



# EMERGENCY RADIOLOGY 2023

8th Nordic Course in Emergency Radiology, Aarhus, Denmark

## Multicenter Study: AI in Acute Low Dose Abdominal CT

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Clinical Imaging

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Cardiothoracic Imaging

## Diagnostic accuracy of low-dose and ultra-low-dose CT in detection of chest pathology: a systematic review

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### ARTICLE INFO

#### Keywords:

Ultra-low-dose CT  
Low-dose CT  
Chest pathology  
Diagnostic accuracy  
Systematic review

### ABSTRACT

**Purpose:** Studies have evaluated imaging modalities with a lower radiation dose than standard-dose CT (SD-CT) for chest examination. This systematic review aimed to summarize evidence on diagnostic accuracy of these modalities – low-dose and ultra-low-dose CT (LD- and ULD-CT) – for chest pathology.**Method:** Ovid-MEDLINE, Ovid-EMBASE and the Cochrane Library were systematically searched April 29th–30th, 2019 and screened by two reviewers. Studies on diagnostic accuracy were included if they defined their index tests as ‘LD-CT’, ‘Reduced-dose CT’ or ‘ULD-CT’ and had SD-CT as reference standard. Risk of bias was evaluated on study level using the Quality Assessment of Diagnostic Accuracy Studies-2. A narrative synthesis was conducted to compare the diagnostic accuracy measurements.**Results:** Of the 4257 studies identified, 18 were eligible for inclusion. SD-CT (3.17 ± 1.47 mSv) was used as reference standard in all studies to evaluate diagnostic accuracy of LD- (1.22 ± 0.34 mSv) and ULD-CT (0.22 ± 0.05 mSv), respectively. LD-CT had high sensitivities for detection of bronchiectasis (82–96%), honeycomb (75–100%), and varying sensitivities for nodules (63–99%) and ground glass opacities (GGO) (77–91%). ULD-CT had high sensitivities for GGO (93–100%), pneumothorax (100%), consolidations (90–100%), and varying sensitivities for nodules (60–100%) and emphysema (65–90%).**Conclusion:** The included studies found LD-CT to have high diagnostic accuracy in detection of honeycombing and bronchiectasis and ULD-CT to have high diagnostic accuracy for pneumothorax, consolidations and GGO. Summarizing evidence on diagnostic accuracy of LD- and ULD-CT for other chest pathology was not possible due to varying outcome measures, lack of precision estimates and heterogeneous study design and methodology.

### 1. Introduction

When evaluating patients with suspected pathology in the chest, imaging modalities with the most optimal diagnostic accuracy and limited risks for the patients are preferred. Computed tomography (CT) provides detailed visualization of the lung parenchyma and has become a well-established modality for evaluating the thorax. However, imaging modalities with high diagnostic accuracy like standard dose computed

tomography (SD-CT) and high-resolution computed tomography (HRCT) have drawbacks such as higher radiation dose and cost (compared to e.g. chest x-ray). A standard dose chest CT (SD-CT) with an effective dose of 8–10 mSv corresponds with a cancer risk of approximately 1:2000.<sup>1</sup>

Advances in CT scanners have enabled dose-reduction and image quality improvement, while maintaining an acceptably high diagnostic accuracy for detection of pathology in the chest. Diagnostic modalities

**Abbreviations:** ULD-CT, ultra-low-dose CT; LD-CT, low-dose CT; SD-CT, standard-dose CT; mSv, millisievert; IR, iterative reconstruction.

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### Observational Study

Medicine

OPEN

## Ultra-low dose computed tomography of the chest in an emergency setting A prospective agreement study

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### Abstract

Ultra-low dose computed tomography (ULD-CT) assessed by non-radiologists in a medical Emergency Department (ED) has not been examined in previous studies. To (i) investigate intragroup agreement among attending physicians caring for ED patients (i.e., radiologists, senior- and junior clinicians) and medical students for the detection of acute lung conditions on ULD-CT and supine chest X-ray (sCXR), and (ii) evaluate the accuracy of interpretation compared to the reference standard. In this prospective study, non-traumatic patients presenting to the ED, who received an sCXR were included. Between February and July 2019, 91 patients who underwent 93 consecutive examinations were enrolled. Subsequently, a ULD-CT and non-contrast CT were performed. The ULD-CT and sCXR were assessed by 3 radiologists, 3 senior clinicians, 3 junior clinicians, and 3 medical students for pneumonia, pneumothorax, pleural effusion, and pulmonary edema. The non-contrast CT, assessed by a chest radiologist, was used as the reference standard. The results of the assessments were compared within each group (intragroup agreement) and with the reference standard (accuracy) using kappa statistics. Accuracy and intragroup agreement improved for pneumothorax on ULD-CT compared with the sCXR for all groups. Accuracy and intragroup agreement improved for pneumonia on ULD-CT when assessed by radiologists and for pleural effusion when assessed by medical students. In patients with acute lung conditions ULD-CT offers improvement in the detection of pneumonia by radiologists and the detection of pneumothorax by radiologists as well as non-radiologists compared to sCXR. Therefore, ULD-CT may be considered as an alternative first-line imaging modality to sCXR for non-traumatic patients who present to EDs.

**Abbreviations:** CT = computed tomography, CXR = chest X-ray, DLP = dose length product, ED = Emergency Department, mSv = millisievert, NCCT = non-contrast computed tomography, PACS = Picture Archiving and Communication System, sCXR = supine CXR, ULD-CT = ultra-low dose computed tomography.**Keywords:** accuracy, chest X-ray, Emergency Department, low-dose CT, ultra-low dose CT

### 1. Introduction

Non-traumatic patients who present to Emergency Departments (ED) with acute respiratory symptoms are typically referred to a chest x-ray (CXR). CXR detects the most common diseases seen in these acute patients.<sup>[1]</sup> However, CXR misses a significant proportion of lesions in patients presenting to an ED with

decompensated heart failure, pneumonia, or pneumothorax.<sup>[2–7]</sup> The CXR can only be performed in a supine position for the most critically ill patients, which significantly lowers the diagnostic accuracy.<sup>[8,9]</sup>

The first-line imaging modality used in the ED needs to be accurate and patient-safe, especially in cases where the examination can only be done with the patient in a supine position.

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The authors have no conflicts of interest to disclose.

The data that support the findings of this study are available from a third party, but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are available from the authors upon reasonable request and with permission of the third party: Region of Southern Denmark

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*Chest Imaging*

# Diagnostic accuracy of ultra-low-dose chest computed tomography in an emergency department

**Maria Tækler,  
Pernille W  
Graumann**

**Fransen<sup>4</sup>,  
and Ole**

Dear Dr. Maria Tækker,

I hereby have the privilege and honor to inform you that your article by the Editorial Board of the journal has been elected as the **best scientific article from a Nordic institution** published in the journal in 2022.

The prize consists of a diploma to be awarded to you during the next Nordic Congress of Radiology in Helsinki, Finland in May, 2023.

Best wishes,

Henrik S. Thomsen  
Professor, DMSc  
Editor in Chief  
Acta Radiologica



# Participants



## On-site Oslo University Hospital, Ullevål, Norway (Oslo):

Principal investigator Oslo: **Anselm Schulz**, MD, PhD

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Tom Mala, Professor, MD, PhD

Knut Waagan, PhD, Senior Statistician



## On-site Odense University Hospital, Denmark (Odense):

Principal investigator Odense: **Bo Mussmann**, Research Radiographer, PhD,

Ole Graumann, Professor, MD, PhD

Stefan Posth, Associate Professor, MD, PhD

Mark Bremholm Ellebæk, Associate Professor

# DETECT Acute

Diagnostic Performance of Deep learning image reconstruction in low Dose CT for the  
Detection of Acute Abdominal Conditions

# DETECT Acute

Deep learning image reconstruction

Low Dose CT

Acute Abdominal Conditions

# DETECT Acute - Aim

## Primary:

Low-dose CT covering the **full spectrum** of acute abdominal conditions (not only e.g. appendicitis)

To evaluate the diagnostic performance for acute abdominal conditions of contrast enhanced low-dose CT with DLIR “TrueFidelity” (TF) compared to standard full-dose CT.

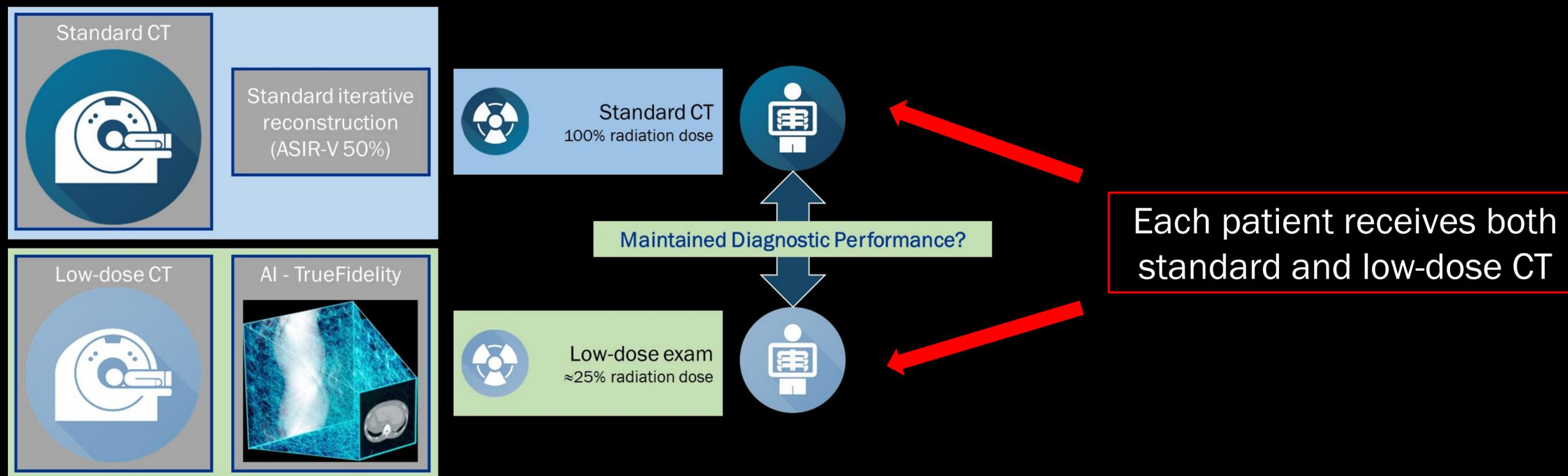
## Secondary:

To evaluate technical and perceived image quality (qualitatively and quantitatively).

# DETECT Acute - Methods

**Inclusion (total n = 200-300 patients, 100-150 at each site)**

- Patients under evaluation for an acute abdominal condition referred to CT
- Age >18 years



# DETECT Acute - Results

## Study status:

Recruiting since dec 2022

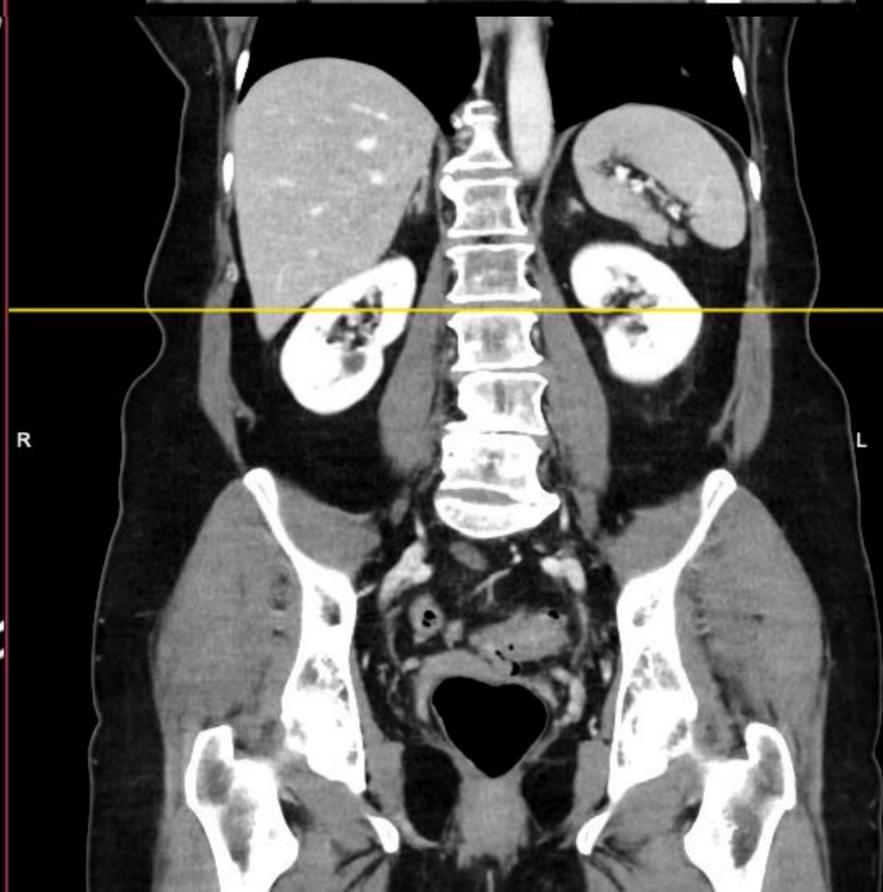
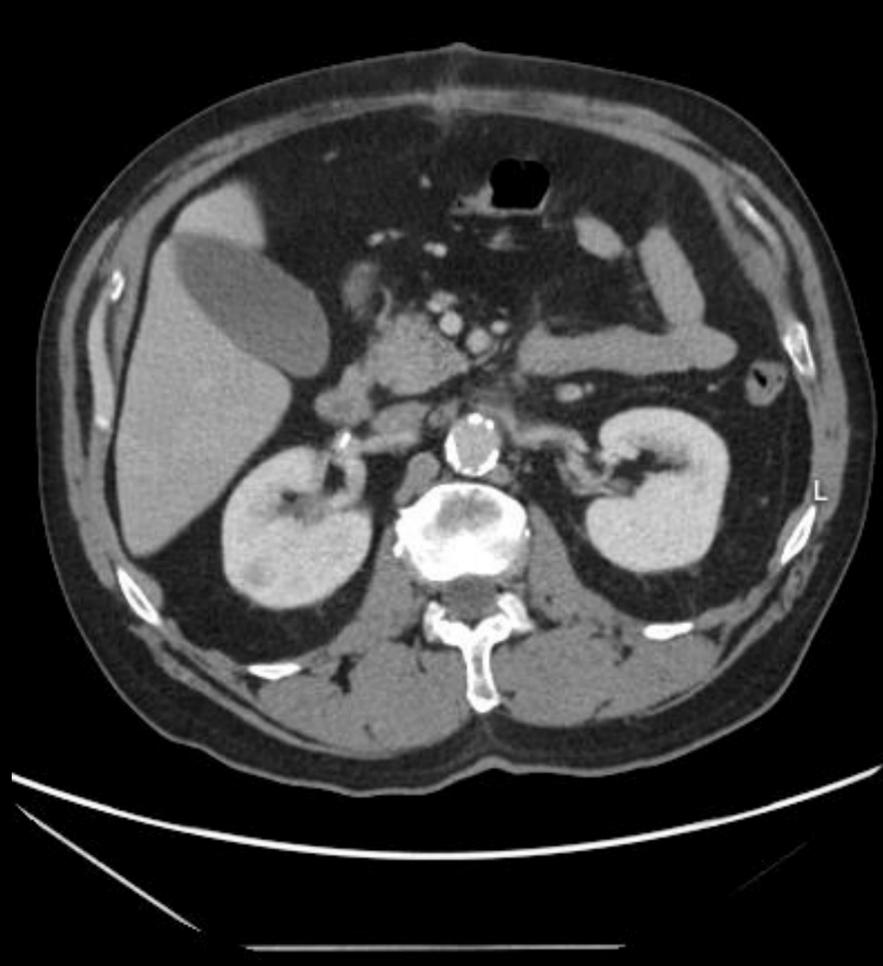
Clinical Trials: [NCT05651360](https://clinicaltrials.gov/ct2/show/study/NCT05651360)

### Diagnostic performance

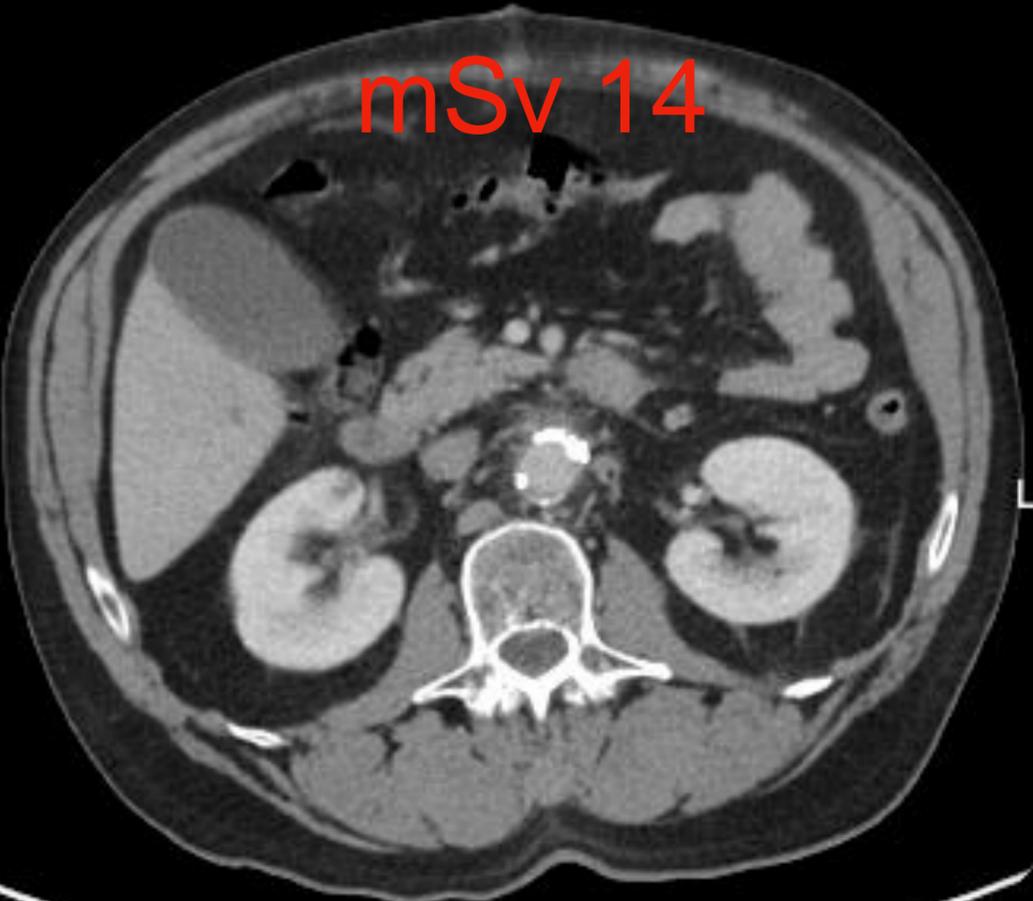
low-dose vs standard CT with 100% dose

	Sensitivity	Specificity	PPV	NPV
Low-dose CT TrueFidelity	Missing Data			
Low-dose CT Iterative	Will be updated soon			
Standard CT 100% dose				

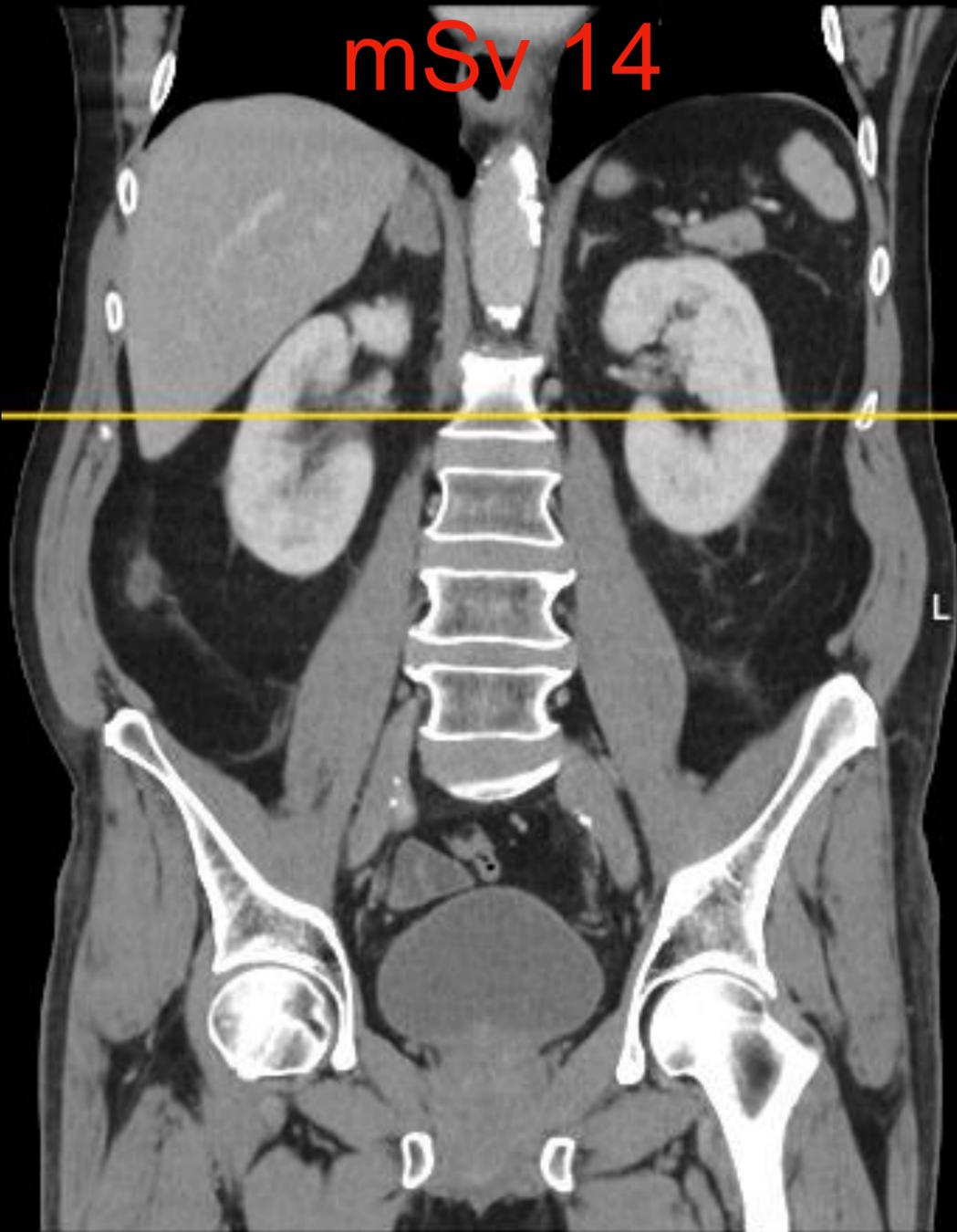
Positive predictive value (PPV); Negative predictive value (NPV)



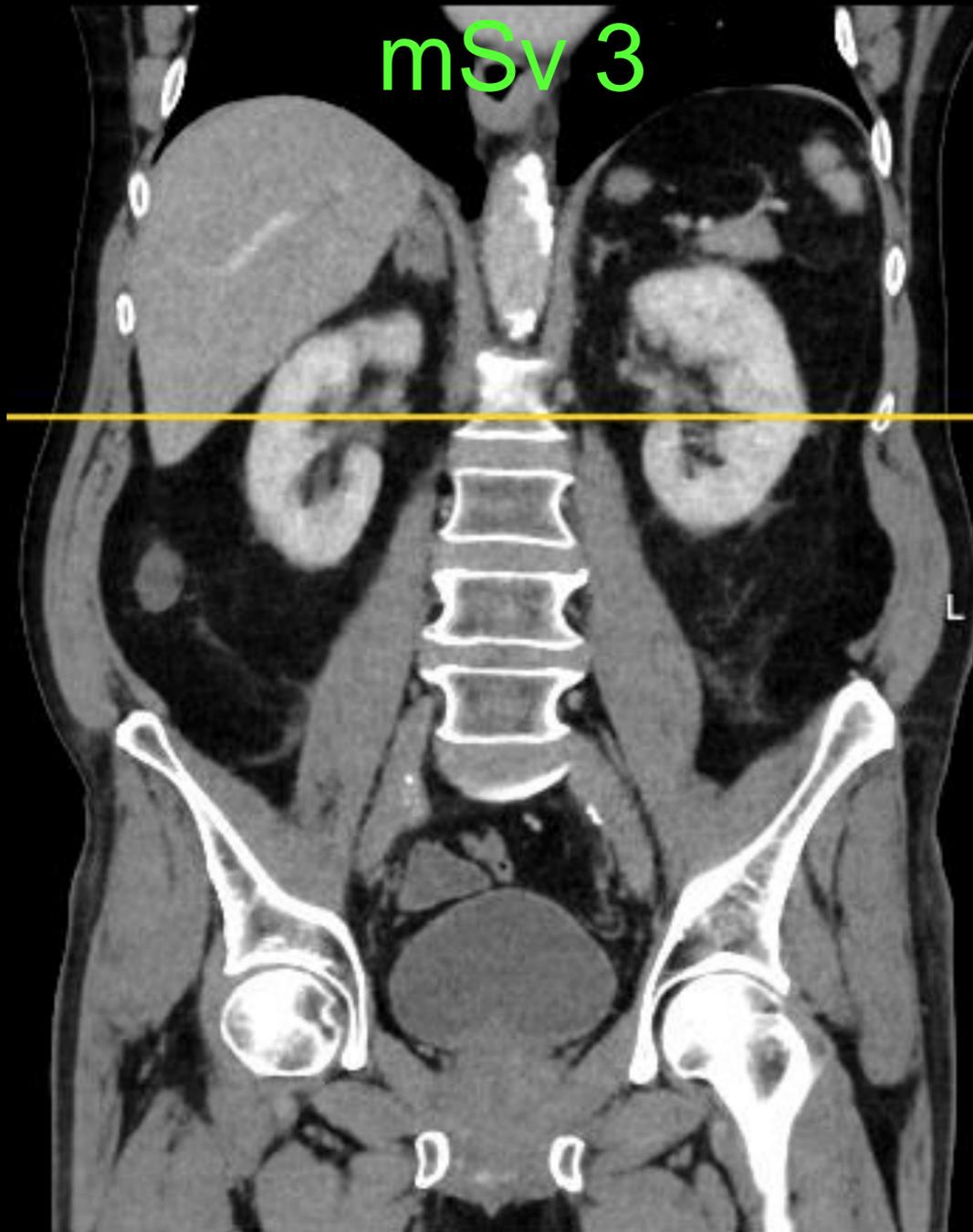
mSv 14



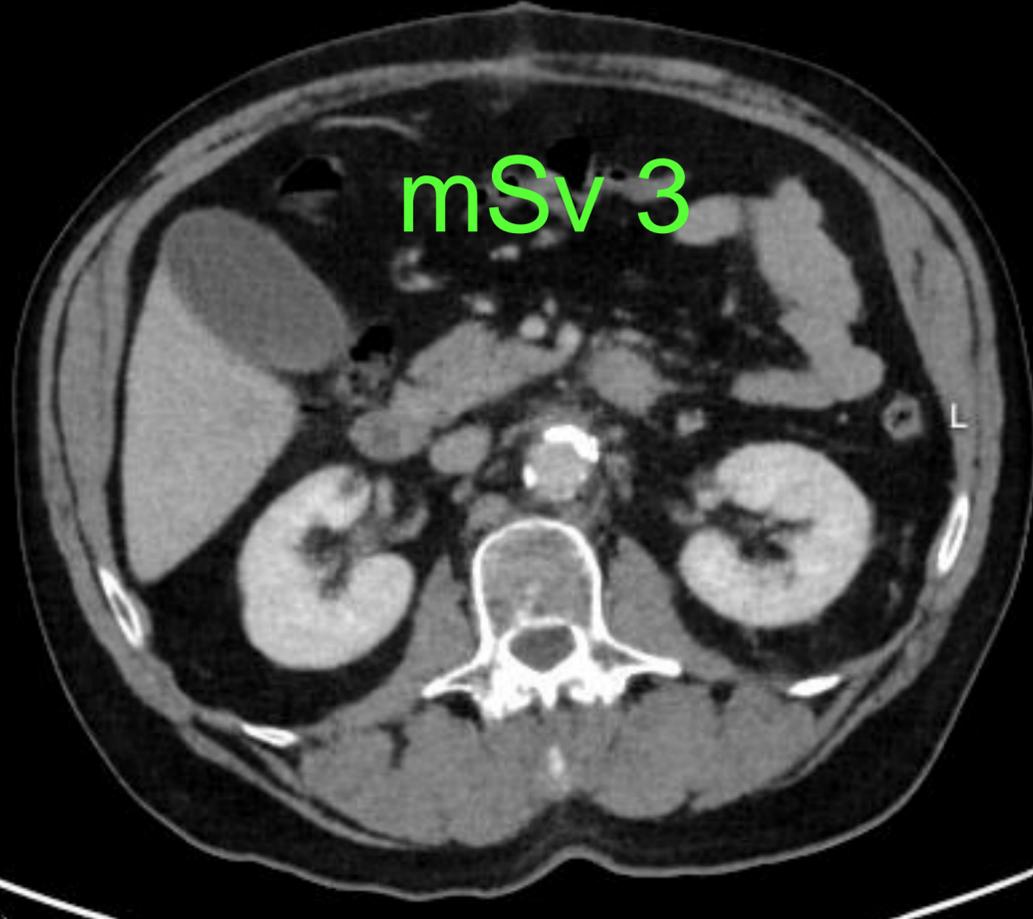
mSv 14



mSv 3



mSv 3



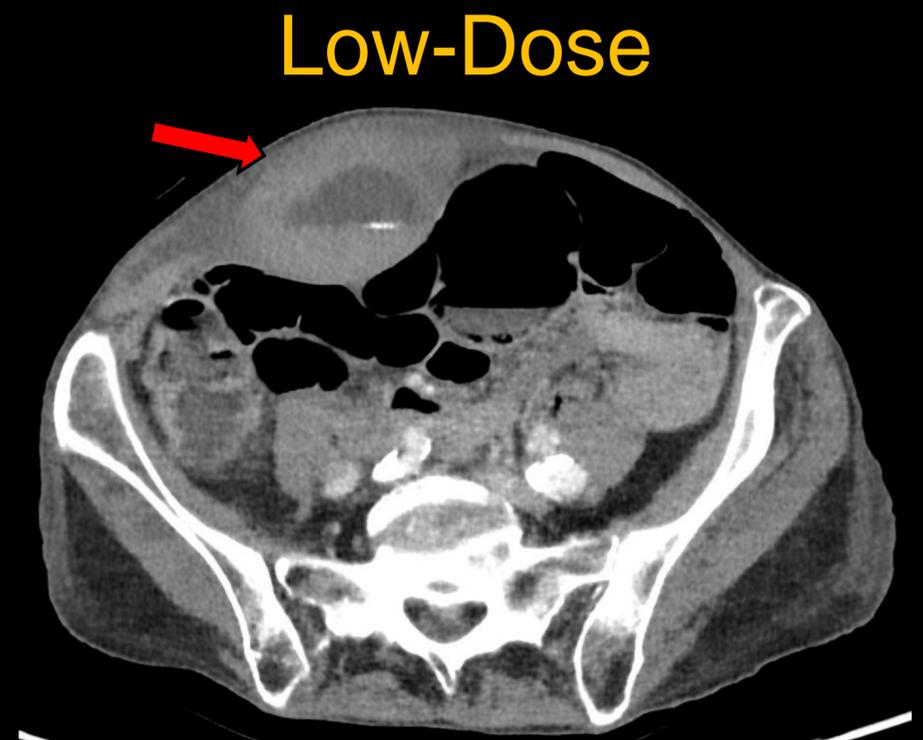
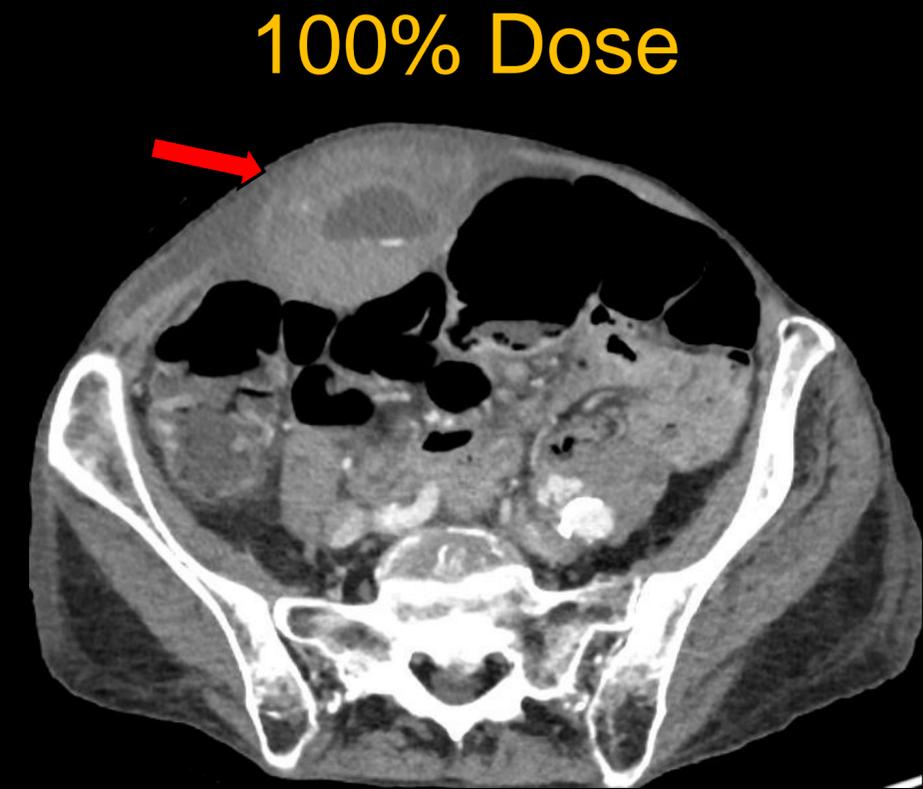
80%

# OS Case 01

## Clinic

- 80 years, female
- Recently treated for haemophilus influenzae pneumonia
- Acute pain in the right lower quadrant
- Rebound tenderness
- No fever

## Appendicitis?



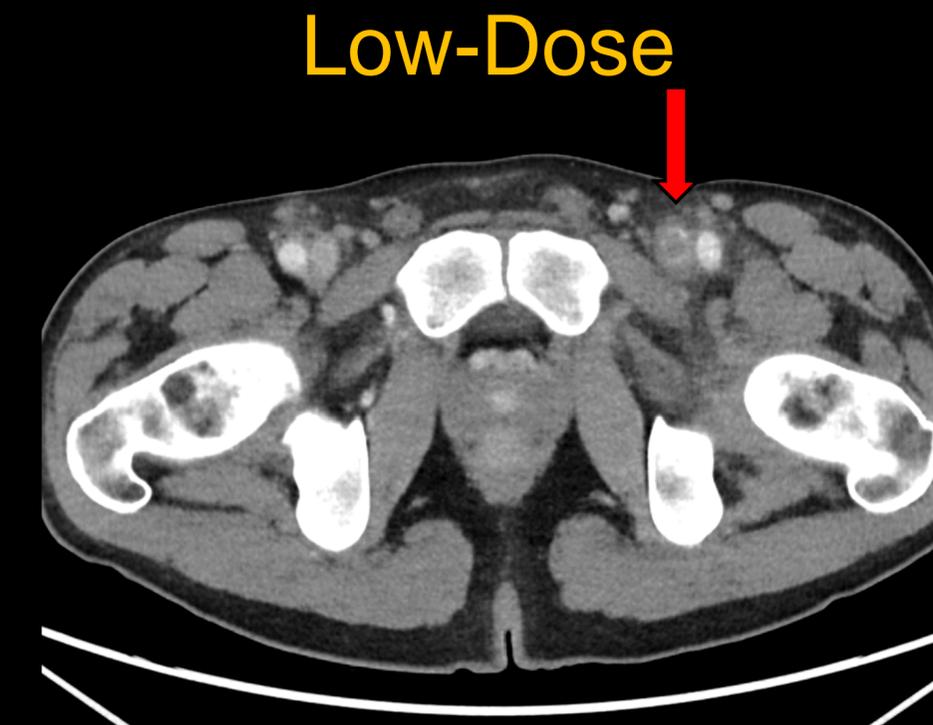
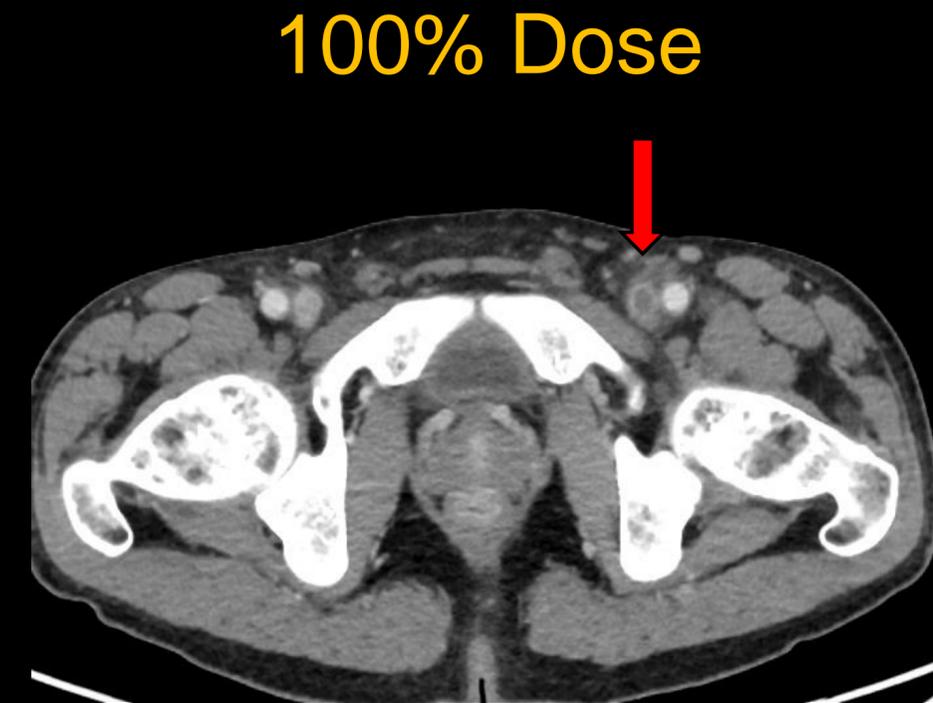
# OS Case 02

## Clinic

- 40 years, male
- Known history of drug abuse
- Misplaced injection left groin
- CRP 288
- Fever and chills

**Thrombosis?**

**Abscess?**



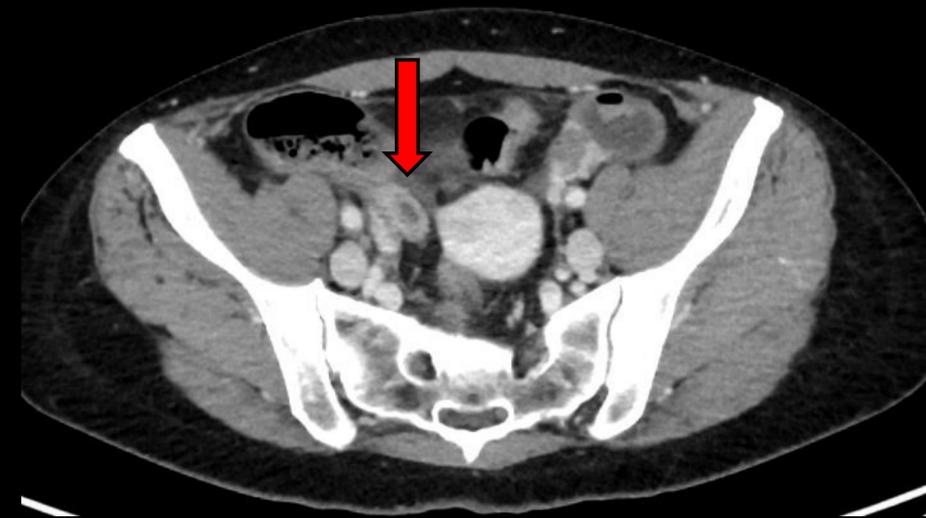
# OS Case 03

## Clinic

- 52 years, female
- Strong pain in the lower parts of the abdomen
- Duration 6-8 h
- CRP neg.
- Leukocytosis

**Appendicitis?**

100% Dose



Low-Dose



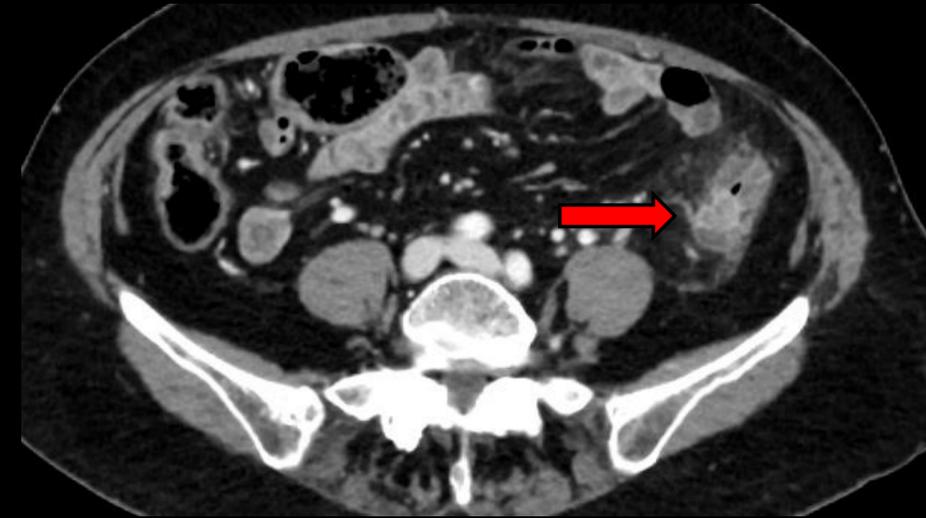
# OS Case 04

## Clinic

- 70 years, female
- History of perforated diverticulitis
- 1 day with abdominal pain in left hemiabdomen. Increasing.
- Fever
- Nausea and vomiting
- Rebound tenderness left lower quadrant

**Diverticulitis?**

100% Dose



Low-Dose



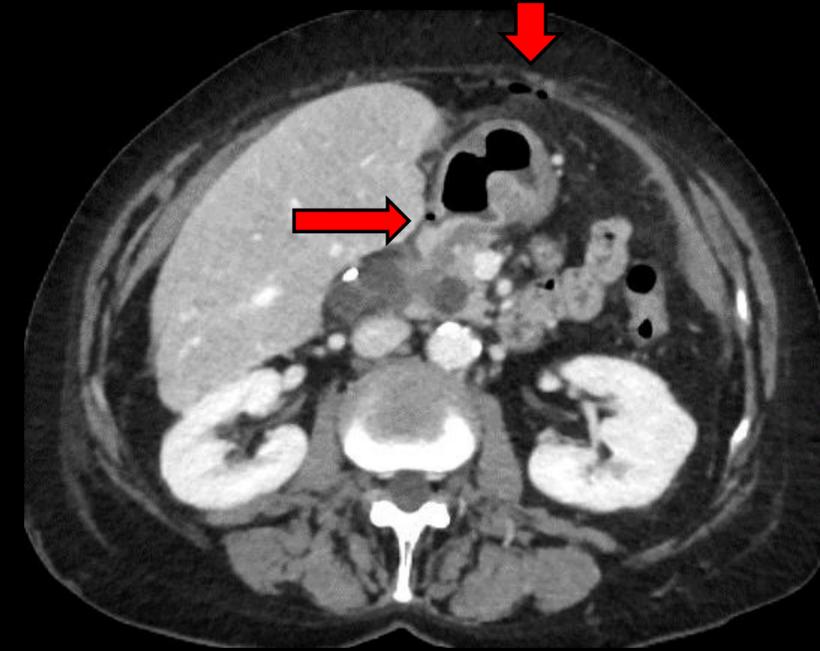
# OS Case 05

## Clinic

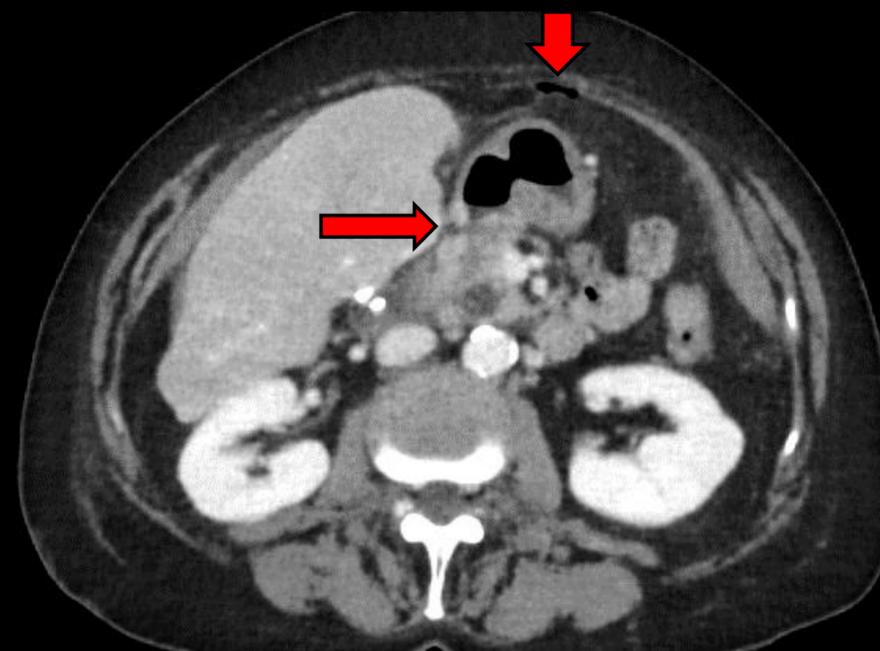
- 67 years, female
- Costa fractures 14 days ago
- High intake of painkillers
- Now increasing abdominal/epigastric pain
- Extremely painful palpation in the epigastric region

**Perforated ulcer?**

100% Dose



Low-Dose



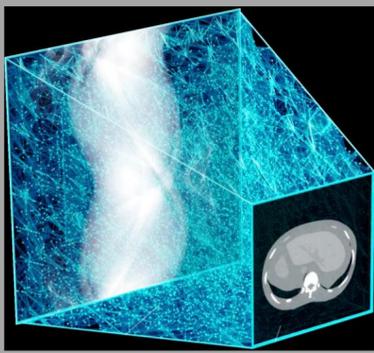
# Future perspectives

## Dual-energy CT in Emergency Imaging

Dual-energy CT



AI - TrueFidelity



Low-dose

Diagnostic Performance?

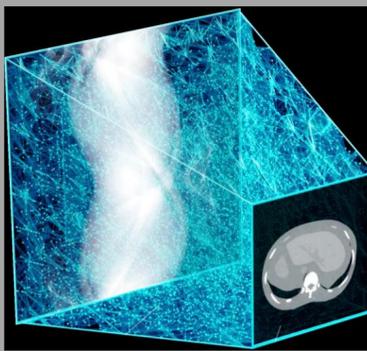
# Future perspectives

## Dual-energy CT in Emergency Imaging

Dual-energy CT



AI - TrueFidelity



Low-dose

Diagnostic Performance?

Emergency Radiology (2023) 30:41–50  
<https://doi.org/10.1007/s10140-022-02099-1>

ORIGINAL ARTICLE



## Toward automated interpretable AAST grading for blunt splenic injury

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Received: 20 September 2022 / Accepted: 4 November 2022 / Published online: 12 November 2022  
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### Abstract

**Background** The American Association for the Surgery of Trauma (AAST) splenic organ injury scale (OIS) is the most frequently used CT-based grading system for blunt splenic trauma. However, reported inter-rater agreement is modest, and an algorithm that objectively automates grading based on transparent and verifiable criteria could serve as a high-trust diagnostic aid.

**Purpose** To pilot the development of an automated interpretable multi-stage deep learning-based system to predict AAST grade from admission trauma CT.

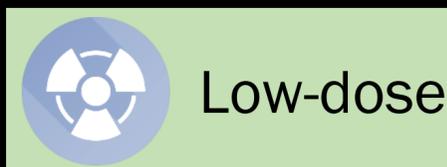
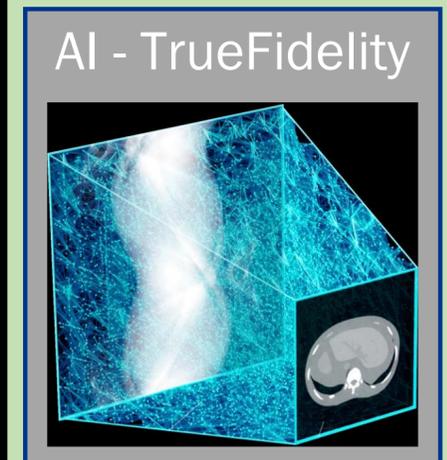
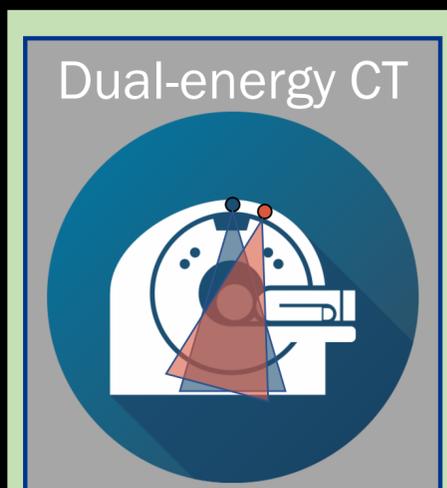
**Methods** Our pipeline includes 4 parts: (1) automated splenic localization, (2) Faster R-CNN-based detection of pseudoaneurysms (PSA) and active bleeds (AB), (3) nnU-Net segmentation and quantification of splenic parenchymal disruption (SPD), and (4) a directed graph that infers AAST grades from detection and segmentation results. Training and validation is performed on a dataset of adult patients (age  $\geq 18$ ) with voxelwise labeling, consensus AAST grading, and hemorrhage-related outcome data ( $n = 174$ ).

**Results** AAST classification agreement (weighted  $\kappa$ ) between automated and consensus AAST grades was substantial (0.79). High-grade (IV and V) injuries were predicted with accuracy, positive predictive value, and negative predictive value of 92%, 95%, and 89%. The area under the curve for predicting hemorrhage control intervention was comparable between expert consensus and automated AAST grading (0.83 vs 0.88). The mean combined inference time for the pipeline was 96.9 s.

**Conclusions** The results of our method were rapid and verifiable, with high agreement between automated and expert consensus grades. Diagnosis of high-grade lesions and prediction of hemorrhage control intervention produced accurate results in adult patients.

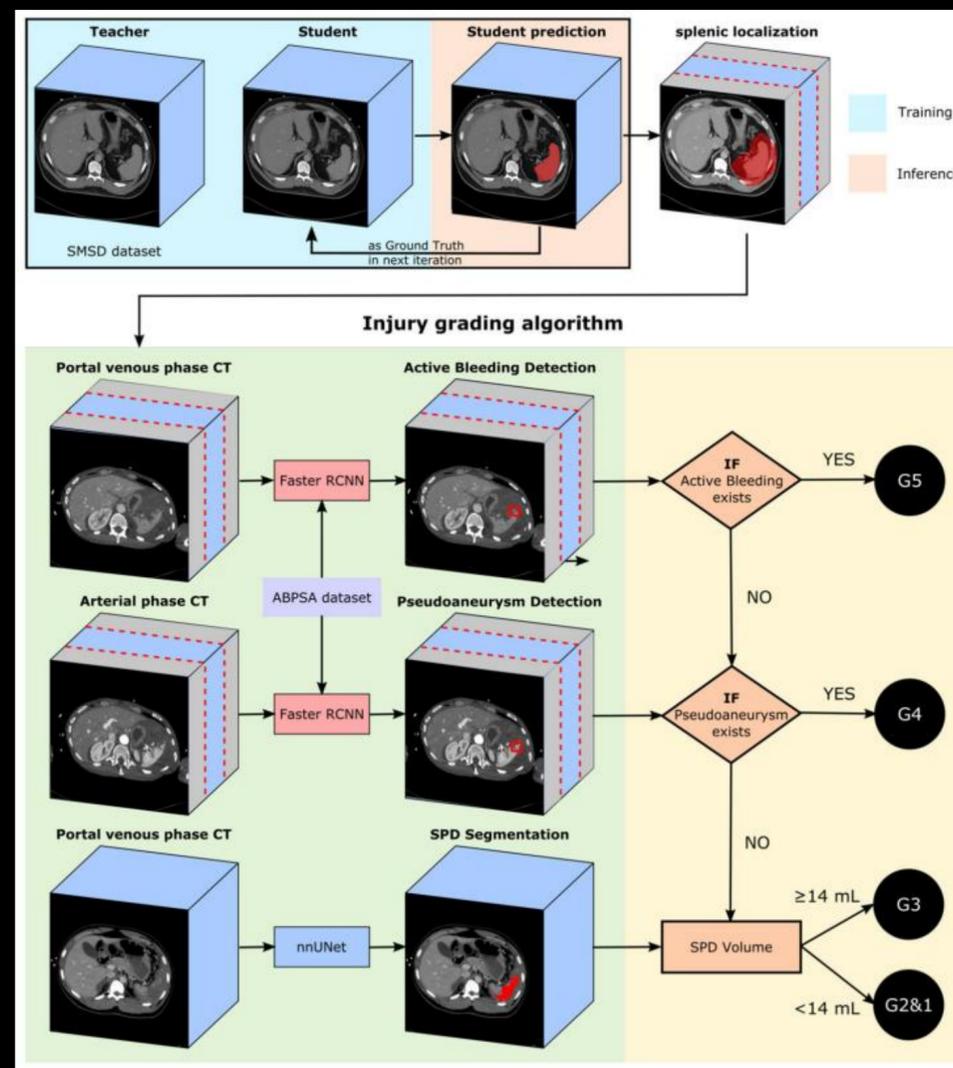
# Future perspectives

## Dual-energy CT in Emergency Imaging



Diagnostic Performance?

## Automated Detection of Abdominal Emergencies



## Photon Counting CT + AI



- Superb Image Quality?
- Ultra Low-Dose?
- Automated Detection?



Created by Midjourney AI

Game Changer? Dawn of a new Era?