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Software Aided Treatment Plan Verification

2017 AAPM
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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

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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

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Commercial systems

- DICOM based dose secondary calculations
- Display data / export data for analysis
- 3D display of reconstructed source positions, dose points

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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.

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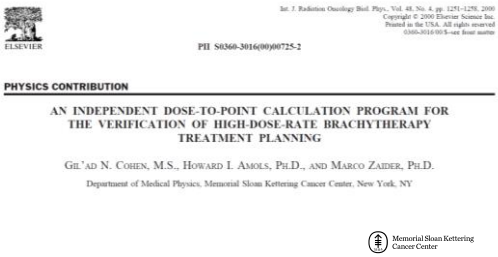

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Int. J. Radiation Oncology Biol. Phys., Vol. 48, No. 4, pp. 1251–1258, 2000

0360-3016/00/$–see front matter

PII S0360-3016(00)00725-2

PHYSICS CONTRIBUTION

AN INDEPENDENT DOSE-TO-POINT CALCULATION PROGRAM FOR THE VERIFICATION OF HIGH-DOSE-RATE BRACHYTHERAPY TREATMENT PLANNING

Gil'ad N. Cohen, M.S., Howard I. Amols, Ph.D., and Marco Zaider, Ph.D.
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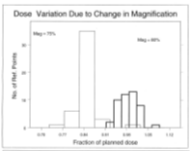
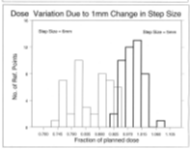
Key features:

- 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





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Most common errors detected:

- Mis-digitized channels/catheters
  - Switching, doubling, etc
- Mis-identified reference points
- Clinic guidelines not followed
- ~~Errors in dose calculation~~

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Brachytherapy 11 (2012) 359–368

BRACHYTHERAPY

A dose verification tool for high-dose-rate interstitial brachytherapy treatment planning in accelerated partial breast irradiation

Mohamad Feras Marqa[1,2], Jean-Michel Caudrelier[3], Nacim Betrouni[1,2,4,*]

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[3]Department of Radiation Oncology, The Ottawa Hospital Cancer Centre, Ottawa, Canada
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Key features:

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

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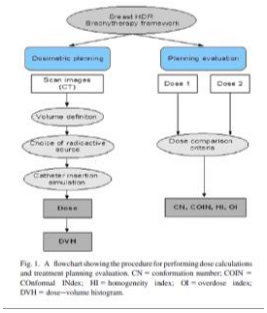

Fig. 1. A flowchart showing the procedure for performing dose calculations and treatment planning evaluation. CN = conformation number; COIN = COnformal INdex; HI = homogeneity index; OI = overdose index; DVH = dose–volume histogram.

Main Quality parameters used to assist in planning:

- CN – PTV & healthy tissue
- COIN – PTV, OAR & Healthy tissue
- HI – PTV homogeneity

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Radiotherapy and Oncology 113 (2014) 420–424
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Radiotherapy and Oncology
journal homepage: www.thegreenjournal.com

Plan verification in brachytherapy

Independent brachytherapy plan verification software: Improving efficacy and efficiency

Antonio L. Damato *, Phillip M. Devlin, Mandar S. Bhagwat, Ivan Buzurovic, Scott Friesen, Jorgen L. Hansen, Larissa J. Lee, Christina Molodowitch, Paul L. Nguyen, Desmond A. O'Farrell, Akila N. Viswanathan, Christopher L. Williams, Joseph H. Killoran †, Robert A. Cormack †

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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

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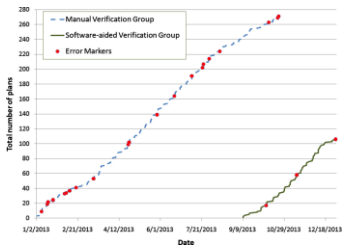
Results: reduced errors and improved efficiency



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Custom (home grown) software tools:

Implementation requires time, know-how

Yet

Increase efficiency, efficacy
Customizable to clinics needs

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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

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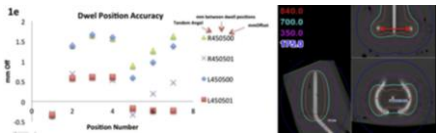
Example: Applicator specific customization

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



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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:

$$\left(\frac{T}{s\ Gy^{-1}}\right) = 2.247 \left(\frac{V}{cm^3}\right)^{.23} \exp(0.07[E-1])$$

$$\left(\frac{T}{s\ Gy^{-1}}\right) = 0.0659 \left(\frac{M}{mg\ h}\right)_{\left[A\left(\frac{0.5}{2}\right)^2\right]} \left(\frac{h}{0.5}\right)^2 \times \exp(0.05[E-1])^{3/4}$$

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Things to watch for:

- Manual processes:
  - Image calibration (magnification)
  - Length measurements
  - Further considerations for LDR (intraoperative workflows)
- Vendor
  - Updates
  - CTB

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A note on process design

- Requires clear and precise definitions
- Agreed upon clinical process to followed by all members of the BT team

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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

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Thank you!

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