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Abstracts*)

Diagnostic Error in Medicine

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Oral Presentations Plenary session

Sunday November 6, 2016, 3.30-4.45 pm

1) An Exploration of Patient and Family Self-Reports of Diagnostic Errors

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Background: Although comprehensive reporting could help understand the origin, impact and prevention of diagnostic errors, existing reporting systems only capture a fraction of errors. Reports from patients can provide valuable insight into safety-related problems. We conducted a descriptive analysis of patient- and family-reported diagnostic error narratives to understand factors that contribute to those errors.
Methods: Our study sample included patient- and family-reported adverse medical events submitted to a survey-based online reporting platform housed by the Empowered Patient Coalition (EPC) between January 2010 and February 2016. Patients, family members and caregivers submitted data to report their care experiences via structured data and free text. We conducted a qualitative content analysis of all cases of self-reported diagnostic errors with written narratives of patient experiences. Diagnostic error narratives were coded by two coders, merged and discussed to identify major themes. Data analysis is ongoing.
Results: Of the 100 cases analyzed thus far in this study, 63.0% involved female patients; 94.0% resided in the United States, and average age was 45.5 (range 1 week to 87 years old). The types of diagnostic errors experienced included: 77.0% delay in diagnosis or treatment, 63.0% misdiagnosis, 46.0% proper test not ordered, 31.0% test results lost, misplaced or disregarded, and 9.0% laboratory or pathology error. Forty eight of the respondents included a narrative specifically about a diagnostic error. Analysis of those narratives revealed the diagnostic testing process to be particularly problematic across many of the stories (n=30, 62.5%). Respondents reported incidents related to ordering of tests (e.g., failure or refusal to order or ordering inappropriate tests); communication of test results (e.g., failure or delay in communication); and interpretation of test results (e.g., misreading of tests). Table 1 provides illustrative quotes. Many of these process breakdowns were attributed to communication issues such as failure to listen to patients or failure to discuss testing decisions. Respondents indicated a sense of frustration when physicians made final decisions about testing without discussion or incorporating patient preferences. In some cases, respondents indicated they sought a second opinion to obtain necessary testing and diagnosis.
Conclusion: Among patient- and family-reported diagnostic errors, diagnostic testing issues are prominent and emerge when physicians fail to listen to patients or fail to discuss testing-related decisions. Our findings highlight the need to augment the use of patient-centered communication and shared decision-making principles to facilitate decisions that are made alongside patients, families and caregivers rather than for them.

Table 1: Examples of Respondent Quotes on Testing Issues (n=48)

Communication of test results	*"Fatal lab values were not communicated to patient; until after patient was discharged and had died."* *"Loss of function and ultimately death from undiagnosed metastatic cancer that was noted in radiology report but never communicated to patient or follow-up on"*
Ordering appropriate testing	*"Her Thoracic surgeon kept telling her she has clear chest x-rays and she was fine. MRI's showed her brain was fine. It took a retired neurosurgeon, a distant friend of the family, to step in and assert himself into the situation, to get the long requested lumbar puncture, which gave the final diagnosis."* *"I was misdiagnosed with muscle pain when what I really had was a sphenoid sinus infection...I asked on more than one occasion for a head CT or MRI, but my doctor refused. I finally sought care elsewhere and was treated with a month long course of antibiotics."* *"She even went to the ER via ambulance on several occasions because her pain was so severe. She was told to get a life and not focus on her pain. Since they believed that her pain was fictitious they did no testing..."* *"My blood pressure stayed high, and I started feeling sick, and had trouble breathing and couldn't eat or drink, the hospital staff, doctor, said I seemed all right, though they never took x-rays or did anything else to check me out..."*
Interpretation of test results	*"I had picked up the copy of the CAT scan at the hospital and the radiologist at the hospital said that the scan was definitive and that more testing was unnecessary. I begged and pleaded for more tests but all they wanted to do was operate...I had the full blown heart surgery...When I awoke...the surgeon walked in and said there was nothing wrong with my aorta. He even laughed and said how "lucky" I was that I didn't have a torn aorta."* *"Records showed test results that indicated infection and organ failure yet action was not taken and patient and I were not told of deteriorating condition."* *"During the period from February 25 until August 7, in spite of numerous blood tests, MRI's, X-rays, etc. no one could see that I had a staph infection."*

2) The EARLY BIRD Looses the Diagnostic Worm – How Screening for EARLY Disease Increases Diagnostic Error in Medicine

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Statement of problem: Advances in medical science have led to a dramatic increase in our capacity to screen for early disease. The hope is to reduce morbidity and mortality. However, this new capability to detect earlier stages of disease has led to decreasing reliability of diagnostic criteria. The result? A downward spiral of litigation, legislation, and regulation forcing providers to systematically err on the side of making the diagnosis of a disease that is not present and treating the patient unnecessarily to avoid malpractice lawsuits, hospital sanctions, and loss of income. Considering the risks of therapy, this trend has placed large numbers of patients in harm's way.
Description of the intervention or program: An in depth review of the literature on the subject of screening was done to explore this problem. The review focused on the early diagnosis of breast, prostate, and thyroid cancer where major screening programs have been in place for many decades.
Findings to date: The literature review reveals rates of these cancers have gone up dramatically in screened populations while mortality has remained essentially unchanged. Evaluation of diagnostic criteria reveals decreasing reliability in populations screened for early disease. There is now a growing awareness of a lack of concordance between physicians as to what constitutes appropriate diagnostic criteria as well as their proper application. There are a number of potential reasons for this including but not limited to:

1. Smaller subclinical lesions are now biopsied many of which are not harmful to the patient.
2. Absence of definitive findings in smaller biopsy specimens that are found earlier in the disease process.
3. Presence of some diagnostic findings in benign specimens forcing a malignant diagnosis.

Lessons learned: In order to significantly reduce diagnostic error in early screening it will be necessary to:

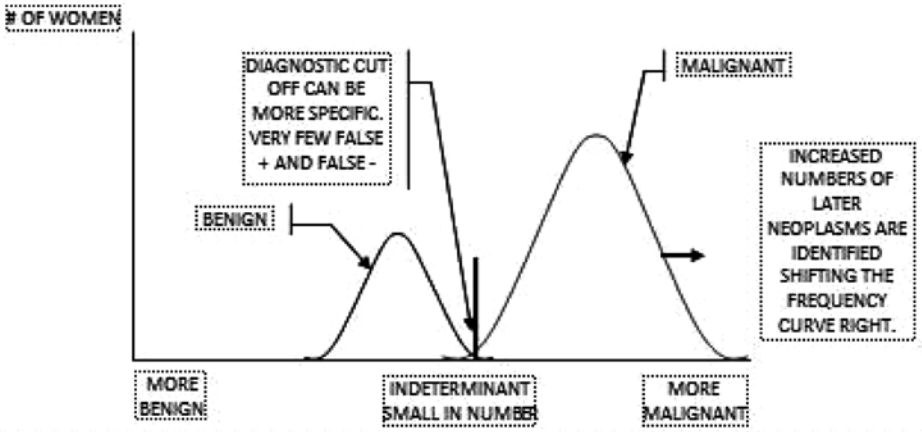
1. Develop new more reliable radiologic and pathologic diagnostic criteria.
2. Develop genomic/ribonomic/proteomic methods to confirm and/or rule out a diagnosis.
3. Halt the growing pressures on health care providers to make a diagnosis where there is none.
4. Educate providers as to the present limitations of early diagnosis through screening.
5. Educate our patients regarding the limitations of medical science at this juncture.

WHEN NORMAL IS NOT NORMAL!

GRAPHIC HISTORY OF HOW DIAGNOSTIC SCREENING AND TREATMENT MODALITIES AFFECT THE EPIDEMIOLOGY OF BREAST NEOPLASMS AND DIAGNOSTIC CRITERIA LEADING TO MORE NOT LESS HARM

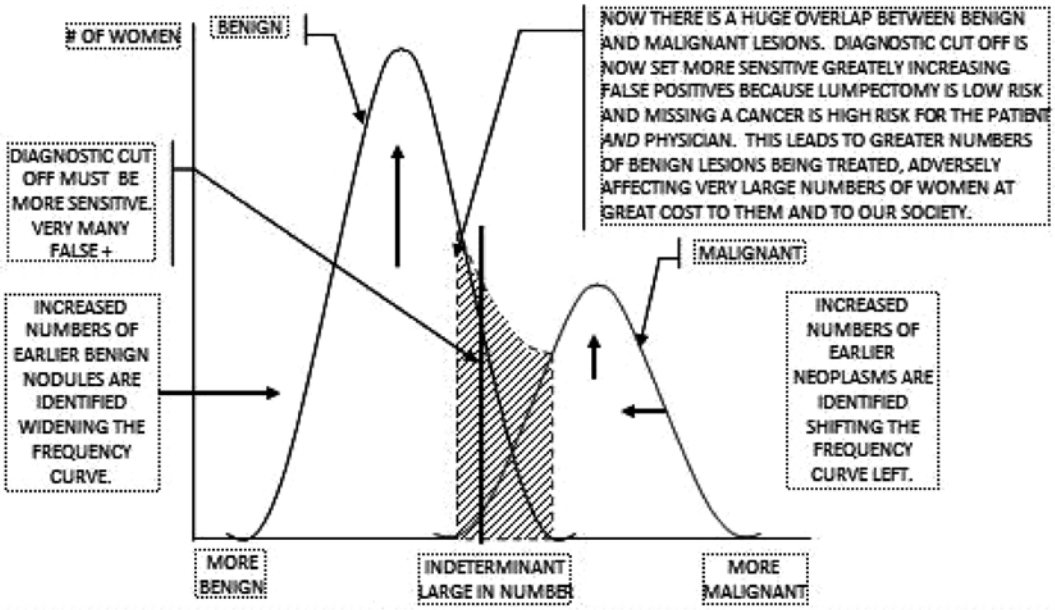
BEFORE THE MID 1970'S:

- FEWER WOMEN HAVE EXAMINATIONS
- NO MAMMOGRAPHY AVAILABLE
- TUMORS PRESENT LATER AND SO ARE MORE OBVIOUSLY MALIGNANT ON BOTH GROSS AND MICROSCOPIC EXAMINATION
- LUMPECTOMY IS NOT AVAILABLE



AFTER THE LATE 1970'S INTO MID 1980'S:

- MANY WOMEN HAVE EXAMINATIONS LEADING TO EARLIER DETECTION LEADING TO RISING EXPECTATIONS
- MAMMOGRAPHY GENERALLY AVAILABLE LEADING TO EARLIER DETECTION AND RISING EXPECTATIONS
- TUMORS ARE SMALLER AND LESS OBVIOUSLY MALIGNANT ON BOTH GROSS AND MICROSCOPIC EXAMINATION
- THEREFORE, A GREATER NUMBER OF BENIGN AND BORDERLINE CASES ARE REMOVED AND OVER DIAGNOSED LEADING TO SUPRIOUS INCREASE IN TUMOR SURVIVAL DATA AND MORE RISING EXPECTATIONS
- THEN, IN 1984 LUMPECTOMY BECOMES MAINSTREAM AND SHIFTS THE DYNAMICS EVEN MORE...LEADING TO INVALIDATION OF CLINICAL TRIAL STUDIES DUE TO A SHIFT IN DIAGNOSTIC CRITERIA AND TUMOR POPULATION!



3) Overcoming Delayed and Missed Diagnoses of Adverse Drug Reactions: Randomized Controlled Trial of Interactive Voice Response Coupled with Pharmacist Outreach

J. Medoff[1], **E. Klinger**[2], **A. Salazar**[2], **L. Walsh**[1], **M. Amato**[1], **E. J. Medoff**[1], **P. Dykes**[1], **J. Haas**[2], **D. Bates**[2] and **G. Schiff**[1]
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[2]Brigham & Women's Hospital, Boston, MA

Background: One of the most important diagnoses to make in a timely and reliable fashion is that of an adverse drug reaction (ADR). Failure to make such diagnoses can lead to inappropriate treatment for an incorrectly diagnosed condition, prolonged treatment, morbidity, and even mortality from continuing the offending drug, and potential medical-legal consequences of such missed and delayed diagnoses.
Methods: We conducted a cluster-randomized controlled trial deploying a system to proactively reach out to patients and make earlier diagnoses of ADRs (CEDAR study, Calling for Earlier Detection of Adverse Reactions). Using Interactive Voice Response (IVR) technology, we called primary care patients starting medications for one of four conditions (insomnia, depression, hypertension and diabetes). Calls contained a structured survey about potential ADR symptoms; patients were called 4-6 weeks and again 4-6 months after the start of the new medication. Patients reporting symptoms were immediately transferred to a live clinical pharmacist who assessed the likelihood of an association between the target medication and the patient-reported symptoms. Outcomes measured included total number of symptoms identified, physician notation and diagnosis of adverse reactions in clinical notes, and time to identification of symptoms.
Results: Of 11,128 eligible patients identified, 5,143 were randomized to the intervention group, and 5,985 to the control group. Overall, 776 (15%) of intervention patients answered the call and participated in the IVR survey, with 776 matched controls identified using propensity scoring. A total of 1,358 unique symptoms were found in the intervention group compared with 164 documented in the control group. For the primary outcome – physician-documented symptoms related to target medications – 177 intervention patients and 120 control patients had symptoms documented in the EHR (p=0.0002). Overall physician-documented symptoms in the intervention versus control groups were 277 and 164, respectively. Survival analysis also showed a significantly shorter time to documentation of first symptoms in the intervention versus control (log-rank p=0.0005).
Conclusion: IVR screening for medication-related symptoms, coupled with live pharmacist support, leads to more exhaustive and earlier diagnosis of potential ADRs. As one of the few evidence-based interventions demonstrating a reduction in missed or delayed diagnosis, in addition to the fact that diagnosing ADRs is a priority for clinicians and patients, this study suggests that such proactive efforts are an imporant and promising approach for more timely and reliable diagnosis.

4) Simulation to Assess Diagnostic Skills: Performance of Rapid Response Teams

D. Murray and **J. Cheng**
Washington University School of Medicine, St Louis, MO

Statement of problem: A recent Institute of Medicine (IOM) report entitled 'Improving Diagnosis in Health Care' offered a new framework to assess diagnostic errors and suggested a number of initiatives that would improve diagnosis and enhance patient safety. We describe a novel simulation methodology that provided pediatric rapid response with an opportunity to correct a diagnostic error and communicate an accurate diagnosis. We assessed team performance using an assessment tool based on recommendations of this IOM report.
Description of the intervention or program: In designing a simulation experience to train our pediatric rapid response teams, we included scenarios that required the team to recognize a diagnostic error. We assessed a team's diagnostic performance using an assessment tool based on the newer definition of diagnostic error. The RRT is called to evaluate a 10-year old child admitted with a diagnosis of pneumonia who, if the team evaluates the child's history and reviews available imaging information, will determine that the child has congestive heart failure. The study cohort included 9 pediatric rapid response teams who managed the 10-minute scenario in our pediatric simulation center. Each of the teams included a team leader (fellow or advanced practice nurse), a respiratory therapist and nurse. Two raters scored the team based on the following: 1) Did the team evaluate the child and the diagnosis? 2) Did the team question the diagnosis? 3) Did the team establish and confirm the new diagnosis? 4) Did the team implement therapy based on the new diagnosis? 5) Did the team communicate the new diagnosis to the family?
Findings to date: All 9 of the rapid response teams conducted an evaluation of the child. Four of the nine teams did not question the diagnosis of pneumonia. The remaining 5 teams questioned the diagnosis, but only 3 of these teams suggested a change in management based on the diagnosis of congestive heart failure. Two of the 9 teams accomplished all 5 of the scoring actions during the scenario.
Lessons learned: Health care professionals have few opportunities to improve their diagnostic skills and learn how to recognize diagnostic errors. Based on the rapid response team performance in this scenario, the majority of teams would benefit from an education intervention in diagnosis. Simulation is recognized as a method for practitioners to develop practice skills and could be used to provide health care professional teams with prospective experiences in recognizing and correcting diagnostic errors.

5) Measuring Missed Strokes Using Administrative and Claims Data: Towards a Diagnostic Performance Dashboard to Monitor Diagnostic Errors

N. Nassery[1], **K. Mane**[2], **F. Liu**[2], **N. X. Sangha**[3], **A. Sharp**[3], **E. Shamim**[2], **K. B. Rubenstein**[2], **H. Kharrazi**[1], **P. Nagy**[1], **M. Kanter**[4], **M. Horberg**[2], **D. Ford**[1], **P. J. Pronovost**[5] and **D. Newman Toker**[1]
[1]Johns Hopkins University, Baltimore, MD
[2]Kaiser Permanente, Rockville, MD
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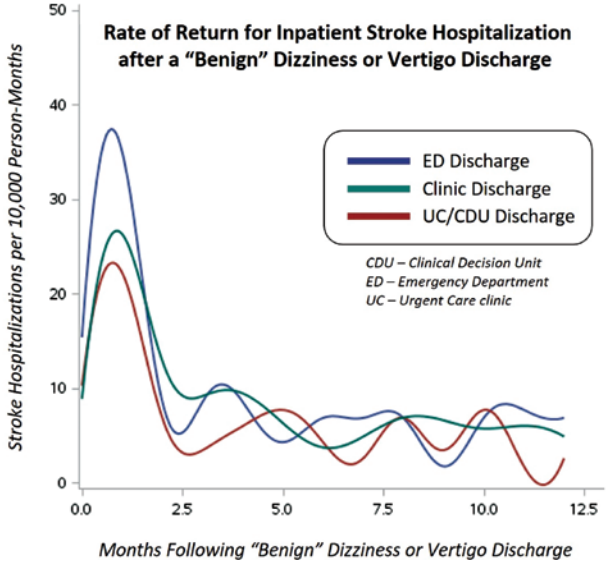
[4]Southern California Permanente Medical Group, Pasadena, CA
[5]Johns Hopkins University School of Medicine, Baltimore, MD

Background: Stroke misdiagnosis is a significant public health problem. An estimated 100,000 strokes are missed at first medical contact annually in the US; the majority present with symptoms of dizziness or vertigo. **Objective:** In this collaboration between Kaiser Permanente Mid-Atlantic States (KPMAS) and Johns Hopkins University, we sought to identify strokes not initially diagnosed among patients with dizziness. KPMAS healthcare facilities include ambulatory outpatient clinics, urgent care clinics (UC), and clinical decision units (CDU). CDUs provide pre-hospital triage. If patients require emergency department (ED) care or hospitalization, they attend non-KPMAS facilities.
Methods: Retrospective cohort analysis using administrative (KPMAS) and claims (non-KPMAS) data. Our cohort was adult patients discharged from an outpatient clinic, UC, CDU, or ED with a primary diagnosis of benign or non-specific dizziness/vertigo (ICD-9-CM codes 386.x or 780.4). We identified subsequent hospital admissions with a primary inpatient diagnosis of stroke (Healthcare Cost and Utilization Project Clinical Classifications Software code level 3). For patients with more than one dizziness visit during the study period, we used the first. We constructed rate-of-return-with-stroke curves for short-term risk of admission after treat-and-release visit. We used rate curves to define the time window and number of patients potentially harmed by a missed index visit cerebrovascular event.
Results: Between January 2010 and September 2015, 46,700 patients had 68,941 visits with a primary discharge diagnosis of benign or non-specific dizziness/vertigo. These included 40,957 primary care clinic; 13,425 other ambulatory clinic; 7,824 ED; 4,537 UC; and 2,198 CDU visits. Aggregate rate-of-return-with-stroke curves identified a short-term increased risk of stroke (peak rate ~60 per 10,000 person-months; base rate <10 per 10,000 person-months) in the first 60 days after the dizziness/vertigo discharge. The short-term increased risk was highest for patients seen in the ED and lower for patients seen in other settings (i.e., outpatient clinics, UC, CDU), though the temporal profile of increased risk was almost identical, peaking at 30 days and stabilizing after ~60 days (Figure). In aggregate, there were 635 (0.9%) short-term stroke admissions within 60 days of the index visit over the 5-year period.
Conclusion: Approximately 1% of patients released from ED and ambulatory care settings as "benign dizziness" had strokes resulting in subsequent readmission. Accurate initial diagnosis and prompt treatment might reduce the risk of any harms from diagnostic delay. Administrative and claims-based methods to measure unexpected clinical events could be used to operationally monitor missed diagnostic opportunities and assess interventions to reduce them.



Oral Presentations Research Parallel Track – Scientific Abstracts

Monday November 7, 2016, 2.20-5.45 pm

1) Patient Perspectives on Communication of Diagnostic Uncertainty

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[3]Texas Children's Hospital, Houston, TX

Background: Communication of diagnostic uncertainty can negatively affect patient satisfaction, confidence in the physician, and patient adherence. However, given the prevalence of diagnostic error, we need to understand how to effectively communicate uncertainty to patients. We evaluated the effects of three different strategies for communicating diagnostic uncertainty on patient perceptions of physician competence and visit satisfaction.
Methods: We used an experimental, vignette-based study design involving pediatric cases presented to a convenience sample of parents. We created 3 vignettes, each describing the same initial clinical scenario with a new pediatrician, followed by communication of diagnostic uncertainty to the parent by the pediatrician through one of 3 different strategies - (1) explicit expression of uncertainty ("not sure" about diagnosis), (2) implicit expression of uncertainty using broad differential diagnoses and (3) implicit expression of uncertainty using "most likely" diagnoses. In all 3 scenarios, the pediatrician subsequently reassured the parent and provided a plan of action. We used previous literature and input from patient advocates and experts to design our survey items and refined it after pilot-testing with 15 participants. We then recruited participants and randomly assigned them to one of the three vignettes. Study sample consisted of all parents participating in the patient and family advisor email listserv at a large pediatric academic center and a parent social-media group. Participants answered a 37-item web-based survey, consisting of subscales to measure perceived technical competence, trust, visit satisfaction, adherence to provider instructions, parent activation(parent PAM-10) and self-tolerance to uncertainty. Descriptive analyses were reported and ANOVA was used to compare differences between the three groups, followed by individual t-test comparisons.
Results: Forty participants have thus far responded. In preliminary analyses, participants across the 3 groups were similar with respect to parent activation(PAM) levels, tolerance to uncertainty scores, parent age and child age. There were significant statistical differences in sub-scales for clinician competence, trust, visit satisfaction and patient adherence between the three groups. Direct expression of uncertainty was associated with lower perceived technical confidence in the provider($p=0.01$), less trust($p=0.03$), less visit satisfaction($p<0.01$), and lower patient adherence($p=0.02$) as compared to the other two groups where uncertainty communication was implicit. The latter two groups showed no differences.
Conclusion: Our preliminary findings suggest that parents of pediatric patients prefer implicit expressions of diagnostic uncertainty using broad differential diagnoses or more likely diagnoses, over explicit expression. Strategies that clinicians can use to communicate diagnostic uncertainty while maintaining patient confidence still need to be defined.

2) Quantifying the Cascading Effect of Ordering an Unnecessary Test

R. DeMonte III[1], **S. Mullinax**[2], **Y. Kim**[1], **X. Jiang**[1] and **R. El-Kareh**[1]
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Background: Overtesting is a substantial hurdle in achieving quality patient care; not only does it result in misdiagnoses and wasted resources, but it can set off a cascading effect of further testing. The cascading effect results in a chain of potentially unnecessary procedures and diagnostic tests because of a false positive or an unexpected result from an initial unnecessary test. This chain of events can be harmful for the patient because additional tests are costly and often have risks associated with them. Quantifying the cascading effect of ordering an unnecessary test has yet to be fully explored. The purpose of this paper is to introduce a method for estimating the full cascading effect of ordering a single unnecessary test.
Methods: This is a retrospective observational study of ICU patients from the MIMIC III database. All diagnostic lab tests ordered on patients were partitioned into states based temporal proximity. These states were then categorized by diagnosis and used to construct a first order Markov model, which was analyzed.
Results: There were 46,252 ICU patients in the MIMIC III database used to build the Markov chain. A Markov chain was constructed using patients diagnosed with diabetic ketoacidosis. The model was constructed using 676 patients meeting the diagnosis criteria, and contained 4436 states. The model indicated that there was no significant difference in the number of hemoglobin tests ordered between starting states containing hemoglobin (1.47 future tests expected), and starting states not containing hemoglobin (3.01 future tests expected). This result implies that ordering a hemoglobin test on a patient did not lead to a cascading effect, insofar as hemoglobin tests were concerned.

Conclusion: The use of a Markov model to quantify cascading effects of an unnecessary test has potential to help understand the full cost and impact of overtesting. The efficacy of the model would be greatly improved with more detailed information linking specific tests to specific clinical scenarios. Future work includes application of this approach in other settings (e.g., ambulatory care and non-ICU hospital settings), exploration of using this model as a predictor for diagnoses through path analysis, and advancing to higher order models for predictive purposes.

3) Making Diagnostic Error Relevant for Medical Students

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[2]San Francisco VA Medical Center and University of California San Francisco, San Francisco, CA
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[6]University of Minnesota, Minneapolis, MN

Background: 15% of inpatient and 5% of outpatient diagnosis are incorrect, missed or delayed (1,2). Medical students encounter these diagnostic errors frequently, but most medical schools lack formal curricula that address this key quality and safety issue. As a result, opportunities to analyze these errors and enhance the diagnostic education of medical students are lost. To address this educational gap, we designed a curriculum to introduce students to the problem of diagnostic error and to build a foundation to improve their diagnostic skills.
Methods: An online virtual patient case depicting a diagnostic error was created using a set of learning objectives developed by the Society to Improve Diagnosis in Medicine Education Committee through an interactive consensus process. Third-year medical students on their Internal Medicine Clerkship were asked to complete this online case and a survey about the case followed by a didactic session. In the one-hour seminar, the online case was reviewed with an emphasis on the cognitive biases that occurred and a framework to analyze diagnostic error was introduced. Students were then led through a second case involving a diagnostic error (3). Emphasis was placed on features that placed the patient at risk for a diagnostic error. Methods to improve diagnostic reasoning and reliability were provided at the conclusion of the session. The survey was thematically analyzed by two investigators; narrative feedback about the session was collated by its facilitator (RG).
Results: Students felt the online interactive case had parallels with cases they had seen in their clerkships. Group discussion of a published case of diagnostic error in "real time" enabled students to learn from each other's experience and solidify their knowledge about cognitive biases. Several students commented on developing "a sense of responsibility" to improve their clinical reasoning. Students preferred more time be spent on tools to improve their diagnostic abilities.
Conclusions: Third year medical students are eager to learn about diagnostic error, cognitive biases, and methods to combat both. A virtual case completed before a "real-time" case provided a foundation for discussion of core concepts of diagnostic error. Students can relate diagnostic error concepts learned through a virtual patient case and in-class discussion to their own clinical experience.

4) Stratifying Risk of Urinary Tract Malignant Tumors (UTMT) in Patients with Asymptomatic Microscopic Hematuria (AMH)

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[2]Kaiser permanente, Oakland, CA

Background: AMH in the general population is common, occuring 9-18%. Even low degrees of AMH have been considered a risk factor for UTMT. Although the prevalence of UTMT is low (.01-3%), many asymptomatic patients undergo unnecessary and hazardous evaluations. In 2007, the Kaiser Permanente (KP) urologists started a multi-year QI effort to research and develop a risk stratified evidence-based approach in the evaluation of AMH. Clinicians determined that our guideline, was delivering low yield with poor predictability and was exposing many of members to significant radiation risk.
Methods: We conducted a retrospective analysis to determine the incidence of urinary cancer, and stratify risk according to age, gender, smoking history, and degree of hematuria. A multi-regional prospective, observational study was then conducted. We used a data collection tool embedded within an EMR to determine patients with AMH who are at greatest risk for UTMT, and patients who might benefit from urologic evaluation or safely avoid unnecessary workup and radiation exposure. In addition, we recruited 151 urologists from four regions for a prospective data collection and study.
Results: 4,414 patients had full urologic work up. Overall, 100 bladder cancers were diagnosed among 4,414 patients (2.3%), and only 11 renal cancers (0.2%) were pathologically confirmed. Multivariable logistic regression was conducted for 5 common parameters: age, gender, smoking history, degree of microscopic hematuria, and history of gross hematuria within the past 6 months. The most important risk factors were age > 50, and prior history of gross hematuria. A hematuria risk index (HRI) was developed, which significantly improved predictability (AUC =. 809-HRI vs. 532-AUA guideline). Overall, 32% of the population was identified as low risk with only 0.2% cancer detected; 14% of the

population was identified as high risk, of whom 11.1% had a cancer diagnosed. KP changed the clinical practice recommendation to avoid work up in patients with essentially no risk of malignancy and adverse radiation exposure in those at moderate risk but still undergo cystoscopy, and subject only those at highest risk for malignancy to CT scan screening along with cystoscopy.
Conclusions: With implementation of evidence based algorithm, KP has seen a decline of CT urograms, an increase of cystoscopies for hematuria, bladder cancer detection rate appears stable and we have seen a downward trend in the renal cancer diagnosis rate, which we are analyzing further.

5) Missed Opportunities for Diagnosis in Pediatric Primary Care Practices: Project Redde

M. Rinke[1], **H. Singh**[2], **M. Heo**[3], **J. Adelman**[4], **H. O'Donnell**[1], **S. Choi**[1], **A. Norton**[5], **R. Stein**[1], **T. Brady**[6], **C. Lehmann**[7], **S. Kairys**[8], **K. Thiessen**[9], **E. Rice-Conboy**[9] and **D. Bundy**[10]
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[3]Albert Einstein College of Medicine of Yeshiva University, Bronx, NY
[4]Columbia College of Physicians and Surgeson, New York, NY
[5]A. Mandatory, Inc, Ithaca, NY
[6]Johns Hopkins School of Medicine, Baltimore, MD
[7]Vanderbilt University School of Medicine, Nashville, TN
[8]Jersey Shore University Medical Center, Neptune, NJ
[9]American Academy of Pediatrics, Elk Grove Village, IL
[10]Medical University of South Carolina, Charleston, SC

Background: Missed opportunities for diagnosis (MODs) cause appreciable morbidity, but are understudied in pediatrics. General pediatricians have expressed interest in reducing sub-critical/high frequency MODs, but the frequency of these MODs is unknown.
Methods: As part of a national quality improvement collaborative, 25 primary care pediatric practices were randomized to collect five months of retrospective data on one of three sub-critical/high frequency MODs: adolescent depression, elevated blood pressure, and 5 specific abnormal laboratory values. Relationships between MOD rates and patient age, gender, and insurance status were explored with mixed-effects logistic regression models.
Results: Practices randomized to investigate MODs of adolescent depression reported on 400 adolescent health supervision visits. Practices randomized to investigate MODs of elevated blood pressure reported on 389 patients with either elevated systolic or diastolic blood pressure. Practices randomized to investigate MODs of abnormal laboratory values reported on 381 patients with an abnormal laboratory value. The MOD rate in pediatric primary care was 37 per 100 presumed depressed adolescents, 54 per 100 patients with elevated blood pressure, and 11 per 100 patients with abnormal laboratory values. Rates did not vary by patient age, gender, or insurance status. When examining the number of times a pediatrician may have recognized an abnormal condition, but either knowingly or unknowingly did not act according to recommended guidelines: providers did not pursue an evaluation for adolescent depression in 62 per 100 adolescent health supervision visits, did not document recognition of an elevated blood pressure in 51 per 100 patients with elevated blood pressure, and did not document recognition of an abnormal laboratory value without a delay in 9 per 100 patients with abnormal laboratory values.
Conclusion: MODs occur at an appreciable rate in pediatric primary care. Primary care practices should work to identify and eliminate these sub-critical/high frequency errors, as they may contribute to patient harm.

6) Analysis of Diagnosis-Related Medical Malpractice Claims

D. Siegal
CRICO Strategies, Boston, MA

Background: To understand common vulnerabilities driving medical malpractice claims, CRICO, the Medical Malpractice Insurer of the Harvard Medical Institutions maintains a national database of > 350,000 medical malpractice claims from academic and community organization across the country. Analysis of this data provides detailed insights into common patterns and trends that result in medical error, allowing for focused practice improvements strategies that target realized events.
Methods: Using CRICO's multi-tierd, clinical coding taxonomy, clinical specialists summarize the medical and legal files for every claim, capturing key elements of each case (e.g. allegation, responsible service, inital and final diagnoses, comorbidities, etc.), and assign associated causation factors (e.g. clinical judgment, communication, technical, behavioral etc.), providing a rich database for analysis.
Results: Analysis of 22,292 medical malpractice claims filed 2008-2012 found **21% related to diagnostic error**. Of the 4,519 diagnosis related cases, 51% (2,531 cases) occurred in ambulatory care, 28% (1,253) were inpatient and 16% were ED. **General Medicine** accounted for nearly 50% of the **ambulatory cases**; **Surgery**, 17% (Orthopedics and General); **Radiology**; 14%. **Cancer and cardiac events** topped the list, - **60% resulted in serious harm or death.** Medicine (Internal, Hospitalist, Cardiology, Neurology) was most named in **inpatient diagnostic related**

cases (45%); Surgery accounted for 23%. Main allegations were missed cardiac events and missed complications of care; **73% resulted in server harm or death**. Cardiac, Neurology, and GI events led the **ED events**. Clinical judgment factors were found in nearly 75% of all cases e.g. **narrow diagnostic focus** and **failure to order;** inpatient consult (17%) ambulatory referral (19%). Gaps in **communication between providers** was more prevalent in the inpatient setting (20% vs. 10% in ambulatory) while failure to order tests (31%) was a key driver of ambulatory claims. **Misinterpretation of diagnostic studies** effects both inpatient (15%) and ambulatory (21%) cases.
Conclusion: As recommended in the recent IOM report on Diagnosis, analysis of malpractice cases offers a unique lens into the most egregious of diagnostic failures. By studying these cases we gain insight into specific patterns of care that may be amenable to improvement opportunities and safer care delivery. Based on these data, CRICO/Harvard prioritized several patient safety efforts focused on specific diagnostic issues in both the ambulatory and inpateint setting. These efforts focus on improved communications, test ordering and result management, and referral management.

Oral Presentations Practice Improvement Parallel Track - Applied Innovations

Monday November 7, 2016, 2.20-5.45 pm

1) Teaching Clinical Reasoning By Stumping the Professor

J. Baang
Lewis Katz School of Medicine at Temple University, Philadelphia, PA

Statement of problem: Clinical reasoning is a fundamental part of the diagnostic process. Unfortunately, the complex and intuitive nature of clinical reasoning makes it difficult to teach in a class room setting. Even when it is taught, it is often heavily weighted towards teaching the theory of clinical reasoning and not as practical to students who have minimal clinical experience.
Description of the intervention or program: The sub-internship course at our institution is an intensive 4-week rotation for 4th year medical students. The students are take the role of an intern and do almost everything that an intern is expected to do. This includes doing admission, putting in their own orders which later on needs to be activated by a supervising resident, calling in consults and answering pages, and discharging patients. During these 4 weeks, meetings are held once a week with a faculty member. The main focus of these meetings is to teach clinical reasoning through the process of "thinking out loud" rather than about disease management. We name these sessions "Stump the Chump". A faculty member meets with them on a weekly basis and ask them to bring an interesting case with a confirmed diagnosis. They are encouraged to leave out information that is too revealing. The medical students present their case and with each bit of information the faculty starts explaining his reasoning process and his differentials which tends to change and evolve over the course of the presentation. Through this process, the faculty members talk about basic clinical reasoning and diagnostic concepts such as the importance of problem representation, illness scripts, etc. Importantly, when a diagnostic error is made, the faculty discusses why the error happened incorporating common cognitive errors including biases into their teachings.
Findings to date: By teaching clinical reasoning with cases that students, we learned that we are able to engage our students more effectively, make it more practical than teaching it in a classroom setting, and raise awareness of the cognitive process and errors involved in diagnostic successes and failures.
Lessons learned: This project not only help us in teaching clinical reasoning more effectively but has lead to some students changing their specialty choice because of the cognitive aspect of the diagnostic process. Despite the successes it has been challenging in finding and developing faculty to run these sessions.

2) Diagnostic Adverse Events in Practice Inquiry Colleague Groups

W. Buffet[1], **N. Birnbaum**[1] and **L. Sommers**[2]
[1]Sutter East Bay Medical Foundation, Albany, CA
[2]University of California, San Francisco, San Francisco, CA

Statement of problem: Physicians are traditionally characterized as reluctant to disclose adverse events (AEs) in patient care yet, in "Practice Inquiry Colleague Groups," AEs are discussed as frequent examples of clinical uncertainty in primary care. Since 2002 in the San Francisco Bay Area, in facilitated practice-based small groups, primary care colleagues have engaged in open-ended conversation about case- based uncertainty. Clinicians voluntarily present cases to explore dilemmas through tactful inquiries, reflections on experience, and searches for evidence and resources. Facilitators encourage clinicians to see blind spots, reconstruct decision options, and recognize the possibility of error. To learn how Practice Inquiry Colleague Groups could better support clinicians in diagnostic decision-making, we carried out a qualitative analysis of 28 diagnostically-oriented AEs (DAEs) presented in eight groups.
Description of the intervention or program: In a log of the patients presented in all colleague groups that LS (author) facilitated, she routinely documented: 1) uncertainty statement/question; 2) key patient/clinician data; and 3) summary of group discussion. Two physician

reviewers (authors) read log entries for all AEs. Using the criterion, "diagnostic reasoning played a significant but not sole role in DAE", they identified DAE cases and used five codes to describe them: type, cause, outcome, care process location and common/rare disease. Colleague group discussion content was also coded.

Findings to date: Of 450 uncertainty cases in the log, 51 AEs (11.3%) were introduced by clinicians with words connoting "Something went wrong." Of these, reviewers identified 28 (55%) as DAE patient cases: 16 females,12 males, median age 56. Twenty-four (86%) had serious consequences: 8 deaths and 16 significant morbidity. Diagnoses appeared delayed in 13, missed in 12, and wrong in 3. Fifteen (54%) had common diagnoses. The causes of 17 DAEs (61%) were judged as combinations of clinician cognition, systems, and human relationships, with 11 as clinician cognition alone. For 7 DAEs (25%), care process location appeared as the clinician-patient interaction with all others occurring in both the interaction and outside it (e.g., testing, referral). During colleague group discussion, diagnostic reasoning appeared central in 21 DAEs (75%) but patient communication, systems, clinician role interpretation problems were also mentioned.

Lessons learned: Although colleagues' discussion focus on diagnostic reasoning partially validated the reviewers' DAE identification process, for over half the DAEs, log data was inadequate for determining the role clinician cognition played. Looking ahead, colleague group facilitators should develop methods for encouraging and documenting discussion about diagnostic decision-making and AE causality. Employing such strategies without shaming-and-blaming will require new training for facilitators.

3) Reducing Diagnostic Error in Medicine through the Integration of Systems and Cognitive Processes – Syscog

M. Gusack
Veterans Affairs Medical Center of Huntington WV, Huntington, WV

Statement of problem: Accelerating improvements in healthcare have created a paradox of increased capability offset by increased complexity, societal and technological. This has impacted latent organizational system problems under which the clinician's diagnostic cognition delivers health care. Present taxonomy of diagnostic error addresses systems and cognition separately leading to an inherent weakness in classification, identification, and prevention of errors. The result; a body of work lacking a unified architecture that hinders the **Reduction of Diagnostic Error in Medicine**.

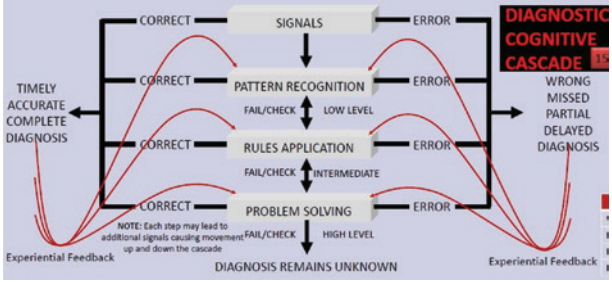
Description of the intervention or program: An in depth review of the literature covering both systems and cognitive aspects of error was made. This included the fields of health care, aerospace, air traffic control, rail road control, and nuclear facility control. The knowledge acquired from this review provided the means to consolidate systems and cognitive error into a single unified taxonomy. A modified form of **Failure Mode and Effect Analysis** [**mFMEA**] was used to assemble this taxonomy for ease of classification, investigation and resolution. The result? A taxonomy that shows great promise as an effective framework for reducing Diagnostic Error in Medicine by:

- **Prospectively** redesigning systems and implementing improved diagnostic cognition
- **Concurrently** monitoring for diagnostic errors to mitigate effects of errors that cannot be prevented
- **Retrospectively** investigating and patching in place systems and cognitive capabilities

Findings to date: A first comprehensive SYSCOG schema that integrates cultural, systems, and cognitive factors into a unified whole is proposed and illustrated.

Lessons learned: In order to significantly reduce Diagnostic Error in Medicine, it is necessary to:

- Do an exhaustive review of a broad range of human activities outside the healthcare field to more fully understand the problems we face.
- Establish a unified taxonomy of and methodology for identification, characterization, and management of errors.
- Develop the operational tools that integrate systems redesign and professional redevelopment into a single highly effectively effort to reduce Diagnostic Error in Medicine.

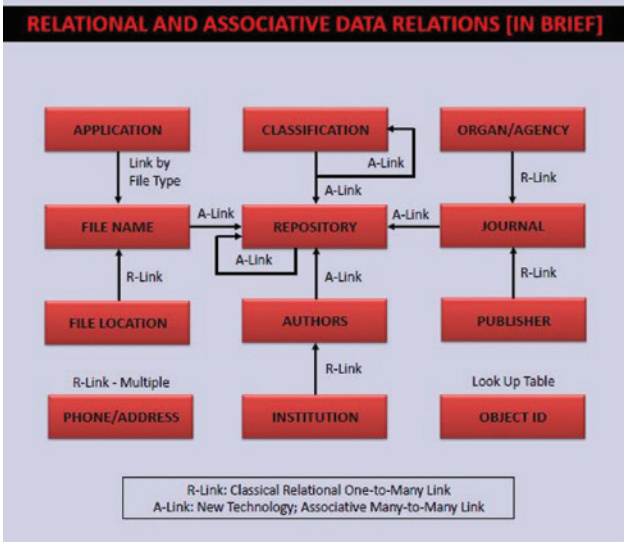


4) Reducing Diagnostic Error through the POWER of Knowledge Management

M. Gusack
Veterans Affairs Medical Center of Huntington WV, Huntington, WV

Statement of problem: Reduction of error in a complex activity like health care requires a clearly defined and well maintained core of knowledge that can be easily disseminated. This is achieved through knowledge management. Although well-established in most areas of high risk human endeavor, knowledge management is all but ignored in the healthcare field. Yet it is the healthcare field that is most in need of such management. The effect of this deficit is the growing realization that **Diagnostic Error in Medicine** has become a central problem that we face.
Description of the intervention or program: I am presently working with a group of librarians/cyberians across the country under the auspices of Dr. Mark Graber, President, Society to Improve Diagnosis in Medicine [**SIDM**]. We are designing and testing a model Electronic Knowledge Repository [**eKR**] targeting this problem. At this time, we have an application up and running based upon an associative database management system [**ADMS**].
Findings to date: So far the model **eKR**includes:
- A database allowing storage and retrieval of journal articles references, audio, images, and text.
- Additional capability to store and activate links to internet references and web sites.
- A working user interface with simple pushbutton access to application functions.
- A set of basic capabilities to store, query, report and manipulate these resources.
- A methodology to associatively link these resources to build knowledge structures.
- A model document management system that allows for addition of user knowledge to the repository.

Lessons learned:
- The health care field lags far behind other fields in the realm of knowledge management.
- The lack of this capacity prevents our profession from making significant strides in reducing Diagnostic Error in Medicine.
- The development of an electronic knowledge management system provides the means of gathering, evaluation, and disseminating proposed causes and solutions to Diagnostic Error in Medicine.



5) Lessons Learned from a Controlled Trial of a Team-Based Checklist on an Academic Service

D. Jaganathan, **G. Singh**, **A. Soudagar** and **P. Foster**
Greater Baltimore Medical Center, Towson, MD

Statement of problem: Previously we developed a checklist tool (TACT) to formalize resident rounding team assessment of night-float patients. While impacting resident perception of engagement and learning, and anecdotally improving patient care, TACT has not been studied in a controlled fashion that clearly demonstrates improved accuracy, length or cost of care. Multiple methodologic questions need answers in designing such investigation, primarily controlling for patient and practitioner variability and assessing outcomes. We also need an effective surrogate marker that predicts diagnostic error and allows rapid testing of similar tools.
Description of the intervention or program: We performed our first 2-week pilot trial, with daily alternating use of TACT. Residents and attendings were paired for analysis to control for personal differences. Outcome measures included anticipation of principal diagnosis at

discharge, and 60 days as seen from perspective of patient and primary physician, cost of care and length of stay. We also created a worksheet comparing admitting resident's and attending's impression in three dimensions: whether to test for alternate diagnoses, essential clinical questions affecting diagnostic approaches, and complications needing prophylactic action. All reported as a single correction score. This score captures the attending's impact on the diagnostic and care plan. We also qualitatively assessed the team's clinical discussion and participant reactions.
Findings to date: The correction score increased with use of TACT, indicating that it influenced attending action. The impact of the pilot mechanics on clinical work appeared acceptable. Given only 15 total cases, we detected no difference in diagnostic accuracy. Use of TACT was variable and relatively superficial consistent with incomplete training. Residents with more training felt the tool more helpful.
Lessons learned: Although we designed the correction score to monitor the impact of TACT itself, we found it may represent a candidate marker for diagnostic error in an academic setting. In simplest terms, improving diagnosis requires better discrimination of when to test and treat. Articulating residents' perception of risk in relation to their perceived threshold for action appears to normalize them across multiple complex and diverse decisions. A comparison of attending correction of the residents' decisions can then occur with rigor and simplicity. We report the analysis behind this insight and lessons learned from this initial pilot. We plan further pilot trials to guide design of a definitive larger trial.

6) Formal Diagnostic Radiology Consults to Reduce Errors

K. Johnson
Yale University, New Haven, CT

Statement of problem: Errors in medical imaging occur because the wrong test is selected, the history given is incorrect or incomplete, the reading is incorrect, or a reading is misconstrued.
Description of the intervention or program: We propose that these problems can be ameliorated by more intense involvement of radiologists in patient care. We are initiating a formal diagnostic radiology consultation service, meant to function completely analogous to other specialist consultants. This is not primarily gatekeeping or patient education. The radiologist sees the patient, takes a history and physical examination, reviews the chart and imaging, and writes a formal note in the chart. The radiologist follows the patient until discharge. Radiologists expend great effort to craft accurate reports. Written reports are by their nature an abstraction; abstractions reduce complex rich data into far simpler, and therefore clearer, data but throw out much along the way. The radiologist typically limits the differential diagnosis and recommendations based on what he/she knows about the patient at the time it is ordered. This may or may not be based on adequate clinical history, and of necessity excludes information that comes to light after the test is ordered. Unfortunately the EMR poorly conveys the patient narrative, and for the radiologist to reconstruct it is daunting. After imaging, the ordering clinician must interpret the radiologist's reading in light of the larger clinical picture. This step is a "meta-interpretation", an interpretation of an interpretation, where an entire category of new mistakes can be made.
Findings to date: Cases were collected from the medical records of inpatients at Yale New Haven Hospital from January 2013 through spring of 2016 from internal medicine, radiology and surgical colleagues in which the radiology interpretation was adversely affected by a poor history, or in which the report was misinterpreted by the medical or surgical teams after the fact, leading to error in care of the patient. Examples will be presented.
Lessons learned: We propose that accuracy of diagnoses can be improved, and errors reduced, by diagnostic radiologists assuming the role of bedside consultant. Our research aims to test these hypotheses.

7) I See That Now: Learning Principles of Quality and Safety in Visual Arts Experiences

A. Miller
Arts Practica, Guilford, CT
201 Dromara Rd, Guilford, CT

Statement of problem: Overconfidence endangers clinical judgment and healthcare delivery. Three related failures include 1) integrating others' perspectives in diagnostic processing, 2) recognizing the need to solicit help, 3) pessimism towards bias preventing self-awareness. Research suggests a need for clinicians to better recognize the limits of their knowledge, the subjectivity of their views, and the value of others' unique intelligences. Overconfidence is particularly difficult to address; CME programs may strike clinicians as punitive or uninteresting.
Description of the intervention or program: Hypothesizing that works of art provoke experiences where uncertainty is safe, interesting, and helpful, "Aesthetic Attention" is a workshop module designed to increase clinical skill in visual inquiry, collaborative analysis, and critical reflection. Varying in scope (.5 day to 2-day sessions), the model engages clinical faculty co-teachers, local art museums, and: 1) guided experiences with visual art; 2) case discussions; 3) critical reflection; 4) dissemination of known best practices in quality and safety. From 2014-2016, groups came together for Aesthetic Attention courses at four sites: The American College of Physicians' Internal Medicine 2016 (.5-day course, National Gallery, Washington, DC; enrollment: 77; co-teaching faculty: Joel Katz, MD, MACP, and Shahram Khoshbin, MD, FACP, both Harvard Medical School) and IM 2015 (Museum of Fine Arts, Boston; enrollment: 124; co-teachers: Katz and Khoshbin); the Center

for Narrative Practice (2-days, MFA, Boston; enrollment: 12; co-teacher: Amy Ship, MD, Harvard Medical School), Canadian Memorial Chiropractic College (2-days, Art Gallery of Ontario; enrollment 8; co-teacher: none; case developed in consultation with Patricia Tavares D.C.). All co-teaching faculty received criteria for case selections and provided curricular consultation. Surveys and field notes provided data.
Findings to date: Across sites, the module was reviewed as clinically relevant and enjoyable. Comments further valued: 1) exposure to the way others "see" / identifying divergences among points of view; 2) access to untaught aspects of clinical mastery; 3) psychologically safe space; 4) reconnection to purpose / joy. Additionally, participants from the 2-day sessions stated: 1) increased curiosity towards own biases; 2) increased likelihood to solicit input on patient cases; 3) appreciation of feedback. They further stated intentions to apply learnings in a) thinking (pause, forcing strategies), b) use of time and clinical space (make time count), c) communication (think aloud, teach-back); d) compassion; e) teaching.
Lessons learned: Clinicians report eagerness to address uncertainty. The data suggests a unique opportunity to address overconfidence, reinforce best practices in high reliability sciences, and promote joy.

8) A Spaced Online Learning Module on Diagnostic Error

A. Walker[1], **T. Clarke**[1], **L. Tan**[2], **F. Hilton**[2] and **S. Dalton**[3]
[1]Clinical Excellence Commission, Haymarket, Australia
[2]Royal Australasian College of Physicians, Melbourne, Australia
[3]Clinical Excellence Commission, Sydney, Australia

Statement of problem: Lack of physician awareness about the risks of diagnostic error, cognitive biases and strategies to address these risks.
Description of the intervention or program: An online education module using a spaced education framework (Q-stream) was used to deliver case scenarios style questions combined with a brief explanation of the answer and discussion forum for debate regarding the topic. The questions are framed in a manner that prompts discussion and debate in order to heighten learning and critical thinking. The overall aim of this education package was to improve clinician awareness of the risks associated with diagnostic error in order to reduce the morbidity and mortality associated with missed, incorrect and delayed diagnoses. Case scenarios were developed using real cases predominantly identified through Root Cause Analysis reports. Each question identified a different case that highlights the various systems and cognitive factors that may contribute to a diagnostic error, and potential strategies that may be useful in reducing risk. The Royal Australasian College of Physicians (RACP) hosted the education module and participants were recruited through RACP membership forums.
Findings to date: The education module ran from the end March through to May (2016) and participation was capped at 200 participants. Evaluation through the learning platform enabled assessment of engagement, participation and performance. Analysis of the percent answered correctly during first attempt, those answered correctly eventually and forum comments relating to each question will provide valuable feedback on the effectiveness of each question in achieving the learning outcome. Survey feedback will assess the course content with regards to clarity, interest, and applicability to practice. Feedback regarding the learning platform assesses the value of the discussion forum and ease of use.
Lessons learned: The bite-sized spaced education platform using real case scenarios is an ideal format for providing learning material in a way that is meaningful to clinicians who are time poor. The format appreciates the use of mobile devices and encourages short, sharp interactions that provide immediate feedback and enhanced learning with voluntary discussion forums. The ambiguity of question responses are designed to encourage discussion and debate which in turn fosters critical thinking. Impact on patient care and outcomes will result as a consequence of increase discussion and recognition and reflection regarding diagnostic error and the potential for harm to patients.

9) The Red Team Blue Team Challenge - a Strategy to Decrease Diagnostic Error

A. Walker[1], **T. Clarke**[1] and **S. Della-Fiorentina**[2]
[1]Clinical Excellence Commission, Haymarket, Australia
[2]Campbelltown Hospital, Campbelltown, Australia

Statement of problem: The Red Team / Blue Team Challenge has been developed to challenge decision making and traditional hierarchical barriers in a safe learning environment and designates clinicians to approach diagnostic decision-making from a "Devil's Advocate" position, allowing juniors to develop skills in assertiveness, whilst protecting them from the potential negative consequences of questioning more senior clinicians.
Description of the intervention or program: The Red Team / Blue Team Challenge is adapted from the military exercises testing force readiness in which the red team strive to find weaknesses in the system. In the military, this is set in a hypothetical space. For application in the healthcare setting it has been adapted to fit the critical live environment. Triggers for undertaking the red team / blue team challenge are identified that include; specific time points in the patients' journey, when things aren't going as planned, the patient is deteriorating, or something doesn't quite fit. Team members are allocated to a red team or blue team role. Ground rules ensure a safe environment. A scripted start and finish reminds clinicians it is the diagnosis being challenged, not the individual, and prompts are provided that encourage the red team to consider possible alternative diagnoses, question the relevance of investigations, and rule out the worst case scenario.
Findings to date: Evaluation incorporates staff satisfaction and patient outcomes in a pilot series of 18 patients since Jan 2016. Three patients had their initial diagnosis changed as a result of Red Team / Blue Team Challenge. Additional investigations were requested that confirmed

the alternative diagnosis in all 3 cases. Clinicians report an improved understanding of senior clinician thinking, a greater sense of team decision making, and an optimised environment for learning. The Challenge is rated extremely highly by Junior medical staff in terms of improvements in knowledge and confidence in decision making, questioning and challenging, and enhanced teamwork. Further 6 months of data will be presented.
Lessons learned: Team changeovers and end of term vacancies posed a challenge for maintaining staff skill and momentum. Further development of a sustainable education model would be beneficial in ensuring a seamless continuation during staff rotations. Implementation at the patient's bedside and incorporating the patient has not yet occurred, but is planned as a next phase for implementation. The benefits for conducting the Challenge at the bedside include; visual clues on patients condition, patient input into decision making, and an opportunity for them to voice any concerns relating to their diagnosis.

Poster Presentations – Scientific Abstracts

Sunday November 6, 2016, 4.45-7.00 pm

1) Public Attitudes and Opinions on Medical Errors in India

J. Baldwin[1], **V. Bhise**[1,2], **A. Sadana**[3] and **H. Singh**[1]
[1]Center for Innovations in Quality, Effectiveness and Safety, Michael E. DeBakey Veterans Affairs Medical Center and Baylor College of Medicine, Houston, TX
[2]University of Texas School of Public Health, Houston, TX
[3]Carnegie Vanguard High School, Houston, TX

Background: Improving patient safety in developing countries faces several challenges, including the lack of a comprehensive healthcare delivery system that invests in resources to improve safety. Public opinion about medical errors could be an important driver for making changes. We surveyed community members in India to gather information on their knowledge and opinions related to medical errors, including diagnostic errors.
Methods: We designed a web-based survey, using a previously validated structured survey instrument that captured patient perceptions of medical errors(Patient Views of Public Health in Massachusetts, Harvard School of Public Health). Survey items consisted of closed-ended questions to understand participant's familiarity and past experiences with medical errors. The survey was sent to a convenience sample of members of a community organization. Participants, who were familiar with errors, were asked additional questions about contributing factors and perceived seriousness of medical errors. SurveyMonkey was used to administer the survey to a convenient sample of adult patients in India from April 2015 to October 2015. Descriptive analyses are reported here.
Results: Thus far, 52 participants have responded. In preliminary analyses, most participants(73.1%,n=38) were familiar with the term medical error. Of these participants, most had heard or read news reports about the occurrence of medical errors and patient injuries in Indian hospitals over the last year(57.9%,n=22), and considered them a very serious or a somewhat serious problem(55.3%,n=21). Most participants felt they were likely to experience a medical error when receiving healthcare in India(47.4%,n=18), and believed there were big differences in the frequency of such errors between different hospitals. Participants attributed most medical errors to poor physician and nurse training(68.4%,n=26), overworked and tired medical personnel(65.8%,n=25) and unclear follow-up instructions from the provider(65.8%,n=25). Most participants(63.2%,n=24) felt that over half of medical errors could be prevented. Over one-third(39.5%,n=15) personally experienced a preventable error or knew someone who experienced one, with serious health consequences(66.7%,n=10). Additionally, one-third(33%,n=5) of these errors were diagnostic errors. Most of these errors occurred in the hospital(66.7%,n=10), were not communicated to the participant(80.0%,n=12) and were not reported by the participant to the hospital, doctor, nurse or an official agency(80.0%,n=12).
Conclusion: Our study seeks to understand the current state of knowledge and awareness of medical errors in India. Our preliminary findings suggest medical errors are perceived to occur very frequently in Indian healthcare settings and diagnostic errors appear to be common. This work will help garner support for increased health professional and statewide public policy action in this area.

2) Development of Methods to Measure Diagnostic Uncertainty in Primary Care Settings

V. Bhise[1,2], **S. S. Rajan**[2], **D. F. Sittig**[3] and **H. Singh**[1]
[1]Center for Innovations in Quality, Effectiveness and Safety, Michael E. DeBakey Veterans Affairs Medical Center and Baylor College of Medicine, Houston, TX
[2]University of Texas School of Public Health, Houston, TX
[3]University of Texas Health Science Center at Houston, Houston, TX

Background: Clinicians commonly experience diagnostic uncertainty in outpatient settings. Although essential for understanding diagnostic safety, little is known on measuring diagnostic uncertainty in clinical practice. To better understand diagnostic decision-making during uncertainty, we developed a strategy to measure diagnostic uncertainty from clinician documentation in the electronic health record (EHR).

Methods: We reviewed the literature to operationally define diagnostic uncertainty as "a subjective perception of ignorance experienced by the clinician during the diagnostic process" and identified documentation elements that would enable its measurement. We used expert input to design a 16-item instrument to identify diagnostic uncertainty from a physician note of a primary care visit. We evaluated for both direct expression of diagnostic uncertainty as well as indirect inference. Documentation elements that supported direct expression included when clinicians used question marks, differential diagnoses or vocabulary such as probably, maybe, likely, unclear or unknown, while describing the patient's diagnosis. Documentation elements that supported indirect inference included no diagnosis documented at the end of the visit, ordering multiple consultations or diagnostic tests, use of suspended judgment, test of treatment and risk-averse dispositions. We pilot tested the strategy on a random sample of visits. A physician-reviewer determined whether there was new diagnostic activity during the visit and used the instrument to determine clinician-perceived diagnostic uncertainty at the end of the visit. Quality of the patient medical note and ICD-9 CM diagnoses codes for the visit were also recorded.
Results: Of 55 patient records reviewed thus far, 36 had evidence of new diagnostic activity. Of these, we found 28 visits (77.8%) where clinicians experienced some diagnostic uncertainty. In most cases (19; 67.9%), clinicians directly expressed diagnostic uncertainty in the visit note using one or more elements using uncertain vocabulary such as likely, probably, maybe, possibly, (13, 46.4%) and differential diagnoses (11, 39.3%). No diagnoses were documented at the end of the visit in 13 cases (46.4%). When uncertain, clinicians most often ordered additional tests (19, 67.9%) or used test of treatment (8, 28.6%).
Conclusion: Our findings suggest that diagnostic uncertainty can be measured through review of electronic medical records. This work is now informing a larger study on measuring uncertainty during the diagnostic process to help better understand how clinicians make diagnostic decisions and communicate diagnosis-related information to patients. Measurement of diagnostic uncertainty is foundational to future research to understand the relationship of uncertainty and error and to inform interventions to improve diagnostic safety in this area.

3) Measuring Diagnostic Safety of Inpatients Using Trigger Tools

V. Bhise[1], **D. F. Sittig**[2], **L. Wei**[1] and **H. Singh**[1]
[1]Center for Innovations in Quality, Effectiveness and Safety, Michael E. DeBakey Veterans Affairs Medical Center and Baylor College of Medicine, Houston, TX
[2]University of Texas Health Science Center at Houston, Houston, TX

Background: In outpatient settings, diagnostic errors are estimated to occur in 1 in 20 adults annually and involve common conditions. However, there are very few studies of diagnostic errors in inpatient settings. Using electronic health record (EHR) data, we explored the use of a trigger "unexpected escalation to a higher level of care" to study inpatient diagnostic errors.
Methods: We used a clinical data repository at a large academic medical center to identify all instances of escalation of inpatient care among patients with low baseline risk of inpatient mortality. Within a 3-year study period (2011-2013), we used an algorithm to select a cohort of adult patients below 65 years with minimal comorbid conditions (Charlson Comorbidity Index < 2), and less than 3 prior hospitalizations over the past year that were admitted to a medical service. Within this cohort, we identified escalation of care as transfer to the intensive care unit (ICU) or initiation of rapid response team (RRT) within 15 days of admission. A physician reviewed the record (notes, tests and consultations) to evaluate for diagnostic and other medical errors during the inpatient stay. We defined diagnostic errors as missed opportunities to make an earlier diagnosis based on retrospective review, irrespective of harm. Five process dimensions described in a previous framework (patient factors, patient-physician encounter, test performance and interpretation, test follow-up and tracking, or the referral process) were used to understand care breakdowns. Anticipated severity and duration of harm were recorded.
Results: Of the 41,950 admissions during the 3-year period, 52 (0.1%) unique patients encountered an unexpected escalation of care during their inpatient stay. Of these, 4 (7.7%) experienced diagnostic errors and 7 (13.5%) encountered medication errors. Other preventable adverse events recorded were patient falls (4, 7.7%), procedure-related complications (2, 3.8%) and hospital associated infections (2, 3.8%). Diagnostic errors included missed diagnoses of deep vein thrombosis, hemothorax and alcohol withdrawal. Contributing factors included breakdowns in the patient-provider encounter (n=3, 75%) involving failures in information gathering and interpretation (e.g. history of alcohol use was missed, and leg pain in an immobilized patient was not evaluated during patient assessment), and delays in test follow-up and tracking (n=1, 25%). Potential for harm was temporary (one year or less), however, the magnitude of harm was serious in all four cases of diagnostic error.
Conclusion: Our preliminary evaluation suggests that electronic trigger tools could be useful to study inpatient diagnostic errors and warrant further exploration.

4) Enhancing Basic Science Teaching: The Need for More Theoretical Grounding and Focus on Transfer to Clinical Reasoning

J. M. Castillo[1], **Y. S. Park**[2], **I. Harris**[2], **J. Cheung**[3], **L. Sood**[4], **M. Clark**[5], **R. Brydges**[6], **M. Kulasegaram**[6], **G. Norman**[7] and **N. Woods**[6]
[1]Universite de Nantes, 44035 Nantes Cedex 1, France
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[3]University of Toronto, Toronto, ON
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Background: The development of clinical reasoning is a major goal of Health Professions Education (HPE) longitudinal curricula. Basic sciences knowledge acquired during preclinical years can advance the development of clinical reasoning, providing dynamic mental structures for medical problem-solving. "Transfer" refers to the application of a previously learned concept to problem solving in another context. Promoting transfer from basic sciences education to clinical reasoning is a critical, but difficult, challenge for educators because of the field's limited knowledge about what constitutes effective interventions in HPE from the perspective of transfer. This study aimed to identify interventions designed to develop basic sciences knowledge in HPE; describe their contexts, approaches and outcomes; and examine the nature of evidence about interventions documenting transfer of basic sciences knowledge to clinical reasoning.
Methods: An integrative literature review was conducted to identify articles related to basic sciences teaching at the "undergraduate level" in HPE, published between 1980 and 2015, and including learning outcomes. Articles were selected and summarized based on their context, approaches, and outcomes. Articles reporting interventions that enhanced understanding of basic sciences education were analyzed.
Results: Out of 9,803 articles initially identified, 78 were selected for further review; ninety-eight percent (98%) focused on how to introduce a basic sciences learning concept and the remaining 2% focused on the practice of multiple clinical problems to teach a learning concept. Methods of transfer were explored in 35% of the papers. Eighty-five percent (85%) were practice-based research, 15% were use-inspired basic research (i.e., goal of improving practice and understanding of the phenomenon studied). Teaching interventions that successfully enhanced the transfer of basic sciences learning concepts to clinical reasoning were associated with the development of deep conceptual structures of the learning concepts. Our analysis found that the development of deep conceptual structures was achieved in these studies through strategies, including the presentation of causal mechanisms of clinical features or analogies, or the practice of multiple problems in multiple contexts. We also found that factual recall memory tests did not detect differences in transfer.
Conclusion: Our study identified limited evidence in the peer-reviewed literature regarding the mechanisms and conditions required to achieve the transfer of basic sciences knowledge to clinical reasoning in HPE. We believe that a theoretically-grounded focus on transfer and its understanding would likely support the development of this vital linkage between pre-clinical basic sciences education and clinical reasoning in developing practitioners.

5) Isolating Red Flags to Enhance Diagnosis (iRED): An Experimental Vignette Study

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Background: The recent Institute of Medicine report, "Improving Diagnosis in Health Care," calls for enhanced educational interventions to improve the diagnostic process. Recent studies show that errors in diagnosis occur despite the presence of clear 'red flags' that warrant further patient evaluation. Furthermore, differential diagnosis is absent from many error cases.
Methods: We conducted an experimental vignette study with 2×2 between-subjects design (iRED strategy: Yes/No and Case Complexity: Complex/Simple) and recruited pediatric residents at a university-based teaching hospital for participation. Red flags were defined as a constellation of symptoms, signs, clinical data or circumstances that should lead to heightened suspicion for a serious condition and trigger additional evaluation. Participants in control group described general impressions of the clinical vignettes, whereas participants in iRED group were asked to pause and identify red flags within the vignettes prior to making differential diagnosis. Diagnostic accuracy was measured using weighted and unweighted score. The weighted score was computed as 1, 0.5 or 0.25 if the correct diagnosis was listed as the 1st, 2nd or 3rdrespectively in the differential diagnosis, and 0 if not. The unweighted score was computed as 1 if any of the three differentials included the correct diagnosis, and 0 if not. The data were analyzed using GLM, a model for weighted score and logistic regression for the unweighted score.
Results: 71 pediatric residents (36 iREDs and 35 controls) participated in the study. For the weighted score, the mean weighted score was marginally higher in the iRED group compared to the control group, 0.47 vs. 0.29, $p<0.08$ (ns). For the unweighted score, there was a significant effect of iRED strategy; a greater proportion of the participants in iRED group identified the correct diagnoses compared to control group, 62% vs. 32% ($P<0.05$). The iRED strategy increased diagnostic accuracy for the complex case, 41% vs. 10% ($p<0.0001$), but not for the simple case, 80% vs.69% (ns). The iRED group used significantly less time (459sec vs 603sec, $p< 0.05$) to arrive at a diagnosis. Within the iRED group, participants who isolated more red flags had significantly better accuracy ($p<0.0001$).
Conclusion: An "isolating red flags to enhance diagnosis (iRED)" strategy significantly improved diagnostic accuracy in an experimental vignette study, and particularly in complex cases.

6) Does Spinal Immobilization Affect the Decision to Use Computed Tomography Imaging of the Cervical Spine?

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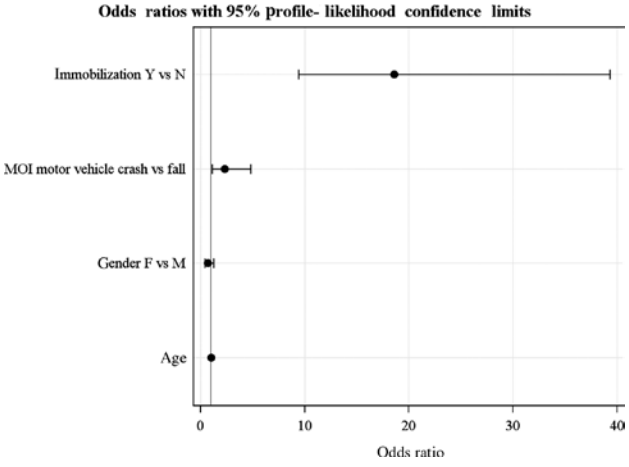
Background: Diagnostic decisions are the result of multiple sensory inputs weighed against medical knowledge. Victims of low-severity-mechanism trauma present from various sources including Emergency Medical Services (EMS). The presence of spinal immobilization as a factor in the decision to employ computed tomography has not been investigated. Separating immobilization from the decision to obtain CT imaging provides an opportunity to decrease associated risk and cost. This study analyzed physician decision making regarding patients who presented with trauma of low-severity mechanism and who were clinically cleared using the National Emergency X-Radiography Utilization Study (NEXUS) protocol. This retrospective cohort study examines whether the presence of spinal immobilization with cervical collar and/or back board is a predictor of cervical spine imaging with CT.
Methods: The study setting was a 32,000 visit level 3 trauma center based in a community hospital. Criteria for inclusion were: 1) Presentation for a chief complaint/mechanism of fall or motor vehicle crash. 2) Discharged from the emergency department to home. Exclusion criteria: 1) Age less than 18. 2) Pregnancy. 3) Any trauma alert activation criteria. 4) Complaint of neck pain. 5) Dementia or other medical condition that precluded use of NEXUS criteria to clinically clear the cervical spine.
The study underwent review and approval by the Carilion Clinic Institutional Review Board. Data were collected on demographics, injury, immobilization, and imaging. Logistic regression analysis was used to predict cervical spine CT from age, gender, and mechanism of injury.
Results: 401 visits were analyzed with 106 cervical spine CTs performed. Of 61 immobilized patients, 80.3% had CT imaging, while 16.9% of the non-immobilized group underwent CT. In a regression controlling for age and gender, the presence of immobilization and mechanism of injury (fall vs. motor vehicle crash) significantly predicted ($p < 0.05$) whether a cervical spine CT was obtained. Immobilized patients were 18.6 times more likely to receive a cervical spine CT than those who were not immobilized. Patients in a motor vehicle crash were 2.3 times more likely to receive a cervical spine CT compared to those who had sustained a fall.
Conclusion: Immobilization in this study had a significant impact on the decision to obtain CT imaging in the emergency department. To decrease unnecessary radiation exposure and inappropriate resource utilization, further investigation of signaling in diagnostic decision making for the trauma patient is necessary.



7) Electronic Clinical Surveillance of Delays in the Diagnosis of Chronic Kidney Disease

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Background: Abnormal lab results that lack clinical follow-up may contribute to diagnostic errors. The Kaiser Permanente Southern California (KPSC) Outpatient Safety Program uses electronic clinical surveillance to scan for results lacking appropriate follow-up, thus aiming to trigger clinical action. To understand which factors contribute to delays in follow-up, we selected one lab (creatinine) from this program for further study.

Methods: KPSC is an integrated delivery system that uses a comprehensive electronic health record. KPSC consists of over 6,000 physicians who serve over 4 million health plan members. Members age 21 years or older with an incident elevation in creatinine during 2010-2014 were included in a mixed-methods study. Members were excluded if they had an elevated creatinine lab result during the prior 2 years, history of chronic kidney disease, or history of kidney cancer. Surveillance algorithms were developed to quantify care-gaps in the timely follow-up of a newly elevated creatinine lab result (reduced estimated glomerular filtration rate). Expected care (i.e., no care-gap) was defined as a follow-up creatinine lab test 60-150 days after the incident elevation. This definition was based on clinical stakeholder input and consensus guidelines. If patients had a repeat test within 60 days that indicated normal kidney function, they were classified as having received expected care. If a repeat lab within 60 days indicated continued impairments in kidney function, another lab 60-150 days after the incident elevation was still expected to establish chronicity. Individual interviews with 30 physicians are ongoing to identify physician-perceived factors that contribute to appropriate or delayed follow-up.
Results: Of 221,900 members with an incident elevation in creatinine during the study period, approximately 60% had a care-gap in follow-up. Preliminary descriptive analyses suggest that members with a care-gap had slightly better kidney function than those without. Males were less likely to experience a care-gap (56% vs. 62% of females). Whites were slightly more likely to experience a care-gap (63%), compared to blacks (44%), Hispanics (56%), and Asians (58%). The likelihood of a care-gap decreased with increasing Charlson score, from 61% among those with Charlson 0 to 36% among those with Charlson >=2. Most providers (84%) had at least 1 member with a care-gap.
Conclusion: Preliminary descriptive results from this mixed-methods study quantify the nature of care-gaps in follow-up of elevations in creatinine labs. With additional work, we will determine factors contributing to delays and design strategies to reduce them.

8) Patient-Reported Adverse Events: Factors That Contribute to Patient Harm

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Background: Interest in error reporting by patients is growing because patients can provide valuable information missing from incident reporting systems, the medical record, and root cause analysis reports. Analysis of error reports from patients might be able to provide new insights into safety-related problems. Our study aim was to determine the association between patient-reported contributory factors and patient harm.
Methods: We conducted a secondary analysis of patient-reported adverse medical events submitted to a survey housed at the Empowered Patient Coalition (EPC) between January 2010 and February 2016. Harms included physical, emotional, and financial, and for analysis and to separate participants into four outcome harm groups (no physical, only physical, physical plus one other harm, all three). Adverse event contributing factors (such as personnel behaviors, communication, and knowledge) were assessed by four item ordinal scales (0-3) in 13 questions first separately and then overall using adjusted summary scores. Patient demographics and adverse event characteristics were also compared by outcome harm group. Fisher-exact and Kruskal-Wallis tests were used to determine for significance ($p<0.05$).
Results: There were 351 patient reports with outcomes of physical, emotional, or financial harms. Nearly one-third (31.6%) reported experiencing all three, 25.9% reported physical harms only, 27.9% reported physical harms and one additional harm, and 14.5% reported only non-physical harms. Age ($p=0.0050$), years to response ($p<.0001$), and presence of a diagnostic error ($p<.0001$) were significantly different among the four groups (Table 1). The most commonly reported contributing major factors affecting patient harm were those related to communication from health care personnel to patients, and this was significantly different for those reporting all three harms ($p<.0001$). Adjusted summary scores were lowest for those with only physical harms (4.0, STD 6.7), and more than doubled or tripled with the addition of each category of harm (phy+1 harm:10.0, STD 6.7; 3 harms:12.0, STD 6.9), respectively ($p$trend<.0001).
Conclusion: Patients who reported more harms were also more likely to report more contributory factors (i.e., health care personnel behaviors, communication, and knowledge). These types of factors are often missing from formal reporting, but can be systematically collected from patients via structured data collection instruments to further the science of adverse medical events. The identification and implementation of strategies to address these factors can promote better collaboration between patients and health care personnel and potentially reduce diagnostic errors.

Table 1. Patient Factors Associated with Types of Self-Reported Physical Harm Outcomes from Adverse Events

	No Physical Harm n=51 (14.5%)	Physical Harm Only n=91 (25.9%)	Physical Harm & Emotional or Financial Harm n=98 (27.9%)	Physical, Emotional, and Financial Harm n=111 (31.6%)	*P*-value
Sex					0.0543
Female	35 (14.8%)	50 (21.1%)	69 (29.1%)	83 (35.0%)	
Male	15 (14.4%)	36 (34.6%)	28 (26.9%)	25 (24.0%)	
Age occur*	52 (±14.8)	55 (±13.4)	50 (±13.1)	49 (±10.3)	***0.0050***
Years between event and report*	1.0 (± 4.1)	4.0 (± 9.2)	4.0 (± 7.7)	4.0 (± 6.7)	***<0.0001***
Event Location					0.6770
Not a hospital	16 (15.7%)	22 (21.6%)	28 (27.5%)	36 (35.3%)	
Hospital	34 (14.2%)	65 (27.1%)	68 (28.3%)	73 (30.4%)	
Community Size**					0.1365
Small	23 (12.4%)	40 (21.5%)	55 (29.6%)	68 (36.6%)	
Large	25 (16.7%)	44 (29.3%)	40(26.7%)	41(27.3%)	
Diagnostic Error					***<0.0001***
Yes	18 (9.9%)	41 (22.5%)	46 (25.3%)	77 (42.3%)	
No	33 (19.6%)	49 (29.2%)	52 (31.0%)	34 (20.2%)	

*Median and standard deviation

**Small, population ≤ 100,000-500,000; Large, population > 500,000

9) Development of an Electronic Trigger Tool for Identifying Inpatient Diagnostic Error

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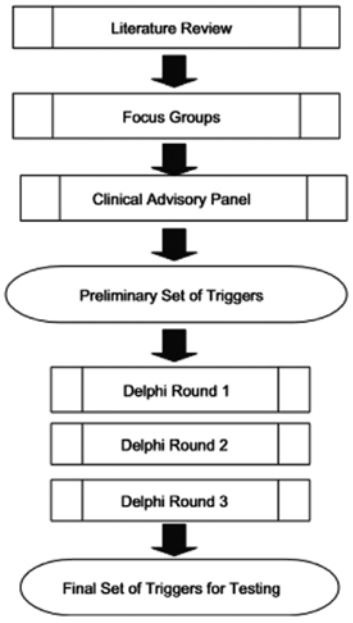
Background: Diagnostic errors—defined as incorrect or delayed diagnoses—are common and often preventable. One estimate attributed diagnostic error for causing 40,000 – 80,000 deaths in the US annually in the inpatient setting alone. Trigger tools have been proposed to improve the identification and study of diagnostic error; however, established criteria for diagnostic errors in hospitalized patients did not yet exist. We sought to create a trigger tool for diagnostic error in hospitalized patients through literature review, focus groups and an expert Delphi panel.

Methods: Applying established methodology, the 29 diagnostic error trigger criteria identified by our prior comprehensive literature review underwent additional refinement. These criteria were reviewed and prioritized by two multi-disciplinary focus groups, a clinical advisory panel, and three Delphi rounds with experts in diagnostic error (**Figure**).

Results: The diagnostic trigger tool criteria were narrowed to 10 high yield triggers and 4 secondary tier triggers (**Table**).

Conclusion: Diagnostic error is a significant source of preventable healthcare harm. Our study established a preliminary trigger tool for diagnostic error in hospitalized patients. These criteria should be prospectively validated in different settings to verify their utility in identifying important diagnostic errors.



Primary Diagnostic Error Trigger Criteria
Incident report for case that was classified as diagnostic error
Case referred to quality assurance or quality improvement committee
Complaint by patient or family related to speed or accuracy of diagnosis
ED visit within 7 days before admission
Change of primary service within first 48 hours of hospitalization
Urgent or emergent surgery > 12 hours after admission
Discrepancy between working diagnosis and (non-autopsy) pathology results
Discrepancy between working diagnosis and blood culture
Performance of autopsy
Newly abnormal tests which are not repeated
Secondary Diagnostic Error Trigger Criteria
Increased level of care
Subsequent readmission within 72 hours of discharge from hospital
Discrepancy between admission diagnosis and discharge diagnosis
Discrepancy between preliminary and final radiology diagnoses

10) Factors of Unexpected Readmissions within 7 Days after Prior Discharge from a Japanese Acute Hospital

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Background: Data of unexpected readmissions to hospital within six weeks after prior discharge is available in Japan. However, data regarding unplanned readmissions with a 7 day window period is very rare, and no reports analyzing factors associated with those readmissions are available in Japan.
Methods: This is a retrospective cohort study in a Japanese acute hospital with over 600 beds. All admitted patients from 1st January 2014 to 31st December 2014 were included. Among the admitted patients, re-admissions within 7 days after prior admissions were extracted. Patients with planned re-admissions and admissions for examinations were excluded. After the primary screening, departmental managers reviewed the data to verify whether each admission was planned or unexpected.
Results: 20, 127 patients were admitted to the hospital during the research period. 372 patients had unexpected readmissions within 7 days following their prior discharge, and after review by clinical departments, 369 (1.83%) were confirmed as unplanned. The average age of the cohort was 68.2 years old. The readmission rate amongst general internal medicine, gastroenterological medicine, and hematology departments were relatively high at 3.3%, 3.7%, and 3.8% respectively. An in-depth analysis was conducted of the aforementioned departments with high unexpected re-admission rates by reviewing all medical records and categorizing the cohort into two groups: A) unplanned readmissions due to the natural course of terminal conditions (e.g. aspiration pneumonitis), and B) diagnostic errors. Patients'characteristics such as age, multiple complications, unknown fever and high inflammatory reaction prior to initial discharge, low albumin and activities of daily living were observed among patients who were readmitted within 7 days after their prior discharge.
Conclusion: This retrospective study has identified that certain medical departments, namely general internal medicine, gastroenterology, and hematology have somewhat higher unplanned readmission rates to a Japanese acute care hospital. The identified reasons included terminal illness and diagnostic errors. This hospital receives an unselected population of patients, unlike other hospitals in Japan, and therefore this may account for such readmission rates. However, such reasons need to be investigated in a multi-center prospective study, and to determine if such readmission rates can potentially be reduced.

11) Identification of Changes in Diagnoses after Hospital Admission through Systematic Peer Feedback

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Background: Feedback about diagnostic reasoning is one of the most pragmatic and promising methods to improve diagnostic reasoning. Systematic, rapid peer feedback regarding trainees' diagnostic reasoning regarding patients admitted to the hospital through a standardized

feedback tool proved to be promising through a pilot at the University of Minnesota in 2015. Trainees reported a trend towards increased confidence in performing diagnostic reasoning skills, increased awareness of the frequency with which differential diagnosis creation is discussed ($p = 0.01$) and increased confidence in mitigating cognitive biases ($p = 0.049$). Further analysis was performed of the feedback forms' content and rates of diagnostic change.

Methods: The 2015 University of Minnesota pilot project included feedback to and from Internal Medicine and Internal Medicine-Pediatrics trainees. A total of 62 unique forms were analyzed after the exclusion of duplicates. The forms contained a list of initial admission diagnoses and diagnoses after the first day of admission. These diagnoses were compared and classified by the investigators according to a novel scheme, including no change, evolution/refinement of diagnoses, and major diagnostic change or error.

Results: Of the 62 forms analyzed, 37 (59.7%) were classified as no change, 21 (33.9%) as an evolution or refinement of the diagnoses, and 4 (6.5%) as a major diagnostic change. Despite prompting within the feedback tool to clarify the diagnostic accuracy of their colleagues, no form mentioned diagnostic error and instead described changes in terms of diagnostic "shift", "evolution", or "prioritization."

Conclusion: Systematic, rapid peer feedback is an effective mechanism to identify changes in diagnosis after hospital admission. Approximately 40% of patients in this sample were identified as having at least some change in diagnosis after admission, although trainees are loathe to explicitly identify errors. This high rate of diagnostic refinement/evolution reveals the importance of this feedback after transitions of care; if trainees are not aware of these changes, opportunities for calibration are lost. Systematic, rapid peer feedback about the diagnostic process should be implemented in all training programs, and a multi-centered trial is planned for the coming year.

12) Understanding Diagnostic Safety in Emergency Medicine: A Risk Management Perspective

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Background: The report *"Improving Diagnosis in Health Care"* calls for collaboration between professional liability insurance carriers and health care providers to identify opportunities to improve diagnostic performance. We used this collaborative approach to analyze diagnosis-related Emergency Medicine closed claims to identify areas for risk mitigation.

Methods: We analyzed 64 closed diagnosis-related emergency medicine malpractice cases between 2008 and 2015 from a large malpractice insurer. A multidisciplinary team of five personnel - three registered professional nurses (RNs), of which two are Certified Professionals in Healthcare Risk Management, and two Emergency Medicine physicians - reviewed all claims-related data, including expert reviews, case details, depositions, and interviews. We used the "*Safer Dx*" conceptual framework to inform our data collection strategy about diagnostic process breakdowns and defined diagnostic errors as missed opportunities to make a correct or timely diagnosis based on the evidence available during the initial ED visit. This included errors that involved both ED and non-ED providers. Each of the three RN team members independently reviewed one case using the framework and then discussed in detail to improve inter-rater reliability. Each nurse reviewer then reviewed a portion of the 64 cases followed by an independent review of all cases by two Emergency Medicine physicians to verify outcomes, including errors and process breakdowns. Finally, all team members collectively discussed each case in detail and established consensus to ensure data quality. We used descriptive statistics for analysis.

Results: Diagnostic errors occurred in 62 of the 64 cases reviewed (two cases closed prior to full investigation and not analyzed). Two-thirds (n=41) had breakdowns involving the patient-provider encounter (most often history taking or ordering tests). Errors most commonly involved abdominal pain (n=20), trauma (n=13), and neurological conditions (n=6). The most frequently missed abdominal presentations were bowel perforation/ischemia (6/20) and testicular torsion (5/20). Nearly three quarters (46 of 62) had an initial disposition to home, of which 34 had an unscheduled return visit to the ED. Analysis revealed a host of systems and cognitive contributing factors affecting an evolving diagnostic process.

Conclusion: A collaborative approach involving risk management/patient safety professionals and emergency medicine physician reviewers offered greater insight into diagnosis process failures that may not have been elucidated if cases were reviewed in silos. Focused review findings led to a multidisciplinary improvement collaborative to develop clinical guidelines for improving at-risk practices and informed a simulation-based training initiative.

13) Methods for Evaluating Mobile Applications for Test Ordering and Diagnosis

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Background: There has been a rapid increase in both availability of medical mobile applications and adoption of mobile devices by physicians for clinical decision support. However, most applications are not evaluated in terms of their usefulness as clinical decision support or educational tools. We sought to establish and pilot test methods for evaluating effects of mobile applications on clinical decision making related to test ordering and diagnosis, as well as their perceived usefulness as learning tools. We focused this evaluation on *PTT Advisor*, a CDC-developed application that assists physicians with follow-up test ordering and diagnosis related to certain types of coagulation and bleeding disorders (when patients have normal prothrombin and abnormal partial thromboplastin times).
Methods: We created and refined the evaluation materials, including 8 paper-based patient vignettes and a questionnaire. The vignettes consisted of challenging clinical scenarios prompting physicians to make laboratory test ordering and diagnosis decisions in two conditions: with the help of the mobile application or with the help of usual clinical decision support. With these vignettes, we assessed impact on clinical decision making by collecting percent of test ordering and diagnostic decisions made correctly, reported confidence, and time taken to assess the vignettes. The questionnaire consisted of questions meant to assess physicians' perceptions about the application's usefulness for clinical decision making and learning using a modified Kirkpatrick Training Evaluation Framework. We pilot tested the evaluation materials with physicians specializing in internal medicine or hematology/oncology. Each physician solved 4 random vignettes in each condition.
Results: Preliminary results with 6 physicians suggest advantages for using *PTT Advisor* over usual clinical decision support on mean accuracy (85.5% vs 80.2% correct; p=.40) and mean confidence in decisions made (8.8 vs 7.0 out of 10; p=.06), as well as a reduction in mean vignette completion time (3:14 min. vs 3:42 min.; p=.58). Additionally, physicians reported positive perceptions of the application's potential for improved clinical decision making and learning. However, a desire was also noted for the application to address broader medical issues.
Conclusion: Given enthusiasm for mobile applications, evaluating their effects on physicians' decision making is essential. We propose our evaluation method is a useful model for evaluating mobile clinical decision making and educational applications. Additionally, our preliminary evidence shows that the mobile medical application, *PTT Advisor*, can contribute to better clinical decision making and serve as a learning tool. We are presently conducting a larger evaluation study to verify these findings.

14) Pediatrician Perspectives on Communicating Diagnostic Uncertainty to Parents and Colleagues

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Background: The recent IOM report highlights that correctly diagnosing patients includes communicating those diagnoses to them and sharing the uncertainty of the diagnoses with them as well. However, we know very little about clinicians' perspectives on discussing diagnostic uncertainty with their patients and colleagues or how *(or if)* this communication occurs. To enhance our understanding of these issues, we examined pediatricians' perspectives related to communication of diagnostic uncertainty.
Methods: We conducted in-depth, face-to-face interviews in a purposive sample of pediatricians at a large tertiary healthcare facility in Texas. Interviews were guided by open-ended questions developed by our interdisciplinary team and were audiotaped, transcribed, and analyzed using qualitative content analysis. Using ATLAS.ti software, two researchers independently reviewed and coded the transcripts, then discussed discrepancies to reach consensus.
Results: In 8 interviews analyzed thus far, we found diagnostic uncertainty is commonly experienced in pediatrics and it is the norm to discuss this uncertainty with colleagues. Additionally, pediatricians consider many factors when deciding to communicate the presence of diagnostic uncertainty to patients' parents. Considerations include severity of patients' illnesses, pediatricians' familiarity with patients and their parents, stage of diagnostic process patients are in, and level of trust built up with patients' parents. They also reported various challenges when communicating diagnostic uncertainty, including complex cases with unknown diagnoses, and characteristics of parents such as low literacy, heightened emotions, high expectations, new patient relationships with no previously built-up trust, and cultural and language barriers. In discussing uncertainty, the pediatricians purported using multiple strategies to communicate to their patients' parents. These strategies include prioritizing illnesses when patients had multiple illnesses, discussing process of elimination, and discussing multiple differential diagnoses. Pediatricians reported generally positive experiences when communicating uncertainty to parents. However, while parents were understanding about the diagnostic uncertainty, they were sometimes frustrated when their children remained undiagnosed.
Conclusion: Pediatricians are open to communicating diagnostic uncertainty to their patients' parents as well as to their colleagues, but stage and severity of patients' illnesses and dynamics of patient-parent-provider relationships may affect whether they communicate diagnostic uncertainty. In addition, various challenges in communicating uncertainty effectively may arise, such as language issues or heightened emotions and expectations from the parents. This work will inform additional research to understand the relationship between communicating uncertainty and diagnostic errors and more specifically, if the communication of diagnostic uncertainty helps mitigate diagnostic errors or diagnostic error-related harm.

15) Doknosis: An Open Access Medical Cognitive Assistant to Support Differential Diagnosis and Continuous Learning

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Background: The failure to consider a broad enough set of diagnoses, also known as premature closure, is a well-known and common cognitive bias that leads to many diagnostic errors. Differential diagnosis (DDX) generators can help providers in many settings to navigate medical decision making in a structured manner that is less susceptible to bias and error. However, accessibility, associated costs, technical and workflow integration have remained key barriers to their widespread utilization. Towards this end, we sought to develop and evaluate an open digital diagnostic support system, Doknosis.
Methods: We constructed a medical knowledge base of over 2000 ICD-10 coded diseases and 450 medications, with over 8000 unique observations encoded as SNOMED or LOINC terms. We developed two "diagnostic" algorithms to parse this knowledge base, evaluated their accuracy and compared our results to the performance of existing platforms. The initial version of the knowledge base and the two presented algorithms were formally evaluated by using 117 case reports from trusted journals such as the New England Journal of Medicine, The American Journal of Tropical Medicine, and from UWorld question bank. The rank of the correct explanation in the produced differential was mapped to a score value. Score differences were analyzed using Wilcoxon signed-rank test.
Results: The evaluation of Doknosis found the quality of the knowledge base and the accuracy of our first algorithm to be comparable to established diagnostic tools such as Isabel and DXplain. Doknosis and DXplain perform comparibly but both provided significantly better results than Isabel ($Z=2.44$, $p<0.014$). DXplain outperforms Doknosis on the NEJM dataset but Doknosis excells in the tropical diseases. Overall Doknosis performs insignficantly (7%) better than DXplain. Addition of an interactive module which suggested "next best questions" and allowed for input of negative-findings led to a 27% improvement in diagnostic accuracy. Through informal user feedback, Doknosis was reported as simple to use by all testers, though selection of advanced settings such as geographic location, algorithm and number of outputs were noted to be inefficient and are currently being redesigned.
Conclusion: We have built and successfully evaluated a new medical diagnostic assistant. Our system performed comparably to or surpassed existing commercial applications. We propose the combination of open access knowledge base and open source algorithms will improve access for providers in many settings and facilitate community development and system improvement.

16) The DX: Diagnostic Excellence Pilot- Feasibility and Acceptability of an Online, Virtual Patient Case about Diagnostic Error for Medical Students

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[2]UCSF, SAN FRANCISCO, CA
[3]University of Washington/Seattle Children's Hospital, Seattle, WA
[4]Maine Medical Center, Tufts University School of Medicine, Portland, ME
[5]San Francisco VA Medical Center and University of California San Francisco, San Francisco, CA

Background: Diagnostic error is a major public health problem in the United States. Evidence-based, effective approaches to improve education about the diagnostic process are needed. Most published curricula about diagnostic error have focused on resident-level education, leaving the feasibility and acceptability of teaching about diagnostic error to medical students unknown: it is feasible and acceptable to teach medical students about the fallibility of the diagnostic process at the same time that they are first learning it? To address this question and develop an intervention to meet this educational gap, we developed and piloted the DX: Diagnostic Excellence project.
Methods: A series of learning objectives was developed by a group of experts in diagnostic error and the diagnostic process and a series of six, online virtual patient cases was developed by a group of educators representing diversity in speciality and experience. The first case was piloted in core internal medicine clerkships and elective courses in three US medical schools, each with different accompanying in-classroom approaches. Students were invited to participate in a survey about their experiences and perceptions after completing the module. Faculty from national educational organizations were also invited to complete the case and complete a survey about its perceived educational value and the likelihood of implementation.
The contents of the faculty and student surveys were analyzed by two investigators and themes identified and reconciled through consensus discussion.
Results: A total of 36 students and 25 faculty (12 clerkship directors) completed the survey. Overall, students felt that they learned about diagnostic error through the case; most commonly, students identified an increase in their knowledge about cognitive biases. They were also

empathetic to the patients and providers involved in the error and able to identify potential methods to improve their diagnostic reasoning. Faculty universally felt that the topic was important and all the clerkship directors stated they would plan to use the case in their clerkships.
Conclusion: An online, virtual patient case about diagnostic error is acceptable to both students and faculty and has promise for broad implementation. Students are able to identify strategies to improve the diagnostic process after the case. Based on these results. a multi-centered study examining 6 virtual patient cases is currently underway.

17) Diagnostic Pitfalls: A New Approach to Understand and Prevent Diagnostic Error

H. Reyes Nieva[1,2,3], **M. Volodarskaya**[1,4], **A. Wright**[1,2], **H. Singh**[5], **E. Ruan**[1,6] and **G. Schiff**[1,2]
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[2]Harvard Medical School, Boston, MA
[3]Johns Hopkins Bloomberg School of Public Health, Baltimore, MD
[4]University of Chicago, Chicago, IL
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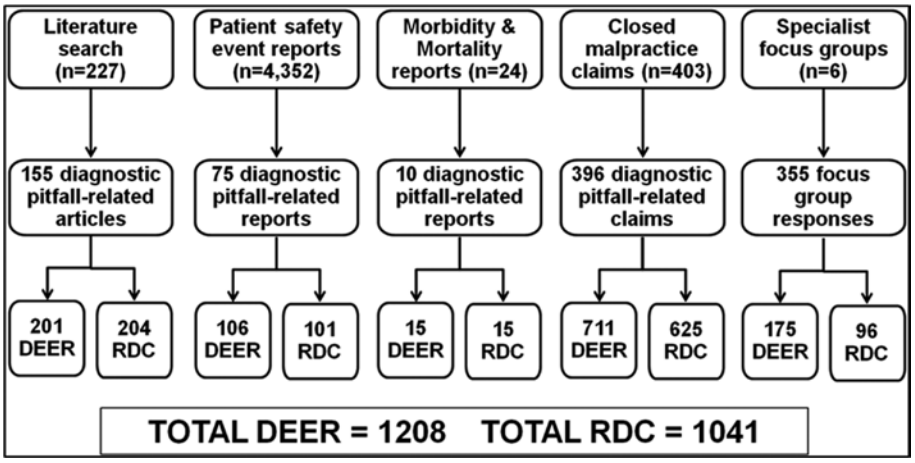
[6]Tufts University, Boston, MA

Background: While there is much debate over definitions and whether diagnostic errors are more rooted in cognitive vs. system failures, it is clear that most are multi-factorial and require fresh approaches to ensure more reliable care. We aimed to develop a new construct—"diagnostic pitfalls" – to bridge system and cognitive issues. We conceptualized diagnostic pitfalls as "recurrent clinical situations which present vulnerabilities to frontline clinicians and predispose them to make errors in their diagnostic decision-making." In this study, we evaluated how diagnostic pitfalls were represented in diagnostic errors collected from various data sources.
Methods: We examined multiple data sources to identify diagnostic errors, looking for clinical situations with patterns of vulnerabilities where we could delineate potential diagnostic pitfalls. Sources included: narrative literature review, AHRQ WebM&M (Morbidity and Mortality) cases, institutional ambulatory M&Ms and risk management patient safety event reports, focus groups with specialist physicians, and closed diagnosis-related primary care malpractice claims for a 5-year period from two leading malpractice insurers in Massachusetts. For each relevant case, we extracted key variables including diagnoses (correct and erroneous) and presenting signs and symptoms. To provide a framework for characterizing diagnostic pitfalls, we used two previously published taxonomies – Diagnosis Error Evaluation and Research (DEER) and Reliable Diagnosis Challenges (RDC). We performed an iterative thematic content analysis to derive both general and disease-specific diagnostic pitfalls.
Results: We identified 1208 DEER and 1041 RDC items (Figure 1) from our 5 data sources. From these we found 424 disease-specific and 19 general diagnostic pitfalls. A number of overarching pitfall themes emerged from our analysis including: disease A repeatedly misdiagnosed as disease B; failure to appreciate limitations of test results or exams; diagnoses thrown off by atypical presentation; presumption that chronic diseases account for new symptoms (especially among complex patients); overlooking drug (or other environmental factors) causing symptoms or disease progression; failure to monitor evolving symptoms; and overlooking counter-diagnosis cues, things that don't fit, and red flags from histories.
Conclusion: Use of a new concept of diagnostic pitfalls appears to be useful to integrate the interfaces between the disease, systems, and cognitive factors contributing to misdiagnosis. Pitfalls were identified from different cross-sectional data sources including locally reported cases, regional malpractice claims, and published reports suggesting the validity of this concept to further the study of both generic and disease-specific types of errors. Use of pitfalls for various research and educational endeavors can increase awareness and help prevent diagnostic errors in medicine.



18) Provider-Associated Variation in Genetic Test Positivity Across the U.S

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[2]ARUP Laboratories, Salt Lake City, UT
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Background: Achieving an accurate diagnosis requires the thoughtful selection of diagnostic tests. Overordering of tests in low yield settings may lead to overdiagnosis due to non-zero rates of false-positive results. Conversely, underuse of tests may lead to underdiagnosis. Both over- and under-diagnosis are difficult to measure directly because of the lack of naturally occurring gold standards. However, positivity rates of individual tests are directly measurable, and may shed light on the underlying thresholds used by different physicians for ordering decisions. This in turn may be useful for studying variation in diagnostic practices, and informing development of diagnostic guidelines.
Methods: Comparative analysis of positivity rates for three different common genetic tests for thrombophilia ordered through 794 laboratories in 44 different U.S. states. Hierarchical regression was used to assess the impact of organizational factors after controlling for expected ethnicity-based prevalence. Ethnicity was estimated using U.S. census data.
Results: Positivity rates varied greatly across healthcare organizations. Controlling for ethnicity-based prevalence did not alter this pattern.
Conclusion: For these three common genetic tests, physicians have widely varying positivity rates. This suggests wide practice variation in diagnostic test ordering for thrombophilia.

19) The Contemporary Spectrum of Misdiagnosis of Multiple Sclerosis: A Multicenter Study

A. Solomon[1], **D. Bourdette**[2], **A. Cross**[3], **A. Applebee**[1], **P. Skidd**[1], **D. Howard**[1], **R. Spain**[2], **M. Cameron**[2], **E. Kim**[2], **M. Mass**[2], **V. Yadav**[2], **R. Whitham**[2], **E. Longbrake**[3], **R. Naismith**[3], **G. Wu**[3], **B. Parks**[3], **D. Wingerchuk**[4], **B. Rabin**[4], **M. Toledano**[5], **W. O. Tobin**[5], **O. Kantarci**[5], **J. Carter**[4], **B. M. Keegan**[5] and **B. Weinshenker**[5]
[1]University of Vermont, Burlington, VT
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Background: Multiple sclerosis (MS) remains a clinical diagnosis, as no specific biomarker for MS has been identified. Diagnosis relies upon the appropriate interpretation of radiological data in patients with the appropriate history and neurologic exam suggestive of demyelination. In spite of well-validated diagnostic criteria, misdiagnosis remains a problem that has significant implications for patients, their providers, and healthcare systems. Few studies have characterized patients misdiagnosed with MS. The aim of this pilot study was to determine the contemporary spectrum of alternative diagnoses mistaken for MS and to understand the risks associated with these misdiagnoses. We subsequently assessed whether these diagnostic errors were avoidable by identifying problems arising from application of patient clinical and MRI data to current MS diagnostic criteria.
Methods: Over 13 months, twenty-three MS specialist neurologists at four academic MS Centers submitted data concerning individual patients whom they had evaluated and determined to have been misdiagnosed with MS.
Results: Of 110 misdiagnosed patients, 51 (46%) had "definite" and 59 (54%) "probable" misdiagnoses according to study definitions. 107 (97%) of the patients were informed by participating neurologists that their MS diagnosis was incorrect. The most frequent primary diagnoses were migraine alone or in combination with other diagnoses 24 (21%), fibromyalgia 16 (15%), nonspecific or non-localizing neurological symptoms with abnormal MRI 13 (12%), conversion or psychogenic disorder 12 (11%) and neuromyelitis optica spectrum disorder 7 (6%). 27 additional diagnoses were identified. 32 (29%) of patients carried a misdiagnosis between 3-9 years and 29 (26%) for 10-20 years. 77 (70%) had received disease modifying therapy for MS. Four (4%) patients had participated in a research study for a MS therapy. In 79 (72%) of patients, participating neurologists indicated that there was evidence an earlier missed opportunity to make a correct diagnosis and 34 (31%) suffered unnecessary morbidity as a direct result of a misdiagnosis. Inappropriate attribution of symptoms to demyelinating disease contributed to misdiagnosis in 72 (65%) patients, and reliance upon historical symptoms without corroborating objective evidence of a lesion in 53 (48%). Over-reliance on MRI abnormalities to satisfy dissemination in space in a patient with nonspecific neurological symptoms contributed to misdiagnosis in 66 (60%).
Conclusion: Common disorders and syndromes are often mistaken for MS. Misdiagnosis of MS leads to unnecessary and potentially harmful risks to patients. Misinterpretation and misapplication of MS clinical and radiographic diagnostic criteria may be important contemporary contributors to misdiagnosis.

20) A Novel Method to Identify Diagnostic Discrepancy Between Emergency Department and Inpatient Records

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[2]Boston Childrens Hospital, Boston, MA

Background: Diagnostic accuracy is a focus of the 2015 Institute of Medicine Report. Diagnostic error can lead to increased morbidity, mortality, healthcare utilization and cost.
Methods: This was a retrospective study of patients hospitalized at a single free-standing pediatric institution from March 2010 to September 2015. High-risk diagnoses were selected based on malpractice data with modified Delphi methodology to select the top ten diagnoses. All patients with available electronic ED physician records and corresponding electronic inpatient discharge summaries were eligible for inclusion. A semi-automated electronic tool using natural language processing (NLP) was created and then fine-tuned by clinician training. After manual medical record review, clinicians classified visits as concordant if the final diagnosis was similar or was considered in the medical decision-making documented in the ED physician record.
Results: Of the 55,233 ED records with corresponding inpatient discharge summaries, 2,161 (3.9%) had one of the 10 high-risk diagnoses. After application of the NLP tool and manual medical record review, we identified 67 (3.1%) were deemed truly discordant. The discordance rate varied across diagnosis category [table 1].
Conclusion: A novel semi-automated electronic tool was able to identify discordance between ED and inpatient discharge diagnoses. This tool could guide initiatives to improve diagnostic accuracy in a pediatric ED.

High-risk Diagnosis (defined by)	Number of cases	N (%) discordant by NLP platform	N (%) discordant after clinician review
Hemolytic Uremic Syndrome (anemia, elevated creatinine, and thrombocytopenia)	18	4 (22)	2 (11)
Sinus venous thrombosis (imaging)	22	13 (59)	2 (10)
Stroke (imaging)	20	16 (80)	2 (10)
Kawasaki Disease (IVIG therapy)	194	66 (34)	17 (9)
Septic Arthritis (surgical procedure)	162	39 (24)	12 (7)
Pancreatitis (elevated lipase)	310	85 (27)	16 (5)
Ovarian Torsion (surgical procedure)	58	7 (10)	3 (4)
Septic Shock (vasopressor within 24 hours of presentation)	225	116 (52)	6 (3)
Appendicitis with/ without perforation (surgical procedure/ imaging)	1135	85 (8)	7 (0.6)
Pulmonary embolism (imaging)	7	1 (14)	0 (0)

21) Diagnostic Error in Head and Neck Cancer: A Descriptive Study in an Integrated Healthcare System

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[2]Kaiser Permanente Oakland, Oakland, CA
[3]Kaiser Permanente, Oakland, CA

Background: Squamous cell carcinoma of the head and neck is relatively rare, for which there are there are no routinely used screening protocols. Therefore detection relies on the accurate diagnosis of nonspecific symptoms, such as sore throat, neck mass or hoarseness. Head and neck surgical oncologists frequently notice missed and delayed diagnoses in these patients. In the majority of cases, these patients present with late stage disease, where survival outcomes are poor and treatment morbidity is high. Literature on diagnostic error in H&N CA is scant. Therefore, we sought to evaluate the diagnostic pathway of head and neck cancer at our institution in order to assess means for improvement.
Methods: Retrospective cohort study of subjects diagnosed with squamous cell carcinomas of the larynx, nasopharynx, oral cavity (diagnosed between 2007-2010) and oropharynx (2013) within Kaiser Permanente Northern California were studied. Demographic (age, gender, race/ethnicity) and clinical characteristics (presenting symptoms, tumor stage and clinical visit dates) in the diagnostic pathway were recorded and time intervals calculated.
Results: In total, 827 patients were studied, composed of 240 Larynx, 306 Oral Cavity, 179 Oropharynx and 102 Nasopharynx cancer patients. Larynx: 36% of patients presented with late stage disease. Primary care physicians (PCP) initially misdiagnosed 17% of patients, as acid reflux, post-nasal drip or laryngitis. 24% of patients experienced a delayed referral to otolaryngology of greater than 4 weeks. Otolaryngologists initially misdiagnosed 17% of patients, as laryngitis, thrush or a benign lesion. Oral Cavity:33% presented with late stage disease. 40% initially presented to a dentist. Diagnostic error was rare. Oropharynx: 90% presented with late-stage disease. 84% of cases were HPV-related. 30% were initially misdiagnosed as infection and prescribed antibiotics by the PCP. 42% of initial fine-needle aspirations performed by Otolaryngologists were not diagnostic of cancer. Nasopharynx: 64% presented with late-stage disease. Patients were initially misdiagnosed by the otolaryngologist 46% of the time. Of the initial nasal endoscopies, 32% did not reveal a nasopharyngeal lesion. Of the initial imaging studies, 32% were not interpreted to have a nasopharyngeal lesion.
Conclusion: Squamous cell carcinoma of the head and neck frequently is diagnosed in late stage and diagnostic errors are common. Multiple specialties - primary care physicians, otolaryngologists, dentists and radiologists - are involved in the diagnostic pathway. Since screening is not feasible at this time, evidence-based diagnostic algorithms may be helpful in guiding the clinicians workup for suspicious symptoms and preventing diagnostic error.

22) Improving Diagnostic Language: A Bibliometric Study of Pathognomonics

J. Wofford, **C. Campos** and **A. Dharod**
Wake Forest University School of Medicine, Winston-Salem, NC

Background: The term “pathognomonic” has traditionally been used to convey certainty about a medical diagnosis based on a telltale, unmistakable physical examination finding. If there is a solid database of pathognomonic findings, it should be showcased, known by practitioners, and taught as a body of knowledge to students. Despite its common use in clinical care, the term has become confusing and misused. We sought to explore meaning and value of the term “pathognomonic” in the active medical literature.
Methods: Using the search term “pathognomonic”, we identified all PubMed citations published in year 2015. We reviewed all abstracts in order to identify study type (review, case-control, case report, case series, other research study), type of pathognomonic finding (historical item, physical examination, genetic, microbiologic, microscopic/histologic, other, claim of no pathognomonic finding). The disease type associated with the pathognomonic finding was classified by pathologic process or organ system (genetic syndrome, ophthalmologic, neurologic, cancer, infection, other). Reports of pathognomonic findings by physical examination were examined in closer detail to determine accompanying quantitative estimates of specificity.
Results: Of 126 citations published during 2015, most were review articles (39), followed by case reports (28), basic science research studies (20), and case series (18). Other clinical study designs (23) included cross-sectional (17), case-control (2), meta-analysis (1), and multicenter prospective studies (1). Twenty-one percent (27/126) of abstracts included statements that there were no pathognomonic findings for the specific diagnosis under consideration. Pathognomonic findings were most often based on microscopy/histology (25), followed by imaging (17), genetic/molecular testing (17), and physical examination (14). Diseases/organ systems related to pathognomonic findings most often included cancer (18), neurologic conditions (16), infections (11), congenital syndromes (6), and dermatologic conditions (6). In the case of 14 pathognomonic physical examination findings, there were no data provided to quantify accuracy (i.e., specificity, positive predictive value).
Conclusions: The term “pathognomonic” is alive and well in the active medical literature, but its use is casual and without accompanying quantitative data to support its claim of ultimate specificity. Pathognomonics related to physical examination findings are not common in this sample. In the drive toward more precision medicine, claims of pathognomic findings should be tempered or supported by quantitative data in order to improve diagnostic language.

Poster Presentations - Applied Innovations

Sunday November 6, 2016, 4.45-7.00 pm

23) Improving Clinical Diagnosis through Remote Expert Second Opinions

M. Bonaca[1,2], **D. Harrison**[3] and **L. Levy**[3]
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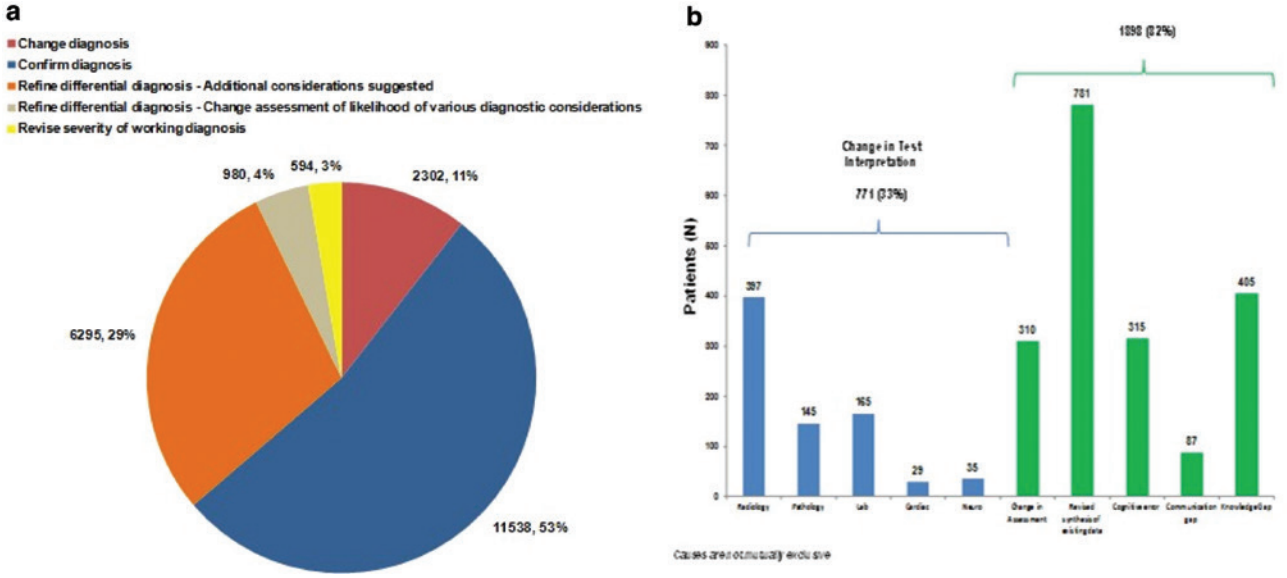
[3]Best Doctors, Inc, Boston, MA

Statement of problem: Patient initiated second opinions may improve or refine diagnoses ultimately and result in treatment changes. In person second opinions may be expensive, result in unnecessary repeat testing, and are both resource and time intensive. Geographic factors may make second opinions at leading academic medical centers impossible for some patients.
Description of the intervention or program: An electronic, remote, second opinion program called Best Doctors allows patients to initiate a second opinion, collects records and testing, and matches cases to nationally recognized experts. This process allows for second opinions by recognized clinical experts using web based tools to remotely view clinical data while removing time and geographic barriers to patient engagement.
Findings to date: Trained physicians prospectively reviewed 21,709 completed second opinion cases from 4/1/2013 through July 1, 2016. Overall second opinions led to a change in diagnosis in 2302 (11%) a refinement in the differential or the severity of the diagnosis in 7869 (7275, 36%) and confirmation of the diagnosis in 11538 (53%) (Figure 1a). Changes in diagnoses were generally due to a variety of causes (Figure 1b) including different interpretations of tests (771, 33%) most frequently imaging (397, 17%) as well as changes in the synthesis of data and overall clinical assessment (1091, 47%). Other causes of changed diagnosis included cognitive errors or knowledge gaps (720, 31%) and communication failures (87, 4%). In cases where the diagnosis was changed or refined (10171, 47%), a corresponding recommendation to change treatment was made in 3853 (38%) and for an additional 32%, additional diagnostic evaluation was needed before appropriate treatment could be determined. Even in those cases where the diagnosis was confirmed, recommendations to change treatment were made in 2367 (21%).
Lessons learned: An internet based, remote, second opinion process connecting patients to a pool of recognized expert physicians resulted in either a change of diagnosis or an important refinement in diagnosis in almost half of cases. Changes in diagnosis occurred for a variety of reasons including changes in test interpretations, changes in data synthesis and clinical assessment, knowledge gaps. Recommendations to change treatment were frequent occurring in >20% of cases even when the diagnosis was confirmed, as were recommendations to perform additional diagnostic evaluation prior to embarking upon a treatment course.

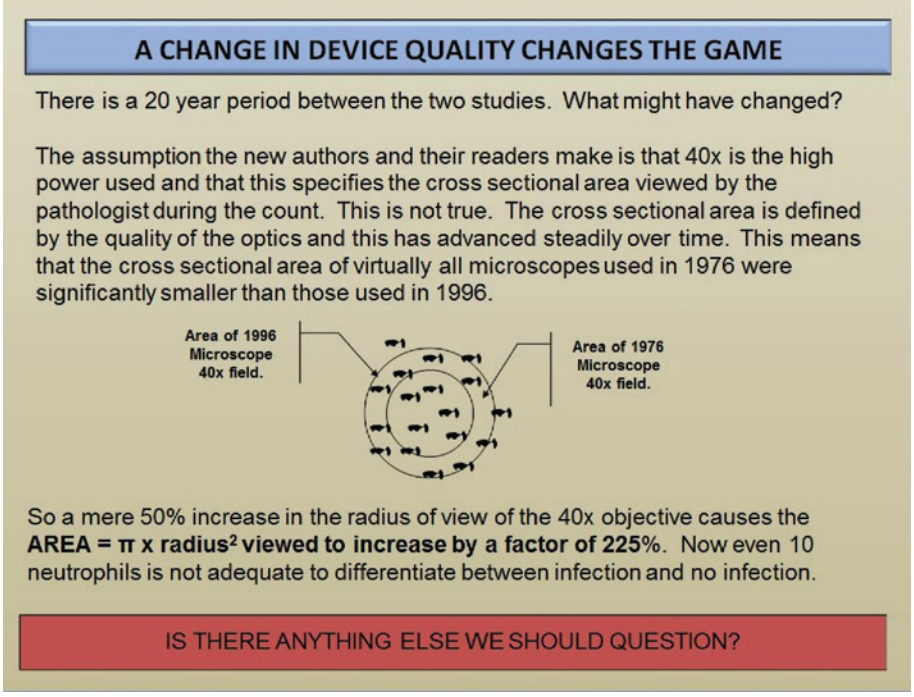


24) Painting By the Numbers: Physician Reliance on Single Test Results Leads to Increased Diagnostic Error in Medicine

M. Gusack
Veterans Affairs Medical Center of Huntington WV, Huntington, WV

Statement of problem: There is a tendency on the part of our profession to want to take a very complex biologic system – the human body – and, in the process of rendering a diagnosis, reduce it to a single number. Although being able to quantitate certain patient information is vital to the diagnostic process, the degree to which this is taken leads to systematic **Diagnostic Error in Medicine**.
Description of the intervention or program: A quantitative approach to diagnosis was chosen and evaluated to determine its reliability. The method chosen was the neutrophil count at frozen section on tissues excised from failed total knee replacements to determine if bacterial infection is present. My study revealed that the use of a neutrophil count was unreliable. A cause for this lack of local validity of a nationally accepted method was sought and identified in the very literature that purported to support it. This allowed for definitive refutation of this approach. These findings were presented to the submitting providers in an attempt to change their behavior.
Findings to date: Over a six year period, all providers involved with knee replacement surgery were show these results. Each refused to change their behavior despite clear evidence that refuted the method. This included a definitive contradiction within literature itself that revealed a major flaw in the methodology. During this period the educational background of each provider and over 400 medical students was examined. This revealed that only three had an adequate educational background that included logic and mathematics focusing on statistical analysis. This limited their ability to understand the limitations of quantitative methods and critically review the mathematics used in the literature.
Lessons learned:
In order to significantly reduce **Diagnostic Error in Medicine**, it will be necessary for providers to understand:

- Research that purports to show a correlation between quantitative findings and a diagnostic decision point is often flawed leading to inappropriate application of a single number to a diagnostic decision.
- The tendency to place too much significance upon numerical information is very strong and needs to be counterbalanced by refocusing our attention on the patient's unique clinical circumstances and not just on the number.
- A major sea change needs to take place in the culture of medicine to counter the adverse effects of an increasingly innumerate profession now being buried in a blizzard of statistical analyses.



25) The Process of Creating a Conceptual Framework and an Inventory of Nationally Recognized Measures of Diagnostic Error

D. Hunt
DHHS Office of the National Coordinator for Health Information Technology, Washington, DC

Statement of problem: In September 2015, the National Academy of Medicine (NAM), released the report, *Improving Diagnosis in Health Care*, which documented that "most people will experience at least one diagnostic error in their lifetime, sometimes with devastating consequences" and that diagnostic errors contribute to an estimated five percent of adult ambulatory care and up to 17 percent of hospital adverse events. Despite this, the 2015 NAM Committee also found that data on diagnostic error is sparse and that few reliable measures of diagnostic errors exist.
Description of the intervention or program: To reconcile this need, the U.S. Department of Health and Human Services (HHS) has tasked the National Quality Forum to develop a conceptual framework for measuring health care organization structures, processes, and outcomes that address the improvement of diagnostic accuracy; and identify any existing structure, process, and outcome measures consistent with the conceptual framework that could be used to nationally measure baseline status and improvement of healthcare organizational efforts to improve diagnostic accuracy. In particular, this project was initiated to achieve three of the following eight goals set forth by the NAM:
- Facilitate more effective teamwork in the diagnostic process among health care professionals, patients, and their families;
- Develop and deploy approaches to identify, learn from, and reduce diagnostic errors and near misses in clinical practice;
- Establish a work system and culture that supports the diagnostic process and improvements in diagnostic performance;

Findings to date: This framework shall utilize the evidence, concepts, models and recommendations contained in the NAM improving diagnosis report. The NQF will inventory measures consistent with the conceptual framework. The inventory, which will include measures in development, in testing and in use also will use information contained in and produced by AHRQ's Network of Patient Safety Databases Analyses of Patient Safety Events report on diagnostic error. This work also will identify which of the identified measures are endorsed by the NQF. Finally, it will determine where there are gaps in the array of structure, process and outcomes measures of organizational supports for improving diagnostic accuracy.
Lessons learned: The NQF will do this by convening a group of key stakeholders comprised of individuals with diverse representation and knowledge on diagnostic error, including the Society to Improve Diagnosis in Medicine, among others.

26) Demonstration of Medical Error Reporting in Medical Students Following Educational Intervention

Y. Ibrahim, **J. Kaur** and **D. Levine**
Wayne State University, Detroit, MI

Statement of problem: Medical errors currently constitute the third leading cause of death in the US, with a mean estimate of 251,000 deaths each year. Reporting medical errors has become the focus of national organizations including National Patient Safety Foundation and The Center of Medicare and Medicaid Services. At the present time, most error reporting is done by nursing with a substantially lower contribution from physicians. One way to improve physician reporting is to teach medical students the importance of reporting.
Description of the intervention or program: We developed a patient safety curriculum for junior medical students. The curriculum was delivered during a 4-hour workshop which included viewing an episode of Grey's Anatomy depicting a series of errors and included discussions about conditions contributing to errors, types of errors and the importance of reporting. Students were also required to submit a near miss or adverse-event report to an online learning-management system (BlackBoard). Students completed a pre-intervention survey which included asking a question about whether they had ever reported a near miss/adverse event at their clinical site. At the end of their academic year, students were surveyed using a simple two-question survey: "Did you ever submit a formal Near Miss/Adverse Event Report to the hospital site where you completed your Year 3 clerkships?" and if so "on which rotation?". The survey was sent 3 times between July 7th-24th 2016.
Findings to date: Two hundred eighty of 283 (98.9%) attending the workshops completed the pre-intervention survey; 24 students (8.5%) reported submitting an error report. 243 of 286 (85%) students who completed the academic year responded to the end-of-year survey; 18% responded they had submitted a formal near miss/adverse event report for a total of 43 reports. Students reported on all in-patient clinical services. The predominant rotation in which reporting occurred was Internal Medicine (90.7%; 39 reports) followed by Surgery (4.7%; 2 reports). No reports were submitted on outpatient rotations.
Lessons learned: To our knowledge, this is the first study that looks at medical student error reporting. We are able to demonstrate that an educational intervention resulted in 18% of medical students reporting near miss/adverse events. This study provides a starting point for learning about medical student error reporting. Identifying the types of errors reported would allow further understanding of what students see, recognize, and report. The educational intervention we implemented has become part of the formal curriculum in our medical school. We have also included a location-specific curriculum on how to report at each clinical site.

27) Pathologytracker Decreases Errors

S. Smith
CEO and Founder Complete.MD, Savannah, GA

Statement of problem: Medical errors involving pathology testing can result from specimen loss, incorrect biopsy site identification, and miscommunication among patients, pathologists, and physicians. Presently, there is no shared platform for the patient, physician, pathologist, health system, or malpractice underwriter to decrease errors and to assess system performance. A Lean Six Sigma approach for decreasing errors can be integrated into the current EMR platforms.
Description of the intervention or program: In-exam room Microsoft Surfaces capture biopsy site images and create RIFD labels (radio frequency identification) that track each specimen location. Employing a newly defined set of codified codes, pathologists efficiently communicate their recommendations to physicians and have a mechanism to ensure their recommendations are enacted. All communication of pathology results and outcomes are shared on a Web based platform through a mobile patient App.
Findings to date: To date 37,497 specimens have been tracked using the Pathologytracker system. The RIFD tracking has documented the transport of all specimens. Pathologists used the Codified Codes effectively analyzing all 37,497 specimens and they recommended 9,163 additional procedures.
Lessons learned: Image capturing has enabled better biopsy site identification and decreased wrong site surgery. During the process, patients continued to use the mobile App to communicate with the medical team, track specimen locations, and obtain pathology results. Decreasing errors relating to pathology testing can be achieved through the Pathologytracker system.

Poster Presentations - Clinical Vignette

Sunday November 6, 2016, 4.45-7.00 pm

28) Unusual Presentation of Invasive Pneumococcal Disease

N. Ando, **K. Tsukada**, **K. Teruya**, **K. Yoshimi** and **S. Oka**
National Center for Global Health and Medicine, Tokyo, Japan

Learning objectives: Recognize an anchoring as a possible pitfall
Case information: A 44 year-old man with HIV, hemophilia A and post-splenectomy who had a liver transplantation with 13 years of tacrolimus treatment, complained of a left calf pain. He was well until 2 days prior to admission when he developed loss of appetite. On the day of admission, he noticed a left calf pain which he thought was different from his usual pain that came from possible hemorrhage of hemophilia A, but to reduce the risk of worsening it, he infused factor VIII product. A few hours later, since his pain was not improved, he visited Emergency department in our hospital. On examination, he appeared well with no fever but had hypotension, tachycardia, and tenderness on his left calf. Cefazolin and fluid infusion were given under the working diagnosis of cellulitis and dehydration. But after some bolus of fluid infusion, hypotention was persistent. Septic shock was suspected and he was put on vasopresser, and his antibiotics was switched to meropenem. The next day, *Streptococcus pneumonia* developed in two sets of blood culture. He was diagnosed with invasive pneumococcal disease. Two weeks of antibiotics has been completed with some improvement.
Discussion: IPD is a life-threatening disease especially in immunocompromised host due to its rapid progression. Early recognition and intervention such as appropriate antibiotics and supportive care are the keys to its management. Pneumococcal cellulitis that consists of 0.9 % of pneumococcal bacteremia is a rare manifestation. Although the assessment of general appearance is one of the most important parts of physical examination, in this case, his good general appearance did not correlate with the severity of the disease hence blinded us from diagnosing possible bacteremia. The dissociation might have acted as anchoring. Thus, it is important to assess patient's information totally to avoid possible diagnostic errors.

29) The Illusion of Communication

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[3]University of Pittsburgh Medical Center, Pittsburgh, PA

Learning objectives: Failure to communicate abnormal imaging results and follow-up recommendations is widespread. This contributes to bad outcomes and delay in diagnosis of certain diseases. Errors in communication are the fourth most frequent allegation against radiologists in medical malpractice claims.

Case information:
A 51-year-old man was seen in the emergency room for alteration in mental status. He had fallen earlier at home. On examination he was not verbally communicative, able to follow basic commands, and mildly agitated. He had right sided weakness. A chest x-ray showed a 6.7 × 8.2 cm mass within the left midlung peripherally suspicious for neoplasm. A CT scan brain showed a 23 × 30 mm soft tissue mass in the left frontal lobe with considerable surrounding edema and mass effect. A CT thorax showed a large necrotic left upper lobe mass measures concerning for lung cancer. A search for an "old chest x-ray" revealed that he was seen two years earlier at a sister hospital following an assault. A chest x-ray done at the time was read by the emergency room physician to be negative. The radiologist read was of "a 2 cm nodule over the left mid chest; follow up CT scan is recommended". This was not communicated to the treating clinician and no follow up was done.
Discussion:
Both reporting radiologists and referring clinicians have a responsibility to ensure appropriate action following an abnormal imaging. The main error lies in communication between the referring clinicians and the radiologists. Better systems for appropriate identification and follow-up of abnormal findings are needed. Safeguards, such as tracking systems, should be developed to prevent failure to follow up on such results.

30) Meningeal Symptoms, a Great Masquerade

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Learning Objectives: 1: Understand the common etiologies of heart failure. 2: Recognise the limited sensitivity and specificity of cardiac MRI for myocarditis, so a negative MRI doesn't necessarily rule it out. High index of suspicion is required to diagnose by taking clinical picture and viral panel into consideration. Sensitivity and specificity of MRI for myocarditis is 81% and 71% respectively.
Case information: A 57-year-old female health care worker presented with 4 days of progressively worsening fever, headache, neck pain and generalised malaise. She had past history of poorly controlled diabetes on Insulin. Review of systems was also remarkable for cough and shortness of breath from 1 week but she denied blurred vision, passing out, chest pain and palpitations. Vitals, Blood pressure 87/54mm-hg, Pulse 100bpm, Temp 39 °C source Oral, Resp. rate 18/min with sat 97%. She had faint systolic murmur at the apex, fine crackles at the lung bases on both sides and JVP was not elevated without lower extremity edema. Scattered erythematous papules were noted up to the thighs. EKG showed normal sinus rhythm. Labs revealed WBC of 13, Troponin of 1.21, CK of 285, B.Glucose – 368mg/dl and her LFTs, AST – 61, ALT-220, ALP – 461, T. Bilirubin 1. A Lumbar Puncture was done to rule out meningitis which revealed CSF Protein - 94mg/dl, Glucose - 164 mg/dl, Gram Stain - Few white cells, no bacteria. Chest X-ray showed cardiomegaly with bilateral pleural effusions. An echocardiogram was done to further evaluate her elevated troponin as she had no EKG changes which incidentally showed an Ejection Fraction of 30% with severe left ventricular global hypo kinesis without valvular vegetations consistent with new onset Systolic Heart failure. No angiographic evidence of coronary atherosclerosis, with elevated right and left ventricular pressures on Cardiac Catheterization. Because of her viral constitutional symptoms with elevated troponin, cardiac MRI was done to rule out myocarditis which showed small pericardial effusion with bilateral pleural effusion. As she continued to be febrile and without a focus for bacterial infection and negative blood cultures, viral panel was ordered which interestingly revealed Coxsackie b4 antibody titre of 1:640 (Ref: >1:32 indicate recent infection) with positive Epstein Barr Virus DNA consistent with viral myocarditis.
Discussion: Shortness of breath and cough are the common problems encountered by the general internist. A methodical approach is important in determining the less common causes of this problem. One approach is taking all the associated symptoms into consideration and list out possibilities that could cause it. In our patient, fever, headache, neck pain, generalised malaise, myalgias and rash is consistent with viral prodrome. Further she had new onset systolic heart failure on Echocardiogram and no atherosclerotic changes on angiogram with elevated Coxsackieb4 antibodies on viral panel. All together it was consistent with viral myocarditis due to Coxsackie B virus. Interestingly she also had positive EBV DNA. An estimated 95 percent of Americans have been infected with EBV by adulthood but the virus remains dormant. Stress is known predictor of reactivation of EBV and this explains the positive EBV DNA in our patient. Myocarditis affects 1% of the American population, 50% of which are caused by Coxsackie B virus. Cardiac tissue is the prime target of coxsackie virus with myocardium being affected preferably. Progressive destruction of myocardial tissue results in cardiac failure with subsequent fluid overload. Cardiac manifestations of viruses, especially myocarditis is well known although rarely recognised in the clinical practice. Physicians should be adept in identifying viral myocarditis as a cause of heart failure.

31) Parotid Tumor Misdiagnosed As Bell's Palsy

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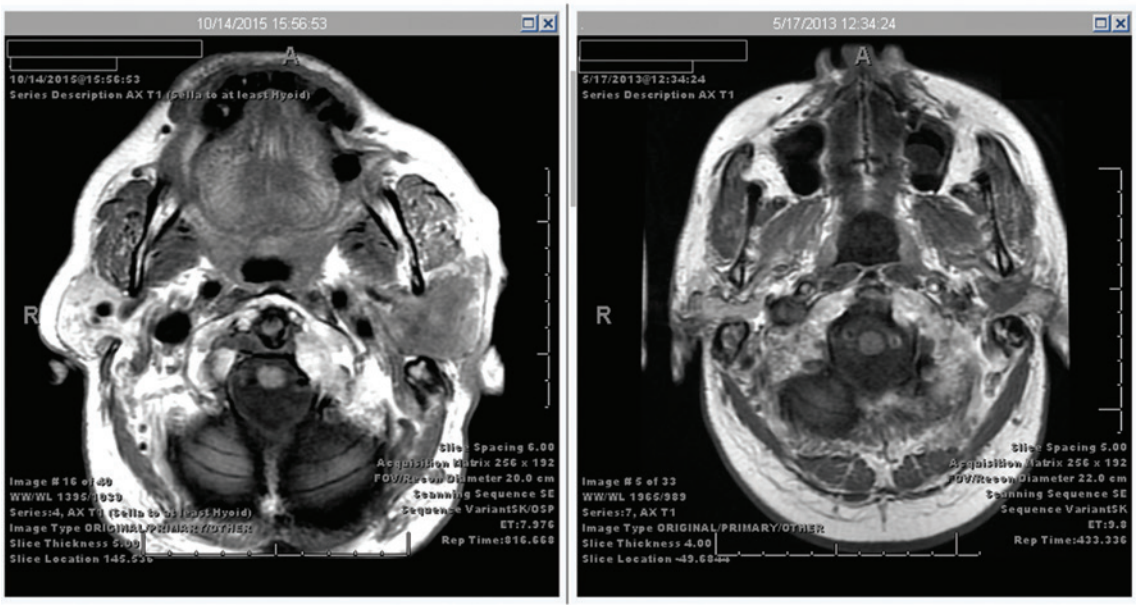
Learning objectives:
1. Discuss the differential diagnosis of facial nerve paresis
2. Implement appropriate clinical evaluation and workup for parotid tumor as a cause of facial nerve paresis
3. Recognize the importance of reviewing radiological examination

Case information: An 81-year-old man with chronic lymphocytic leukemia and cutaneous malignancies presented to the emergency department for left facial droop, where upper and lower divisions of the left face were weak. He was diagnosed with Bell's palsy, treated with

Acyclovir and Prednisone and asked to follow up with his PMD. Ironically, he was evaluated by an otolaryngologist that day for biopsy of cutaneous melanoma. Two months later, he showed no improvement. An MRI of the brain was ordered, and he was referred to a neuro-otologist. Three months later, he remained stable and was referred to a facial plastic surgeon, who performed four facelift procedures over two years for facial asymmetry. Two and a half years after presentation, he complained of a left facial mass, found to be a 4 cm parotid squamous cell carcinoma, requiring radical parotidectomy with facial nerve sacrifice.

Discussion: Bell's palsy is often cited as the most common cause of acute onset unilateral facial nerve weakness. However, a parotid gland tumor may also cause sudden facial nerve paresis. The case demonstrates failure of multiple primary physicians, including an otolaryngologist, to consider parotid tumor as the cause of this patient's paresis. Clinical exam should include facial motor testing and parotid palpation; Clinic ultrasound may help. Imaging is based on clinical suspicion; However, imaging the entire facial nerve course should be performed if Bell's palsy shows no improvement in 6-8 weeks. Here, initial MRI revealed a 2 cm ipsilateral parotid tumor - a finding overlooked by the radiologist and multiple otolaryngologists. As a result, the patient underwent multiple unnecessary surgeries and complications.



32) A Case of Decompensated Kabuki Syndrome: An Anatomy of a Diagnostic Error

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Learning objectives:

1. Appreciate how teamwork and care coordination across different specialties can be an important factor in the production and prevention of medical errors in clinically complex cases
2. Appreciate the significance of poor communication amidst inter-organizational transfer policies that lead to medical errors
3. Recognize the need to train junior physicians on how to provide care for patients with rare and complex diseases

Case information: A 20-year-old female with Kabuki Syndrome, SLE, type 1 diabetes, pancreatic insufficiency, and epilepsy, presented with unusual fatigue, tachycardia. Patient was admitted with diagnosis of sepsis and acute liver failure. Plan was to transfer to ICU in the event of haemodynamic compromise and escalate care to a tertiary liver unit if any signs of decline. However, documented plan was not implemented despite continuing signs of hypotension, tachycardia. Regular blood tests were not scheduled as planned and no evidence of communication between housestaff, senior attending, tertiary liver specialists, or ICU consultants. Instead of care escalation, patient was managed overnight under minimal supervision and no further investigation. AM blood tests showed abnormal levels of clotting factors, platelets, and leukocytosis (19.8), LFTs, and elevated lactate (13.5), only then was transfer to tertiary center initiated. However, patient went into cardiac arrest during transfer preparations, and resuscitation failed.

Discussion: This case is a clear demonstration of the growing number of patients who die from medical errors. Evidenced were multiple systematic failures in communication, coordination, clinical judgment, and diligent observation leading to substandard care where a failure to instigate controlled fluid management, diabetic control, and correction of acidosis in conjunction with an arterial blood gas analysis decreased likelihood of survival. This case teaches us that patients with rare and complex conditions, who require management across several institutions, clear care coordination protocols needs to become mandatory policy to minimize errors.

33) Glucocorticoid Therapy for Orbital Pseudotumor Resulting in Invasive Orbital Aspergillosis

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Learning objectives: 1) Recognize that orbital Aspergillosis is often misdiagnosed as orbital pseudotumor, resulting as premature closure subsequent to initial improvement of symptoms by steroids. 2) Suspect and diagnose a fungal etiology by prompt biopsy in immunocompromised patients with orbital apex syndrome (OAS).
Case information: A 64-year- old previously healthy Asian woman presented with five months history of subacute right orbital pain associated with worsening visual acuity. Preliminary diagnosis of orbital pseudotumor was made with transient relief of visual symptoms subsequent to 4 repeated pulses of high dose intravenous steroid therapy. However, the symptoms recurred with new onset ophthalmoplegia. Laboratory testing revealed β-D glucan 23 pg/ml (<6 pg/ml), and MRI with gadolinium demonstrated an infiltrative process in the right orbital apex, culminating in the diagnosis of OAS. Oral steroids were held until endoscopic surgical resection was performed, with histopathologic analysis of the removed lesion demonstrating Aspergillus species. The patient was treated with intravenous voriconazole, and despite a good outlook with initiation of antifungals, only modest improvement in vision and exophthalmos was seen.
Discussion: OAS is a vision-threatening emergency manifested by optic neuropathy and ophthalmoplegia, requiring prompt diagnosis and treatment. Frequent etiologies include malignant conditions and traumatic OAS, accounting for more than half of the cases. While literature suggests a useful role of steroids in OAS of inflammatory etiology, presumptive use of steroids should be with caution as invasive Aspergillosis is often misdiagnosed as orbital pseudotumor. Although an infectious etiology of OAS is rare, immunocompromised patients with painful ophthalmalgia should raise concern for a fungal infection. As surgical biopsy of the lesion is often required for definitive diagnosis, and surgical debridement with antifungal is the preferred modality of treatment for invasive Aspergillosis, it should be done without delay when suspected.

34) Diagnosis at the Click of a Mouse

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Learning objectives:
Critical thinking is inherent in making sound clinical reasoning.There are two major ways in which we think and process information, "intuitive (type I)" and "analytic (type II)". The Intuitive approach is automatic, and the analytic is a conscious process. We present a case where the process was achieved without any kind of thinking.
Case information:
A 27-year-old woman was admitted to an outside hospital with a 1.5-year history of generalized weakness and fatigue with worsening symptoms over the past week. She stated that her entire body ached,and also complained of generalized body edema, and 20 lbs weight gain over the past six months. She felt weak subjectively but on examination, was able to walk and stand from a sitting position. She left the hospital against medical advice because they would not do an "MRI to rule out MS". The only abnormality found at the time was a mildly elevated creatine kinase (CK) of 2867 IU/l for which she was being hydrated. She presented to the emergency room of a university hospital to get the MRI and EMG. The treating physician did not feel that that was necessary, but did a bunch of tests to placate and reassure her. The repeat CK was 1704 IU/L and the patient was admitted. The bunch of tests included a TSH which was 161.9 u/IU/ml and a diagnosis of hypothyroidism was made. The TSH was sent without any thinking.
Discussion:
The classical ways we use to diagnose patients will likely see disruption in the coming years. In this age of comprehensive metabolic panels, pan-testing and pan scanning, many a diagnosis will be done by the click of a mouse. Laboratory, radiologic and clinical support systems will replace clinical judgements. This type of technology-mediated non-thinking reasoning should be the focus for future research.

35) Tocilizumab Can Mask Systemic Toxicities in Patients with Necrotizing Soft Tissue Infections

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Tokai University School of Medicine, Isehara, Japan

Learning objectives: We should consider necrotizing soft tissue infections (NSTIs) when we encounter patients treated with tocilizumab even if it looks like cellulitis.

Case information: A 76-year-old Japanese woman with rheumatoid arthritis treated with prednisolone 7.5 mg per day and tocilizumab 400 mg per month presented with redness and pain in her right thigh of 2 days duration. She had stable vital signs and her quick SOFA was 0 point. No crepitus, bullae or severe pain were noted. The Laboratory Risk Indicator for Necrotizing fasciitis (LRINEC) score was 3 points. She was hospitalized with a primary diagnosis of cellulitis and an antimicrobial therapy with cefazolin was started. She had been stable until 4thday of her admission when swelling of her right thigh became worse rapidly with development of purpura and she was unable to walk because of pain. A CT scan revealed multiple abscesses with gas formation in her right thigh. MRI T2-weighted image showed high intensity area in the fascial planes. A diagnosis of NSTIs was made and extensive debridement was performed. We changed the antibiotics to tazobactam / piperacillin, vancomycin and clindamycin. And then multiple organisms including ESBL-producing *E. coli* were cultured, so we changed again the antibiotics to meropenem. For the next 4 months, additional debridement was done 5 times. She improved significantly enough to be able to walk.
Discussion: At the time of initial presentation this patient lacked systemic toxicities and local findings suggesting NSTIs, so she was diagnosed as having cellulitis. She had been treated with tocilizumab which is interleukin-6 receptor antagonist, so acute-phase reactions and findings of inflammation might be masked. Recognition of representativeness restraint might have let to earlier diagnosis and treatment.

36) A Perilous Case of Diagnostic Momentum in the Era of Early Thrombolysis

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Learning objectives: Identify potential pitfalls in the emergent diagnosis and treatment of ischemic stroke mimics.
Case information: A 64-year-old female presented to our stroke center designated hospital via ambulance as a cerebral vascular accident (CVA). One hour prior to arrival in the Emergency Department (ED), the patient experienced sudden onset of right leg paralysis.
On arrival, the patient demonstrated dense right leg weakness. She was unable to lift the leg from the bed. Her right arm was minimally stronger. She described decreased sensation over the entire right side of the body.
Non-contrasted computer assisted tomography of the head was emergently read by a radiologist who had been informed of the patient's condition and presentation. The formal interpretation included the following; "dense left side middle cerebral artery sign". Tissue plasminogen activator (tPA) was ordered. During preparation of thrombolytic therapy the patient developed "numbness" to the left side and a "burning" hyperesthesia on her right side. Following this re-assessment, preparation of the tPA was discontinued. After further evaluation, a diagnosis of idiopathic Brown –Sequard Syndrome was made. A reinterpretation of the radiologic images found no evidence of arterial occlusion.
Discussion:
This case illustrates the importance of re-assessment in the patient with an evolving neurologic complaint. Current guidelines from several organizations stress early administration of agents with significant morbidity and mortality risks. The pressure to meet therapeutic timelines exposes the clinician to confirmation bias, diagnostic momentum and anchoring.
Studies demonstrate that a decreasing interval of "door to needle" time, leads to an increase in the number of patients presenting with CVA mimics receiving thrombolysis. The benefits of early thrombolysis and the avoidance of misadministration can be realized only through careful patient re-assessment and thoughtful evaluation of the risks and benefits.

37) Risk of Staying in Hospital

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Learning objectives:
1. Recognize the difficulties of diagnosing in-hospital stroke

Case information:
A 68 year-old Japanese man was admitted to receive neoadjuvant chemotherapy for his hypopharynx cancer. His past medical history was remarkable for iron deficiency anemia and chronic numbness in both arms after a car accident 12 years ago. He had no allergies and his social and family histories were unremarkable.
On day 2, he felt weakness of his right arm when he woke up complained that he could not eat breakfast because he was unable to use his chopsticks. He denied headache, nausea, vomiting, neck pain, chest pain, new numbness or dysarthria.
On physical exam, his vital signs were unremarkable and his neurological exam showed only a slight weakness (4/5) of the right arm. His blood work was normal. Past cervical CT scan showed cervical spondylosis and his symptoms were getting better. We thought his cervical spondylosis had transiently worsen, so we decided to watch and wait. However, by day 7 his symptoms persisted, therefore we ordered a cervical MRI and consulted the orthopedic surgeon who suggested a brain MRI. It revealed a left putaminal hemorrhage. Fortunately, the patient was getting better and the neurosurgeons suggested rehabilitation.

Discussion:
According to the literature, patients with in-hospital stroke have longer waiting times to undergo neuroimaging and are more likely to be dead or disabled at discharge compared with those with community-onset stroke. In this case, our decision to watch and wait was based on improving symptoms, "anchoring" to his past medical history of neck trauma and probably some "confirmation bias" when we detected the cervical spondylosis. Fortunately, the patient recovered full function of his arm. Our institution would benefit from establishing a protocol for in-hospital stroke evaluation that mimics that of a community-onset stroke.

38) Atypical Chest Pain

L. A. Schols and **S. Klein Nagelvoort-Schuit**
Erasmus University Medical Centre, Rotterdam, Netherlands

Learning objectives: Patient history with possible unnecessary additional research. In the idea of a just culture a start was made to talk about diagnostical error in transfer of shifts at 08:00 AM at our hospital.
Case information: A 61 year old male is presented at the emergency ward. He complained about chest pain. The pain was increasing in intensity and seemed to increase with breathing activity. We examined an anxious patient with increased breathing activity (25/min). The pain was located retrosternal and increased in intensity. He was increasingly sweaty and seemed nervous. Pain score was 7. Medical history stated a cardiac ablation. Ambulance personnel informed us about a large difference in measured blood pressure between the left and right arm. Left 140/70 mmHg and right 75/50 mmHg. Alarmed by this we decided after a quick primary survey to send our patient immediately to the CT-scan with a high risk of a thoracic aorta dissection or pulmonary embolism. After having ruled out these diagnoses we decided to do additional lab research and history taking. At the end of the night shift we sent our patient home.
Discussion: There was a strong " jumping to conclusion" atmosphere. The presentation of the patient was confirming our pre-thoughts. The effect of fatigue of everybody contributing in the patient treatment. Personally looking back, also the fact that it was my last nightshift in a week of four in total there was also a role in this case best described as " get there -itis". The fact that we worked for the fourth nightshift together with the same team also introduced a term called " group think". A few days later I saw that this patient was known with a personality disorder type B (theatrical personality)….could this be more explanatory in the patients presentation that night?

39) Subdural Empyema, an Insidious Headache with Catastrophic Consequences

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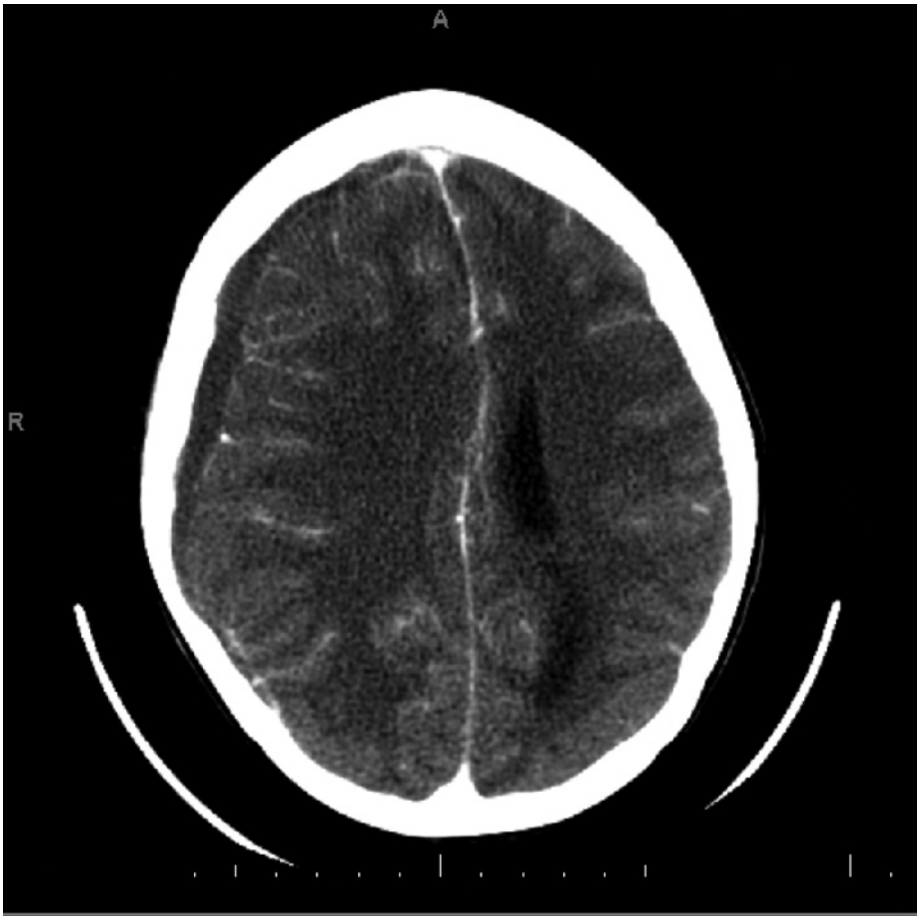
Learning objectives: Recognize and identify patients with subdural empyemas to swiftly initiate the appropriate workup and surgical consultations.
Case information: A 14 year old healthy male presented to the ED with 1 week of headaches with progressive fevers, nausea, vomiting, diarrhea, and confusion two days prior to presentation prompting a visit to the ED. Patient had normal vitals. Physical examination revealed no neurological deficits, no nasal discharge, and no nuchal rigidity. Laboratory testing exhibited leukocytosis of 18.2 K/uL, hyponatremia (127 mEq/L), hypokalemia (3.4 mEq/L), and hypochloremia (95 mEq/L). After discussion with the pediatrician consult, computer tomography imaging (CT) and lumbar puncture were deferred at this time. Patient was given two fluid boluses and was subsequently sent home. The next day, the family noted that the patient was slow to wake, atypically non verbal, and not eating or drinking. Patient was brought back to the emergency department where patient was noted to have a fever of 101.7 F and physical exam revealed sluggish pupils, discordant eye movements, and "a stiff neck". Patient was immediately started on empiric broad spectrum antibiotics and stat CT head was performed which revealed a right subdural fluid collection with associated mass effect and subfalcine herniation and right frontal and anterior ethmoid sinus opacification. The patient was emergently taken to the operating room for craniectomy where a significant amount of purulent fluid was drained. Post operative exam revealed no neurological response from the patient and brain death was declared.
Discussion: Subdural empyemas are devastating complications from sinusitis which present with non specific symptoms of headache, fever, nausea, and vomiting. Morbidity rates (27%) and mortality rates (3.3%) are high despite aggressive treatment. Early recognition and diagnosis with prompt surgical and medical treatment is key to limiting the morbidity and mortality of this devastating complication.



40) Loss of Consciousness: Head or Heart?

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Learning objectives: Recognize that distinguishing unwitnessed syncope from other causes of loss of consciousness (LOC) is crucial in revealing its correct etiology.
Case information: A fully ambulant 67-year-old Asian man arrived to the emergency department with chief complaint of syncope. He claimed of lying on the floor when realized while working in his office. There were no preceding symptoms or witness upon the event. Pertinent symptoms included slight headache and nausea. His past medical history was remarkable for atrial fibrillation and low ejection fraction due to myocardial infarction with an implantable cardioverter defibrillator. He smoked one pack per day for 40 years. He did not drink or use recreational drugs. His family history was insignificant. On physical examination, he was alert/oriented x3 and his heart rate was 102 bpm; the rest of exam showed no abnormalities. Laboratory testing showed slight anemia, but otherwise normal. A telemetry electrocardiogram was unremarkable. Computed tomography scan of the head revealed subarachnoid hemorrhage (SAH). Endosaccular coil embolization was performed and he was discharged without any physical impairment.
Discussion:
Major causes of syncope include neurally mediated syncope, orthostatic hypotension, and cardiac arrhythmias. Neurologic causes such as transient ischemic attack are considered rare, and usually does not warrant testing of brain imaging. The patient in the present case presented with subjective “transient” LOC, which was translated as syncope for further investigation. His vast medical history of cardiovascular disease was misleading, and lead to premature closure in the preliminary diagnosis of cardiogenic syncope. However, upon meticulous history taking and focusing on the patient’s associated symptoms, differential diagnosis of LOC lead to the correct diagnosis of SAH. This case highlights an error-prone situation in which misdiagnosis may potentially occur due to confirmation bias.

41) Hypertensive Emergency Resulting As Type 2 Myocardial Infarction in a Patient with Neurofibromatosis Type 1

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Teine Keijinkai Hospital, Sapporo, Japan

Learning objectives: 1) Recognize that neurofibromatosis type 1 (NF-1) patients with hypertension highly complicates pheochromocytoma. 2) Treat PC hypertensive crisis with type 2 myocardial infarction (MI) with prompt antihypertensive therapy and eventual surgery.
Case information: A 60-year-old Japanese female with past medical history of hypertension and NF-1 presented with fever and chest pain. Vital signs included temperature of 37.8 C, blood pressure (BP) 200/120 mmHg, heart rate 110 beats per minute, and O2 saturation 93% room air. Electrocardiogram showed ST-depression in the lateral leads, without wall motion abnormality by echocardiography. Contrast CT scan was organized to rule out aortic dissection, while this revealed consolidation in the left lung base and an incidentally found left adrenal mass. Laboratory data showed WBC 22000 /μl, high sensitivity troponin T 950 pg/ml, and CRP 19 mg/dl. Provisional diagnosis was made of pneumonia and type 2 MI caused by pheochromocytoma. Antibiotics and oral doxazosin was initiated subsequent to evaluation by coronary angiography which excluded any underlying coronary artery disease. Hydration with intravenous fluids followed, with eventual rate control achieved by propranolol. Successful laparoscopic adrenalectomy was performed three weeks later.
Discussion: Pheochromocytoma occurs in 20-50% of hypertensive NF-1 patients, a much higher prevalence compared to 0.1% of all hypertensive individuals and up to 5% in NF-1 patients without hypertension. Hypertensive emergency is a commonly known condition caused by pheochromocytoma. In this case, pneumonia precipitated the pheochromocytoma crisis with release of catecholamine increasing myocardial oxygen demand, resulting in type 2 MI. It is important to note that type 2 MI is not infrequent, with most commonly identified causes, responsible for more than 50% of the cases, being anemia and sepsis. Although pheochromocytoma is a rare entity per se, its recognition as a predictable complication in NF-1 patients with hypertension is crucial in appropriate management after clinical assumption and diagnosis.

42) In Search of a Link Between Positive ANCA and Nephrotic Syndrome – Bacterial Infection-Related Glomerulonephritis

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Learning objectives: 1) Describe the clinical features of infection-related glomerulonephritis (IRGN), which most commonly manifests as acute nephritic syndrome with new-onset hematuria and proteinuria, edema, and reduced renal function. 2) Recognize that infection triggers autoimmunity, associated with induction of anti-neutrophil cytoplasmic antibody (ANCA) and vasculitis.
Case information: A 43-year-old Japanese male presented with intermittent low grade fever and edema of three months duration. Past medical history was significant for intravenous (IV) drug abuse and significant weight gain of 6 kg over the last month. Clinical examination revealed poor oral hygiene and anasarca. Blood tests revealed Cr 1.6 mg/dl (baseline 0.7 mg/dl), Alb 2.6 g/dl, seropositive ANCA, cryoglobulin, hepatitis B core antibodies, with normal complement levels. 24-hours urinary protein was 5.6 g/day with hematuria. Blood cultures were negative. Echocardiogram revealed no vegetation. Kidney biopsy showed endocapillary proliferative and exudative glomerulonephritis with crescents. Immunofluorescence revealed granular staining with characteristic "hump-shaped" appearance by electron microscopy. Diagnosis of IRGN was made based on the constellation of findings. Treatment of dental caries with antibiotics and corticosteroids was initiated.
Discussion: Etiology of adult IRGN is heterogeneous with nonspecific symptoms, resulting in frequently delayed recognition. In this case, misleading features of ANCA seropositivity and history of IV drug abuse raised concern of other glomerular involvement, and oral findings were overlooked until kidney biopsy suggested its central role in pathogenicity of the disease. Furthermore, part of the delays in diagnosis was contributed by overconfidence of ANCA positivity. Despite its usefulness as a diagnostic tool in the diagnosis of ANCA-associated vasculitis, as infection and certain drugs have been implicated in the induction of ANCA, it is of importance to recognize its limitations as a biomarker. There lies clinical significance in acknowledging a rather frequent and overlooked condition of IRGN and the interpretation of ANCA, as pictured in this case.

43) Non-Hodgkin Lymphoma Mimics Retroperitoneal Fibrosis

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Learning objectives: When treatment isn't effective and you suspect your diagnosis, you must think to take the risk and try to do best for real diagnosis.
Case information: A 79-year-old woman presented with right flank pain. CT scan revealed rupture of ureter and retro-peritoneal soft-tissue mass. She was diagnosed as retroperitoneal fibrosis (RF) without biopsy. Urology doctor started prednisone as standard treatment of RF but her symptom became worse. So we was consulted to us and did CT guided biopsy. Although we took enough sample, the result of biopsy

showed that there was no sign of malignancy and it was consistent with RF. We increased steroids and observed her but symptoms never improved. We worried about complication of open biopsy, because of long-time steroid treatment and general condition. We discussed well with surgical doctors and decided to do open biopsy in most easy way for her. Pathological report showed non-Hodgkin B-cell lymphoma finally and we started R-CHOP chemotherapy. She became better and now continue treatment.
Discussion: RF is usually diagnosed through clinical symptom and imaging studies. First choice of treatment is steroid. Differential diagnosis are infection, malignancy and autoimmune disease. When steroid is not effective, we should do biopsy. CT-guided biopsy is safe and good option for retroperitoneal mass, but the result is not satisfactory, it is better to do open biopsy like this case.

44) Readily Accepting the Most Obvious Diagnosis May Increase the Risk of Search Satisfaction Bias

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Learning objectives: In order to avoid search satisfaction bias, a thorough and complete physical examination is recommended for patients presenting with new symptoms.
Case information: An 80-year-old Japanese man with chronic obstructive pulmonary disease and previous esophagectomy presented with a 1-week history of upper respiratory symptoms, fever, and loss of appetite. On examination, he was tachypneic with late inspiratory crackles on auscultation over his right upper lung. He was diagnosed with bacterial pneumonia and hospitalized to receive Ceftriaxone intravenously. 3 days after admission, the patient unexpectedly developed right-sided abdominal pain without guarding or rebound tenderness. A resident physician examined only the abdomen and considered the following differential diagnoses: Clostridium difficile colitis, ischemic colitis, or infectious gastroenteritis. Several hours later, however, a consultant attending physician examined the patient thoroughly from head to toe and identified palpable purpura in the upper and lower extremities. The patient was hence diagnosed with IgA vasculitis involving the skin, gastrointestinal tract, and kidneys. Although his symptoms resolved fully and he was discharged on day 11, he returned to hospital with recurrent abdominal pain and purpura. His condition gradually deteriorated as he developed renal failure, rectal ulcers, and healthcare-associated infection. He died on day 104.
Discussion: IgA vasculitis (Henoch-Schönlein Purpura) is a small-vessel leucocytoclastic vasculitis characterized by palpable purpura, polyarthritis, abdominal pain, and renal disease. This is commonly recognized in children, but it can rarely occur in adults, where it is associated with a poorer prognosis. This case of IgA vasculitis demonstrates the importance of physicians performing complete, thorough bodily examinations in order to avoid search satisfaction bias.

45) CT Negative ICH

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Learning objectives: Non contrast Computer Tomography (CT) is an essential and rapid tool of diagnosis of intracerebral hemorrhage (ICH). We experienced a case of ICH that showed no hemorrhage on the first CT, but turned out to be positive on the CT taken 3 hours later. We will review the sensitivity of a head CT for diagnosing ICH and alternative methods when CT are negative.
Case information: A 47-year-old man came to our emergency department on 6 am, complaining of a sudden headache from 5 am. We performed a head CT which showed no hemorrhage. After several hours, he had numbness on his right leg, decreased thermal nociception on his right side of the face and left lower limb, gaze-evoked nystagmus on the left side, and had no meningeal signs.Suspecting ICH from his history and physical exam, we took another head CT after 3 hours which showed hemorrhage in the medulla oblongata.
Discussion: A head CT is essential and the primary test for diagnosing ICH. Sensitivity is 90% and specificity is 99.4% for acute ICH, and negative likelihood is 0.1. When pretest probability is low, ICH can be ruled out with negative CT. However, when pretest probability is high, negative CT cannot rule out ICH. After a negative head CT, repeating a head CT is one option in order to make the diagnosis of ICH, and MRI would be an alternative. MRI will not be an initial choice because of its time and expense, but is reported to be as efficacious as a head CT.

46) It's Not Lupus,It's Never Lupus!

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Learning objectives: Consider making differential diagnosis other than lupus enteritis when patients with SLE(Systemic Lupus Erythematosus) present chronic diarrhea.

Case information: 35-year-old Japanese woman presented with a 1-month history of diarrhea. She was taking immunosuppressants (steroids, mizoribine) for several years because of SLE. On physical examination, she was bed-ridden and was passing a large amount of watery diarrhea (3-4L/day). Laboratory data showed severe hypoalbuminemia. We initially suspected lupus enteritis, and performed steroid pulse and *Intravenous* cyclophosphamide pulse treatment but her condition deteriorated. Next, we started oral vancomycin on suspicion of *Clostridium difficile*infection, but with no resultant improvement in her condition. We finally performed a lower gastrointestinal endoscopy, and found a very small number of macrophages which stained positive for PAS(Periodic acid-Schiff stain) on repeated histopathological evaluation. Based on these findings we suspected Whipple's disease, and initiated treatment with antibiotics(ceftriaxione, sulfamethoxazole/trimetoprim). Her condition gradually improved, and in 6 months she was well enough to leave the hospital unassisted.
Discussion: Whipple's disease is an important differential diagnosis when patients present chronic diarrhea. Additionally, identifying PAS-positive macrophages can expedite the diagnosis of Whipple's disease.

47) Expert Opinion; Mostly Trustworthy, Sometimes...

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Learning objectives: 1) Diagnosis of scabies is sometimes challenging. 2) Scabies often mimics other skin diseases including urticaria, seborrheic dermatitis, or bullous pemphigoid. 3) Too much rely on expert opinion might lead to delay and misdiagnosis.
Case information: A 72-year-old Japanese man with a past medical history of diabetes and ischemic stroke with right hemiplegia and aphasia was admitted to our hospital because of hyperglycemia caused by prednisolone (30 mg/day) for one-month treatment of bullous pemphigoid by a dermatologist. The diagnosis of bullous pemphigoid was clinically considered by a experienced dermatologist. The patient received the prescription of oral prednisolone as well as steroid ointment for large gray crusted hyperkeratotic plaques on the left shoulder, arm, and dorsal hands. Despite no notable improvement, clobetasol propionate ointment was also added. Two weeks after initiating this ointment, with deteriorating skin lesions, (figures 1A,B), a skin scraping biopsy was performed, showing many mites and eggs suggestive of crusted scabies.
Discussion: Based on the diagnosis of crusted scabies, the immunosuppressive therapy for bullous pemphigoid was discontinued and oral ivermectin and crotamiton cream were both administered. As a result, the skin lesions of scabies gradually improved. Scabies often mimics other skin diseases including urticaria, seborrheic dermatitis, or bullous pemphigoid as in this case. Most cases of crusted scabies occurred among bed ridden patients with difficulty of speech, resulting correct diagnosis is often delayed. Scabies are uncommon infectious disease in Japan, hence scabies are less likely to be considered as a differential diagnosis for dermatological problem (representative heuristic). Additionally, we tend to stick the diagnosis made by the expert opinion, this might sometimes lead to misdiagnosis and delay re-make new diagnosis as in this case (premature closure and anchoring bias).