues and Billed Tests



Clinical Pathology Billed Tests by Service

Fiscal Years 2014-2018



Robertson Davenport, MD
Director, Blood Bank & Transfusion Service

Lauren Smith, MD
Director, Hematopathology

- influenza point-of-care molecular assay using a Cepheid® analyzer, to be fully implemented in the upcoming flu season.
- rapid bilirubin testing for identification of elevated bilirubin in newborn outpatients in four health care centers.
- metabolic panel testing at Northville health center for pre-infusion testing for cancer patients.

Transfusion Medicine

Transfusion medicine includes the Blood Bank, Apheresis Procedure Unit, and the Cellular Therapies Laboratory. Increased activity in the Blood Bank reflected overall Michigan Medicine clinical activity. Immunohematology Reference Laboratory activity was slightly decreased, but this does not reflect the complexity of the work-ups performed. Increased activity in the Cellular Therapies Laboratory reflected increased faculty in the Blood and Marrow Transplantation program. In conjunction with the Blood and Marrow Transplantation program, Transfusion Medicine successfully obtained approval from the Michigan Medicine Board for creation of the Michigan Medicine Center for Cell Therapy. This will facilitate provision of investigational and commercial cellular therapy for Michigan Medicine patients by providing centralized resources for regulatory compliance, manufacturing, clinical care, and operational activities. The proposal supports incremental staff and equipment for the Cellular Therapies Laboratory.

The notable increase in unrelated transplants represents a programmatic shift toward these more complex type of transplants. The marked increase in CAR-T product reflects FDA approval for two commercial CAR-T products, Kymriah™ and Yescarta®, which were introduced into the Cellular Therapies Laboratory. These new protocols will aid in the treatment of B-cell acute lymphoblastic leukemia and for diffuse large B-cell lymphoma. CAR-T testing is likely to continue in growth. Activity in the Apheresis Procedure Unit was slightly increased.

Transfusion Medicine acquired and/or replaced several pieces of equipment this year. The Apheresis Procedure Unit replaced the aging COBE® Spectra apheresis devices with Spectra OPTIA® devices. The Blood Bank acquired a Rad Source RS 3400 X-Ray Blood Irradiator, partially funded by a grant from the Department of Energy. The Cellular Therapies Laboratory acquired a Miltenyi CliniMACS® cell section platform to enable performance of CD34 selected allogeneic HPC transplants. *(See chart in Appendix on **pg 69**.)*

Hematopathology

Hematopathology is the branch of pathology that deals with diseases of the blood, lymphoid tissues and the blood-producing organs such as the bone marrow, spleen, and the thymus. This service is supported by the hematology and coagulation laboratories and the flow cytometry laboratories. In FY 18, the service experienced a 4.4% increase in bone marrow and lymph node cases, with 2,180 cases signed out. In preparation for relocation to the North Campus Research Complex in early FY 19, the hematopathology section instituted ordering of aspirate iron and cytochemical staining using the Soft Laboratory Information System.

In addition, the volume of transfer cases increased by 8% over FY 17, with 1,539 cases and the consult volume remained constant at 1,144 cases. While volumes increased year over year, no major changes have been necessary on this service and the turn-around times have been continually watched to discover opportunities for improvement, especially on the consult service.

Hematology and Coagulation

The hematology and coagulation laboratories provide testing on urine and blood specimens to measure various blood components such as red and white blood cells, platelets, and clotting factors as well as the impact made by heparin and other anticoagulants on blood clotting processes. Urinalysis is able to measure the amount and type of blood products found in urine, protein in the urine and other abnormalities to help diagnose infections and other urinary tract issues. This service has had a slow, but steady growth over the past five years, with a 1.3% year-over year test increase and a 10% five-year increase. In FY 18, these labs processed 1,236,698 tests.

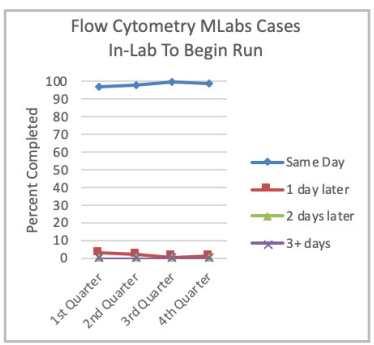
During FY 18, new laboratory locations were added at West Ann Arbor and Northville clinics, and additional hours of service were added for nights, weekends and holidays for STAT HIT testing. These required significant training of technicians and other clinical staff and were accomplished under the guidance of Dr. Lee Schroeder.

The STAT HIT testing expansion allowed the laboratories to bring the testing for Serotonin-Release Assay back in-house, saving approximately $90,000 annually.

Additional coagulation testing was added with multiple new reagents validated, improving the quality control reliability for these tests, increasing sensitivity, and reducing turn-around times for reporting patient results. Clinicians are now able to transition patients to more appropriate anticoagulants or to adjust current medications more quickly to improve patient outcomes.

Flow Cytometry

The flow cytometry laboratory uses equipment called flow cytometers to perform counts of lymphocytes, stem cells, CD4, and other blood components to aid in the diagnosis of leukemias and other diseases. Flow cytometry is an expanding field with new charged-antigen tests being routinely developed. In FY 18, we had 87,062 billed tests run, an 11.06% increase compared to FY 17. Over the past five years, this lab's test volume has increased by 20.6%. This growth was primarily due to the increased number of charged antigens tested per case, which also promoted a 12% increase in revenues with only a 2% increase in expenses. The actual case volume remained relatively stable.



A significant portion of the work conducted in the flow cytometry lab is for our MLabs clients. Over 90% of these cases are run the same day.

Clinical Immunology

The Clinical Immunology lab provides testing related to immune responses in patients with Rheumatoid arthritis, Lupus, Scleroderma and other similar conditions. The lab experienced a 3.3% year-over-year and a 47.25% five-year increase in billed tests, processing 71,432 tests in FY 18.

The laboratory added two Optilite® analyzers, a BioPlex® 2200, and an AFT 3000™ and Navigator Image Analysis System over the past year. The latter has improved technicians' efficiency in processing antinuclear antibody (ANA) Immunofluorescence Antibody Assay (IFA) testing to detect if patients have an auto-immune disorder. To complement this enhanced equipment, Dr. Lee Schroeder, Dr. Jeff Warren, and Jeff Lott, in collaboration with the Department of Rheumatology, developed an improved ANA-screen test cascade.

Finally, the laboratory began sending positive Scl70 antibody results (obtained from the BioPlex® 2200) to RDL Reference Laboratory (Los Angeles, CA), for testing with less sensitive, but more specific ELISA and immunodiffusion assays. This has improved the specificity of testing in patients suspected to have scleroderma.

Clinical Microbiology and Virology

The microbiology and virology laboratories focus on identifying bacterial, viral, and fungal pathogens to aid in the diagnosis and treatment of patients. In FY 18, the microbiology laboratory processed 508,152 tests, a 5.4% increase over FY 17 and a 17.23% growth over the past five years. The virology laboratory processed 41,266 tests, an increase of 6.63% over FY 17 and a 148.7% growth over the past five years.

These laboratories invested significant resources to the acquisition, validation and training on new equipment including a B.D. Kiestra™ Total Laboratory Automation system for the new microbiology laboratory at the North Campus Research Complex. This automated line will change workflows from body-site focused (urine, respiratory, etc.) to chronological reading of plates. The Kiestra line will improve efficiencies and is anticipated to reduce time to results by several hours. In addition to the Kiestra line, the laboratories also upgraded 12 FilmArray® stand-alone units to the FilmArray® Torch tower system, which saves space and allows for distribution of the platform in both the new NCRC laboratory as well as in the University hospital laboratory to optimize patient turnaround time.

New test assays and processes were also brought online over the year, including the CMV viral load, EBV viral load, digital gram stain technology, Helicobacter pylori antigen EIA, and Giardia/ Cryptosporidium EIA.

Rajan Dewar, MBBS, PhD
Director, Hematology Laboratory

Daniel Boyer, MD, PhD
Medical Director, Clinical Flow Cytometry

Jeffrey Warren, MD
Director, Clinical Immunology

Duane Newton, PhD, D (ABMM), FIDSA
Director, Clinical Microbiology Laboratory

Molecular & Genomic Pathology

Thomas Giordano, MD, PhD
Director, Molecular Diagnostics

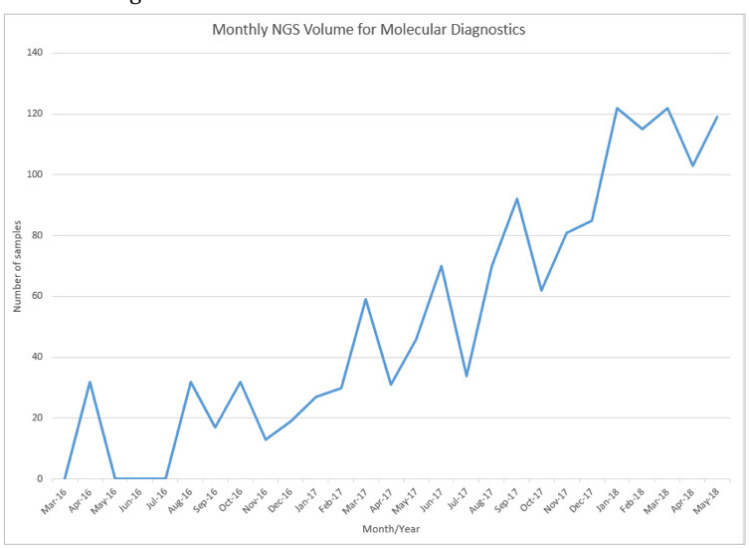
Noah Brown, MD
Director, Molecular Diagnostics Laboratory

Molecular diagnostics is the science of analyzing biological markers in the genome and proteome, an individual's genetic code, and how their cells express their genes as proteins. These techniques are used to diagnose and monitor disease, detect risk, and decide which therapies will work best for individual patients. During the past year, the Division of Molecular and Genomic Pathology made significant progress in realizing its overarching mission of coordinating activities of the various molecular pathology laboratories within the Department of Pathology and to interface with the Michigan Molecular Genetics Laboratory within the Department of Pediatrics. In the summer of 2018, the six disparate laboratories will relocate to contiguous state-of-the-art laboratories at the North Campus Research Complex.

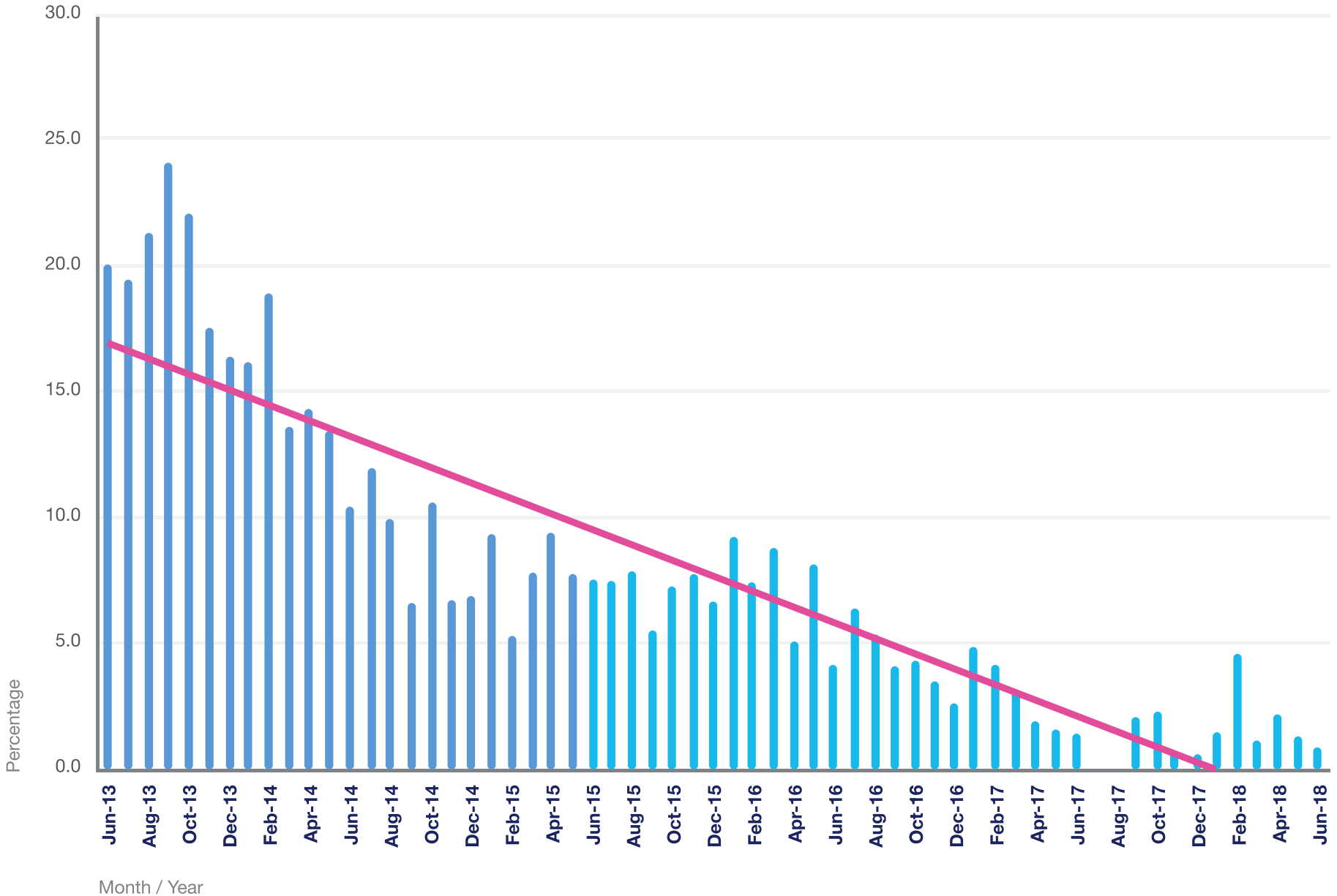
Molecular Diagnostics Laboratory

In FY 18, the Molecular Diagnostics Laboratory processed 17,026 billed tests as compared to 15,899 in FY 17, a 7.09% increase. This is a rapidly developing field that is moving away from single gene testing to next generation sequencing panel testing (NGS panels). In the past year, the Molecular Diagnostics Laboratory added four new NGS panels: Lung Cancer, Colorectal Cancer, Melanoma, and Solid Tumor. In addition, they added a BCR/ABL quantitative analysis test while discontinuing the Apolipoprotein E assay due to low volumes, reimbursement issues and marginal clinical utility.

The major advance in the Molecular Diagnostics Laboratory (MDL) during this past year was the successful transition from single gene assays to several NGS panels based on the Oncomine Focus Assay. The benefits of this panel are numerous and include more comprehensive coverage of actionable mutations and the ability to detect gene fusions and copy number alterations using much less starting material. This panel can be performed with less than 10 ng of nucleic acid enabling testing of extremely small and/or hypocellular biopsies and aspirates. This results in greatly reduced assay failure (QNS) rates (***pg. 19***) and improved turn-around times. The successful implementation of the Oncomine platform has also significantly reduced the number of tests sent out for commercial testing (e.g. Foundation Medicine) for several cancer types, resulting in significant institutional savings.



Monthly Percentage of QNS Solid Tumor Samples



Lina Shao, PhD, FACMG
Director, Cytogenetics

Jeffrey Innis, MD, PhD
Director, Michigan Medicine Genetics Laboratory

Omar Moussa, Msc, PhD, D(ABHI)
Director, Histocompatibility Laboratory

Reducing the number of specimens that are rejected (QNS) or that fail after a testing attempt is a key priority for the MDL. QNS/failed specimens result in a significant negative impact on patient care due to the need for repeated invasive procedures with associated treatment delay, complications, as well as possibly preventing patients from receiving efficacious targeted therapies. In previous years, the proportion of QNS/failed specimens was dramatically reduced through improvement to the microdissection process. This year, we continued this reduction by validating a process for extracting DNA/RNA from H&E slides for exhausted formalin-fixed, paraffin-embedded blocks as well as Diff-Quik or Papanicolaou-stained aspirate smear slides for cell blocks with low cellularity. Overall, these improvements have reduced the percentage of QNS/failed specimens from > 25% to < 5%.

The laboratory undertook several process improvement projects over the course of the year. They improved the ordering process for molecular testing within MiChart, which reduced errors and improved clinician and patient satisfaction. They also streamlined the workflows for slide scanning and for NGS repeat testing. By using data, they were able to reduce the number of TRG testing that needed to be repeated by 78%, reducing turn-around times by 7% and costs by 76%. Their efforts led to a Quality Month poster that earned "Exemplar Finalist," a first for the Department of Pathology.

Cytogenetics

Cytogenetics involves testing samples of tissue, blood, or bone marrow to look for changes in chromosomes, including broken, missing, or extra chromosomes. Changes in certain chromosomes may be a sign of a genetic disease or condition, or some types of cancer. In FY 18, our Cytogenetics Laboratory processed 9,296 tests as compared to 8,399 in FY 17, a 10.7% increase. This increase is due in part to adding MidMichigan Health as an MLabs client in late March 2018, as well as adding a new multiple myeloma FISH (fluorescence in situ hybridization) panel, which had previously been sent out to Mayo Laboratory, resulting in significant savings in send-out costs.

The Cytogenetics team undertook several process improvement efforts in FY 18. In the constitutional blood section, they established a synchronized culture to improve chromosome length and quality; adjusted hypotonic solution concentration to optimize chromosome spread; and switched slide preparation from a cold room to a Thermotron, which improved consistency and quality of chromosome slides while reducing technicians' exposure to methanol and acetic acid. The Microarray section replaced the use of ice with a cool box to keep enzymes and other reagents cold, eliminating the need for ice makers. In addition , they implemented the use of Temptrak® to improve monitoring of temperature-sensitive equipment.

In preparation for relocation to the North Campus Research Center, the Cytogenetics team also updated their equipment, obtaining a RoboSep™ from Stemcell for automatic plasma cell enrichment, a new Thermotron®, a Nikon® TMS-F phase scope, along with other basic laboratory equipment.

Michigan Medicine Genetics Laboratories

The MGP Division continues to work closely with the Michigan Medicine Genetics Laboratory (MMGL). The MMGL offers a wide range of biochemical and genetic testing services, including germline testing for cancer predisposition of individual gene (e.g. BRCA, PTEN, TP53) and panels of relevant genes (Hereditary Breast and Ovarian Cancer Comprehensive Germline NGS Panel). Specifically, the MMGL is working closely with the MCTP to perform germline testing for those Michigan Medicine patients that undergo OncoSeq testing.

Histocompatibility Laboratory

The Histocompatibility Laboratory works to match donor organs with donors. As part of the mission of the Histocompatibility (HLA) Laboratory, implementation of NGS and PCR testing in the lab has advanced our molecular typing process in the form of improved clinical results with reduced typing costs and improved turn-around times.

In FY 18, the HLA laboratory expanded the use of the virtual crossmatch protocol to cover all of the transplant candidates prior to the final flow crossmatch. The virtual crossmatch is an electronic process to assess the immunological risk before transplantation. Prior to October 2017, this process was peformed on only a small subset of transplant candidates. Currently, the process is performed routinely on every patient prior to final crossmatch and transplantation. This improvement can greatly enhance

immunological risk assessments and will ultimately help in improving patient outcomes. Additionally, this process can aid more transplant patients that previously had limited access to transplantation due to positive flow cytometry crossmatch and no HLA donor-specific antibodies. We have expanded the use of the virtual crossmatch to include stem cell transplant candidates receiving HLA haplotype matched or partially mismatched donor stem cells.

In FY 18, the Histocompatibility Laboratory processed 23,801 billable cases, up 12.88% from FY 17, in which they processed 21,085 billable cases. The laboratory is performing more comprehensive testing for our patients, for accurate antibody identification, enabling better transplantation outcomes for our patients. In FY 18, 968 high resolution typing was completed, as compared to 815 in FY 17, an 18.8% increase. Donor specific antibody testing increased 10.2% from 2,935 tests in FY 17 to 3,234 in FY 18. Flow crossmatches (allo) increased 2.4% from 532 to 545 in FY 17 and FY 18 respectively. In addition to these routine tests, there has been an ever-increasing need for additional testing, such as HLA-DP typing, supplemental antibody screening beads, surrogate crossmatches and auto crossmatches for kidney and extra-renal patients.

We instituted process improvements in FY 18 resulting in faster turnaround times for our patients. Among these improvements is the performing of DP typing at the time flow crossmatching is conducted if we observe that the patient has the DP antibody. We recommend that DP typing be performed on all new kidney patients, kidney donors, heart, and lung patients at the time of original typing to reduce delays.

In FY 18, the HLA laboratory obtained several new pieces of equipment as we prepare to move into the new laboratory space at the NCRC. Following extensive review and testing, the CytoFlex flow cytometry platform has been purchased and is undergoing validation. In addition, we purchased a Sysmex XP300™ Hematology Analyzer, allowing us to look at a 3-part differential and identify all cellular components that may affect the flow crossmatch. This has eliminated the human error component of counting cells, enabling us to have more accurate and quicker cell counts for our flow cytometry crossmatches, yielding superior results. The lab also evaluated the QuantStudio™ 6 Real Time PCR System and the Biomek i5® Span 8 Liquid Handler. The QuantStudio™ 6 will enable stat typings to be completed in 1.5 hours versus the current 4 hours, greatly facilitating organ donation and matching among critical patients. The Biomek® i5 will position us for growth in next generation sequencing in the laboratory.

Dermatopathology Molecular Diagnostic Laboratory

The Dermatopathology Molecular Diagnostic Laboratory is focused on developing and offering new diagnostic and prognostic assays for melanocytic and non-melanocytic cutaneous neoplasms. Current test offerings include two related tests to help discriminate between benign and malignant melanocytic tumors, one based on FISH testing and one based on array CGH. Testing can be done in conjunction with full Dermatopathology consultation or as a stand-alone test. Test volumes increased significantly (40-64%) after gross charges were adjusted in January 2017.

Aleodor A. Andea, MD
Director, Molecular Dermatopathology Research Laboratory, and Dermatopathology Molecular Diagnostics Laboratory

Michigan Center for **Translational Pathology**

Arul M. Chinnaiyan, MD, PhD
Director of Michigan Center for Translational Pathology

In 2011, the Michigan Oncology Sequencing Center (MI-ONCOSEQ), a CLIA-certified laboratory, was established to take advantage of the rapid advances in high-throughput DNA sequencing technologies with a goal of realizing "precision cancer medicine." This Center utilizes an integrative sequencing approach to provide a comprehensive landscape of the genetic alterations in individual tumor specimens for the purpose of identifying informative and/or actionable mutations.

This approach enables the detection of point mutations, insertions/deletions, gene fusions and rearrangements, amplifications/deletions, and outlier expressed genes. Furthermore, we can identify certain germline alterations that may also be relevant. We applied this to over 3000 adult and pediatric patients thus far; a breakdown of the major cohorts for whom results are returned in the form of a molecular report is listed in the table to the right. Overall, the molecular results show that informative and/or actionable mutations are identified in nearly 60% of cases and germline mutations in ~10% of patients.

Additionally, our sequencing facility supports a number of specialized programs and clinical studies. We intake and sequence samples from the Multiple Myeloma Research Foundation (>500 samples thus far) and have plans to extend the study into the next phase. Through partnership with MLabs, we have a non-exclusive license with Tempus Health, Inc. to help develop the OncoSeq assay and we sequenced over 150 patient and validation samples toward this effort (this program is no longer active). We have an agreement with Progenics Pharmaceuticals to sequence patients enrolled in the OSPREY clinical trial focused on prostate cancer patients (HUM00129179/ UMCC 2017.047). Internally, we support the Michigan Medical Genetics Laboratories (MMGL), a comprehensive CAP/CLIA certified clinical genetics testing laboratories housed in the Department of Pediatrics, by providing them with sequencing data for select patients.

Cohort	Patients Enrolled/ Sequenced	Patients Enrolled/ Sequenced in FY 19
MO- (MiOncoseq)	1328	345
TP- (Tumor Profiling)	597	136
PO- (Peds Oncoseq)	390	84
MM- (Multiple Myeloma)	643	274
GL- (Germline for MMGL)	136	92
PG- (OSPREY Study)	42	28

Listed is a summary of revenues generated by the programs:

Program	FY 17 Revenue	FY 18 Revenue	2019 Projected Revenue
MMRF	$898,639	$1,367,303	$1,500,000
MMGL	$14,596	$116,766	$175,000
Tempus	$473,000	N/A	N/A
Progenics	N/A	$154,000	$275,000

More recently MI-ONCOSEQ has been supporting several ongoing clinical trials/studies (charges based on select cases chosen for sequencing):

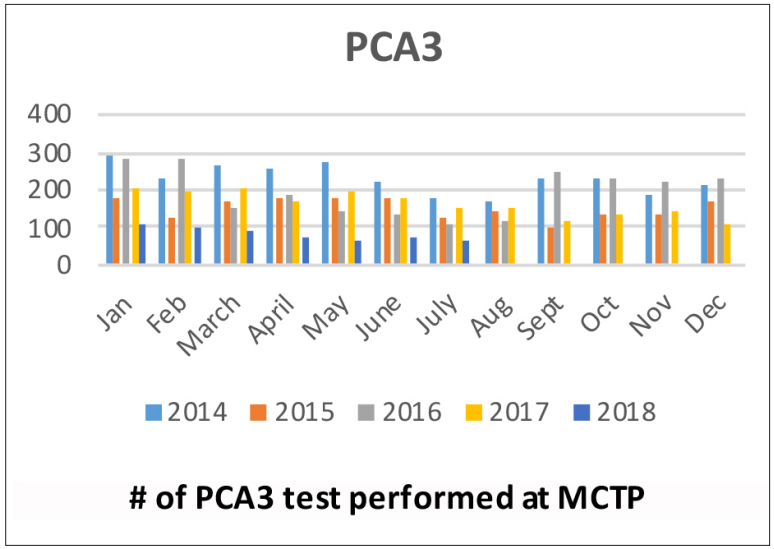
- **HUM00130035**: A Randomized Phase II Study of Nivolumab in Combination with Gemcitabine/Cisplatin or Ipilimumab as First Line Therapy for Patients with Advanced Unresectable Biliary Tract Cancer
- **Karmanos**: An Open-Label, Parallel, Phase II Study of Single-Agent Oral ESK981 in Men with Castrate-Resistant Prostate Cancer (CRPC)
- **HUM00135161**: FAST: Feasibility trial of Anti-PD(L)1 and SBRT in the Treatment of Advanced, Platinum-Refractory Urothelial Carcinoma
- **UMCC 2017. 057**: Phase II multi-center study of pembrolizumab in combination with platinum-based doublet chemotherapy in patients with EGFR mutation and ALK positive NSCLC (Non-Small Cell Lung Cancer) with progressive disease following prior tyrosine kinase inhibitors (TKIs)

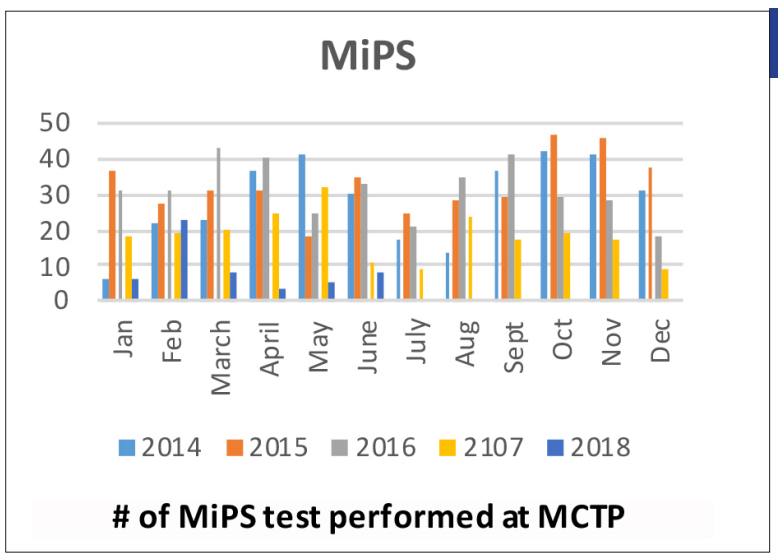
In association with MLabs, MCTP's Molecular Testing Lab (MTL) receives orders for and carries out PCA3, Mi-Prostate Score (MiPS) and to a smaller extent, Cell Search Circulating Tumor Cell (CTC) assays. MTL processed a total of 1310 PCA3 and 148 MiPS assays in FY 18.

MTL also supports a number of clinical studies and research projects:

- **UMCC 2013.117**: A Randomized Phase II Study of Androgen Deprivation Therapy with or without PD 0332991 in RB-Positive Metastatic Hormone-Sensitive Prostate Cancer
- **ENACT Study**: A Clinical trial assessing the efficacy of enzalutamide in men with prostate cancer on active surveillance
- A Randomized Phase II trial of Abiraterone, Olaparib, or Abiraterone + Olaparib in Patients with Metastatic Castration-Resistant Prostate Cancer with DNA Repair Defects (c16-168)
- **UMCC 2016.106**: A Phase I Trial of Neoadjuvant Stereotactic Body Radiotherapy Prior to Radical Prostatectomy for High Risk Prostate Cancer
- **HUM00117711**: Targeted Early Detection Program in Men at High Genetic Risk for Prostate Cancer
- **MI-ONCOSEQ** (clinical sequencing program): The Tissue/Informatics Core has been critical for the success of this program. The Core supports this study by participating in biospecimen procurement from biopsies and preparing samples to undergo sequencing in a CLIA-certified facility.

Collaborative project, "Validation of Mitochondrial Markers for Prostate Cancer" with Samantha Maragh (National Institute of Standards and Technology).





Jeffrey L. Myers, MD
Director of MLabs Reference Laboratory

Julia Dahl, MD
Associate Director, MLabs Reference Laboratory

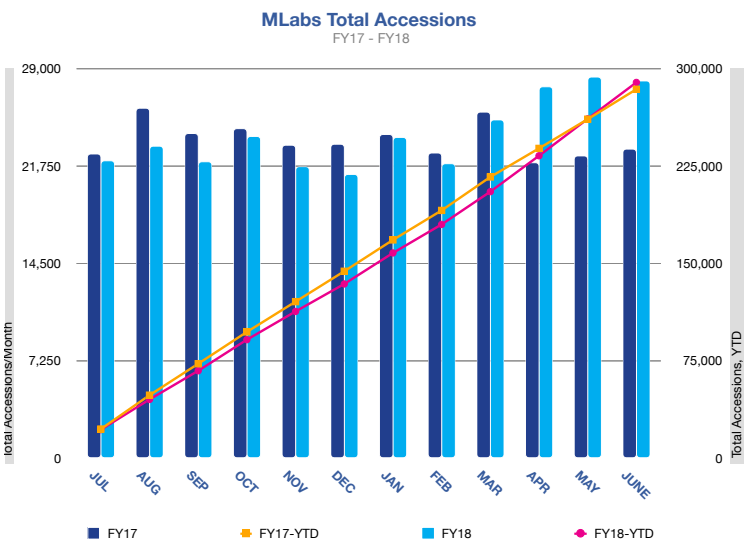
MLabs
Reference Laboratory

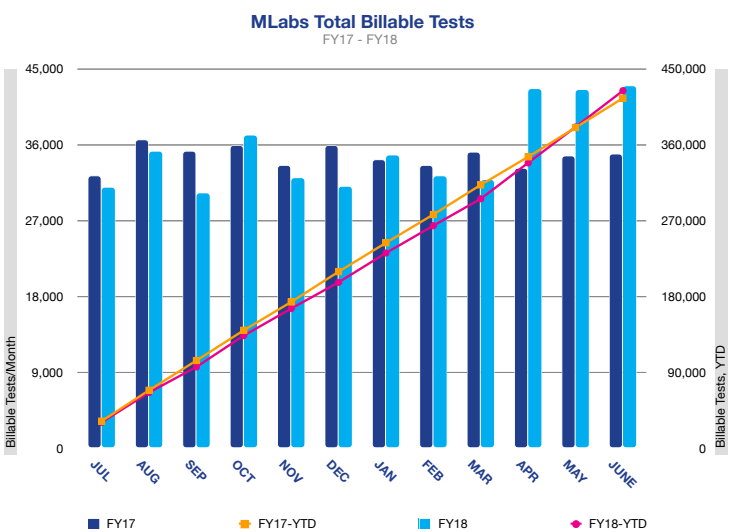
MLabs is a full-service reference laboratory that leverages the combined strengths of our faculty, trainees, staff, and state-of-the-art laboratories to revolutionize the experience of health care for providers and patients of strategic interest to Michigan Medicine and others outside our expanding health system network. Our continued successes in nurturing long-term relationships with a diverse portfolio of clients is predicated on the promise of expertise delivered personally with a passionate commitment to service excellence.

Total activity showed year-over-year growth of 1.8% measured as total number of accessioned cases (289,620) and 2.1% measured as total billable tests (424,505). Total gross charges grew at an annual rate of 5.5% compared to FY 17 (Figure 2), showing strong 4th quarter growth driven by the corresponding bump in activity with a favorable case mix. This continues a trend toward positive growth curves over the last 5 years; from FY 14 to FY 18 gross charges increased 18.3%.

Hospitals, physician offices, and hospital-based pathology groups were the areas of greatest revenue growth in FY 18, showing year-over-year increases in gross charges of 13.3%, 2.7%, and 18.9%, respectively (Figure 3). This reflects the impact of onboarding MidMichigan Health as part of Michigan Medicine's network expansion strategy and continued growth in the anatomic pathology and hematopathology consultation practice. Taken together these 3 market segments account for nearly 80% of gross charges.

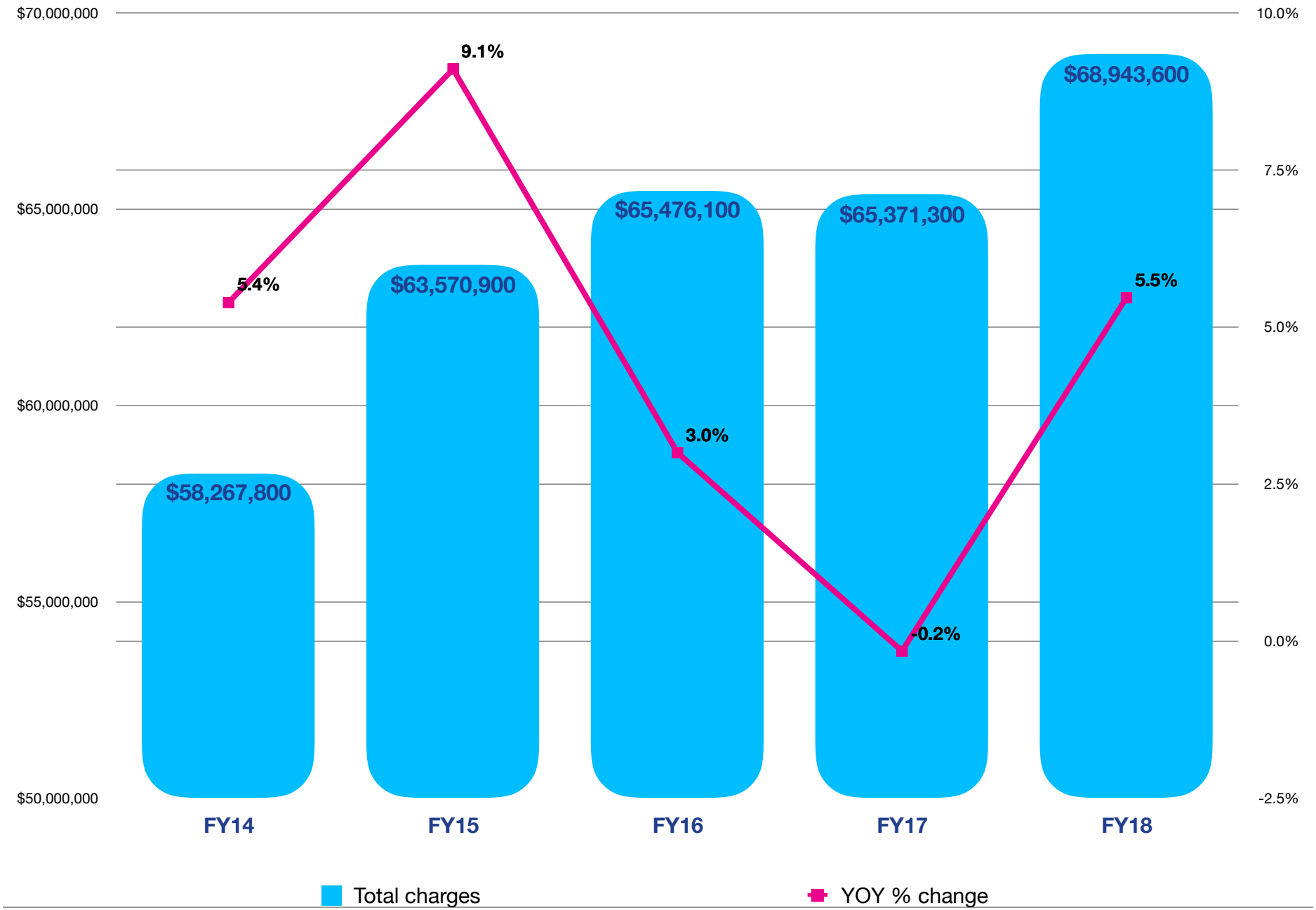
Growth in these market segments was partially offset by a nearly 20% decline in gross charges associated with reference and commercial laboratory clients. This continues a trend that reflects declining share in the increasingly commoditized molecular testing market. New strategies for contracting these services at hospital system levels will be an important area of focus for our new Business Development Manager.





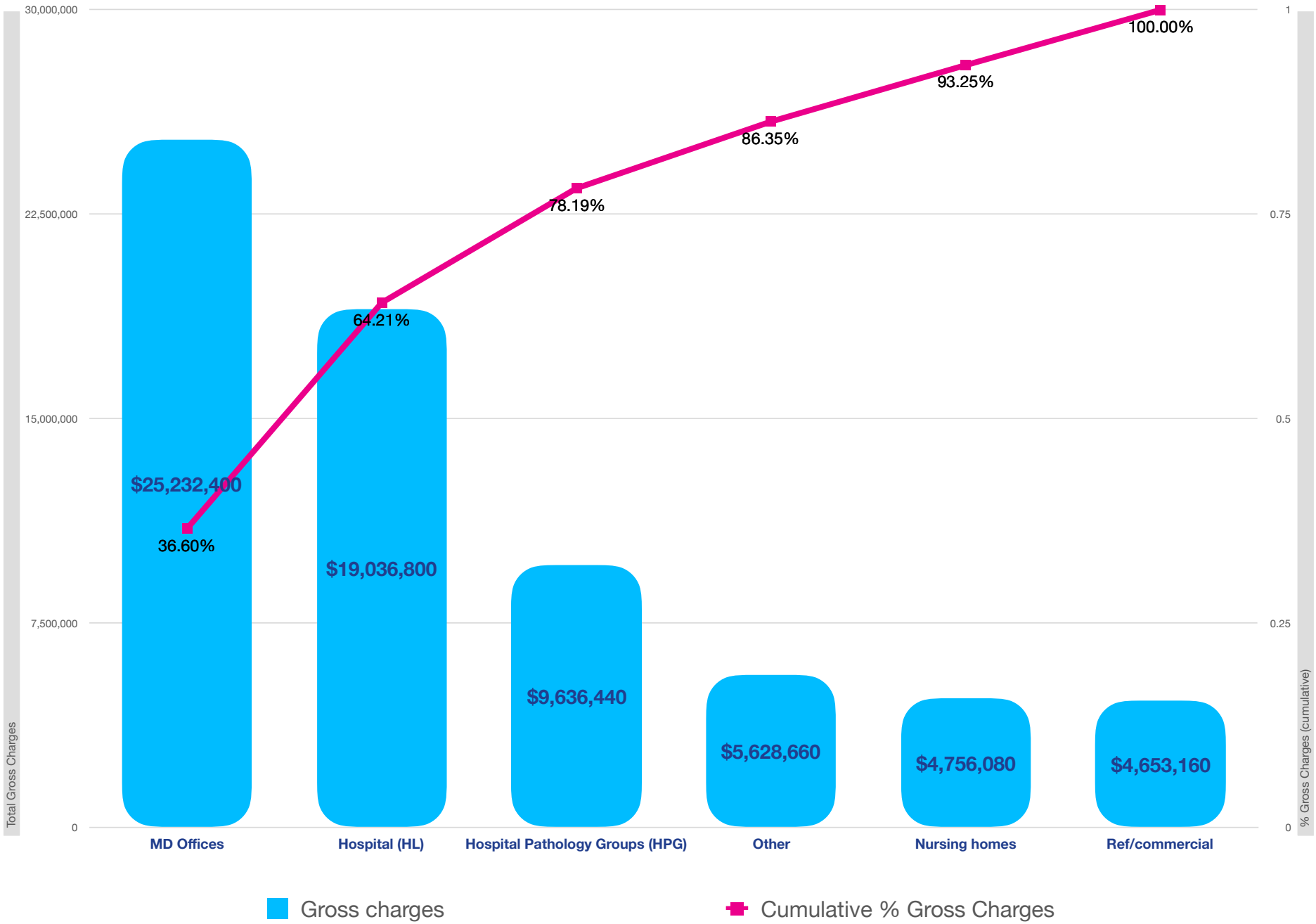
Total Gross Charges

FY14 - FY18



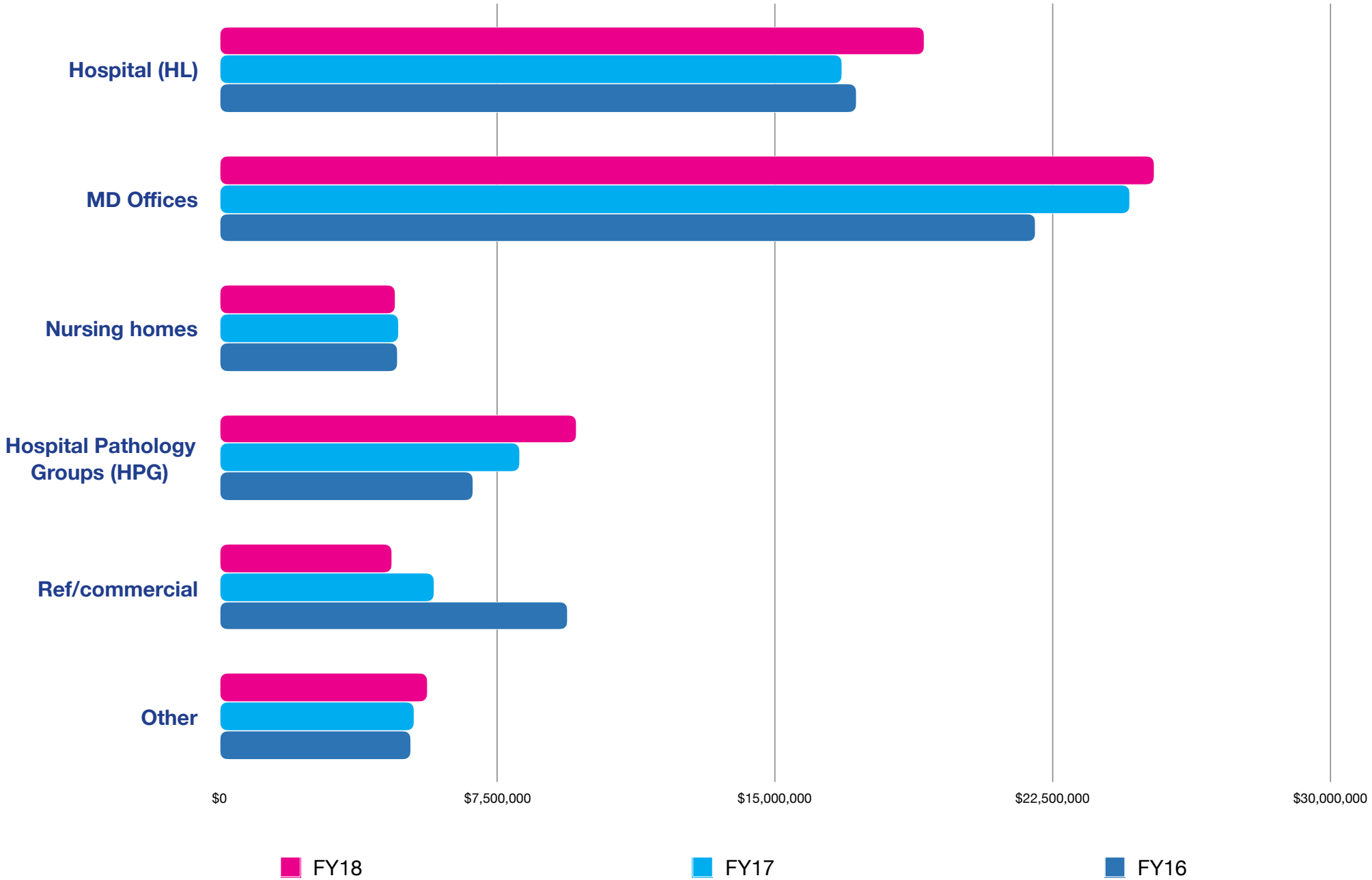
Contribution of Market Segments to Gross Charges

FY18



Total Gross Charges by Market Segment

FY16 - FY18



Veterans Affairs
Pathology & Laboratory Medicine

Stephen Chensue, MD, PhD
Director, Veteran's Administration Hospital Laboratories, VA

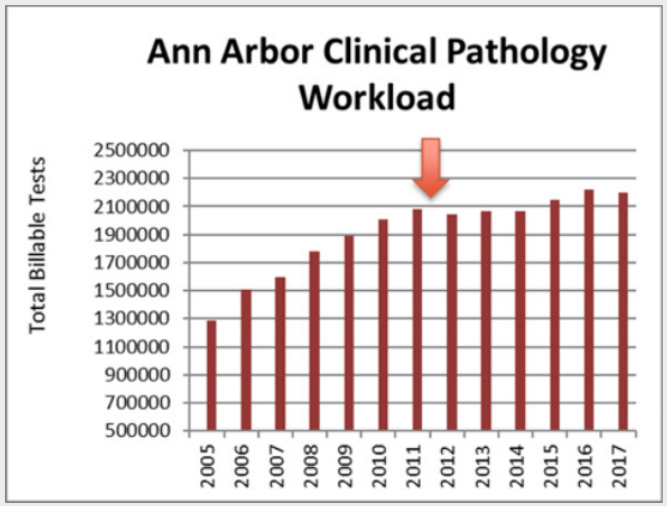
The Pathology and Laboratory Medicine Service of the Veterans Affairs Health Center in Ann Arbor, Michigan, is staffed by pathologists with a joint appointment at the University of Michigan Medical School. The VA Ann Arbor location houses the regional full-service pathology laboratory, with basic chemistry and hematology offered in Toledo, Ohio, and point-of-care testing offered in Flint and Jackson, Michigan. In addition, they support the anatomic pathology needs in Surgical Pathology and Cytopathology for Battle Creek and Saginaw, Michigan and the Gynecologic Cytopathology needs for Detroit, Michigan. Due to differences in fiscal years, the data presented below is for the year ended December 31, 2017.

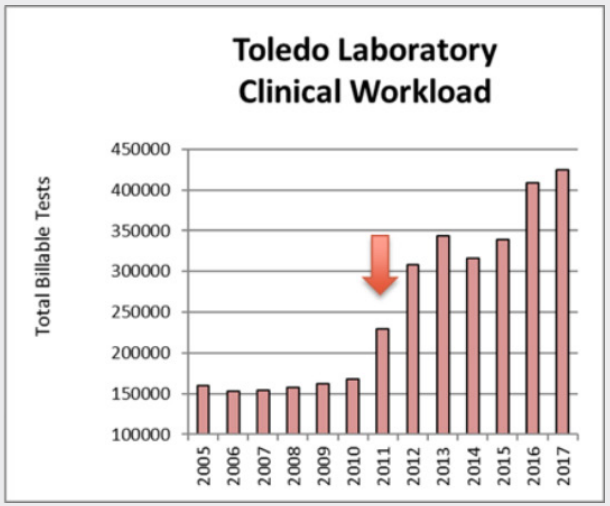
The clinical workload in the Ann Arbor laboratory has been relatively flat since 2011, with a small increase seen in 2016 and 2017, due to bringing the Toledo, Ohio, laboratory online. Likewise, the Anatomic Pathology workload has also remained stable. The laboratory faculty and staff work hard to ensure patients receive timely care, meeting clinical pathology STAT specimen turn-around time goals at least 94% of the time. In Anatomic Pathology, all service lines met or exceeded their targets except for cytology (gyn and non-gyn), which narrowly missed due to an extended leave of a key member of the team. When compared to other VA Health Center Laboratories, the VA Ann Arbor Health Center pathologists' productivity is among the highest with the lowest pathologist labor expense per billable test, and patient satisfaction is the highest among all VISN 10 facilities. Our phlebotomy labs see 92.6% of patients in less than 10 minutes with 90.2% of patients indicating they are satisfied with their service. Overall, 89% of patients find the quality of our laboratory staff to be high and 87% believe we are available and timely in our service during normal working hours.

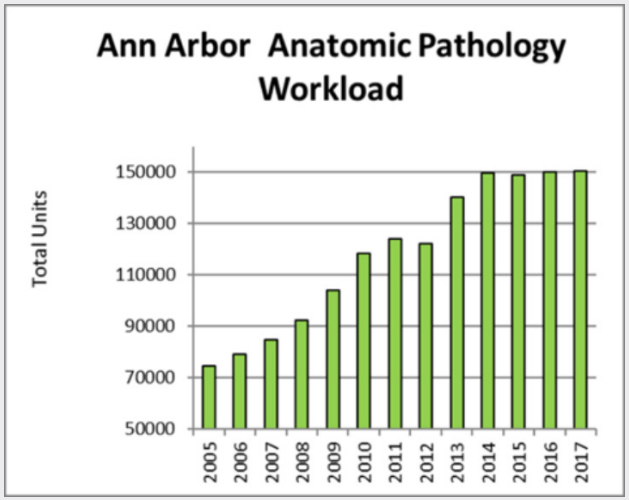
We are working diligently to reduce FTE demands by implementing integrated clinical laboratory testing using robotic systems to link multiple analyzers as well as to automate specimen storage and retrieval. In addition, we are integrating image analysis into hematology to reduce the need for manual differential analysis of blood smears and applying bar code tracking to Anatomic Pathology to reduce the potential for errors and to improve operational efficiencies. Finally, we are using spectroscopic molecular pattern analysis in microbiology for rapid bacterial and fungal identification at lower costs.

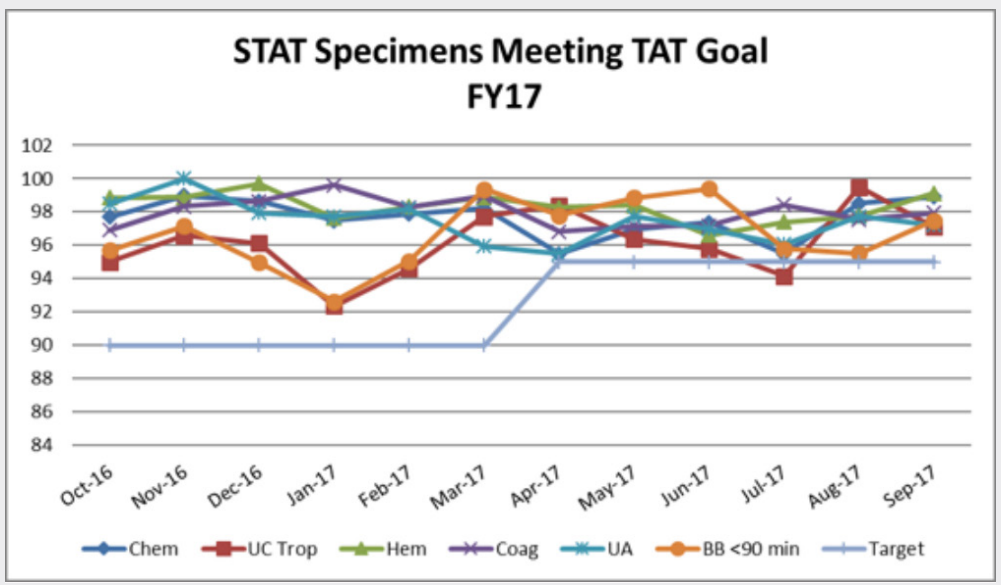
Parameter	Case#	Target	FY 17 Outcome
Surgical Report <2d	13,851	95%	96.2%
Non-Gyn Cytology Report <2d	2,821	95%	91.7%*
Gyn Cytology Report <14d	1,843	95%	89.1%*
Frozen Section Report <20min	579	95%	100%
Autopsy Report <30d	5	100%	100%

**Extended leave of cytotechnologist in FY 17*

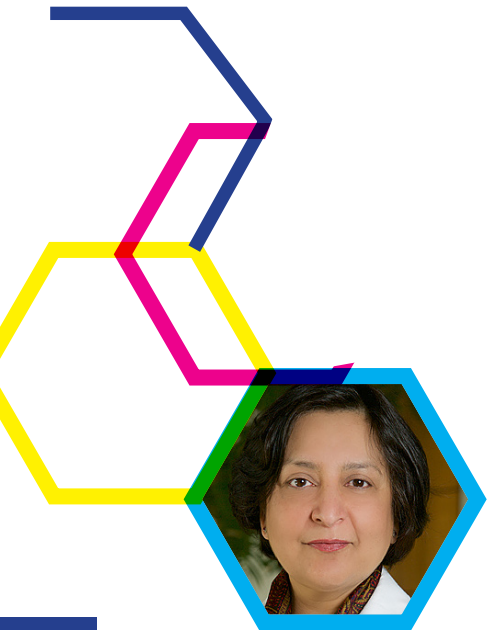

Ann Arbor Clinical Pathology Workload
Total Billable Tests
2500000
2300000
2100000
1900000
1700000
1500000
1300000
1100000
900000
700000
500000
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017


Toledo Laboratory Clinical Workload
Total Billable Tests
450000
400000
350000
300000
250000
200000
150000
100000
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017


Ann Arbor Anatomic Pathology Workload
Total Units
150000
130000
110000
90000
70000
50000
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017


STAT Specimens Meeting TAT Goal FY17
102
100
98
96
94
92
90
88
86
84
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Chem
UC Trop
Hem
Coag
UA
BB <90 min
Target

Research Mission



Asma Nusrat, MD
Director of Experimental Pathology

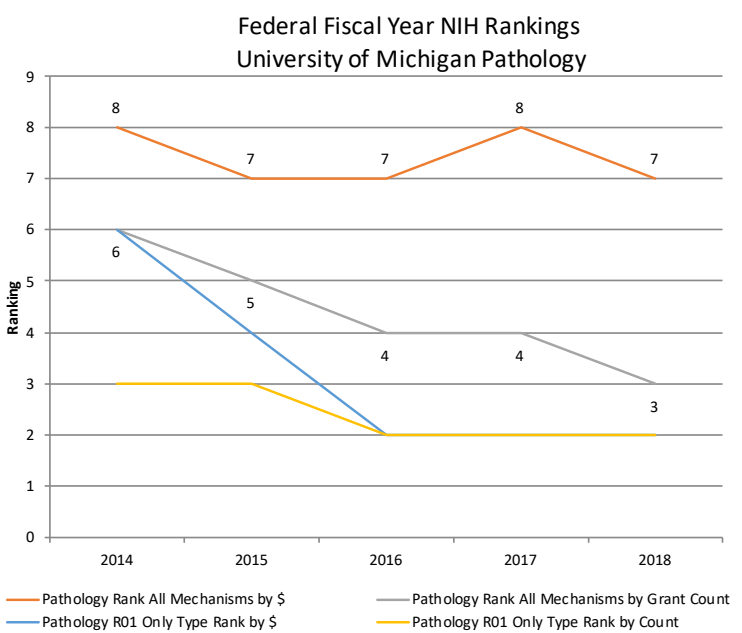
The research mission of the Department of Pathology is aimed at better understanding the mechanisms of disease and finding ways to treat or cure diseases. While many of the faculty have responsibilities within the clinical mission of the Department in addition to their research efforts, the Department also houses a Division of Experimental Pathology which is home to 85 faculty representing 40 research laboratories with 15 endowed professorships.

The Experimental Pathology faculty are both established and emerging young investigators occupying 61,293 sq. ft. of research space located in multiple buildings across the medical campus. These faculty are at the forefront of cutting-edge research that integrates new discoveries with the practice of medicine. Their scientific projects address many aspects of biology, disease pathogenesis and therapeutics.

Primary areas of research in the Division include aging, cancer biology, development and DNA repair, inflammation and immunology, mucosal inflammation and epithelial pathobiology, and neuropathology.

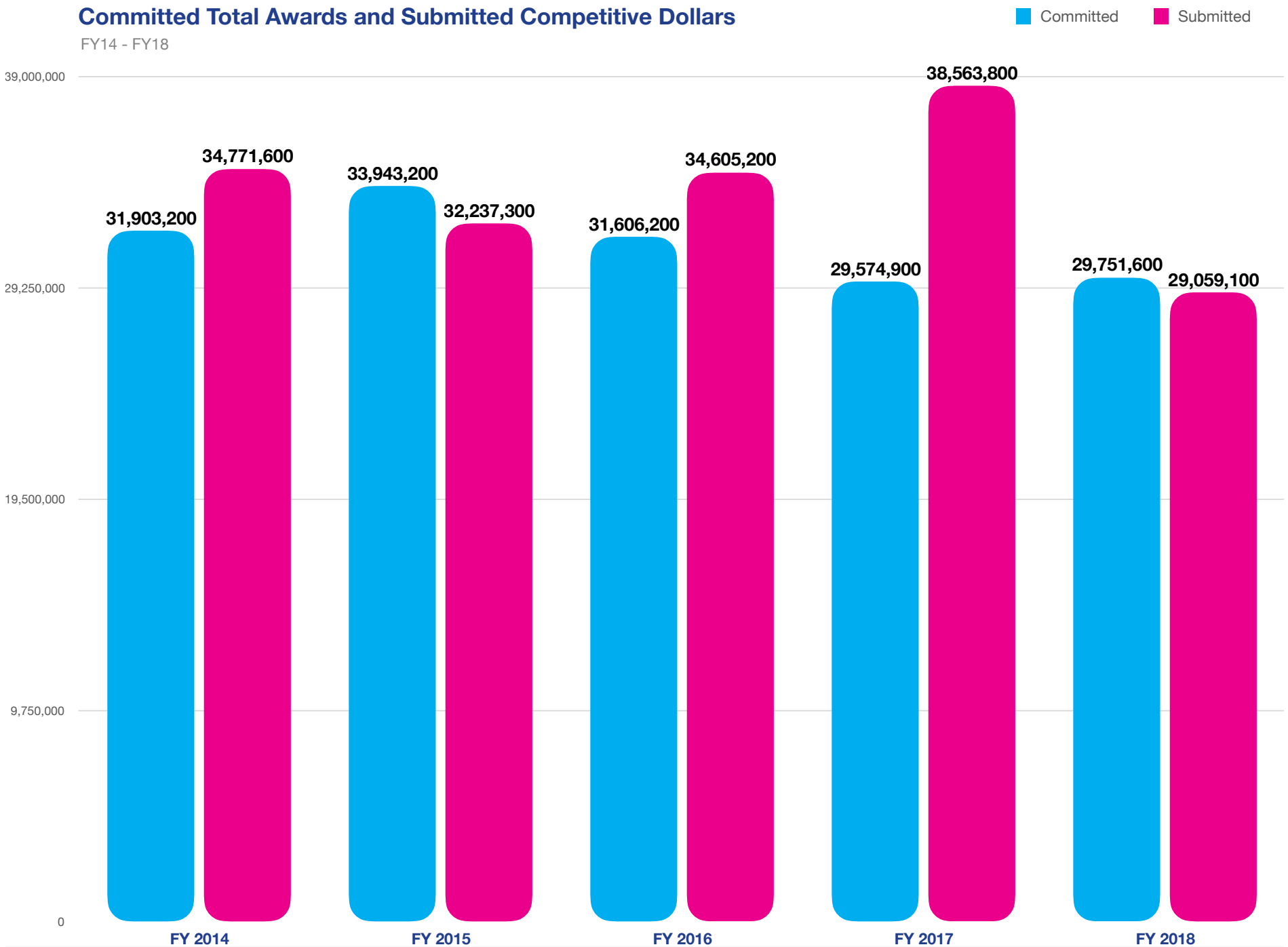
The New Mary H. Weiser Food Allergy Center was opened during FY 18, which resulted in joint Pathology/Food Allergy Center recruitment of three faculty members: Chang Kim, PhD, Simon Hogan, PhD, and Taeko Noah, PhD. In December 2018, Dr. Chang Kim was endowed as the Kenneth and Judy Betz Family Endowed Professor. Dr. Hogan was also named as the Askwith Research Professor of Food Allergy, both with the Mary H. Weiser Food Allergy Center.

In FY 18, our faculty received 53 awards from the NIH and ranked 8th in the nation in funding received by the NIH and 2nd in the nation when considering RO1 grant awards only. The average award size from the NIH was 73% of those received at other higher-ranked institutions, up from 70% in FY 17 and 65% in FY 16, showing a steady growth in amounts awarded.



Committed Total Awards and Submitted Competitive Dollars

FY14 - FY18



Aging

Six faculty working in two laboratories are focused on various aspects of aging research:

- Sirtuin deacylases and their roles in Disease: **Dr. David Lombard** laboratory
- Genetics and aging: **Dr. Richard Miller** laboratory

Cancer Biology

Thirty-six faculty working in twenty laboratories are focused on cancer biology, including:

- Bone cancers: **Dr. Laurie McCauley** laboratory
- Brain cancers, adult and pediatric: **Dr. Sriram Venneti** laboratory
- Colon cancer: **Dr. Eric Fearon** laboratory
- Epigenetics, gene expression and neoplasia: **Dr. Yali Dou** laboratory
- Leukemia/hematologic malignancies: **Dr. Andrew Muntean** laboratory, **Dr. Russell Ryan** laboratory
- Genitourinary cancer: **Dr. Evan Keller** laboratory, **Dr. Scott Tomlins** laboratory
- Breast cancer: **Dr. Celina Kleer** laboratory
- Genomics and bioinformatics: **Dr. Arul Chinnaiyan** and the Center for Translational Pathology
- Genomic stability diseases: **Dr. David Ferguson** laboratory
- Gynecologic cancers: **Dr. Kathleen Cho** laboratory, **Dr. Analisa DiFeo** laboratory
- Ophthalmic cancer: **Dr. Rajesh Rao** laboratory
- Pediatric oncology: **Dr. Elizabeth Lawlor** laboratory
- Proteomics and cancer systems: **Dr. Jean-Francois Rual** laboratory
- Renal/posttransplant viral oncogenesis: **Dr. Evan Farkash** laboratory
- Sirtuin deacylases and their roles in disease: **Dr. David Lombard** laboratory
- Small molecule inhibitors/drug discovery: **Dr. Jolanta Grembecka** and **Dr. Tomasz Cierpicki** laboratory, **Dr. Zaneta Nikolovska-Coleska** laboratory

Development and DNA Repair

Six faculty working in five laboratories are conducting research on development and DNA repair:

- Epigenetics, gene expression and neoplasia: **Dr. Yali Dou** and **Dr. Yifan Liu** laboratory
- Kidney developmental biology: **Dr. Gregory Dressler** laboratory
- Genome stability diseases: **Dr. David Ferguson** laboratory
- Adult and pediatric brain tumorigenesis: **Dr. Sriram Venneti** laboratory
- DNA double-strand break repair: **Dr. Thomas Wilson** laboratory

Inflammation and Immunology

There are twenty-three faculty working in seven laboratories whose research is focused on Inflammation and Immunology. The research conducted by these faculty include:

- Neurology/neuropathology: **Dr. Anuska Andjelkovic-Zochowska** laboratory
- Food allergy: **Dr. Simon Hogan** and **Dr. Chang Kim** in the Mary H. Weiser Food Allergy Center
- Gastrointestinal/colon: **Dr. Naohiro Inohara**, **Dr. Gabriel Nuñez** Laboratory
- Immune cell activation and cytokine biology: **Dr. Steven Kunkel** laboratory
- Lung injury and fibrosis: **Dr. Sem Phan** laboratory
- Skin biology: **Dr. James Varani** laboratory
- Acute inflammatory response: **Dr. Peter Ward** laboratory

Mucosal Inflammation and Epithelial Pathobiology

Six faculty members working in three laboratories are focused on mucosal inflammation and epithelial pathobiology. The research conducted by these faculty include:

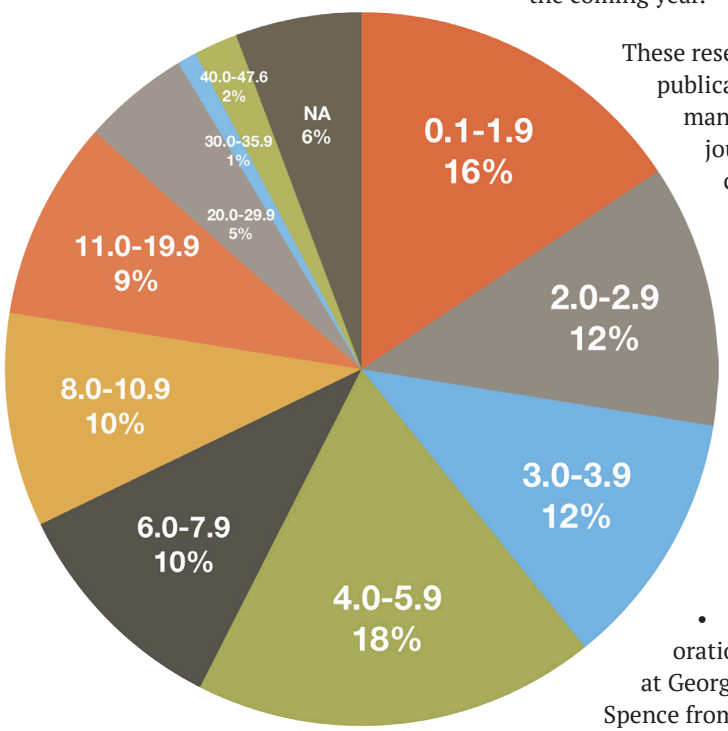
- Kidney/glomerular diseases: **Dr. Jeffrey Hodgin**
- Gut and lung allergic responses: **Dr. Nicholas Lukacs** and the Mary H. Weiser Food Allergy Center
- Intestinal Inflammation and Epithelial Pathobiology: **Dr. Asma Nusrat** and **Dr. Charles Parkos** laboratory

Neuropathology

Five faculty members working in four laboratories focused on neuropathology. The research conducted by these faculty include:

- Molecular mechanisms of cerebrovascular diseases: **Dr. Anuska Andjelkovic-Zochowska** laboratory
- Neurodegenerative diseases: **Dr. Andrew Lieberman** laboratory
- Sirtuin deacylases and their roles in disease: **Dr. David Lombard** laboratory
- Adult and pediatric brain tumors: **Dr. Sriram Venneti** laboratory.

Our total sponsored research spending in FY 18 exceeded $33.4 million, which represents funds awarded over the past several years. In addition, our faculty submitted more than $29 million in grant applications during FY 18 and were awarded $29,751,609 in grant funds. Our Anatomic and Clinical Pathology faculty were Principal Investigators or Co-investigators with our Experimental Pathology faculty on $21.3 million in funded grants, a testament to the dedication and versatility of our faculty. The Michigan Center for Translational Pathology (MCTP) held 25 grants valued at $7.7 million, which was a decrease of nearly 20% as compared to FY 17 ($9.6 million, 23 grants) and a five-year decrease of 28% as compared to FY 14 ($10.7 million, 30 grants). However, Dr. Arul Chinnaiyan was awarded a $6.5 million award in early FY 19, so these numbers are expected to increase in the coming year.



These research efforts resulted in 454 peer-reviewed publications in FY 18, with nearly 20% of these manuscripts appearing in 41 high-impact journals (Impact Factor >10). Again, our clinical faculty were actively involved in the publication efforts of the Department, with AP faculty contributing to 350 peer-reviewed publications, CP faculty contributing to 178 peer-reviewed publications, MCTP publishing 39 manuscripts and PI publishing 9 manuscripts. Many publications included joint authorships across divisions as our faculty work together to advance knowledge and patient care.

Some of the key highlights this year have included the following studies:

- Dr. Asma Nusrat's laboratory, in collaboration with Dr. Andres Garcia (a bioengineer at Georgia Institute of Technology) and Dr. Jason Spence from the Department of Internal Medicine at Michigan Medicine, identified a synthetic engineered hydrogel matrix for growth and differentiation of pluripotent stem-cell-derived human intestinal organoids that were successfully implanted into healing colonic mucosal wounds of mice, suggesting that this approach can be used to treat non-healing mucosal injuries in inflammatory disorders. This work was published in *Nature Cell Biology* 2017, 19:1326-1335.

- Dr. Jean-Francois (Jeff) Rual's laboratory, in collaboration with Drs. Yali Dou, Venkatesha Basrur, and Alexey Nesvizhskii and others published a study in *EMBO Journal* demonstrating that methyl-lysine reader, L3MBTL3, switches the Notch coactivator RBPJ to a transcriptional repressor by mediating removal of activating histone marks at Notch target genes in mammalian cells, including brain and breast cancer cell lines. *In vivo* analyses of the homolog of L3MBTL3 in reductionistic models that include *Drosophila melanogaste*r and *Caenorhabditis elegans* demonstrate that the functional link between RBPJ and L3MBTL3 is evolutionarily conserved, thus identifying L3MBTL3 as a universal modulator of Notch signaling in metazoans. *EMBO J* published online October 13, 2017 DOI:10.15252/embj.201796525

- Dr. Arul Chinnaiyan, and the MCTP team identified LncRNA that provides insight into a key driver of prostate cancer – and a potential target for future therapy. This group identified a novel gene they named ARLNC1, which controls signals from the androgen receptor. Inhibition of ARLNC1 in cell lines expressing androgen receptor led to cancer cell death and prevents tumor growth. Conversely, in mouse models, elevating ARLNC1 resulted in large tumors. This study was published in *Nature Genetics* 2018 June, 50(6):814-824.

- The Chinnaiyan laboratory also identified a new subtype of prostate cancer that occurs in about 7 percent of patients with advanced disease. The subtype is characterized by loss of the gene CDK12 and it was found to be more common in metastatic prostate cancer compared with early stage tumors that had not spread. CDK12 mutant cases were associated with elevated neoantigen burden ensuing from fusion-induced chimeric open reading frames and increased tumor T-cell infiltration/clonal expansion and thereby defines a distinct class of metastatic prostate cancers that may benefit from immune checkpoint immunotherapy. *Cell*. 2018 Jun 14;173(7):1770-1782.

Another measure of our faculty performance is their invited sem-

inars. The majority of our faculty, 113, were invited to lecture at seminars, symposia, and other venues 564 times in FY 18.

Division	Faculty Invited	Invited Lectures
Anatomic Pathology	39	205
Clinical Pathology	20	81
Experimental Pathology	39	178
Michigan Center for Translational Pathology	15	100
Total	**113**	**564**

Sixteen patents/innovations were filed or issued to our faculty in FY 18.

- **Ul Balis, MD**, created PathTrack RealTime Geospatial Tracking Software; a solution for Anatomic and Clinical Laboratory Medicine workflow where testing is performed at multiple locations.
- **Ul Balis, MD**, developed the Michigan Diabetes Education Tool, MiDiET, a lightweight electronic medical record and laboratory information system intended for low resource settings.
- **Ul Balis, MD**, developed PathCMS, a comprehensive dynamically-rendering content management system designed specifically to support academic departments in the health sciences.
- **Ul Balis, MD**, developed VIPER: Validated Identification of Prescreened Exemplar Regions, a high-performance image-segmentation and annotation tool based on a proprietary GPU-based, massively parallel segmentation library designed to run on the Cuda architecture.

- **Noah Brown, MD, and Bryan Betz, PhD**, created a Next-Generation Sequencing, Data Analysis and Visualization Tool to aid in the interpretation of sequencing results.
- **Noah Brown, MD**, also filed a patent for the detection of recurrent urothelial carcinoma in urine samples using allele-specific real-time PCR for TERT promoter mutations.

- **Arul Chinnaiyan, MD, PhD**, has a patent pending on the Detection of CDK12 alterations to predict prostate cancer therapeutic sensitivity.

- **Jolanta Grembecka, PhD, and Tomasz Cierpicki, PhD**, received three patents for small molecules to treat Leukemia. They have licensed their menin inhibitors to Kura Oncology and these will be tested in a Phase 1 clinical trial for the treatment of Leukemia beginning in FY 19.

- **David Keren, MD, and Lee Schroeder, MD, PhD**, filed their invention of the InheRET, Inherited Risk Evaluation Tool.

- **Sean Li, MD, PhD**, developed and licensed to the University of Michigan the Plasminogen activator inhibitor-1 (PAI-1), inhibitor and method of use.

- **David Lombard, MD, PhD**, is the co-inventor on two patents that include the potential use of inhibitors of sirtuins and PAPP-A as anti-aging drugs.

- **Zaneta Nikolovska-Coleska, PhD**, received a patent for the design of compounds to hinder DOT1L recruitment by MLL-fusion proteins.

- **James Varani, PhD**, patented a compound that focuses on the use of biologically active moieties, such as all-trans retinoic acid, for the treatment of acne.

Education Mission

Kathleen Cho, MD
Vice Chair for Academic Affairs.

Allecia Wilson, MD
Director, Residency Training Program

Education is another of the core missions of the Department of Pathology as part of an Academic Medical Center. The Department is a key provider of learning for medical students, graduate students, dental students, residents, and fellows. Our faculty have been among those most revered and remembered by graduates of the medical school, and have garnered formal recognition in the form of teaching awards over the years. In addition, many Pathology faculty members play key roles in education in other clinical departments throughout the Medical Center and in University departments outside of Medicine. Similarly, our trainees are part of the educational process for their more junior counterparts and for others in the health system. The ways in which we fulfill this core mission are constantly evolving and adapting to new circumstances and demands.

Graduate Medical Education – Pathology Residency Program

In 2018, The University of Michigan Pathology Residency Program was the #1 ranked program in the United States among large public hospitals and was ranked 6th overall by Doximity, an online social networking service for U.S. physicians with over 400,000 verified physician members. In addition, 100% of our graduates from the past five years indicated that the training they received in our residency program was "excellent."

Program Type	Ranking by Reputation	Ranking by Research Output
All U.S. programs	6	13
All large public hospitals	1	3
Midwest programs	2	4

For our incoming resident cohort, we received 450 applications to fill 8 open slots. As such, we were able to recruit high-caliber residents from a wide geographic region. All eight of our 2018 incoming first-year residents matched in AP/CP and were highly ranked by UM in the National Residency Matching Program (NRMP) match.

This group includes graduates of medical schools all over the country:

- **Margaret Fang** / Medical College of Georgia at Augusta University
- **Efrain Gutierrez-Lanz** / Universidad Autonoma de Baja California
- **Justin Kelley** / Wright State University Boonshoft School of Medicine
- **Lauren Kroll-Wheeler** / Albany Medical College
- **Natalia Liu** / Indiana University School of Medicine
- **Tim Miller** / University of Colorado School of Medicine

- **Catherine Perez** / University of Illinois College of Medicine
- **Will Perry** / Wayne State University College of Medicine

Our residency curriculum consists of daily didactic, gross or slide presentations, 13 AP and 7 CP core subspecialty rotations, Quality Improvement course, Path 862 Translational Pathology course (combined with PhD students), and ASCP Lab Management University with certification.

A vibrant and varied morning Pathology Educational Series takes place most mornings at 8 am, from September through mid-June. In 2017-18 there were approximately 180 conferences, each offering CME credit! They were presented by visiting faculty from other institutions, residents, fellows, staff, and departmental faculty. The morning conference series may be the one venue that most often draws together residents, fellows, AP faculty, and CP faculty.

In collaboration with our Division of Quality and Health Improvement, our first- and second-year residents participated in Quality Improvement and Patient Safety projects as part of our Quality Improvement curriculum. Residents worked through web-based learning modules, attended lectures and discussions, and worked in teams on clinically-focused quality improvement projects. Data for knowledge assessment tests indicate a trend toward continuous improvement of the post-test mean scores, with significantly improved post-test over pre-test scores in each of the three years the curriculum has been administered.

Table 1. Comparison of pre- and post-test means for the three years of administration of the QI curriculum.

Year	Pre-test mean score	Post-test mean score	p-value (paired t-test)
2016	12.6	16	0.0001
2017	14.2	16.2	0.04
2018	14.1	17.4	0.02

The Pathology Informatics lecture series in which they participate prepare Residents for engagement with the technical aspects of medicine in the future. This newly restructured curriculum unit is designed to cycle every three years, ensuring all residents in our training program are exposed to the full content at least once.

Our residents are highly-engaged members of the medical and pathology communities with many serving in local, regional and national organizations. (*See chart on **pg. 69** of the Appendix.*)

Ten residents completed residency training in 2018 including our first AP/NP resident. All have begun fellowship training in Dermatopathology, Gastrointestinal Pathology, Molecular Genetic Pathology, Gynecologic Pathology, Surgical Pathology, Forensic Pathology and Neuropathology. Seven continued their training at Michigan and the other 3 have fellowships at the University of Washington (Breast and Gynecological), Brigham and Women's Hospital (Hematopathology), and Memorial Sloan Kettering (Surgical Pathology).

Key achievements of our graduating residents include:

- All graduating residents earned certificates in Lab Management University.
- All graduating residents participated in at least one cycle of the QI curriculum.
- All graduating residents participated in a CAP inspection or mock inspection.
- 1 graduating resident completed the Healthcare Administration Scholars Program. A 2-year certificate-level program covering various topics in healthcare administration, culminating in a senior administrative project.

100% of the graduating class passed the American Board of Pathology certification examination on the first attempt. Our current 5-year certification rate is 96% for first time takers.

Pathology Fellowship Program

The Department of Pathology offers 9 ACGME-approved fellowships offering 16 approved positions plus an additional 10 clinical fellowship programs. Our Pathology Informatics fellowship program is in the process of converting to an ACGME-approved program in Clinical Informatics. Once approved, this program will be the only

Sarah Rooney, MD
Chief Resident

Libby Simon, MD
Assistant Chief Resident

Laurence Briski, MD
HO IV

Sara Hawes, MD
HO IV

Sameer Khatri, MD
HO IV

David Manthei, MD, PhD
HO IV

Jon Mowers, MD, PhD
HO IV

Stephanie Skala, MD
HO IV

Grace Wang, MD
HO IV

John Kennedy, MD
HO III

Shula Schechter, MD
HO III

Brian Soles, MD
HO III

Lauren Stanoszek, MD, PhD
HO III

Milad Webb, MD, PhD
HO III

Steven Weindorf, MD
HO III

Helen Worrell, MD
HO III

Kyle Conway, MD
HO II

Amanda Kitson, MD
HO II

Emily McMullen, MD
HO III

Chelsea Styles, MD
HO II

Burke Van Norman, MD
HO II

Nicholas Zoumberos, MD
HO II

Krista Chain, MD
HO I

Laura Griesinger, MD
HO I

Cisley Hines, MD
HO I

Ania Owczarczyk, MD, PhD
HO I

Ashley Smith, DO
HO I

Alex Taylor, MD
HO I

Margaret Fang, MD
Incoming HO I

Efrain Gutierrez-Lanz, MD
Incoming HO I

Justin Kelley, MD, MPH
Incoming HO I

Lauren Kroll-Wheeler, MD
Incoming HO I

Natalia Liu, MD
Incoming HO I

Tim Miller, MD
Incoming HO I

Catherine Perez, MD
Incoming HO I

William Perry, MD, MPH
Incoming HO I

2017-2018 **Pathology Residents**

Clinical Informatics program to serve the Health System.

This year, we welcomed:

- Breast Pathology Fellow
  Ellen East, MD
- Bone and Soft Tissue Pathology Fellow
  Cody Carter, MD
- Cytopathology Fellow
  Miguel Rufail, MD, PhD
- Dermatopathology Fellows
  Grace Wang, MD and **Joseph Zahn, MD**
- Forensic Pathology Fellow
  Milad Webb, MD, PhD
- Gastrointestinal Pathology Fellow
  Jonathan Mowers, MD, PhD
- Genitourinary Pathology Fellow
  Zhichun Lu, MD
- Gynecologic Pathology Fellow
  Stephanie Skala, MD
- Hematopathology Fellows
  Sarmad Jassim, MD, **Shweta Chaudhary, MD,** and **Nick Olson, MD**
- Histocompatibility Fellow
  Kristina Davis, MD
- Molecular Genetics Fellows
  David Manthei, MD, PhD and **Eman Abdulfatah, MD, PhD**
- Neuropathology Fellows
  Kyle Conway, MD and **Andrew Pratt, MD**
- Pathology Informatics Fellow
  Keluo Yao, MD
- Pulmonary Pathology Fellow
  Jian Jing, BM, PhD
- Surgical Pathology Fellows
  Sara Hawes, MD, **Kenneth Hughes, MD**, **Dongmin Gu, MD, PhD,** and **Tanmay Shah, DO**

Madelyn Lew, MD
Director, Medical School
Pathology Education Curriculum

Medical Student Teaching

The Department has a long history of playing an integral role in pre-clinical medical student education. In *Foundations of Diagnostics & Therapeutics*, one of the first sequences encountered by medical students in the Scientific Trunk, we introduce the foundational principles of Pathology. This lays the groundwork upon which students build in subsequent organ-based fused sequences. Each of these include pathology lectures and many also utilize pathology laboratory sessions. Lectures and laboratories are conducted by many pathology faculty members including Drs. Madelyn Lew, Scott Owens, Evan Farkash, Paul Harms, Alexandra Hristov, Allecia Wilson, Kristine Konopka, Paul Killen, Scott Tomlins, Aaron Udager, Karen Choi, Angela Wu, Andrew Sciallis, May Chan, Charles Ross, Laura Cooling, and Kate McFadden. Under the direction of Dr. Madelyn Lew, Director of Medical Student Education for the Department of Pathology, our faculty are working to continue integrating pathology content with other clinical and basic science elements in fused sequences and to incorporate new interactive methods of delivering education material.

In the *Transitions to Clerkships* Course, Dr. Madelyn Lew authored one of the standardized patient presentations, which provides Blood Bank faculty an opportunity to participate in medical education as leaders of small group sessions. In the new *Surgery & Applied Sciences Clerkship*, students are introduced to the clinical practice of pathologists. For this clerkship, Dr. Madelyn Lew is developing a curriculum to consolidate foundational principles learned in the Scientific Trunk and to introduce their clinical applications in the daily activities of the Pathology Department. This curriculum will utilize different learning environments including small groups sessions, observation of clinical activities, and online modules.

In the Branches, faculty are participating both as Branch mentors as

Stacy Arnold, MD
Cytopathology

Sarah Avedschmidt, MD
Forensic Pathology

Cody Carter, MD
GYN Pathology

Michael Carter, MD, PhD
MGP

Nathan Charles, MD, PhD
MGP

Adam Covach, MD
Forensic Pathology

Kristina Davis, MD
HLA

Ellen East, MD
Surgical Pathology

Shohreh Eliaszadeh, MD
Hematopathology

Mark Ettel, MD
GI Pathology

Kenneth Hughes, MD
Pulmonary Pathology

Forest Huls, MD
Hematopathology

Zaid Mahdi, MD, PhD
Surgical Pathology

Jayson Miedema, MD
Dermatopathology

Drew Pratt, MD
Neuropathology

Tanmay Shah, MD
GU Pathology

Yulei Shen, MD, PhD
Hematopathology

John Sherbeck, MD
Blood Bank

Reena Singh, MD
Bone & Soft Tissue Pathology

Michael Wang, MD, PhD
Dermatopathology

Keluo Yao, MD
Cytopathology

Osman Yilmaz, MD
Surgical Pathology

2017-2018 **Pathology Fellows**

Graduating Fellows 2017-2018

Five of our 2017-2018 Fellows, Cody Carter, Ellen East, Kenneth Hughes, Tanmay Shah, and Keluo Yao, opted to complete a second fellowship year as listed above, while we bid farewell to these graduating Fellows:

Fellow	New Position	Institution
Stacy Arnold	Associate Pathologist/ Cytopathologist	Clin-Path Associates (AZ)
Sarah Avedschmidt	Independent Contractor	Sacramento County Coroner's Office (CA)
Michael Carter	Pathologist	Nova Scotia Health Authority (NS)
Nathan Charles	Pathologist	Great Lakes Pathologists (WI)
Adam Covach	Assistant Medical Examiner	Fond du Lac County Medical Examiner's Office (WI)
Shohreh Eliaszadeh	Oncologic Surgical Pathology Fellowship	Moffitt Cancer Center (FL)
Mark Ettel	Assistant Professor	University of Rochester (NY)
Forest Huls	Hematopathology	Pending
Zaid Mahdi	GI Fellowship	Beth-Israel Medical Center
Jayson Miedema	Assistant Professor, Dermatology	University of North Carolina
Yulei Shen	Molecular Genetic Pathology Fellowship	Texas Children's Hospital, Baylor College of Medicine (TX)
John Sherbeck	Director of Transfusion Medicine	IHA Pathology (MI)
Reena Singh	Assistant Professor	Oregon Health Science (OR)
Michael Wang	Pathologist	North Shore Pathologists (SC)
Osman Yilmaz	GI Fellowship	Brown University (RI)

Kristine Konopka, MD
Director, Pathology Clerkship
Program Director, Pulmonary Pathology Fellowship

well as Science Advisors for the Diagnostics & Therapeutics Branch. Students in their third and fourth years can participate in a variety of integrated electives that include multiple disciplines to enhance their understanding of disease process, presentation, and management.

Pathology Elective Rotation

The Pathology Elective experience is now under the direction of Dr. Kristine Konopka. The elective has undergone improvements to tailor to the career goals of rotating students. Through the efforts of faculty and staff, particularly Desiré Baber, medical students now have a more structured framework in which they are assigned to specific pathology services which are correlated to their chosen career paths. Throughout this rotation, students select cases to write-up in order to enhance their understandings of clinic-pathologic correlations. Additionally, students are required to write an in-depth paper about a topic within Pathology that correlates to their own personal or career interests. While many of the students rotating in our elective may choose other fields of practice, a distinct subset take part in our Career Exploration elective to evaluate Pathology as a possible career choice. For these students, individualized mentoring is provided by faculty in the department, particularly from Drs. Kristine Konopka, Aaron Udager, and Madelyn Lew.

Molecular and Cellular Pathology Graduate Program

The Molecular and Cellular Pathology Graduate Program (MCP) is one of the Programs in Biomedical Sciences (PIBS) graduate programs and is supported through the Department of Pathology. The MCP Graduate Program, under the direction of Dr. Zaneta Nikolovska-Coleska, has 41 Pathology research mentors/labs from which to choose and had 23 students performing their PhD thesis research in Pathology Department laboratories during FY 18.

Zaneta Nikolovska-Coleska, PhD
Director of Molecular and Cellular Pathology Graduate Program

In August 2017, our new MCP and PIBS students participated in a half-day event to discuss the program and to learn about available research rotation projects. Once the students selected their laboratory, they were encouraged to work with their mentors to attend mentoring sessions offered by Rackham's Office of Student Success and to prepare their mentoring plan. At the first thesis committee meeting, students present their proposal written in an R21 format.

Each year, the Director of the MCP meets with the students to discuss their progress. In addition, students are invited to an annual MCP Student Council meeting to hear students' opinions and suggestions. This is to ensure students remain on track and their needs are being adequately addressed during their thesis research work.

Students are also engaged with outreach and professional development activities to build their mentoring skills with younger students and undergraduates. In FY 18, the students participated in

- STEM Career Panel at Estabrook Elementary School
- Galens Medical Society, Chair of the Financial Allocations Committee
- miLEAD Consulting
- Bridge to BCG Program
- Michigan DNA Day
- OrgLead's 16-week Leadership Development Training Program
- Ele's Place facilitator
- Middle school science Olympiad coach
- Gymnastics Program for Autistic Children, volunteer
- HELP hospital volunteer program
- Detroit Zoological Society Fellowship in Science Communication
- MHSPEA Lab Instructor

In addition, the students organized the Department Research Symposium, November 10, 2017. James Ropa was awarded the Outstanding Research Award. Kelley Kennaley received the Best Oral Presentation Award and Ulas Ozkurede and Sierrah Grigsby received the Best Poster Awards. Planning is well underway for next year's Research Symposium where Dr. Mina Bissell, Lawrence Berkeley National Laboratory, will be the keynote speaker.

To address the social needs of the MCP students, a number of events are held each year, including a Student/Faculty picnic at Island Lake Park, a happy hour student/faculty mixer, a student camping trip to South Higgins Lake, and an ice cream social.

During this fiscal year, two students wrote, defended and successfully completed their preliminary exams, which allowed them to pass to candidacy during their second year and begin to focus on their research thesis work. In addition, six students graduated with their PhD:

- Emmalee Adelman (*Figueroa Lab*)
- Talha Anwar (*Kleer Lab*)
- Allison Johnson (*Andjelkovic-Zochowska Lab*)
- Mary Rogawski Morgan (*Ferguson Lab*)
- Justin Serio (*Muntean Lab*)
- Hung-An "Anna" Ting (*Lukacs Lab*)

Our graduate students were successful in obtaining grants, travel awards and fellowships this year. Paloma Garcia and Jaqueline Mann obtained F31 Fellowships, Abhijit Parolia and Yajia Zhang obtained DoD Fellowships. Training grants were received by Angela Guo (Training in the Biomedical Research of Aging), Samantha Kemp (Training Program in Translational Research), and Sabra Djomehri (PICTP 2nd Year Training Grant), while seven students obtained travel awards.

The MCP students published five first-author manuscripts and 15 co-author manuscripts in peer-reviewed journals. Six students received awards for their work.

Student Name	Award
Andi Cani	1st place in the UM Department of Pathology CHAMP Research Symposium
Sabra Djomehri	CCBS UCI Course NIH Fellowship
Sierrah Grigsby	Minority Student Abstract Achievement Award, American Society of Hematology Conference
Kelly Kennaley	2nd place in the 4th Annual Midwest Case Competition
Siva Natarajan	1st place in the Michigan Graduate Consulting Case Competition
Abhijit Parolia	AACR Scholars-in-Training Award; Prostate Cancer SPORE Poster Award – 2nd Place

Translational Pathology Training Grant

The NIH T32 Training Program in Translational Research, directed by Drs. Andrew Lieberman and Zaneta Nikolovska-Coleska, was funded and started on July 1, 2016. This T32 grant is supported by the NIH, National Institute of General Medical Sciences and supported 4 predoctoral trainees for year 2 of the 5-year cycle.

Trainee	Academic Program	Mentor	Years Training
Shawn Whitefield	Microbiology & Immunology	Dr. Evan Snitkin	2nd
Lucas Huffman	Neuroscience	Dr. Roman Giger	2nd
Karson Kump	Chemical Biology	Dr. Zaneta Nikolovska-Coleska	1st
Samantha Kemp	Molecular & Cellular Pathology	Drs. Marina Pasca Di Magliano and Celina Kleer	1st
Strongly affiliated with the T32 TPTR Program			
Andi Cani	Molecular & Cellular Pathology	Dr. Scott Tomlins	2nd
Hanjia Guo	Molecular & Cellular Pathology	Dr. David Lombard	2nd

Postdoctoral Research Fellows

The department is also home to 58 postdoctoral research fellows working in more than 40 laboratories within Pathology. These research fellows are under the training of their faculty mentors, who provide them with funding and laboratory space to continue their research efforts until they are able to become successful, independent investigators. Each postdoctoral fellow's training is unique to the needs of the fellow, their research interest and the mentoring of their faculty lead.

Medical Technologist Training

Our clinical laboratories also train medical technologists who rotate through our labs. In FY 18, we trained 8 medical technology students. This training includes observation of specimen preparation and instrument operation with senior medical technologists, flow diagnostics and reporting with attending Pathologists, raw data


Remember Dolly??!
Why then we don't replicate ourselves or our organs?
And the big question: What is the basis of organ and tissue-specificity?

analysis and QA/QC management education with the Medical Director. Monthly flow meetings are attended by the lab director, manager, and technologists to discuss technical issues, test development, and educational topics.

Conferences and Symposia

The Department of Pathology hosts numerous conferences and symposia each year to provide continuing education for our faculty, trainees and staff as well as for professional development opportunities for pathologists and trainees from other institutions. In FY 18, we offered the following:

- New Frontiers in Pathology, October 21-23, 2017. Invited speakers included Paul Wakely (Ohio State), Christina Isaacson (CellNetix) and Adam Bagg (Pennsylvania), with multiple case presentations and digital microscopy sessions presented by UM Faculty. Proceeds from the meeting were published in 2 issues of *Archives of Pathology and Laboratory Medicine*.
- Pathology Graduate Student Research Symposium, November 10, 2017. A symposium planned and led by graduate students.
- Association of Pathology Informatics Digital Pathology Workshop, December 2017. Held at Henry Ford Hospital in Detroit, MI, the Pathology Informatics Division served as co-secretariat of this new meeting focusing on deployment strategies for realizing clinical whole-slide-imaging workflow.
- CHAMP (Clinical, Hemato-, Anatomic, and Molecular Pathology) Research Day, February 8, 2018. A showcase of scientific presentations by departmental faculty and trainees. Keynote speaker was Dr. Pedram Argani from Johns Hopkins Hospital.
- The 9th Clinical Pathology Symposium, April 23, 2018. The 2nd Annual Batsakis Lecture, "Anti-Nuclear Antibody Testing: It Ain't Easy Not Being Green" was presented by James D. Faix, MD, Montefiore Medical Center.
- Pathology Informatics Summit 2018, May 2018, Pittsburgh, PA, was organized and convened by our Pathology Informatics leadership.
- Histology Image Analysis International Working Group Workshop, May 2018, Pittsburgh, PA. Our Pathology Informatics Division served as the co-secretariat of this annual event, which draws an international audience of machine vision scientists with specific interest in whole slide imaging.
- Advances in Forensic Pathology, May 10-11, 2018. The inaugural Dolores M. and John E. Finger, MD, Forensic Lecture Award was presented to Dr. Gregory Hess, Chief Medical Examiner of Pima County, Tucson, AZ, and Clinical Assistant Professor of Pathology at the University of Arizona.
- Current Topics in Blood Banking, May 12, 2018. Featured speaker Matthew Elkins, MD, PhD, presented "Myth Busters from the Blood Bank."

In addition, each week, there are numerous smaller conferences and seminars – whether they be multidisciplinary case conferences, tumor boards, research seminars, resident educational conference presentations, hematopathology educational conference presentations, or other educational opportunities for our faculty and trainees. There is a weekly research seminar series highlighting research from our own faculty and trainees as well as research conducted by special guest lecturers. This year, the A. James French Visiting Professorship hosted Aaron James (Johns Hopkins), Alex Lazar (MD Anderson) and Daniel Brat (Northwestern). The Young Visiting Professor Exchange hosted Dipti Karamchandani (Penn State), Gary Tozbikian (Ohio State), and Nicole Cipriani (Chicago).

Pathology **Informatics**

Ulysses Balis, MD
Director of Pathology Informatics

The Division of Pathology Informatics (PI), which serves as one of the functional units of the overall Pathology Department, serves the tripartite missions of the department, including: clinical operations support, original research, and education. As an informatics division, it is somewhat unique among contemporary academic pathology departments, in that it maintains both its own technical staffing and associated IT infrastructure, with both elements being wholly-contained within the department and similarly, under the exclusive direction of Pathology leadership. This autonomy affords the division both the ability to carry out internal prioritization of the department's many projects, as well as the ability to independently carry out original IT development efforts. In addition, the division hosts its own active thrusts in fundamental areas of information technology, machine vision and deep learning research, including: computational imaging of WSI subject matter, asset tracking solutions, computational pathology, natural language processing, and medical information interoperability.

Fundamentally, PI operates as a *service unit* within the greater department, covering a wide range of operational and strategic functions, with these various missions tied together by a centrally-governed team of superbly-trained information technology specialists.

Continuing in its substantial preparative efforts in both 2016 and 2017, the PI Division played a central and fundamental role in the recent PRR initiative over the 2018 summer, facilitating a relatively smooth transition of all related information technology elements of the department, including substantial effort in finishing and subsequently deploying the much-anticipated PathTrack application. Additionally, the PI division played a major role in providing logistical support for the deployment of a massive incremental presence of network-based IT appliances and devices associated with the Anatomic Pathology Division's *en masse* relocation, which took place over a single weekend. Following the physical relocation of a number of laboratory units, the PI division continued to play a central role in the stabilization and optimization of many IT solutions and devices.

Clinical Support Activities

Support for the Laboratory Information System was a major component of the clinical work conducted in Pathology Informatics. This included creating a large number of electronic interfaces as a result of the move to the North Campus Research Complex and the addition of the B. D. Kiestra™ microbiology automation line, which was activated during the summer 2018. Continued institutional growth also required the addition of several incremental Admission, Discharge and Transfer interfaces as well as deployment of two IBM P8-based server clusters in two data center locations. In the midst of this, a major upgrade to the LIS system was completed, resolving a large number of longstanding user interface and management reporting defects.

In addition, PI implemented high-complexity bi-directional reference laboratory electronic interfaces to support new MLabs clients, MidMichigan Health and West Shore Urology. This also required an IIB interface engine upgrade, which facilitates all inbound and outbound electronic traffic, both within Michigan Medicine and with our growing external MLabs client base.

The PI team was also instrumental in ensuring the proper computer


Chart
Autoselect instances
return dispatch => {
let accessToken, details, stationInfo, persist
axios
.post(auth.laravel, {username, password})
.then(laravelResponse => {
/**
* Build pipeline test.
*/
if (typeof laravelResponse.data.type === 'undefined') {
return loginResponse({
title: laravelResponse.data.title,
msg: laravelResponse.data.msg,
type: laravelResponse.data.type,
})
}
/** We then give the token over to express for
* verification and processing */
accessToken = laravelResponse.data.accessToken
persist = laravelResponse.data.persist
if (persist && !isEmpty(persist) && dhcpScanner === null) {
dispatch(persistUserSettings(persist))
}
let post = isEmpty(auth.scanner)
? laravelResponse.data
: {sessionId: auth.scanner.session_id}
/**
* If we are off-site or at an unassigned IP
* address, attempt to add a dhcpScanner to the
* request. If none is chosen, don't assign.
*/
if (dhcpScanner !== null) {
post.dhcpScanner = dhcpScanner
}
axios
.post(auth.express, post)
.then(expressResponse => {
if (expressResponse.data.type) {
return loginResponse({
title: 'Login Error',
type: 'error',
})
}

hardware and services were ordered, set up, and installed for the clinical laboratory and faculty/staff relocation from multiple locations on campus to the NCRC. This was a herculean effort that was accomplished smoothly and enabled the clinical services of the Department to continue functioning.

The clinical support activities were not limited to the Michigan Medicine system. In partnership with Dr. Kolars and the Medical School Students Abroad program, the PI Division has assisted in establishing a comprehensive light-weight electronic medical record (Michigan Diabetes Education Tool – MiDiET), with integrated laboratory value documentation capability and tri-lingual decision support reporting tools, in support of a clinical trial in Trincomali, Sri Lanka. Additionally, in 2018, PI was instrumental in deploying point-of-care hemoglobin A1c analyzers in several clinics in Trincomali. Now in its second year of deployment, the project has attained several major milestones of: a) implementing a light-weight electronic health record in support of Trincomali's diabetic patient population and b) effectively implementing a prospective clinical trial with support from the Mend Division (Bill Herman, Jennifer Wyckoff), seeking to identify the utility of point-of-care A1c measurements in a low resource setting, in tandem with field-deployed decision support tools, as a means of managing uncontrolled Diabetes Mellitus in the general population.

Most Recent Laboratory Data: (Reported to be fasting values with a 6 hour interval)

Blood Glucose	100	mg/dL
HgA1C	12.4	%
Blood Urea Nitrogen	8.0	mg/dL

Health Status Dashboard:

Glycemic Control கிளைசெமிக் கட்டுப்பாடு ග්ලයිසීමික් පාලනය	**At Target Values** இலக்கு மதிப்புகளில் ඉලක්කගත අගයන්
Blood Pressure இரத்த அழுத்தம் රුධිර පීඩනය	**Requires Immediate Attention** உடனடி கவனம் தேவைப்படுகிறது ක්ෂණික අවධානය යොමු කිරීම
Lipid Levels லிப்பிட் நிலைகள் ලිපිඩ් මට්ටම	**At Target Values** இலக்கு மதிப்புகளில் ඉලක්කගත අගයන්
Complications சிக்கல்கள் සංකූලතා	**Nothing Documented** ஒன்றும் ஆவணப்படுத்தப்படவில்லை ලියකියවිලි කිසිවක් නැත

Diabetes Health Synopsis

Visit Date: August 23, 2018

Demographics:

අහඟුඳු, අරිසෙන්	DOB:	November 15, 1950
	Gender:	Male
	Age:	68
	Years with Diabetes:	20
	Year D.M. First Diagnosed:	1998
	Calculated MRN:	12E34280F7
	Mobile Tel::	+94 112 675 449
	Education Level:	Secondary School
	Type of Diabetes:	Type 2

Current Medications:

Metformin:	750mg BID	(Total Dose: 1500mg)
Hydrochlorothiazine:	25mg QD	(Total Dose: 25mg)
Lovastatin:	40mg QD	(Total Dose: 40mg)
Aspirin:	75mg QD	(Total Dose: 75mg)
Clopidigril:	300mg QD	(Total Dose: 300mg)
Regular Insulin:	8u @ Breakfast	11u @ Lunch 14u @ Dinner 6u @ Bedtime

Immunizations:

None Reported

Review of Systems:

Recent Weight Loss	(first noted 21/8/2018)	
Ankle Swelling	(first noted 26/8/2018)	
Muscle Pain/Aches	(first noted 27/8/2018)	
Nocturia	(first noted 27/8/2018)	(maximum of 3 episodes per night)

Women's Health:

Not applicable

Lifestyle:

Smoking:	None reported
Alcohol Consumption:	None Reported

Physical Exam:

Body Habitus	Weight:	65.0 Kg
	Height:	160.0 cm
	Calculated BMI:	26.4
Blood Pressure:	Systolic:	175
	Diastolic:	112
Visual Inspection:	Left Foot:	Cellulitis: Plantar arch
	Right Foot:	Callus: L Great Toe

(left & top) Computationally-generate tri-lingual (English, Sinhala, Tamil) recommendations generated by use of a field-deployed clinical decision support rules engine.

(right) The Pathology Informatics MiDiET application being used in an outpatient setting in Trincomali, Sri Lanka, as a field trial for the U-M Medical School Diabetes Outreach Project, intended for in low resource settings.

Division of Quality & Healthcare Improvement

Scott Owens, MD
Director, Division of Quality and Health Improvement

The Division of Quality and Healthcare Improvement works across Divisions to support the efforts of each Division to ensure Departmental resources are used effectively and that the quality of care for patients is at the highest levels. As noted in the Education Division, the DQHI team engages in teaching quality improvement processes to our Residents so they can continue to implement these techniques throughout their careers, multiplying their efforts. In FY 18, the DHQI undertook several key initiatives.

Patient Asset Management Initiative (PAMI)

With guidance from a Steering Committee composed of departmental leadership, Amy Mapili continued her leadership in FY 18 as overall manager of this departmental initiative aimed at stewardship of patients' physical and digital assets while they are in our care. Ultimately, the scope of this initiative will stretch from test ordering through archiving of physical materials (such as slides and blocks) and diagnostic data. The bulk of this year's activity focused on the development and implementation of ***PathTrack*,** a digital application developed by our partners in Pathology Informatics that has the ability to interact with the laboratory information system (Soft) to accurately track the movement of assets throughout the Department. The work this year was intentionally focused on ensuring the ability to track assets (specifically patient specimens) as they move throughout the enterprise in the new workflows created by the departmental move to NCRC. Feedback from users during several pilot projects and initial deployment has been very positive.

Laboratory Stewardship Initiative/Committee

Spearheaded by Project Manager Jeff Lott, this initiative involves a partnership with leaders in Internal Medicine and the Michigan Program on Value Enhancement (MPrOVE; *ihpi.umich.edu/our-work/strategic-initiatives/mprove*), and is centered on the *Laboratory Stewardship Committee* (LSC), a sub-committee of the institutional Lab Formulary Committee co-chaired by Jeffrey Warren, MD (Pathology) and Timothy Laing, MD (Rheumatology). This year saw the departure of the Internal Medicine co-chair of the LSC, Dr. Christopher Petrilli, who took a position at New York University. The substantial void left by Dr. Petrilli's departure was filled by Dr. Ashwin Gupta, a Clinical Lecturer and Hospitalist in Internal Medicine with both experience in and enthusiasm for quality initiatives and test utilization-centered projects. Dr. Gupta joins Lee Schroeder, MD, PhD, as co-chair of the LSC, and work continues apace on several subprojects involving partnerships with stakeholders in Internal Medicine and Pathology, including:

- Optimization of *C. difficile* testing
- Ending complex and costly thrombophilia testing for inpatients
- Developing evidence-based reflex ordering systems for anti-nuclear antibody and thyroid hormone testing
- Creating a test utilization dashboard for feedback to providers

The table on ***pg. 51*** provides an overview of opportunity estimates

Guideline	Lab Test	Low-value tests (%)	Patients affected	Admitted (%)	Outpatient (%)	ED (%)
THYROID PANEL TESTS						
Thyroid panel tests should not be ordered unless there is an abnormal TSH in prior 60 days.	T4	882 (66%)	818	73 (46%)	743 (70%)	65 (61%)
T4 tests not included above due to same-day abnormal TSH.	T4	368 (28%)	239	59 (37%)	270 (25%)	38 (36%)
Thyroid panel tests should not be ordered unless there is an abnormal TSH in prior 60 days.	T4, free	22,151 (72%)	18,722	1404 (51%)	19,069 (74%)	1676 (70%)
FREE T4 tests not included above due to same-day abnormal TSH.	T4, free	7,229 (23%)	4216	915 (33%)	5,656 (22%)	657 (27%)
HCV GENOTYPE TESTS						
Hepatitis C genotyping should not be ordered more than once	Hepatitis C genotype	292 (59%)	284	16 (38%)	274 (61%)	2 (100%)
Hepatitis C genotyping must follow an abnormal hepatitis C antibody	Hepatitis C genotype	440 (89%)	433	36(86%)	402 (89%)	2 (100%)

Selected opportunity estimates for low-value laboratory testing (courtesy of Yifan Xiang, Jenna Keedy, James Henderson, MPrOVE). ED: Emergency Department

for reduction of low-value laboratory testing that was provided to the LSC by members of MPrOVE. Highlights include the facts that 72% of all free T4 tests are ordered inappropriately (without an abnormal TSH in prior 60 days) and that 89% of hepatitis C genotype assays do not follow an abnormal hepatitis C antibody study.

Compliance, Accreditation and Quality Activities

Andrea Arlen spearheaded an interim CAP self-inspection that involved several DQHI team members as inspectors and support personnel. CAP inspections of laboratory facilities in Kellogg Eye Center, Northville Health Center, West Ann Arbor Health Center, and Livonia Health Center were also completed. Andrea, Margaret Rayer, Lisa Brown, and Brian Tolle have worked diligently in follow-up to these inspection activities to help laboratory personnel and management address identified deficiencies In addition, Margaret maintains a laboratory audit schedule focused on *Quality System Essentials* in accordance with the Departmental Quality Plan, endorsed by the members of the Departmental Quality Council.

Finance & Administration

Martin Lawlor
Director of Finance and Administration

The Division of Finance and Administration, which is under the auspices of the Office of the Chair, is responsible for the business, operational, and fiscal affairs of the Department of Pathology, as mandated by the policies of the Chair, Michigan Medicine, and the University. In this section, we will highlight the key achievements of our Finance and Administration team and provide an overview of the supporting services provided by this division. Mr. Lawlor served on various departmental, health system, university, and professional committees including the Ambulatory Care Operating Committee, Cancer Center Ambulatory Care Coordinating Group (Co-Chair), Executive Committee for the Joint Venture Hospital Laboratories (Chair), and is immediate past chair of the Association of Pathology Chairs – Pathology Department Administrators Committee. (2017-2019).

Some key divisional highlights for this academic year include:

- Incorporated Lean Facility Design principles in planning space solutions for NCRC Buildings 30, 35, 36 and 60.
- Facilitated relocation of the first teams to the NCRC pathology space.
- Reviewed faculty salaries and initiated equity adjustments.
- Completed Departmental and WCMEO audits and subsequent follow-ups.
- Conducted financial management didactics for new residents and Pathology Education series presentations.
- Held weekly open position reviews for all replacement and new positions, providing timely response to Departmental needs.
- Oversaw a 15% reduction in annual blood costs over the past 6 years.
- Successfully supported faculty and staff in the implementation of the Department's Point of Care testing menu at off-site clinics.
- Secured approval and capital funding for the Rogel Cancer Center Phlebotomy Renovation Project to renovate and expand phlebotomy bays and improve patient throughput.
- Worked closely with Dr. Parkos and the Vice Chairs for a very successful recruitment year with many new recruits.

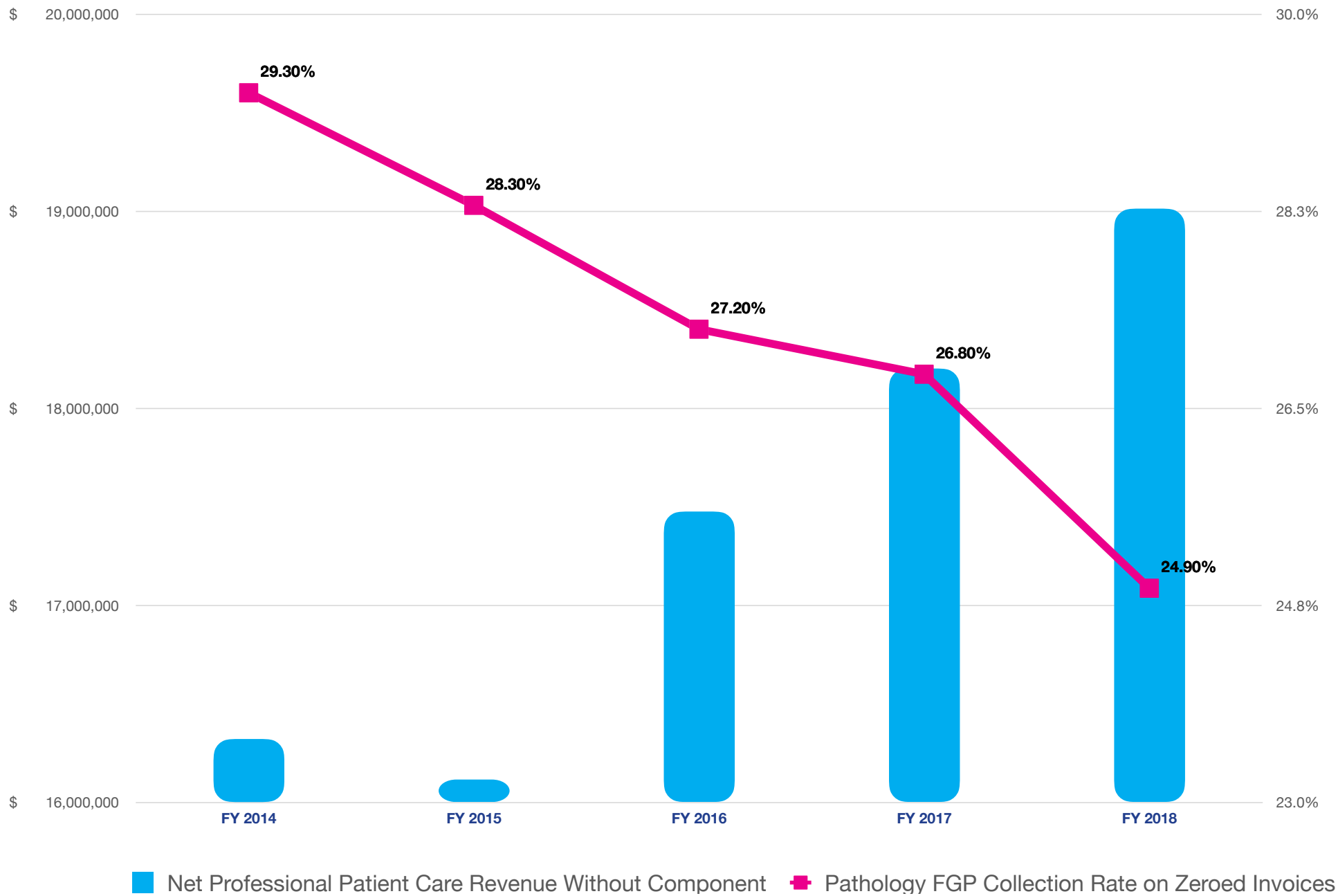
Administrative Support Center

The administrative support center is divided into support services for the Pathology Laboratories; Academic and Business Affairs; and Human Resources, Faculty Affairs, and Education.

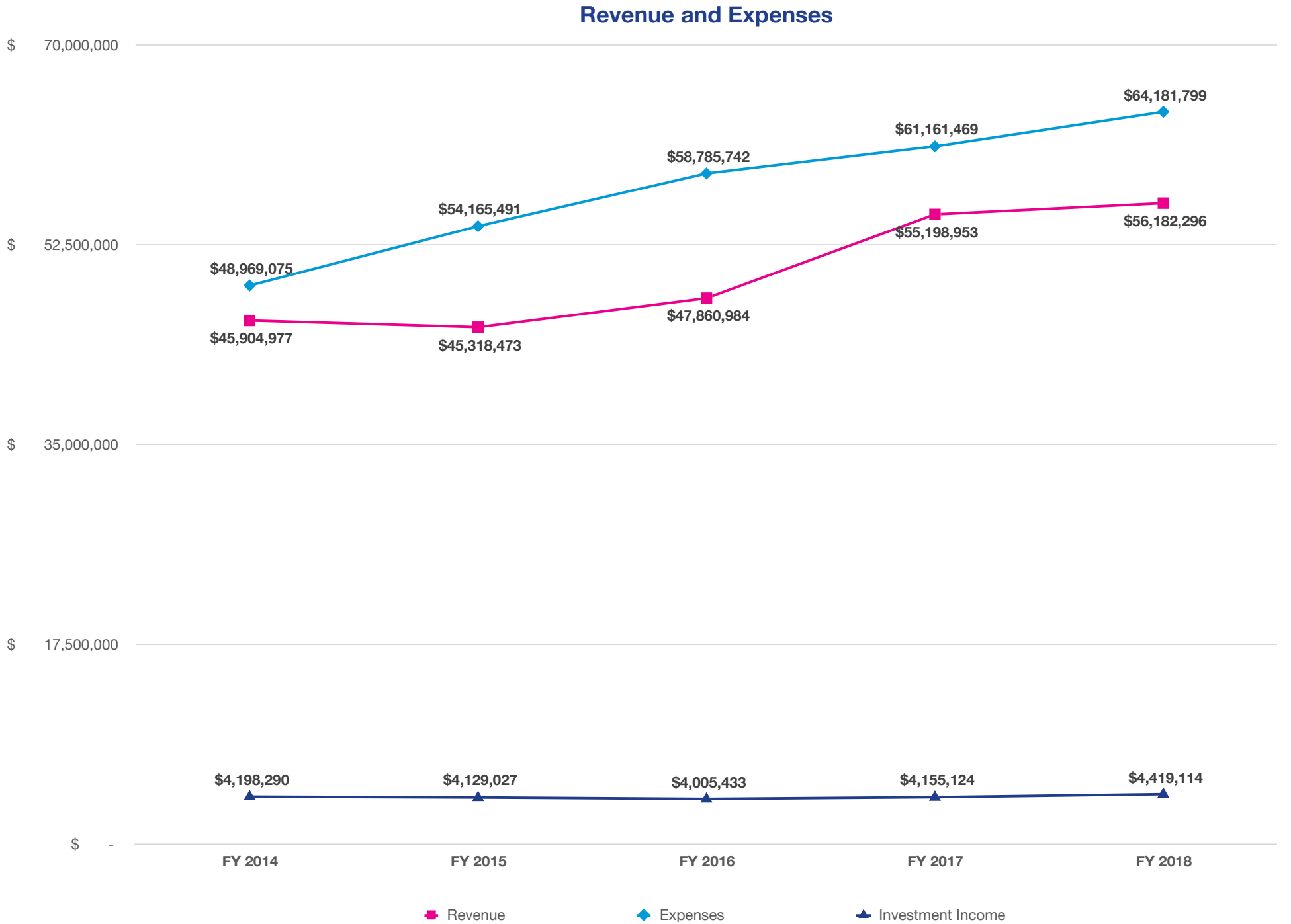
Pathology Laboratories

The Administrative Support Center for Pathology Laboratories is responsible for the preparation and monitoring of all Hospital laboratories' revenue, expense, and capital budgets, and personnel and payroll systems. During this period, total laboratory expenditures were $126 Million. Pathology is responsible for 10.0% of total Hospital Gross Revenue and 4.0% of total expense. To help

Net Professional Patient Care Revenue Without Component

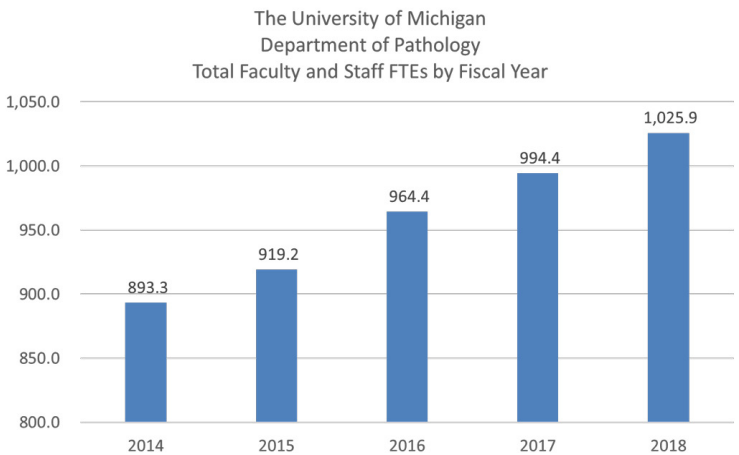


Revenue and Expenses



control expenses, several long-term contracts with major vendors like Mayo Medical Laboratories, Ventana, and Atlas Medical Systems were re-negotiated this year.

The Administrative Support Center team worked diligently in FY 18 to prepare for the relocation of the clinical laboratories to the North



Campus Research Complex, promoting Lean concepts and teaching quarterly Lean classes, leading monthly gemba walks within the laboratories, planning for the equipment and facility needs (including obtaining quotes and conducting ROI evaluations), as well as coordinating with the entire PRR team to ensure a smooth transition. In addition to the PRR project, the team was involved in the planning of other institutional ambulatory care building projects, such as the Rogel Cancer Center Phlebotomy Renovation Project, Brighton Health Center expansion, East Ann Arbor Surgery Center expansion, and others.

Members of the Administrative Support Center team served as department liaison with nursing and the Office of Clinical Affairs, Office of Clinical Safety, Biomedical Engineering, and Hospital Finance. They served on the Quality Month Committee, Pathology Diversity, Equity and Inclusion Committee, Pathology Patient and Family Advisory Council, Pathology Social Media Committee and others.

FY 18 Pathology Income Statement

REVENUE	FY 17	FY 18
Patient Care Revenues	$19,279,000	$20,089,169
Michigan Medicine Service Payments	$7,783,284	$8,512,424
Net Total Research (Directs & Indirects)	$19,826,841	$19,481,262
Gifts and Other Income (Wayne/Washtenaw ME, etc.)	$8,309,828	$8,099,660
Total Revenue	**$55,198,953**	**$56,182,515**
EXPENSES		
Total Salaries	$46,143,215	$49,435,747
Total Non-Payroll Expense	$15,018,255	$14,746,051
Total Operating Expenses	$61,161,470	$64,181,798
Operating Margin (Loss)	($5,962,517)	($7,999,283)
Non-Operating Income and Expense (1) *(Includes Investment Income, UMHS Margin Sharing, Departmental Commitments, etc.)*	$5,134,107	$7,744,324
Total Margin	**($828,410)**	**($254,959)**

(1) Excludes funds transferred to the Clinical Investment Fund

The team addressed patient safety issues, and cooperated on process improvement initiatives with partners such as the Rogel Cancer Center, UH operating rooms, and various medical procedure units.

Office of Academic and Business Affairs – Medical School

The Office of Academic and Business Affairs –Medical School is responsible for all administrative and academic operations associated with the Department, including management of department finances (budgets, contracts, research grants, forecasts, and analysis), as well as clinical billing (professional and technical front end operations), in collaboration with the Chair and Administrative Director. Mr. David Golden implements and directs strategic goals for Medical School operations including development of policy and business plans, management of faculty compensation and departmental funds,

Thomas Morrow
Administrative Manager, Clinical Operations

Kristina Martin
Manager, Clinical Operations

Christine Rigney
Assistant Administrator of Operations, Division of Anatomic Pathology

David Golden
Director, Finance

and use of departmental facilities, including modifications, renovations, and reassignment of department space.

This office also manages the Michigan Medicine and All Funds expenditures and forecast processes. Key departmental metrics include:

- Total Medical School All Funds expenditures for FY 18 were $73.5 Million and Hospital expenditures were $133.4 Million.
- Hospital technical gross revenue for FY 18 was $791.4M, compared to $749.7M in FY 17, an increase of 5.6%.
- Professional fee gross charges were $85.4M.
- Overall gross charges for Pathology's group practice were up 15.8% ($11.6M).
- Pre- and post-award research enterprise management included 147 research proposals submitted to external sponsors this year with 56 of these submitted to the NIH.
- Committed awards for FY 18 were $29.8 Million, an increase of 1% compared to FY 17 committed awards.
- Actual sponsored research expenditures were $33.2 Million, 0.6% decrease when compared to FY 17 actual research expenditures. Overall, the academic side of the Department saw a 2% decrease ($1.2 Million) in federal and non-federal research revenues from FY 17 to FY 18.

Business Affairs

Business Affairs is responsible for oversight of all accounting and financial transactions for the Department as well as ensuring appropriate hospital and medical school funds flows. Our billing office handles all send-out, component, and MLabs billing, and any interdepartmental, MLabs, or Hospital patient billing error corrections. The grants management office handles the day-to-day management of research funds to ensure compliance with funder requirements, and to ensure the funds are distributed appropriately both within Pathology as well as across internal and external research groups.

Business Affairs is also responsible for Hospital and Medical School financial reporting and budget preparation for the Department and in administering numerous contracts, including the Washtenaw and Wayne County Medical Examiners contracts. As part of the budgeting process, they also develop and maintain the capital equipment process, prepare financial analyses, produce numerous *ad hoc* reports, and oversee the Pathology Renovation and Relocation project to ensure contract terms are met, budgets are managed, and capital investments are approved according to Michigan Medicine and Pathology procedures, and facilities are prepared for the 500 person move to the NCRC to occur in late FY 18 and early FY 19. In addition, all faculty and staff effort and funding changes are processed through this unit.

Finance

The Department of Pathology is in a strong financial position and continues to thrive under the leadership of Dr. Charles Parkos and Mr. Martin Lawlor, with endowments and FFAE to support our clinical, research, and educational missions exceeding $90.5 million. Pathology began professional component billing for Clinical Pathology outpatient services in the 4th quarter of 2010, and FY 18 net revenue for component billing was $1,081,959. Michigan Medicine, Department of Pathology was the first group to institute professional component billing in the state of Michigan. However, in FY 18, we experienced a widening gap between our revenues and expenses, with Revenues at $56.2 million and expenses at $64.2 million. This resulted in an operating loss of nearly $8 million. The loss was mostly offset by income from our investments, but the year ended with a net loss of $254,959. In FY 17, we also experienced a net loss of $828,410 as our non-operating and investment income was significantly lower.

Michigan Medicine has long-range expansion and upgrades budgeted, including Pathology's Renovation and Relocation Project, that requires greater-than-average net budget increases as compared to those seen over the past decade. As a result, there is significant pressure on Departments to reduce expenses and increase revenues. While our revenues continue to grow, the collection rate is at its lowest point in the past 15 years, at just 24.9% of charges. Meanwhile, in order to keep up with workloads, our faculty and staff FTEs have increased to 1,025.9 from 994.4 in FY 17. The combination of increased budgetary needs, increased workloads/staffing needs and decreased collection rates poses challenges for meeting Michigan Medicine tar-

Name	New Rank	Division
Aleodor Andea, MD	Professor	AP
Sandra Camelo-Piragua, MD	Associate Professor	AP
May Chan, MD	Associate Professor	AP
Laura Cooling, MD	Professor	CP
Robertson Davenport, MD	Professor	CP
Yali Dou, PhD	Professor	EP
Nisha D'Silva, BDS, MSD, PhD	Professor	EP
Alexandra Hristov, MD	Associate Professor	AP
Lakshmi Priya Kunju, MD,MBBS	Professor	AP
Xinna Li, PhD	Assistant Research Scientist	EP
Jonathan McHugh, MD	Professor	AP
Alexey Nesvizhskii, PhD	Professor	EP
Duane Newton, PhD	Professor	CP
Judy Pang, MD	Associate Professor	AP
Miguel Quiros Quesada, PhD	Research Investigator	EP
Scott Tomlins, MD, PhD	Associate Professor	EP
Xiaoming (Mindy) Wang, PhD	Research Investigator	MCTP
Chisa Yamada, MD	Associate Professor	CP
Melody Zeng, PhD	Research Investigator	EP

Twelve of our faculty successfully completed the promotion process.

gets for the Department. As a result, filling vacant staff positions has become more difficult. We are grateful to our staff, who have stepped up to the plate to take on additional duties to ensure the missions of Pathology continue to meet and exceed expectations.

We have outstanding faculty and staff who continue to support exceptional scholarship and clinical care. Our Clinical services continue to grow and maintain the highest quality. New educational opportunities continue to attract top trainees and our future looks bright as we move forward into our new facilities, designed for the future. Overall, FY 18 has been a tremendous year for our department.

Human Resources, Faculty Affairs and Education

Our **Staff Human Resources** Team provides support for Pathology's hospital laboratories (approximately 630 FTEs) and Medical School support staff, including our research programs (approximately 200 FTEs). This includes processing all new hires, promotions, merit increases, orientation, as well as transfers when staff move to other departments or terminations for those who leave our institution. They also help to coordinate employee recognition events and awards.

Faculty Affairs is responsible for coordinating appointments, reappointments and promotions for our 162 active faculty and the 24 supplemental appointments in the Department. In FY 18, 13 new faculty joined the Department of Pathology while we bid farewell to five faculty members and grieved the loss of two of our Emeritus Faculty, **Drs. Gerald Abrams** and **Bernard Naylor**.

Our faculty received numerous awards in recognition of their achievements in academics, research, and clinical service: (*See Appendix on* **pg 72.**)

The Education Office includes the Residency and Fellowship Training Programs (28 residents and 22 fellows in 9 ACGME and 7 non-ACGME programs) and the Medical Student Education Teaching Programs for the M1 and M2 laboratories and the M4 Clerkship Program as well as the Molecular and Cellular Pathology PhD program with 22 students actively pursuing their doctoral degrees. Management responsibilities are focused around curriculum management (including the Research Seminar Series), academic records, budget planning and financial operations, recruitment, and program activities such as the annual departmental research symposium. The department also holds two NIH training grants (PIs Nicholas Lukacs, PhD; Andrew Lieberman, MD, PhD, Zaneta Nikolovska-Coleska, PhD) which support 4 pre- and 6 post-doctoral trainees. The education office performs the human resource functions for the department's graduate students (30 including 6 non-MCP students with Pathology mentors and 4 training grant trainees).

Office of the Chair

The staff in the Office of the Chair coordinates the Advances in Forensic Medicine and Pathology conference, which was held for its eighth year in FY 18. They also reconcile departmental purchasing

Gerald Abrams
1932 - 2017

Bernard Naylor
1926-2017

2017 - 2018

New Faculty

cards, renew medical licenses, process CME requests for faculty, coordinate and develop departmental communications including the *Inside Pathology* magazine and the Annual Report, and prepare numerous reports and presentations for various meetings. In addition, they provide support to the Chair and Department Administrator, including scheduling, travel arrangements, data collection, event planning, correspondence, committee support, and faculty recruitment.

Community Service

In support of our mission as a non-profit healthcare provider, our faculty and staff engage in numerous service activities throughout the year. Some of the activities our faculty and staff engaged in this year included.

Local Activities (UM, Ann Arbor or Michigan)

- Relay for Life Teams to raise funds for cancer treatment
- Assisted MetroHealth in validating the Verify-Now assay for aspirin and Plavix-specific platelet aggregation
- Gift of Life Michigan board and committee memberships
- Patient and Family Advisory Council (PFAC)
- Numerous Medical School and Health System committee leadership/membership, see our list of new leadership positions.
- High school genetics, ethics, Doctors of the Future, and other programs as well as volunteering to coach or direct athletic programs
- High School Ethics Bowl judge
- Service on multiple non-profit boards of directors

National

- Assisted in multiple inspections for College of American Pathologists (CAP), American Association of Blood Banks (AABB), American Society for Histocompatibility and Immunogenetics (ASHI)
- Serving on multiple national and international professional organization boards and committees, see our list of new leadership positions added in FY 18.

International

- Exploring transport solutions for patient samples in remote African villages to laboratory testing facilities
- Developing Essential Diagnostic Test List for low resource settings
- Implementing comprehensive 8-marker flow cytometry to accurately diagnose acute pediatric and adult leukemia patients in low-middle income countries, implementing it in Addis Ababa, Ethiopia
- Cervical cancer screening initiative in India

Employee Recognition

The Department of Pathology recognizes the valuable contributions made by our faculty and staff alike. In FY 18, we recognized the years of service for faculty and staff who have served for 10, 20, 30 and even 40 years as well as those who received Above and Beyond Awards, as nominated by their peers. The number of employees who have been in the department for over 20 years speaks to the dedication of the employees as well as to the collegial atmosphere of our Pathology Department. In addition to this recognition event, the Department hosted an employee appreciation breakfast/dinner on May 2nd and a social event, the Zoo Boo at the Detroit Zoo, on October 14th. This was a well-attended and enjoyable event, in spite of the rainy weather! (*See chart of all 'Years in Service Recognition' in the Appendix on* ***pg 74***.)

This year we also honored our retirees. Harry Neusius (Clinical Pathology), Cindy Howard (Pathology Informatics), Mary Greene (Administration), Sue Stern (Clinical Pathology), Lynn Forbes (Clinical Pathology), Sue Valliere (MLabs) and Tom Peterson (Pathology Informatics).

Lynn Forbes

Mary Greene

Cindy Howard

Harry Neusius

Tom Peterson

Sue Stern

Sue Valliere

Pathology Renovation & Relocation Project

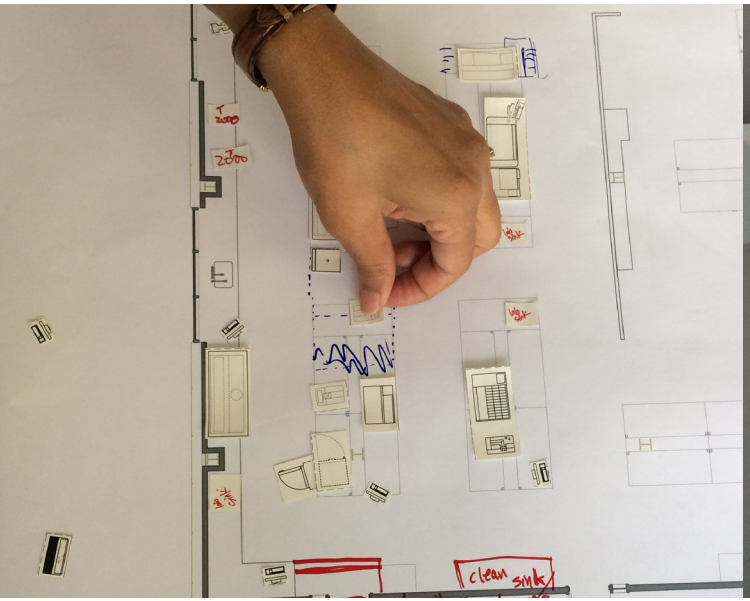
Christine Baker
Project Manager for PRR

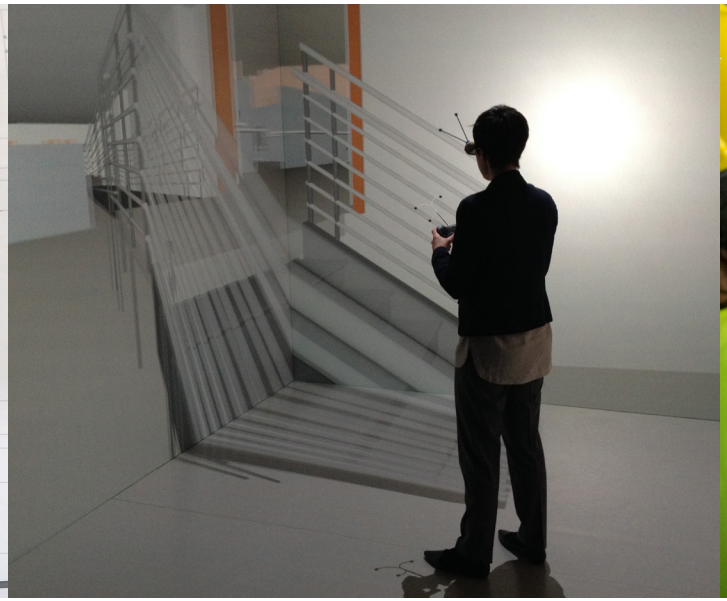
FY 18 saw continuation of our Pathology Renovation and Relocation Project, which includes 140,000 sq. feet of clinical laboratory and office space at the North Campus Research Complex as well as renovation of 46,000 square feet at the University Hospital. This $160,000 million project completed Phase 1 during FY 18. Phase 1 includes consolidation of non-stat Pathology functions into the off-site facility at the NCRC, including administration, faculty, and five major clinical laboratories including Anatomic Pathology, Molecular Pathology, Microbiology, Immunology and Special Chemistry. Faculty, staff, and laboratories were preparing to relocate at the end of FY 18.

Ms. Christine Baker is the project manager for the Pathology Relocation and Renovation (PRR) Project and is responsible for facilitating and orchestrating the project tasks for the Pathology Department. She leads the planning, design, and activation activities, and works closely with colleagues in Michigan Medicine Facilities and on the design team to ensure the project is on schedule, within scope, and on budget. This project is the first full-scale Lean Facility Design effort conducted at Michigan Medicine. Lean Facility Design is a process that designs space that conforms to Lean processes and principles rather than redesigning our processes and workflows to conform to the space. This process commenced six years ago with a complete review of current state process flow engaging faculty and staff at all levels in the process. Based on the data gathered, "paper dolls" (paper or cardboard) representing key pieces of space or equipment were laid out on a detailed space diagram. A warehouse was used to test space features, to test multiple space design options, and to select the ideal design elements for maximized efficiencies.

The designs also include great attention to lines of sight and accessibility of natural lighting. Laboratories were designed with central "Nerve Centers" with large windows overlooking the laboratory to ensure that faculty and staff have clear lines of sight between the administrative areas and the laboratories, facilitating communications. Floor-to-ceiling windows overlooking a park-like setting line the exterior walls, ensuring plenty of natural light will fill the space. In lower-level laboratories, excavation and installation of new windows will ensure natural lighting for all laboratory staff. Faculty offices, sign-out rooms, and conference rooms utilize glass walls and partitions, with conference rooms lining exterior walls in the faculty suite.

Having completed the design phase for NCRC, substantial demolition of existing spaces and construction began. Construction continued throughout FY 18 with the end of construction activities started in May 2018, allowing for sequenced activation in the summer. Faculty and staff from across the department played major roles in activation and operational planning for the laboratories, in developing an asset tracking/distribution system, in designing office/administrative and education areas that promote human interaction, developing a sign-out room utilization format that promotes sharing, and enhancing digital pathology solutions. Strategies for asset management and






laboratory workflows, onboarding and validating of new instruments, and developing novel staffing models have been and are currently being optimized. The histopathology, cytopathology, immunohistochemistry, grossing, and electron microscopy laboratories at NCRC are state-of-the-art with beautifully designed environments that will enhance productivity and efficiency. The grossing room was specifically designed not only for efficiency, but also to enhance education and gross/microscopic correlation due to its open floor plan and adjacency to sign-out rooms.

The spacious new microbiology lab is adding a BD Kiestra™ Total Lab Automation system, designed to increase efficiency, streamline processes, and deliver high-quality and consistent results with improved turnaround times. This conveyor-belt style track allows for automated processing and evaluation of microbiology specimens with camera feeds to computers to allow technicians to view the plates without disturbing the temperature-controlled growth environment.

Our six molecular labs that have been scattered across Ann Arbor, will be merged into a large, centralized molecular laboratory with shared Pre-PCR, Post-PCR and nerve center space. The close proximity of these labs to each other will foster collaboration, expand access to common instruments and resources, and allow for equipment redundancies in case of equipment failure. As part of this process many new instruments were purchased including, among others, an Illumina® NextSeq sequencer, thermal cyclers, fractionation instruments, Ion S5™ sequencer, NanoDrop™ One DNA/RNA quantitation instrument, slide imprinters, autostainers, digital imaging systems, microtomes, flow cytometry instruments, additional Luminex™ and cryopreservation storage units, all of which will enable the labs to better serve patients.

The faculty office area at NCRC was designed to enhance human interaction and collaboration by employing small offices and large common spaces created to encourage pathologists to spend less time in their offices and more time networking with colleagues. We anticipate that this will reduce the silos that had developed in our previous site by co-locating pathologists of various subspecialties. We anticipate this novel space design, along with inculcating a sense of unity and collaboration among faculty, will yield high rewards in terms of innovation and creativity. The faculty sign-out area similarly was

designed for collaboration by co-locating all sign-out stations within a single area with enhanced visibility through extensive use of glass partitions and doors. Sign-out rooms will no longer be reserved for specific subspecialty services. Instead, the standard layout will allow various sign-out services to share the rooms when not occupied.

The MLabs offices will also be relocated to the NCRC. Located adjacent to key departmental resources, including finance and pathology informatics, we anticipate this move will create efficiencies and allow for improved service. Our client services group will be co-located with the laboratory operations group in anticipation of an integrated patient and client services center intended to meet the needs of not only MLabs clients and their patients, but also Michigan Medicine providers and patients.

The new Residents and Fellows suite is larger, brighter, better-equipped, and more conveniently located. It is adjacent to the sign-out and grossing rooms and directly below the faculty suite. Trainees and others have access to specialty shared space including a treadmill workstation, yoga and meditation room, lounge with coffee, couches and fireplace, as well as numerous collaborative spaces with a variety of seating types overlooking ponds, woods and fields.

The DQHI and Administrative teams were among the first to relocate to the NCRC in late June 2018. The transition to the new space proceeded smoothly thanks to the hard work of the PRR team. In addition to the aesthetically-pleasing environment, the location of the NCRC also boasts a park-like setting, greatly improved parking options, easier freeway access and numerous local businesses for a more satisfactory day-to-day experience for everyone. In addition, just a few buildings down on the NCRC complex is a complete exercise facility with both individual and group exercise options available, a daycare center, and a full-service cafeteria.

Due to the challenge of covering frozen sections, cytopathology on-site evaluations, autopsies, and multidisciplinary conferences from our remote location, we have developed various staffing and digital pathology models and solutions. For frozen section coverage, we have deployed a frozen section “SWAT team” consisting of primary and back-up surgical pathologists, a surgical pathology fellow, a resident, and lab techs to cover the various frozen section rooms at University Hospital, Mott Hospital, Cardiovascular Center, and East

Ann Arbor. We also have deployed robotic microscopes that pathologists operate remotely. For example, our Neuropathology service has successfully developed and validated a method for reading all frozen section cases virtually via telepathology.

Open House activities were held in early June at the close of FY 18, with our first specimen received at the NCRC on June 25th! Faculty, staff, and laboratories will be relocating in early FY 19.

In the Spring of 2018, renovation of the Rogel Cancer Center blood draw station began. This space had not been renovated in nearly 28 years. The environment was worn and unwelcoming, the patient throughput was inefficient and caused unacceptable wait times for patients. The renovated space was designed using Lean Facility Design processes and will house six newly-designed draw bays (four incremental), a new specimen processing bench area, two additional check-in stations, streamlined supply workflow and updated finishes throughout. This project is scheduled for completion by September 2018.

Design and construction timelines are underway for the UH renovation. It is anticipated that construction and relocation of services will continue for the next three years. This project will include transfusion medicine and apheresis, toxicology, automated chemistry, frozen sections, autopsies, cytopathology, phlebotomy, and other STAT services. In the transfusion medicine space, the new facilities will allow for more efficient operations, growth in apheresis and cell collection activities, and manufacturing of cellular therapies products, which will position Michigan Medicine to continue as a leader in transfusion medicine. In toxicology, immunology and automated chemistry, a new automation track system for chemistry and immunoassays will be added to increase efficiencies and enable continued growth in processing.

Surgical Pathology In-House Case Volumes							
	2014	2015	2016	2017	2018	1 Yr	5 Yr
Breast	2236	2517	2485	2319	2478	6.9%	10.8%
Gastrointestinal	18133	19802	22807	23789	23115	-2.8%	27.5%
Genitourinary	2382	2510	2910	3365	3734	11.0%	56.8%
Gynecologic	6018	6210	6759	6965	7216	3.6%	19.9%
Sign-Outs	10657	11100	12359	13552	13839	2.1%	29.9%
Frozen Sections	3419	3398	3572	3525	3647	3.5%	6.7%
Total	42845	45537	50892	53515	54029	1.0%	26.1%
Cytopathology Case Volumes							
Aspirates	2896	2787	3192	3001	2951	-1.7%	1.9%
Cytology-Non Paps	7655	7743	6855	6668	7402	11.0%	-3.3%
Cytology-Paps	22727	23045	23548	23292	22999	-1.3%	1.2%
Total	33278	33575	33595	32961	33352	1.2%	0.2%
Dermatopathlogy Case Volumes							
In-House Derms	13433	14182	15712	15229	15746	3.4%	17.2%
Squares	453	393	487	545	528	-3.1%	16.6%
MLabs	8200	8836	8409	12239	10394	-15.1%	26.8%
Transfer/Consults	3864	3945	4203	4310	4149	-3.7%	7.4%
Total	25950	27356	28811	32323	30817	-4.7%	18.8%
Autopsy and Forensics: UH, Washtenaw/Livingston, and Wayne Counties							
Washtenaw/Livingston	365	327	359	407	412	1.2%	12.9%
UH (adult)	188	183	168	189	218	15.3%	16.0%
UH (peds)	37	31	41	43	43	0.0%	16.2%
Wayne (full autopsies)	1904	2242	2053	2359	2417	2.5%	26.9%
Wayne (total exams)	2638	2921	2822	3226	3272	1.4%	24.0%
Total	5132	5704	5443	6224	6362	2.2%	24.0%
Pediatric and Perinatal Pathology Case Volumes							
Peds Surgery	2791	3433	3277	3514	3565	1.5%	27.7%
Placentas	1710	1756	1832	1834	2071	12.9%	21.1%
Pediatric Autopsies	31	29	20	28	31	10.7%	0.0%
Fetal Exams	126	147	164	178	215	20.8%	70.6%
Total	4658	5365	5293	5554	5882	5.9%	26.3%

(continued)

Neuropathology Case Volumes							
Surgicals	788	764	748	846	773	-8.6%	-1.9%
Muscle Biopsies	242	224	175	156	139	-10.9%	-42.6%
MLabs Muscle Biopsies	126	150	194	178	189	6.2%	50.0%
Transfer/Consults	172	153	132	138	112	-18.8%	-34.9%
Total	1328	1291	1249	1318	1213	-8.0%	-8.7%
Other Pathology Case Volumes							
Ophthalmic	1123	1286	1276	1248	1311	5.0%	16.7%
Renal	1205	1130	1180	1099	1295	17.8%	7.5%
Anatomic Pathology Consult Case Voumes							
Gastrointestinal	2876	3146	3338	3449	3566	3.4%	24.0%
Dermatopathology	2328	3421	2754	3380	3017	-10.7%	29.6%
Pulmonary	1750	1733	2243	2350	2413	2.7%	37.9%
Bone and Soft Tissue	688	732	886	1030	1112	8.0%	61.6%
Gynecologic	592	659	899	1007	1068	6.1%	80.4%
Genitourinary	433	493	657	735	736	0.1%	70.0%
Breast	465	580	777	600	687	14.5%	47.7%
Head & Neck	400	370	552	545	622	14.1%	55.5%
Cytology	473	459	572	598	594	-0.7%	25.6%
Endocrine	244	331	380	414	407	-1.7%	66.8%
Neuropathology	223	198	248	312	385	23.4%	72.6%
Pediatric	121	99	124	137	220	60.6%	81.8%

Table 1 : *Anatomic Pathology Case Volumes 2014-2018 (From pg. 12)*

Clinical Pathology Billed Test Volumes							
	2014	**2015**	**2016**	**2017**	**2018**	**1 Yr**	**5 Yr**
Clinical Chemistry							
Chemical Pathology	2,250,691	2,300,846	2,545,505	2,861,047	2,990,055	5.%	33.%
Special Chemistry	550,204	615,414	659,007	642,556	650,105	1.%	18.%
Total	2,800,895	2,916,260	3,204,512	3,503,603	3,640,160	4.%	30.%
Transfusion Medicine							
Pathology Blood Bank	273,988	274,535	285,079	307,395	315,601	3.%	15.%
Blood Procurement	100,907	93,207	67,765	61,994	64,254	4.%	-36.%
Blood Bank Bone Marrow	1,335	1,203	1,127	1,155	1,118	-3.%	-16.%
Transfusion/Apheresis	81,139	9,590	2,165	1,804	1,965	9.%	-98.%
Total	457,369	378,535	356,136	372,348	382,938	3.%	-16.%
Other Clinical Laboratories							
Heme/Coag Unit	1,124,250	1,146,563	1,186,694	1,220,890	1,236,698	1.%	10.%
Flow Cytometry	72,165	79,130	78,958	78,390	87,062	11.%	21.%
Cytogenetics	8,466	8,104	8,283	8,399	9,296	11.%	10.%
Histocompatibility	26,199	25,051	24,152	21,085	23,801	13.%	-9.%
Clinical Microbiology	433,476	444,409	453,426	482,104	508,152	5.%	17.%
Molecular Diagnostics	17,665	20,384	20,736	15,899	17,026	7.%	-4.%
Virology	16,594	32,072	35,064	38,801	41,266	6.%	149.%

Table 2 : *Clinical Pathology Billed Test Volumes (From pg. 14)*

Table 3 (right page - left side): *Transfusion Medicine Number. (From pg. 16)*

Table 4 (right page - right side): *Department and Institutional Committee Service. (From pg. 38)*

Transfusion Medicine

Blood Bank Main Laboratory	FY 14	FY 15	FY 16	FY 17	FY 18	Change
Red Blood Cells		28,667	26,515	30,905	32,004	3.6%
Random/Pooled Platelets		47,264	20,959	6,009	6,080	1.2%
Apheresis Platelets		873	6,394	10,120	10,648	5.2%
Plasma		8,688	6,642	6,997	7,267	3.9%
Cryoprecipitate		4,979	6,011	6,431	7,404	15.1%
Total Components Transfused	**100,887**	**90,471**	**66,521**	**60,462**	**63,403**	**4.9%**
Immunohematology Reference Lab						
Antibody identifications	1,084	1,107	1,081	1,376	1,240	-9.9%
ABO resolution	146	150	156	111	187	68.5%
M-Labs referrals	27	18	8	5	-	-100.0%
BMT	425	322	247	203	320	57.6%
Eulates	188	184	174	227	215	-5.3%
Adsorptions	365	241	317	464	319	-31.3%
Titers	213	259	303	324	295	-9.0%
Special antigen typing				6,314	5,896	-6.6%
Total Activity*	**2,938**	**2,763**	**2,801**	**9,861**	**9,097**	**-7.7%**
**Includes procedures not listed above*						
Cellular Therapies Laboratory						
Collections processed	538	518	415	452	427	-5.5%
Bags frozen	785	614	542	718	619	-13.8%
Transplants, autologous	161	137	116	122	136	11.5%
Transplants, allogeneic	37	45	45	36	32	-11.1%
Transplants, unrelated	77	69	61	44	67	52.3%
CAR-T products	-	-	-	4	12	200.0%
Transplants, total	275	251	222	202	235	16.3%
Apheresis Service						
Therapeutic plasmapheresis		1,313	1,389	1,207	1,220	1.1%
HPC collections	418	386	416	370	345	-6.8%
Donor pre-evaluations	250	258	243	219	255	16.4%
Therapeutic phlebotomy	158	163	40	-	-	0.0%
LDL apheresis	228	212	124	89	106	19.1%
RBC exchange	53	96	120	103	112	8.7%
CAR-T collections	-	-	-	4	12	200.0%
Total Procedures		**2,218**	**2,407**	**2,024**	**2,074**	**2.5%**

Departmental and Institutional Committee Service

ACGME Self-Study Committee	Laboratory Formulary Committee
Advisory Council for Patient and Family Centered Pathology Care	Pathology Diversity, Equity and Inclusion Committee
Blood Transfusion Committee	Pathology Relocation and Renovation Project Resident Representative
Clinical Pathology Director Search Committee	Pathology Social Media Team Member
Cytopathology Director Faculty Search Committee	Phlebotomy Working Group
Histology Committee	Program Evaluation Committee
House Officer Quality and Safety Council	

Professional Society Membership and Engagement

A. James French Society of Pathologists	Hans Popper Hematopathology Society
American Academy of Family Physicians	International Society of Bone and Soft Tissue Pathology
American Association for Clinical Chemistry	International Society of Gynecological Pathologists
American Association of Blood Banks	International Society of Urological Pathology
American Medical Association, and Resident & Fellow Section Delegates	Michigan Association of Medical Examiners
American Society for Clinical Oncology	Michigan Society of Pathologists
American Society for Clinical Pathology, and Resident Representatives, Resident Council and Chair of the Resident Council	Michigan State Medical Society
American Society of Dermatopathology	Rodger C. Haggitt Gastrointestinal Pathology Society
Association for Molecular Pathology	United States and Canadian Academy of Pathologists, and Resident Advisory Subcommittee and Ambassadors
College of American Pathologists and Residents' Forum	Washtenaw County Medical Society

Faculty	Award Name	Organization
Richard Miler, MD, PhD	Elected	Association of American Physicians
Andrew Lieberman, MD, PhD	National Neuropathology Core Steering Committee	National Alzheimer's Coordinating Center
Sriram Venneti, MD, PhD	St. Baldrick's Research Scholar Award	St. Baldrick's Foundation
Sriram Venneti, MD, PhD	Distinguished Scientist Award	Sontag Foundation
Sriram Venneti, MD, PhD	Young Physician-Scientist Award	American Society for Clinical Investigation
Sriram Venneti, MD, PhD	Emerging Scholar of the Taubman Institute	A. Alfred Taubman Medical Research Institute
Sriram Venneti, MD, PhD	New Innovator Award	Alex Lemonade Stand
Tomasz Cierpicki, PhD	Cancer Research Award	Forbes Institute
David Lombard, MD, PhD	Harrington Scholar-Innovator Grant	Harrington Foundation
Zaneta Nikolovska-Coleska, PhD	Harrington Scholar-Innovator Grant	Harrington Foundation
Nisha D'Silva, PhD	Sustaining Outstanding Achievement in Research	University of Michigan Medical School
Steven Kunkel, PhD	Distinguished University Professor	University of Michigan Medical School
Nicholas Lukacs, PhD	MICHR Distinguished Mentorship Award	University of Michigan Medical School
Celina Kleer, MD	MICHR Distinguished Clinical and Translational Research Award	University of Michigan Medical School
Jiaqi Shi, MD, PhD	GI Innovation Fund Award	Fast Forward Medical Innovation, University of Michigan Medical School
Scott Owens, MD	Kaiser Permanente Award for Excellence in Pre-Clinical Teaching	University of Michigan Medical School
Ulysses Balis, MD	Lifetime Achievement Award	Association for Pathology Informatics
Thomas Annesley, PhD	Outstanding Contributions in Education Award	American Association of Clinical Chemistry

(continued)

Elizabeth Lawlor, MD, PhD	St. Baldrick's Foundation Award	St. Baldrick's Foundation
Jean-Francois Rual, PhD	St. Baldrick's Foundation Award	St. Baldrick's Foundation
Gabriel Nuñez, MD	Rous-Whipple Award	American Society for Investigative Pathology
Sethuramasundaram Pitchiaya, PhD	Valor Young Investigator Award	Prostate Cancer Foundation
Sethuramasundaram Pitchiaya, PhD	SPORE Career Enhancement Award	University of Michigan Medical School
Arul Chinnaiyan, MD, PhD	Outstanding Investigator Award	National Institutes of Health/ National Cancer Institute
Arul Chinnaiyan, MD, PhD	Howard Hughes Medical Institute Investigator Award	Howard Hughes Medical Institute
Arul Chinnaiyan, MD, PhD	Shubitz Cancer Prize and Lectureship	University of Chicago Comprehensive Cancer Foundation and the University of Chicago Cancer Research Foundation
Arul Chinnaiyan, MD, PhD	Victoria and Vinny Smith PCF Challenge Award	Prostate Cancer Foundation
Arul Chinnaiyan, MD, PhD	Kiran Mazumdar-Shaw Award	Biocon Foundation
Arul Chinnaiyan, MD, PhD	Peacock Memorial Award	UT Southwestern
Thomas Glover, PhD, FACMG	Distinguished Faculty Lectureship in Biomedical Research	University of Michigan Medical School
Yashar Niknafs, PhD	Precision Health Award	University of Michigan Medical School

Table 5 : *List of Faculty and awards received 2017-2018 (From pg. 57)*

New National Leadership Positions - 2018	
Faculty	**Role**
Nicholas Lukacs, PhD	President, Society of Leukocyte Biology
Asma Nusrat, MD	President, American Society for Investigative Pathology
Charles Parkos, MD, PhD	Board Member, FASEB Member Societies
Nicholas Lukacs, PhD	Scientific Director, Mary H. Weiser Food Allergy Center
Thomas Giordano, MD, PhD	Board Member, American Thyroid Association

New Department Leadership Appointments	
Chisa Yamada, MD	Blood Bank Fellowship Assistant Director
David Lombard, MD, PhD	Director of Pathology Research Seminar Series
David Lombard, MD, PhD	Director of Cancer Biology PhD Program
Sean Li, MD, PhD	Associate Residency Program Director
Kristine Knopka, MD	Director of Medical Student Clinical Clerkships in Pathology
David McClintock, MD	Associate Chief Medical Information Officer, Michigan Medicine
Jeffrey Myers, MD	UMMS Executive Committee
Thomas Wilson, MD, PhD	Advisory Committee on Appointments, Promotions and Tenure
Zaneta Nikolovska-Coleska, PhD	Associate Director of the Graduate Program in Biomedical Sciences (PIBS)

Table 6 *(right-page) : New Faculty positions and Appointments (From pg. 57)*

Years of Service Recognition		
10 Years		
Andrea Arlen	Rafael Jimenez	Jill Russell
Jeffrey Bauer	Temuulen Johnson	Nora Scharf
Brigid Boggs	Lily Keenan	Sally Smith
Thomas Franks	Michele Keener	Lindsay Szczepanski
Michelle Garrasi	Xinna Li	La'Cretia Thomas
Laura Hou	Tara Lilley	Yuan Wen
Lisa Hudelston	Christina Long	Saba Weslati
Joshua Jacques	Theresa Nurmi	
Chuck Jasmin	Yusuf Peaks	
20 Years		
David Austin	Farah Keyoumarsi	Mary Smith
Therrence Barrett	Stacie Larabell	Brian Smola
Lorraine Bourassa	Chia-Jen Liu	Cindy Straub
Bo Chiu	Cassandra Narvab	Ruth Tarrow
Kimberly Fera	Priti Patel	Rong Wu
Lorrie Gosselin	Melissa Perry	
30 Years		**40 Years**
Connie Brenke	Usha Kota	Kathy Davis
Mary Erber	Dawn Lossos	Therese Horning
Lynn Forbes	Sheri McLelland	Annette Rush
Tina Gray	Renee Perry	Jonathan Schroeder
Phyllis Gruszczynski	Shannon St. Andrew	Cynthia Smitka
Sandra Hoffmann	Eric Vasbinder	Sue Stern
Lisa Johnson		Karen Wilkerson

Above and Beyond Award Recipients		
Anatomic Pathology		**Finance**
Diane Canepa	Misty Sayar	Brook Dougherty-Reyes
Chelse Decker	Sally Smith	Mary Greene
Gerson Gran	Lynn Tague	Tammy Kutter
Lori Hufstedler	Tammi Toth	
Anita Kittell	Nikki Williams	
Clinical Pathology		
Joy Beuregard	Merideth Hoag	Saira Ramirez
Brooke Boone	Sheri Hugan	Karen Schairer
Heywyda Dari	Sara Isles	Gregory Simmons
Amy Drouillard	Krystal Johnson	Chris Smith
Courtney Fields	Peter Ouillette	Rita Spiegelberg
Jennifer Havas	Ashley Powers	Terri Tallmadge

Table 6: *Years of Recognition and Above and Beyond Award Recipients (From pg 59.)*


EXIT