Detecting Underdiagnosed Medical Conditions with Deep Learning-Based Opportunistic CT Imaging

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INTRODUCTION

- Over **85 million computed tomography** (CT) scans are performed each year, providing diagnostic insights into patient health [1]
- **Opportunistic CT** involves leveraging existing CT scans to generate additional diagnostic insights beyond their original purpose, potentially identifying **underdiagnosed conditions** [2-4]:
  1. **Sarcopenia**: Progressive loss of skeletal muscle mass and strength
  2. **Hepatic Steatosis**: Excessive fat accumulation in the liver
  3. **Ascites**: Pathological accumulation of fluid in the abdominal cavity
- Despite their clinical relevance, these conditions are often **under-recognized** in electronic health records (EHRs)
- Manual assessment of muscle mass, liver morphology, and fluid accumulation is *time-consuming* and prone to *variability*.

- **GOAL: To evaluate 2,674 inpatient CT scans and explore discrepancies between *imaging findings*, *radiology report findings*, and *ICD-coding* for sarcopenia, hepatic steatosis, and ascites.**

METHODS

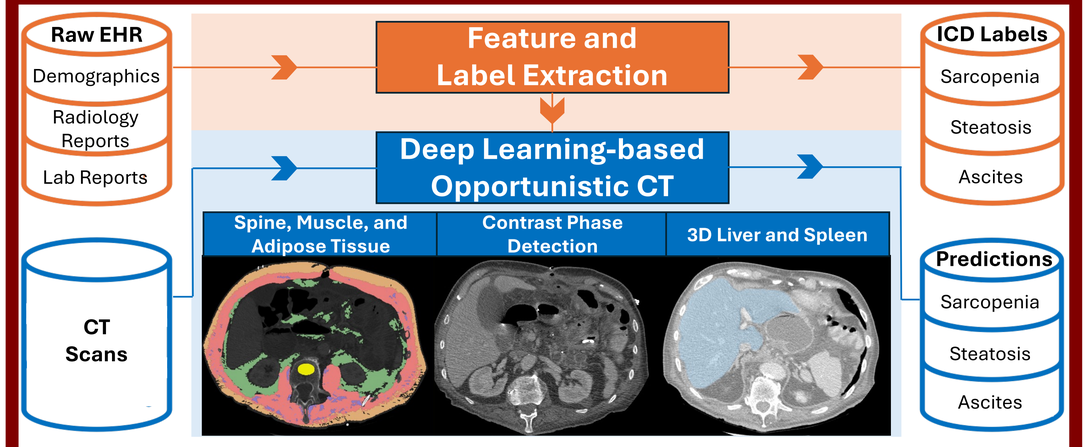

Figure 1: Schematic: 1) Data processing, 2) Opportunistic CT, 3) Diagnosis analysis

- **Data Acquisition:**
  - Retrospective CT dataset from a single medical center (2014-2018), comprising **23,540 patients** and **33,548 CT scans**
- **Body Composition Analysis:**
  - **Comp2Comp** [5] uses convolutional neural networks to segment CT images, enabling consistent and reproducible extraction of body composition metrics
- **Criteria for Clinical Diagnosis:**
  - **Sarcopenia:**
    - T-Score = $\frac{L3SMI-47.5}{6.6}$ and $\frac{L3SMI-60.9}{6.6}$ for female and male
    - BMI-Z-Score = $\frac{I-\hat{I}}{SD(I)}$, where $I = \frac{L3SMA}{height}$
  - **Hepatic Steatosis:**
    - Liver Attenuation ≤ 90 HU
    - Liver-Spleen Attenuation Difference ≤ -19 HU
  - **Ascites:** Fine-tuned Merlin [6] model for Ascites prediction

RESULTS & DISCUSSION

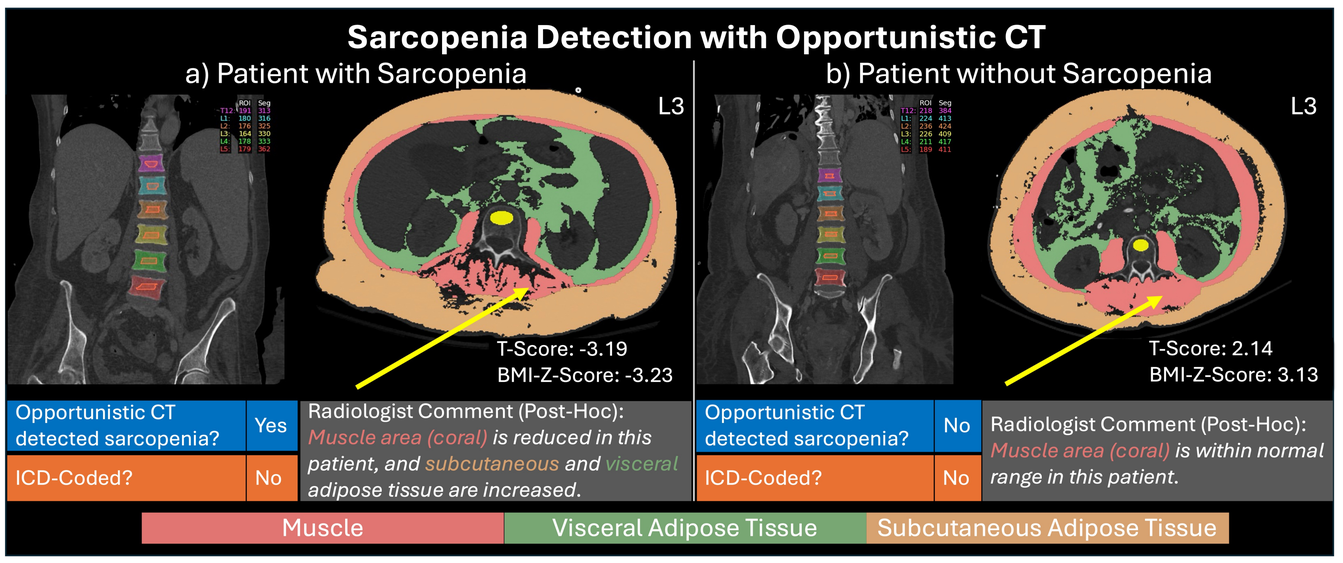

Figure 2. Sarcopenia - Opportunistic detection and ICD coding

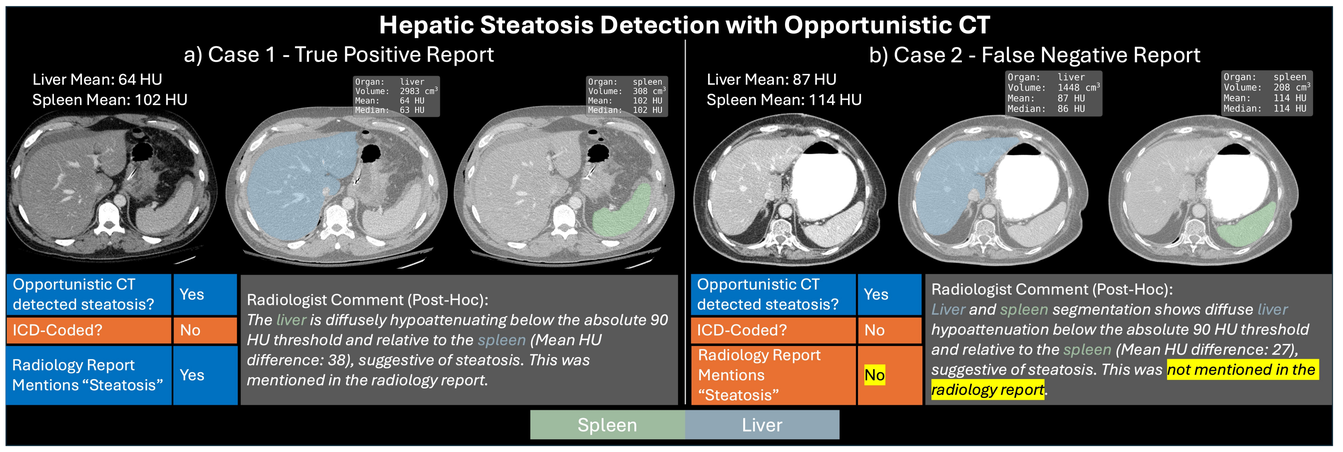

Figure 3. Hepatic steatosis - Opportunistic detection, radiology report diagnosis, and ICD coding

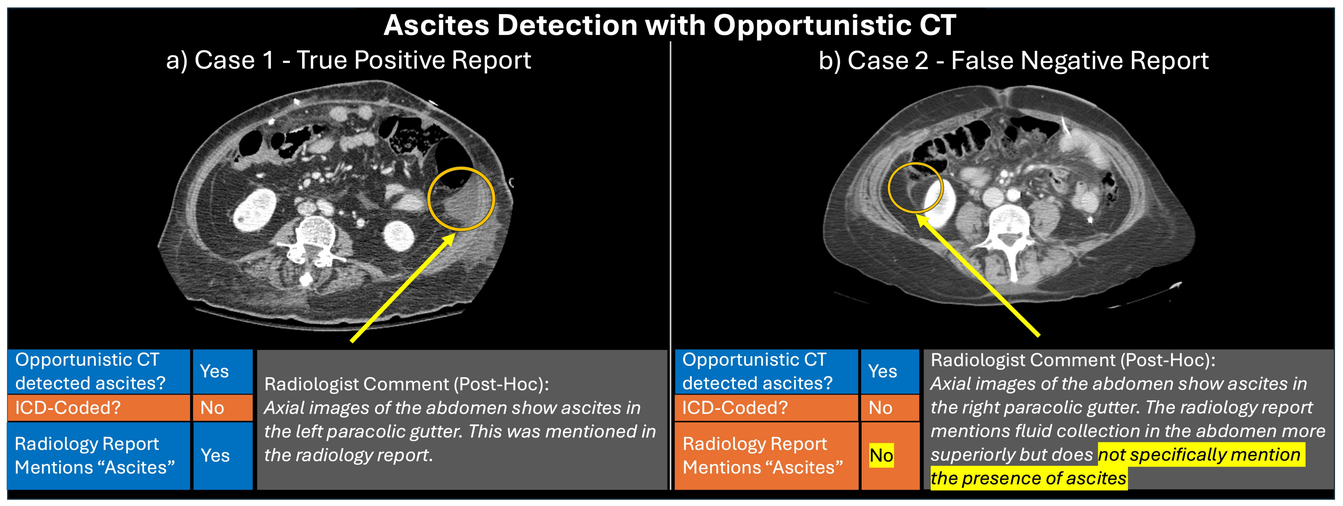

Figure 3. Ascites - Opportunistic detection, radiology report diagnosis, and ICD coding

CONCLUSIONS

- Found substantial discrepancies b/w condition prevalence and coding:
  - **Sarcopenia:** Out of scans diagnosed through opportunistic imaging, only **0.5% scans were ICD-coded**
  - **Hepatic Steatosis**: Out of scans diagnosed through opportunistic imaging or radiology reports, only **3.2% scans were ICD-coded**
  - **Ascites:** Out of scans diagnosed with ascites through opportunistic imaging or radiology reports, only **30.7% scans were ICD-coded**

References
[1] Winder M et al. *Are we overdoing it? Changes in diagnostic imaging workload during the years 2010–2020 including the impact of the SARS-CoV-2 pandemic.* (2021).
[2] Boutin RD et al. *Value-added opportunistic CT: insights into osteoporosis and sarcopenia.* (2024).
[3] Mellinger JL et al. *Hepatic steatosis and cardiovascular disease outcomes: An analysis of the Framingham Heart Study.* (2015).
[4] Moreau R et al. *Clinical characteristics and outcome of patients with cirrhosis and refractory ascites.* (2004).
[5] Blankemeier L et al. *Comp2comp: Open-source body composition assessment on computed tomography.* (2023).
[6] Blankemeier L et al. *Merlin: A Vision Language Foundation Model for 3D Computed Tomography.* (2024).