Software Aided Treatment Plan Verification

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Learning objectives

• Verification approaches
  strengths, weaknesses
• Adapting plan verification to clinical process
  hardware
  available resources
• Integration of modern verification tools in the clinic
Plan verification basics

- **What we check:**
  - Concordance with prescription (ID, site, isotope, dose, fx...)
  - Dose calculation
  - Geometry
  - Plan quality
  - Other (technical) checks

- “Classical” plan checking
  - Manual secondary dose calculations
  - Re-planning
  - Check lists
  - Nomograms

- **Modern verification tools**
  - Excel worksheets
  - DICOM based software
  - Custom software
Commercial systems
• DICOM based dose secondary calculations
• Display data / export data for analysis
• 3D display of reconstructed source positions, dose points

Commercial systems -- limitations
• Rely on TPS DICOM data and exported implant geometry
• Lack verification with written directive, EMR
• May not address facility specific process, quality assessment, technical requirements.
Key features:
• Treatment console file = primary input
• Independent detection & reconstruction of standard applicators
• User assisted reconstruction of template based implants (prostate, GYN interstitial, H&N)
• Calcs within 2% for std applicators, 5% for all implants

Most common errors detected:
• Mis-digitized channels/catheters
  – Switching, doubling, etc
• Mis-identified reference points
• Clinic guidelines not followed
• Errors in dose calculation
Key features:

- Imports DICOM data (incl contours, dose)
- Performs secondary dose calculation
- Evaluates plan quality using independently calculated dose-volume indices.

Main Quality parameters used to assist in planning:

- CN – PTV & healthy tissue
- COIN – PTV, OAR & Healthy tissue
- HI – PTV homogeneity
Key features:
• Taps patient EMR:
  – Verification with written directive
  – Verification of channel assignment and length
• Eliminates manual checks
• Highly customizable to clinics requirements and processes (e.g. reasonableness criteria)
• Secondary dose calculation

Results: reduced errors and improved efficiency

Custom (home grown) software tools:
Implementation requires time, know-how
Yet
Increase efficiency, efficacy
Customizable to clinics needs
Example: Afterloader specific customization

• Verification of catheter length (Elekta)
  – Ensure planned and measured lengths agree

• Verification of minimum dwell time (GammaMed)
  – Ensure plan is executable with all possible source strengths

Example: Applicator specific customization

• Correction of source dwell position definition to account slack in curved applicators
  – Varian Tandem and Ring
  – Split ring applicator

Example: Clinic specific customization

• Plan reasonableness:
  – TRAK assessment
    – If new, consider existing systems and adjust after gaining experience
      e.g. Applying Manchester system to HDR:

      \[
      T = 2.24 \left( \frac{V}{\text{cm}} \right)^{3} \exp\left( \frac{0.07 + 0.05}{1 - T} \right)
      \]

      \[
      T = -5.009 \left( \frac{\text{cm}}{\text{cm}} \right) \left( \frac{V}{\text{cm}} \right) \exp\left( \frac{0.07 + 0.05}{1 - T} \right)
      \]
Things to watch for:

• Manual processes:
  – Image calibration (magnification)
  – Length measurements
  – Further considerations for LDR (intraoperative workflows)

• Vendor
  – Updates
  – CTB

A note on process design

• Requires clear and precise definitions

• Agreed upon clinical process to followed by all members of the BT team

Summary:

• Secondary dose calculation can be performed efficiently. All report within 5% of TPS
• Independent reconstruction of geometry is an useful tool
• Assessment of quality parameters may be used to assist in planning process.
• Software can be tailored to specific hardware & EMR requirements and clinical preferences
Thank you!