Building Bridges in Health Physics

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Bridge to Nowhere? Resolving the Low Dose Problem

- Epidemiology: limited risk detection <100mSv
- Problems with biophysical approach
- Systems biology and emergent properties of cancer

Source: Brenner et al. PNAS; 2003
Epidemiology Limits

- Detection horizon determined by ratio of spontaneous and radiogenic risks
- Risk detection difficult below 100 mSv
- Absence of evidence is not evidence of absence
Biophysical Approach: Marginalizing Disease Complexity

- LNT relates dose and cancer risk
- Biophysical approach argues probability of cell damage is proportional to dose
- Absence of non-linear post-initiation processes?
- *Dumontier et al. v. Schlumberger Tech (2008)*
  - Plaintiffs sued after exposure to Cs137 but have no cancer
  - Ninth Circuit affirmed MT Dist Ct decision in favor of Defendant
  - subcellular damage does not necessarily lead to bodily injury
  - S.C. declined to review

Source: Fearon and Vogelstein *Cell*: 1990
Biophysical Approach: Not All Cancer is Disease

- Cancer bottleneck: cancer is commonly initiated but promotion and progression to full malignancy is rare
- Observed incidence of early-stage cancer suggests most DCIS does not progress to disease requiring treatment
- 50-70% of DCIS does not contribute to breast cancer risk

Sources: Welch and Black *Ann Int Med*; 1997; Welch, *Should I Be Tested for Cancer?*; 2004
Cancer: A Disease with Emergent Properties

- More than a collection of proliferating abnormal cells
- Tumor behavior not endowed in individual cancer cells
- Risk reflects systems effects, not cellular effects
Systems Biology and Uncertainty

• Non-targeted effects ($V_{\text{eff}} > V_{\text{targ}}$): dose as surrogate for risk?
• Connecting initiation with later events in carcinogenesis: integrating events at different levels of biological organization
• Post-initiation biomarkers
• Source and magnitude of risk uncertainties
• Integrate systems biology and epidemiology
Bridge to Better Understanding

- **Messengers**: trusted media sources; opinion leaders; credibility; communication skills

- **Messages**:
  - need to be appropriately framed
  - frames trigger a new way of thinking by linking relevant concepts about issue
  - frames are not false spins on an issue
Some Message Frames in Health Physics

**Accountability Frame**: we are all in this together; proper use of science/experts in decision-making; stakeholder involvement; transparency, ownership, responsiveness

**Precaution Frame**: need for precautionary action in face of uncontrolled consequences; risk aversion; no dose is safe; 1-2% of cancers from CT (Brenner and Hall, *NEJM*; 2007)

**Social Frame**: nuclear technology as a social good; nuclear power and medical imaging improve quality of life

Source: Nisbet *Environment*; 2009
Bridging Policy and Science

• Link between science and policy is problematic
• Failure to properly consider risk assessment, risk communication and risk management and then consolidate them in a process that leads to sound policy
  – uncouple risk assessment from risk management (Nat. Res. Council)
• Uncertainty analysis is key to sound policy decisions
  – risks are hard to measure at small doses
  – risks can be misinterpreted and misunderstood without uncertainties
  – more desirable to characterize uncertainties than rely on conservative risk assessments
• Boundary Organizations- should serve as unbiased brokers of policy choices by providing balanced and objective scientific analyses
  – Group polarization
  – Single-position advocacy is constraining
Boundary Organizations

- Sit at the interface of science and politics
- Subject to the authority of each
- ICRP, Nat. Res. Council, NCRP
- US NRC response to ICRP 103
  - radiation protection is adequate
  - but pressure to align with international recommendations
  - middle ground: establish more restrictive fetal dose limit; reject occupational dose limit and environmental recommendations
Better Bridges

• Systems biology and epidemiology mutually inform
  – DCIS and breast cancer risk

• Messenger and audience
  – better communications through careful framing of messages

• Policy-science
  – best policies when all options on table
  – uncouple risk assessment and risk management
  – more visible role for uncertainty analysis in risk management and risk communication