Automated Machine Learning Segmentation and Measurement of Urinary Stones on CT Scan

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**Problem**
- Treatment for kidney stones are variable and based on several factors
  - Stone size
  - Location
  - Renal anatomy
- Current methods for measurement of these characteristics depend on manual measurement by humans.
- This process introduces inter- and intra-observer variation and is laborious and time-consuming

**Goal**
- Our objective was to evaluate the performance of a machine learning algorithm to quickly and accurately automate measurement of stone features and renal anatomy

**Strategy**
- Cross-section of 95 randomly-selected CT scans from adults and children with renal calculi
- Measurements of 46 scans: 3 orthogonal dimensions, renal pelvis width, and ureter diameter
- Remaining 49 scans used to train and test a deep learning model to segment kidney stones from the surrounding kidney
- Statistical analysis:
  - Two-way random intraclass correlation (ICC) score calculated to quantify interrater agreement
  - Times for manual and machine calculations
  - Specificity and sensitivity of stone detection

**Results**
- Sample for assessment: 19 scans with kidney stones, 17 with ureteral stones, and 10 with both.
- Algorithm stone identification:
  - Number of stones: 100% sensitivity and 100% specificity
  - Number of voxels: 58% sensitivity and 100% specificity
- The algorithm reliably captured the centers of stones and the total area of kidney stones identified by the machine was smaller and more accurate than that identified by human raters (Figure 3)

**Time to measure stones**
- 16.1 s stone
- 12.0 s total

**Conclusions**
- Manual measurements of kidney stones and anatomy on CT are limited by the time required and poor reproducibility.
- The more rapid and accurate measurements provided by the machine learning algorithm have a high probability to transform clinical care as it enhances and standardizes assessment across patients, institutions, and providers.

**Acknowledgements**
- I would like to acknowledge the patients that made this study possible and my wonderful research team at the Children’s Hospital of Philadelphia