An update on the dosimetric accuracy of different treatment planning system algorithms in the IROC lung phantom

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Imaging and Radiation Oncology Core

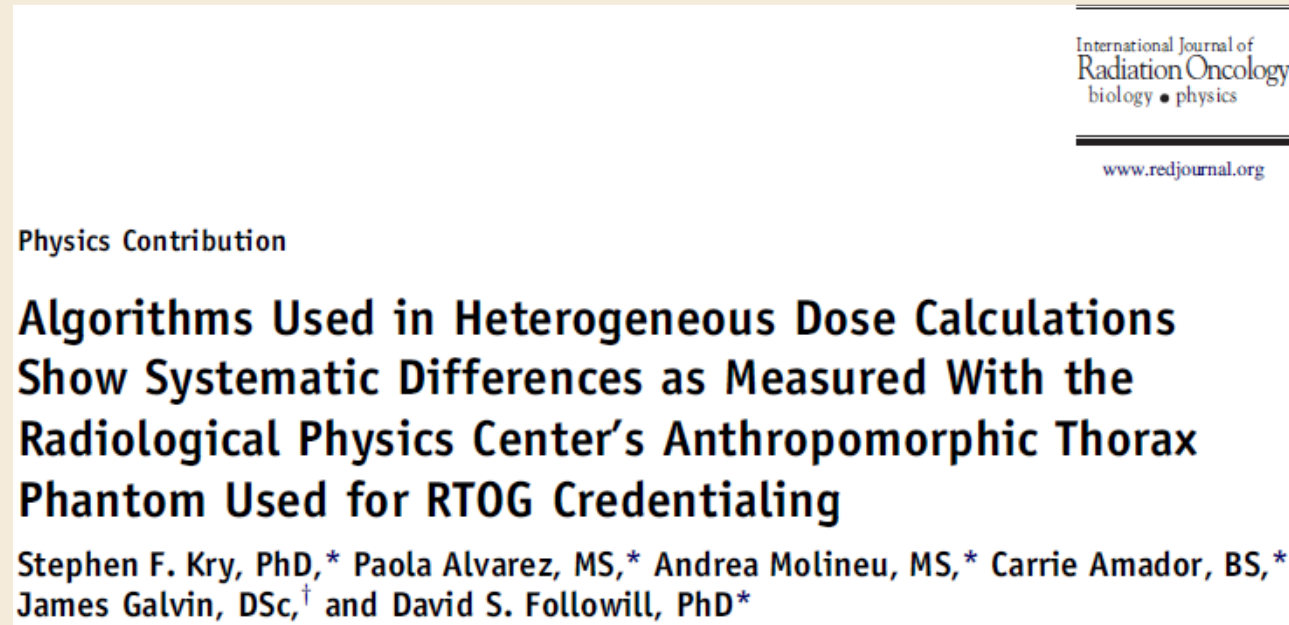The University of Texas MD Anderson Cancer Center,

Houston, TX

IROC Lung phantom

- **Assess dose in a heterogeneous environment**
  - **Following a clinical workflow**
  - **Moving phantom**
- **Dose assessment**
  - **2 TLD in center of lung target (3 cm x 5 cm)**
  - **Film in 3 planes**
- **How accurate are current treatment planning systems?**
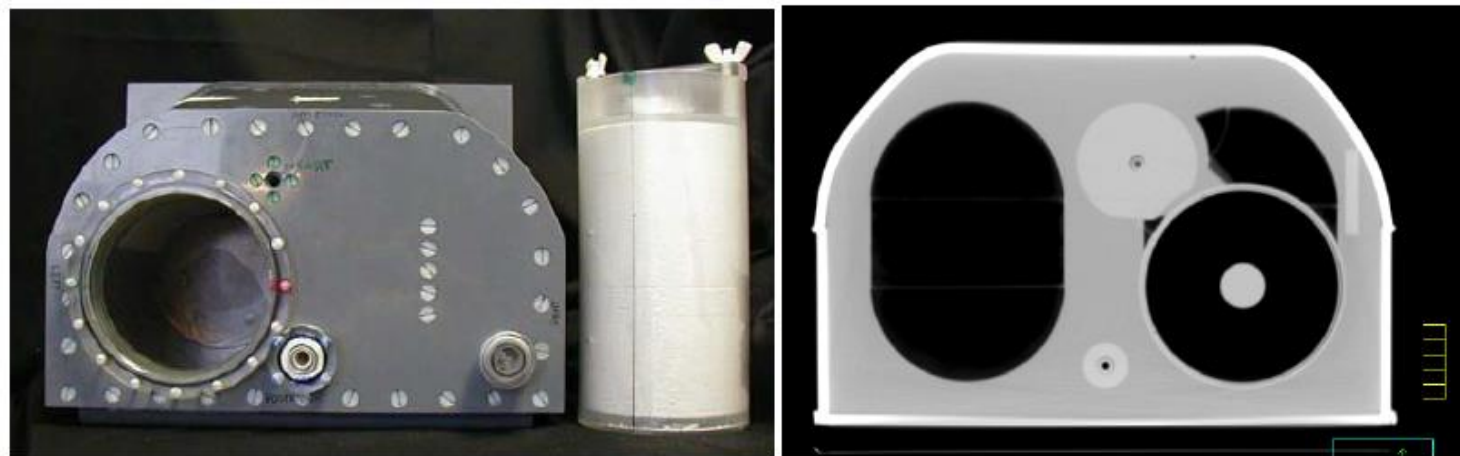
Publication on this (2013)

- **There were <u>systematic</u> differences in dose calculation accuracy to the center of the target between different algorithms**

Physics Contribution

Algorithms Used in Heterogeneous Dose Calculations Show Systematic Differences as Measured With the Radiological Physics Center's Anthropomorphic Thorax Phantom Used for RTOG Credentialing

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TLD Dose Findings (2013)

- **Dose to the center of the target**
- **Measured doses systematically lower than calculated doses for S/C and AAA algorithms (p<0.0001)**
- **No significant difference between C/S AAA algorithms**
- **MC results looked good**

- For C/S AAA algorithms:
- No significant difference between IMRT (mean=0.963) and 3D CRT (mean=0.964) irradiations (p=0.7)
- No significant difference between moving (mean=0.961) and static (mean=0.964) irradiations (p=0.5)
- No significant trend versus irradiation date (p=0.2)
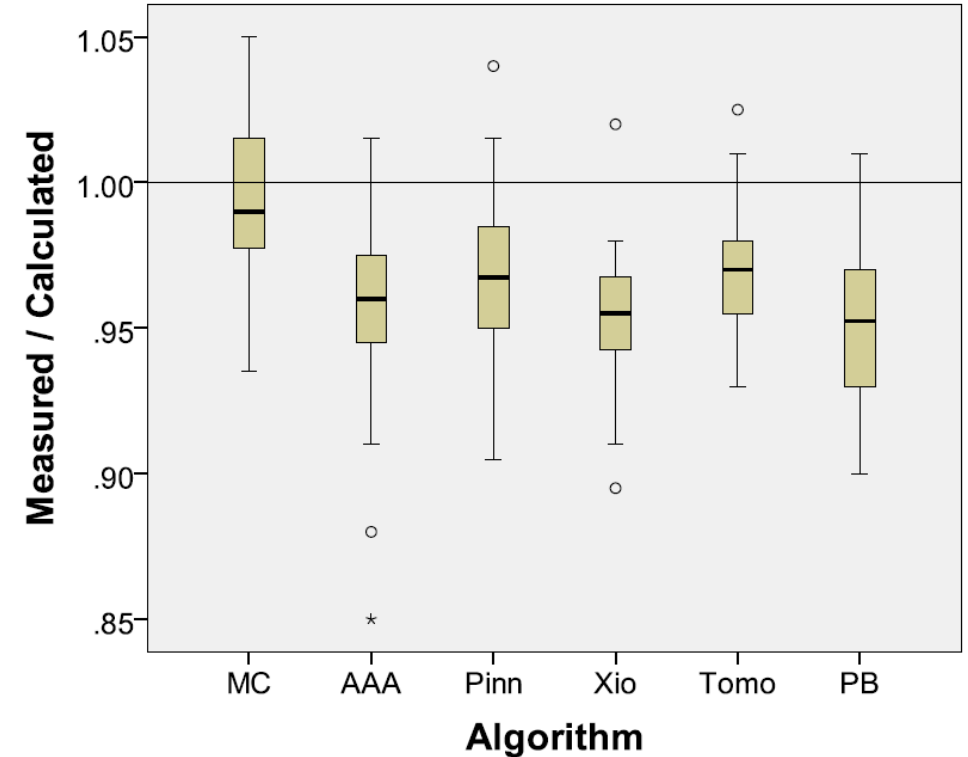
Status

Previous study

- **Based on 304 irradiations**

- **All Monte Carlo results combined (n=32)**

- **No Acuros**

Present day

- **965 irradiations**

- **Monte Carlo can be divided (n=89):**
  - **Multiplan (n=50)**
  - **Monaco (n=19)**
  - **iPlan (n=18)**
- **Acuros results (n=63)**

How do the new results look
Particularly compared to historical values?

Measured/Calculated Dose to the centre of the target (TLD)

Prior Results
- AAA (n=98)

–**0.959 (0.003)**
- S/C (n=87)

–**0.966 (0.002)**
- MC (n=32)

–**0.994 (0.005)**
- Acuros

–**N/A**

Updated Results
- AAA (n=417)

0.962 (0.001)[1]
- S/C (n=360)

0.968 (0.001)[1]
- MC (n=89)

0.982 (0.003)[2]
- Acuros (n=63)

0.991 (0.004)[2]

S/C

- **Previously, there were trends but no significant differences between any S/C algorithm**
- **New results, similar trends, some significant:**

Algorithm	N	Meas/Calc	St. Dev of mean
XiO	39	0.961*	0.004
Pinnacle	250	0.967	0.002
Raysearch	13	0.973	0.004
Tomotherapy	53	0.977*	0.003

Monte Carlo results: Measured/Calculated (TLD)

Prior Results

- **N=32**

−0.994 (0.005)

- **25/32 results were Multiplan**

Updated Results

- **Overall (n=89)**

0.982 (0.003)

- **Multiplan (n=50)**

0.992 (0.005)[1]

- **Monaco (n=19)**

0.971 (0.007)

- **iPlan (n=18)**

0.970 (0.004) [2]

A few points

- **Dose to center of target**

  - **6 MV beam achieves electronic equilibrium**

- **Other IROC phantoms (homogeneous):**

  - **Average agreement between measurement and calculation:**

  - **within 1% (Ibbott G et al. *Technol Ca Res Treat* 2006;5:481)**

- **Differences between algorithms have been seen**

  - **MC recalculations of S/C**

  - **Larger irradiated volumes in SBRT lung tumors when CS/AAA plans recalculated with MC**

    - **(Li Int J Radiat Oncol Biol Phys; 84;508:2012)**

Conclusion

- **SC/AAA overestimate dose to center of target in IROC thorax phantom (3.5%)**
- **Issue for dose calculation accuracy**
  (TG-65 goal: 1-2%)
- **Potentially issue for dose reporting/prescribing**
- **Different Monte Carlo algorithms provided different levels of accuracy**
- **Many unknowns remain**
- **Acuros and Multiplan provide best accuracy**

Thank You!

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