Clinical reasoning & research evidence: How good decisions are really made

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Diagnosis – A blueprint for clinical reasoning

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Why clinicians are natural Bayesians*

- Reverend Thomas Bayes (1701-1761)
- Degree of belief and probability
- Appraisal of probability of an event shifts as new evidence becomes available
- Examination & evaluation= accumulation of evidence!

*Gill CJ, Sabin L, Schmid CH. BMJ 2005 May 7;330(7499):1080-3

Elements of Patient Management

- Examination - the collection of evidence
- Evaluation – synthesis of the data
- Diagnosis
- Prognosis
- Intervention / Treatment
- Outcomes

Examination

- Patient demographics and medical history
- History of current concern
- Systems Review -Brief examination of integument, cardiovascular / pulmonary, neurological / neuromuscular, G-I,
- A well organized and conducted interview and review leads to a working (pre-test)hypothesis (es)
- Tests and Measures – confirming or refuting *belief* about a diagnosis

Consider this patient

- A 38 year old teacher and avid tennis player who presents complaining of intermittent medial knee pain of insideous onset, with occasional catching and giving way (primarily while playing tennis) and intermittent swelling. History of 1 prior knee injury (believes an MCL sprain) in high school that prevented participation in football for 3 weeks). He otherwise appears healthy and expresses no other concerns.
- What do you think is wrong?

Evaluation and data synthesis

- Evaluation is an *iterative process* used to weigh the probabilities of competing diagnoses
- New evidence alters the clinicians *"degree of belief"* as to what is wrong
- Gill et al are correct - clinicians (*athletic trainers*) are Bayesians! But we do not teach, learn or pursue evidence-based practice from the perspective of Bayes' theorem

Teaching Evaluation: and why Bayes is Important

- "When I was in school" students learned to do a lot of tests
- With the shift to embrace a paradigm of EBP there has been increasing emphasis on test result interpretation and the usefulness of physical examination procedures
- 2016- time put it all together. Test results must be interpreted in context - athletic trainers are natural Bayesians but we don't teach from our natural foundation

Bayes' Theorem

$$P(T|E) = \frac{P(E|T) \times P(T)}{P(E|T) \times P(T) + P(E|\neg T) \times P(\neg T)}$$

http://www.trinity.edu/cbrown/bayesweb/

Bayes' Theorem

- The probability that a theory (T) is true shifts in the presence of new evidence.
- The probability that the patient has sustained a tear of a meniscus (T)
- Shifts with a positive McMurray test (E)

Have we cultivated an isolationist perspective of diagnostic tests?

Sensitivity, specificity, and likelihood ratios

		Gold Standard Result	
		Condition Present	**Condition Absent**
Clinical Examination Procedure Result	**Positive**	*Cell A* True positive	*Cell B* False positive
	Negative	*Cell C* False negative	*Cell D* True negative

Sensitivity

- Sensitivity- the number of injuries (or illness) that are diagnosed by a test divided by the true number of injuries based upon gold standard

$$\frac{\text{\# of injuries dx}}{\text{\# of true injuries}} = \frac{A}{A+C}$$

Specificity

- Specificity number of negative exams based upon a test divided by number of negative cases based on gold standard.

$$\frac{\text{\# dx without the injury}}{\text{\# true negatives}} = \frac{D}{B+D}$$

Interpretation

- Values for Sp and Sn range from 0.0-1.00 with higher values representing better tests
- But – what is good enough?
- How are high sensitivity and low specificity (or vice versa) values interpreted?

Likelihood Ratios

- A logical extension of Sn and Sp
- A positive likelihood (+LR) ratio is indicative of the impact of a positive examination finding on the probability that the condition in question exists.

+ LR= Sensitivity / (1 – Specificity)

Likelihood Ratios

- A negative likelihood ratio addresses the impact of a negative examination on the probability that the condition in question is present.

- LR = (1 – Sensitivity) / Specificity

Interpretation (Jaeschke et al 1994)

- (+ LR > 10 or -LR < .1) - large, often conclusive shift in probability a condition is present
- (+LR of 5-10 or – LR 0.1-0.2) - moderate, but usually important shifts in probability a condition is present
- (+LR of 2-5 or -LR 0.2-0.5) - small, sometimes important shifts in probability a condition is present,
- (+LR of 1-2 or -LR 0.5-1) - very small, usually unimportant shifts in probability a condition is present.

Application

- Shifts in probability?
- Pre-test probability? (remember your interview and review of the medical record)
- Is Bayes talking?

Again consider

- Consider a 38 year old teacher and avid tennis player who presents complaining of intermittent medial knee pain of insideous onset, with occasional catching and giving way (primarily while playing tennis) and intermittent swelling. History of 1 prior knee injury (believes an MCL sprain) in high school that prevented participation in football for 3 weeks)
- You elect to perform a McMurray test - what can be learned?

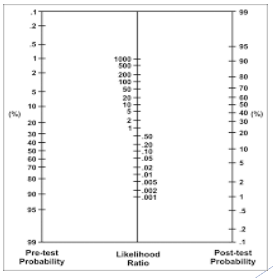
Application—positive physical examination

- Based on history pre-test probability of meniscal tear is estimated to be 80%
- Pre-test odds - probability / (1- probability) .8/(1-.8) = 4:1
- Pre-test odds x LR = post-test odds
- If LR = 3 then post-test odds would be 12:1
- Convert post-test odds to probability by post-test odds / post-test odds + 1 (92%)

Application—negative physical examination

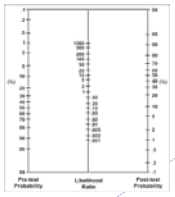
- Based on history pre-test probability of meniscal tear is estimated to be 80%
- Pre-test odds - probability / (1- probability) .8/(1-.8) = 4:1
- Pre-test odds x LR = post-test odds
- If - LR = .5 then post-test odds would be 2:1
- Convert post-test odds to probability by post-test odds / post-test odds + 1 (66%)

Post-test probability nomogram



Nomograms and On-line calculators

- http://www.medcalc.com/bayes.html
- http://www.med.wisc.edu/pds/ebm/calculators/pp-calc.html



Decisions and Actions

- **"In this world nothing can be said to be certain, except death and taxes" Benjamin Franklin**
- **A high degree of certainty is sufficient to recommend a course of treatment. Lesser degrees of certainty warrant gathering more evidence (think referral).**
- **The degree of certainty required for action are weighed in the contexts of the consequences of inaction and being wrong.**

Summary

- **Athletic trainers are Bayesians**
- **The process of establishing and acting on a diagnosis is repeated with every new encounter**
- **Acknowledging and understanding this foundation will advance, teaching, learning and patient care.**
- **Establishing a diagnosis is only the beginning – consider how data from studies of prevention and treatment can be best used to guide our patient care decisions.**

THANK YOU!!