Post Procedure Evaluation

William S. Bice, Jr., Ph.D.
UTHSCSA, San Antonio, Texas
IMPS, San Antonio, Texas
Texas Cancer Clinic, San Antonio, Texas

Objectives

- Why evaluate implants <u>after</u> the procedure?
- Know the two types of post procedural evaluation and the goals of each.
- Know the characteristics of modern treatment planning.
- There is a hierarchy of evaluation tools.
- Believe in the importance of goal setting, self evaluation, change and re-evaluation.

Why Evaluate After the Procedure?

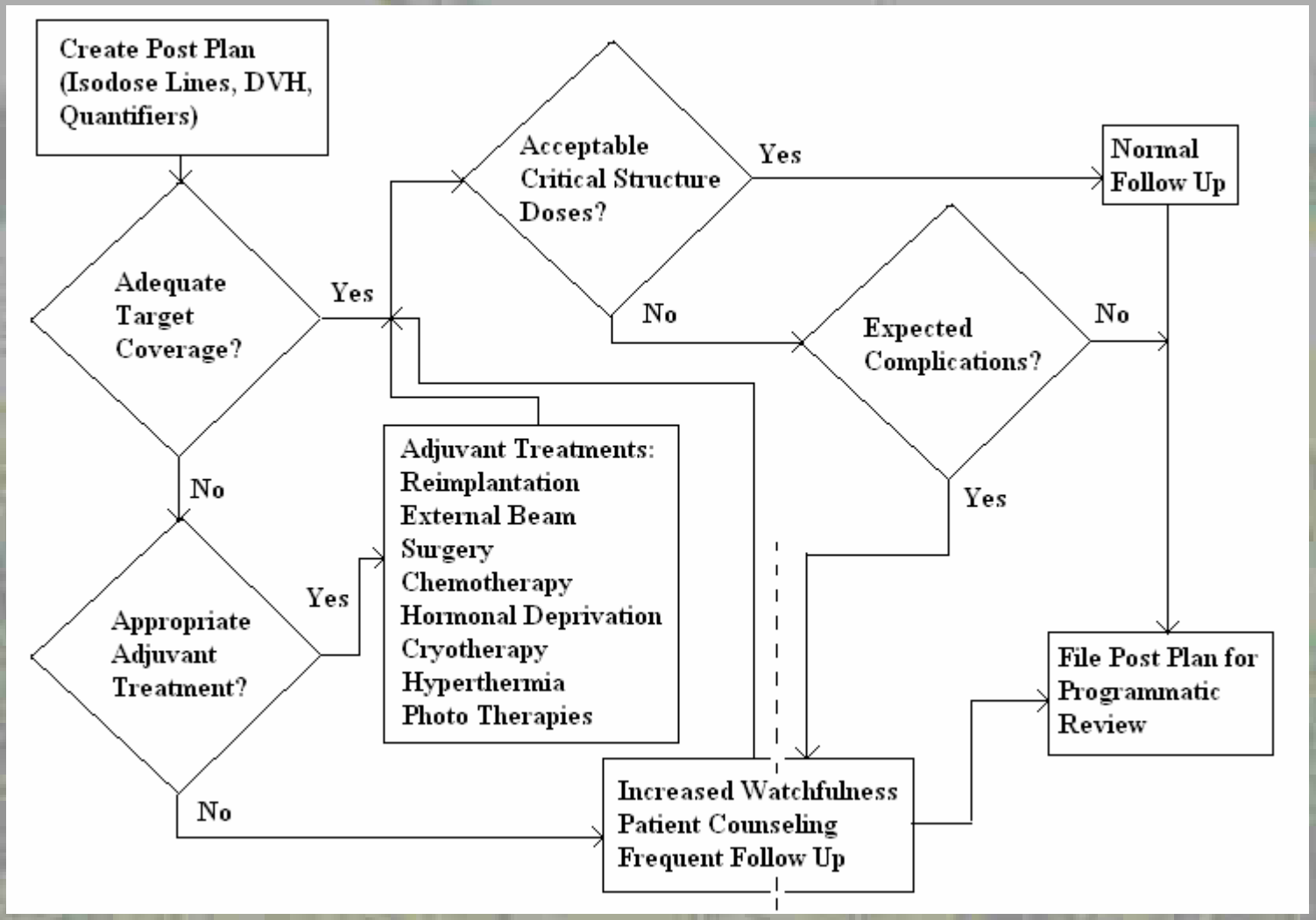
- What is being evaluated?
  - implant quality
- Why?

Assess and Improve Quality

Why Evaluate After the Procedure?

- Individual implant assessment
- Programmatic improvements
- External incentives
  - Standard of Care (ABS, ACR, AAPM)
  - Regulatory (CFR, State regulations)
  - Fiscal (CMS)
  - Legal

Plan Evaluation Paradigm



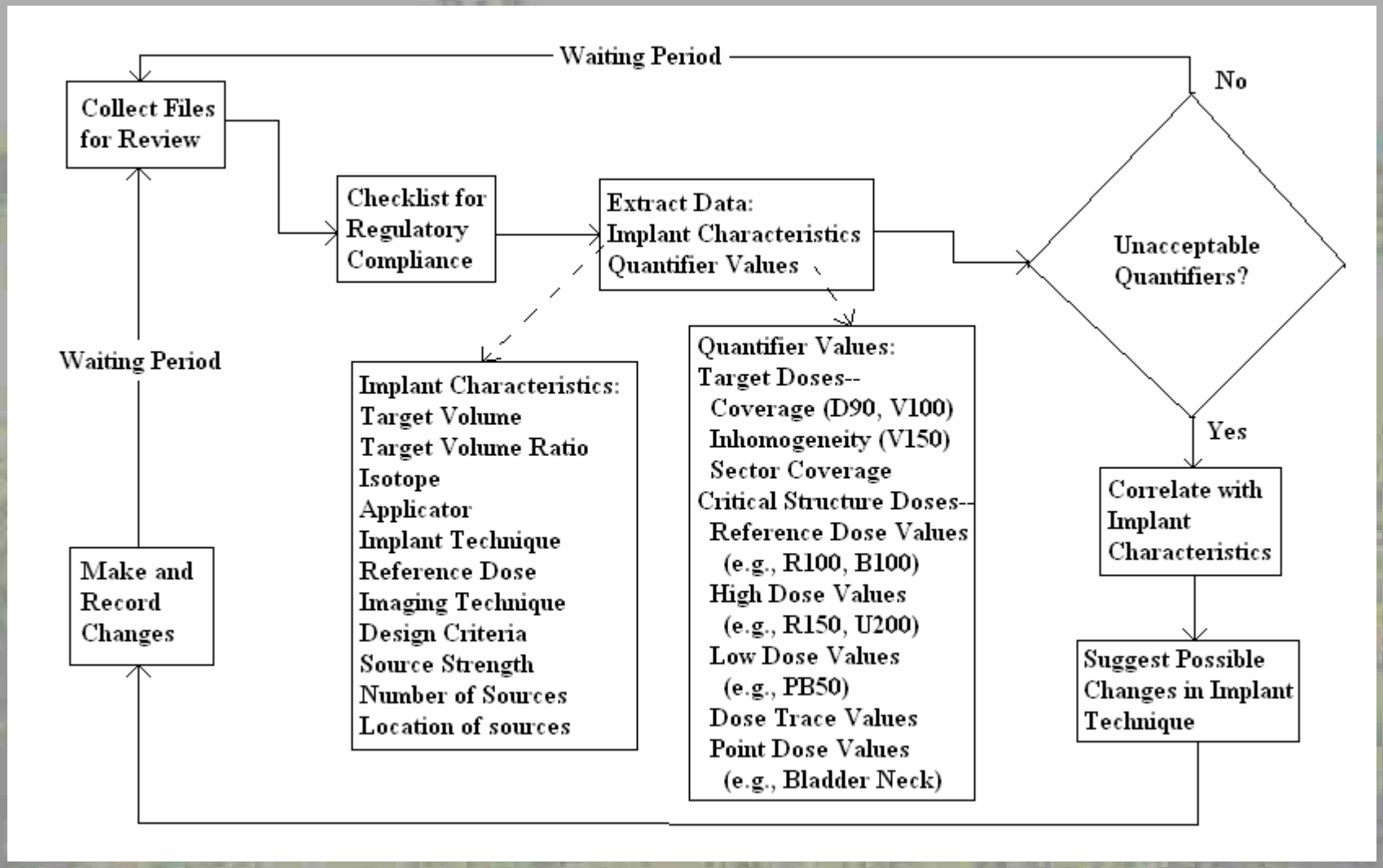
Individual Implant Assessment: Inadequate Target Dose

- Therapeutic intervention
  - Adjuvant therapies
    - Re-implantation
    - External beam radiation
    - Chemotherapy / hormonal manipulation
    - Surgical intervention
  - Salvage therapy: follows recurrence
- Increased vigilance
  - Follow up and diagnostics (imaging and biochemical evaluation)

Individual Implant Assessment: Excessive dose to normal tissues

- Therapeutic intervention:
  - Almost always salvage rather than adjuvant (cross your fingers)
  - Hyperbaric oxygen to promote healing
  - Surgical intervention
- Increased vigilance
  - Patient awareness
  - Follow-up visits
  - Diagnostic procedures

Group Analysis Paradigm



Programmatic Improvement

- Technique evaluation
  - Planning
  - Delivery
    - OR methods (Example: patient alignment)
    - Brachytherapist
- Equipment evaluation
  - Delivery systems
    - Example: Loose seeds / Mick applicator
    - Example: Loose / stranded seeds
  - Broken on maladjusted equipment

Tips for Group Analysis

- Perform early and often
  - Usable data from small sets
  - Quick results energizes efforts
- Limit number of evaluation criteria
  - Too much data can be confusing
  - Fix one item at a time

Tips for Group Analysis

- Perform early and often
  - Usable data from small sets
  - Quick results energizes efforts
- Limit number of evaluation criteria
  - Too much data can be confusing
  - Fix one item at a time

Post Implant Evaluation

- Patient follow up
- Group analysis
  - Program review
    - Technique assessment
    - Equipment assessment

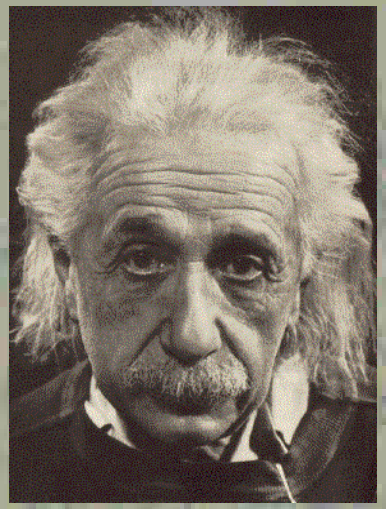
If needed

Post Planning

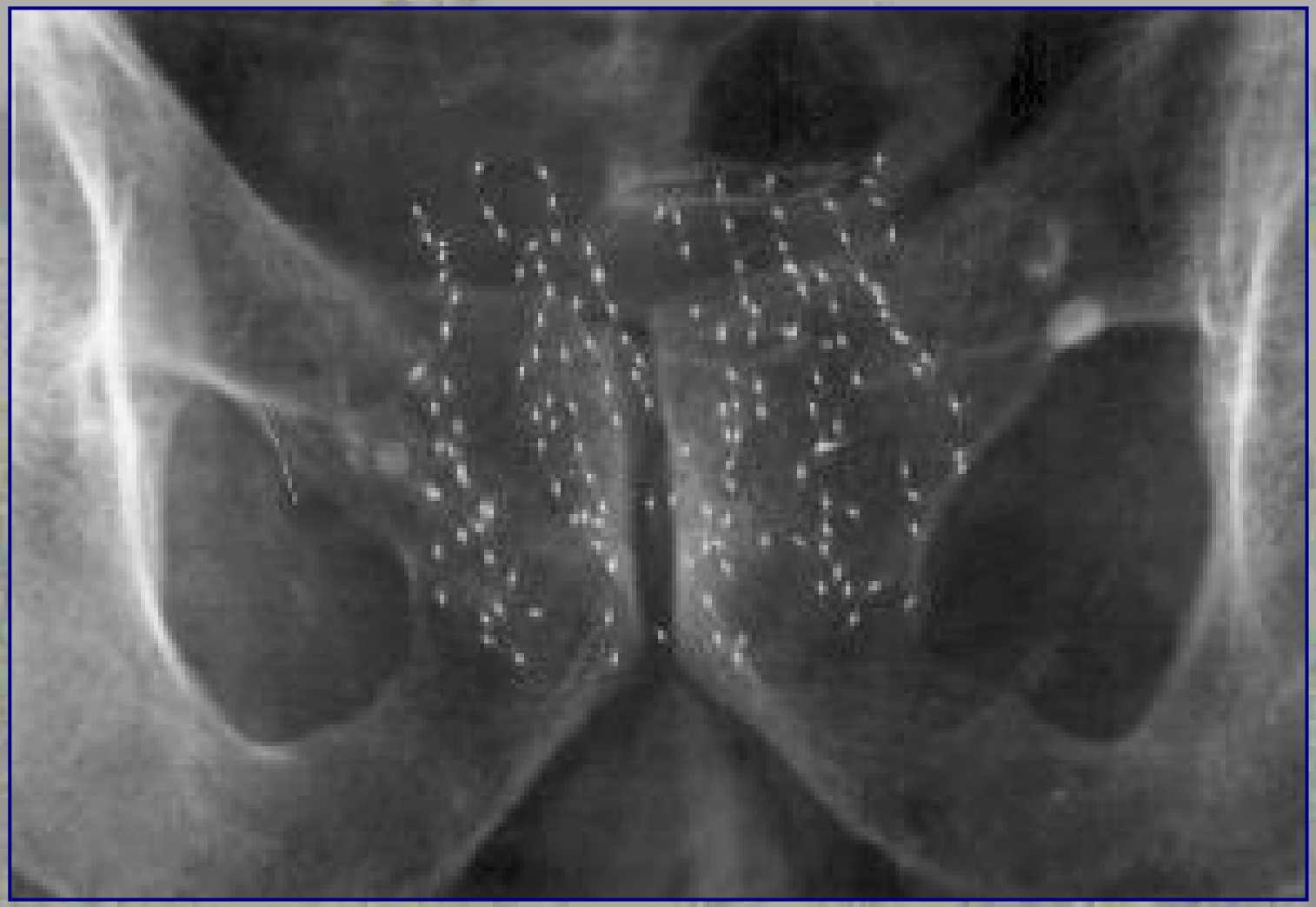
Post Implant Dosimetry

Post implant evaluation cannot be performed without post implant dosimetry. Sometimes this requires a new image set which shows source locations, targets and critical structures. You cannot evaluate what you have done without seeing what you have done. Any hope of developing a grand unification theory depends upon this.

—A. Einstein, 1921, Nobel Prize acceptance speech

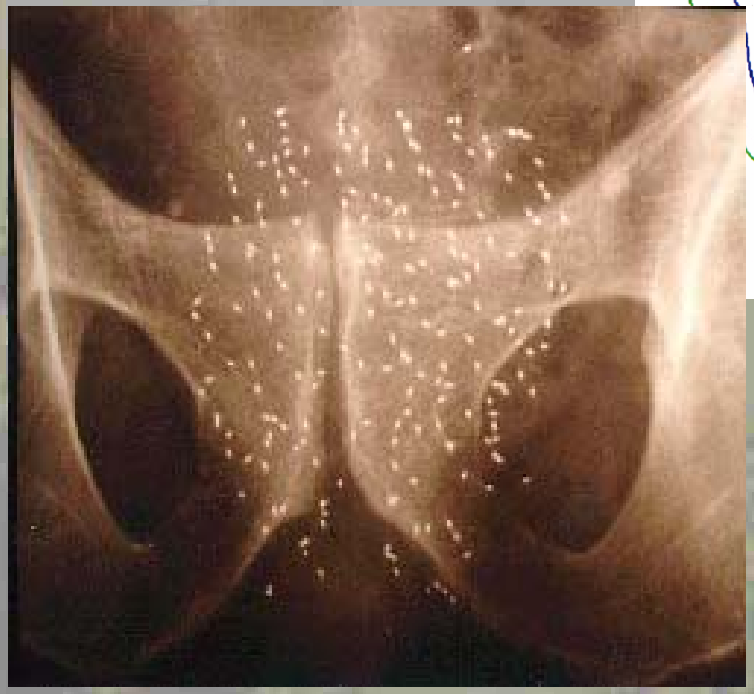


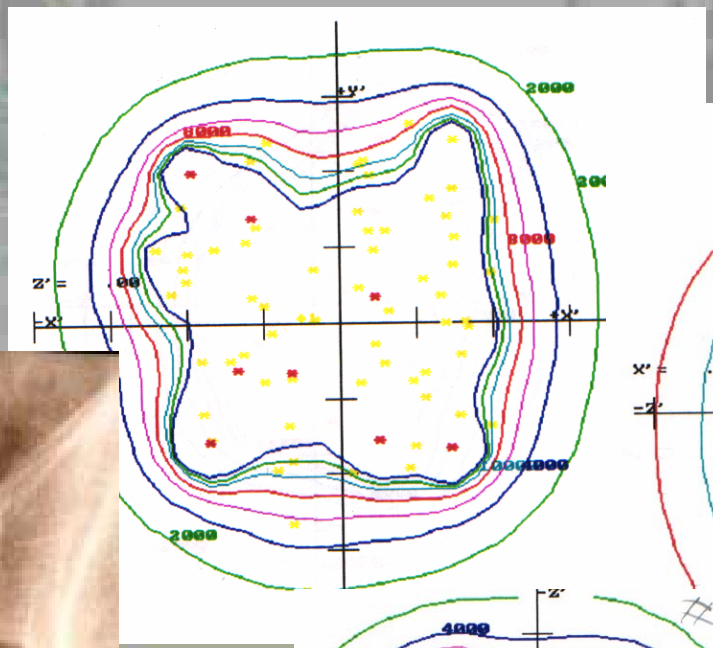
Films for Record

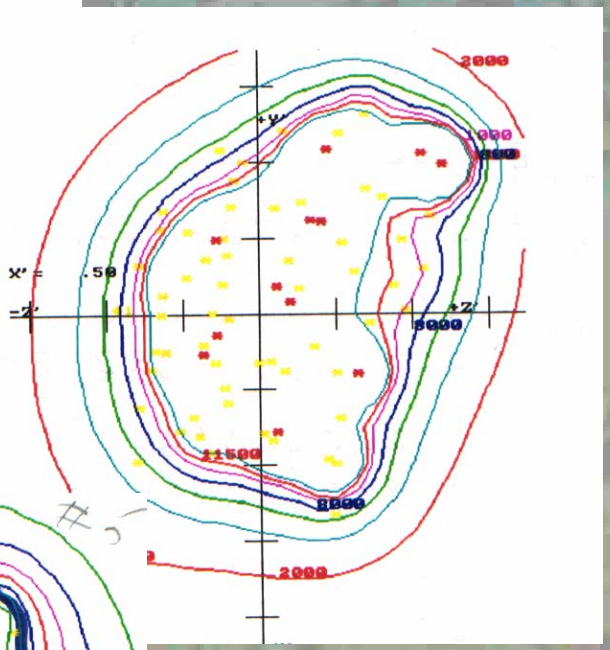


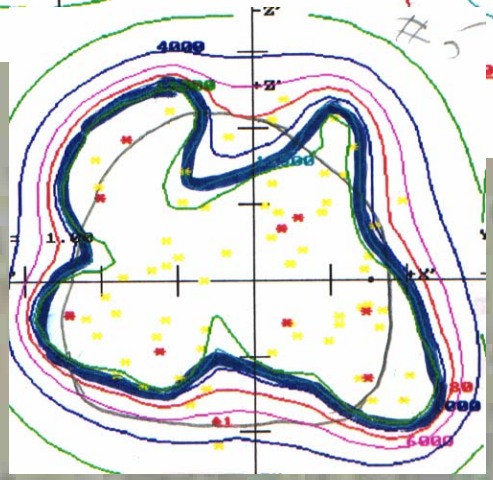
Films for record

Paired-Film Isodose Curves



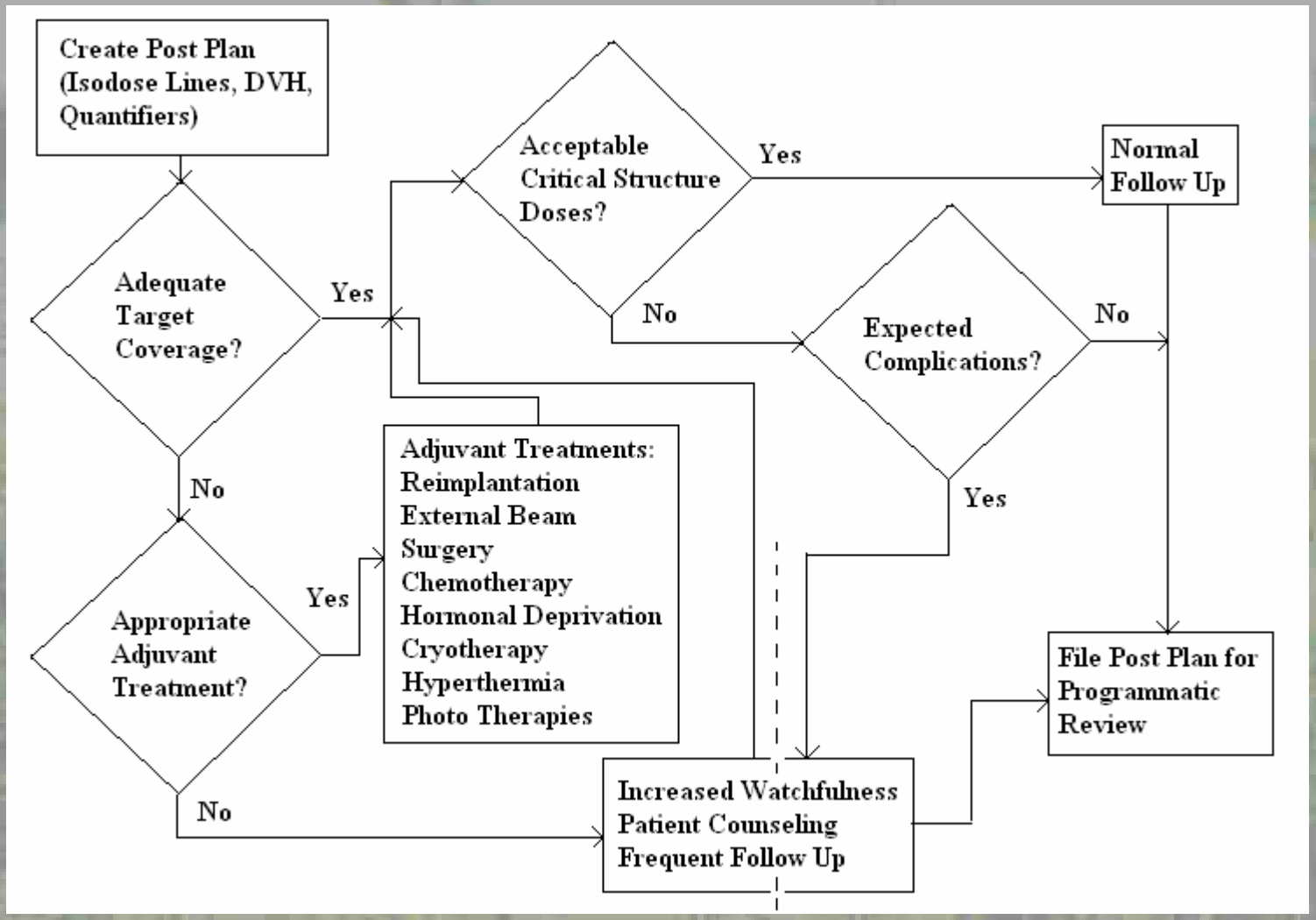






Modern Treatment Planning

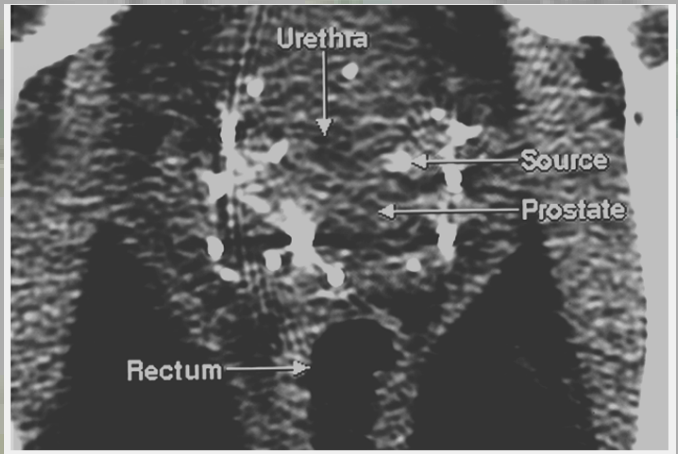
Plan Evaluation Paradigm

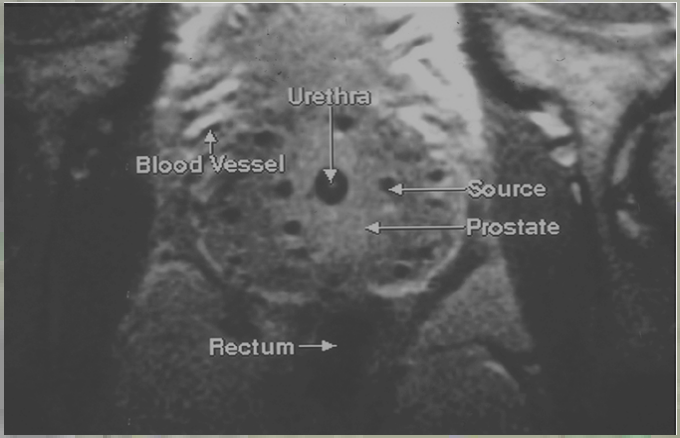


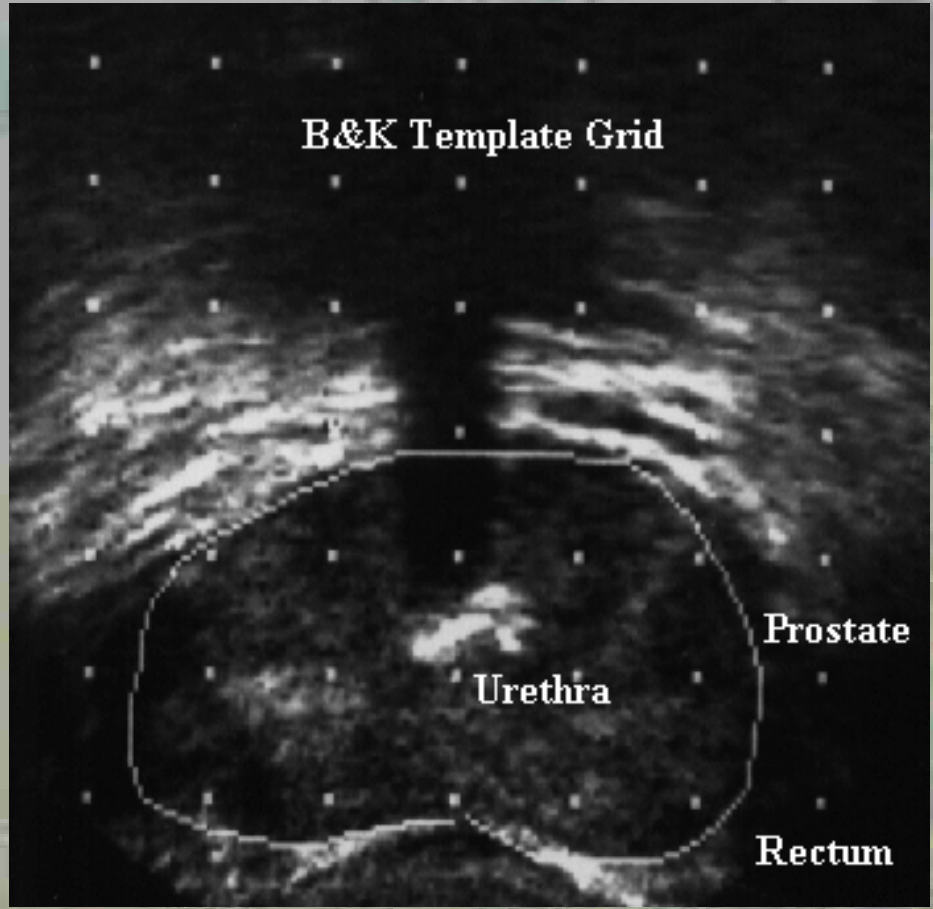
Meaningful Post Planning

- Tomographic Image Based
- “Modern” Treatment Planning
  - 2-mm or smaller grid size
  - 3-dimensional calculation
  - Structure based analysis
  - Seed sorting
  - DVH based analysis

Tomographic Imaging Based Evaluation





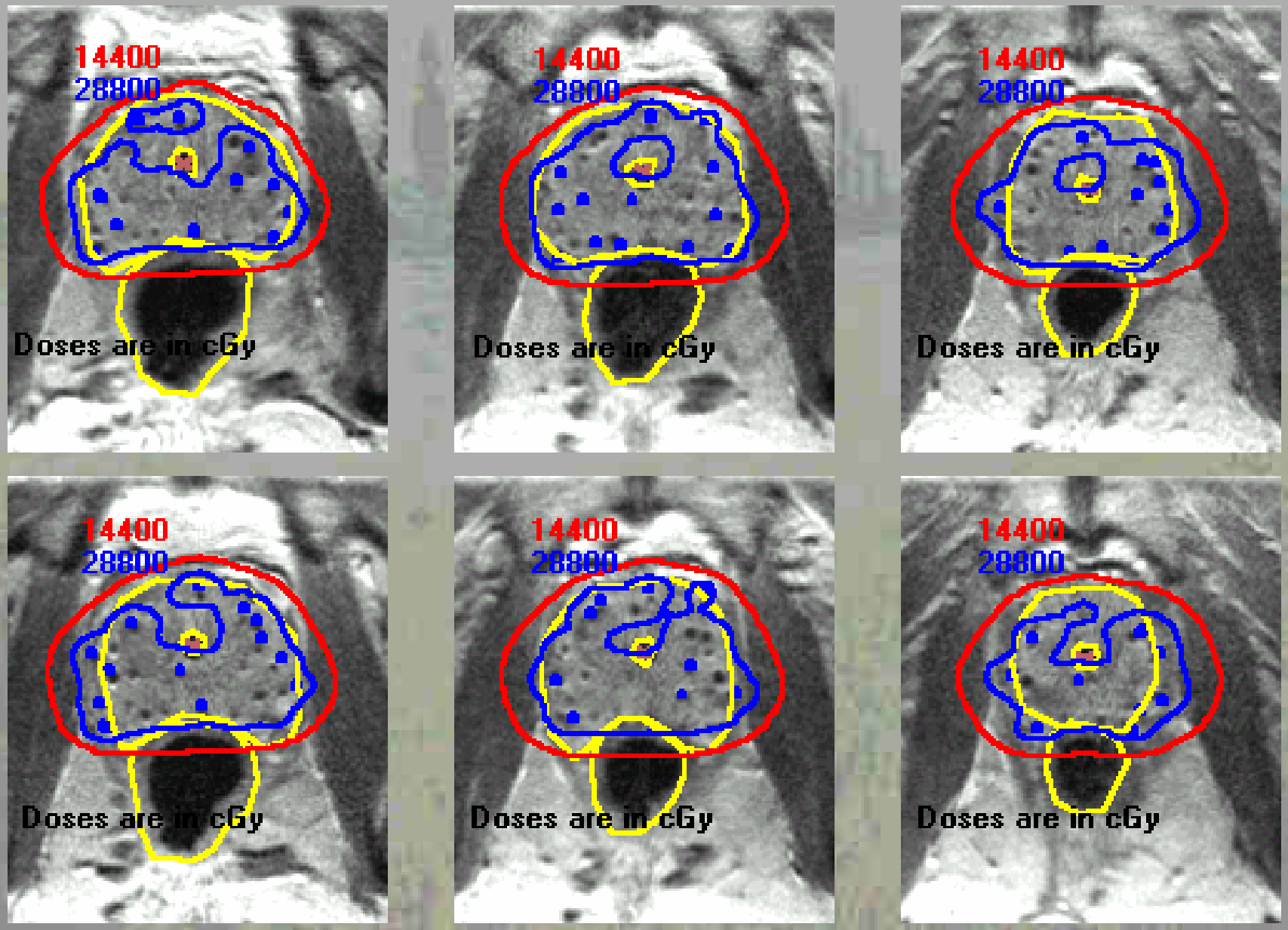


Treatment Plan Evaluation: The Dose Evaluation Hierarchy

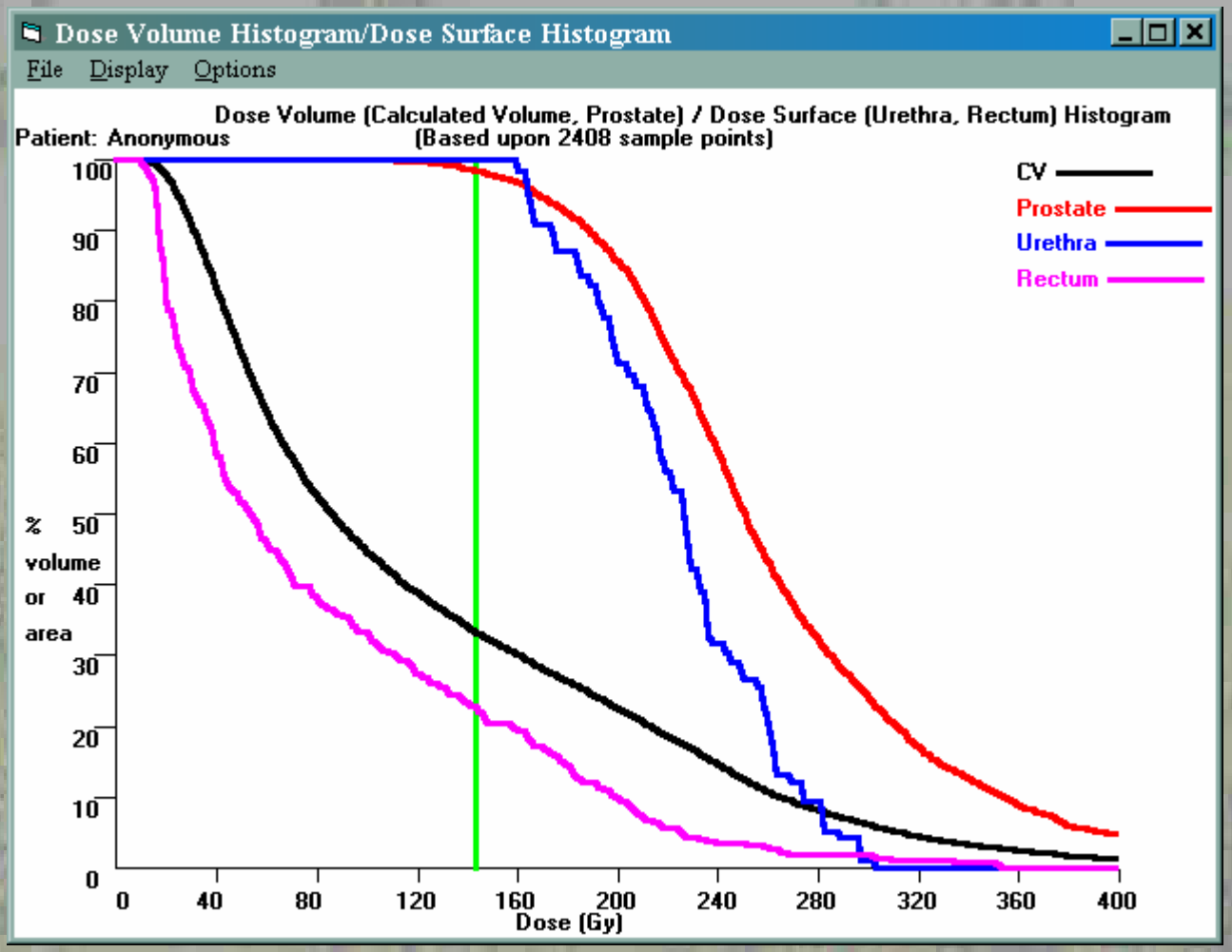
- Isodose Displays
- DVH
- Quantifiers

Analytical tool	Spatial information	Dose information	Dose analysis
Isodose displays	X	X	X
Dose-Volume Histograms		X	X
Dose Trace Displays	X	X	X
Quantifiers			X

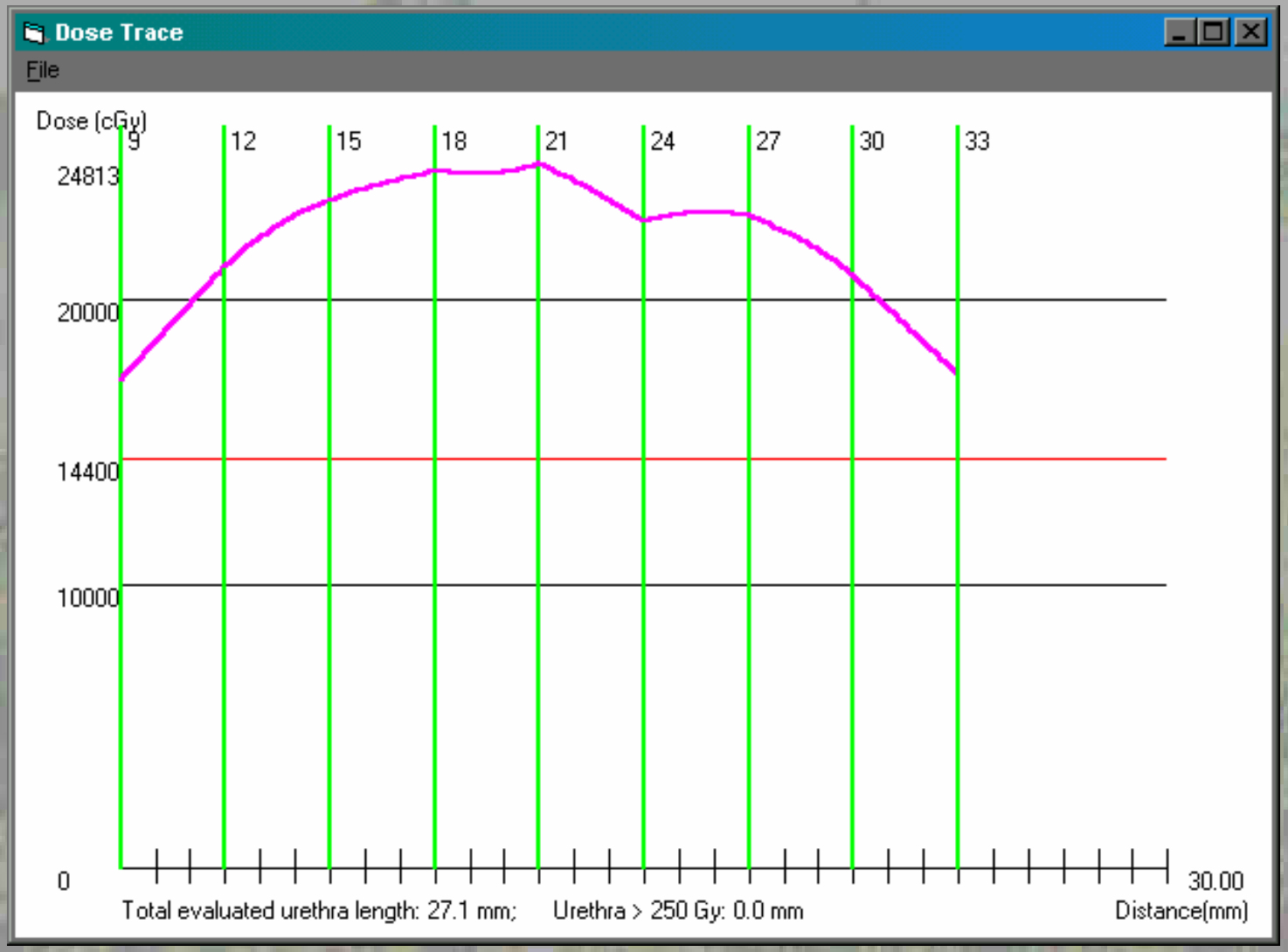
Post Implant Isodose Distribution



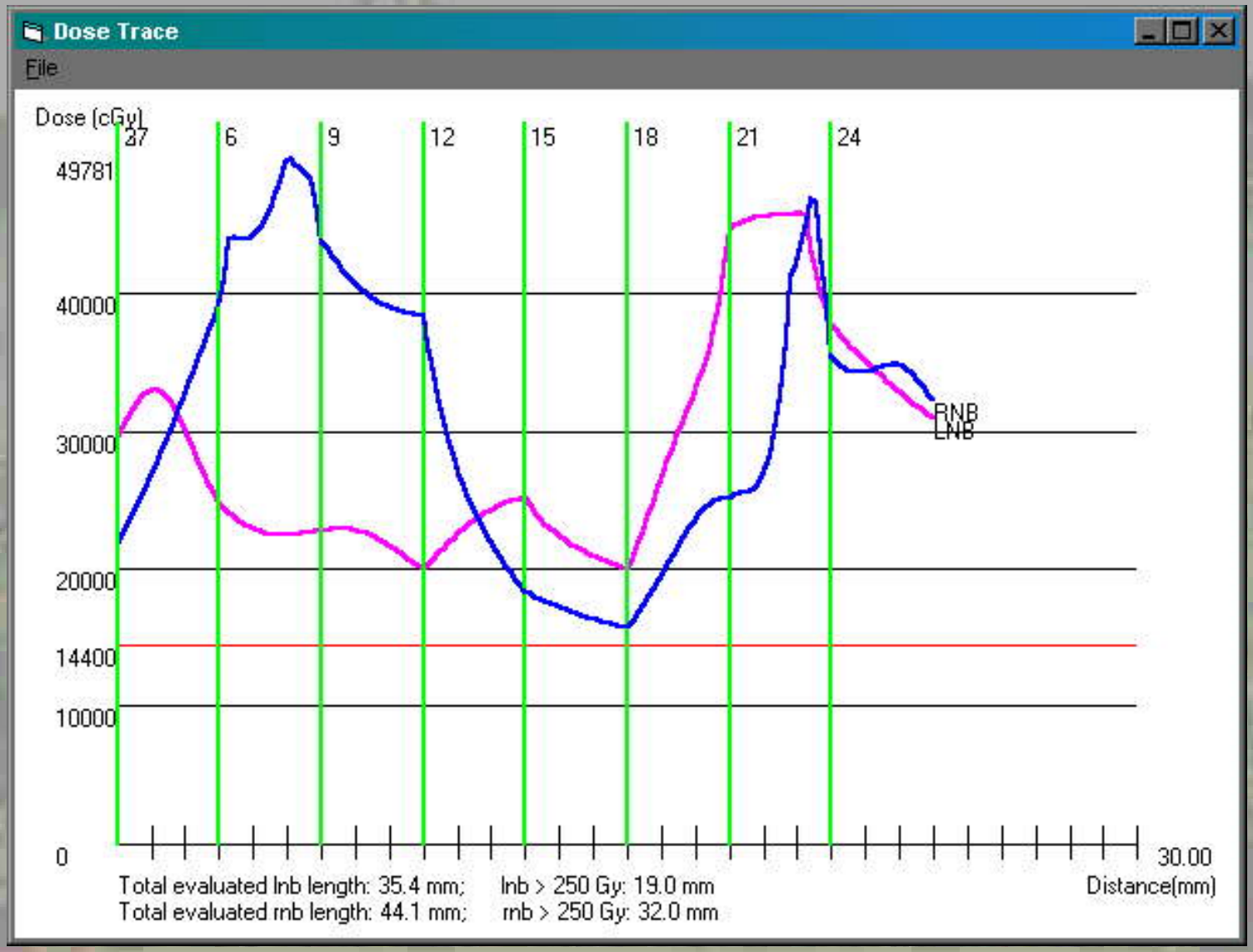
Dose Volume / Dose Surface Histograms



Urethral Dose Trace



Neurovascular Bundle Dose Traces



Implant Quantifiers

CI

mPD

HDR

Basal Dose Rate

TVR_1

C_{80}

DHI_2

C_{100}

DHI_1

UI

FWHM

NTCP

DNR

Reference Dose

D_{90}

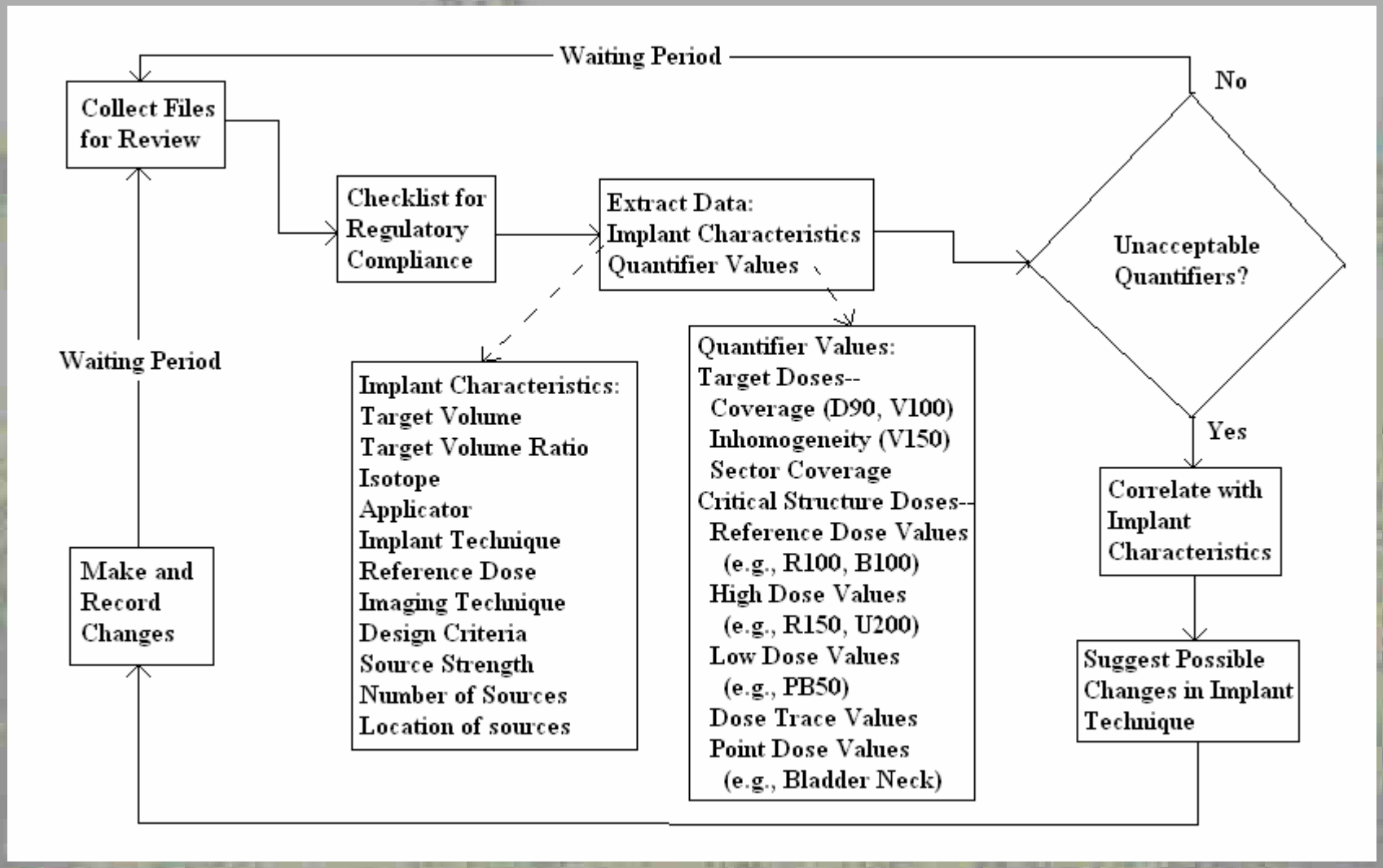
TCP

LDR

TVR_2

MPD

Group Analysis Paradigm



A bevy of quantifiers

- Structure-based, DVH-derived
  - V quantifiers
  - D quantifiers
- Coverage
- Uniformity
- Complication probabilities, dose delivered to critical structures

Coverage Quantifiers

- Volume (V_{100}, V_{90}, V_{80})
  - Structure (target) based
  - V_N is the percentage of the target covered by N% of the reference (prescription) dose
  - Prostate example: For an iodine implant in which 145 Gy was prescribed, a V_{90} of 92% means that 92% of the gland received 130 Gy (0.9 x 145 Gy) or better

Coverage Quantifiers

- Dose (D_{90})
  - Structure (target) based
  - D_N is the minimum dose received by N% of the target
  - Prostate example: a D_{90} of 140 Gy means that 90% of the gland received 140 Gy or better
  - Note: largely in an effort to compare Palladium and Iodine results some authors have taken to normalizing the D quantifiers to the reference dose. This can get quite confusing…

Implant Targets

- “It is a far, far better thing to have a firm anchor in nonsense than to put out on the troubled sea of thought.”

  – **John Kenneth Galbraith**

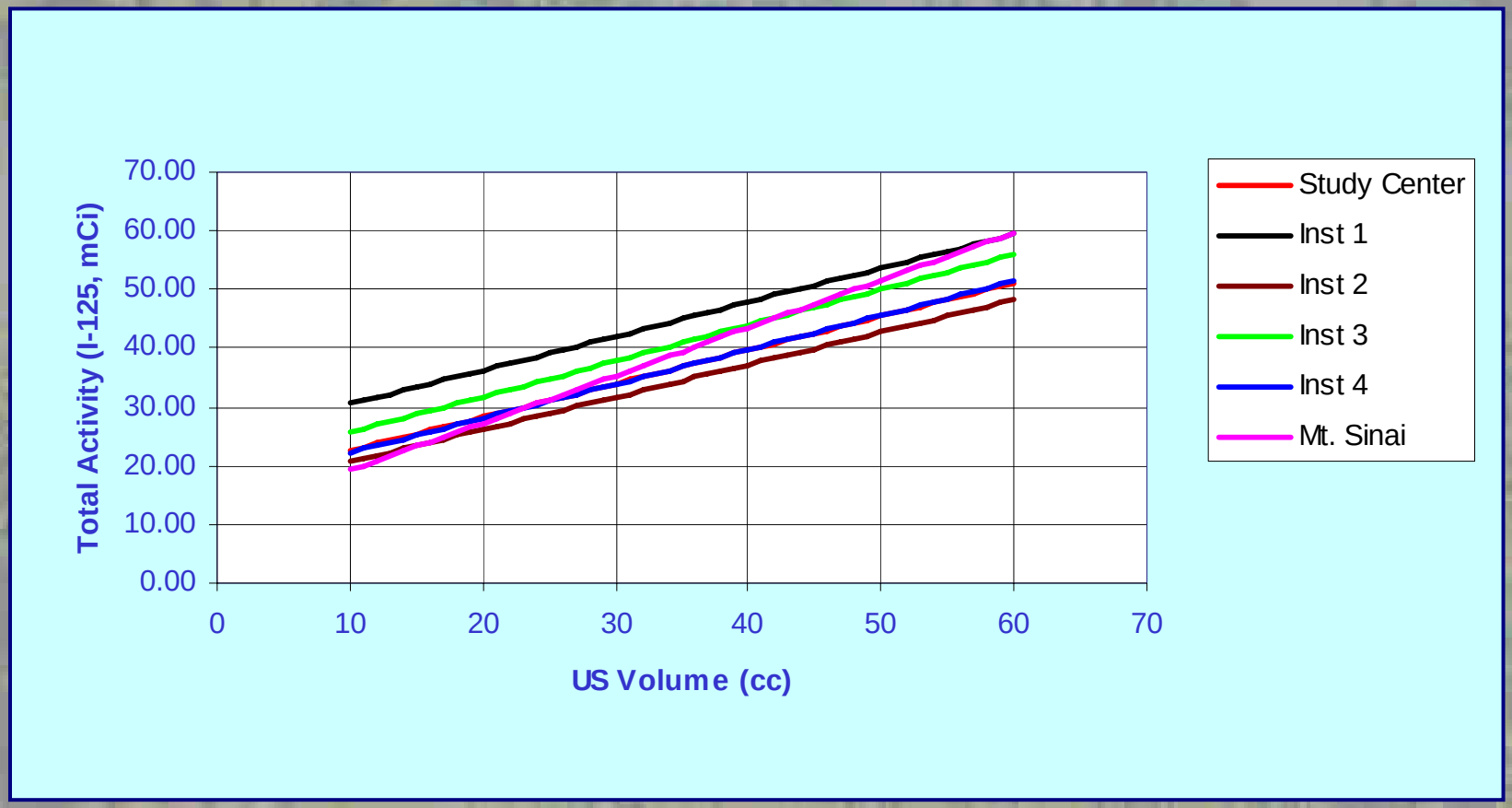
Prostate Example: Implant Quantifiers (TG-64 / ABS)

- **Conformity / Coverage**
  - V_{100}
  - V_{90}
  - V_{80}
  - D_{90}
- **Uniformity**
  - V_{150}
- **Critical Structures**
  - **Urethra**
    - **Line plot**
  - **Rectum**
    - **Dose surface histogram**

More Prostate: Revised ABS recommendations (Nag, et al., IJROBP, 2002)

- "Morbidity is intimately related to the dose to normal tissues"???????
- Urethra
  - Line plot (0.5 cm intervals)
  - DVH (urethra)
  - Prostate V_{100}, V_{150}, V_{200}
- Rectum
  - DVH (rectum)
- Potency
  - Neurovascular bundles
  - Bulb of penis

Total Activity (~~mCi~~ U/1.27) by US Prostate Volume (cc)

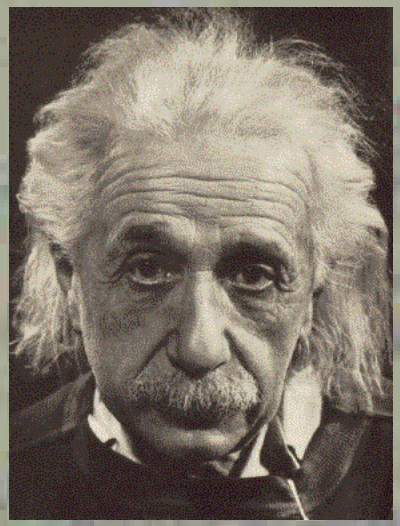


Bice, et al., IJROBP, 1998

Publishing Data

If you present clinical implant results and you don’t bother to quantify and describe the dosimetric characteristics of the patient data set, you are a **bobohead**. This is like making a cake without flour, strudel without apples or love without a woman. Don’t do it, God will play dice with you.

—A. Einstein, Nobel Prize acceptance speech, Stockholm, 1921



Conclusions

- Post procedure evaluation is used to
  - Assess individual implant quality
  - Characterize group traits in order to make improvements in
    - Planning and delivery methods
    - Functionality of equipment
- Post implant dosimetry sometimes requires a new image set and treatment “plan”

Conclusions

- Modern treatment planning is performed from image sets that depict source and anatomical data together
- Post treatment dosimetry relies on
  - Isodose distributions
  - DVH / DSH
  - Quantifiers
- Establish goals and evaluate your ability to consistently meet them

Questions?