Science in Medicine   FY180

"Medicine is a science of uncertainty and an art of probability" - Sir William Osler

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Course overview:

The aim of science is to reduce uncertainty. However, science, being a human endeavor, is inherently fraught with error and uncertainty. Scientific "fact" is constantly changing. Medicine, being a science whose subject is people, is particularly filled with uncertainty. The emergence of science in medicine has done much in the past two hundred years to reduce the uncertainty surrounding illness, and we will explore how this process has evolved and how it is at work today. Nevertheless, uncertainty remains in medicine. It is present in every medical statement, decision, and treatment. It is often hidden, neglected, or under appreciated by scientists, physicians, and especially the public. One of the primary goals in this class will be to learn to expose this uncertainty. In other words, we will be skeptical, we will critically analyze medical claims, and we will try to distinguish fact from myth because this is how medicine progresses. We will also explore how the science of medicine is used to make decisions and how uncertainty is dealt with in these situations. Other limitations of scientific medicine will be explored by looking at examples of science gone astray, the placebo effect, and the process of healing.

Course objectives:
- To understand the role that science currently plays in medicine from a historical and global perspective
- To understand the scientific process that leads to advances in medicine
- To be able to critically evaluate research studies and medical claims in the media
- To understand the basics of medical decision making and the role science plays
- To appreciate the inherent imperfections and limitations of science in medicine
- To enjoy your 8th block

Resources:
1) Porter, Roy, *Blood and Guts: A Short History of Medicine*, 2002
2) Greenhalgh, Trisha. *How to Read a Paper: The Basics of Evidence Based Medicine*, 2001
3) Gawande, Atul, *Complications: A Surgeon's Notes on an Imperfect Science*, 2002
4) Articles on Electronic Reserves (password: FY108)
   a. Hill, Sir Austin Bradford, "The Environment and Disease: Association or Causation?" *Proceedings of the Royal Society of Medicine*, 1965 May;58:295-300.

b. Williams D, Garner J, "The case against the 'evidence': a different perspective on evidence-based medicine," *British Journal of Psychiatry*. 2002;180:8-12.

c. Beecher HK, "The powerful placebo," *JAMA*, 1955;159(17):1602-6.

d. Hrobjartsson A, Gotzsche P, "Is the placebo powerless?" *New England Journal of Medicine*, 2001;344(21):1594-1602.

e. Brody, Howard, "The Chief of Medicine," *The Healer's Power*. New Haven, Yale University Press;1992:1-11.

f. Kleinman, Arthur, "The Healers: Varieties of Experience in Doctoring," *The Illness Narratives*, New York, Basic Books;1988: 209-26, 227-228.

g. Zuger A, "Dissatisfaction with medical practice," *New England Journal of Medicine*, 2003;350(1):69-75.

Projects:

1) Paper I   2-4 pages, due 1st Friday (4/23/04)
   a. Option 1
      i. Pick a health condition and describe how its explanatory model has changed over time, focusing on the historical description
   b. Option 2
      i. Pick a historical idea, invention, person, or event that had an impact (positive or negative) on the evolution of science in medicine and discuss how this influenced the role of science in medicine.
   c. Informal, non-graded, approx 3 min presentation to class on 1st Friday

2) Paper II   8-12 pages, due 3rd Wednesday (5/5/04)
   a. Critically evaluate the scientific merit and limitations of a contemporary medical/health claim (from anyone, anywhere) by comparing and contrasting the claim to the results of a clinical research paper that addresses the topic
   b. Included in the evaluation should be a critical analysis of formal research done on the topic with a discussion of the limitations of the research
   c. Also include a discussion of what can (in your opinion) be objectively concluded about the topic (if anything) and what could be done to further clarify the issue (if it isn't completely resolved)
   d. References: at least one clinical research paper (not a review article)
   e. Informal, non-graded, approx 10 min presentation to class on 3rd Wed

3) Paper III   3-5 pages, due 4th Tuesday (5/11/04)
   a. Describe the health care system of another country, culture, or subculture in which science may or may not have a central role.
   b. Informal, non-graded, approx 5 min presentation to class on 4th Tuesday

Grading:

- 10% Paper I, 40% Paper II, 10% Paper III
- 20% Final
- 20% Class participation (presentations are NOT graded)

4/19/04

Day	Class activity / *Lecture*
1 (Mon, 4/19)	Introductions / *Course overview*
2 (Tues, 4/20)	*Foundations of science in medicine*
3 (Wed, 4/21)	*Explanatory models*
4 (Thurs, 4/22)	*Observation & investigation*
5 (Fri, 4/23)	Presentations / *Modern medical myths*
6 (Mon, 4/26)	Discussion of claims / *Using the medical literature*
7 (Tues, 4/27)	*Critical analysis*
8 (Wed, 4/28)	Trip to UCHSC Library, visit new campus / *Population medicine and prevention* by Dr. Byers
9 (Thurs, 4/29)	*Diagnosis and decision*
10 (Fri, 4/30)	*The human side of decisions*
11 (Mon, 5/3)	Film: Bronowski's "Knowledge and Uncertainty" / *Medical hubris*
12 (Tues, 5/4)	*Pain and the placebo*
13 (Wed, 5/5)	Student presentations
14 (Thurs, 5/6)	*Beyond science*
15 (Fri, 5/7)	*Education, error, and discontent*
16 (Mon, 5/10)	*Student choice*
17 (Tues, 5/11)	Student presentations / *Review*
18 (Wed, 5/12)	Final

FY180 SYLLABUS

Day 1, Mon, Apr 19   **Overview**

Day 2, Tues, Apr 20   **Foundations of science in medicine**
- Assignments (to be done night before)
  - o *Blood and Guts* chapters 1-4 (pp 1-98): "Disease", "Doctors", "The Body", and "The Laboratory"
  - o Sign up to www.medscape.com to start receiving their newsletter
- Learning objectives
  - o To appreciate the gradual shift in the medical system from Hippocrates to the 20th century
  - o To understand how medicine evolved to have a foundation in science

Day 3, Wed, Apr 21   **Explanatory models**
- Assignments
  - o *Blood and Guts* chapters 5-7 (pp 99-152): "Therapies", "Surgery", and "The Hospital"
  - o Hill, Sir Austin Bradford, "The Environment and Disease: Association or Causation?"
- Learning objectives
  - o To understand how the modern concept of disease was formed
  - o To understand the differences in disease terminology including illness, symptom, sign, disorder, and syndrome
  - o To understand how a "gold standard" defines a disease
  - o To understand the differences between cause and association
  - o To understand some basic criteria to determine causality

Day 4, Thurs, Apr 22   **Observation and investigation**
- Assignments
  - o *How to Read a Paper* chapter 3 sections 2-8 (pp 41-54): "Getting Your Bearings" gives an intro to different types of studies, and chapter 5 (pp76-92): "Statistics for the non-statistician" gives an intro to basic statistics used in studies
- References - http://www.cebm.net/levels_of_evidence.asp *Levels of evidence and grades of recommendation* from the Oxford Center for Evidence Based Medicine
- Learning objectives
  - o To understand the basics of the scientific method
  - o To understand the different types of clinical studies used and some of their benefits and limitations
  - o To understand some basic medical statistics including p-value, confidence interval, relative risk, and absolute risk

Day 5, Fri, Apr 23   Student Presentations / **Modern medical myths**
- Assignments

- o Paper I due
- Learning objectives
  - o To appreciate the persistence of medical myths today

Day 6, Mon, Apr 26   **Using the medical literature**

- Assignments
  - o Pick three medical claims or controversies and search the media (internet, newspapers, magazines, and/or TV) for statements regarding the topics
  - o *How to Read a Paper*, chapter 1, pp 1-12: "Why read papers at all?"
- Discussion of claims in class
- Learning objectives
  - o To know how to use Pubmed and the library to find relevant studies on selected topics

Day 7, Tues, Apr 27   **Critical analysis**

- Assignments
  - o *How to Read a Paper*, chapter 3 section 1 (pp 39-41): "The science of trashing papers", chapter 4 (pp 59-74): "Assessing methodological quality", chapter 6 (pp 94-102): "Papers that report drug trials", chapter 8 section 1 (pp120-122): "Papers that summarize other papers (systematic reviews and meta-analyses)", Appendix 1 (pp 201-3): "Checklist to determine what a paper is about", "Checklist for the methods section of a paper", "Checklist for the statistical aspects of a paper"
- Learning objectives
  - o To be able to identify weaknesses and limitations of different studies
  - o To understand different types of bias and how they can occur
  - o To appreciate how critical thinking can be applied to modern medical controversies
  - o To appreciate the differences that may exist between public perception and medical knowledge

Day 8, Wed, Apr 28   **Trip to Denver**

- Assignments
  - o Solidify Paper II topic and perform literature search
- Lecture by Dr. Byers, an epidemiologist at UCHSC, on population medicine and prevention
- Visit to UCHSC medical library to get journal articles as needed
- Trip to new UCHSC medical campus at Fitzsimmons

Day 9, Thurs, Apr 29   **Diagnosis and decision**

- Assignments
  - o *How to Read a Paper*, chapter 7 (pp 105-119): "Papers that report diagnostic or screening tests", chapter 9 section 1 (pp 139-141): "The great guidelines debate" in "Papers that tell you what to do (guidelines)"
- Learning objectives
  - o To understand the basic steps in diagnosis and clinical decision making

- To understand some basic statistics of diagnostic tests, including sensitivity, specificity, and positive and negative predictive value
- To be able to calculate post-test probability given sensitivity, specificity and pre-test probability

Day 10, Fri, Apr 30   The human side of decisions
- Assignments
  - *Complications*, (pp 3-8): "Introduction", (pp 35-46): "The computer and the hernia factory" explores whether people or machines are better at medical decision making, and (pp 228-252): "The case of the red leg" is a great description of decision making in practice
  - *How to Read a Paper*, chapter 11 (pp 166-177): "Papers that go beyond numbers (qualitative research)"
  - Williams D, Garner J, "The case against the 'evidence': a different perspective on evidence-based medicine," *British Journal of Psychiatry*. 2002;180:8-12.
- Learning objectives
  - To appreciate the uncertainty of diagnosis and clinical decisions
  - To appreciate some limitations of evidence based medicine
  - To understand the basis for qualitative research and what it means to "treat the patient"

Day 11, Mon, May 3   Medical hubris
- Assignments
  - *Complications*, (pp 187-201): "The final cut" is an essay on the autopsy and uncertainty.
- Film: Bronowski's "Knowledge and Uncertainty" from *The Ascent of Man*
- Learning objectives
  - To appreciate how arrogance and disregard for uncertainty can have tragic outcomes
  - To understand basic ethical principles of clinical practice and research

Day 12, Tues, May 4   Pain and the placebo
- Assignments
  - *Complications*, (pp 115-129): "The pain perplex" illustrates how poorly pain is understood
  - Beecher, "The powerful placebo," *JAMA*, 1955.
  - Hrobjartsson, "The powerless placebo," *New England Journal of Medicine*, 2001.
- Learning objectives
  - To appreciate how theories of pain have changed
  - To appreciate what the placebo effect is and what it might mean

Day 13, Wed, May 5   Student Presentations
- Assignments
  - Paper II due

Day 14, Thurs, May 6   **Beyond science**
- Assignments
  - *Blood and Guts* chapter 8 (pp153-169): "Medicine in modern society"
  - Brody, Howard, "The Chief of Medicine," *The Healer's Power*, New Haven, Yale University Press;1992:1-11.
  - Kleinman, Arthur, "The Healers: Varieties of Experience in Doctoring," *The Illness Narratives*, New York, Basic Books;1988: 209-26, 227-28.
  - *Complications*, (pp 130-145): "A queasy feeling" uses a case of intractable vomiting to illustrate how important symptoms are to patients
- Learning objectives
  - To appreciate the differences between being a scientist and being a healer
  - To appreciate how healing may be facilitated and why it seems so few doctors do it successfully
  - To appreciate the draw toward complementary medicine

Day 15, Fri, May 7   **Education, error, and discontent**
- Assignments
  - *Complications*, (pp11-34): "Education of a knife", (pp 47-74): "When doctors make mistakes"
  - Zuger A, "Dissatisfaction with medical practice," *New England Journal of Medicine*, 2003;350(1):69-75.
- Learning objectives
  - To appreciate the fallibility of physicians and steps taken to prevent medical error
  - To understand the medical education process
  - To appreciate some reasons for the increase in discontent in physicians today

Day 16, Mon, May 10   **Student choice**

Day 17, Tues, May 11   Student Presentations / **Review**
- Assignments
  - Paper III due

Day 18, Wed, May 12   **Final**
- Final format
  - Several short essay questions
  - Some basic medical math questions

DEFINITIONS

- Absolute risk reduction (risk difference) – the amount the absolute risk is reduced
- Allopathy – therapy with remedies that produce effects differing from those of the disease treated
- Association – a state in which two attributes occur together either more or less than would be expected by chance
- Bias – a factor that produces results which depart from the true values in a consistent direction
- Cause – an agent or condition that permits the occurrence of an effect or leads to a result
- Case-control study – a study where a group with disease are identified and a group without disease are used as controls for comparison
- Cohort study – a study of a group with individuals with and without a particular experience, exposure, or characteristic to observe the different rates of disease occurrence
- Confidence interval, 95% – the interval over which one can be 95% confident the true value is found
- Disease – a harmful deviation of normal function of any body part, organ, or system that is characterized by at least two of the following: recognized etiologic agents, identifiable group of signs or symptoms, and consistent anatomical alteration.
- Disorder – a derangement or abnormality of function, structure, or both, resulting from an unknown etiology but may include genetic or embryologic failure in development or from exogenous factors such as poison, trauma, or disease
- Effectiveness – the extent to which a treatment produces a beneficial effect when implemented under the usual conditions of clinica lcare
- Efficacy – the extent to which a treatment produces a beneficial effect under ideal conditions of an investigation
- Etiology – 1) the science dealing with causes of disease; 2) assignment of a cause, an origin, or a reason for something
- False negative – an individual with a negative test result but who actually has the disease as defined by the gold standard
- False positive – an individual with a positive test result but who actually does not have the disease as defined by the gold standard
- Gold standard – the criterion used to unequivocally define the presence and absence of a condition or disease
- Homeopathy – system of medical treatment based on the use of minute quantities of remedies that in massive doses produce effects similar to those of the disease being treated
- Illness – 1) poor health; the experience of disease. 2) disease.
- Incidence – frequency of occurrence
- Medicine – 1) *modern*: the science of diagnosing, treating, or preventing disease and other damage to the body or mind, 2) *archaic*: the practice of curing illness

- Odds ratio – a ratio measuring the degree of association applicable to all types of studies using nominal data but usually applied to case-control and cross-sectional studies; the odds of having the risk factor if the condition is present divided by the odds of having the risk factor if the condition is not present
- P value – the probability of obtaining data at least as extreme as the data obtained if there were no true difference (true null hypothesis)
- Placebo – an inert substance given for psychological effect to satisfy the patient
- Predictive value of a negative test – the proportion of individuals with a negative test who do not have the condition as defined by the gold standard
- Predictive value of a positive test – the proportion of individuals with a positive test who actually have the condition as defined by the gold standard
- Prevalence – the total number of cases of a disease in a given population at a specific time
- Prognosis – a prediction of the probable course and outcome of a disease.
- Randomized clinical trial – an investigation where patients are assigned to study and control groups by a process of randomization
- Relative risk – a ratio of the probability of developing the outcome with the risk factor present divided by the probability of developing the outcome if the risk factor is not present.
- Relative risk reduction – the relative amount by which the risk is reduced
- Science – the observation, identification, description, experimental investigation, and theoretical explanation of phenomena.
- Scientific method – the totality of principles and processes regarded as characteristic of or necessary for scientific investigation, generally taken to include rules for concept formation, conduct of observations and experiments, and validation of hypothesis by observation or experiments
- Sensitivity – the probability that a person having a disease will be correctly identified by a clinical test; equal to the number of people with disease identified as having disease divided by the total number of people with disease
- Specificity – the probability that a person who does not have a disease will be correctly identified by a clinical test; equal to the number of people without disease identified as being without disease divided by the total number without disease
- Sign – objective evidence of disease, ie that perceived by examining physician
- Symptom – any subjective evidence of disease or of a patient's condition as perceived by patient; does not necessarily implicate an underlying problem or physical etiology
- Syndrome – a complex of symptoms indicating the existence of an undesirable condition or quality
- True negative – an individual who does not have the condition as defined by the gold standard, and has a negative test result
- True positive – an individual who has the condition as defined by the gold standard, and has a positive test result