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Unresolved Issues of Quantitative Analysis

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Unresolved Issues of SUV Quantitation

- Which factors of Δ SUV assessment are really limiting?
- Can we easily correct SUVs when they are obviously wrong compared to an internal reference organ?





Standardized Uptake Value - SUV

$$\text{SUV} = \frac{\text{PET-Tissue Concentration [MBq / kg]}}{\text{Injected Activity [MBq] / Body Weight [kg]}}$$

- Requires absolute scanner calibration
 - Normalization, cross-calibration dose calibrator
 - Attenuation correction
 - Scatter correction





Central QC for PETAL Study

- 1/3 fulfill all quantitative requirements
- 1/3 initially not acceptable
- 1/3 minor issues
- Problems can be easily fixed
- Support from central QC readily accepted by centers

- Centers certified for previous multicenter studies still adequate
- External certification has lasting effect



Factors affecting FDG SUV

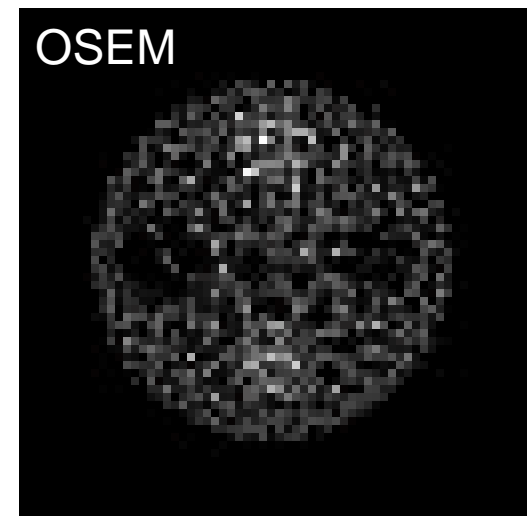
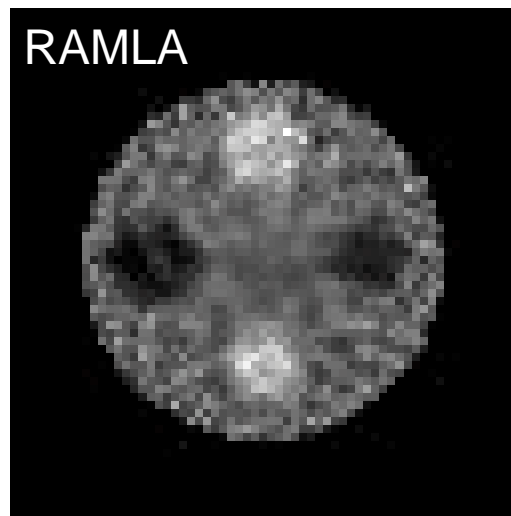
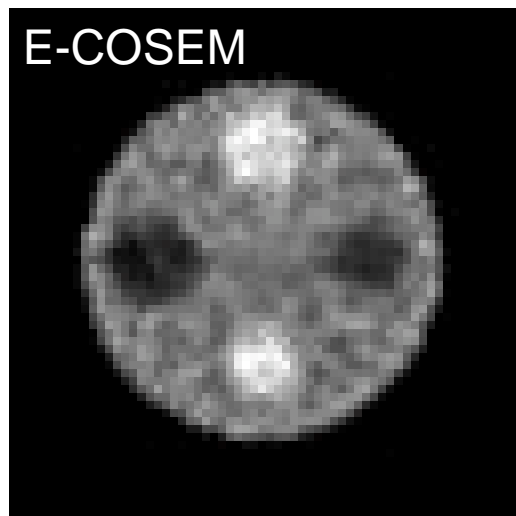
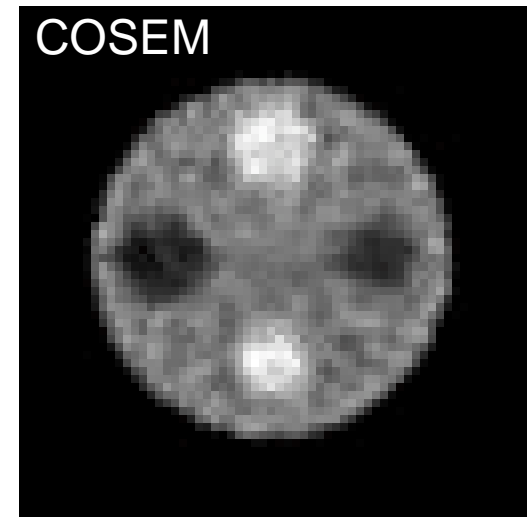
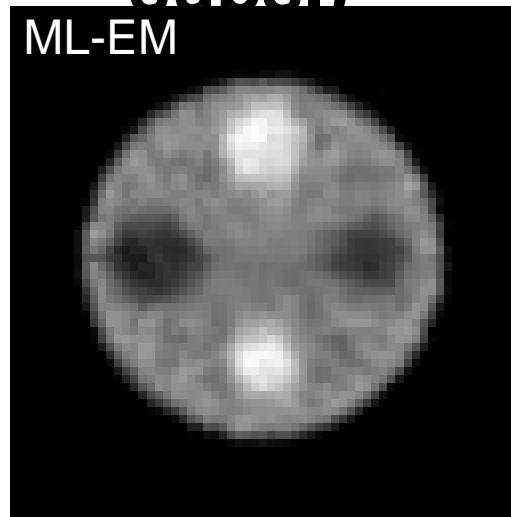
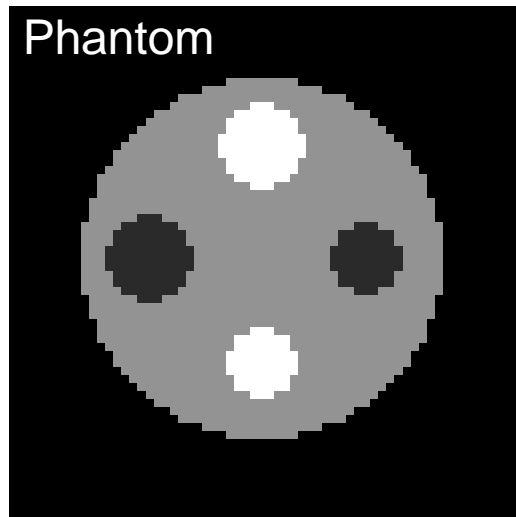
- Physics
 - Corrections (attenuation, scatter, detector response, ...)
 - Reconstruction (Filter, Regularisation, ...)
 - Resolution: Recovery and Spillover
 - Image noise characteristics
 - Region-of-Interest (ROI)
 - Form, size, shape, and position of ROI
 - Form, size, shape, and position of object
 - Reproducibility of ROI segmentation





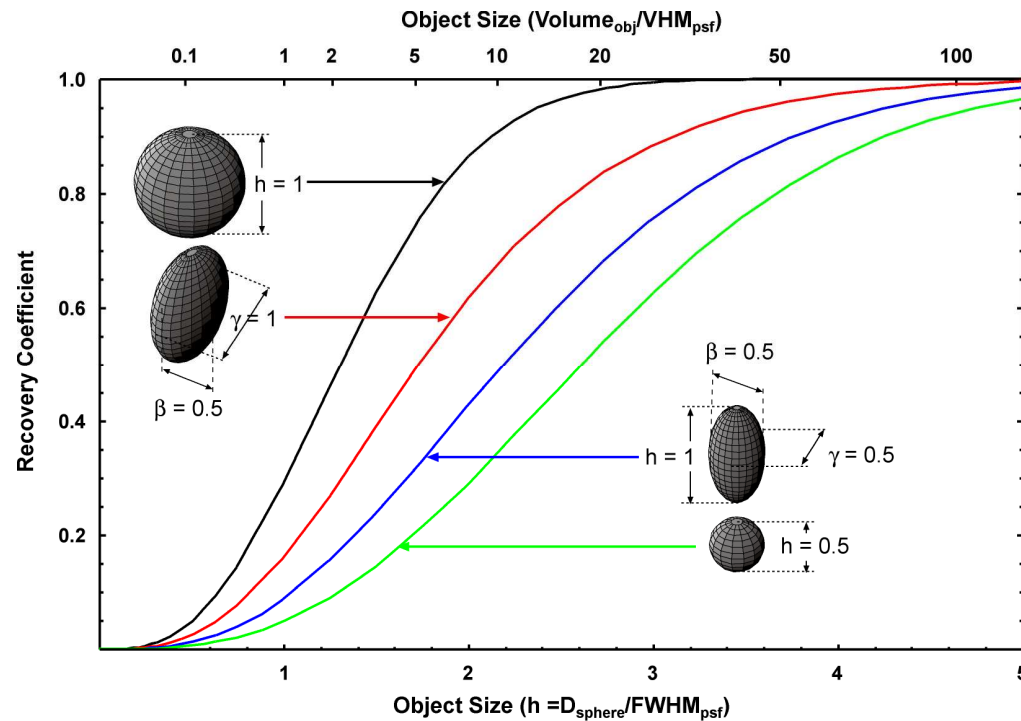
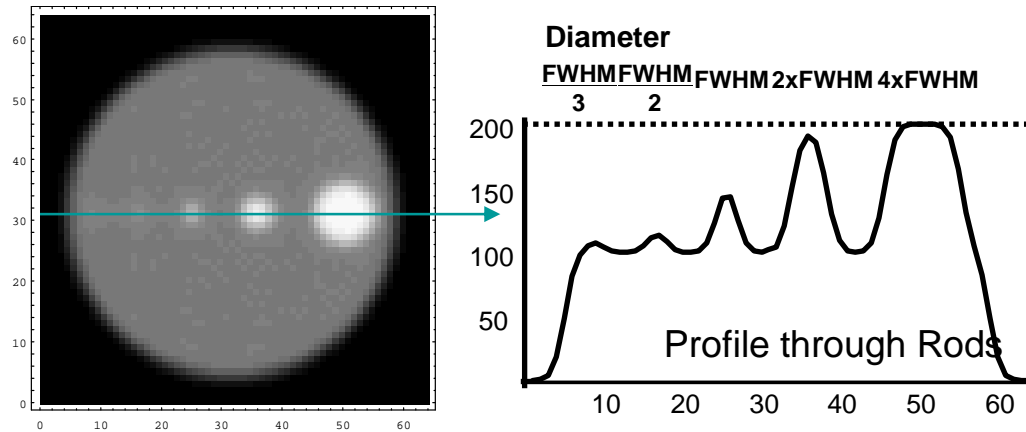
Statistical Reconstruction

Regularization and Convergence (20 iter./ 32 subs.)



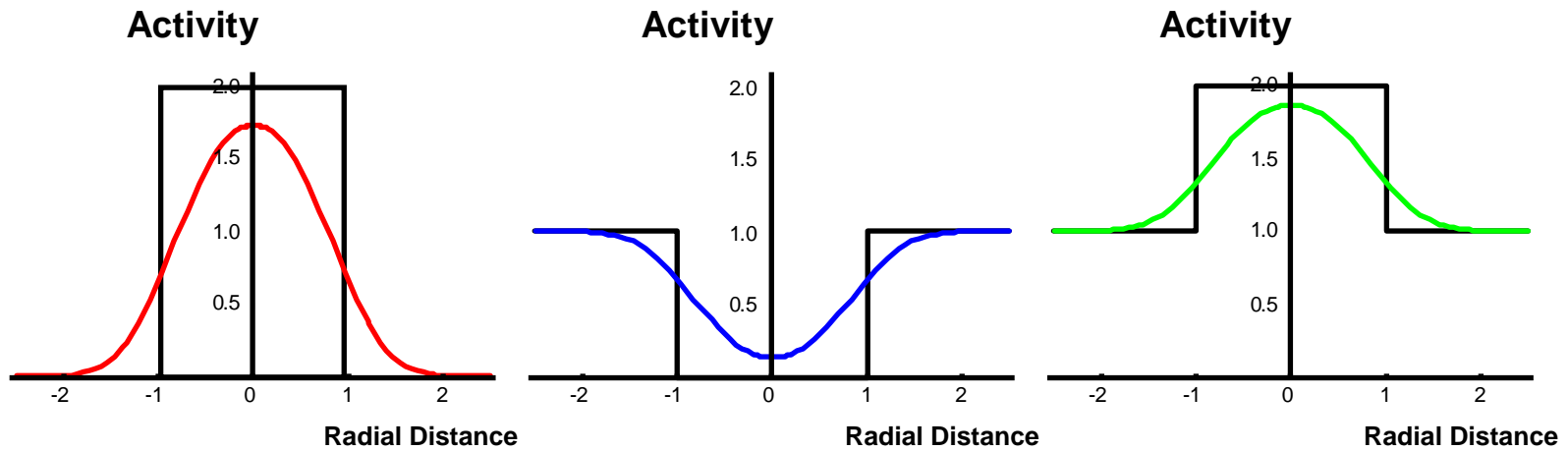
PET Recovery Correction

Rods of Identical Activity Concentration

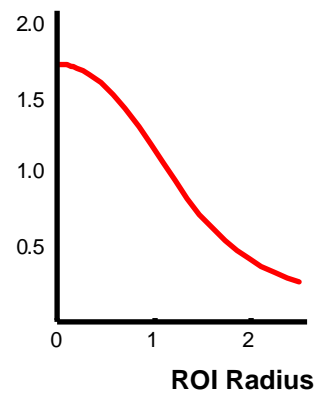




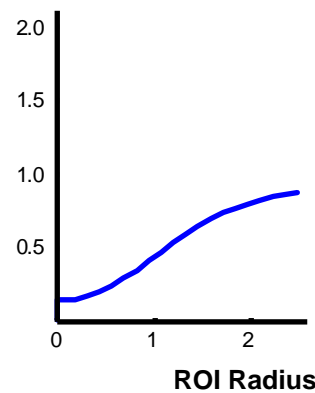
Recovery and Spillover



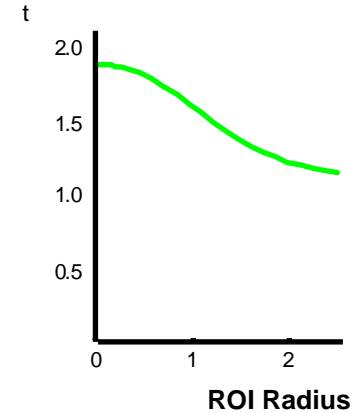
Mean ROI Activity



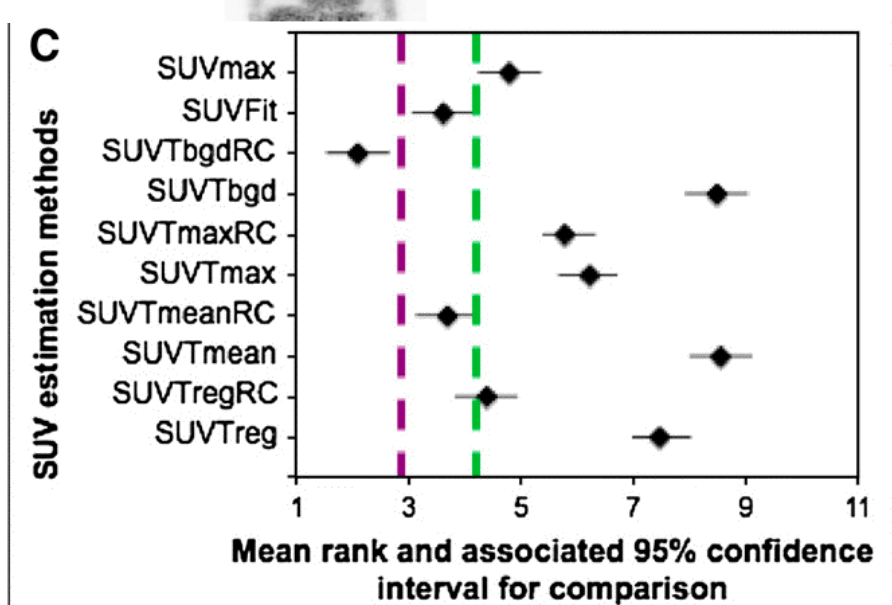
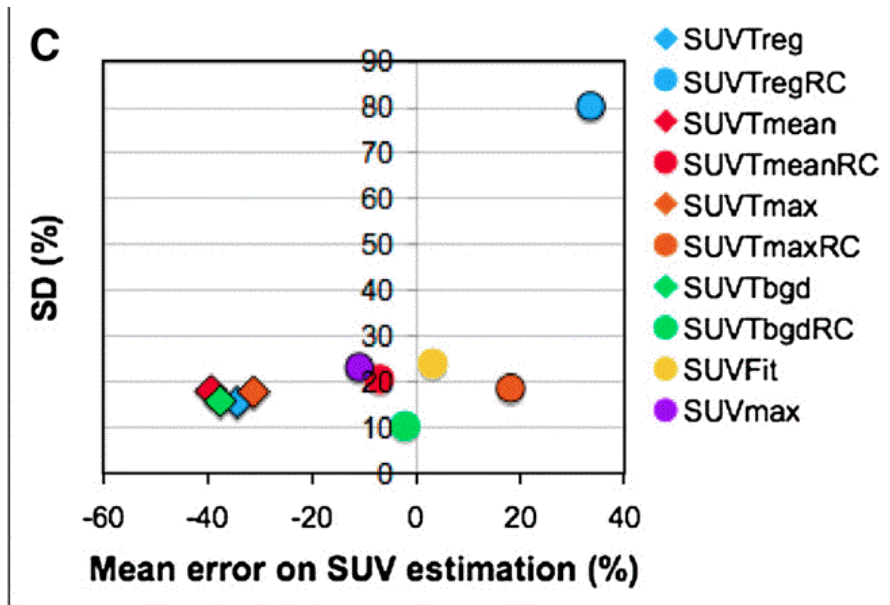
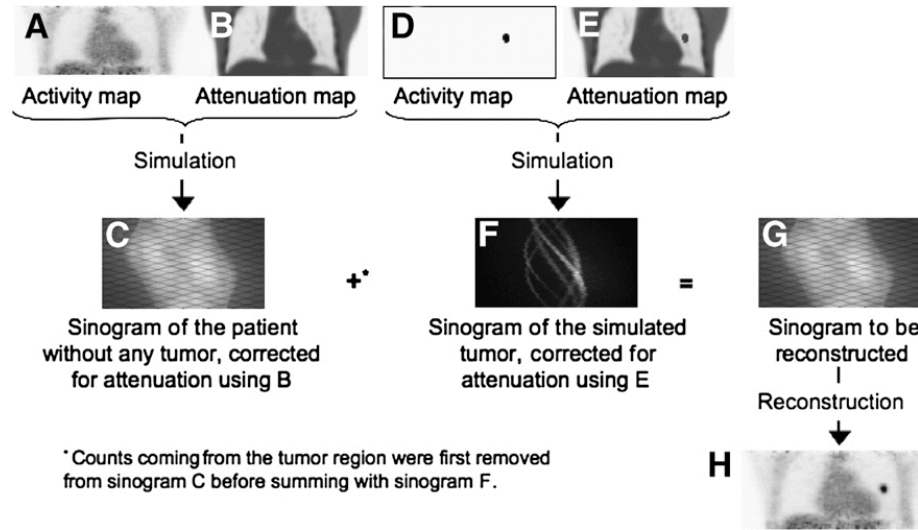
Mean ROI Activity



Mean ROI Activity



Quantitation Algorithms





Improved Quantitation Algorithms

- Reference values, e.g. 2/3 reduction of ΔSUV or absolute thresholds, were established with simple quantitation algorithms
- Do they need to be adapted to more sophisticated quantitation algorithms





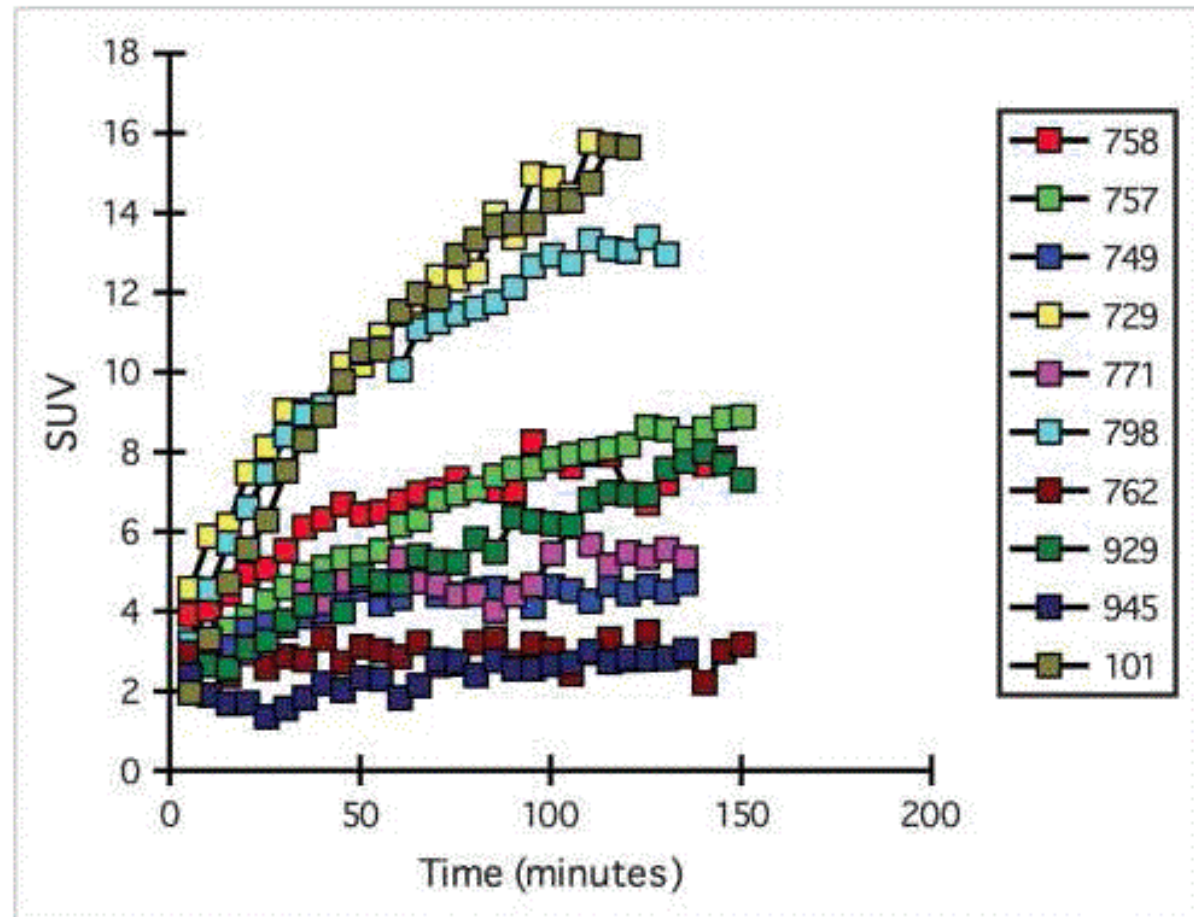
Factors affecting FDG SUV

- Biology
 - Time between injection and PET scan
 - Blood glucose concentration
 - Distribution volume of FDG (body composition)
 - FDG – Elimination (kidneys)

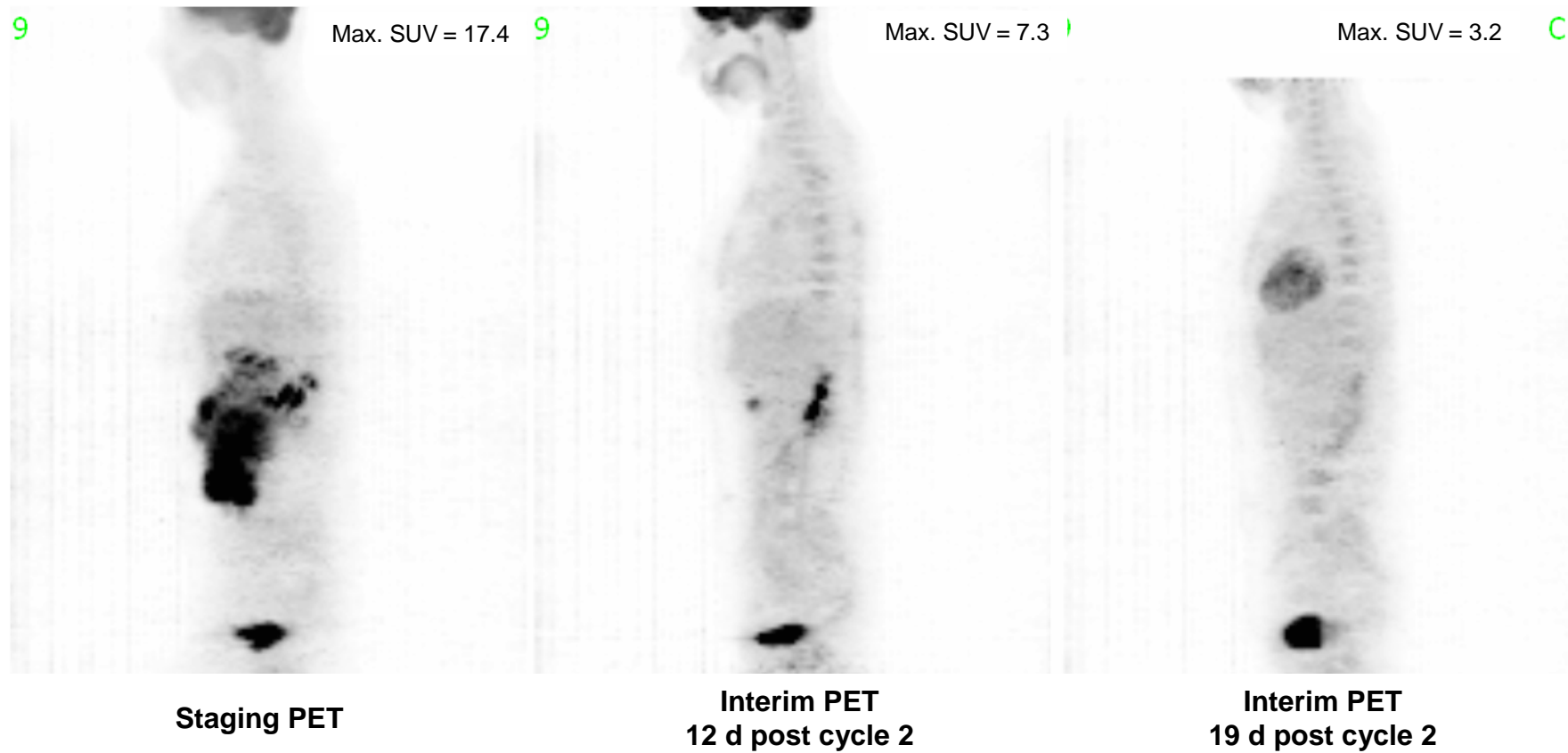




Einfluss Intervall Injektion - Scan



Influence of Time Point for Interim-PET



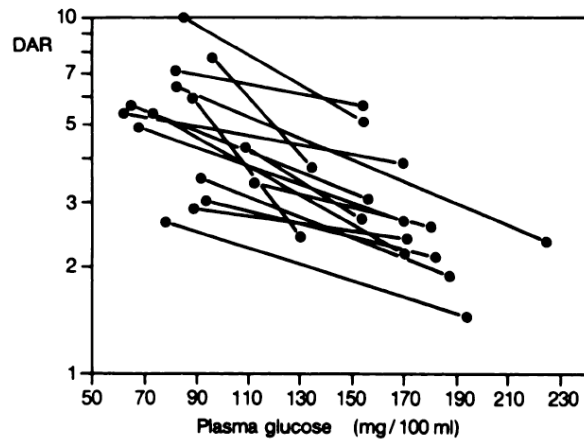
- Optimal time point
- Standardization (PETAL Resp.: 19.5 ± 4.2 d, Non-Resp.: 19.5 ± 4.3 d)



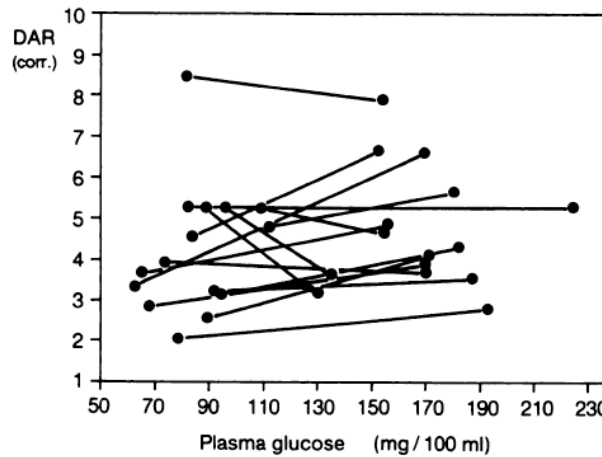


Blood Glucose Concentration

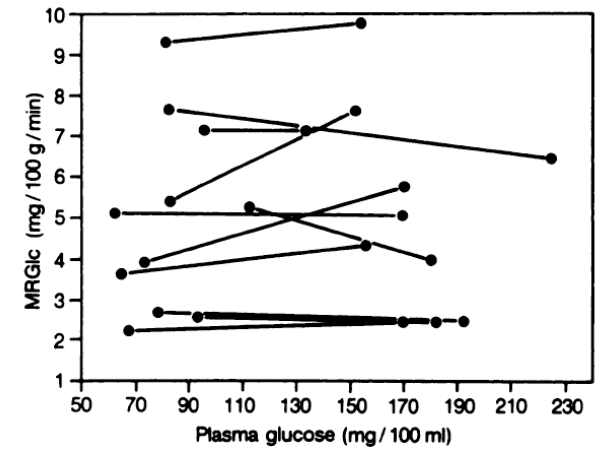
FDG Uptake in NSCLC



SUV



$SUV_{gl} = [Glc]/100 * SUV$



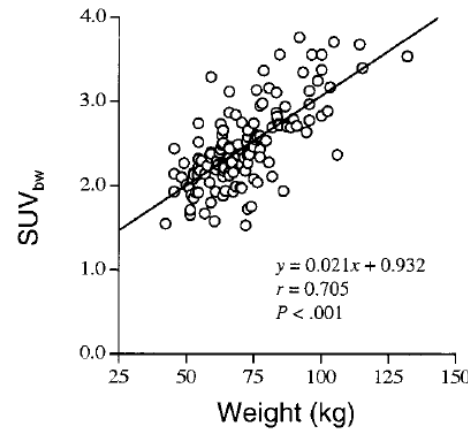
$MRGlc_{Patlak-Plot}$

Insulin sensitivity different in various tissues

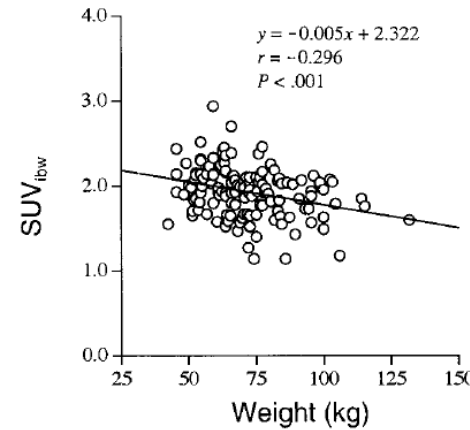


Distribution Volume

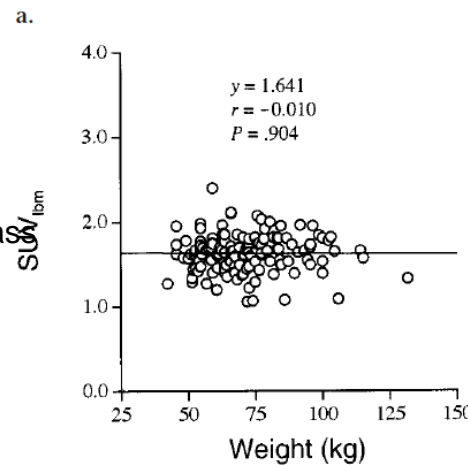
SUV_{Body Weight}



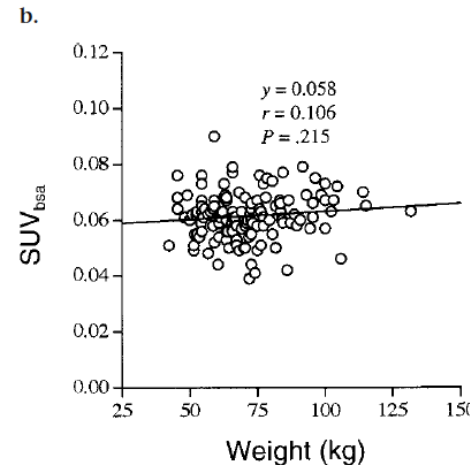
SUV_{Ideal Weight}



SUV_{Lean Body Mass}



SUV_{BSA}



No major change between Staging and Interim PET



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- Biology
 - Time between injection and PET scan
 - Blood glucose concentration
 - Distribution volume of FDG (body composition)
 - FDG – Elimination (kidneys)
- **Standardization required**





Standardization of Interim-PET

- Eliminates inter- and intra-observer variability
 - Important for multicentric trials
 - No reference reading necessary
- Standardization feasible
 - Similar to clinical routine PET protocol
 - Similar efforts should be undertaken anyway for visual evaluation
- Feedback from trial improves discipline





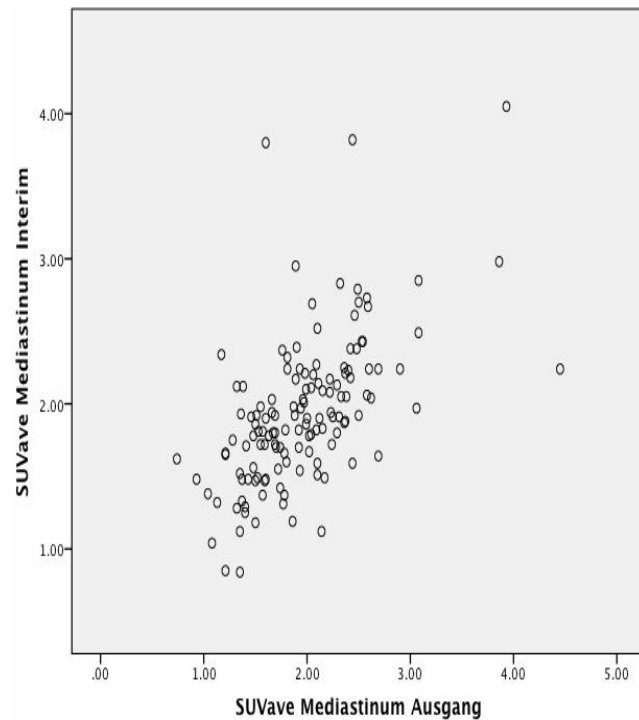
Unresolved Issues of SUV Quantitation

- Which factors of Δ SUV assessment are really limiting?
 - Standardization prerequisite for reliable quantitation
- Can we easily correct SUVs when they are obviously wrong compared to an internal reference organ?
 - no

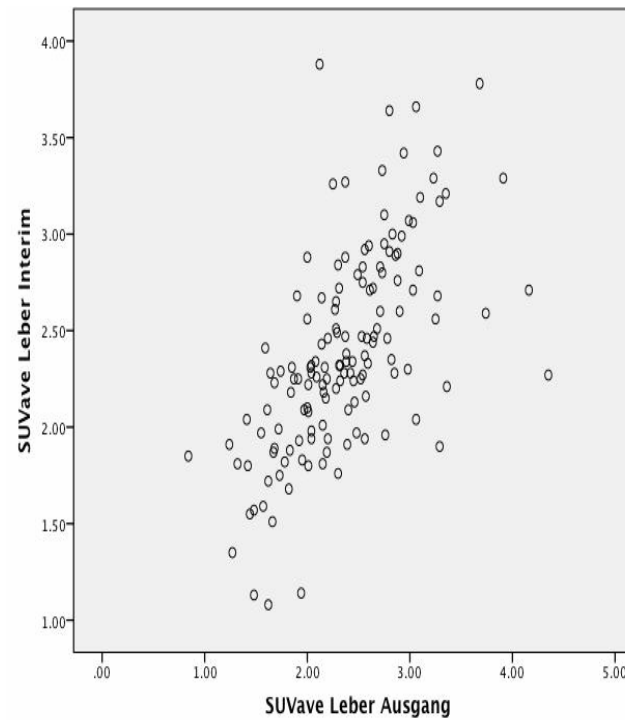


FDG-SUV in Reference Organs under R-CHOP Chemotherapie Results from the PETAL-Study in Non-Hodgkin Lymphoma

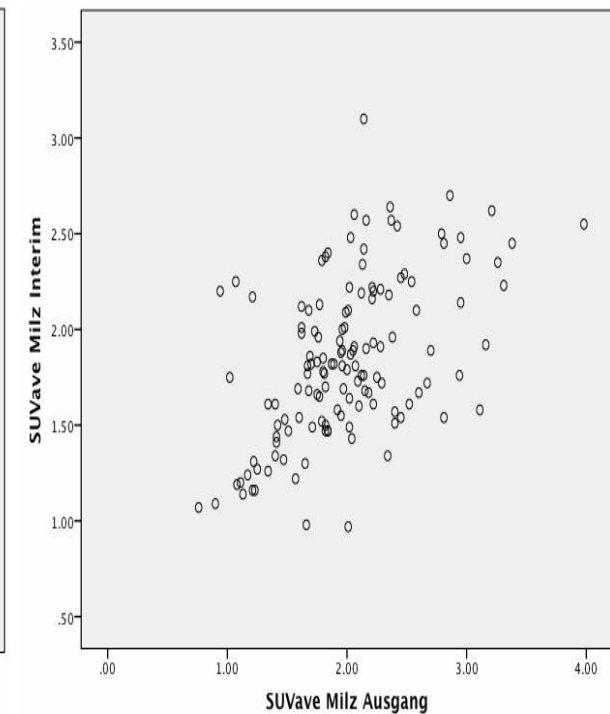
- 145 patients (Universitätsklinikum Essen) with aggressive NHL (PETAL Study)
- FDG-PET/CT baseline and interim (median 19 d after 2. cycles R-CHOP)
- Mean SUV in spherical 2 cm diameter VOI in mediastinal bloodpool, liver and spleen
- Excluded patients with lymphoma manifestations in reference organs



Mediast. Boodpool



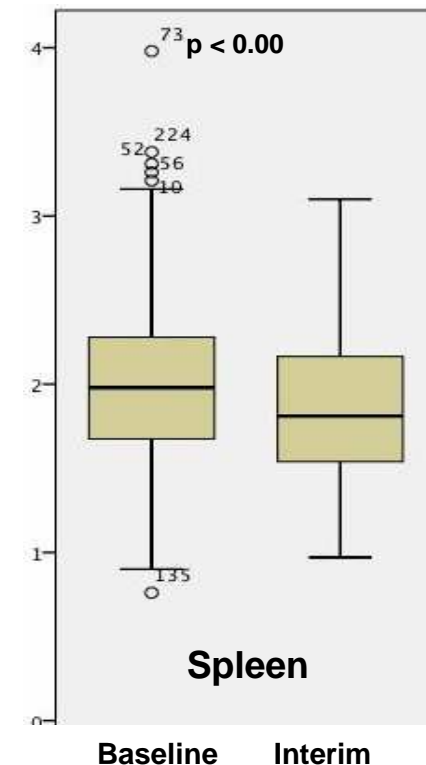
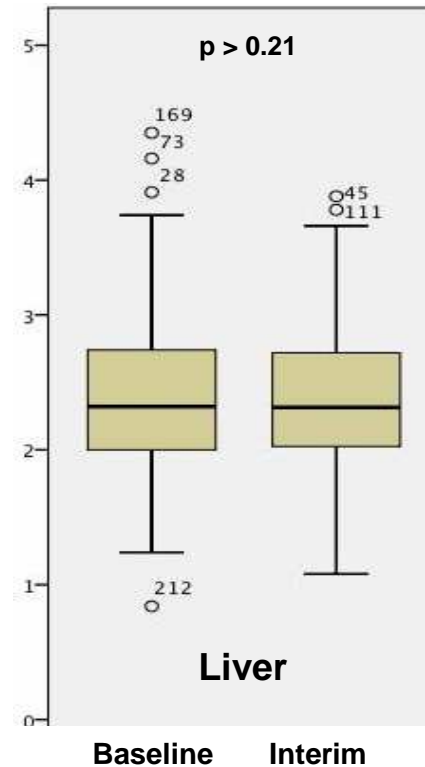
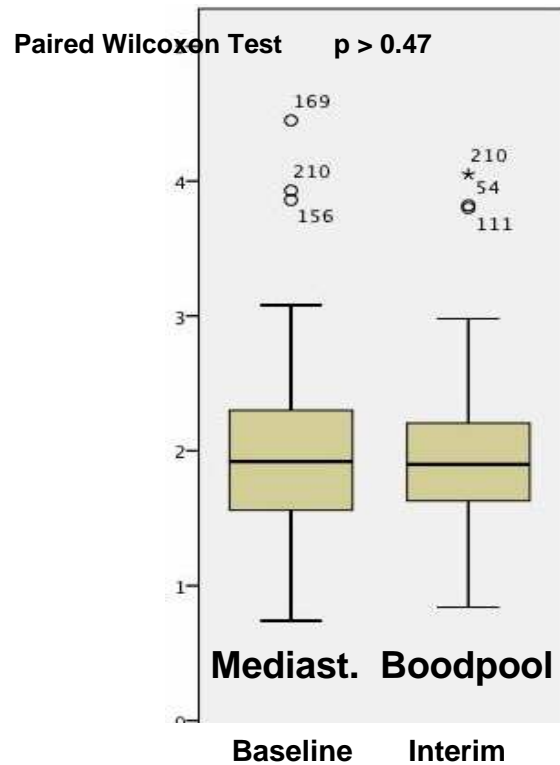
Liver



Spleen

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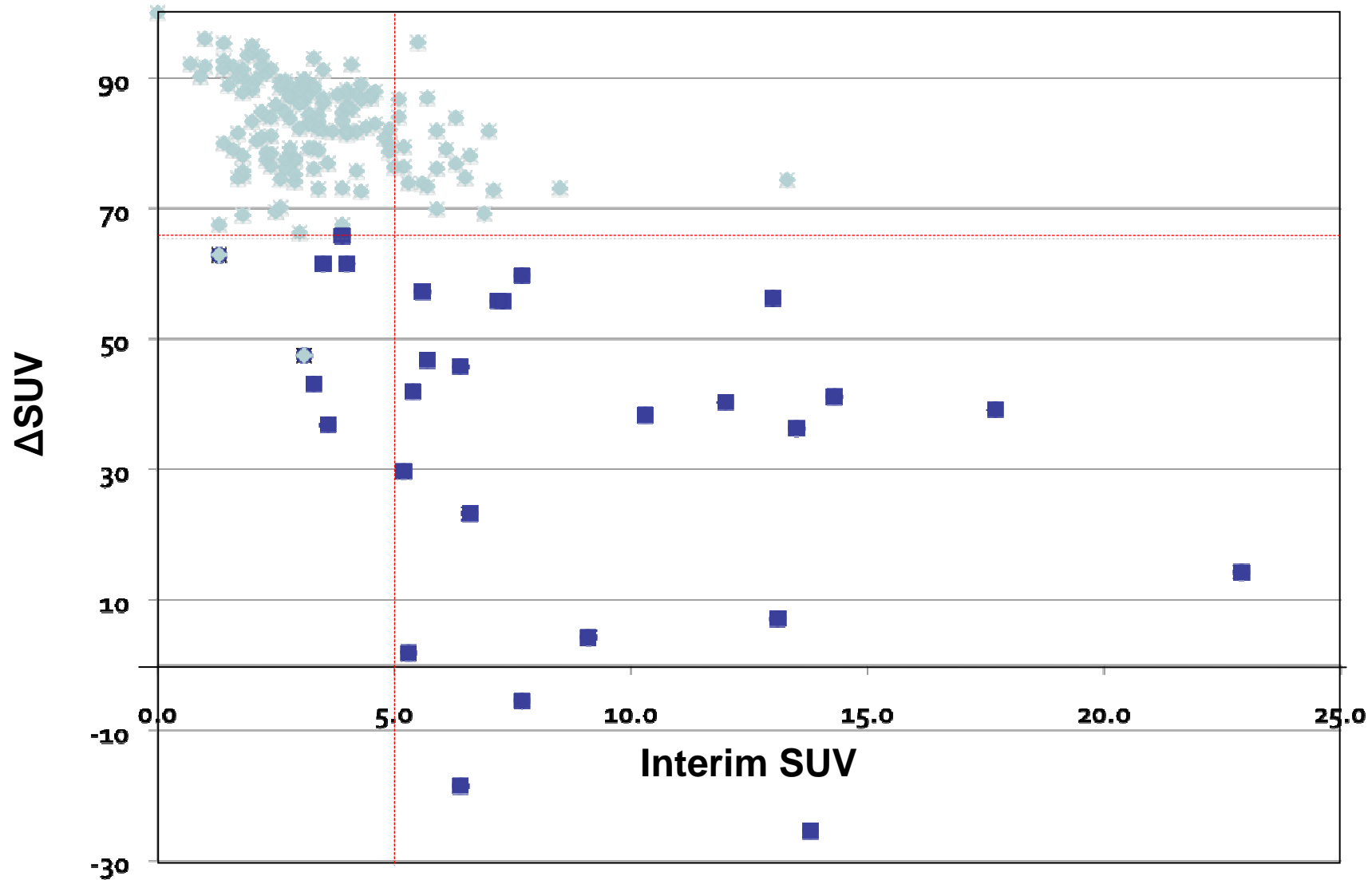
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- SUVs in mediastinal bloodpool and liver are stable
- SUV decrease in the spleen is significant but not relevant



Δ SUV vs. Interim SUV





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