How calibrations can help save lives

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THE UNIVERSITY OF TEXAS
MD Anderson Cancer Center
Making Cancer History®

Outline

What value does an ADCL bring to clinical practice?

1. Dosimetric value

2. Non dosimetric value

Dosimetric Value

- Central dosimetric value:

Minimize uncertainty in dose in medical applications

- Provide calibration factors that allow for consistent and accurate determination of dose
  - At least under reference conditions

Minimize uncertainty

- ADCLs also contribute scientific and clinical knowledge to improve existing standards
  - Minimize theoretical uncertainty and ensure it can be achieved in practice.

Addendum to the AAPM's TG-51 protocol for clinical reference dosimetry of high-energy photon beams

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Minimize uncertainty

- ADCLs also contribute scientific and clinical knowledge to help develop new standards
  - Characterize new brachytherapy sources
  - Develop new equipment

Reference dosimetry in magnetic fields: formalism and ionization chamber correction factors

D. J. O'Brien, D. A. Roberts, G. S. Ibbott, G. O. Sawakuchi

Air-kerma strength determination of a new directional ^{103}Pd source

Manik Aima,[a] Joshua L. Reed, Larry A. DeWerd, and Wesley S. Culberson
Department of Medical Physics, School of Medicine and Public Health, Univ
Madison, Wisconsin 53705

REVIEW OF SCIENTIFIC INSTRUMENTS 77, 015105 (2006)

Large-volume ionization chamber with variable apertures for air-kerma measurements of low-energy radiation sources

W. S. Culberson, L. A. DeWerd, D. R. Anderson, and J. A. Micka
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Calibration of New High Dose Rate ^{192}Ir Sources

K.E. Stump,[a] L.A DeWerd, J.A. Micka, and D.R. Anderson
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How important are these numbers?

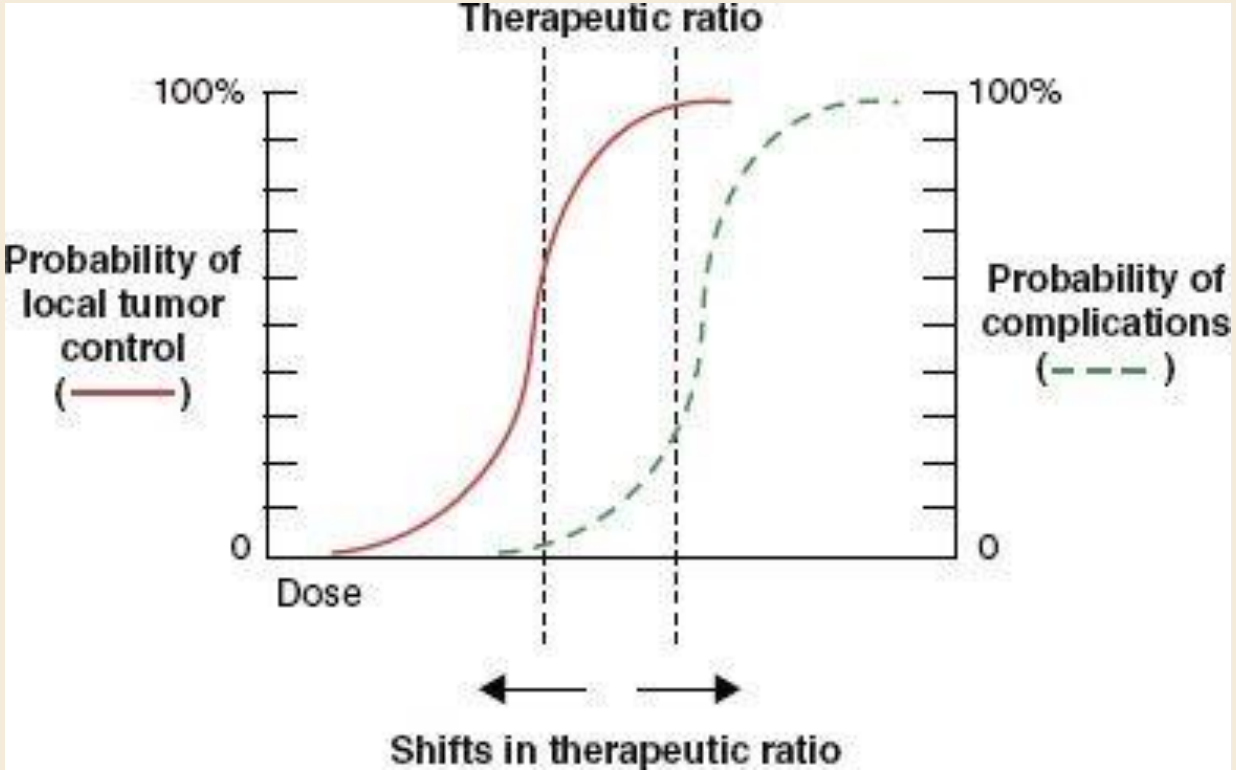
- The end result is small uncertainties that people are familiar with
  - Farmer chamber, $N_{D,W}$ 1.3% (k=2)
- ADCL deals with uncertainties that are often <1%.
- Does this level of control matter?
- We often use the expression that an effect size must be at least 5% to manifest clinically.
- Does that make ADCL accuracy and precision unnecessary?

Clinical uncertainty

- Where does this 5% value come from?
- ICRU Report 24 (1976)
  - "…the available evidence… points to the need for an accuracy of +/- 5% in the delivery of an absorbed dose to a target volume if the eradication of the primary tumor is sought."
- TG-65
  - 2 cases where Radiation Oncologists detected calibration errors because of unexpected patient performance
    - Tumor control and Toxicity
  - Calibration errors of 7%

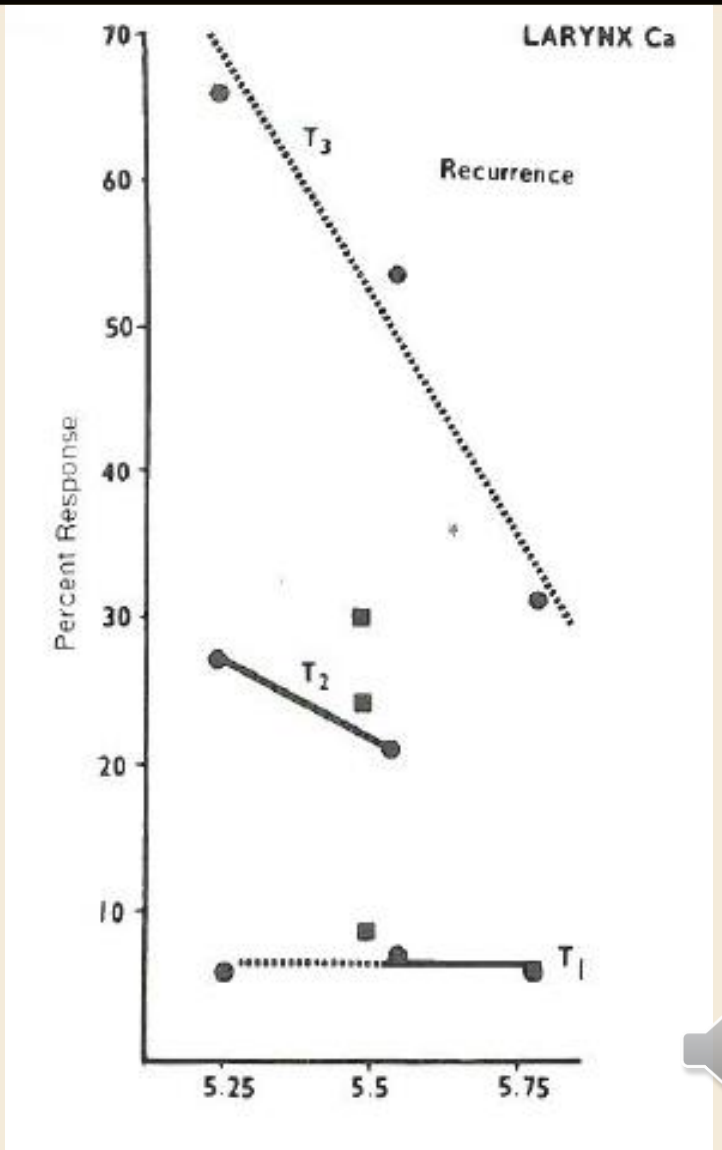
Underlying behaviour

- Underlying dose response is sigmoid
- No threshold at 5%
- As dose changes more, effect changes more



Underlying Data

- ICRU data; 5% accuracy
- Different stages have very different responses
  - Different slopes on dose response curve
- At a steep part of the curve, 5% change in dose results in a 20% change in tumor control



Underlying Data

- TG-65:
- 7% dose change led to observed clinical effect
  - 20 patients (tumor control), 67 patients (toxicity)
- If we are concerned with a larger number of patients, the size of the effect we can see is smaller.
- Clinical trials: 1,000s of patients
- ADCL calibrations: 100,000s of patients

Actual clinical Uncertainty

- Response and necessary consistency vary by disease site and stage
- Systematic dosimetric standards involve more than just a handful of patients and “What is clinically apparent”
  - Continuous, sigmoidal dose response
- 2016 IAEA Report on required accuracy in RT:

  ….it is reasonable to strive for accuracies in systematic bias of 1-2%.
- This is why need tight tolerances of ADCL, and why calibration labs worry about small uncertainties

Non Dosimetric Value of ADCLs

- While the focus of the ADCLs is to minimize dosimetric uncertainty, staff is also available to answer questions!
- We have a wealth of information
- We emphasize independence/unbiased information

- We get lots of questions and you are welcome to ask!

Types of questions

- Information/options on equipment
  - Is there an electrometer with lots of channels
- Procedural questions
  - k_Q for chambers not in TG-51
  - Differences between TG-51 and TRS-398
  - Best ways to cross calibration equipment
  - Where to get a barometer calibrated
- Troubleshooting
  - Initial screening if equipment isn't working
  - Result changed

Final thoughts

- We’re all working together to eradicate cancer.
- ADCLs are part of the team.
  - Provide dosimetric expertize
  - Minimize uncertainties
  - Increase consistency
  - Help answer questions

- Maximize quality of RT, maximize benefit to patient

Thanks!

Questions?