Diagnostic Error

LEARNING RESOURCE FOR CLINICIANS

CLINICAL
EXCELLENCE
COMMISSION

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LESSON 1

DIAGNOSTIC ERROR – THE BASICS

WHY SHOULD I CARE? WHAT IS IT?

WHERE, WHEN, AND HOW OFTEN WILL IT HAPPEN?

WHAT ARE THE CAUSES?

Estimated Time of Completion: 20 minutes

Learning Objectives: After completing this lesson, you will be able to:

1. Define diagnostic error
2. Describe where and when diagnostic error is likely to occur
3. Estimate the odds of diagnostic error in your own practice, and in general
4. Define the two major causes of diagnostic error: System-related and cognitive breakdowns

WHY SHOULD I CARE?

There are two powerful and convincing reasons to address diagnostic error:

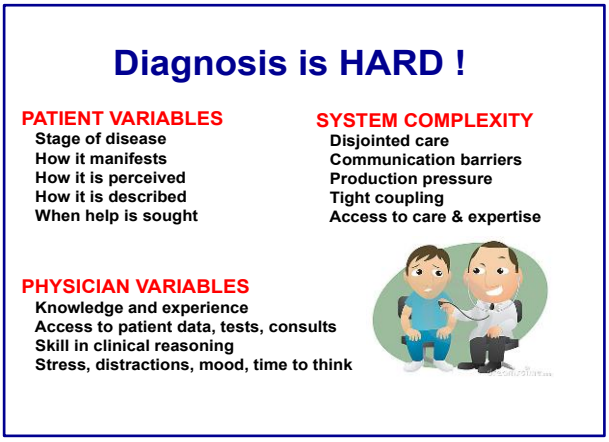
1. It could happen to you! We will all be patients someday. If you become ill, you have just two questions: What do I have and when will I get better? The answers all start with making the correct diagnosis, as quickly as possible. One in three people surveyed report having experienced a medical error in the past 5 years involving themselves, their immediate family, or closest friends. Half of these are diagnostic errors, and many are associated with permanent harm or death. Diagnostic error is the most common concern of patients being seen in Emergency Departments.

2. Diagnosis is a defining characteristic of our professional role as physicians. We share a moral obligation to make the diagnostic process as reliable, accurate, efficient, and safe as we possibly can. We all want to excel at diagnosis, and to minimise diagnostic error in our own practice and in our own organisations. "First, do no harm."

Diagnosis is …"the most critical of a physician's skills. It is every doctor's measure of his abilities. It is the most important ingredient in his professional self-image". *Sherwin Nuland, 1993*

THE CHALLENGE OF DIAGNOSIS

Diagnosis has been described in many different ways: like solving a puzzle, as ferreting out the answer to a mystery, and as putting a name on a complaint. Diagnosis is the process of trying to understand the nature of a patient's problems to clarify their prognosis and treatment options. Regardless of how you define it, diagnosis is quite possibly the most difficult cognitive challenge that exists. This reflects the complexity, variability, and uncertainty that exists at every step of the diagnostic process. Although there are thousands of diseases, the human body can respond in only a limited number of ways. A complaint of weakness or fever, for example, or fever, could be the presenting sign in literally thousands of diseases. Which one is it? Each new patient is a new puzzle, a new mystery to be solved.



The number of possibilities to consider is very large and growing all the time. There are two organisations that track the number of diagnoses: The World Health Organisation, through its International Classification of Disease, lists over 12,000 diagnoses in the latest compilation. The National Library of Medicine identifies over 8000 diagnoses in its "Medical Subject Headings" (MESH) system. Every year, hundreds of new diagnoses are added, as definitions and criteria for identifying them improve.

How Many Diseases are There ?

World Health Organization:

– ICD 1	1893	161
– ICD 8	1965	1000+
– ICD 9	1979	8000?
– ICD 10	1999	12,420

World Health Organization

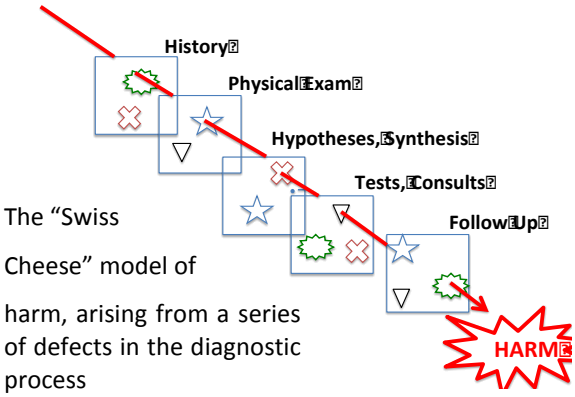
NATIONAL LIBRARY OF MEDICINE

NLM:
8000 MESH terms
Growing - 200+/year

DIAGNOSIS AS A SUCCESS STORY

Given the uncertainty and complexity that exists every step of the way, the fact that clinicians 'get it right' so often is quite remarkable. According to best estimates, the diagnosis is correct roughly 90% of the time. The challenge, of course, is to do just a bit better, because every diagnosis that is incorrect or missed carries the risk of harm.

WHAT IS IT? DEFINITIONS OF DIAGNOSTIC ERROR



The "Swiss Cheese" model of harm, arising from a series of defects in the diagnostic process

<u>Breakdowns in the diagnostic process and missed opportunities</u>

The diagnostic process refers to all the steps involved in deriving and confirming the diagnosis. Identifying breakdowns at one or more steps of the diagnostic process is one way to define diagnostic error. These breakdowns reflect 'missed opportunities' to have made the diagnosis more accurately or more efficiently.

<u>Defining errors in retrospect</u>

Errors seem much easier to recognise looking back on them. Autopsies are considered the 'gold standard' for identifying diagnostic errors. Major diagnostic errors at autopsy are defined as instances of disagreement with the clinical findings, where the management and possibly the outcome could have changed, if

the true diagnoses had been known. Autopsies are on the decline, but diagnostic information that is close to definitive can also be obtained from biopsies, cytology, and highly-specific diagnostic test results. With this kind of information, three types of diagnostic error can be defined:

- Missed — No diagnosis was ever made
- Wrong — A diagnosis was made, but not the correct diagnosis
- Delayed — The correct diagnosis was made, but not in a timely manner

There is substantial overlap in this classification, because in many cases of delayed diagnosis, the wrong diagnosis was considered initially. Defining a delay is also difficult, because diagnosis always plays out over time, be it hours, days, or years, and there are no agreed-upon standards for what constitutes an unacceptable delay. Until these standards exist, only the most egregious delays can safely be categorised as examples of a delayed diagnosis.

Case example: A 64 year old male chronic smoker presents with symptoms of an upper respiratory condition with a prominent cough and fever. Oral antibiotics are prescribed and the fever resolves but the cough persists. A chest X-ray is ordered and shows a lower lobe area of consolidation, spiculation and hilar adenopathy all suggestive of malignancy. The report is sent to the ordering physician who has moved to another city, and is not reviewed until the patient returns 3 months later to see a new provider who notices the X-ray report.

Analysis: This case reflects delayed diagnosis due to both system-related and cognitive error. The malignancy could and should have been detected earlier. The original physician was responsible for following up on the X-ray as part of the diagnostic process but did not. The system process for relaying critical test results was ineffective, and there was no process in place to 'close the loop'. No one told the patient to insist on seeing the test results.

UNDER-, OVER-, AND MIS-DIAGNOSIS

Diagnostic error, or misdiagnosis, typically refers to situations where the correct diagnosis was missed or should have been made sooner. An emerging concept in the field of population health is to also identify situations of under- and over-diagnosis. Just like mis-diagnoses, these can lead to avoidable harm and costs.

Under-diagnosis typically refers to populations of patients with a known medical condition that have yet to be diagnosed. If treatment for the condition is available and effective, these

UNDERDIAGNOSIS
"An estimated 21% of people living with AIDS are undiagnosed."

diagnostic errors will cause harm. Many diagnostic errors could be avoided, for example, if patients receive appropriate screening for breast, colorectal, and cervical cancer. Patients who have little or no access to medical care are obviously a population at increased risk for under-diagnosis.

OVERDIAGNOSIS

"Some men with elevated PSA levels are found to have low-grade prostate cancer. Treatment can cause them to become incontinent or impotent, even though the cancer would not have progressed."

Over-diagnosis refers to a diagnosis that is correct, but irrelevant because the disease is not expected to cause the patient any symptoms, or death. The problem is important in situations where patients are treated, because the treatment cannot have true benefit, but can cause harm. The harm may be psychological (the patient is forever labelled as having a 'disease') or physical (harm from a side effect of the treatment).

Over-diagnosis also refers to the medicalisation of non-diseases. For example, an elderly patient with a blood pressure of 126/84 could be labelled as having 'pre-hypertension' according to guidelines, but this could also be considered a value in the upper range of normal. Testosterone levels in men normally fall with age, but by labelling this a new "Low-T" syndrome, the pharmaceutical industry creates the message that this is a well defined disease condition that should be treated with androgens.

WHERE, WHEN, AND HOW OFTEN WILL ERRORS OCCUR?

There is substantial evidence that one in every 10 diagnoses is wrong. Although the great majority of diagnostic errors are caught in time, or are inconsequential, they can also result in substantial harm. According to best estimates, diagnostic error is one of the top ten causes of death in countries with modern healthcare systems, and also one of the top reasons for patients to file a claim of malpractice. Roughly one in every 1000 diagnostic encounters results in harm. This helps explain why we may only rarely encounter a patient harmed by diagnostic error in our own practice, but at the level of a healthcare organisation or a nation, these numbers add up. Being overconfident about our skills and our decisions is just human nature, and this is re-enforced in medicine because we get relatively little high-quality feedback; autopsies are disappearing, our colleagues are reluctant to tell us about our errors that they've discovered, and patients who experience medical errors often change providers rather than confront their physician.

TYPES OF EVIDENCE SUGGESTING DIAGNOSTIC ERRORS ARE COMMON

AUTOPSY	Major diagnostic errors are found in 10 – 20% of cases.
SECOND REVIEWS	Up to 30% of breast cancers are missed on mammography. 2% or more of cancers are missed on biopsies.
SURVEYS	Over half of surveyed clinicians report making a diagnostic error at least once or twice a month
CASE REVIEWS	The median delay in making the correct diagnosis of asthma is 3 years. Fatal delays in diagnosis are seen in over a third of patients with aortic dissection.
STANDARDISED PATIENTS (SECRET SHOPPERS)	13% of 'patients' with common conditions (eg. rheumatoid arthritis or COPD) are mis-diagnosed in ambulatory practices.

The Emergency Department is the natural laboratory for studying diagnostic error, given the many factors that detract from optimal diagnostic conditions in this setting, including time pressure, distractions, incomplete access to information, and the fact that the physician typically has never seen the patient before. But diagnostic errors occur in every healthcare setting, including primary care clinics, inpatient wards, and sub-specialty practices. Although diagnostic errors are seen even in common conditions, like anaemia, unusual conditions are definitely a risk factor.

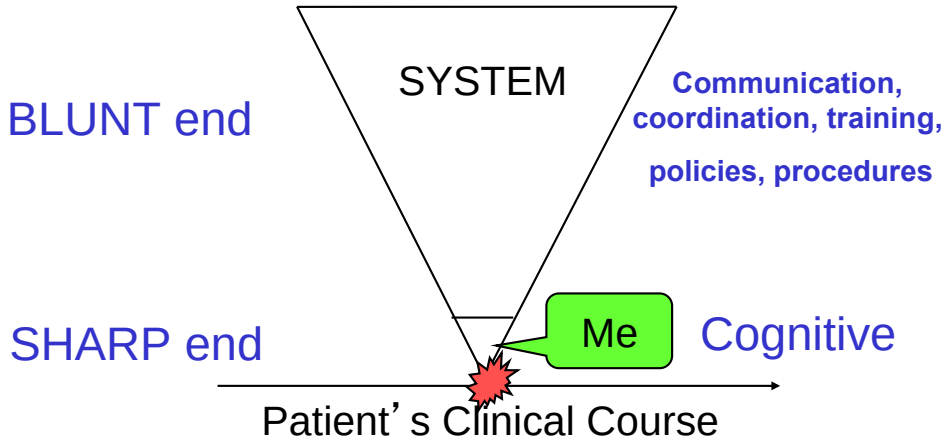
WHAT ARE THE CAUSES?

Most diagnostic errors are, at least in theory, preventable. In any given case, there are typically multiple contributing factors.

<u>The Sharp end: Ourselves</u>

Most diagnostic errors involve a cognitive slip that the physician makes at the 'sharp end' of clinical care, at one or more points in the diagnostic process. As examples, we may miss a key aspect of the history, overlook an important finding on physical exam, not know the best test to order, or fail to consider the correct diagnosis.

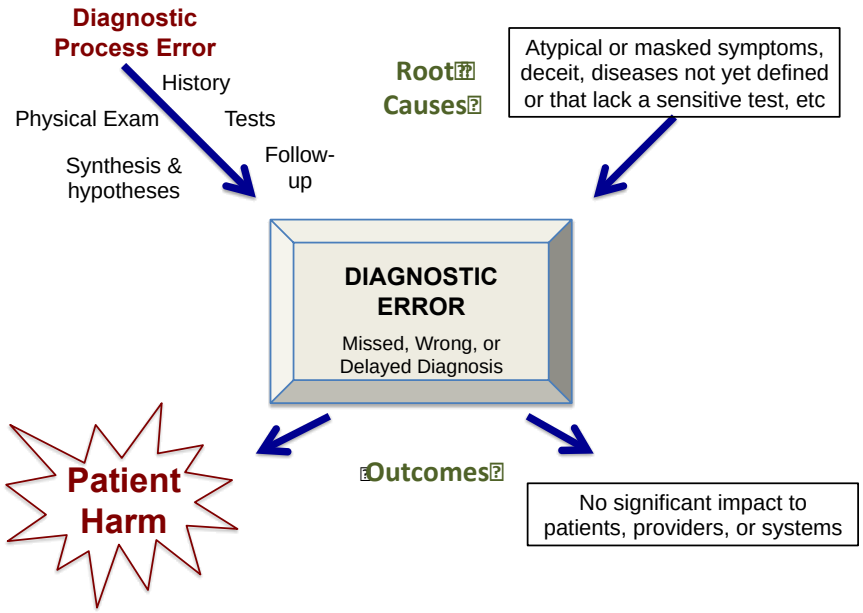
Causes of Diagnostic Error



The Blunt end: Our system

Most diagnostic errors also involve breakdowns in the 'blunt end', that is, all of the system-related factors that impact on diagnostic quality and timeliness. Our training, our experience, our environment, the diagnostic services that support us (the clinical laboratory and radiology), the culture in our organisation, and a host of other 'system' factors all play a role in how efficient and how effective we are in diagnosis.

Some diagnostic errors are simply unavoidable, and aren't easily classified as system-related or cognitive breakdowns. For example, a malignancy may be too small to detect with current technology, or a disease may present in some atypical fashion or before the symptoms are well developed. Patients may be unable to communicate, may present misleading stories on purpose, or may disregard suggestions for further diagnostic evaluation. A patient may also present with a disease that hasn't been described before, probably a very remote occurrence, even though every disease we now know started off this way!



Summary Points

- Diagnostic errors are common. Most do not have serious consequences, but roughly one in every thousand diagnostic encounters involves a diagnostic error that causes harm, making the errors appear unusual to a provider, but common at the level of a healthcare organisation or country.
- Diagnostic errors can best be defined retrospectively once the true diagnosis is known. If the true diagnosis is not known, breakdowns in the diagnostic process can be identified and studied.
- Diagnostic errors occur in every healthcare setting. The Emergency Department is at highest risk.
- Diagnostic errors are encountered in diagnosing both common and unusual conditions.
- The basic causes of diagnostic error reflect weaknesses in our healthcare systems and in the cognitive aspects of the diagnostic process.

OPTIONAL EXERCISES AND RESOURCES

1. Ask your 5 closest colleagues if they can recall a diagnostic error they've encountered (or made themselves) in the past month.
2. For 1 day, write down all of the system-related factors you encounter that ENHANCE the quality of diagnosis or DETRACT from it.
3. Ask the Risk Manager of your practice or organisation if they have identified any diagnostic errors this past year.
4. Of the next 10 patients you see, what fraction of eligible patients have had recommended screening tests for breast, colorectal, or cervical cancer?

VIDEOS

Jess' Story: Do No Harm. (10 min) The death of a teenager due to diagnostic error in recognising the long-QT syndrome. Her loss-of-consciousness episodes were attributed to a seizure disorder. The case richly illustrates both cognitive and system-related breakdowns.

The Lewis Blackman Story (6 min) The death of an adolescent boy from a ruptured ulcer, diagnosed originally as constipation.
http://www.youtube.com/watch?v=WElE_hRucpo

Free, but requires registration:

- Robert Wachter: Diagnostic Error as a Patient Safety Issue (10 min)
- Mark Graber: Diagnostic Error in Medicine (45 min)
- Gordy Schiff: Introduction to Diagnostic Errors in Medicine (10 min)

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LESSON 2

HOW DOCTORS THINK – THE COGNITIVE ORIGINS OF DIAGNOSTIC ERROR

THE DUAL PROCESS PARADIGM

CLINICAL REASONING IN ACTION

COGNITIVE CONTRIBUTIONS TO DIAGNOSTIC ERROR

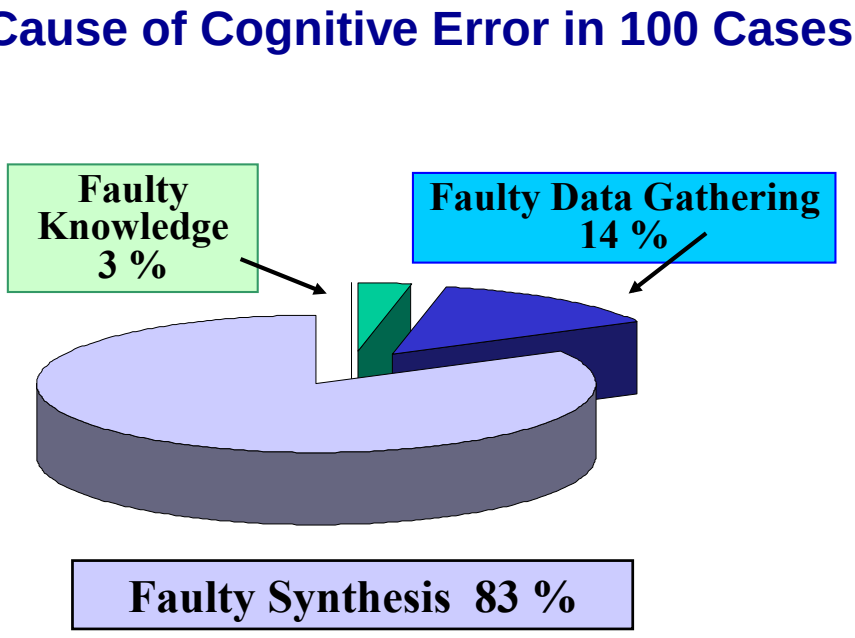
Estimated Time of Completion: 20 minutes

Learning Objectives: After completing this lesson, you will be able to:

1. Describe how clinical decision-making evolves from the interplay of intuitive cognition (System 1) and deliberate consideration (System 2)
2. List common breakdowns in each of these pathways that contribute to diagnostic error
3. Relate how expertise evolves from applying knowledge in practice, obtaining feedback on performance, and incorporating this into improvement

INTRODUCTION

The majority of diagnostic errors involve cognitive errors of one sort or another, and typically several different cognitive flaws can be identified in the same case. Diagnosis involves collecting all the facts in a case, and applying medical knowledge to solve the problem. Although diagnostic errors can involve knowledge deficits (especially for early trainees!), or faulty data gathering, by far the most common breakdown is in synthesising all of the available data – putting everything together to arrive at the diagnostic possibilities.



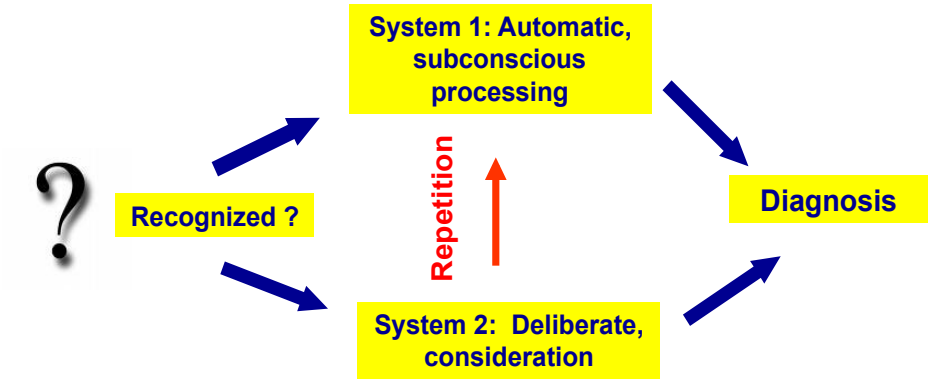
Faulty knowledge is rarely the cause of diagnostic error because most patients present with common conditions we are familiar with. According to estimates, just 100 conditions account for over 95% of the patient diagnoses a physician will see in the average year. On the other hand, the Library of Medicine MESH system lists over 8,000 distinguishable diseases and this number grows with the addition of several hundred newly-recognised conditions each year. Diagnosing a rarely-seen disease is difficult, or impossible if you aren't aware of it at all.

Faulty data gathering typically reflects sub-optimal collection of the patient's history, missing key findings on the physical exam, or problems ordering diagnostic tests or appropriately interpreting the results.

THE DUAL PROCESS PARADIGM

Problems in the synthesis phase of diagnosis, where we generate the diagnostic possibilities to consider, are the most common cause of cognitive errors. According to the current paradigm that describes human decision-making, the analysis process begins with the question of recognition. If we recognise the problem, the diagnosis is immediately apparent, within milliseconds. This is System 1, an intuitive, subconscious, automatic process that characterises expert-level problem solving.

If we don't recognise the problem, we resort to deliberate, conscious consideration (System 2), a process that takes time and effort. All medical trainees start off using System 2 to solve clinical problems, and as they gain knowledge and experience, these same problems become ingrained. This same sequence is followed if you are learning a new musical instrument, or acquiring a new sport skill. At first, everything requires your full thought and attention, but with time it all becomes automatic.



Experts typically use System 1 in problem solving because they are so familiar with most problems in their field. The great majority of problems seen by clinicians in practice are common ones that they have encountered many times before, and these are recognised immediately and accurately. We use System 1 constantly in our everyday lives as well; almost all of our actions and encounters are familiar ones that we carry out with little, if any, conscious consideration. As a result, we come to trust our intuition in these settings, just as we trust the intuitive diagnoses we make on our patients.

HEURISTICS

The mental shortcuts used in problem solving are called heuristics. Over 100 different heuristics have been described. We are all familiar with extrapolation, for example: If you saw a patient with a new cough that developed within the first few weeks of starting a newly-marketed ACE inhibitor, you might consider that the cough was a side effect of the new drug. This would be an extrapolation from your knowledge that other ACE inhibitors commonly cause a cough. The two heuristics most commonly discussed related to diagnostic problem solving are representativeness and availability:

Representativeness - Related or perhaps identical to the pattern-matching that initiates System 1 cognition, clinicians solve many diagnostic challenges by comparing the key features of a new case with the key features of the disease patterns they have learned (the illness scripts). Example: A dialysis patient with new-onset of chest pain that radiates to the back and is associated with a cardiac friction rub is likely to have …. pericarditis.

Availability - A diagnosis may just immediately spring to mind because we're so familiar with how that disease presents. The diagnosis is 'available'. Example: An elderly patient with a vesicular rash in a dermatomal distribution has ….. shingles.
Heuristics all operate at a subconscious level and are generally successful in helping us arrive at a diagnosis. Unfortunately, they are all imperfect at problem solving.

THE COGNITIVE ORIGINS OF DIAGNOSTIC ERROR

AVAILABILITY

PROS:
Typically leads to the correct diagnosis, because the conditions most 'available' to recall are the conditions that are the most common in our patient population. The odds therefore greatly favour our having made the right choice. Also, like all heuristics, arriving at the answer is fast and effortless.

CONS:
Favouring the first diagnosis that comes to mind implies that other possibilities weren't considered; we didn't use System 2 to create a differential diagnosis. Just because a diagnosis is 'available', doesn't mean it is correct. In particular, we will always miss the diagnosis of a condition we've never seen before. Finally, we are overly influenced by dramatic cases or a 'big case'. Example: a resident ultimately establishes a diagnosis of sarcoidosis in a patient presenting with fever, cough and pulmonary infiltrates. That resident may be more likely to consider sarcoidosis in the next patient who presents similarly, even though common community-acquired pneumonia is a much more likely possibility.

Unfortunately, neither System 1 nor System 2 is error-proof. Diagnostic errors can reflect breakdowns in either of these pathways, and also commonly involve failure of System 2 to carry out its normal oversight of System 1. In these cases we simply trust our intuitively-derived diagnosis inappropriately, and overconfidence in our decision making is a well-established human trait.

Breakdowns in System 1

System 1 is susceptible to a very large array of cognitive shortcomings that singly or in combination contribute to diagnostic error. The most common problems are:

Context and framing errors - All problem solving begins with trying to make sense of the available facts. When a patient presents with a new problem, the sense-making process results in a 'problem representation' that is hopefully accurate and non-biasing. Unfortunately, we can be easily misled. If a patient presents with abdominal pain, we tend to think the problem is gastrointestinal when it may not be. If we are told by a referring provider that he is sending us a patient with decompensated heart failure, we tend to accept this problem representation without considering other causes of shortness of breath and oedema.

Anchoring and confirmation bias - Once we settle on a preliminary diagnosis, we often become too attached to it. This leads to our placing too much weight on confirmatory findings and not enough on contradictory or unexplained findings.

CONTEXT ERRORS

AVIATION: The pilot thinks the wings are ice-free but they aren't.

MEDICINE: Seeing a patient with advanced COPD, the ER physician interprets the patient's new shortness of breath as an exacerbation, without considering the possibility of other causes (eg. pulmonary embolism).

ANCHORING

A child is admitted with a diagnosis of bronchiolitis and pneumonia, but fails to respond to antibiotic therapy over the first week or to an augmented regimen the second and third weeks. Ultimately, a diagnosis of combined immunodeficiency is established, a diagnosis that could have been considered much sooner.

Search satisficing - Once we've solved the puzzle and explained all the findings, we tend to be satisfied with our solution and quickly move on to the next patient or problem. This is another universal human trait, and may be the most common of all the cognitive dispositions to diagnostic error. Instead of using an optimal approach to decision making (i.e. constructing a full differential diagnosis) we 'satisfice' and accept the first reasonable answer that comes along.

Breakdowns in System 2

Diagnostic errors involving System 2 most often reflect simply not following the 'rules' of the diagnostic process appropriately. For example, we miss a key finding in the history, our physical exam is perfunctory or inept, or we fail to adequately review the medical record and the existing data. Other problems involve not having an appropriately broad base of medical knowledge, lacking skills in evidence-based practice and decision making, or failing to consider the possibility of a false-positive or a false-negative test.

Example of a System 2 Error: Misunderstanding the power of tests

QUESTION: Phenylketonuria is a devastating disease, with an incidence of 1/14,000 births. It can be detected at birth with an accurate blood test that has a sensitivity and specificity of 99.9%. An infant tests positive for PKU and the resident tells the parents that the disease is likely. Is this true?

ANSWER: The likelihood of disease is still low. The specificity of 99.9% means that 1 child in 1000 will have tested positive for PKU but doesn't really have the disease. If you tested 14,000 infants, one is likely to have PKU and would be detected by the test, but 14 infants would have false-positive tests. The likelihood of having PKU with a positive test is therefore 1 in 15, or about 7%.

	PKU EXISTS	PKU ABSENT
TEST IS POSITIVE	1	14
TEST IS NEGATIVE	0	13,985

Affective bias - Our emotions and feelings can also contribute to diagnostic error. We are sometimes 'turned off' by a patient who is a bad historian, antisocial, abusive or uncooperative. Similar problems may arise when seeing patients who are alcoholic, morbidly obese, or appear to be drug seeking. In these situations the reliability of diagnosis may be degraded unless a conscious effort is made to overcome these biases. Conversely, cognitive errors are also more likely when caring for friends and

relatives; we aren't as objective and careful as we might otherwise be, we are less likely to recommend invasive testing, and we tend to discount worse case scenarios.

EXPERTISE

Expertise in clinical problem solving evolves from our ability to aggregate medical knowledge and experience into 'illness scripts' that capture the essence of a medical condition as a recognisable entity. When we confront a new patient, we first try to make sense of the situation by, either consciously or subconsciously, developing a concise summary, called a problem representation. For familiar conditions, the problem representation then evokes an available illness script, and the diagnosis emerges immediately via System 1.

Expertise depends on amassing ever more knowledge and experience, augmented by frequent, appropriate, and detailed feedback that can be incorporated into future performance. There is no quantitative measure of expertise in medicine. Experts are therefore most commonly identified by their peers, using the definition of Shanteau, "as those who have been recognised within their profession as having the necessary skills and abilities to perform at the highest level." Experts, by definition, make the fewest errors, have the greatest degree of situational awareness, and are most able to predict future events. Experts will also excel at problem solving using intuitive responses, as summarised by Simon: "The situation has provided a cue: This cue has given the expert access to information stored in memory, and the information provides the answer. Intuition is nothing more and nothing less than recognition."

An interesting aspect of intuition is that our confidence in it does not correlate very well with its accuracy. As reviewed in Module 5, just because a diagnosis seems correct doesn't make it so, and even experienced clinicians have difficulty predicting which of their diagnoses are correct or not. Overconfidence is a predictable aspect of human nature, and physicians are no exception: we tend to be overconfident about the accuracy of our diagnoses, and we believe diagnostic errors are far less common than they really are.

Summary Points

- Every diagnosis is derived by some combination of subconscious, intuitive thought (System 1) and deliberate consideration (System 2).
- Although these processes work well most of the time, they are not perfect. Diagnostic errors can arise from shortcomings in either pathway, and from the lack of a cognitive check on answers that derive from System 1.
- Diagnostic errors deriving from System 1 reflect the intrinsic shortcomings of the many different cognitive shortcuts (heuristics) we use to make sense of a situation and to make decisions. The most common errors involve choosing the wrong context or framework to interpret a problem, becoming too attached to the initial diagnosis and failing to consider alternative explanations, and breakdowns in using the various System 1 heuristics.
- Diagnostic errors deriving from System 2 reflect breakdowns in the standard steps of the diagnostic process, or inadequate knowledge, including failure to appreciate the limitations of diagnostic testing.
- Expertise in diagnosis arises from deliberate study, obtaining copious feedback, and having an extensive base of knowledge and experience. By definition, experts make the fewest mistakes.
- A part of human nature is a tendency to be overconfident in our skills and in the wisdom of our decisions. Analogously, we tend to be overconfident of our diagnoses in medicine.

OPTIONAL EXERCISES AND RESOURCES

1) Give yourself 20 seconds for this exercise: What are the objects shown? Did you use System 1 or System 2 to provide the answers?
2) What is more common, the letter R as the first letter of a word, or the 3rd letter of a word?
3) What are the pros and cons of using the 'representativeness' heuristic in diagnosis?
4) Which causes more diagnostic error – System 1 or System 2?

Answers:

1) Most people immediately recognise the telephone and the can opener on the top row (System 1) but then struggle with the bottom two objects. This invokes System 2, as we try to reason out what these are. The two bottom objects are an external hard drive, and another can opener.
2) The letter R is more than three times more common as the 3rd letter of a word, but many people find it easier to think of word that STARTS with the letter R, and choose that as the correct answer. If you chose that option (R as the first letter) you used the availability heuristic and were led to the wrong answer.
3) Pros: Like all heuristics, it's fast, effortless, and typically correct (System 1). It also promotes consideration (System 2) of the differential diagnosis, and consideration of how the typical findings in various diseases compare in trying to differentiate one possibility from another. Cons: It detracts from considering the base rate of disease (i.e. the pre-test probability). Our experience is limited; we may not know of a disease whose features match the findings in our patient.
4) We don't know, and this question is hotly debated. We do know that both are error prone. In terms of which leads to more diagnostic errors, we also know that this will depend on the level of the learner: Novices are typically using System 2 to problem-solve, and most of their diagnostic errors will necessarily derive from System 2 issues. Experts typically solve problems relying on System 1, and their diagnostic errors will derive from shortcomings in this approach.

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LESSON 3

SYSTEM-RELATED FACTORS CONTRIBUTING TO DIAGNOSTIC ERROR

HUMAN FACTORS AND HOW IT INFLUENCES PERFORMANCE

SYSTEM-RELATED ELEMENTS THAT IMPACT THE RELIABILITY OF DIAGNOSIS

DIAGNOSTIC ERRORS RELATED TO DIAGNOSTIC TESTING: RADIOLOGY AND THE LAB

Estimated Time of Completion: 20 minutes

Learning Objectives: After completing this lesson, you will be able to:

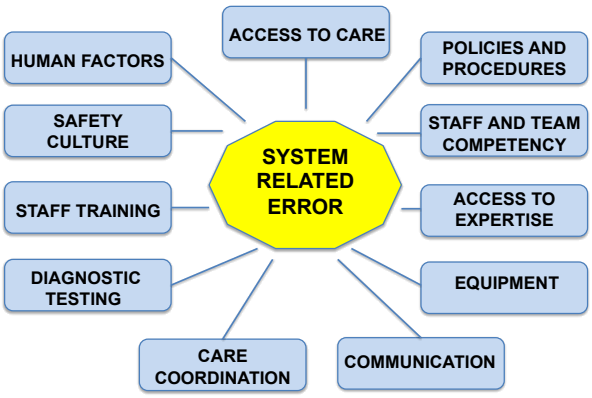
1. Describe how diagnostic quality evolves from the interplay of human decision making and the environment in which this takes place
2. List the most common system-related flaws that contribute to diagnostic error
3. Identify how human factor determinants influence the quality of diagnosis

INTRODUCTION

According to the US Institute of Medicine, the most effective approach to improving patient safety is to design safe systems from the outset, and study existing systems to find and repair the system-related flaws that detract from optimal performance. This advice applies to diagnostic errors as well, and two out of every three cases of diagnostic error involve one or more system-related contributing factors. More importantly, essentially all of the system-related problems that contribute to diagnostic error are considered preventable. Said differently, all systems have subtle but inevitable design flaws, and the sheer number of elements that come into play in the diagnostic process virtually guarantees that problems will arise, some of which will be consequential.

Besides determining the quality of the diagnostic process, system-based qualities also play a key role in determining whether an error results in harm. Well-designed healthcare systems have built-in safeguards to catch errors, help make them recognisable, and mitigate any potential harm.

A systems perspective of the diagnostic process emphasises that the diagnostic process involves, besides the patient and the physician, a host of factors that can influence the success of the diagnostic process. [13]



SYSTEM ERRORS

System errors are the low hanging fruit in efforts to reduce diagnostic error. In part, this reflects the prevailing belief that it will be much more difficult to improve the more cognitive aspects of the diagnostic process. Human behaviour is difficult to manipulate under the best of circumstances, and we face the reality that our brains have evolved over thousands of years to the point that our cognitive tendencies are truly 'hard wired'. There is also abundant evidence that system-based interventions have effectively improved safety in many of the areas where system reengineering has been attempted: Central-line associated infections, medication safety, and preventing wrong-site surgery are all notable examples. In fact, many of the system-related shortcomings that contribute to adverse events in other settings also play a prominent role in diagnostic errors, particularly problems coordinating care and communication.

EXAMPLES – SYSTEM-RELATED DIAGNOSTIC ERROR

DOMAIN	DIAGNOSTIC ERROR EXAMPLE
Access to care	An indigent farmer living in a rural area has persistent cough in the setting of longstanding smoking. There is no local physician or clinic and the patient has never had a screening chest X-ray; delayed diagnosis of lung cancer.
Communication	An elderly patient relates in detail a recent fall and residual wrist pain to a pre-visit nurse. Neither the patient nor the nurse mentions this to the physician, who focuses on the patients 8 chronic conditions; missed wrist fracture.
Coordination of care	A patient is seen by 3 different subspecialists for severe back pain, none of whom can see the notes or impressions of the others; delayed diagnosis of paraspinal abscess.
Availability of expertise	A pneumothorax is discovered by a radiologist reviewing X-rays taken over a weekend shift. The finding was missed by the resident physician who ordered the study.
Culture of safety	Repeated instances of the same error type aren't recognised or addressed. Example: If there were multiple X-rays misread during weekends, evenings and holidays in the ER because radiologists aren't available to read films in real time.
Supervision of trainees	A patient with vasculitis is misdiagnosed by an admitting team of trainees who assume fever, cough, sinusitis, and pulmonary infiltrates reflect community-acquired pneumonia.
Human factor, work design elements	Ascribed to having an excessive workload and being behind schedule, a cursory history fails to include a complete family history; missed diagnosis of inherited coagulation disorder.
Reliability of diagnostic tests	The rhythm interpretation provided by the software of an electrocardiogram machine is incorrect; delayed diagnosis of complete heart block.

HUMAN FACTORS

The field of human factors is dedicated to understanding the spectrum of components that comprise a work system, and how to design these elements to promote optimal human performance and safety. Using basic principles of behavioural psychology and engineering, human factors analyses make up the science that underlies patient safety and, in our case, medical diagnosis. Although we make an artificial distinction between the system-related and cognitive contributions to diagnostic error, using a human-factors perspective is a more appropriate approach to understanding diagnostic error because it focuses specifically on the interface between the two.

To illustrate the complex interplay of these human factor elements, consider the diagnostic process in an Emergency Department. How many different cases is the physician handling at one time? How many distractions and interruptions will arise during the encounter? How chaotic or noisy is the environment? How difficult will it be to contact an expert consultant? Will old medical records be available? How about recent diagnostic tests and consultations? Is a translator available if you need one?

PATIENT-RELATED ISSUES

The first requirement for successful diagnosis is access to medical care. Access problems may be the most common reason for delayed and missed diagnosis, and access can be sub-optimal for many different reasons, including living in a medically-underserved area, lack of transportation, insurance or financial constraints, overcrowded clinics or emergency departments, and limited access to healthcare on nights and weekends.

The second requirement is to establish and maintain an effective medical relationship between the patient and the physician. Ideally, there is enough time and effort expended at the first visit to establish a collaborative relationship and obtain a meaningful and complete history. Diagnosis will suffer if communication isn't open and complete, if trust isn't established, or if goals aren't aligned. In these situations, the patient may not relate all the essential facts in their medical history, they may hide 'hidden agenda' issues (depression, abuse, fear), or they may be less than fully cooperative in carrying through with diagnostic testing recommendations. Patients who are frankly dishonest or misleading are rare, but invariably create interesting diagnostic challenges. More commonly, patients may simply misunderstand the significance of certain information, resulting in misinterpretations on the part of the physician or patient.

COMMUNICATION AND COORDINATION OF CARE

Breakdowns in communication and care coordination lead the list of system-related issues in every type of adverse event in healthcare, and diagnostic errors are no exception. To begin with, this reflects the enormous importance of communication in establishing a diagnosis.

Communication between the physician and the patient is critical. Various authors have asserted that the diagnosis is evident from the history alone in 80 – 90% of cases; if communication during the initial encounters is suboptimal, diagnostic reliability will suffer. Emphasising this point, patients who are unable to communicate for any reason (infants, patients intubated or unconscious, foreign language speakers) are highly predisposed to diagnostic error.

Communication between the physician and other healthcare professionals is equally problematic. Communication and coordination problems arise because diagnosis typically plays out over time, space, and providers. Patients can see a sequence of physicians and consultants over a period of days, weeks, or months and these interactions can occur in different clinics, emergency departments, and inpatient wards. Suboptimal communication at any one of these interfaces creates the opportunity for diagnostic error.

EXAMPLES OF COMMUNICATION PROBLEMS LEADING TO DIAGNOSTIC ERROR:

Handover failures: Healthcare increasingly relies on handovers from one provider to another. Studies indicate that handovers are too often incomplete, inadequate, or absent altogether. Conversely, transitions that are well done represent an opportunity to catch errors and improve care.

Documentation failures: Medical records may be unavailable, unreadable, or incomplete. Electronic medical records solve many of these problems but create new errors through sloppy copy\paste usage, selecting the wrong patient's record, and other problems.

Communication failures: with consultants, radiologists, pathologists, and the clinical lab.

Inadequate time for diagnostic evaluation: With clinic appointment times progressively shrinking and ER workloads progressively expanding, the time available with the patient to obtain the history and physical exam and then think about this case, is growing

shorter. Many experts believe this is the single most important cause of diagnostic errors today.

COMMUNICATION

The single biggest problem in communication is the illusion that it has taken place.

George Bernard Shaw

DIAGNOSTIC TESTING

Problems relating to diagnostic testing are identified in 50 – 80% of diagnostic errors. Although failures in the analytical phase of testing are still encountered (for example, false-positive or false-negative tests) these errors are increasingly rare in modern laboratories. Most problems now involve pre- or post-analytical errors, and some examples will illustrate these:

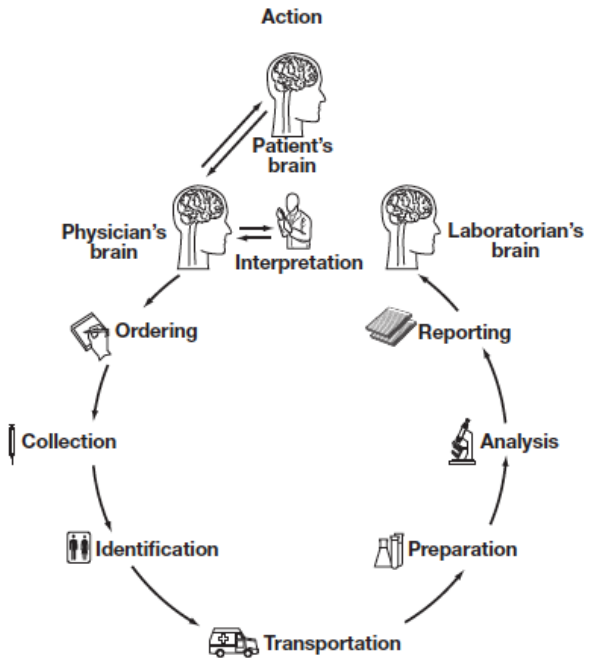


Figure 1 The brain-to-brain loop for laboratory testing 40 years later.

Pre-analytical errors - By the physician: Ordering the wrong test or test series, especially for unusual tests.
By the lab: Sample labelled or processed incorrectly.

Post-analytical errors – By the physician: Delay in reading results; misinterpreting results; failure to appreciate interfering substances; delays acting on results.
By the lab: Results sent to the wrong provider; corrected results not reported in a timely manner; failure to follow-up on receipt of critical test results.

DIAGNOTIC TESTING FACTS

- Modern reference laboratories offer over 10,000 diagnostic test options and the list is growing rapidly because of expanding options for genetic testing
- Increasing use of diagnostic testing and imaging are the factors contributing the most to the rising cost of healthcare
- 10 – 20% of ordered tests are considered inappropriate or redundant
- A full time primary care provider will review over 900 discrete test results per week and 60 - 70 radiology or pathology reports
- 41% of inpatients have test results still pending at discharge. 40 – 60% of patients seen in Emergency Departments have test results still pending at discharge.
- 5 – 10% of critical alerts are not acted upon within 30 days
- Only one in three ambulatory care physicians use a reliable practice to ensure receipt of ordered test results

AVAILABILITY OF EXPERTISE

Diagnosis is often constrained by the available resources. The spectrum of available expertise varies enormously depending on where you live. At one end of the spectrum, patients living in rural, medically-underserved areas may only have access to a lay person or medic; at the other extreme, patients being seen in large academic medical centres have access to all the best that modern medicine has to offer. The quality of diagnosis will parallel the resources and expertise that can be applied in any given case, and factors that detract from optimal diagnosis exist at even the best medical centres. For example, there may be challenges accessing appropriate expert consultants in a timely manner. A common problem is having access to Radiologists available 24\7 to read imaging studies – to the extent that if studies are not read in real time by experts, diagnostic quality and timeliness will be less than ideal. A related problem involves medical care provided by trainees. Appropriate supervision is a pre-requisite to avoid diagnostic errors.

CULTURE

The ‘safety’ culture in any setting is a major determinant of the ability to improve healthcare quality and safety. Improving the reliability of the diagnostic process

requires moving *away* from a culture of blame and indifference, and *towards* a culture of openness, learning, and improvement.

Formal surveys of safety culture are now widely used, and several elements related to diagnosis can supplement these evaluations of the culture climate:

- Timeliness of consults: Are there guidelines for providing timely consultations and are these followed?
- Availability of records: Are medical records and recent test results available for patient care?
- Normalisation of deviance: Are there instances of the same system-related problems recurring over and over?
- Interpersonal relations: Are relations among consultants and peers collegial?
- Open discussion and learning: Are there case conferences to review root cause of diagnostic error cases and consider approaches to improving care?

Summary Points

- System-related elements are identified in most cases of diagnostic error, reflecting the major influence that our environment exerts on the quality of the diagnostic process. The science of human factors analysis describes how our performance is determined by our interaction with our environment.
- System-related flaws are considered to be the low-hanging fruit in efforts to reduce diagnostic error, and diagnostic errors that derive from system-related shortcomings are generally thought to be preventable.
- Inadequate communication and problems coordinating care are the most common system-related factors identified in cases of diagnostic error. Having expertise available when needed and supervising trainees are other critical areas.
- Accurate diagnosis relies on accurate and timely diagnostic testing. There is a small, but non-negligible, error rate associated with both clinical laboratory testing and diagnostic imaging. Increasingly, these errors arise in the pre- and post-testing steps involving the clinician who ordered the test and is interpreting the results.

Case Study: System-Related Diagnostic Error

Case

A 56 year old male was admitted to the ICU with an 8 day history of increasing cough, fever, shortness of breath, hypoxemia, and pulmonary infiltrates. The admitting diagnosis was pneumonia and the patient was started on intravenous broad-spectrum antibiotic coverage. A Nephrology consult was requested to investigate a slightly elevated creatinine and the possibility of Wegener's granulomatosis or a related multi-system vasculitis was raised, with the recommendation to obtain cANCA and related serologies. The tests were ordered, but the patient expired of massive pulmonary haemorrhage 3 days later. Autopsy was consistent with vasculitis and the cANCA eventually returned strongly positive, consistent with the diagnosis of Wegener's granulomatosis. On investigation, it was learned that the cANCA serum was in the laboratory freezer awaiting the providers to fill out a special 'send-out' test request form. An email had been sent to the ICU team about this, but none of the team members (medical residents) read intra-hospital emails. Further, they were unaware of the requirement for filling out a send-out test request form.

Analysis

This case illustrates many different failures that contributed to the fatal and potentially preventable outcome in this case. Over 85% of patients with Wegener's granulomatosis respond to appropriate chemotherapy if treated in time:

Over-reliance on printed policy:
Providers were not aware of the lab's policies. Policies and procedure manuals only weakly support quality practice; safety 'in the world' is a better approach.

Failure to appreciate immediacy of testing needs:
The lab failed to appreciate the need for a very rapid turnaround time on vasculitis testing.

Communication failure:
The lab failed to communicate the need for the form to be completed; the care team failed to indicate the urgency of their need and to follow up on the missing test results. The inadequacy of email was not appreciated. Clinical providers and the lab had no established communication pathway.

Inadequate supervision:
Supervising physicians could have been more assertive in investigating the missing test results.

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LESSON 4

LEARNING FROM CASES OF DIAGNOSTIC ERROR

FINDING DIAGNOSTIC ERRORS

IS IT A DIAGNOSTIC ERROR?

USING ROOT CAUSE ANALYSIS TO UNDERSTAND HOW DIAGNOSTIC ERRORS ARISE

LINKING UNDERSTANDING TO ACTION

Estimated Time of Completion: 20 minutes

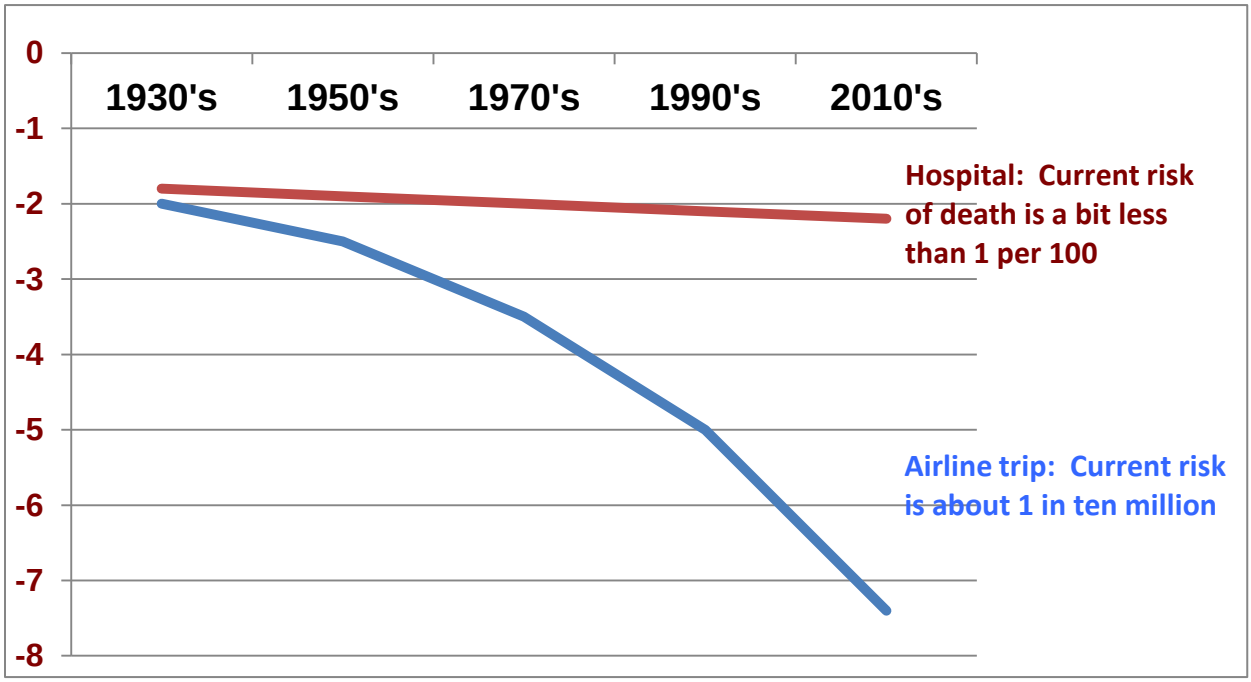
Learning Objectives: After completing this lesson, you will be able to:

1. Describe 4 methods for identifying diagnostic errors
2. Apply different definitions of diagnostic error in the appropriate setting
3. Conduct a root cause analysis of diagnostic error
4. Implement a change process to reduce the likelihood of error in the future

INTRODUCTION

Although many travellers still dread their next flight, the odds of death on a commercial airline are now less than one in ten million. In contrast, the odds of death from an adverse medical event in the hospital are in the range of two to four per hundred, and a large fraction of these reflect diagnostic errors. How can we explain how safety in aviation has improved orders of magnitude over the past decades, while safety in healthcare has stagnated? The leading explanation is that aviation has "learned how to learn" from disasters and near misses, and healthcare has not. The goal of this chapter is to present an approach to learning from diagnostic errors - every error presents an opportunity to learn about how to prevent the next one.

Log Risk of Death from a Single Airline Flight vs. Hospital Admission



FINDING DIAGNOSTIC ERRORS

An occasional case of diagnostic error will make headline news, but most are buried away in the everyday goings-on of busy hospitals and clinics. Contributing to their relative invisibility, the risk management processes now used in most healthcare settings are poorly designed to uncover diagnostic errors. Autopsy is considered the gold standard for identifying diagnostic errors, but autopsies are on the decline, so fewer and fewer of these errors are coming to attention.

Diagnostic errors are common if you think to look for them. These are the most fruitful approaches:

Asking patients:
Patients are typically well aware of diagnostic errors. Following up with patients recently seen in the emergency room, or after a diagnostic encounter, will uncover many diagnostic errors that otherwise will be missed.

Asking physicians:
Physicians detect diagnostic errors regularly, but typically don't report these either to the providers involved or to safety staff. Establishing a system to pro-actively ask physicians about errors they've encountered works well to identify new diagnostic errors.

Using the EMR:
The electronic medical record and data warehouses offer a new and very effective way to identify breakdowns in the process of care, such as laboratory tests that haven't been followed up, consultations or tests that were ordered but never completed, or critical abnormalities that need attention and action.

Electronic data can also be used to identify populations of patients at higher risk of diagnostic error, for example patients who have an unplanned admission in the weeks following a visit to an ambulatory clinic or emergency department.

IS IT A DIAGNOSTIC ERROR?

Many diagnostic errors are just obvious, typically those cases where some time has gone by, and definitive information has emerged. Other cases fall into grey zones, where people will debate whether or not an error occurred. Here are some definitions of diagnostic error that will be helpful in making these distinctions:

Avoid trying to make distinctions that are generally not helpful (or easy):

- Is an error preventable? All errors are theoretically preventable.
- Does the error reflect a diagnosis that is wrong, missed, or delayed? These categories overlap extensively and, for the purposes of learning, it doesn't matter.

If definitive information is NOT available, use one of these definitions:

Diagnostic error reflects a mistake or failure in the medical diagnostic process. This may include any failure in timely access to care; elicitation or interpretation of symptoms, signs, or laboratory results; formulation and weighing of differential diagnosis; timely follow-up and specialty referral or evaluation; or disease screening. (Schiff et al, 2009***)***

EMPHASIS = PROCESS OF DIAGNOSIS

Diagnostic error reflects a 'missed opportunity', and requires a judgement that adequate information was present to suggest the final, correct diagnosis at an earlier date or situations where abnormal findings should have prompted additional evaluation that would have revealed the correct, ultimate diagnosis. (Singh et al, 2006***)***

If definitive information is available, use this definition:

Diagnostic Error is a medical diagnosis that is wrong, missed, or unacceptably delayed, as subsequently determined by an acceptably-definitive diagnostic test result or clinical finding

EMPHASIS = GOLD STANDARD

(Graber et al, derived from that used by the Australian Patient Safety Foundation - *Barbara Levings, personal communication, July 4, 2001*

USING ROOT CAUSE ANALYSIS TO UNDERSTAND HOW DIAGNOSTIC ERRORS ARISE

Root cause analysis is the approach used most often to analyse adverse patient safety events that have already occurred, with the goal of understanding what happened. Cases of close calls are just as instructive as cases of harm in terms of learning. The basic idea is to use a structured process for analysis that allows you to consider a wide range of factors that might have contributed to the bad outcome.

OVERVIEW OF THE RCA PROCESS

Every RCA follows the same basic steps, although the time and detail devoted to each step will vary depending on the resources available and the case being analysed.

Step 1 - Get started: Get permission to analyse the case. Identify the team members. Orient the team members to the RCA process to be used. Gather the facts.

Step 2 - Decide WHERE did things go wrong? What phase of the diagnostic process was involved? Diagram the process involved to discover steps that were involved.

Step 3 - Identify the root factors. Keep asking: Why? Why ? Why? Use an organised approach.

Step 4 - Propose a limited number of feasible action items that could help prevent a similar event in the future.

Step 5 - Share the findings and recommendations as widely as possible to promote learning and a culture of safety.

Hindsight Bias – Avoid it!

It is too easy, looking back, to say that a bad outcome was predictable. Avoid being a "Monday Morning Quarterback" by trying to put yourself in the shoes of the staff involved in the incident, given just what they knew at the time.

Diagnostic Error RCAs - The Facts of Life

There is no right or wrong way to conduct an RCA. Just try to use an organised approach that covers all the bases.

The RCA process is not reproducible. Another RCA team could well derive a different understanding of the case.

There really are no true root causes – Causation is something we construct after the case. Your real goal is try to understand why things that were done made sense at the time, and learn from this analysis.

MISTAKES TO AVOID IN ROOT CAUSE ANALYSIS:

Don't point fingers - An RCA is about understanding, not about blame. Try to avoid hindsight bias. If possible, don't tell the outcome to the analysis team – this will help them keep an open mind and try to see things from the perspective of the involved staff BEFORE the incident.

The analysis is too removed from the incident - In this case, no one can remember all the 'little things' that contributed. These may be the most important human factor elements that need attention.

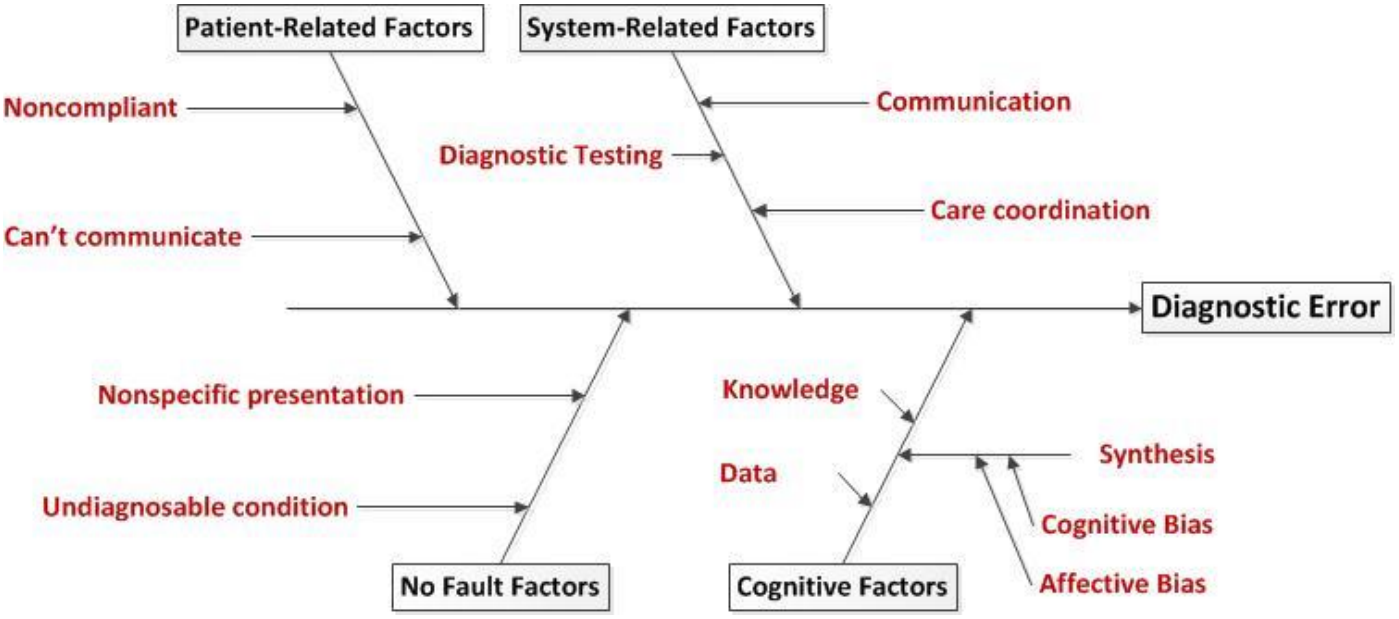
The proposed solutions are weak - Avoid recommendations for more training or more policies. Try to envision solutions that become the default operational mode, built into the workflow, or solutions that are obvious in the real world, without having to look anything up.

Too many different projects are proposed - Try to identify just a small set (3 or 4 at the most) that can be acted upon. Although many RCAs yield dozens of suggestions, the more recommendations you create the less likely it becomes that any will actually be implemented in earnest.

ROOT CAUSES OF DIAGNOSTIC ERROR – AN APPROACH

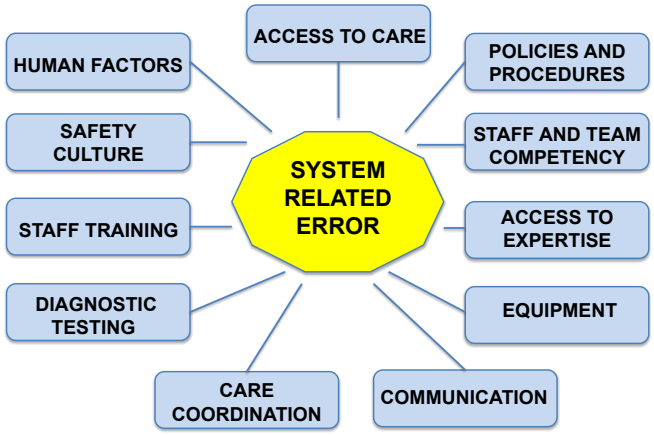
To be credible, a root cause analysis requires a structured approach, so that all of the major contributing factors can be identified. One such approach is illustrated here, and involves considering 4 cardinal factors (Systems, Cognitive, Patient-Related, and No Fault) that are potentially involved in diagnostic error. By studying and understanding how humans operate within their work environment, a human factors perspective can be especially helpful in identifying root causes.

The figure below can be applied to analysing any particular case, just keep in mind that for each of the cardinal factors (the main branches), there are many more root cause factors that might be identified beyond those illustrated here as examples.



SYSTEM-RELATED CAUSES

Most diagnostic errors involve one or more breakdowns in the system-related factors that affect the diagnostic process. Some of these factors are illustrated here.



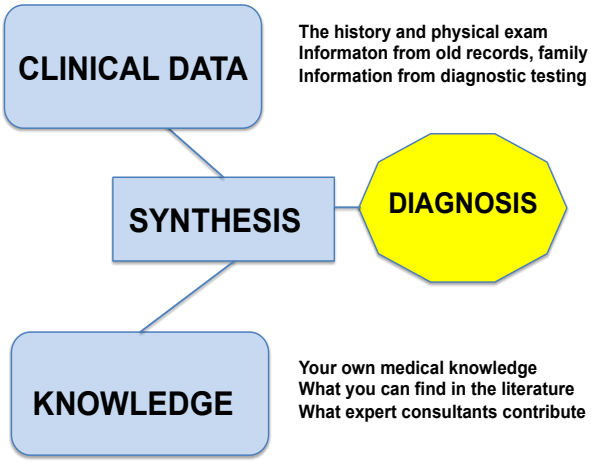
The first requirement for successful diagnosis is access to medical care. Access problems are common reasons for delayed and missed

diagnosis. Access can be sub-optimal for many different reasons, including living in a medically-underserved area, lack of transportation, lack of insurance or financial resources, overcrowded clinics or emergency departments, and limited access to healthcare on nights and weekends. Suboptimal access to appropriate expertise is another factor that commonly contributes to diagnostic error.

Communication issues and problems coordinating care are the two factors that are most commonly implicated in diagnostic error. These problems typically reflect the complexity of modern health care, distributed over so many different sites and individuals, and the reality that diagnosis typically plays out over some interval of time. This involves transferring information from one provider to the next, a process that is seldom ideal. The medical record plays a key role here in documentation, another common site where breakdowns occur. Electronic medical records solve many documentation issues, but create new ones, such as inaccurate notes because information was inappropriately copied from a prior note.

COGNITIVE CAUSES OF DIAGNOSTIC ERROR

The cognitive contributions to diagnostic error typically reflect a breakdown in one of three major areas: a deficit of medical knowledge, sub-optimal gathering or interpretation of clinical data, or defective synthesis of all of this information into a working diagnosis. A careful root cause analysis can typically identify several different root causes in these different areas.



A 'cognitive autopsy' also involves considering the more subtle factors that influence clinical decision-making. These include human factor elements such as fatigue or illness, distractions, workload stress and time pressure. A wide range of affective factors come into play in some cases, including both positive biases (eg. providing medical care to a friend or colleague) and negative ones (eg. providing care to a patient who is abusive, drunk or obese).

The cognitive autopsy should also include a review of the many different factors that influence "System 1" cognitive processing, and these will be encountered frequently in cases of diagnostic error. Over one hundred of these 'biases' have been described. Some of the ones most commonly encountered clinically are:

Context errors - When trying to make sense of a new case, physicians may inadvertently choose the wrong context to interpret the data. For example, the physician may assume that abdominal pain reflects a gastrointestinal problem, when the pain is later found to be caused by shingles.

Framing biases are related and equally prevalent – the physician assumes that the diagnosis or synthesis given to them by another physician or the patient is correct, without rethinking the case.

Premature closure reflects our human tendency to stop thinking once we have solved a puzzle. We don't consider other possibilities; we 'satisfice' instead of using more optimal decision-making approaches. A recent study of diagnostic error found that over 80% of the medical records did not contain a differential diagnosis.

Confirmation bias - We tend to order more tests and consults that support our diagnosis instead of looking for dis-confirmatory evidence.

Availability bias - We are overly influenced by recent cases we have seen, or important cases in the news or from our past. This distorts the true probability of disease in our patient.

PATIENT-RELATED CAUSES OF DIAGNOSTIC ERROR

The diagnostic process begins with obtaining the medical history and, according to many authorities, the diagnosis emerges from the history alone in 80 – 90% of cases. Patients who are unable to communicate appropriately, for any reason, are highly susceptible to diagnostic errors. This includes infants, patients who are comatose or intubated, patients with advanced dementia, and patients who don't speak the native language of the physician. On occasion, a patient may purposefully try to be misleading or deceptive, and typically succeed in causing a diagnostic error.

Patients also play an important role in many other steps of the diagnostic process, including complying with recommended tests or consultations, and following-up as

expected. Many patients are also reluctant to seek medical care on a timely basis for new problems, and this is a common factor that contributes to delayed diagnosis.

'NO FAULT' CAUSES OF DIAGNOSTIC ERROR

Given that there are over 10,000 known diseases and that the presentations of these various conditions can overlap considerably, it is no surprise that the correct diagnosis may not be immediately apparent, especially early in the disease process. Other 'no fault' situations include:

Incidental findings with no clinical consequences - for example, an adrenal adenoma found on an abdominal CT scan done for another reason;

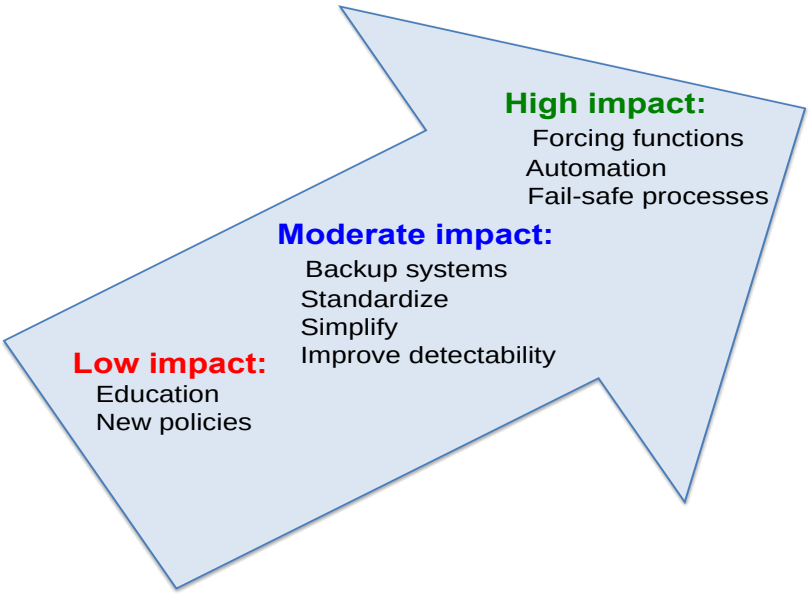
Diseases without definitive tests or findings - for example, a great many psychiatric conditions;

Diseases that could potentially be diagnosed by very expensive or unusual tests, or by approaches beyond the usual standard of care – for example, a small tumour that could be diagnosed on a 256-slice scanner, but the scanners available locally are only 64-slice, or a single research lab has the correct molecular probe to identify a new genetic disorder, but this test is not offered commercially.

LINKING UNDERSTANDING TO ACTION

A comprehensive root cause analysis of diagnostic error will identify, on average, six different 'root causes'. Each of these may in turn suggest several different remediation strategies, but keep this in mind: The goal is to identify just a small set of actions that can help prevent the next error by learning from the last one. Change in healthcare is never easy, so RCA teams should meet with local healthcare leadership to identify the changes that could have the most impact and the highest chances of being implemented successfully. Ideally, the change process includes ways to measure impact, and ensure that any changes that are monitored to detect any unanticipated consequences.

THE POSSIBLE ACTIONS RESULTING FROM THE RCA, AND THE LIKELIHOOD THEY WILL PREVENT FUTURE ERRORS



Summary Points

- Just as aviation has improved its safety record by learning from disasters and near misses, out best chance to reduce diagnostic errors is to learn from actual cases in our own practice settings.
- The existing tools to discover adverse medical events are not sensitive in detecting diagnostic errors. To find these cases will require new approaches, such as facilitating reports from involved patients and providers. Leveraging electronic data is another promising approach to enhance detection of diagnostic errors and breakdowns in the diagnostic process.
- To be effective and credible, a systematic approach is needed to analyse cases of diagnostic error. For example, the analysis should consider all of the cognitive- and system-related root causes, in addition to 'no fault' causes and issues relating to the involved patients.
- The goal of root cause analysis is to identify remediable factors and implement appropriate changes that would help prevent subsequent similar errors. The best approaches are those that operate by default in the real world. Training, education, and new policies are considered weak solutions.

RESOURCES

- The RCA tool used by The Joint Commission
- A Diagnostic Error RCA fishbone diagram (Robert Trowbridge)

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LESSON 5

INTERVENTIONS TO REDUCE DIAGNOSTIC ERROR TIPS FOR CLINICIANS

Estimated Time of Completion: 20 minutes

Learning Objectives: After completing this lesson, you will be able to:

1. Distinguish approaches to reducing diagnostic error that target cognitive- versus system-related causative factors
2. Describe several different ways to reduce the likelihood of cognitive error
3. Specify your role as a healthcare provider in bringing system problems to attention

PHYSICIANS NEED TO OWN THE PROBLEM OF DIAGNOSTIC ERROR

By tradition, by legislation, and by accreditation, physicians are responsible for diagnosis in medicine. It's true that a host of other factors influence the success of the diagnostic process, including prominent roles for the patient and healthcare systems, but at the end of the day, it's the physician who determines the quality of the process, and is responsible for any errors that result.

Motivating physicians to address diagnostic error is hindered by the almost universal perception that diagnostic errors are rare. Despite being acutely aware of the ever-present threat of a malpractice claim, most clinicians believe that errors are more likely to be made by someone else, someone less careful, less skilful, or less knowledgeable than themselves. Several factors explain the yawning gap between this perception of near-perfect practice and the evidence that diagnostic errors are ubiquitous, perhaps as common as one case in ten:

- Most diagnostic errors are caught, or don't matter: Most acute conditions resolve on their own, or respond to the treatment prescribed even if the diagnosis is incorrect.
- Many diagnostic errors aren't reported back to the physician: With autopsies becoming increasingly rare, physicians are less likely to find out about serious diagnostic errors. Many patients are reluctant to go back and inform a physician that the diagnosis was wrong, and professional colleagues are similarly disinclined to frankly discuss errors with their peers.
- Substantial harm from diagnostic errors is rare: Although the aggregate harm from diagnostic errors is staggering, the odds that any one physician will be responsible for an error-related death are quite low. The average physician might be responsible for just one or two in a lifetime of practice, and it is possible that even these are not reported back to the physician.

In the same way that many cognitive errors arise from hardwired 'human nature', physicians are generally overconfident of their skills, including their decision-making skills. Studies consistently show that physicians are unable to predict accurately which of their diagnoses are right or wrong, indicating a general problem with calibration. The antidote for this is to get more feedback on performance, and physicians should take every opportunity to obtain this kind of feedback.

Requesting autopsies, giving permission to patients and colleagues to report back any diagnostic missteps, and practising reflectively are thought to be the most effective approaches to improving calibration.

Demonstrations of Physician Overconfidence

Autopsies are considered the gold standard for establishing the correct diagnosis. In one such study, Landefeld et al (*Diagnostic yield of the autopsy in a university hospital and a community hospital. New Engl J Med 1988; 318:1249-54*) asked physicians to gauge the likelihood of there being a 'major unexpected finding' on autopsy. Of physicians who estimated this likelihood as being less than 10%, there was a 17% incidence of such findings on autopsy.

Similarly, Podbregar et al asked physicians working in an intensive care unit to estimate their confidence about the cause of death. Although the confident physicians were more likely to identify a correct diagnosis, the likelihood of finding a potentially treatable discrepancy at autopsy was essentially the same regardless of whether the physicians rated their confidence as 'complete certainty' or 'major uncertainty':

	Correct Diagnosis	% of fatal but potentially treatable errors
Complete Certainty	**60%**	**9%**
Minor Uncertainty	**40%**	**10%**
Major Uncertainty	**34%**	**10%**

Should we confirm our clinical diagnostic certainty by autopsies? M Podbregar et al. Intensive Care Med 2001; 27: 1750-1755

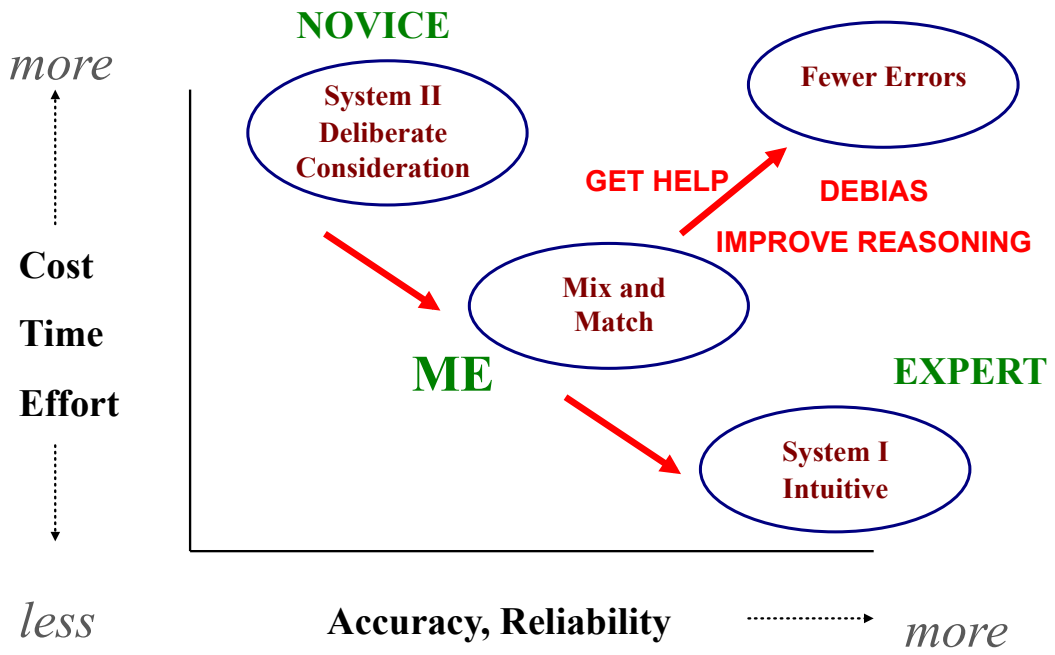
Friedman et al asked senior clinicians to provide diagnoses on 9 case scenarios. Of the cases they were 'highly confident' about, the diagnosis was incorrect in a third. *(Do physicians know their diagnoses are correct? Implications for decision support and error reduction. J Genl Int Med 2005; 20:334-339)*

These studies of physicians are in full agreement with a large number of similar studies in non-medical fields, all demonstrating a tendency to overconfidence in rating one's own decision-making skills. In general, novices are the most overconfident, and calibration improves with increasing expertise. Another general finding is that calibration improves with feedback. Although making fun of the weatherman is a universal sport, their degree of calibration exceeds that of almost any other studied group, because they get constant and often loud feedback regarding their predictions. Given the almost constant uncertainty that attends medical diagnosis and the known limits of human knowledge and judgement, one can make the case that the ideal physician should be not only competent but, even better, well calibrated.

SHORT-TERM AND LONG-TERM APPROACHES TO REDUCING COGNITIVE ERROR

Improving diagnostic performance involves developing a long-term plan to develop clinical decision-making skills, but also having an approach to optimise the diagnostic process for the next patient you'll see today. This concept is illustrated in the figure below, which depicts the evolution every physician experiences between their first days in medical school and the maturity as an experienced clinician. Everyone starts out as a novice diagnostician, using System 2 almost exclusively, and struggling with that for lack of a complete knowledge base and skill set. At this stage, establishing a diagnosis is a difficult, time-consuming, and error-prone process. At the other end of the spectrum are the true medical experts, who ideally have 'seen it all before', and so rely commonly on System 1 cognition.

Diagnosis for experts is often effortless, instantaneous, and generally accurate. Most physicians lie somewhere short of the 'expert' level, and use a balanced mix of System 1 and System 2 as appropriate for each case. In this framework, there are basically two ways to improve reliability: either developing increased expertise as a long-term plan, or having options and resources available to improve diagnostic performance for the case at hand.



AVOIDING COGNITIVE ERROR

Becoming an expert

In the long run, the best way to improve diagnostic quality is to become an expert in one's field. By definition, experts make the fewest mistakes (or more accurately, have made them all before!). Excellence in 'System 2' cognition demands an extensive and up-to-date knowledge base, skill in critical thinking, proficiency in practising evidence-based medicine, and a base of clinical experience that is both deep and broad. All of these things take time, and evolve over a lifetime of practice.

"Experience is that marvellous thing that enables you to recognise a mistake when you make it again."

Thomas J Krizek MD. Arch Surg 138: 447-54, 2003

In the meantime, what can you do?

Because many diagnostic errors arise from the inherent shortcomings of System 1 cognition, learning about these and employing 'debiasing' strategies are potentially effective ways to reduce diagnostic errors. Probably the best advice is simply to take a diagnostic 'time out'. Reflecting on the case allows System 2 to review the adequacy of the diagnostic process and may identify gaps.

Because framing errors and premature closure are the two most common causes of System 1 error, strategies to encourage consideration of other diagnostic possibilities are warranted. The universal antidote is simply to ask: "What else could this be?" Completing a differential diagnosis is another way to avoid having an overly narrow focus.

Importance of the Differential Diagnosis

In a series of 190 diagnostic errors identified in ambulatory care settings:

"no differential diagnosis was documented at the index visit in 81.1% of cases."

Singh et al. Types and origins of diagnostic errors in primary care settings. JAMA Internal Medicine 2013; 173: 418-425.

GETTING HELP

Besides relying on one's own resources, getting help is another approach to avoiding diagnostic error in any particular case. Second opinions, from a colleague or a consultant, are particularly valuable. Fresh eyes catch mistakes. Taking advantage of decision support resources is another valuable approach.

A General Checklist for Diagnosis

- Obtain YOUR OWN, COMPLETE history
- Perform a FOCUSED and PURPOSEFUL physical examination
- Generate some initial hypotheses, and differentiate these with appropriate questions, additional physical examination, or diagnostic tests
- Pause to reflect – a diagnostic TIME OUT
    - Was I comprehensive?
    - Did I consider the inherent flaws of System 1?
    - Was my judgement affected by any other bias?
    - Do I need to make the diagnosis NOW or can I wait?
    - What's the worst case scenario? What are the 'don't miss' entities?
    - What else could this be? Have I considered a differential diagnosis?

High-Risk Situations for Diagnostic Error

Are there 'don't miss' diagnoses that need to be considered?

Did I just accept the first diagnosis that came to mind?

Was the diagnosis suggested to me by the patient or another clinician?

Is there any data about this patient I don't have? Old records? Family? Primary care provider?

Are there any pieces that don't fit?

Was this patient handed off to me?

Was this patient seen in the ER or clinic recently for this same problem?

Was I interrupted or distracted while evaluating this patient?

Is this a patient I don't like for some reason? Or like too much (friend or relative)?

C Comprehensive history and physical exam

A Alternate explanations

T Take a diagnostic time out to be certain

C Consider critical diagnoses not to be missed

H Ask for help

ADDRESSING SYSTEM-RELATED ERROR

Some system-related factors contributing to diagnostic errors are under your control, and some are not, and this balance will depend on the nature and circumstances of your practice. You can help avoid diagnostic errors by fixing as many things as you can, and calling attention to the factors that are more properly the responsibility of others in your healthcare system. You may not make any friends by calling system barriers to the attention of a local manager, but you will earn respect for doing the right thing. Too many diagnostic errors arise from staff indifference to these barriers, and 'normalisation of deviance', situations that would normally be judged unacceptable, but they happen so often they become the new norm.

Normalisation of Deviance - Do any of these sound familiar?

- No staff radiologist to read films on the weekends
- Charts missing or incomplete
- Unable to reach a key consultant for an emergency
- Rude behaviour by Doctor "X"
- Delayed turnaround time on reading diagnostic imaging studies

You may be surprised by how many system-related issues you can fix personally:

☐ Do your staff and colleagues know how to reach you?

☐ Do your patients know how and when to get back to you if their symptoms progress or don't respond as expected?

☐ Do you have a system in place to know that consults you've ordered were completed?

☐ Do you have a system in place to ensure that all diagnostic test results are reviewed in a timely manner?

☐ Do you designate a surrogate if you'll be away from your practice?

☐ Do you know a colleague in the clinical lab or Radiology you can speak with personally about choosing the right imaging procedure or laboratory test?

Summary Points

- Physicians are generally overconfident about their diagnostic skills, and under-estimate the odds of diagnostic error.
- One approach to improving diagnostic reliability is to develop a long-term plan for improving expertise through self-development and acquiring additional skills and experience.
- In the short term, the likelihood of cognitive error can be minimised by invoking System 2 to consciously monitor System 1. This involves trying to be comprehensive in developing a differential diagnosis, keeping an open mind, debiasing judgements, and remaining ever vigilant as the diagnostic workup progresses and the patient's symptoms and signs evolve. Getting help, from colleagues or decision support resources, is another valuable approach.
- Physicians have an obligation to repair any inherent system-related flaws that are under their control and to call attention to everything else.
- We will never be perfect, nor will our healthcare systems. Make the patient your partner in diagnosis and enlist their help in trying to avoid diagnostic errors.

OPTIONAL EXERCISES AND RESOURCES

Challenge exercise: Pick 5 things from this list to improve diagnostic quality in your own practice

1. **Be reflective. Take a diagnostic 'time out'**
2. **Listen, really listen, to your patients and their caregivers**
3. **Learn the causes of cognitive error and how to avoid pitfalls**
4. **Don't trust your intuition – Always construct a differential diagnosis**
5. **Take advantage of second opinions**
6. **Use diagnosis-specific decision support resources: DXplain, Isabel, VisualDx, checklists**
7. **Make the patient your partner in diagnosis: Ensure they know how to get back to you if symptoms change or persist**
8. **Ensure all ordered diagnostic tests and consults are completed and that you know the results; Designate a surrogate to review test results if you plan to be away**
9. **Speak directly with the staff providing you with diagnostic test results: Radiologists, Pathologists, and Clinical Pathologists. If you aren't sure of the most appropriate diagnostic strategy, ask, or use online test-ordering advice**
10. **Empower your colleagues to let you know if they become aware that a diagnosis you made has changed**

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LESSON 6

INTERVENTIONS TO REDUCE DIAGNOSTIC ERROR – THERE'S A JOB FOR EVERYONE

DIAGNOSIS – IT'S A TEAM AFFAIR

HEALTHCARE ORGANISATIONS – STEPPING UP

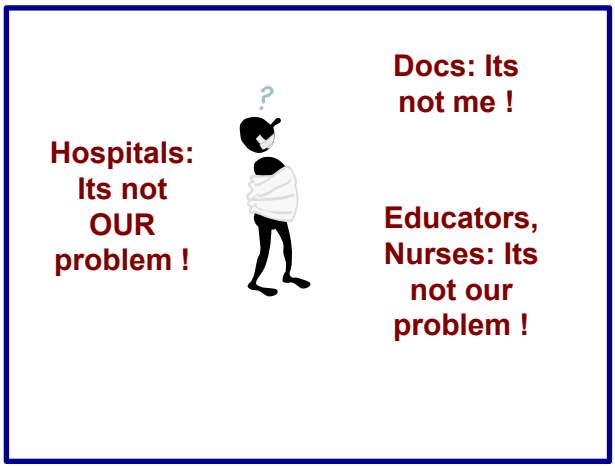
PATIENTS: CATCHING DIAGNOSTIC ERRORS BEFORE THEY CATCH YOU

Estimated Time of Completion: 20 minutes

Learning Objectives: After completing this lesson, you will be able to:

1. Outline the importance of the healthcare team in diagnosis, especially nurses and trainees
2. List the many ways that leaders of healthcare organisations can improve the diagnostic process
3. Specify actions that patients can take to improve the odds of getting a timely and correct diagnosis

DIAGNOSIS – IT'S A TEAM AFFAIR



Although healthcare ultimately sees medical officers as the 'owner' of diagnosis in medicine, the overall quality of diagnosis will depend on the performance of a much larger team, including the patient, carers and, other clinical staff, in particular nurses and administrative staff who provide structure and organisation to the process. Optimising the quality of diagnosis requires that everyone involved considers how each can help.

Nurses, patient and carers: Part of the team

The best clinicians are alert to subtle changes in the patient's condition, as these are often clues to unexpected problems or complications. No one is more sensitive in detecting these early warning signs, than the patient's family, and the nurses caring for the patient. If they tell you 'something's not right' – pay attention! Nurses are also perfectly situated to help ensure communication between the patient and the physician is effective.

ACADEMIC MEDICAL CENTERS

Diagnosis in the curriculum

Diagnosis is largely taken for granted in our medical and nursing schools. With the substantial gains that have been made recently in understanding human error, human factors, team dynamics, and the cognitive aspects of diagnosis, schools need to incorporate these elements in the curriculum. Residency programs should emphasise diagnostic competencies, ensuring that graduates can skilfully obtain the history and physical findings, competently generate a differential diagnosis, and know how to refine this appropriately with diagnostic testing, consultation, and using evidence-based practices. Trainees should understand the strengths and weaknesses of both System 1 and System 2 cognition, and learn how to avoid cognitive errors through reflective practice.

The academic teaching team

In most academic programs, inpatient care still provides the largest fraction of patient-care exposure. The typical team includes one or more medical students, a junior resident, a senior resident, and a faculty member who supervises the team's work. Depending on team dynamics, diagnostic quality can be either enhanced or weakened.

Enhance Diagnosis	Weaken Diagnosis
Information is gathered independently, then compared to discover discrepancies	The most junior person gathers the facts, and the more senior team members review and approve
Each person generates their own diagnostic hypotheses	The diagnostic hypotheses are generated by the group
Team leaders give permission for students and junior members to question them and point out errors	The opinions of the attending physician and\or senior resident are expected to be accepted blindly
The team makes decisions by soliciting different ideas and evaluating them to select the best ones	The team makes decisions by consensus, with subtle pressure to just go along with the dominant idea, or the suggestion from the most senior member of the team (groupthink)

Best practices for teaching teams

Give permission: The attending physician challenges the trainees to find an error made by the attending. Anyone successfully challenging a fact or decision wins a dinner complements of the attending.

Follow up and feedback: The teaching team designates someone to follow-up on any patients transferred to the ICU or another hospital to get the final diagnosis. Someone calls patients discharged without a clear diagnosis to see if the working diagnosis is correct.

Pending tests: The team designates someone to follow-up on any test result still pending at discharge.

HEALTHCARE ORGANISATIONS – STEPPING UP TO THE CHALLENGE OF PREVENTING HARM FROM DIAGNOSTIC ERROR

Diagnosis takes place in healthcare settings that can either enhance or detract from the success of the diagnostic process. The field of human factors studies exactly this kind of problem: How overall system performance is influenced by how individuals interact with each other, their environment and the available resources. Important considerations include having adequate time for each patient's visit, distractions, production pressure, having experts available for consultation, and access to all the patients' notes and diagnostic test data. The most important environmental factor is

the culture of the organisation – does it value and promote quality, safety, and transparency?

Healthcare organisations should seek to enhance the quality of diagnosis as part of their ongoing efforts to improve the overall quality of healthcare provided. This will require special effort and attention, because essentially all of the measures healthcare organisations now use to monitor quality focus on treatment issues, not on diagnosis. The suggestions in the following table are good places to start.

HOW HEALTHCARE ORGANISATIONS COULD IMPROVE THE QUALITY OF DIAGNOSIS

1. Identify diagnostic errors: Follow up with patients recently seen in the ER; Encourage consultant medical officers to report errors
2. Provide clinicians with diagnosis-specific decision-support tools: DXplain, Isabel, VisualDX, Up-to-Date
3. Identify physician volunteers interested in providing second opinions and advertise their services to patients and their physician peers
4. Ensure there is Radiology coverage on after hours to read urgent films
5. Close the loop on diagnostic test results; Send results to patients; Monitor how many critical test results are acted upon within 30 days
6. Ensure that providers on vacation have designated a surrogate to review test results
7. Encourage accurate problem lists, and a differential diagnosis
8. Establish ways for providers to receive feedback on their diagnoses
9. Encourage autopsies or virtopsies (post-mortem CT or MRI imaging)
10. Ensure senior clinicians review all new cases with trainees in real time
11. Encourage and facilitate communication between frontline clinicians and physician staff in radiology and the clinical laboratory
12. Use root cause analysis to identify remediable system-related contributions to diagnostic error; Host “Morbidity and Mortality” conferences with staff to review these cases
13. Empower nurses to become involved in improving diagnosis: Monitor for new or resolving symptoms, ensure tests get done, facilitate communication between patients and providers
14. Empower patients to be proactive in their care, to take advantage of second opinions, and to provide feedback on diagnostic errors

PATIENTS: CATCHING DIAGNOSTIC ERRORS BEFORE THEY CATCH YOU

Patients have the most at stake if they experience a diagnostic error, yet few realise the critical roles they can play in helping reduce the odds this will happen. Traditionally, patients trusted their physicians and the healthcare system to provide accurate and timely diagnoses. In contrast, there is a growing appreciation in the patient community of the many ways they can enhance the quality of the diagnostic process.

STEPS PATIENTS CAN TAKE TO AVOID DIAGNOSTIC ERRORS

1. **Be a partner in your own care;** Assist in providing a good history by keeping records, and communicating your needs and problems clearly. The healthcare system does not always coordinate your care adequately so make sure to communicate information effectively to all the different members of the team.

2. **Be prepared.** Write down what you need to tell the doctor about your symptoms. Try and keep a timeline of your symptoms, what happened and when and how you have responded (or not) to any treatment.

3. **SPEAK UP! Ask:**
   a. What else could it be? What should I expect?
   b. When and how should I follow up if my symptoms persist?
   c. What resources can I use to learn more?
   d. Is this test worthwhile? Can we wait? (More testing does not always mean better care!)

4. **Ask for a copy of your test results** and keep these safe. Follow up in a timely manner if you don't receive copies of the results of tests or consults.

5. **Provide feedback** about diagnostic errors to providers and organisations.

6. **Get a second opinion** for serious diagnoses or unresolved symptoms.

7. Take advantage of cancer screening.

8. Be aware that a diagnosis is never a certainty.

Becoming more proactive in your own care

Patients are increasingly encouraged to become active partners in establishing a correct and timely diagnosis, and the table above outlines a number of steps in this direction. Proactive engagement improves communication, coordination of care, and helps ensure that nothing 'falls between the cracks'. An increasing number of healthcare organisations are sending test results directly to patients, who can act as a safety net in case their providers don't receive the results, or fail to act on them. Similarly, organisations that facilitate patient access to their medical records are finding that this can help avoid errors and misunderstandings

Proactive = Better Outcomes

Hibbard and Cunningham found that 'activated' patients, who were more proactive in their healthcare, had better outcomes.

Hibbard JH, Cunningham PJ. How engaged are consumers in their health and health care, and why does it matter? HSC Research Brief 2008;(8):1–9.

Providing feedback to providers and healthcare systems

Both physicians and healthcare organisations can benefit from obtaining feedback from patients. Just as the hotel industry seeks to constantly improve by surveying recent customers, patients can provide valuable feedback if they experience a diagnostic error by reporting this to the providers responsible. The reports from patients typically identify safety incidents that were not identified by the healthcare system responsible for their care.

Can Patients Identify Adverse Events?

Over a 1 year period, patient families reported 321 events after an admission to a paediatric ward, of which 153 were found to reflect legitimate patient safety concerns. Only 8 of these had been identified by the hospital. *Daniels et al. Identification by families of paediatric adverse events and near misses overlooked by health care providers. Can Med Assn Jnl 2012; 184: 29 – 34*

Only 17% of unsafe events reported by inpatients in Japan were identified by the in-house reporting systems of adverse events and near misses. *Hasegawa et al. Jt Comm Jnl Qual Sat 2011; 37: 502-508*

Informing and participating in governance, policy and research

Patients and patient-based care organisations are playing an increasing role providing input into healthcare governance, policy, quality improvement, and research. The number of such organisations has grown exponentially over the past decade, and these groups are increasingly involved on hospital boards and in legislative matters.

The Clinical Excellence Commission's (NSW) quality and safety programs focus on the involvement of consumers and patients as partners to both drive and implement change. Patient-centered research is a growing area that brings the patient's perspective into decisions on what types of research are most needed and most beneficial.

From the perspective of optimising the diagnostic process, an empowered patient can provide the following….

- Tell a concise and clear story of their illness, in chronological order with little prompting.
- Has an open mind, seeks the physician's opinion rather than suggesting their own ideas about the diagnosis
- Has a questioning attitude: "What else could this be?"
- Is able to ask questions with the assistance of printed and online resources to understand their diagnosis
- Understands uncertainty and ambiguity, and the importance of following up
- Keeps their own records of what happens to them including copies of diagnostic tests, consultations and hospital admissions
- Knows where to gain assistance if symptoms persist or change

Summary Points

- Diagnosis has traditionally been the responsibility of the physician, but the ultimate quality of the diagnostic process depends on many other members of the diagnostic team, including the patient.
- Teams can enhance diagnostic quality or detract from it. Teams in academic settings can benefit from adopting approaches known to improve team-based decisions.
- Healthcare organisations can support diagnostic quality by focusing on diagnosis as a key component of quality.
- Nurses are the eyes and ears of the team and can play a major role in preventing and detecting diagnostic errors.
- Patients can help avoid diagnostic error by acting as a safety net. Being proactive, providing feedback about diagnosis, and becoming involved in healthcare policy discussions are all ways that patients can improve diagnostic quality.
- Carers should also be considered as part of the team. Their knowledge of the patient is integral to both making a diagnosis and the subsequent provision of care.

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LESSON 7

DIAGNOSIS AND HEALTH INFORMATION TECHNOLOGY (HIT)

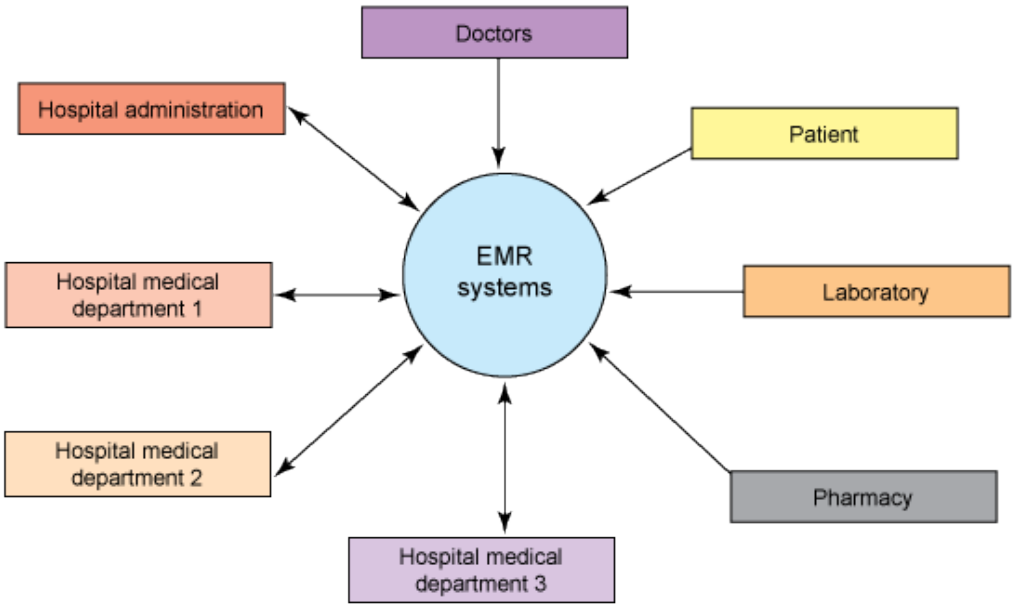
Estimated Time of Completion: 20 minutes

Learning Objectives: After completing this lesson, you will be able to:

1. Describe the ways HIT can improve or detract from diagnostic quality
2. Use decision support software for differential diagnosis
3. Relate how HIT approaches can help find and preventing diagnostic errors

HEALTH INFORMATION TECHNOLOGY (HIT) IS A REALITY

In the foreseeable future, medical practices in every setting will be using electronic medical records (EMRs) and other health informatics resources routinely and exclusively. The inexorable movement away from handwritten notes and orders has profound implications for diagnosis, and changes the diagnostic process in fundamental ways. Improving the quality of diagnosis will depend on maximising the benefits of these innovations, and minimising the hazards and unintended consequences of this new technology.[36]



HOW HIT CHANGES THE DIAGNOSTIC PROCESS

Health information technology has potential applications at every step in the diagnostic process, from taking the patient's history (patients can now enter elements of their own history on kiosks in the waiting room, or from home via internet) to settling on a final working diagnosis (assisted by web-based differential diagnosis suggestions). Recent reviews have catalogued the spectrum of applications relevant to diagnosis, concluding that the potential is vast, but proof of benefit is largely lacking because the field is in its infancy. The many ways that HIT can assist in diagnosis are summarised in Table 1

Table 1: Health Information Technology and Diagnosis[1]

Tools and resources that …

- Assist in gathering, recording and organising new information
- Present information and data to facilitate information processing
- Enhance access to medical knowledge
- Assist in differential diagnosis
- Guide intelligent diagnostic testing choices
- Present reminders for screening tests, for follow-up
- Facilitate communication and collaboration
- Help identify diagnostic errors or situations at risk

HIT AND THE PATIENT

HIT and the electronic medical record are changing patient behaviours just as radically as they are affecting their physicians. Patients can more easily access their own medical records, and this 'open access' movement offers the promise of improving the accuracy of the medical record, and the patient's understanding of their condition. Open access also creates a safety net by allowing the patients to check their own diagnostic test results. This can help prevent the opportunities for diagnostic errors when test results 'fall through the cracks' and aren't reviewed by the physician in a timely manner.

One of the most dramatic changes enabled by HIT is the opportunity to improve patient – physician communication. Replacing the traditional once-in-a-while office visit, communication can now take place almost any time through secure email, chat services, and instant messaging.
What can sometimes suffer is communication in the exam room. The EMR becomes a third party in the room, and when clinicians are working with it, patients feel excluded. A best practice is to place the display screen so that both the clinician and the patient can see it, and invite the patient into the process: "I'm going to review your labs; would you like to see them with me?" [37]

HOW HIT CAN IMPROVE THE QUALITY OF DIAGNOSIS

Electronic data is much easier to store, retrieve, and share across scattered practice sites compared to paper records, and eliminates the problems of the paper chart not being available, and trying to read the handwritten notes. Many EMRs allow lab data to be arranged in data tables or graphs, making it easier and faster to discern both abnormalities and trends over time. Integrated search functionality helps find the notes from specific providers or clinics.

Many features of the EMR save time compared to using paper records, for example the ability to renew multiple prescriptions with just a few clicks, compared to writing each prescription out on paper. To the extent that EMRs free up time, this promotes

diagnostic quality, by providing a few extra minutes to devote to the clinical reasoning process. In some EMR systems, however, this is offset by burdensome documentation and coding requirements.

Having access to an electronic medical record typically implies internet access as well. This provides access to a host of resources that can support and improve diagnosis, including textbooks, journal articles, clinical guidelines, algorithms, calculators, and programs that enhance differential diagnosis. Many clinical prediction rules are now available online, or integrated in EMR products, such as algorithms to predict the likelihood of pulmonary embolism, appendicitis, head trauma, and myocardial infarction.

Can the Differential Diagnosis Help Prevent Diagnostic Error?

In a study of 190 cases of diagnostic errors encountered in primary care clinics, the diagnosis was missed in 68 cases. No differential diagnosis was documented at the index visit in 55 of these cases (81%).[2]

What the differential diagnosis accomplishes:

Conveys a summary of the diagnostic thinking on a case to consultants and the other members of the care team help prioritise plans for diagnostic testing
Combats the two leading causes of diagnostic error:

- Premature closure – settling on just one diagnosis without considering other possibilities
- Context and framing errors - situations where the decision-making process is impacted by the way in which the information is received, or the wrong diagnosis is suggested by the patient or another provider

DECISION SUPPORT FOR DIFFERENTIAL DIAGNOSIS

In many cases of diagnostic error, the reason for missing the correct diagnosis is simply: "I just didn't think of it." Although simple checklists and mnemonics can assist in constructing a differential diagnosis, software programs that incorporate the patient's key findings to construct an appropriate differential are especially effective. A growing number of these decision support tools have become available in recent years, offering greater than 90% sensitivity in suggesting the correct diagnosis.[38] Several of these programs have been successfully integrated into the EMR, making it easier to take advantage of these tools. In contrast, "Googling" a differential diagnosis has a sensitivity of less than 60%, and a specificity that approaches zero.[39] Whenever possible, the best way to obtain help constructing a differential diagnosis is to use a software product that was specifically designed for this purpose.

HOW HIT CAN DEGRADE THE QUALITY OF DIAGNOSIS

Electronic medical records have unintended consequences that detract from diagnostic reliability. “Pick lists”, where the clinician selects their patient from a list of all patients, presents the first opportunity for error, if the wrong patient is selected. Pick lists are also used in some EMRs to select symptoms or signs. These detract from being able to describe these more meaningfully through appropriate text descriptions. The most destructive application of pick lists is the systems that use these for selecting the working diagnosis for a new patient. This approach, which typically allows only a single entity to be considered, has several deleterious effects: A more complete differential diagnosis cannot be posted, the thought-making process that led to the choice isn’t available for review, and the process necessarily forces the clinician to suggest a diagnosis prematurely.

IMPACT OF A WEB-BASED TOOL FOR DIFFERENTIAL DIAGNOSIS

Studied paediatric ICU admissions who did NOT have a diagnosis on admission (n = 206).

Correct diagnostic rates:

- **Residents on their own: 89.4%**
- **Residents + tool: 92.5%**
- **Residents + Consultant + tool 95%**

Thomas et al. International assessment of a web-based diagnostic tool in critically ill children. Technol Health care 2008; 16:103-110

EMRs also predispose to information overload. With all of a patient’s information available in one place, simply finding the most recent and relevant data can be challenging. Notes and reports that scroll onto multiple pages compound the problem, and predispose to errors where key information is presented on these later pages, not up front.

How HIT Can Predispose to Diagnostic Error:

An Erroneous Report of Hyperkalaemia

A 64 year old male was admitted with chest pain to ‘rule out myocardial infarction’. A potassium level drawn on admission was normal, as were multiple prior values over the past few years in clinic. However, the potassium level drawn on day 2 was reported as 6.8 mEq\l, prompting treatment with intravenous glucose and insulin and a beta agonist. Shortly thereafter the patient developed arrhythmias, and a repeat potassium level was now frankly low, at 2.8 mEq/l, and the arrhythmias resolved with IV potassium treatment.

The cause of the elevated level was found to be haemolysis. The patient’s providers noticed the elevated potassium (on Page 1 of the report), but not the report of haemolysis, noted at the bottom of Page 2.

Copy\Paste problems: Another serious concern is the ability of note-writers to copy and paste information from one note into another. If not done carefully, this process

inserts large amounts of often incorrect, unreliable, or redundant data into the medical record, compromising the credibility of the note-writer and the record itself. [40] Guidelines for healthcare organisations and providers on appropriate use of copy\paste functionality is now available.[41]

HOW HIT CAN HELP FIND DIAGNOSTIC ERROR AND PREVENT HARM

Electronic data enables several direct approaches to reducing diagnostic errors and harm, and improving the efficiency of the diagnostic process:

Clinical reminders are a type of decision support enabled by HIT, for example to remind the clinician that the next patient is appropriate for screening tests to detect occult colon or breast cancer. This process can help prevent delayed diagnosis of cancer, perennially in the top 5 reasons of why patients file tort claims against providers and their healthcare systems.

Order checking can detect duplicate or redundant test orders. Software programs can provide advice on the most appropriate test to order in complex situations, saving time and money.

Trigger tools use electronic health data to detect patients at risk for diagnostic error, or instances where errors have already occurred. Examples include programs that detect patients with abnormal screening tests that haven't been followed up, or patients who are overdue for follow-up.[3] Trigger tools that monitor patients with unplanned hospital admissions in close proximity to a clinic visit identify a patient cohort at increased risk for diagnostic error.[42]

Detecting Missed Opportunities Using Electronic Record Data

To detect diagnostic errors: In a study by Singh and colleagues, 'trigger tools' were used to find patients with unanticipated hospital admissions within 2 weeks of a primary care appointment. In a 1 year period, 190 such patients were identified, and the admission was associated with a diagnostic error in 68 patients.[2]

To detect missed opportunities to detect cancer: In a project by Kanter and colleagues, electronic record data was searched to find patients with iron-deficiency anaemia or rectal bleeding, without documented follow up. Over a two year period 168 such patients were identified and referred for colonoscopy.[3]

Summary Points

- Electronic medical records and health information technology are rapidly replacing paper-based processes in every healthcare setting, with profound implications for the reliability of medical diagnosis.
- HIT and the EMR can improve diagnostic reliability in many ways. These include improving access to key information and reports, facilitating communication amongst providers and with the patient, and providing online tools to help construct a differential diagnosis, or evaluate individual possibilities.
- The EMR can also degrade diagnostic reliability. As examples, the EMR can provide an overwhelming amount of information, deprive readers of knowing the thought processes surrounding a diagnostic assignment, or mislead readers through inappropriately pasted content.
- HIT can facilitate finding patients at risk for diagnostic errors, and mitigate harm by targeted interventions. HIT can also be used to identify diagnostic errors for purposes of research or performance improvement.

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