IMPROVING DIAGNOSIS IN HEALTHCARE

UMD Summer Institute in Nursing Informatics (SINI), July 2017

The 5 Worst & 5 Best Ideas for Health Informatics to Improve Diagnostic Safety & Quality

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DISCLOSURES

1. Grant support
   - NIH U01 DC013778-01A1 (NIDCD), 5U01NS080824, (NINDS), U24TR001609-01 (NCATS), AHRQ (pending)
   - Siemens/SIDM, Brainscope, Kaiser Permanente
2. Research VOG devices loaned by
   - GN Otometrics
   - Autronics-Interacoustics
3. Founding Board Member SIDM (unpaid)
4. 'Diagnosis' career focus (academic COI)

Investigational Use – Device

INFORMATICS TO REDUCE DIAGNOSTIC ERRORS
OUTLINE

1. Background (~30 min)
2. Role of Health Informatics (~30 min)
3. Questions (~15 min)

Newman-Toker

INFORMATICS TO REDUCE DIAGNOSTIC ERRORS
LEARNING OBJECTIVES

1. Define diagnostic error and misdiagnosis-related harm
2. List potential health informatics solutions to help reduce diagnostic error
3. Discuss attributes likely to affect success or failure of informatics solutions
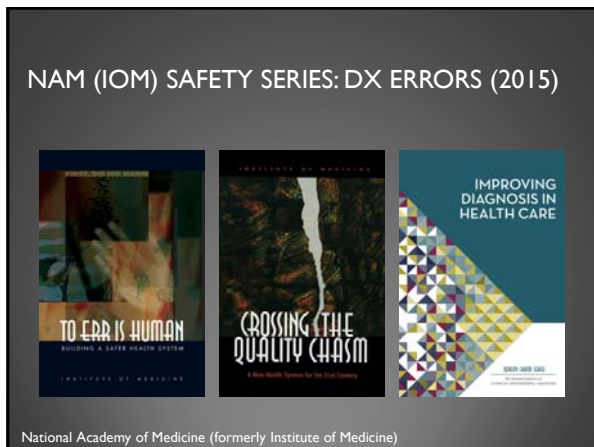
Newman-Toker

IN MEMORIAM
LARRY WEED (1923-2017)

"The religion of medicine is not feats of intellect. The religion of medicine is helping to solve the problems of patients, and the compassion involved in the very act of care." Larry Weed MD

Photos Courtesy of Doug Farrago (left), Art Papier (right)

Diagnostic Errors
BACKGROUND

Diagnostic Errors
NAM (IOM) REPORT

NAM (IOM) SAFETY SERIES: DX ERRORS (2015)

IMPROVING DIAGNOSIS IN HEALTH CARE

TO ERR IS HUMAN
BUILDING A SAFER HEALTH SYSTEM

CROSSING THE QUALITY CHASM
A New Health System for the 21st Century

National Academy of Medicine (formerly Institute of Medicine)

NAM (IOM) Report, September 22, 2015

"The delivery of healthcare has proceeded for decades with a blind spot: Diagnostic errors…"

"…most people will experience at least one diagnostic error in their lifetime, sometimes with devastating consequences."

"Improving the diagnostic process is not only possible, but it also represents a moral, professional, and public health imperative"

NAM (IOM), Improving Diagnosis in Healthcare, 2015

Diagnostic Errors
BURDEN & IMPACT

MAJOR PUBLIC HEALTH PROBLEM

Most Common
Most Catastrophic
Most Costly

All Other Errors Combined

Diagnostic Errors
Harmed > 4 Million
Cost > $100 Billion

Newman-Toker
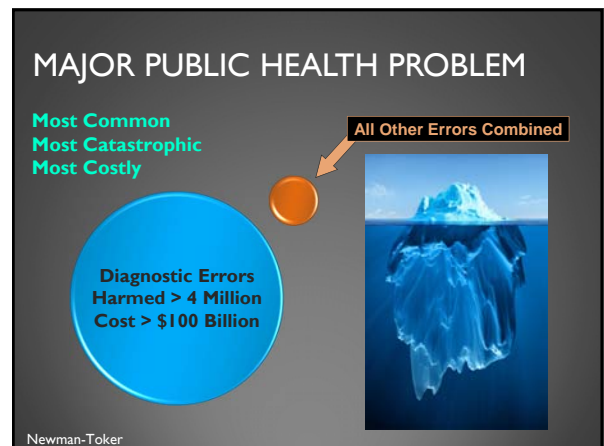
THE 'BIG THREE' CAUSES OF HARM

IOM REPORT—"Early efforts could focus on identifying the most common diagnostic errors, 'don't miss' health conditions that may result in patient harm, or diagnostic errors that are relatively easy to address."

Vascular

Infection

Cancer

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CLOSED CLAIMS & THE 'BIG THREE'

THE DOCTOR'S COMPANY CLOSED CLAIMS REPORT
"Diagnostic Error in Medical Practice by Specialty" (David Troxel, 2014)

Medicolegal Closed Claims	Peds	EM	IM	FM	HM	Card	Surg	Gyn	Orth	OB	TOT	Fraction of All	Fraction of Total Shown
Vascular	0	45	49	18	21	20	0	0	5	7	142	7.6%	25.9%
Infection	13	23	0	0	5	0	18	0	24	3	54	2.9%	9.8%
Cancer	4	0	44	64	4	4	23	37	12	0	168	9.0%	30.6%
TOTAL DX ERROR SHOWN	21	94	93	82	30	30	63	54	57	25	549	29.2%	100.0%
TOTAL DX ERROR	88	242	374	417	118	114	143	98	215	68	1877	100.0%	N/A

- 'Big Three' account for 66% of all claims shown in the report
- 'Big Three' account for 3-5 of top 5 categories across disciplines
- Peds (I > C), PC (C > V), ED (V > I), Hosp/OB (V > I), Surgical (C > I)

From Troxel, 2014, The Doctor's Advocate (The Doctor's Company)

Diagnostic Errors
DEFINITIONS & MODEL

NAM (IOM) DEFINITION OF DX ERROR

DIAGNOSTIC ERROR is the failure to…

(a) establish an accurate and timely explanation of the patient's health problem(s) or

(b) communicate that explanation to the patient

NAM (IOM), Improving Diagnosis in Healthcare, 2015


RELATED DX ERROR DEFINITIONS

▶ Missed Opportunity

…a failure to make a correct or timely diagnosis resulting from a preventable process failure (omission or commission), given the evolving context at the time, linked to the sociotechnical work system *(adapted from Singh, 2014)*

▶ Misdiagnosis-related Harm

…harm resulting from the delay or failure to treat a condition actually present (when the working diagnosis was wrong or unknown) or from treatment provided for a condition not actually present. *(adapted from Newman-Toker, 2009)*

Newman-Toker

Newman-Toker, Diagnosis, 2014

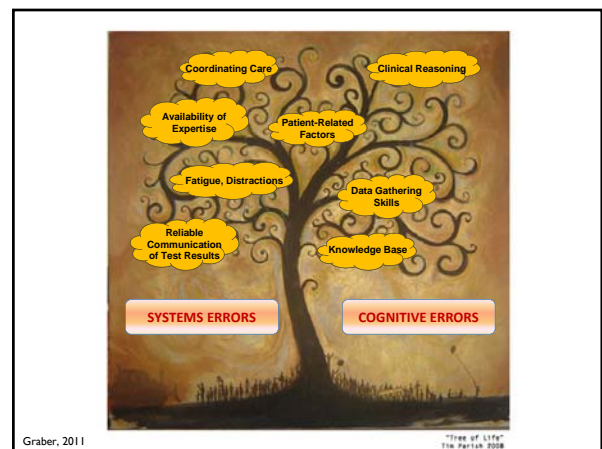Newman-Toker, Diagnosis, 2014

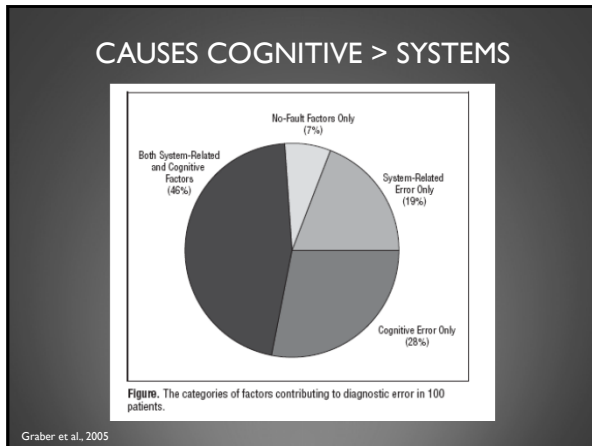Newman-Toker, Diagnosis, 2014
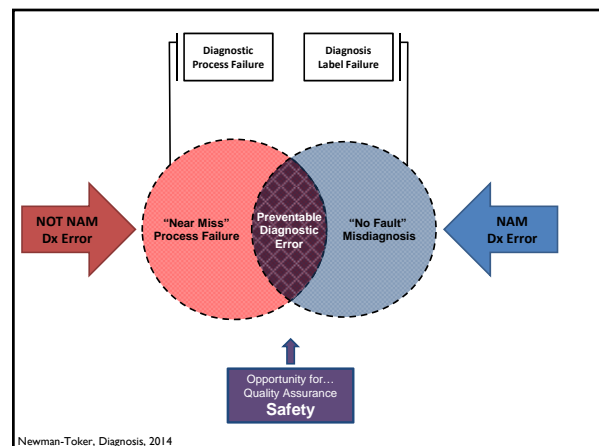
Newman-Toker, Diagnosis, 2014
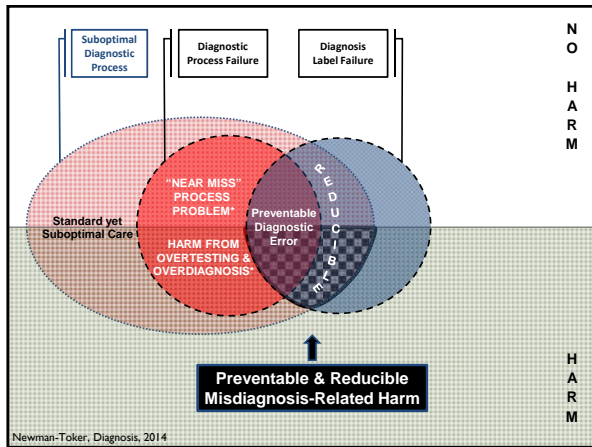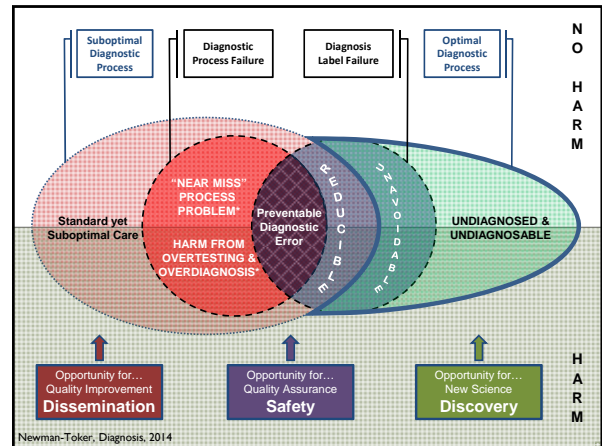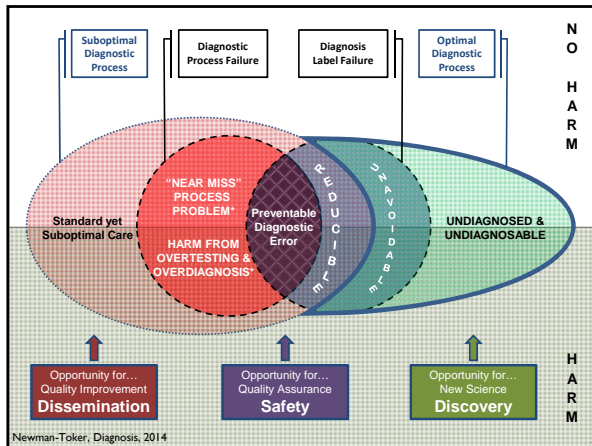
IMPLICATIONS FOR MEASUREMENT

1. Process defect not required for dx error
2. Process defect alone is a 'near miss'
3. 'Suboptimal' is similar to 'failed' process
4. Overdiagnosis & overtesting may harm
5. Harm is a key parameter to measure
6. Focus on preventable & reducible harms

Newman-Toker, NQF Measurement Framework
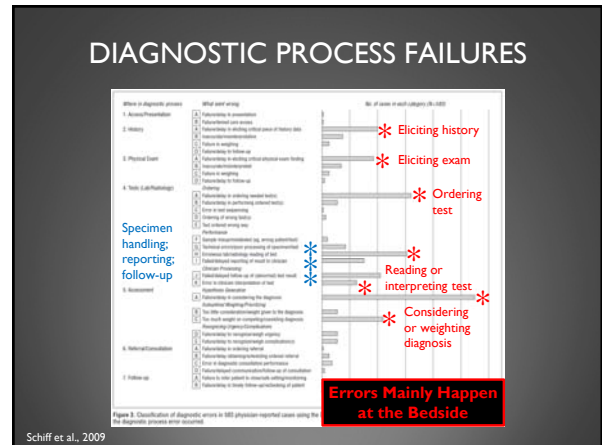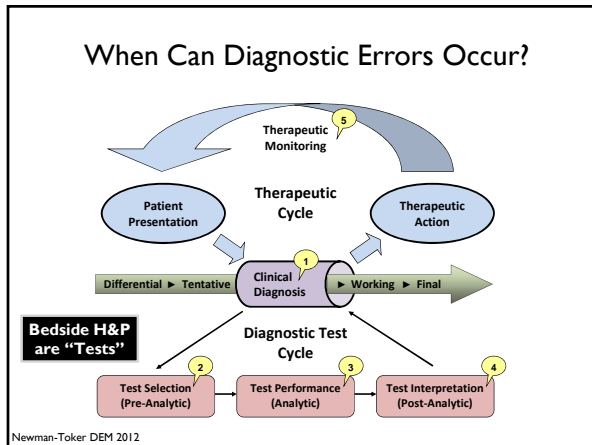
Diagnostic Errors
CLASSES & CAUSES

Graber, 2011

CAUSES COGNITIVE > SYSTEMS

Graber et al., 2005

A FALSE DICHOTOMY … AND THE WRONG FRAME
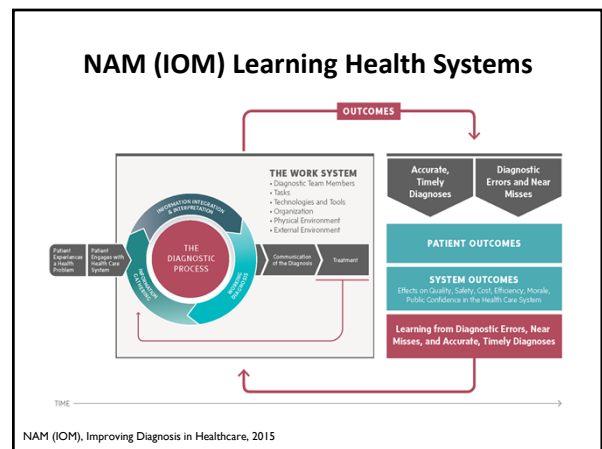
COGNITIVE ERROR AND/OR **SYSTEM FAILURE**

develop SYSTEMS solutions to solve COGNITIVE problems
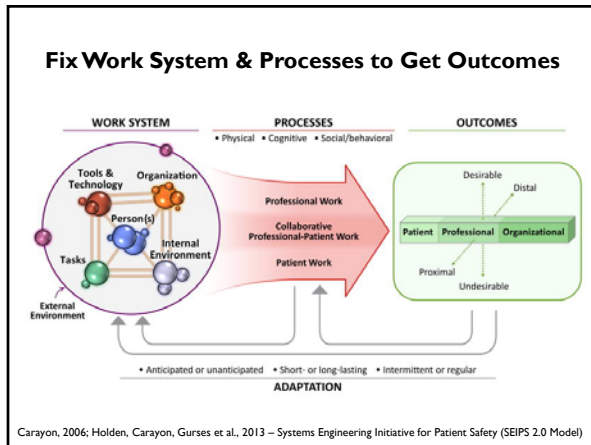
Newman-Toker DEM 2010

When Can Diagnostic Errors Occur?

Newman-Toker DEM 2012

DIAGNOSTIC PROCESS FAILURES

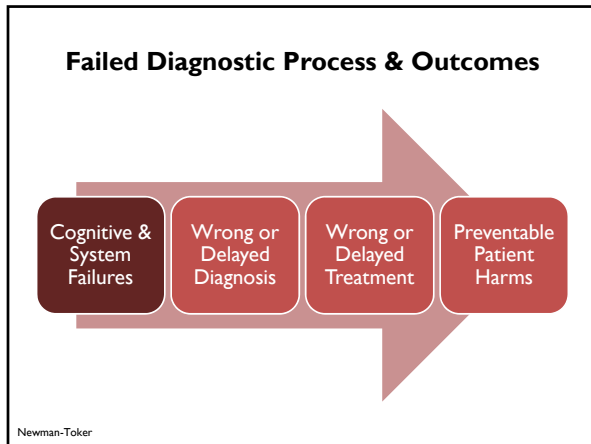Schiff et al., 2009

Diagnostic Errors
DIAGNOSTIC PROCESS & WORK SYSTEM

NAM (IOM) Learning Health Systems

NAM (IOM), Improving Diagnosis in Healthcare, 2015

Failed Diagnostic Process & Outcomes

Cognitive & System Failures → Wrong or Delayed Diagnosis → Wrong or Delayed Treatment → Preventable Patient Harms

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Optimal Diagnostic Process & Outcomes

Supportive System & Culture → Correct, Timely Diagnosis → Correct, Timely Treatment → Improved Patient Outcomes

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Fix Work System & Processes to Get Outcomes

Carayon, 2006; Holden, Carayon, Gurses et al., 2013 – Systems Engineering Initiative for Patient Safety (SEIPS 2.0 Model)
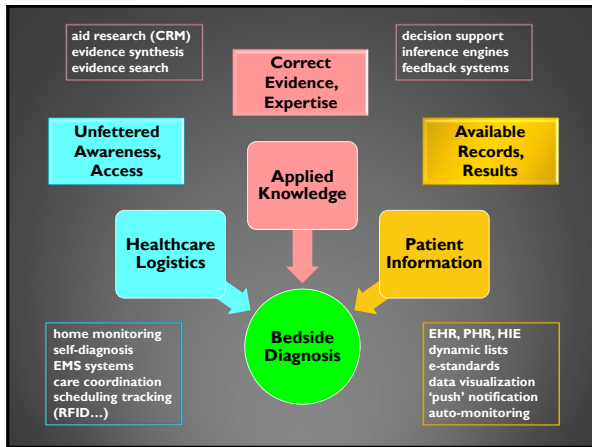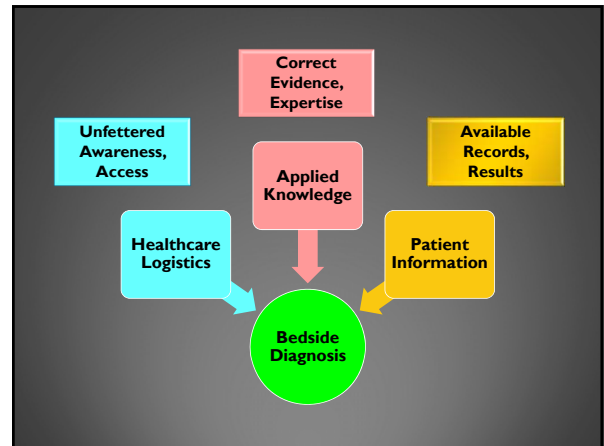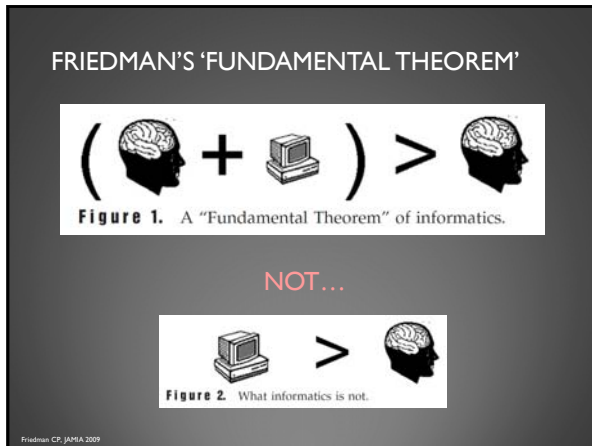
Diagnostic Errors
ROLE OF INFORMATICS

IOM RECOMMENDATIONS FOR HEALTH IT
IMPROVING DIAGNOSIS IN HEALTHCARE

1. Well-designed diagnostic decision-support & related IT tools to enhance diagnosis

2. Interoperability of health IT systems

3. Independent testing/review of HIT systems

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FRIEDMAN'S 'FUNDAMENTAL THEOREM'

$$(\text{🧠} + \text{💻}) > \text{🧠}$$

Figure 1. A "Fundamental Theorem" of informatics.

NOT…

$$\text{💻} > \text{🧠}$$

Figure 2. What informatics is not.

Friedman CP. JAMIA 2009

Correct Evidence, Expertise

Unfettered Awareness, Access

Available Records, Results

Applied Knowledge

Healthcare Logistics

Patient Information

Bedside Diagnosis

aid research (CRM)
evidence synthesis
evidence search

decision support
inference engines
feedback systems

Correct Evidence, Expertise

Unfettered Awareness, Access

Available Records, Results

Applied Knowledge

Healthcare Logistics

Patient Information

home monitoring
self-diagnosis
EMS systems
care coordination
scheduling tracking
(RFID…)

Bedside Diagnosis

EHR, PHR, HIE
dynamic lists
e-standards
data visualization
'push' notification
auto-monitoring

The 5 Worst
The 5 Best

Healthcare Logistics

Pushing Diagnosis into the Field

PUSHING DIAGNOSIS INTO THE FIELD
GOOGLING THE DIAGNOSIS & SELF-DX

Googling for a diagnosis–use of Google as a diagnostic aid: internet based study
Hangwi Tang, Jennifer Hwee Kwoon Ng
BMJ, 2006

'Googling' may work well for rare symptoms or syndrome constellations, but not so well for common problems

THE
MEDICAL
Journal of

The 'Dr Google' phenomenon—missed appendicitis
Neil Avery, Jamish Ghandi, John Keating

JOURNAL OF MEDICAL INTERNET RESEARCH

Viewpoint
Munchausen by Internet: Current Research and Future Directions

Slide 1:

PUSHING DIAGNOSIS INTO THE FIELD
REMOTE (PHYSIOLOGIC) MONITORING

Physiological Measurement > Volume 35 > Number 5

Non-contact video-based vital sign monitoring using ambient light and auto-regressive models

OPEN ACCESS

L Tarassenko[1], M Villarroel[1], A Guazzi[1], J Jorge[1], D A Clifton[1] and C Pugh[2]

Show affiliations

ISRN Neurology
Volume 2012 (2012), Article ID 768794, 10 pages
http://dx.doi.org/10.5402/2012/768794

Review Article
Recent Developments in Home Sleep-Monitoring

Jessica M. Kelly,[1] Robert E. Strecker,[2] and Matt T. Bianchi[1]

[1]Department of Neurology, Massachusetts General Hospital, 55 Fruit Wang 720, Boston, MA 02114, USA
[2]VA Boston Healthcare System and Harvard Medical School, Brock

Targeted remote monitoring for specific diagnoses holds a lot of promise (jury still out on 'surveillance')

Slide 2:

PUSHING DIAGNOSIS INTO THE FIELD
SOLUTIONS THROUGH INNOVATION

Portable Video-oculography: The "Eye ECG" to diagnose stroke in the emergency department

Right — stroke
Right — no stroke

Slide 3:

Applied Knowledge

Bedside Diagnostic Decision Support

Slide 4:

APPLYING KNOWLEDGE AT THE BEDSIDE
DELPHIC ORACLE DECISION SUPPORT

Delphic oracle decision support fails on accuracy, workflow, and psychology

mghlcs

about us **projects** people publications fellowship opportunities directions contact

Overview | Apprentice | CRP | Dictation | **DXplain** | EduOnCall | FastTrack | hub | Qb2 ihealthspace | Nephromatic | OBEMR | OnCall | ORF | PACath | PCOI | Quicksilver | RPDR RPM | Scutwork | SPIN

DXplain®

Using decision support to help explain clinical manifestations of disease

Slide 5:

APPLYING KNOWLEDGE AT THE BEDSIDE
REMINDERS, AIDS, CALCULATORS & TOOLS

isabel
the diagnosis checklist!

visualdx.

Problem-specific decision support tools have the potential to transform diagnosis

Symptom-Specific Checklist 'Apps' Linked to Built-In Evidence-Based Calculator Tools

Slide 6:

Applied Knowledge

'Big Data' for Medical Knowledge & Care

TURNING INFORMATION INTO KNOWLEDGE
'OMICS' & 'BIG DATA' REPLACE DIAGNOSIS

*Looking 'where the light is' doesn't help
…nor does looking in a garbage pile*

TURNING INFORMATION INTO KNOWLEDGE
CONTEXT-SPECIFIC DATA SOURCES & USE

Intensive Care   *Radiology*

*Use informatics to visualize complex
data when data are granular & reliable
…if not, use it to get better data*

Usability characteristics of self-administered computer-assisted interviewing in the emergency department: factors affecting ease of use, efficiency, and entry error.

Patient Information

Coding Diagnoses

CODING & BILLING FOR DIAGNOSES
DISEASE-CENTRIC APPROACH

ICD 386

ICD 780.4

*Billing rules force disease coding for
encounters & encourage 'up-coding'
…hindering diagnostic problem-tracking*

ICD 434

CODING & BILLING FOR DIAGNOSES
SYMPTOM/PROBLEM-CENTRIC APPROACH

List of ICD-9 codes 780–799: symptoms, signs, and ill-defined conditions

*All clinical encounters should be
administratively coded with both a
presenting symptom and final diagnosis
(…and, ideally, a level of uncertainty)*

16 Milestones—10 Years

13. Use of "Not yet diagnosed"

Patient Information

Monitoring Diagnostic Quality & Safety

DIAGNOSTIC OUTCOMES TO MONITOR QUALITY
CURRENT MONITORING STRATEGIES

Were we supposed to know whether our diagnoses were right or wrong?

DIAGNOSTIC OUTCOMES TO MONITOR QUALITY
DIAGNOTIC SAFETY REPORTING

DIAGNOSTIC OUTCOMES TO MONITOR QUALITY
DIAGNOSTIC SAFETY DASHBOARDS

Use complaint-specific EHR trigger tools plus regional HIE to track misdiagnosis (then add patient-reported outcomes)

Healthcare Logistics	Applied Knowledge	Patient Information

Challenges for EHRs

Role for Electronic Documentation	Goals and Features of Redesigned Systems
Providing access to information	Ensure ease, speed, and selectivity of information searches; aid cognition through aggregation, trending, contextual relevance, and minimizing of superfluous data.
Recording and sharing assessments	Provide a space for recording thoughtful, succinct assessments, differential diagnoses, contingencies, and unanswered questions; facilitate sharing and review of assessments by both patient and other clinicians.
Maintaining dynamic patient history	Carry forward information for recall, avoiding repetitive pt querying and recording while minimizing erroneous copying and pasting.
Maintaining problem lists	Ensure that problem lists are integrated into workflow to allow for continuous updating.
Tracking medications	Record medications patient is actually taking, patient responses to medications, and adverse effects to avert misdiagnoses and ensure timely recognition of medication problems.
Tracking tests	Integrate management of diagnostic test results into note workflow to facilitate review, assessment, and responsive action as well as documentation of these steps.

Role for Electronic Documentation	Goals and Features of Redesigned Systems
Ensuring coordination and continuity	Aggregate and integrate data from all care episodes and fragmented encounters to permit thoughtful synthesis.
Enabling follow-up	Facilitate patient education about potential red-flag symptoms; track follow-up.
Providing feedback	Automatically provide feedback to clinicians upstream, facilitating learning from outcomes of diagnostic decisions.
Providing prompts	Provide checklists to minimize reliance on memory and directed questioning to aid in diagnostic thoroughness and problem solving.
Providing placeholder for resumption of work	Delineate clearly in the record where clinician should resume work after interruption, preventing lapses in data collection and thought process.

Schiff & Bates NEJM 2010

Role for Electronic Documentation	Goals and Features of Redesigned Systems
Calculating Bayesian probabilities	Embed calculator into notes to reduce errors and minimize biases in subjective estimation of diagnostic probabilities.
Providing access to information sources	Provide instant access to knowledge resources through context-specific "infobuttons" triggered by keywords in notes that link user to relevant textbooks and guidelines.
Offering second opinion or consultation	Integrate immediate online or telephone access to consultants to answer questions related to referral triage, testing strategies, or definitive diagnostic assessments.
Increasing efficiency	More thoughtful design, workflow integration, easing and distribution of documentation burden could speed up charting, freeing time for communication and cognition.

Schiff & Bates NEJM 2010

TAKE HOME FOR INFORMATICS

1. Solve important diagnostic problems
2. Remember the 'fundamental theorem'
   ▶ Human & computer in the proper roles
   ▶ Human & computer in the proper relationship
3. Build modular, context-specific solutions
4. Emphasize ergonomics, workflow
5. Tackle adaptive barriers head on, early

NATIONAL SOCIETY & MEETING
DIAGNOSTIC ERROR IN MEDICINE

SOCIETY to
IMPROVE
DIAGNOSIS in
MEDICINE
Better Outcomes Through Better Diagnosis

Diagnostic Error in Medicine

10th International Conference

October 8-10, 2017   Boston, MA

COALITION TO IMPROVE DIAGNOSIS (CID)

- ABIM Foundation*
- Alliance for Academic Internal Medicine
- Agency for Healthcare Research and Quality*
- American Academy of Family Physicians
- American Academy of Pediatrics
- American Association of Nurse Practitioners*
- American Board of Internal Medicine*
- American Board of Medical Specialties*
- American College of Emergency Physicians*
- American College of Physicians*
- American Society for Healthcare Risk Management*
- Association of American Medical Colleges
- Association of Clinical Scientists
- Centers for Disease Control and Prevention*
- Consumers Advancing Patient Safety*
- Institute for Healthcare Improvement
- Intermountain Healthcare

- Johns Hopkins Medicine
- Kaiser Permanente
- The Leapfrog Group*
- Maryland Patient Safety Center
- Massachusetts Coalition for the Prevention of Medical Errors
- Midwest Alliance for Patient Safety
- National Association of Pediatric Nurse Practitioners
- National Partnership for Women and Families*
- National Patient Safety Foundation*
- National Quality Forum
- Pennsylvania Patient Safety Authority
- Society of Hospital Medicine
- Society to Improve Diagnosis in Medicine*
- Veterans Health Administration

*Steering Committee

Questions?
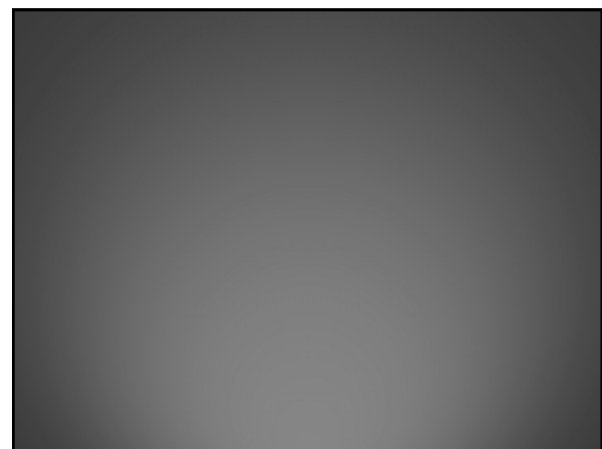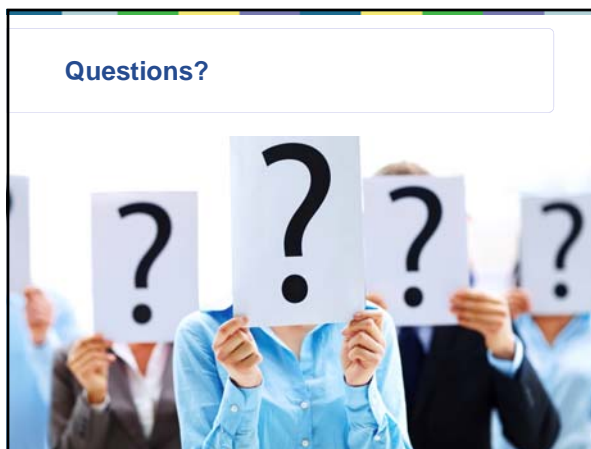
Diagnostic Errors
TEAMWORK IN THE DIAGNOSTIC PROCESS

IOM Report Goal #1

"Facilitate more effective teamwork in the diagnostic process among health care professionals, patients, and their families."

IOM / NAM, Improving Diagnosis in Healthcare, 2015

TRANSDISCIPLINARY TEAMWORK

1) MULTIDISCIPLINARY
   - People from different disciplines working together, each drawing on their disciplinary knowledge
2) INTERDISCIPLINARY
   - Integrating knowledge and methods from different disciplines, using a real synthesis of approaches
3) TRANSDISCIPLINARY
   - Creating a unity of intellectual frameworks beyond the disciplinary perspectives

Stember, Social Sci J 1991

Diagnostic Errors
PHYSICIAN TEAMS

PHYSICIAN-PHYSICIAN COLLABORATION

1) Informal consultations ('curbside,' email listserv)
2) Formal consultations (including tele-consults)
3) Tests ordered (e.g., radiology, pathology, '-scopy')
4) Multidisciplinary teams (e.g., cancer)
5) Diagnostic management teams (e.g., coag labs)
6) Crowdsourcing[+] (e.g., Human Dx project)

Newman-Toker

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TELE-DIZZY CONSULTATION SERVICE

Device-based Decision Support - AVERT (NIH Phase II RCT)

Newman-Toker et al., Stroke 2013

MULTIDISCIPLINARY CANCER TEAMS

Fig. 2. Changes in Gleason grade after JHH MDC evaluation among 865 men with known Gleason grade at time of referral.

PROSTATE CANCER
- 21.5% changed
- 13.3% upgraded
- 8.2% downgraded

PANCREATIC CANCER
- 18.7% changed
- 12.8% upgraded
- 4.4% downgraded

Sundi et al., 2015   Pawlik et al., 2008

LAB DIAGNOSTIC MANAGEMENT TEAMS

Laposata et al., 2004

HUMAN DIAGNOSIS PROJECT

...combining insights from many into one

Collective doctor outperforms >98% of doctors

Shantanu Nundy, 2016

Diagnostic Errors
NURSES & AHPS

HUMAN DIAGNOSIS PROJECT

DE GRUYTER   Diagnosis 2016; 3(2): 49–59

Dana B. Thomas and David E. Newman-Toker*

Diagnosis is a team sport – partnering with allied health professionals to reduce diagnostic errors

A case study on the role of a vestibular therapist in diagnosing dizziness

Thomas & Newman-Toker, 2016

BARRIERS TO ENGAGING NURSES & AHPS

1) LOGISTICAL
   ▸ Separate clinic spaces; segregated for inpatient team

2) REGULATORY
   ▸ Legal & ethical constraints on scope of practice

3) SOCIOCULTURAL
   ▸ Bidirectional – not their job; not my job

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BENEFITS OF ENGAGING NURSES & AHPS

1) AVAILABILITY & AFFORDABILITY
   ▸ 10x number of vestibular PTs as neuro-otologists

2) MORE TIME IN DIRECT CARE OF PATIENTS
   ▸ Nurses spend much more time with post-op patients

3) SPECIALIZED EXPERTISE
   ▸ Speech-language pathologists with swallowing disorders

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WHAT MIGHT ENGAGEMENT LOOK LIKE?

CLABSI

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WHAT CULTURE CHANGE MUST HAPPEN?

1) Interprofessional education & communication
2) Introduce "diagnosis is a team sport" concept
3) Appeal to patient-centeredness and safety
4) Secure top-level leadership buy-in and support
5) Use feedback for individual & team calibration
6) Measure & review diagnostic safety culture

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Diagnostic Errors
PATIENT ENGAGEMENT

WHAT CAN PATIENTS DO?

1) Before – COME PREPARED
   ▸ Prepare a 1-page summary of your symptoms

2) During – AVOID BLIND FAITH
   ▸ Ask probing questions about diagnostic possibilities

3) After – KEEP AN OPEN MIND
   ▸ Know what to expect (record with your mobile phone); monitor your progress & consider possible dx error

Newman-Toker
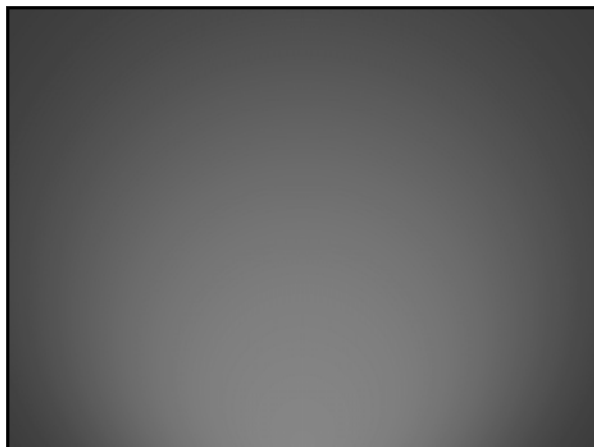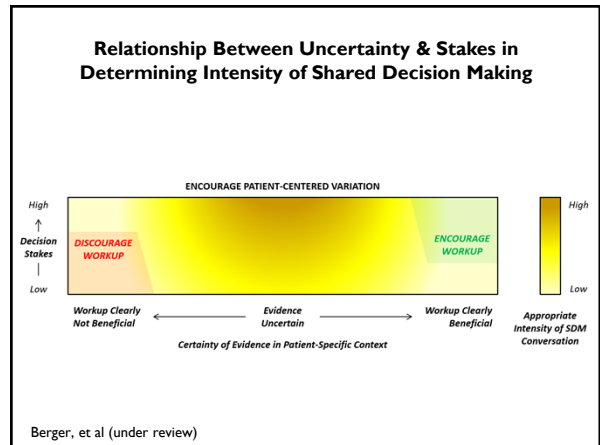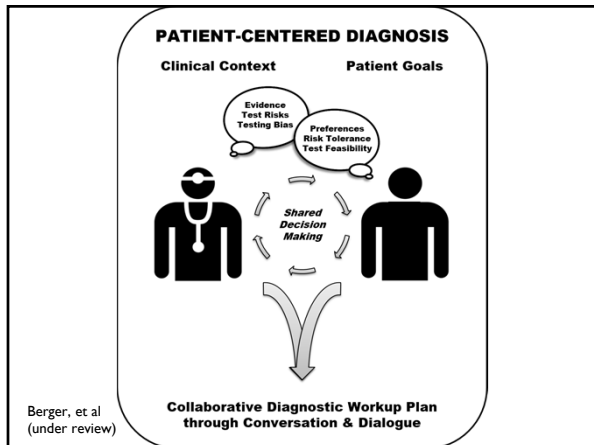
WHAT CAN WE DO FOR OUR PATIENTS?

1) Translation services & cultural sensitivity

2) Patient-centered care & dialogue

   ▸ Relationship building

   ▸ Information exchange

   ▸ Responding to emotion

   ▸ Shared decision making

   ▸ Patient empowerment & self-management

Newman-Toker

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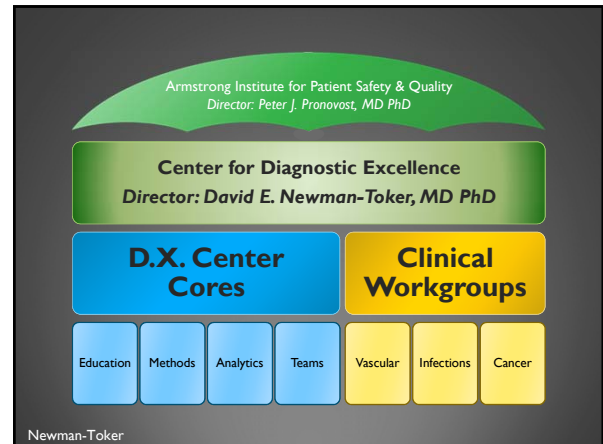
   ▸ Patient empowerment & self-management

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PATIENT-CENTERED DIAGNOSIS

Clinical Context   Patient Goals

Evidence / Test Risks / Testing Bias   Preferences / Risk Tolerance / Test Feasibility

Shared Decision Making

Berger, et al (under review)

Collaborative Diagnostic Workup Plan through Conversation & Dialogue

Relationship Between Uncertainty & Stakes in Determining Intensity of Shared Decision Making

ENCOURAGE PATIENT-CENTERED VARIATION

High / Decision Stakes / Low

DISCOURAGE WORKUP   ENCOURAGE WORKUP

Workup Clearly Not Beneficial   Evidence Uncertain   Workup Clearly Beneficial

Certainty of Evidence in Patient-Specific Context

High / Low   Appropriate Intensity of SDM Conversation

Berger, et al (under review)

Diagnostic Errors
AI D.X. CENTER

D.X. CENTER

▶**Our Mission**:

We will innovate to achieve diagnostic excellence and accountability for Johns Hopkins, the region, and the world by eliminating preventable harms from diagnostic errors, optimizing patient outcomes and experience in diagnosis, and reducing waste in diagnostic assessment.

▶**Who We Are**:

We are a transdisciplinary team of experts in diagnostic research, systems engineering, cognitive psychology, patient-centered communication, education, informatics, biostatistics, and health economics.

Armstrong Institute for Patient Safety & Quality
Director: Peter J. Pronovost, MD PhD

Center for Diagnostic Excellence
Director: David E. Newman-Toker, MD PhD

D.X. Center Cores — Education | Methods | Analytics | Teams

Clinical Workgroups — Vascular | Infections | Cancer

Newman-Toker

LONG-RANGE GOALS (1)

▶RAISE AWARENESS – educate patients, providers, and leaders about diagnostic errors

▶ENGAGE PARTNERS – convene transdisciplinary teams to improve patient-centered diagnosis

▶PRIORITIZE PROBLEMS – measure the frequency and burden of harms from misdiagnosis

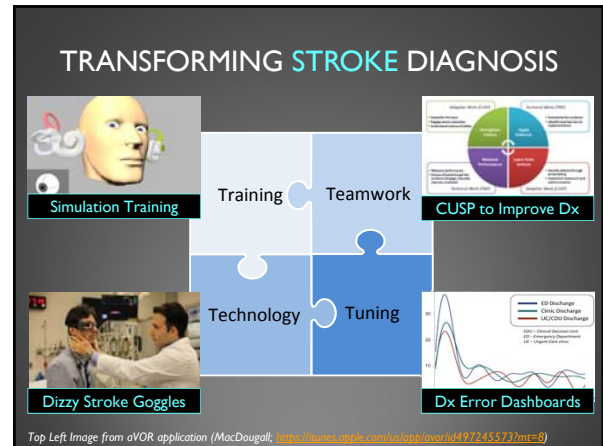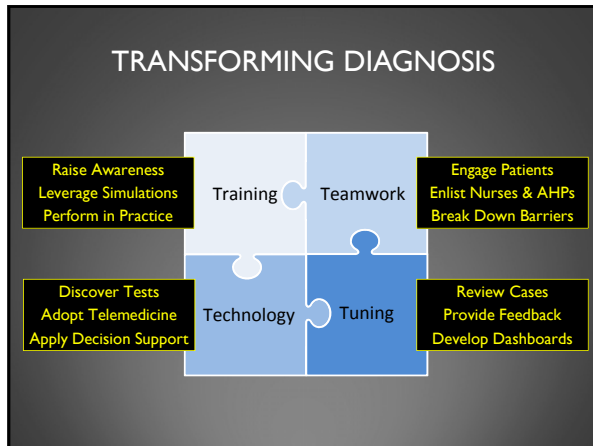▶IDENTIFY CAUSES – find sources of error and envision prevention and mitigation strategies

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LONG-RANGE GOALS (2)

▶IMPLEMENT SOLUTIONS – leverage technology to achieve diagnostic excellence in practice

▶MEASURE IMPACT – measure effects on diagnostic accuracy, efficiency, value, and satisfaction

▶BUILD CAPACITY – foster the next generation of academic leaders and researchers in diagnosis

▶INFLUENCE POLICY – advocate for appropriate performance metrics and diagnostic research funding

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IMPROVING DIAGNOSIS IN HEALTHCARE

1. Make nurses/AHPs/patients part of dx team
2. Teach clinical reasoning & cognitive errors
3. Leverage health IT to improve diagnosis
4. Monitor dx performance & give feedback
5. Change culture to avoid blame & shame
6. Encourage open reporting & liability reform
7. Use payment reform to promote diagnosis
8. Coordinate and increase research funding

Newman-Toker, Paraphrasing IOM/NAM Goals 2015