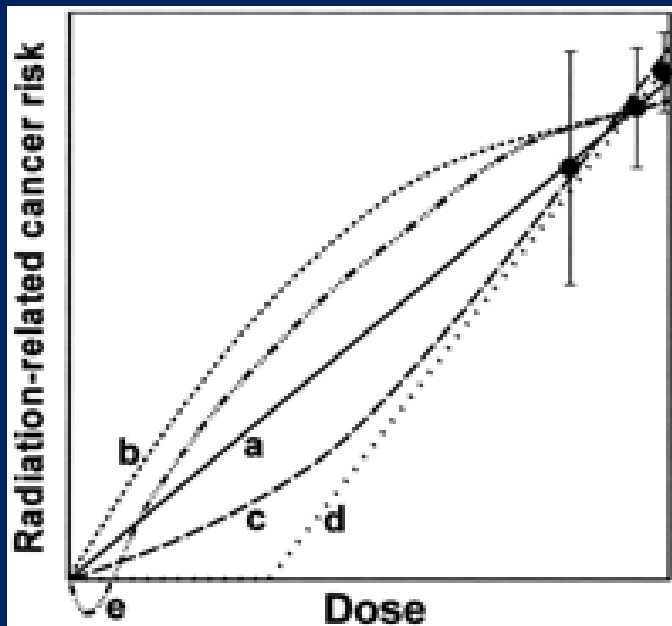


Building Bridges in Health Physics

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Bridge to Nowhere?

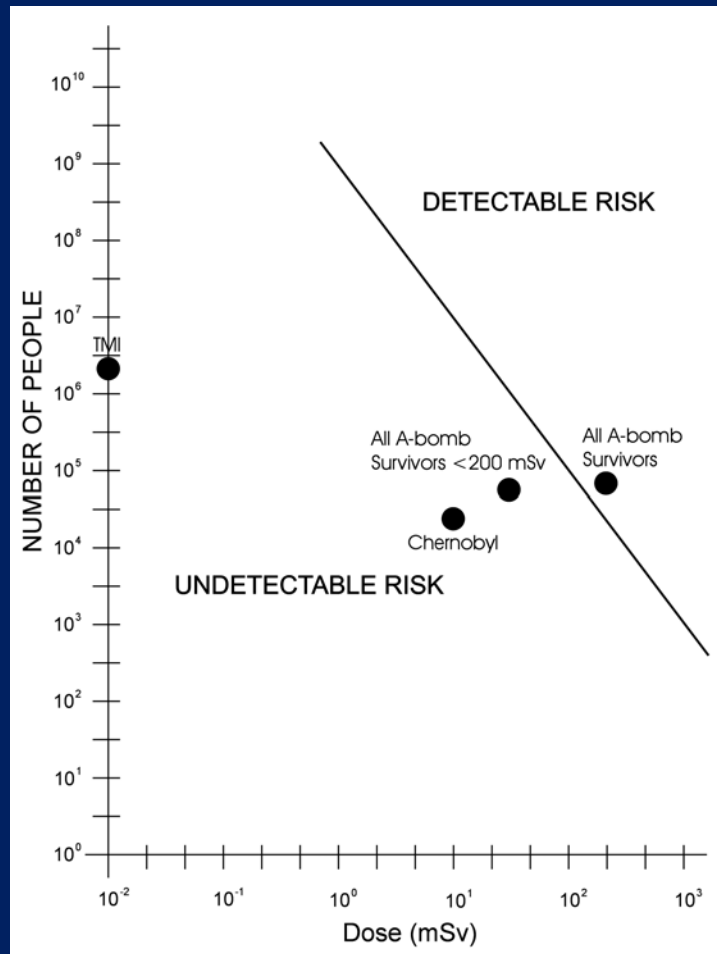
Resolving the Low Dose Problem



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

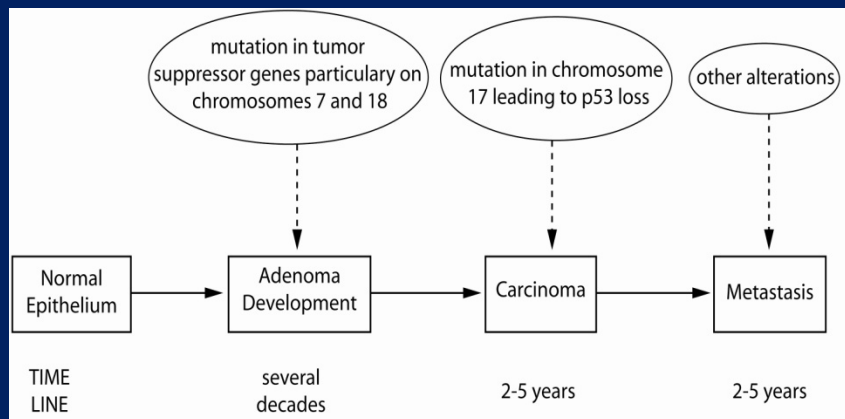
Source: Brenner *et al.* PNAS; 2003

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

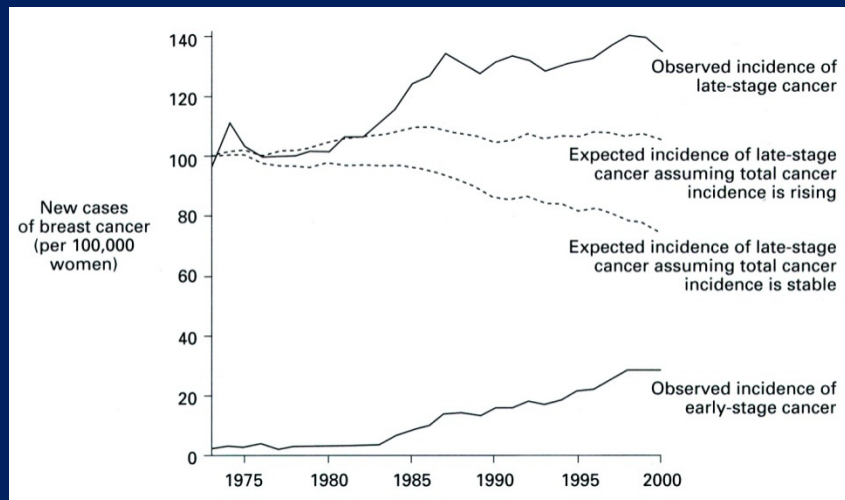
Biophysical Approach: Marginalizing Disease Complexity



Source: Fearon and Vogelstein *Cell*: 1990

- 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

Biophysical Approach: Not All Cancer is Disease



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

- 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

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

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