

Using Focused Laboratory Management and Quality Improvement Projects to Enhance Resident Training and Foster Scholarship

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Abstract

Training in patient safety, quality, and management is widely recognized as an important element of graduate medical education. These concepts have been intertwined in pathology graduate medical education for many years, although training programs face challenges in creating explicit learning opportunities in these fields. Tangibly involving pathology residents in management and quality improvement projects has the potential to teach and reinforce key concepts and further fulfill Accreditation Council for Graduate Medical Education goals for pursuing projects related to patient safety and quality improvement. In this report, we present our experience at a pathology residency program (University of Iowa) in engaging pathology residents in projects related to practical issues of laboratory management, process improvement, and informatics. In this program, at least 1 management/quality improvement project, typically performed during a clinical chemistry/management rotation, was required and ideally resulted in a journal publication. The residency program also initiated a monthly management/informatics series for pathology externs, residents, and fellows that covers a wide range of topics. Since 2010, all pathology residents at the University of Iowa have completed at least 1 management/quality improvement project. Many of the projects involved aspects of laboratory test utilization, with some projects focused on other areas such as human resources, informatics, or process improvement. Since 2012, 31 peer-reviewed journal articles involving effort from 26 residents have been published. Multiple projects resulted in changes in ongoing practice, particularly within the hospital electronic health record. Focused management/quality improvement projects involving pathology residents can result in both meaningful quality improvement and scholarly output.

Keywords

clinical laboratory information systems, data mining, graduate medical education, leadership, management, medical informatics, pathology education, quality improvement

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Introduction

Management, leadership, and informatics skills are increasingly important for physicians in academic, private practice, and industry jobs.¹ Specifically, in the field of pathology, multiple surveys have found that recent graduates of pathology training programs are often viewed as deficient in leadership and management skills.^{2–4} The value and necessity of

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informatics skills has increased along with the complexity of laboratory information systems (LISs), electronic health records (EHRs), and technology (eg, digital pathology).⁵⁻⁷ This necessity was codified with inclusion of laboratory management and informatics in The Pathology Milestones developed jointly by the Accreditation Council for Graduate Medical Education (ACGME) and the American Board of Pathology (especially milestones Systems-Based Practice 4-7, Practice-Based Learning and Improvement 2).⁸ Despite the obvious necessity, teaching management, leadership, and informatics during residency training can be challenging.⁹⁻¹² Anatomic pathology (AP) rotations are often very busy with clinical workload, resulting in limited time to focus on management and informatics issues. As a result, management activities are often delegated to clinical pathology (CP) rotations or elective time. Discrete rotations remain uncommon, and this training is more commonly integrated with subspecialties such as clinical chemistry or informatics.¹³⁻¹⁹ Various groups have published proposed curricula as guides for pathology residency programs to design educational content for laboratory management, leadership, and informatics.^{9,12,17,19} Examples of approaches include residency rotations with managerial responsibilities (eg, CP “superblocks” that mimic the broad CP coverage that may occur in private practice pathology or smaller academic centers) or focused rotations (elective or required) in laboratory management.^{15,17,18,20}

Didactic sessions and assigned readings are a common means to teach management and leadership. Although this approach can provide background knowledge, residents may find it challenging to understand how these activities relate to pathology practice. Focused management/quality improvement (QI) projects are an approach to allow residents to apply and reinforce knowledge.^{13,17} As noted earlier, these activities also align with ACGME Milestone goals for integrating training-related patient safety and QI.^{21,22} In this report, we present our experience with the use of focused management and QI projects in the pathology residency program at the University of Iowa. As we will describe, these projects resulted not only in real-world education experiences with associated changes in laboratory practice but have also yielded substantial scholarly activity for both trainees and faculty.

Material and Methods

Institutional Setting

The University of Iowa Hospitals and Clinics (UIHC) is a 734-bed tertiary/quaternary care academic medical center located in Iowa City, Iowa. The University of Iowa Department of Pathology has an ACGME-accredited AP/CP pathology residency program for 20 residents. The department also has a medical student externship program (analogous to a postsophomore pathology fellowship in which 6 students spend a year doing clinical work in pathology outside the typical medical school curriculum) and fellowship programs in cytopathology, hematopathology, microbiology, molecular genetic pathology, surgical pathology, and transfusion medicine (approximately 10

Table 1. Parameters for Pathology Resident Management/Quality Improvement Projects.

Mandatory	Desired
Pathology resident completes Institutional Review Board (IRB) training	Present at local or national meeting
Data must be obtainable with reasonable effort	Publish in peer-reviewed journal
Outcome must be measurable	Multidisciplinary collaboration and interaction with other departments
Pathology resident must present findings at a pathology conference including clinical pathology morning report, anatomic pathology faculty meeting, and grand rounds (multiple residents may work on various aspects of a larger project but each must present their portion).	

fellows/year in total for all fellowships). The Department of Pathology manages pathology services throughout the medical center and affiliated outlying outpatient clinics, including AP laboratories (cytopathology, surgical pathology, and autopsy pathology), a centralized core clinical laboratory (clinical chemistry, flow cytometry, and hematopathology), clinical microbiology/molecular pathology laboratory, and blood center (donor center, blood bank, tissue/cellular therapy, and therapeutic apheresis).

Structure of Laboratory Management/Quality Improvement Projects

The retrospective time period discussed here covers July 1, 2010, to May 6, 2017. Over this time, residents were expected to complete at least 1 management/QI project. The project was expected to culminate in a conference presentation and/or scholarly publication. The primary faculty responsible for overseeing this program was the Vice Chair of Clinical Pathology and Laboratory Services and the director of the clinical chemistry/management pathology resident rotation (M.D.K.). Until June 30, 2016, clinical chemistry/management consisted of two 5½-week rotations, with the second rotation typically occurring in the third or fourth year of residency training. On July 1, 2016, the residency switched to 4-week blocks, with chemistry/management now having a total of three 4-week blocks during residency training. The possible parameters for the management/QI projects were broad, but emphasis was placed on projects that would yield tangible changes in laboratory practice, standard operating procedures, EHR (eg, test names, warning prompts, or alerts), and/or LIS. Although publication was not required, there was a preference for projects which would have broader interest and thus might be publishable in the general medical or pathology literature. Many of the projects were related to the core laboratory or broader laboratory utilization issues. A small number of projects were focused in AP. A summary of the parameters for the projects is listed in Table 1.

Faculty Development

An additional factor considered in this initiative was faculty development. Several faculty development meetings were held to discuss strategies and barriers for faculty in fostering and mentoring residents in scholarly projects. Much of this discussion occurred at a regular series of faculty development meetings focused on mentoring and career development, especially for clinical and junior faculty. Barriers identified included competing demands on faculty time, minimal prior experience of many residents with scholarly projects, and resident over-commitment with too many projects. Strategies for faculty to utilize in mentoring resident projects to completion were discussed in this setting.

Informatics Capabilities

Since May 2009, the EHR for UIHC has been Epic (Epic Systems, Inc, Madison, Wisconsin), which contains historical data back to 1996. The LIS for all UIHC pathology laboratories until August 2, 2014, was Cerner "Classic" (Kansas City, Missouri). On August 2, 2014, the pathology laboratories adopted Epic Beaker Clinical Pathology,²³ retaining Cerner as the LIS for AP, blood center, and some parts of hematopathology and molecular pathology. In October 2015, the pathology laboratories went to Epic Beaker Anatomic Pathology and Haemogenetics for the AP and blood center LISs, respectively. A key to success for many of the projects described in this report was the ability to utilize Reporting Workbench functionality within Epic. This system allowed for data mining of laboratory orders, medications, and patient demographics for EHR data back to 1996. Some searches required data mining within Cerner or the clinical laboratory middleware system (Instrument Manager; Data Innovations, Burlington, Vermont) that provided interfacing of instruments to Epic Beaker.^{23,24} For more sophisticated searches, a data warehouse (Starmaker, Park Street Solutions, Naperville, Illinois) was used; this database was available to pathology faculty and trainees.²⁵ This warehouse allowed for queries that are either very difficult or even infeasible within Epic Reporting Workbench or other routinely available informatics resources. An additional resource for challenging queries was Healthcare Enterprise Decision Intelligence (HEDI), a data warehouse that had restricted access limited mostly to specialized hospital information technology (IT) staff. Creation of new HEDI searches requires a formal approval process through hospital IT.

Results

Enhancing the Laboratory Management and Informatics Curriculum at Iowa

At Iowa, much of the pathology residents' curriculum in laboratory management and informatics occurs in the chemistry/management rotations. In addition, there is a monthly management/informatics seminar series for all trainees (pathology externs,

residents, and fellows) that covers a wide range of management, human resources, and informatics topics.

- The chemistry/management rotations include resident meetings with a variety of personnel involved in clinical laboratory management (laboratory managers, financial managers, quality assurance staff, informatics staff, and department safety officer). Residents are also involved in hospital-wide safety activities such as participating with the UIHC Safety Oversight Team tasked with root cause analysis for high-level safety events.
- The monthly management/informatics program was originally overseen by 2 faculty members and is currently organized by a faculty member (M.D.K.) and the departmental education manager (A.S.B.). The series has included multiple sessions to provide skills related to pursuing scholarly projects such as effective literature searching, data mining from the EHR and LIS, use of data warehouse, choice of possible scholarly projects, use of citation reference managers, and selection of biomedical journals (Table 2). The inclusion of externs also provides opportunities for medical students to develop interest in and pursue similar projects.

Scholarly Productivity From Management/Quality Improvement Projects

Since July 2010, all pathology residents at the University of Iowa have completed at least 1 management/QI project. Since 2012, 31 peer-reviewed journal articles involving effort from 26 pathology residents and 10 pathology faculty have been published. Many of the projects involved aspects of laboratory test utilization, with other projects focused on other areas such as human resource issues or informatics. Multiple projects resulted in changes within the hospital EHR. A small number of projects were focused in AP QI. The following sections provide examples of projects that resulted in publication. A summary of 32 projects is in Table 3.

Projects Focused on Laboratory Test Utilization

Laboratory test utilization was a main focus of the projects for 11 residents. Many of these projects stemmed from issues that residents confronted during their chemistry/management rotation. Two examples that resulted in a change in EHR include positive hepatitis B surface antigen tests from recent hepatitis B vaccination³³ and ordering of angiotensin-converting enzyme (ACE) serum levels for diagnosis of sarcoidosis in patients on ACE inhibitor therapy (the medication dramatically lowers serum ACE, making the testing unreliable).³² For the hepatitis B surface antigen study, the primary patient population affected by this issue was adult hemodialysis, who undergo regular testing for hepatitis B surface antigen. In the most common scenario, the patient had hepatitis B vaccine administered by a nondialysis

Table 2. Management Series Topics.

Category	Example Topics
Informatics and scholarly productivity	<ul style="list-style-type: none"> • Mining data in the EHR and data warehouse • Efficient use of PubMed and citation managers • Designing scholarly projects • Management of LIS projects
Legal and financial issues	<ul style="list-style-type: none"> • Common legal issues for physicians • Contract negotiations • Pathology finances • CPT coding • Hospital finances capital and operating budgets • Benchmarking clinical laboratory operations
Leadership and personal development	<ul style="list-style-type: none"> • Work–life balance • Microaggression • Reading and responding to other people’s behavioral style • Dealing with procrastination • Identifying and managing conflict effectively • Communication skills • Giving, seeking, and receiving feedback • Leadership skills • Time management • Professionalism
Role of pathologists	<ul style="list-style-type: none"> • Private practice pathology • Management vignettes • Pathologist role in managing laboratory test utilization • Managing outpatient and point-of-care testing • Outreach operations • Effective management of blood product utilization • Understanding and minimizing preanalytical errors • Quality improvement within pathology • Root cause analysis • Six Sigma
Education	<ul style="list-style-type: none"> • Teaching in the integrated medical school curriculum • Effective small group teaching • Effective study techniques • Seeking and using a mentor
Human resources issues	<ul style="list-style-type: none"> • Common human resources issues for pathologists • Managing in a union environment
Regulatory and legislative issues	<ul style="list-style-type: none"> • Laboratory inspections • Health-care reform and other legislative issues • CLIA regulations
Other issues	<ul style="list-style-type: none"> • Genetic counseling; prenatal diagnosis

Abbreviations: CLIA, Clinical Laboratory Improvement Amendments; CPT, Current Procedural Terminology; EHR, electronic health record; LIS, laboratory information systems.

provider and then happened to have routine hepatitis B surface antigen testing within a week of the vaccine dose. Erroneous diagnosis of hepatitis B in a hemodialysis patient has expensive downstream consequences, including use of separate dialysis equipment for hepatitis B-positive patients. This issue has been nearly eliminated by a best-practice alert within the EHR (Figure 1A).³³

Compared to the hepatitis B issue, the ordering of ACE serum levels in patients on ACE inhibitor therapy was much more widespread and occurred in a variety of inpatient units and outpatient clinics. The initiating case for this project was a clinician who called the pathology resident confused that an ACE level was undetectable for a patient despite high pretest probability for sarcoidosis. Subsequent investigation showed that the patient was on lisinopril (an ACE inhibitor), and thus, the ACE level was not reliable due to probable medication interference. Detailed chart review by the pathology resident for this project revealed multiple cases where the diagnosis of sarcoidosis was delayed following a low ACE value likely caused by ACE inhibitor therapy. Like the hepatitis B surface antigen issue, a best-practice alert within the EHR has nearly eliminated the problem (Figure 1B) and was additionally combined with a warning prompt (Figure 2A).³² Another example included inclusion of a best-practice alert for attempts by providers to order a germ line genetic test that had been performed previously (Figure 1C).³⁰

Multiple pathology residents completed projects related to utilization of send-out testing.³⁰ In our institution, the CP resident on call serves as the gatekeeper for a number of restricted tests. The data gathered during the multiple projects allowed for more effective gatekeeping and warning prompts within the EHR. Some of the interventions have resulted in substantial institutional cost savings. Two projects identified erroneous clinician electronic order sets as the basis for specific misutilization problems. One example was the inclusion of 1,25-dihydroxyvitamin D (calcitriol) instead of 25-hydroxyvitamin D in order sets meant to assess routine nutritional status of vitamin D. In the conversion to a new EHR in May 2009 for UIHC, 43 order sets had the incorrect vitamin D test. This resulted in a dramatic increase in misutilization of 1,25-dihydroxyvitamin D, a send-out test that is not appropriate for routine assessment of vitamin D nutritional status.³⁰ More scattered examples of misutilization in order sets included confusion between “look-alike” tests such as beta-2 glycoprotein/beta-2 microglobulin and magnesium/manganese. These type of errors were found to occur both sporadically and due to insertion of the incorrect test in an electronic order set. Correction of the order sets combined with targeted warning prompts have nearly eliminated these look-alike misorders (Figure 2B and 2C).³⁰

Informatics-Based Projects

Five residents were involved in projects related to clinical laboratory informatics, including 2 by residents with very strong interest in informatics (one of whom subsequently

Table 3. Examples of Resident Management/Quality Improvement Projects.

Topic	Number of Pathology Residents/Faculty	Outcome	Resident Role (See Key)*	Presented?	Publication(s)
Anatomic pathology					
Comparison of molecular oncology performed on cytology specimens and FFPE tissue	1/2	<ul style="list-style-type: none"> • Cytology preparations reliable for molecular oncology 	1, 2, 4	Yes	26
Accuracy of fine needle aspiration and imaging in salivary gland lesions	1/1	<ul style="list-style-type: none"> • Compared fine needle aspiration to imaging for salivary gland lesions 	1, 2, 4	Yes	27
Workflow adjustments for gastrointestinal block use	2/2	<ul style="list-style-type: none"> • Cost savings and increased efficiency from change in workflow 	1, 2, 4	Yes	28
Adequacy of powered versus manual bone marrow biopsies	1/1	<ul style="list-style-type: none"> • Manual method superior with respect to percentage and length of evaluable bone marrow 	2, 3	Yes	29
Laboratory test utilization					
Improving utilization of laboratory tests (multiple projects)	7/1	<ul style="list-style-type: none"> • Restricted 170 expensive send-outs • Multiple EHR interventions to prevent misorders 	2, 3	Yes	30
Vitamin D ordering patterns	2/1	<ul style="list-style-type: none"> • Identified misordering of 1, 25-dihydroxyvitamin D • Multiple EHR interventions put in place 	2, 3, 4	Yes	30,31
Ordering of ACE level assay in patients on ACE inhibitor therapy	1/1	<ul style="list-style-type: none"> • Warning prompts and best-practice alert put into EHR (greatly reduced occurrences) 	2, 3	Yes	32
Positive hepatitis B surface antigen tests due to recent vaccination	1/1	<ul style="list-style-type: none"> • Best-practice alert put into EHR (greatly reduced occurrences) 	2, 3, 4	Yes	33
Clinical chemistry					
Validation of plasma as specimen for κ and λ free light chain analysis	1/1	<ul style="list-style-type: none"> • Validated plasma as acceptable specimen for κ and λ free light chain analysis 	1, 2, 3, 4	Yes	34
Direct bilirubin methods	1/1	<ul style="list-style-type: none"> • Identified operational advantages of using vanadate oxidase compared to diazo methods 	2, 3, 4	Yes	35
Myoglobin hook effect	1/1	<ul style="list-style-type: none"> • Published case report, updated laboratory procedure for myoglobin 	2, 3, 4	No	36
Persistent hCG after methotrexate therapy for ectopic pregnancy	1/1	<ul style="list-style-type: none"> • Published case report, updated protocols for workup of “unexpected” elevated hCG 	2, 3, 4	No	37
Interference of antibody assays by subcutaneous immunoglobulin	1/2	<ul style="list-style-type: none"> • Published case report 	2	No	38
Informatics					
Autoverification of chemistry tests	1/1	<ul style="list-style-type: none"> • Identified opportunities to improve autoverification 	1, 2	No	24
Informatics prediction of steroid immunoassay cross-reactivity	1/2	<ul style="list-style-type: none"> • Determined cross-reactivity of 5 steroid hormone immunoassays 	2, 4		39
Middleware interfacing and “hot keys” for electrophoresis sign-out	1/2	<ul style="list-style-type: none"> • Streamlined protein electrophoresis sign-out for pathology residents and faculty 	1, 2, 3, 4	Yes	40
Use of data warehouse for pathology quality improvement	2/2	<ul style="list-style-type: none"> • Proof of concept for use of data warehouse for education, research, and quality improvement 	1, 2, 3, 4	Yes	25
Toxicology and drug monitoring					
Toxic alcohols algorithm	4/1	<ul style="list-style-type: none"> • Revised osmolal gap calculation • Validated and implemented rapid ethylene glycol assay (laboratory-developed test) 	2, 3, 4	Yes	41-43

(continued)

Table 3. (continued)

Topic	Number of Pathology Residents/ Faculty	Outcome	Resident Role (See Key)*	Presented?	Publication(s)
Meconium versus umbilical cord for newborn drug testing	4/1	<ul style="list-style-type: none"> Collaborated with pediatrics to revise newborn drug testing criteria Switched to umbilical cord tissue as the main specimen for newborn drug testing 	2, 3, 4	Yes	44-46
Hair and urine toxicology testing in suspected child abuse cases	3/1	<ul style="list-style-type: none"> Affirmed protocol for hair toxicology testing Demonstrated low yield of urine drug testing 	2, 3, 4	Yes	47,48
Therapeutic drug monitoring (TDM) of pentobarbital	1/1	<ul style="list-style-type: none"> Rapid assay for pentobarbital validated Affirmed value of TDM for pentobarbital Identified comment pre-and postanalytical errors in pentobarbital TDM 	1, 2, 3, 4	Yes	49
Blood ethanol levels in the emergency department during university football games	1/1	<ul style="list-style-type: none"> Demonstrated decrease in moderate to severe blood ethanol levels following university and city initiatives to reduce excessive ethanol use 	2, 3, 4	Yes	50
Hematology and transfusion medicine					
Fetal lung maturity	1/1	<ul style="list-style-type: none"> New laboratory-developed test validated and implemented in hematology 	2, 3	No	No
OD450 assay	1/1	<ul style="list-style-type: none"> Assay discontinued due to lack of clinical utility 	1, 2, 3	Yes	No
Hematopoietic progenitor cell counts for stem cell transplants	1/3	<ul style="list-style-type: none"> New assay validated in hematology 	1, 2, 3, 4	Yes	51
Pathologist blood smear reviews	1/2	<ul style="list-style-type: none"> Analyzed provider ordering of pathologist smear review Laboratory-initiated reviews already caught clinically significant findings 	2, 3, 4	Yes	In review
Improving normovolemic hemodilution for Jehovah's Witness patients	1	<ul style="list-style-type: none"> Innovative use of device to limit blood loss 	2, 3, 4	No	52
Other					
Syphilis testing algorithm	1/2	<ul style="list-style-type: none"> Compared reverse with traditional syphilis algorithm 	2, 3, 4	Yes	53
Recruitment and retention of clinical laboratory staff	1/1	<ul style="list-style-type: none"> Identified areas for improvement and staff satisfaction and recruitment 	2	Yes	No
Breast milk errors	1/1	<ul style="list-style-type: none"> Modified protocol for infectious disease testing 	2	No	No
Pathology considerations for the transgender patient population	1/1	<ul style="list-style-type: none"> Collaborated with LGBTQ clinic leadership Published review article 	1, 2, 4	No	54

Abbreviations: ACE, angiotensin-converting enzyme; EHR, electronic health record; FFPE, formalin-fixed, paraffin-embedded; hCG, human chorionic gonadotropin; LGBTQ, lesbian, gay, bisexual, transgender, queer/questioning; TDM, therapeutic drug monitoring.

*Key for resident involvement in project: 1, extracted data from electronic health record (EHR), laboratory information system (LIS), or other source (eg, middleware, data warehouse); 2, data analysis; 3, chart review; 4, drafted manuscript.

completed a pathology informatics fellowship). One of the informatics projects significantly streamlined and reduced sign-out time for capillary protein electrophoresis, using a combination of "hot keys" and middleware interfacing.⁴⁰ These changes helped support timely turnaround time for protein electrophoresis testing amid a markedly expanding UIHC multiple myeloma program. Two of the informatics projects focused on application of a data warehouse for pathology projects.²⁵ These projects have provided the basis for ongoing work by pathology residents to improve data

mining tools in both AP and CP. The data warehouse was particularly strong in queries that combined medications and specific laboratory results. An example was the ACE inhibitor project mentioned above.³² The EHR at UIHC at the time of this project contained 123 distinct medication order options for 9 different ACE inhibitors in the time period of retrospective analysis. Each of these orders is a separate search item in the standard EHR reporting tools system. The data warehouse allowed for more efficient searching using SNOMED terminology (ie, single search for all ACE

A **Attempt to order hepatitis B surface antigen in patient who was recently vaccinated**

⚠ This patient has had a recent hepatitis B vaccination within the last two weeks. When this happens, the assay can be positive or grayzone (equivocal) because the vaccine itself contains surface antigen that is detected by the test. It is strongly recommended to delay hepatitis B surface antigen testing until at least two weeks after the last hepatitis B vaccination shot. (BPA-id # 1773)

B **Attempt to order angiotension converting enzyme (ACE) level in patient who is actively prescribed ACE inhibitor**

⚠ This patient is on an ACE-Inhibitor which can alter ACE levels. Please discuss holding ACE-Inhibitor therapy for 48 hours before obtaining ACE levels. (BPA-id # 2236)

Acknowledge reason:

C **Attempt to order germline genetic testing that had been previously performed**

⚠ Hereditary Hemochromatosis Screen by PCR is a genetic test that has been performed on this patient in the past. In general genetic testing should not need to be repeated. Please reconsider ordering this test. (BPA-id # 1020)
Last HEREDITARYHE=testing on 12/5/2014

Acknowledge reason:

Comment:

Figure 1. Examples of best-practice alerts in the electronic health record (EHR) to improve laboratory utilization.

A **Angiotensin converting enzyme serum/plasma level**

When intended for diagnosis of sarcoidosis, this testing should NOT be performed in patients taking ACE inhibitors (benazepril, captopril, enalapril, lisinopril) as these drugs dramatically lower ACE levels and make testing unreliable.

B **1,25-Dihydroxyvitamin D**

Measurement of Vitamin D (1,25-dihydroxy) is NOT useful in the routine screening for nutritional vitamin D deficiency. The preferred test is Vitamin D, 25-hydroxy (LAB535). Is Vitamin D (1,25-dihydroxy) testing clinically indicated?

C **Manganese (whole blood)**

Verify that you want "Manganese" (LAB3540) and not "Magnesium" (LAB103).

Figure 2. Examples of warning prompts (requiring acknowledgment by ordering provider) in the electronic health record (EHR) to improve laboratory utilization.

inhibitors). Once constructed, retrieval of all inpatient and outpatient encounters in a 5-year period that included both a completed ACE level order and an active ACE inhibitor prescription took less than 1 minute for the data warehouse to complete. Similar searches in toxicology (eg, how many

amphetamine-positive screening immunoassays occur in patients on specific drugs known to cross-react) and microbiology (eg, how many positive blood cultures occur in patients with neutropenia) are also very quick for the data warehouse once constructed.²⁵

Toxicology and Drug Monitoring Projects

Thirteen pathology residents worked on projects related to toxicology and therapeutic drug monitoring. Four residents tackled various aspects of the algorithm for evaluating toxic alcohol and glycol ingestion (ethylene glycol, methanol, isopropanol). The UIHC is the only institution within the state of Iowa to perform 24/7 testing for toxic alcohols. The osmolal gap-based algorithm that was used at UIHC for evaluating toxic alcohols through 2010 was noted to have frequent false positives for ethanol, resulting in many calls to the pathology resident on call. Many of these calls were in the evening and early morning, given that toxic ingestions often occur outside standard business hours. As a result of multiple projects, the toxic alcohols algorithm was significantly modified, eliminating an estimated 600 resident calls/year.⁴¹ Further modifications to the algorithm incorporated a rapid ethylene glycol assay.^{42,43}

Four residents worked on a series of projects related to newborn drug testing.⁴⁴ This was done in collaboration with the Department of Pediatrics and required substantial chart and literature review. Newborn drug testing is an ethically and technically challenging area of medicine, with the results impacting medical and social services decisions. Two of the most tangible outcomes for the projects were changes in the screening criteria used by pediatricians and family medicine providers for neonatal drug testing and a switch to umbilical cord tissue instead of meconium as the primary specimen at UIHC.⁴⁴⁻⁴⁶

Three residents worked on projects related to use of hair toxicology in potential child abuse cases. Similar to the newborn drug testing projects, these projects required extensive chart review, including determination of whether laboratory results resulted in child abuse reports from providers at UIHC. This analysis showed a high rate of illicit drug exposure in this population.⁴⁷

Other Clinical Pathology Projects

Multiple projects focused on various aspects of assay validation, modification, or discontinuation. These included validation of plasma as an acceptable specimen for κ and λ free light chain analysis,³⁴ comparison of diazo and vanadate oxidase direct bilirubin assays,³⁵ validation of hematopoietic progenitor count on automated hematology analyzer for use in stem cell transplant,⁵¹ and introduction of lamellar bodies assay for fetal lung maturity testing. A transfusion medicine-related project involved innovative use of an inexpensive device to limit blood loss for Jehovah's Witness patients.⁵² One project involved collaboration with laboratory managers to look at areas for improvement in clinical laboratory staff recruitment and retention. Lastly, 1 project examined areas for improvement in pathology for the transgender patient population.⁵⁴

Anatomic Pathology Quality Improvement

A few projects focused on AP quality or process improvement. Most often these were additional projects after the first one was

completed during the clinical chemistry/management rotation. One resident worked on a multiplatform comparison of molecular oncology testing using various cytologic preparations versus formalin-fixed, paraffin-embedded tissue blocks. This analysis demonstrated that a variety of cytologic preparations were reliable sources for molecular oncology testing on multiple different platforms.²⁶ Two residents worked on a project to evaluate the effect of changes in grossing and histologic processing of gastrointestinal biopsy specimens. Their low-cost process change leads to a 17% reduction in the number of blocks used for these specimens and a decrease of 3% total blocks processed by our histology laboratory.²⁸ One resident participated in a multidepartmental study with pathology and otolaryngology colleagues to evaluate the accuracy of fine needle aspiration (FNA) in comparison with imaging in the preoperative workup of salivary gland masses. They demonstrated that FNA is a reliable method to preoperatively assess both benign and malignant salivary gland lesions with higher sensitivity and specificity than imaging.²⁷

Discussion

Training in patient safety, quality, and management is a key component of GME training throughout all specialties. However, training programs often find it challenging to create robust learning opportunities in these domains. Focused management/QI projects are one approach to teach and engage trainees in management, quality, safety, and informatics. This strategy also has the added benefit of increasing scholarship opportunities for clinical faculty.

Within the field of pathology, these activities can be especially valuable in educating pathology residents in concepts of laboratory management, regulatory affairs, and the interface of pathology results with electronic systems such as EHRs and LISs.^{13,17} These activities also align with ACGME goals (Milestones) for pathology resident training in QI and patient safety.^{21,22} Pathology projects can expose residents to operational issues, laboratory statistics, process improvement, and assay validation/introduction. While the possibilities for management/QI projects are theoretically limitless, it can be challenging to select projects that are both feasible and suitable for generating scholarly activity. Many projects extend beyond a single resident rotation, limiting continuity and potentially creating obstacles to project completion.

At the University of Iowa, we have made a concerted effort to improve training in laboratory management and informatics. We have used the monthly management seminar series to present a variety of topics that include design of scholarly projects, informatics resources, and QI. To increase scholarly activity from management/QI projects, a faculty member (M.D.K.) provides primary oversight for the projects and can either directly supervise the resident or facilitate a project with a different faculty member.

An important part of the process has been faculty engagement. A series of faculty development meetings were held to discuss strategies and barriers for faculty in mentoring

residents in scholarly activity with the goal of improving initiation and completion of scholarly projects involving residents. A primary goal was to enhance resident participation in scholarship. Much of this discussion occurred at a regular series of faculty meetings focused on mentoring and career development. Barriers identified included competing demands on faculty time, minimal prior experience of many residents with scholarly projects, and resident overcommitment with too many projects. Other strategies for faculty to utilize while mentoring trainees on projects include setting defined dates for follow-up and explicit expectations for work to be completed by those dates. This becomes particularly relevant for projects that extend past the end of a rotation. In the current environment of increasing clinical demands, it has become challenging for many clinical faculty to generate scholarly output, so being able to successfully mentor trainee projects is critical for faculty success as well. Often GME activities are time-consuming for clinical faculty and decrease time for faculty to invest in scholarly activities. These projects provide an opportunity to combine education with scholarship.

As detailed above, we have been successful at Iowa in generating significant scholarly activity from management/QI projects. Achieving this goal has required some creativity, sometimes by combining efforts from multiple residents into a single publication. This has worked particularly well for projects related to laboratory utilization or complex projects that require time-intensive chart or data review that extend past rotation length. For laboratory utilization, individual residents can each tackle single focused subprojects (eg, look-alike labs, utilization of specific high-priced send-out tests, etc) that all contribute to a broader goal. We have also found that projects facilitate good collaboration across departments. Examples include work with pediatrics on newborn drug testing, collaboration with the physicians involved in transgender patient care, and work with otolaryngology physicians on assessing accuracy of FNA in preoperative workup of salivary gland masses.

Conclusions

While the primary goal of the focused laboratory management or QI projects is to enhance resident education and create opportunity for scholarship, these projects have tangible outcomes that have resulted in changes to our practice and improvements at our institution. The resulting scholarship benefits not only the trainees but also the faculty. These projects provide opportunities for faculty to merge education and scholarship. Focused management/QI projects involving pathology residents can result in both meaningful QI and scholarly output.

Declaration of Conflicting Interests

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