Inter-institutional quantification of spectral results with first-generation clinical photon-counting CT

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Key Facts

- **Photon-counting CT (PCCT)** introduces a new detector technology that facilitates the adoption of **quantitative imaging** but also introduces technical sensitivities that may affect the quantitative consistency between different institutions.
- Spectral results demonstrated **inter-institutional quantitative consistency** across **tube voltages and dose levels**.
- Inter-institutional reproducibility ensures consistent quantification necessary for the **adoption of quantitative imaging** and accurate **diagnostic interpretation**.

Introduction

- **Quantitative imaging** has enhanced the subjective interpretation of images with quantitative measurements for the **diagnosis of disease**.
- Compared to conventional CT, PCCT implements a photon-counting CT detector that enables **improved quantitative reproducibility** through the generation of quantitative **spectral results**.
- Previous studies have demonstrated the **quantitative consistency** of spectral results with varying tube voltages, patient habitus, and radiation dose.
- PCCT's incorporation of new detector technology introduce **new sensitivities** that may affect the performance of PCCT **between institutions**.

Methods

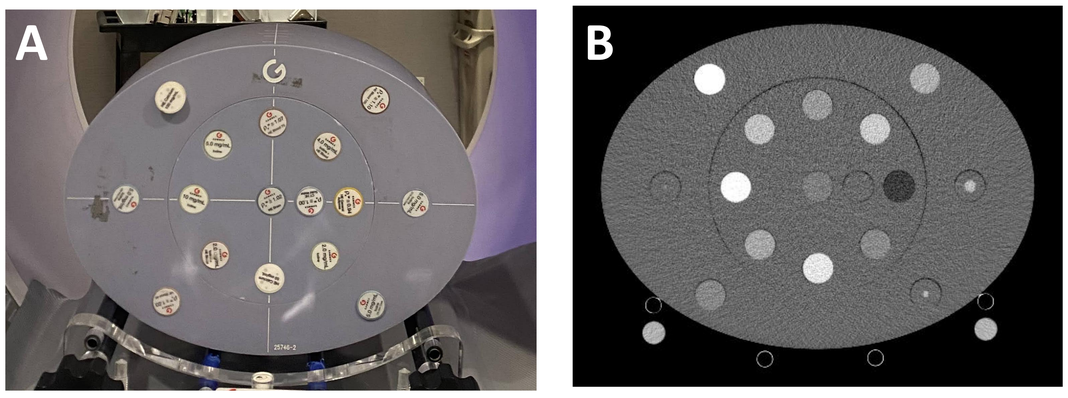


Figure 1. Experimental setup. Phantom (A) and corresponding virtual monoenergetic image at 70 keV (B). WL/WW: 40/400 HU.

- Each of the four institutions scanned their copy of the same phantom model (Multi-energy CT phantom, Sun Nuclear, **Fig. 1**) on their clinical PCCT (NAEOTOM Alpha.Peak, Siemens Healthineers) with a tube voltage of 140 kVp and a $CTDI_{vol}$ of 10 mGy.
- Virtual monoenergetic images (VMI) from 40 to 190 keV, iodine maps, and virtual non-contrast (VNC) were analyzed to determine error relative to the expected value based on manufacturer elemental composition and physical density.
- Corresponding inter-institutional standard deviation was calculated for each insert, spectral results, tube voltage, and dose.

Results

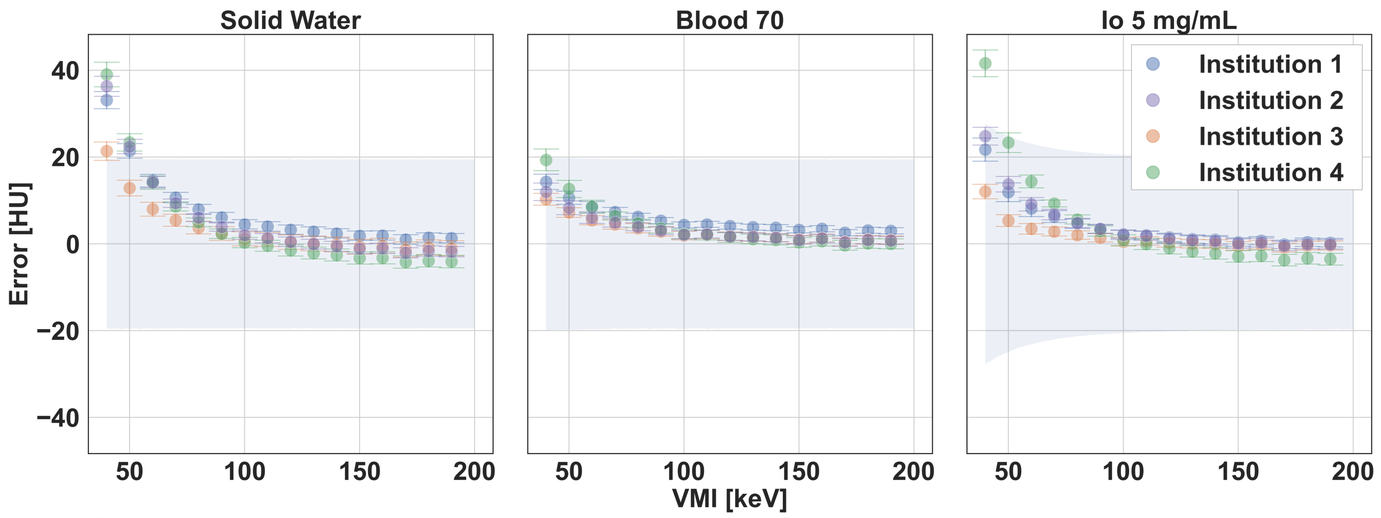
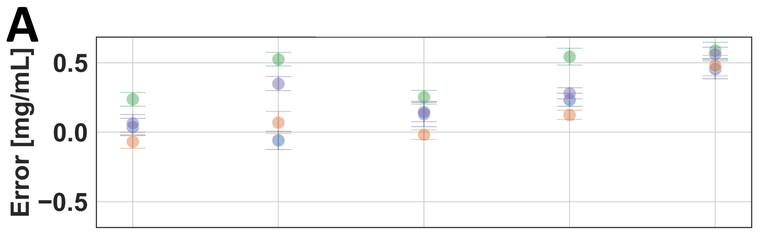


Figure 2. VMI error of select inserts for each institution. Error bars represent the standard deviation of error across scan repetitions and image slices. Blue shaded region corresponds to the expected range of values as determined by manufacturer prescribed tolerance of physical density.

- For all institutions, VMI error decreased with increasing keV (**Fig. 2**).
- VMI 70 keV error of blood 70 and solid water averaged 6 ± 1 and 9 ± 2 HU, respectively.
- Mean iodine and VNC errors for the iodine 5 mg/mL insert were 0.3 ± 0.2 mg/mL and -4 ± 3 HU, respectively (**Fig. 3**).



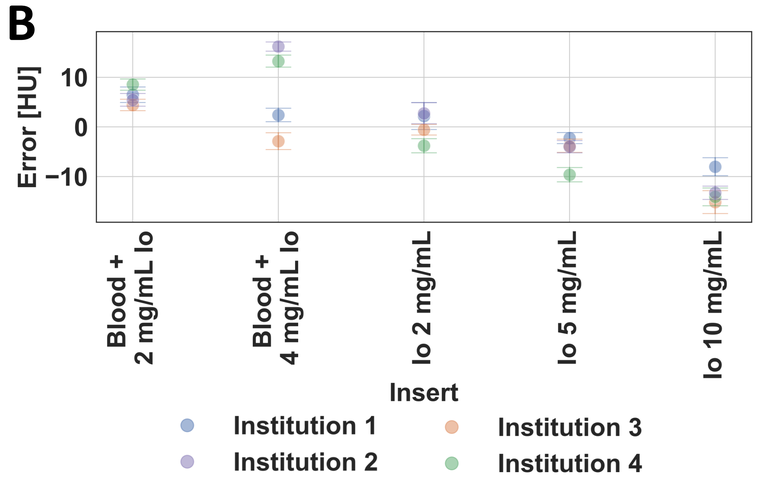


Figure 3. Error of iodine maps (A) and VNC (B) for different iodine-containing inserts across institutions.

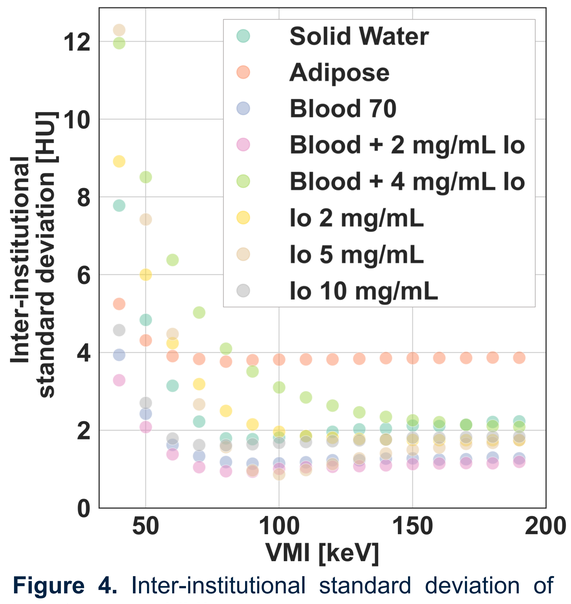


Figure 4. Inter-institutional standard deviation of inserts across VMIs.

- Inter-institutional standard deviation of iodine 5 mg/mL (**Fig. 4**) were 7.8 and 1.6 HU for VMI 50 and 150 keV, respectively.
- Iodine and VNC exhibited an inter-institutional standard deviation ranging from 0.05 to 0.17 mg/mL and 1.3 to 3.2 HU.

Conclusions

- Spectral quantification with PCCT was consistent between four institutions with the same phantom and scanner model.
- Inter-institutional reproducibility enables the development and clinical adoption of biomarkers for improved diagnosis across a range of clinical applications.