Listening to Reason: Strategies for Instilling a Culture of Clinical Reasoning

University of Pittsburgh Medical Center
VA Pittsburgh Healthcare System

Although misdiagnosis often has multiple causes, due to both cognitive and systems-based factors, errors in clinical reasoning have been increasingly recognized as important contributors. As a result, a growing consensus in the medical community points toward the need for better training in medical decision-making at all levels.

Despite this need, explicit instruction regarding clinical reasoning principles is often lacking. Furthermore, the optimal timing and methods for such education have not been established. As outlined in a recent systematic review, the majority of reported curricular interventions are brief (not longitudinal) and are isolated both in terms of learner level and in terms of venue (not incorporated into existing educational structure).

Implementation of such isolated curricular interventions, in our experience, does not lead to lasting change. Instead, we have found that use of a top-down and bottom-up approach (targeting faculty, residents, and medical students) while incorporating curricula into existing educational venues creates a culture in which clinical reasoning concepts are at the forefront.

We developed a comprehensive, multipronged approach for the creation of a culture of clinical reasoning within our Division of General Internal Medicine by disseminating the common language that governs clinical reasoning, role-modeling a systematic approach to case solving, and creating an environment in which errors can be freely discussed. We have implemented the various components of this program incrementally over the past five years.

This issue is important because in a 2015 report, the National Academy of Medicine identified diagnostic error as major threat to patient safety.

Clinical Reasoning Education Program Overview

Our clinical reasoning program includes longitudinal programmatic initiatives, as well as other efforts individualized to our various learner levels. On the programmatic level, we instituted a monthly “Clinical Reasoning Case Conference” at all three of our training sites. This conference, described in more detail below, allows for role modeling of decision-making and for discussion of diagnostic error and cognitive biases, and it is delivered to a diverse audience that includes students, residents, fellows, and faculty.

At the faculty level, we developed a training and development series that includes discussion of the incidence and impact of diagnostic error and review of clinical reasoning terminology. It provides a practical framework for teaching clinical reasoning in the clinical setting as well as for remediation of errors in clinical reasoning. We deliver this series, which includes interactive and case-based exercises, during time set aside for faculty development.

Our residents and medical students similarly learn these concepts through interactive online modules (which are described in more detail below) and case-based workshops tailored to each distinct learner level. We continuously reinforce this content in the real clinical setting through several initiatives, including widely disseminated posters and pocket cards containing key concepts.

Finally, we have incorporated education regarding clinical reasoning topics into existing educational venues, including morning report (through dedicated clinical reasoning training of our chief residents) and noon conferences.

Clinical Reasoning Case Conference

Early experimental evidence supports the use of example-based learning (EBL), wherein a skill is learned through observing examples of that skill, such as for teaching clinical reasoning. However, use of this approach requires that clinical teachers possess the skills to make their own reasoning processes explicit, limiting broad application. To address this educational aspect...
challenge, we developed an interactive conference with a focus on discussion of clinical reasoning principles through inclusion of a “clinical reasoning moderator” and following the principles of EBL.

Our monthly “Clinical Reasoning Case Conference” includes sequential delivery of clinical information from a real patient case to an expert discussant, who in turn describes his or her approach to the case as it unfolds, in a “think-out-loud” format. Cases are challenging and present opportunities for discussion of diagnostic uncertainty. The conference is facilitated by a “clinical reasoning moderator,” who, in keeping with EBL principles, provides explicit commentary regarding the clinical reasoning processes being used and prompts the audience to engage in active learning. This monthly conference has sustained high attendance for nearly three years since its introduction.

In this conference series, a focus on the clinical reasoning process has contributed to the development of a shared clinical reasoning vocabulary within our training program. Furthermore, this format has allowed us to leverage the skills of a small group of clinical reasoning educators across a large and diverse group of learners and to effectively employ EBL principles. The clinical reasoning moderator—who delivers teaching points, probes the discussant’s thoughts, and provides commentary regarding reasoning processes being used—plays a key role in dissemination of broadly applicable clinical reasoning concepts.

Key steps for consideration in conference development include achieving buy-in from key programmatic stakeholders, identifying the ideal venue and timing to maximize attendance and participation, and recruiting and training skilled “clinical reasoning moderators.”

Online Clinical Reasoning Modules

With a goal of being able to efficiently deliver clinical reasoning content to a large group of diverse learners, we developed an interactive online curriculum that teaches the language, theory, principles, and process of medical decision making. We created 11 interactive modules based on extensive review of the literature and expert consultation. Modules are multimedia with video-discussant, interactive patient videos, text, multiple choice and short-answer questions, and branching logic.

Topics covered include diagnostic error, intuitive and analytical reasoning, key steps in the clinical reasoning process, and heuristics/cognitive biases. In addition, the last five modules are dedicated to introduction and training in the use of a cognitive analytic tool developed for use as a bedside decision-making tool. These modules have become a standard component of the educational program for all internal medicine residents as well as for all medical students when rotating through our department. We received written feedback regarding the modules from about 80% of learners, the substantial majority of which were very positive.

Lessons Learned

Since the implementation of these efforts, we have observed increased use of clinical reasoning vocabulary at all levels as well as an increasing frequency of spontaneous discussion of biases and clinical reasoning at core educational sessions and as part of submissions to national meetings. Requests for dissemination to other departments are another marker of our success.

As we have worked to promote a culture of clinical reasoning within our division, a number of principles have emerged as essential. First, dissemination of a common language to all levels is an important first step. Next, use of a centralized and bidirectional approach has been critical; previous scattered and isolated efforts were met with resistance and did not lead to lasting change. Finally, introduction of a systematic approach for decision-making allows for skill-specific education and remediation.

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Accurate Identification of Obstetric Sepsis Using E-record Tools
UPMC Magee-Women’s Hospital

Sepsis accounts for 10% to 15% of all maternal deaths worldwide and is the leading cause of preventable maternal death.1,2 Early sepsis recognition and management protocols developed by the Centers for Medicare and Medicaid Services (CMS) have been implemented since fall 2015. However, the recommended CMS Systemic Inflammatory Response Syndrome (SIRS) guideline parameters for adult patients, based on the CMS Inpatient Quality Reporting Measure, do not factor in normal physiologic changes during pregnancy.

To avoid overuse of resources, the authors developed adjusted SIRS parameters, organ dysfunction parameters, and obstetric (OB) criteria recommended by local obstetric experts and National Perinatal Information Center (NPIC) research, to accurately identify and manage sepsis in OB patients.

The adjusted parameters are used for inpatients who are pregnant or immediately postpartum (within 6 weeks after delivery). The authors developed a screening report in the electronic health record menu to identify OB patients with any of the following:

1. OB Adjusted SIRS Criteria (patient must meet 2):
   - Temperature greater than or equal to 38°C (100.4°F) or less than 36°C (96.8°F)
   - Heart rate greater than or equal to 110 beats per minute
   - Respiratory rate greater than or equal to 20 breaths per minute
   - White blood cell (WBC) count greater than or equal to 15,000/mm³ or less than 4,000/mm³ or greater than 0.5 K/uL bands
   - Fetal heart rate (FHR) baseline greater than 160 beats per minute

2. Organ dysfunction (patient must meet 1):
   - Lactic acid level greater than 2 mMol/L or less than 4 mMol/L
   - Hypotension: Systolic blood pressure less than 85 mmHg or mean arterial pressure less than 65 mmHg
   - Creatinine level greater than 2.0 mg/dL
   - Bilirubin greater than 2 mg/dL
   - Platelet count less than 100,000 mm³
   - International normalized ratio (INR) greater than 1.5
   - Activated partial thromboplastin time (aPTT) greater than 60 seconds

The sepsis screening report automatically prints out on each unit for review by the charge nurse/clinician at 6 a.m. and 6 p.m., to provide a quick alert to the bedside nurse for patients with possible sepsis. Nursing then uses the Magee-Womens Hospital of UPMC Nursing Sepsis Screening Form as a guideline for monitoring and notifying the multidisciplinary team to implement CMS’s recommended sepsis interventions.

The Sepsis Screening Report, Nursing Screening Form, and staff education were implemented over the last three quarters of 2017. From January 2018 through June 2018, the hospital has decreased the number of OB patients who did not meet CMS SEP-1 guidelines to zero.

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Closing the Loop on Critical Stroke Results Reporting
UPMC Pinnacle Hanover

Whether a potential stroke patient is received via inbound emergency medical services or walks through the front door, time is of the essence: time is brain! As a primary stroke center, UPMC Pinnacle Hanover recognizes that communication is key in providing this prompt care.

After identifying that the patient could be having a stroke, it is critical to diagnose the type of stroke (e.g., ischemic, hemorrhagic) correctly in order to render the appropriate treatment. Interventions within a specific time constraint for potential stroke patients are considered critical, and treatment with
alteplase, a tissue plasminogen activator (tPA), cannot be rendered unless the computed tomography (CT) scan result is negative for hemorrhagic stroke.

In early 2017, the facility implemented an approach to enhance and close the loop on communicating stroke CT-scan results. Previously, stroke CT results were reported to the provider by telephone only when the results of the scan were positive for bleed or infarct. But there can be a delay in treatment and/or a negative patient outcome when stroke CT results are not known as soon as they are available. With the new approach, the radiologist calls the emergency department (ED) or ordering provider with the results of all stroke protocol CT scans, regardless of the results.

At the time of the call, the provider may have all the other information needed to make the crucial decision of whether to administer tPA. Having the radiologist contact the provider by telephone helps to eliminate a time delay for the ED provider reviewing the report. Moreover, the physician-to-physician call is an additional safeguard to help prevent a CT report being left unread prior to tPA administration.

Representatives from the emergency medicine, quality improvement, and radiology departments worked together to develop the process and monitor for compliance. This effort did not come without reluctance, and there were challenges to work through.

First, outsourced radiology providers did not immediately embrace the process, because they did not have to do this at the other hospitals they covered. To overcome this challenge, the facility re-educated radiology providers and made clear the expectation of the CT scan communication. The facility then monitored compliance per individual radiologist and reported results to the radiology administrative team and the vice president of medical affairs, who followed up as needed.

Another challenge was related to providers incorrectly ordering the stroke protocol CT for patients who did not meet criteria or who were outside of the stroke window for thrombolitics (such as alteplase) or endovascular therapy, as defined by hospital protocol. The ED team was explicitly educated to use this CT only for patients who meet stroke-alert criteria.

Together, these efforts improve the diagnostic process by reducing delay in communicating critical results for stroke patients, which ultimately may reduce harm to patients with time-sensitive conditions. In addition, monitoring orders for the stroke-protocol CT to protect against its overuse improves diagnosis by eliminating waste and preventing treatment delay.

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Closing the Safety Gap on Pulmonary Nodule Incidental Findings

WellSpan Health

WellSpan Health started an initiative in 2015 to develop a systematic response to the patient safety issue of patient and treating physician unaddressed imaging findings and related follow-up recommendations, by defining and developing a Pulmonary Nodule Incidental Findings registry. The goal of the program is to identify pulmonary nodules/incidental findings and ensure follow-up.

The tracking registry began with limited imaging studies that identified pulmonary nodules that were incidental to the primary reason for the ordered study. When an incidental finding is identified, the radiologist adds specific wording to his or her report that allows the case to be identified by the nodule registry team. Working with the oncology team, a database was built to accommodate tracking, monitoring, and follow-up for these incidental findings.

The incidental finding care coordinator (IFCC) registered nurse reviews each imaging study finding entered into the database and the corresponding electronic medical record, to assess for planned follow-up according to Fleischner Society guidelines and related radiologist recommendations. If there is no identified notation to indicate that the physician or primary care physician (PCP) is aware of the nodule finding or has planned the recommended follow-up, the IFCC will contact them by sending an electronic task or by placing a phone call and having a discussion with the office staff, physician, or PCP. If there is no PCP documented, the IFCC will contact the patient by phone or certified letter.

The IFCCs are making positive care impacts by identifying patients whose imaging study findings require follow-up that may be unknown to the patient’s physician or practitioner. From July 2017 to June 2018, the IFCCs received and reviewed 5,119 patients for pulmonary nodules. All 5,119 patients were identified by a radiologist as needing follow-up. In 12% of all imaging reports reviewed, the PCP (and as a result, the patient) was unaware of or had not followed up on the pulmonary nodule that had been identified in the imaging study. Appropriate follow-up would include notifying the patient of the nodule, planning or scheduling follow-up imaging studies, and scheduling appointments.

As a result of the Pulmonary Nodule Incidental Findings registry review and workflow safety net, 51 patients per month, on average, were made aware of an incidental finding pulmonary nodule that otherwise might have been missed in treatment planning and follow-up. The IFCC Program is functional at the four

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WellSpan Health acute care facilities—York Hospital, Gettysburg Hospital, Ephrata Community Hospital, and Good Samaritan Hospital.

There are plans for possible next steps for the incidental findings registry to include additional nodule or lesion types. The Pulmonary Nodule Incidental Findings Registry Program has had a positive impact on patient safety by ensuring that these important findings are not missed during transitions of care.

### Decreasing Diagnostic Error in a Neonatal Intensive Care Unit

**Einstein Medical Center Philadelphia**

The Finnegan Neonatal Abstinence (FNA) scoring tool is widely used in neonatal intensive care units (NICUs) to guide the diagnosis and treatment of neonates born addicted to opiates. The FNA tool’s severity score, or diagnostic score, is important because it leads the NICU team to the most appropriate treatment protocol; inconsistency in scoring can lead to a longer length of stay and less effective opiate weaning.

NICU nurses at Einstein Medical Center Philadelphia identified several concerns with scoring, so an interdisciplinary team—comprised of nurses, physicians, pharmacists, social workers, and administrators—was formed to focus on increasing uniformity in assessment and diagnosis. The team identified inconsistency among caregivers in assessing and scoring using the FNA tool, including variability in differentiation of moderate tremors from severe tremors, identification of feeding trouble, and differentiating which skin breakdown is an indicator of feeding disturbance.

The process for identifying solutions to decrease diagnostic errors began with a literature review that revealed useful tips and key points for those responsible for scoring. Based on findings from the search, the team created a written competency and a return demonstration skills checklist (returning in a physical demonstration what was taught). These were completed by all NICU staff members.

The NICU team also implemented interobserver reliability training to help newer staff with scoring. A review of the items the infant is consistently being scored for is reported during crib-side handoff, so oncoming nurses know which items require more focused attention during scoring.

These interventions resulted in greater uniformity in staff assessment and scoring using the FNA tool. This supported a more consistent diagnostic process to guide application of opiate-withdrawal protocols and, because of the tool’s precision and uniformity in communicating the care plan, improved parental understanding of the treatment process.

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**The Diagnostic Safety Program at Children’s Hospital Colorado**

**Children’s Hospital Colorado**

Children’s Hospital Colorado formally began addressing patient harm due to diagnostic errors in December 2016. The diagnostic safety program focuses on three main topics: knowledge, culture, and measurement.

Over the past five decades, cognitive psychology has provided great insight into the processes of human decision-making, but that knowledge has not always been incorporated into medical education. The hospital’s educational strategy provides clinicians with basic knowledge of decision-making processes to build awareness of clinicians’ reliance on them in the diagnostic process.

Building on this educational campaign, Children’s Colorado is beginning to address the culture surrounding diagnostic error by systematically redesigning the structure of its clinical case review process (classically known as the morbidity and mortality review, or M&M). This will include M&M facilitator training focused on creating a safe environment in which to discuss diagnostic errors and their connection to system improvement.

Children’s Colorado is also developing a repository of articles about the current science of clinical reasoning and a handbook on best practices for the successful development and execution of M&M conferences. Establishing a scientific understanding of human judgment and creating a culture supportive of discussing flaws in judgment that lead to diagnostic errors will allow clinicians to identify opportunities for reducing harm from such errors.

Another component of the strategy is to identify larger trends in diagnostic error that may be amendable to system-wide solutions. Although patients in a subspecialty or clinical unit may suffer harms unique to their medical circumstances, it is unlikely that the underlying diagnostic reasoning failures are unique. If improved understanding of these underlying failures remains isolated in the knowledge of a single unit, it deprives learning at an institutional level to uncover where, when, and how these diagnostic errors are occurring.
Collecting this knowledge centrally will allow systematic measurement of the frequency and type of diagnostic errors encountered. To that end, Children’s Colorado has created a novel diagnostic error reporting and tracking database that will permit compiling M&M cases from across the hospital to discover trends in diagnostic error. This will foster the study and implementation of improvement strategies that can prevent harm in a much larger proportion of the hospital’s patient population.

Over the past year, progress has been slower than hoped. Openly discussing diagnostic errors creates significant discomfort in diagnosticians. Bringing the harms that result from faulty diagnostic reasoning into the light challenges the diagnosticians’ defining characteristic—to get the diagnosis right. Yet, it is vitally important to ensure the trust and cooperation of diagnosticians because the diagnostic process is so often obscure.

The approach taken to build that trust and cooperation involves a strategy rooted in partnership and establishment of shared goals. For example, the redesign of the M&M process started with one-on-one conversations between the Diagnostic Safety Program leader and M&M facilitators to understand their unique challenges, followed by a retreat with several facilitators to define shared goals, expectations, and components of clinical case review. Similarly, the database developed for tracking case-review details and outcomes is being tested by select clinical units that already have robust case review processes. Feedback is used to refine the database to ensure that it serves both the local case review process within the unit and supports the larger institutional mission.

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Ensuring Follow-Up of ED Radiologic Incidental Findings

Tyrone Hospital providers and staff were challenged by the desire to ensure adequate and accurate patient education about incidental findings. They were eager to participate in the Hospital and Healthsystem Association of Pennsylvania (HAP) Hospital Improvement Innovation Network (HIIN) pilot project. The Pennsylvania Patient Safety Authority and the Health Care Improvement Foundation led the project, and the goal was to decrease diagnostic error.

As part of this project, a team was formed at the hospital to ensure interdepartmental coordination of care, including the chief radiologist, chief nursing officer, emergency department (ED) nurse manager, radiology department director and secretary, and quality director. The team reviewed the electronic medical record for documentation issues and tracking abilities. After project-related meetings and education, the team discussed proposed practice changes for feasibility and implementation.

The changes addressed incidental findings on ED imaging scans. For example, a computed tomography scan of the abdomen and pelvis may be ordered to evaluate for acute appendicitis. However, an incidental finding might be revealed, such as a renal mass or lung nodule. This incidental finding might need further evaluation to assess for malignancy. In addition, the prevalence of preliminary radiologic interpretations for ED cases (performed overnight at many institutions) means that final interpretations may occur when the ordering clinician is off duty.

The following imaging-tracking practice was refined after engagement with the HIIN project. If the radiologist determines that the incidental finding may be clinically significant, he or she flags the case for the department secretary, who then obtains the patient’s contact information and identifies the primary care clinician. The secretary prints the report and drafts a cover letter to the patient and primary care clinician explaining that an abnormality identified by imaging requires follow-up. The radiologist then contacts the patient to discuss imaging findings and recommendations. This educational conversation either takes place in person or by telephone. The related documents are either hand delivered or mailed to the patient. In addition, the report is forwarded to the primary care clinician.

As mentioned above, before the HIIN collaborative effort, Tyrone Hospital had initiated an imaging tracking program in 2015, which was not limited to ED patients. This broader program uses similar procedures to either notify patients or their primary care clinicians of any imaging finding with significant potential for malignancy. Patient feedback to the changes that were put in place during the HIIN project has been positive. Everyone involved in the process strongly believes that a coordinated effort will
result in appropriate diagnosis and treatment in the timeliest manner possible. The team is driven by their passion to improve community health and wellness and provide patients potentially lifesaving treatment.

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Faster Imaging for Earlier Stroke Diagnosis and Treatment

Einstein Medical Center Montgomery

To maintain our certification as a primary stroke center at Einstein Medical Center Montgomery (EMCM), we work diligently to follow standards outlined by Joint Commission. A multidisciplinary committee—which is chaired by the stroke coordinator and includes representatives from the emergency department (ED), diagnostic testing, radiology, laboratory services, case management, neurology, and a community member—meets monthly.

The committee's primary goal is to improve patient outcomes through case review and to determine how the hospital can safely and efficiently improve processes with an emphasis on rapid diagnosis and treatment. The committee reviews all charts of patients who presented as a stroke alert either to the ED or as inpatients and pays particular attention to cases in which the patient received a lytic medication or endovascular thrombectomy.

In the fall 2015, after a review of evidence-based practices for stroke care, recommendations were received from the stroke committee to make significant changes to our stroke-alert process in the ED. Knowing that rapid diagnosis is a precursor for successful patient outcomes, EMCM reached out to local emergency medical services (EMS) organizations that transport patients to our facility to determine whether arriving crews would take patients directly to the radiology department for a computerized tomography (CT) scan on the EMS stretcher.

This is an atypical practice for EMS, although doing so would save precious time by avoiding the patient first being placed on an ED stretcher and then transported for a CT scan. EM’s notifying EMCM prior to the arrival of a potential stroke patient allows early communication and treatment collaboration with the CT technician as well as the other members of the stroke team. Effective implementation of the practices was agreed upon by all parties.

In spring 2017, recognizing that vital time was being lost when a stroke patient had to return to CT scan for a computed tomography angiography (CTA) scan after having a noncontrast imaging study allowed for a change in practice in which a patient undergoes both CT and CTA in rapid succession. Stroke patients now undergo a noncontrast CT that is first read by a radiologist; then, if deemed safe and clinically appropriate, the patient undergoes a CTA without ever being moved from the CT table. The results of the CTA will provide information that will determine whether a patient is eligible for a mechanical thrombectomy.

Patients who present within 3 to 4.5 hours of the start of stroke symptoms are eligible to receive a tissue plasminogen activator (tPA) in an attempt to dissolve the clot that is causing the obstruction to the brain, thereby leading to improved blood flow to the affected area. The standard for ED presentation to tPA administration is 60 minutes. Completion of a noncontrast CT is necessary to determine a patient’s eligibility for receiving this medication.

By decreasing the time it takes for the CT to be completed and read, we have significantly decreased our administration time for tPA. From August 2015 through July 2016, 50% of eligible patients received tPA within 60 minutes of presentation to the emergency department. For 2017, that had grown to 87% of eligible patients receiving tPA within 60 minutes.

By improving our processes and delivering treatment more quickly, we improved our outcomes by improving our patients’ quality of life and limiting the degree of disability as a result of their stroke.

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HIV and Hepatitis C Virus: Improving Diagnosis through Electronic Medical Record-Driven ED Testing

Temple University Hospital

The number of acute hepatitis C infections identified in Philadelphia between 2012 and 2016 has increased ten-fold. Philadelphia County also has the highest 12-year incidence rate of hepatitis C virus (HCV) in the state. And Philadelphia has had more new (human immunodeficiency virus) HIV cases than all other counties in Pennsylvania combined (31,986 cases from 1980 to 2016 in Philadelphia, compared with 28,621 cases for all other Pennsylvania counties). Yet, Philadelphia County comprises only 12% of the total population of the state.

Temple University Hospital, in Philadelphia, serves a high-risk, inner-city population, and many of its residents lack access to primary care. To facilitate early diagnosis and to establish timely follow-up and initiation of care, the hospital has implemented a novel screening program for HCV and HIV through the emergency department (ED), using the electronic health record (EHR).

When patients enter the ED at the main hospital and a community affiliate, a best practice alert in the EHR is triggered if the patient’s medical record indicates that criteria for HCV testing is met, based on current guidelines from the Centers for Disease Control and Prevention (CDC). The alert instructs the provider to offer HCV testing, which can then be ordered by nurses or physicians. A similar program has been implemented at the affiliate site for HIV screening. All patients arriving in the ED, age 18 through 65, are offered HIV testing and consent for testing is obtained in triage if they accept.

The results from these screenings are collected in a registry within the EHR. Navigators then use the registry to contact patients with positive results for appropriate follow-up. Attempts to contact patients are documented in the chart and the results are tracked within the registry. If patients who were not reached by phone or certified letter return to the hospital, the on-site navigators are notified by means of EHR and text messages so the patients can be informed of their results. Once informed of the diagnosis, patients are scheduled for a follow-up appointment with the appropriate specialist.

Since August 2017, more than 4,000 patients have been screened for HCV; testing for 7.4% demonstrated chronic infection. Thirty-three percent of patients with positive HCV test results have been linked to care with an HCV specialist. Of the 1,825 patients who have been screened for HIV, 0.4% had positive test results. All aspects of the process, including triggering of the best practice alert, resultant testing or dismissal of the alert, and patient follow-up, are being tracked to further refine the process to increase the number of patients tested and linked to care.

Early diagnosis of HCV and HIV using this type of EHR-driven testing program can increase the number of patients screened and linked to care. Ultimately, this screening program may lead to improved diagnosis, supporting a decrease in disease transmission and associated morbidity and mortality.

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Improving Diagnosis by Monitoring Serial Procalcitonin Levels

Summit Health

Rapid determination of the pathogenic organism type—bacterial, viral, or fungal—presents a challenge in the diagnosis and treatment of infectious diseases. Until this information is known, treatment remains empiric and largely requires the use of broad spectrum, and potentially unnecessary, antimicrobials. This, in turn, could result in adverse drug effects, increased hospitalization costs, and an adverse effect on local antimicrobial susceptibility patterns.

Summit Health uses the biomarker procalcitonin to identify bacterial infections in a timely manner. Procalcitonin is undetectable in the absence of a bacterial pathogen. Obtaining and monitoring serial procalcitonin levels is especially helpful in determining whether an infection is bacterial and if it should be treated with an antibacterial agent. Further, serial
procalcitonin levels may predict a satisfactory response to antimicrobial therapy, which could enable de-escalation of antimicrobials in a timely manner.2

The pharmacy department partnered with the pulmonology, infectious disease, hospital medicine, infection prevention, and pathology departments to initiate a procalcitonin protocol for patients admitted with bronchitis, pneumonia, chronic obstructive pulmonary disease, or congestive heart failure diagnoses. The protocol included drawing a procalcitonin level at admission and every 48 hours thereafter. The orders for procalcitonin were hard-coded into the computer-physician order-entry order sets. The clinical pharmacist was notified each time a procalcitonin level test result was completed by the laboratory.

When baseline and successive procalcitonin levels were less than 0.1 ng/mL, the case was referred for review by the antimicrobial stewardship team, which included an infectious disease physician. Using procalcitonin level results in combination with other biomarkers such as C-reactive protein, presence or absence of leukocytosis, chest radiography, and temperature trends, the infectious disease physician determined whether communication with the attending physician was warranted to advise the attending physician that an infectious process was unlikely to be bacterial in nature and that discontinuation of antimicrobials should be considered.3

Because of serial procalcitonin measurements, many patients admitted with select diagnoses (e.g., bronchitis, pneumonia) were determined not to have bacterial infections and thus were spared full courses of antimicrobial therapy.

Monitoring serial procalcitonin levels in a subset of patients suspected of having a respiratory bacterial infection can be useful in ruling out a bacterial cause; procalcitonin provides a beneficial tool to improve antimicrobial stewardship.

Notes

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Improving Post-Mortem Diagnosis in Unexpected Neonatal Demise Using Virtual Autopsy

Abington Memorial Hospital

Congenital anomalies are a leading cause of neonatal death worldwide.1 These lesions may not be detected by ultrasound during routine antenatal surveillance but can have significant, and even lethal, implications during the neonatal transitional period.2

A neonatal loss has a profound impact on patients, families, and care providers, and often a traditional autopsy is not pursued by the family because of the delicate nature of the situation and the invasiveness of the procedure. Virtual autopsy or “virtopsy” has been validated through multiple studies as a minimally invasive means of objectively documenting cause of death.3,4 Virtual autopsy is often a composite of imaging, including ultrasound, computed tomography (CT) and magnetic resonance imaging (MRI). Although virtopsy has been studied in adults, it has only recently been studied in neonates.5

At Abington Memorial Hospital, a 30-year-old primagravida presented to labor and delivery with preterm, premature rupture of membranes. She was admitted, given prophylactic antibiotics, and expectantly managed. She had an uneventful labor course, and fetal monitoring was reassuring throughout the night. She quickly progressed to complete dilation; however, after two hours of pushing, there was no descent of the fetal head. A cesarean delivery was recommended. After a difficult delivery, resuscitative measures were unsuccessful, which resulted in a neonatal death. Like many others, the patient and her husband were opposed to a traditional autopsy. A virtual autopsy was offered to the family as an alternative.4

A CT, MRI, and ultrasound were performed, and diagnostic imaging clearly demonstrated an imperforate thin membrane across the trachea distal to the vocal cords, making it impossible for air to flow through the respiratory tract into the lungs despite extensive resuscitative measures.

Imaging demonstrated fluid throughout the tracheobronchial tree and the absence of air in the lungs. The presence of a tracheal air fluid level suggestive of an upright presentation while the infant was supine is particularly compelling for this case. Virtopsy provided noninvasive documentation of findings, which could be analyzed and independently verified with preservation of tissues. The finding of a tracheal web at virtopsy is particularly compelling for this case. Virtopsy provides an alternative means of objectively documenting cause of death.

Obtaining answers in situations like these is of critical importance to prevent inappropriate assignments of guilt and blame for patients and family, as well as providers. In this case, it was particularly instrumental in diagnosing a cause of death and providing closure to all involved.
Virtopsy provided noninvasive documentation of findings that could be analyzed and independently verified, while preserving tissues. However, although virtopsy allows for structural and tissue analysis, it does not provide molecular or genetic information, suggesting that there are still roles for traditional post-mortem evaluation techniques.

As evidenced by this case, using virtopsy to identify a cause of death can be critically important in the process of coping and healing after a loss, and it allows the study of disease through a different lens from that of traditional autopsy. The hope in applying this technique broadly is to provide a minimally invasive way to gain insight and in-depth information that might be unobtainable otherwise.

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‡Patient information has been de-identified.

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**Safer Dx Learning Lab at Geisinger: A Partnership between Researchers and Health System Leaders for Improving Diagnostic Safety**

**Geisinger Medical Center**

Diagnostic errors—missed opportunities to make timely and accurate diagnoses—are major contributors to patient harm but are hard to tackle because they are difficult to identify and measure. Progress in reducing diagnostic errors hinges upon our ability to overcome several unique measurement-related challenges, including operationally defining diagnostic error in real-world settings. Compounding these challenges is the fact that diagnostic errors typically emerge across multiple episodes of care. Although recent studies⁠¹ show that misdiagnosis affects at least one in 20 U.S. adults each year in the outpatient setting, health systems have yet to develop a systematic approach to improving diagnostic performance in either inpatient or outpatient settings.

This compelling need to demonstrate how to identify and reduce diagnostic errors led to the creation of the Safer Dx Learning Lab. Funded by the Gordon and Betty Moore Foundation, clinical leaders at Geisinger and researchers at Baylor College of Medicine have formed a unique learning health system for improving diagnosis. The lab is taking a systematic approach to learn how healthcare systems can enhance the safety and accuracy of the diagnostic process. This collaboration combines Baylor’s multidisciplinary research expertise and Geisinger’s innovative approach to clinical operations, allowing translation of research into meaningful care improvements.

The Safer Dx Learning Lab—Dx stands for diagnosis—uses multiple data sources from the health system (risk management, electronic triggers), providers, and patients to identify missed opportunities in diagnosis. After an initial rigorous review by the Learning Lab team, missed opportunities are then reviewed by the Committee to Improve Clinical Diagnosis (CICD) to further understand how to uncover contributory factors and provide feedback to individuals, teams, and entire divisions.

This analytic process is all about how and what we can learn from the opportunity. We look at five dimensions in the diagnostic process derived from the Safer Dx framework⁠²: (1) patient-provider interactions, (2) diagnostic test performance and interpretation, (3) the referrals process, (4) appropriate follow-up of test results, and (5) patient factors.

Geisinger has harnessed a wealth of electronic data and will leverage it to provide actionable information to improve clinical diagnostic quality. Together with Baylor, the group will use a multidisciplinary, socio-technical approach to improve the measurement and feedback of diagnostic errors.

The unique CICD at Geisinger advises and closely collaborates with the Safer Dx Learning Lab. Its members include senior physicians, clinical and operational leadership, and key stakeholders from quality and safety, risk management, patient experience, medical informatics and information technology. The CICD has an extensive agenda, but in general seeks to identify and assess diagnostic errors while making every error an opportunity for broad-based learning in an open and constructive environment. This project is in its early stages but offers a unique opportunity to address challenges posed by diagnostic errors.
A Standardized Approach to Defining and Rapidly Recognizing Diarrhea

Select Medical

Diarrhea is a common occurrence in critically ill patients. Up to 38% of patients in the intensive care unit have at least one episode of diarrhea.1 These episodes may be noninfectious (i.e., associated with nutritional interventions or enteral feeding) or attributable to insidious hospital-acquired *Clostridium difficile* infection.

Diagnosis and management of diarrhea is especially critical in this patient population because of the impact on the patient’s long-term recovery and nutritional status. However, the lack of standardized definitions of diarrhea, inconsistent approaches to troubleshooting the underlying cause, and the potential for over-use of laboratory *C. difficile* testing make diagnosis and management challenging.

Recognizing these challenges, Select Medical’s *long-term acute care hospital* (LTACH) division embarked on a diagnostic stewardship mission to promote rapid identification and resolution of diarrhea. The approach was to use a standardized diarrhea definition and interdisciplinary management.

Senior leaders from the clinical, dietary, and pharmacy disciplines collaborated to define diarrhea by two criteria, only one of which is required to meet the definition: the presence of three or more watery stools in 24 hours or less or a significant change from patient’s baseline stool consistency. The leaders also developed a diarrhea management algorithm to guide staff through appropriate diagnostic steps after a new onset of diarrhea. The algorithm includes assessment of underlying medical causes, evaluation of potential fecal impaction, and medical record reviews by nursing, pharmacy, and dietary staff to identify any other possible contributing factors to diarrhea prior to ordering tests for *C. difficile*.

Assessment of other clinical or pharmaceutical causes for diarrhea was expected to reduce routine *C. difficile* testing when clinical indications of infection were not present. Additionally, limiting *C. difficile* testing to patients with acute signs and symptoms of infection was expected to reduce the risk of false-positive tests in cases of asymptomatic colonization.

The diarrhea management program was tested in pilot programs at five Select Medical LTACH sites from March 1 through September 30, 2017. Participating sites reported an increase in the number of diarrhea cases identified and improved multidisciplinary collaboration for diarrhea management.

Preliminary results of the program were shared with Select Medical’s National Medical Advisory Board, which approved the roll-out of the strategy to all facilities in the LTACH division in early 2018. Education of clinical leaders at each hospital was completed through a series of structured webinars, and in-service sessions for all staff members on the standardized definition and management protocol were completed in March 2018.

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