

## **Slide 1: Conceptual, methodological, and ethical problems in communicating uncertainty in clinical evidence**

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## **Slide 2: Communicating uncertainty in clinical evidence: a growing need**

- Growth of evidence-based medicine (EBM)
  - “[T]he conscientious, explicit, and judicious use of current best evidence in making decisions *about individual patients*.”<sup>1</sup>
- Rise of shared decision making (SDM) movement
- Increasing visibility of medical controversies

## **Slide 3: Why communicate uncertainty about clinical evidence?**

- Scientific fidelity
- Psychological need
  - Information about uncertainty determines confidence in decision making in all domains of life
  - Propensity towards “overconfidence”
- Ethical mandate
  - Principle of patient autonomy

## **Slide 4: Problems in communicating uncertainty about clinical evidence**

- Conceptual: What are we communicating?
  - Meaning and nature of uncertainty in clinical evidence
- Methodological: How should we communicate uncertainty?
  - Optimal approaches for representing and communicating uncertainty
- Ethical: Why should we communicate uncertainty, and what are the consequences?
  - Benefits and harms of communicating uncertainty in clinical practice

## **Slide 5: Uncertainty**

- Main Entry: un·cer·tain·ty
- Pronunciation: \-tən-tē\
  - 1 : the [quality](#) or state of being [uncertain](#) [doubt](#)
  - 2 : something that is [uncertain](#)

Source: Eisenberg Center Conference Series 2011, Differing Levels of Clinical Evidence: Exploring Communication Challenges in Shared Decisionmaking, Effective Health Care Program Web site  
(<http://www.effectivehealthcare.ahrq.gov/index.cfm>)

- synonyms [uncertainty](#) [doubt](#) [dubiety](#) [skepticism](#) [suspicion](#) [mistrust](#) mean lack of sureness about someone or something. [uncertainty](#) may range from a falling short of certainty to an almost complete lack of conviction or knowledge especially about an outcome or result <assumed the role of manager without hesitation or uncertainty>. [doubt](#) suggests both uncertainty and inability to make a decision <plagued by doubts as to what to do>. [dubiety](#) stresses a wavering between conclusions <felt some dubiety about its practicality>. [skepticism](#) implies unwillingness to believe without conclusive evidence <an economic forecast greeted with skepticism>. [suspicion](#) stresses lack of faith in the truth, reality, fairness, or reliability of something or someone <regarded the stranger with suspicion>. [mistrust](#) implies a genuine doubt based upon suspicion <had a great mistrust of doctors>.

Metacognition: the conscious awareness of ignorance

### **Slide 6: Uncertainty in medicine: a conceptual framework**

- Can distinguish different sources of uncertainty
  - Probability: indeterminacy of future outcomes, 1st order, “aleatory”
  - Ambiguity: indeterminacy of knowledge, 2nd order, “epistemic” uncertainty
  - Complexity: incomprehensibility of information

### **Slide 7: Probability**

- Formal language of uncertainty
- Expression of indeterminacy/randomness
- Alternative interpretations
- Objective (frequentist) interpretation
  - Derivation/application: events repeated in time or space
  - Representation: rates (“natural frequencies”)
- Subjective (Bayesian) interpretation
  - Derivation/application: personal belief, confidence in future events
  - Representation: percentages (“degree of belief”)

### **Slide 8: Ambiguity**

- Decision theory construct<sup>1</sup>
- specific type of uncertainty: “2nd order” vs. “1st order,” “epistemic” vs. “aleatory”
- Lack of “reliability, credibility, adequacy” of information: “epistemic unreliability”

### **Slide 9: Ambiguity: multiple sources and manifestations**

- Incomplete / missing information

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- Amount or quality of available evidence
- Questionable precision or accuracy
  - Wide confidence intervals
- Questionable reliability
  - Inconsistent findings, reproducibility
  - Conflicting expert opinion

### Slide 10: Complexity

- Features of information that make it difficult to understand
- Conditional probabilities, multiple risk factors, attributes, outcomes

### Slide 11: Sources of uncertainty in health care

Diagram of examples and representations of different sources of uncertainty in the example of outcomes of breast cancer treatment

- Probability: 20% probability of benefit from treatment (*Indeterminacy of future outcome*)
- Ambiguity:
  - 10-30% probability of benefit from treatment (*Imprecision*)
  - Expert disagreement about benefits of treatment
  - (*Conflicting opinion/evidence*)
  - Insufficient scientific evidence of benefit (*Lack of information*)
- Complexity: 20% probability of long-term remission from treatment in patients with localized disease and HER2/neu-positive, estrogen-receptor positive, pre-menopausal, with no other comorbidities (*Multiplicity of causal factors and interpretive cues, conditional probabilities*)

### Slide 12: Uncertainty about clinical evidence: exemplars

- Clinical prediction models (CPMs)
  - "...provide the evidence-based input for shared decision making, by providing estimates of **the individual probabilities** of risks and benefits...combine a number of characteristics (e.g., related to the patient, the disease, or treatment) to predict a diagnostic or therapeutic outcome."
- Clinical practice guidelines (CPGs)
  - "...[are] systematically developed statements to assist practitioner and patient decisions about appropriate health care **for specific clinical circumstances.**"

### Slide 13: Uncertainty in CPMs

Source: Eisenberg Center Conference Series 2011, Differing Levels of Clinical Evidence: Exploring Communication Challenges in Shared Decisionmaking, Effective Health Care Program Web site (<http://www.effectivehealthcare.ahrq.gov/index.cfm>)

- Multiple sources, levels

#### **Slide 14: Uncertainty in CPGs: multiple sources, levels**

- Quality of evidence
  - Study design
  - Limiting factors
    - Methodological limitations
    - Inconsistency of results
    - Indirectness of evidence
    - Imprecision of results
    - Publication bias
  - Effect size
- Strength of recommendations
  - Balance of desirable and undesirable effects
  - Patient/societal values
  - Economic costs

#### **Slide 15: Communicating uncertainty in clinical evidence: conceptual problems**

- Single-event probabilities: existence of probability at individual patient level
- Meaning of ambiguity: distinction from probability, importance in DM

#### **Slide 16: The problem of probability in clinical care**

- To use clinical evidence in patient care is to apply objective probabilities to individual patients and single events
- Conceptual problem: objective probability *does not exist* here
  - Idea of objective “single-event probability” logically incoherent
  - Objective (frequentist) vs. subjective (Bayesian) views of probability
- Fundamental irreducible uncertainty: indeterminacy (randomness)
  - No single, knowable “true” probability, “best” course of action for an individual patient

#### **Slide 17: The problem of ambiguity in clinical care**

- Idea of “low evidence” implies existence of distinct uncertainty beyond probability itself
  - Knight (1921) and Ellsberg (1961): “uncertainty about uncertainty”
- But from a pure subjectivist viewpoint: ambiguity *does not exist*
- Normatively, but not descriptively valid...
  - People do distinguish between risk and ambiguity (“ambiguity aversion”)

Source: Eisenberg Center Conference Series 2011, Differing Levels of Clinical Evidence: Exploring Communication Challenges in Shared Decisionmaking, Effective Health Care Program Web site (<http://www.effectivehealthcare.ahrq.gov/index.cfm>)

- Communicating ambiguity thus justified from descriptive standpoint
  - But leads to methodological problems...

### **Slide 18: Communicating uncertainty in clinical evidence: methodological problems**

- Representing indeterminacy (randomness)
- Representing ambiguity
- Communicating uncertainty clinically

### **Slide 19: Representing indeterminacy (randomness)**

- First-order, aleatory uncertainty
  - Represented by probability estimates
  - Quantitative, qualitative, visual representations
  - But conventional representations do not explicitly represent indeterminacy
- Important in domain of single-event probabilities
  - But difficult to understand
  - Non-quantifiable
  - Little prior work
- Emerging work on new qualitative, visual representations

### **Slide 20: Representing indeterminacy in risk estimates: new approaches**

Two graphs illustrating the visual random static and visual random dynamic indeterminacy in risk estimates.

### **Slide 21: Representing indeterminacy in risk estimates: new approaches**

- Limited evidence on effectiveness
  - No apparent effects on risk perceptions
  - Increase subjective uncertainty about risk but no other evidence on “understanding,” decision making
- Unknown outcomes, added value above communicating magnitude of probability estimates

### **Slide 22: Representing ambiguity**

- Second-order, epistemic uncertainty
- In risk modeling: manifest by imprecision, represented by confidence intervals
  - Not often communicated to decision makers
  - Quantitative, qualitative, visual representations

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- In clinical practice guidelines (CPGs): manifest by limited confidence in evidence, represented by quality ratings
  - Non-quantitative (verbal)
  - Emerging formal rating systems (USPSTF, GRADE, ACP)
- New representations, methodological problems
- Limited evidence

**Slide 23: Representing ambiguity in risk estimates: NCI CCRAT**

Two bars illustrating integrated textual and visual risk for developing colon cancer. One bar shows risk as a solid bar. The other shows risk as a blurred bar.

**Slide 24: Representing ambiguity in clinical evidence: USPSTF**

A page of grade definitions from the U.S. Preventive Services Task Force Web site. Available at: <http://www.uspreventiveservicestaskforce.org/uspstf/grades.htm>. Last accessed December 26, 2012.

**Slide 25: Methodological problems**

- Separation of strength of recommendation (risk) vs. quality of evidence (ambiguity) important — at least psychologically
- Formal, explicit, parsimonious rating system a clear advance
- Yet methodologically problematic
  - Logically paradoxical ratings for cases of low evidence
  - Underlying conceptual problem: distinguishability of risk vs. ambiguity
- Lack of empirical evidence
  - Effectiveness and validity of ambiguity rating systems
  - Influence on judgment, decision making
  - Criteria for validation: expert consensus, but patient perspective also important, other criteria

**Slide 16: Communicating uncertainty clinically**

- Even more uncertainty...
- Patient decision support interventions (DeSIs) a natural possibility
  - Yet to be integrated in most existing decision aids
- But communicating uncertainty requires shared decision making
  - Construction of subjective confidence: not an exclusively scientific process
  - Interchange, not unidirectional information transfer from expert to layperson
- Physician-patient encounters
  - Optimal language, counseling techniques
- Implementation within processes of care

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**Slide 27: Communicating uncertainty in clinical evidence:  
ethical problems**

- Patient autonomy
- Benefits and harms

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