Thoughts on Estimating Radiation Doses from an Epidemiologic Perspective

Dosimetry Uncertainty Workshop

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Phases of Dosimetry-related Work

- **Model the source term, radiation transport, etc.**
- **Make environmental measurements (e.g., ^{137}Cs in soils)**
- **Establish a proper unbiased, fixed cohort of people who should be in the study & for whom dosimetry is needed**
- **Make measurements on selected individuals to establish biokinetics, estimate doses to organs, or use as a biodosimeter for "instrumental variable" analyses**
- **Query people regarding locations, circumstances, behavioral aspects, etc**
  - **Dosimetrists may well be limited by how well we do the epidemiologic work**

Account for All Sources of Uncertainty

- Joint pre-planning by dosimetrists & epidemiologists to:
  - Develop comprehensive list of all the potential sources of uncertainty
  - Consider how to get information on the magnitude of uncertainty for each source
- Conduct sensitivity analyses to evaluate effects of assigned magnitudes of uncertainties

Dose Assessments Based on Self-Reports of Locations, Behaviors, etc.

Take Steps to Assure that Dosimetric Assessment is Double-Blinded to Outcomes

- **An early study: questionnaire to get exposure & other information began by asking, "Were you or any members of your household victims of the _____ fallout?"**
- **Study of ^{131}I fallout: Interviewing of study subjects regarding their dietary and other exposure-related behaviors was done after the subjects knew their thyroid screening results.**
- **Keep interviewers, coders, etc as blinded as possible to exposure level**
- **Design questionnaire so that exposure-related information is asked before any health outcome-related questions**

Information from Self-Reports

- **Obtain it from all study subjects. Make a well-organized, strong effort to do this.**
- **Need to determine how to get information most accurately within the constraints of questionnaire length, subject motivation, clarity & understandability**
  - **Try to think of ways answers might be ambiguous, or questions might be interpreted differently**
    - **Be sure to get enough detail to address ambiguities**
    - **Steer away from open-ended questions**
  - **Pilot test questionnaire (use skilled interviewer who can probe to solicit misconceptions, ambiguities, unanticipated responses, etc), & revise it iteratively**
    - **Test and compare alternative questions to solicit information**
  - **Maybe get interactive help on question design from an expert on survey questionnaires, or use focus groups**

Setting Defaults for Unavailable Data

- **Worst-case scenarios vs. range of realistic scenarios**
  - **E.g., living next to the fence of a nuclear facility**
  - **E.g., standing outside 24h/day for lifetime (Nishiyama)**
- **Choices & Validation of Defaults: Self-report data**
  - **Use existing data to set "best" defaults – i.e., don't set blind or theoretical defaults**
  - **If possible, get some validation of variables before setting defaults**
- **Sensitivity Analysis: Evaluate a realistic range of defaults and see what difference various defaults make**

Accuracy of Dosimetry Self-Reports?

- **Depending on exposure source & reporting methods, self-reports can be fairly inaccurate**
  - **Dental x-ray validation study (Preston-Martin, AJE 1985) –Number of dental x-ray visits disagreed ≥ 2 in % of persons: full-mouth x-rays, 22%; all x-rays, 46%**
  - **Diagnostic x-ray reporting in US (Berrington, AJE 2003): Nominally, 38% more underreporting among controls than cases**
  - **Oxford Study of Childhood Cancer (Stewart et al) – Reporting biases may account for up to 25% of nominal *in utero* x-ray effect (per ICRP #90, 2003)**
- **Motivated recall inaccuracy**
  - **Compensation issues – various studies**
  - **Stigma of exposure – A-bomb**

How to Check the Accuracy of Dosimetry?

- See if there is a consistency in dose-response estimates between dosimetric subgroups
  - E.g., A-bomb risk estimates for people outside, in wooden houses, & in factories
- Compare different types of exposure assessments – e.g., Chernobyl settlement soil measurements of ^{137}Cs vs. estimated ^{131}I thyroid levels of residents
- Physical dosimetry vs. biological dosimetry
  - Current issues with biological dosimetry: inherent biological variability (limit on sensitivity), limited sample availability, cost, low-throughput methods

Use Realistic Dose Distributions to Estimate Statistical Power

- Prudent conservatism in doses is valuable for radiation protection
- But, use realistic doses when considering an epidemiologic study
- Lack of dose realism may occur for various reasons
  - Unawareness of how important the dose distribution is in determining statistical power & statistical precision
  - Poor prior information regarding the likely doses
  - Alarmist sentiments that cause inappropriate generalizations about doses (and effects)
  - Desire to get a grant (or approval) to do the study

Summary

- Account for all sources of uncertainty
- Assure that self-report exposure information is double-blinded
- Efforts to assure that self-report data are sufficiently detailed, of good quality, & obtained from all study subjects
- Make defaults for missing data realistic
- Do sensitivity analyses regarding defaults & also regarding magnitude of uncertainty distributions
- Validate accuracy of dosimetry

Thank you