Clinical Trial Personalizing Radiation Therapy Through a Novel Lung Function Imaging Modality

AAPM NIH Investigator Scientific Highlights

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NIH Funding Information

• Clinical Trial Personalizing Radiation Therapy Through a Novel Lung Function Imaging Modality

• NCI: PAR-14-166: Early Phase Clinical Trials in Imaging and Image-Guided Interventions (R01)

• PI: Yevgeniy Vinogradskiy
  Co-investigators
  • CU: Brian Kavanagh, Moyed Miften, Leah Schubert, Phillip Koo (radiology), Derek Linderman (pulmonology)
  • Beaumont Health System: Edward Castillo, Thomas Guerrero
  • UT Galveston (now Emory University): Richard Castillo

• Submission History: 8th percentile, first submission
4DCT-Ventilation

- 4DCT acquired for simulation (reduced time, cost, dose)
- Anatomical + Functional information
- Good spatial resolution
Functional radiotherapy with 4DCT-Ventilation

- Use patients 4DCT data to generate ventilation image
- Use 4DCT-ventilation image to generate functional avoidance plan
- Hypothesis: 4DCT-ventilation functional avoidance will lead to reduced rate of radiation pneumonitis
- Clinical trial to evaluate 4DCT-ventilation functional avoidance
Clinical Motivation/Significance

- Radiation pneumonitis is a major limitation in thoracic radiotherapy

Patients treated with CCRT for NSCLC

Overall Pneumonitis Risk
- 29% (Training set) / 31% (Validation set)

- Carboplatin/Paclitaxel Chemotherapy
  - Risk: 45% (T) / 50% (V)

- Cisplatin/Etoposide or Other Chemotherapy
  - Risk: 24% (T) / 30% (V)

- Age >65
  - MLD ≥ 10 Gy
    - HIGH RISK
      - 59% (T) 57% (V)
  
- Age ≤ 65
  - MLD < 10 Gy
    - INTERMEDIATE RISK
      - 41% (T) 48% (V)

- V_{20} ≥ 25%
  - INTERMEDIATE RISK
    - 28% (T) 38% (V)

- V_{20} < 25%
  - LOW RISK
    - 18% (T) 19% (V)
Preliminary Data

- Validation of 4DCT-Ventilation
- Functional avoidance feasible without sacrificing target/OAR goals
- Dose+function better predictor of pneumonitis than dose alone

Vinogradskiy et al

Castillo et al

SPECT Perfusion

4DCT-Ventilation
Relevant Prior Experience

- PhD topic in radiation pneumonitis/Clinical toxicity
- Collaboration with relevant research team
- Experience writing a clinical trial
- 2-3 papers on the topic
Specific Aims

Clinical trial to evaluate 4DCT-ventilation functional avoidance in clinical trial for lung cancer patients

Specific aim 1: Evaluate clinical toxicity of functional avoidance radiation therapy

Specific aim 2: Treatment assessment using imaging and functional biomarkers

Specific aim 3: Identify quantitative imaging biomarkers that predict for clinical toxicity:

Implicit aim: Open + Complete a clinical trial
Key Scientific Outcomes

• Trial successfully opened at CU, William Beaumont, Denver VA
• 92 patients consented in 2.5 years
Key Scientific Outcomes

- Trial met pneumonitis futility criteria and progressed to stage II of accrual
- How to practically implement functional avoidance
  - Who can benefit
  - Workflow/QA
  - Treatment planning
Key Questions

• What happens when primary trial physicist goes on vacation?
• Stability/Variability of image generation technique?
• What other factors effect toxicity?

Kipritidis et al

Castillo et al

The numerical stability of transformation-based CT ventilation

Edward Castillo¹ ², Richard Castillo³ ⁴, Yevgeniy Vinogradsky⁴, Thomas Guerrero⁴
Future research directions

• What happens when primary trial physicist goes on vacation?
  • Partner with vendor to produce a commercial grade image generation software
• Stability/Variability of image generation technique?
  • Improve image generation robustness
• What other factors effect toxicity?
  • What does functional avoidance look like in the setting of chemoRT+IO
Grant Advice for AAPM Members

- Keep applying (my funding success 4/28 = 14%)
- Range of ideas are suitable for grant applications
Thank you

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