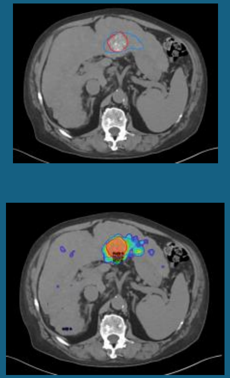
CT Dosimetry for Radiopaque Y90 Microspheres - Impact of Image Noise On Dose Accuracy

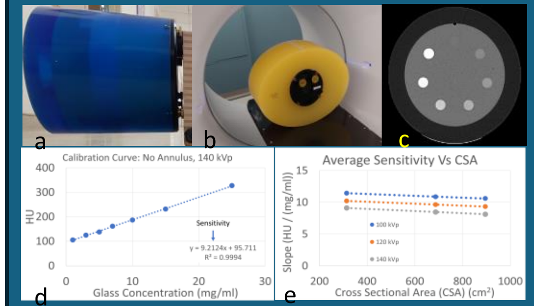
Alasdair Syme[1,2], Andrew Kennedy[3], S. Cheenu Kappadath[4], Courtney Henry[1,2]
1. Nova Scotia Health. 2. Dalhousie University. 3. Sarah Canon. 4. M.D. Anderson Cancer Center.

Background

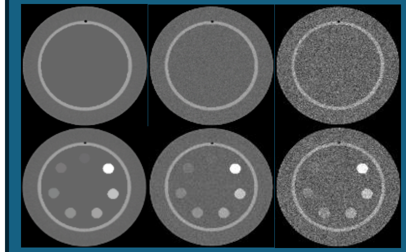
- Radiation dosimetry in Y90 radioembolization remains highly variable among practitioners.
- PET or SPECT imaging is costly and not always available
- Radiopaque glass microspheres are visible in CT images
- CT-based dosimetry could be a novel tool that improves accessibility
- Image noise may affect absorbed dose calculation accuracy



Methods



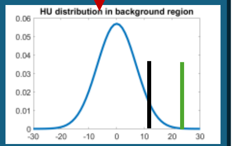
Calibration phantom (a,b) was constructed to understand the relationship between CT image HU and microsphere concentration (c,d,e)



Synthetic CT images of phantom with HU based on real phantom image analysis. Top row: blanks (i.e. pre-administration, no enhancement). Bottom row: uniform uptake regions. Different noise levels considered: Left 0 HU, Middle 15 HU, Right 50 HU

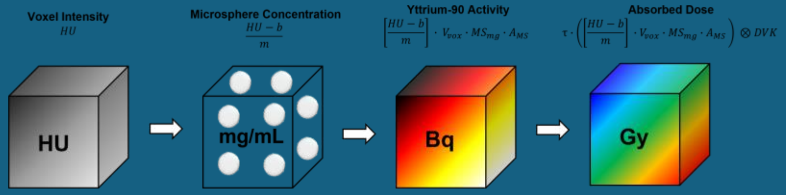
Methods

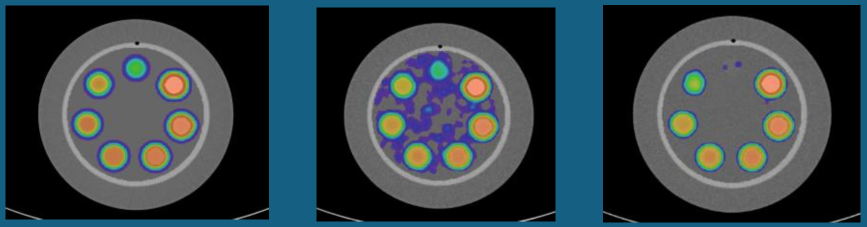
Net HU enhancement



- Image noise: some non-embolized regions have HU > 0 (false positive)
- Some embolized regions have HU < 0 (false negative)
- Inclusion threshold: set glass concentration to 0 if HU value is below either:
  - Limit of Detection (LOD) (1.65 x standard deviation) – some false positives, some false negatives
  - Limit of Quantification (LOQ) (3.29 x standard deviation) – few false positives, many false negatives

Convolution dose calculation (performed in MIM)

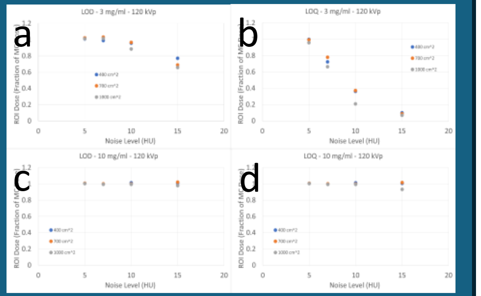




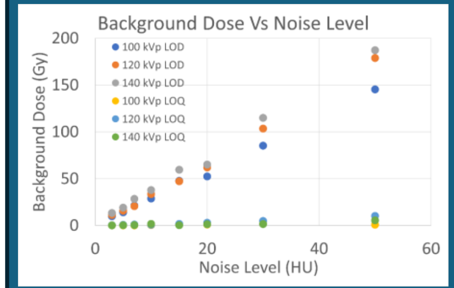
Resultant dose distribution without noise (left) and with a noise level of 7 HU and inclusion threshold of LOD (center) and LOQ (right)

Results

- Noise results in underestimation of dose
- Increased noise increases the magnitude of underestimate
- Noise has greater impact in regions of low uptake
- Impact is greater for larger patients and higher kVp settings



MIM calculations compared against Monte Carlo simulations



- In non-embolized regions:
- Noise results in false positive dose
- Calculated dose Increases with noise if using an LOD threshold
- Dose level stays low if using an LOQ threshold

Conclusions

- CT image information can be used to calculate tumor dose with radiopaque glass microspheres
- Noise in CT images will negatively impact the accuracy of dose calculations in both tumor and normal liver
- Further work is required to understand the impact of noise in non-homogeneous regions of uptake