

**Advances and Innovations in Endoscopic Oncology and
Multidisciplinary Gastrointestinal Cancer Care**

AI-Augmented Next Gen Diagnostics for Early Detection of Pancreas Cancer

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Disclosures

- Consultant for Bayer Inc., and Canel Therapeutics

This presentation and/or comments will be free of any bias toward or promotion of the above referenced companies or their product(s) and/or other business interests.

This presentation and/or comments will provide a balanced, non-promotional, and evidence-based approach to all diagnostic, therapeutic and/or research related content.

This presentation has been peer-reviewed and no conflicts were noted.

The off-label/investigational use of 68Ga-FAPI-46, 18F-FAPI-74 will be addressed.

Cultural Linguistic Competency (CLC) & Implicit Bias (IB)

STATE LAW:

The California legislature has passed Assembly Bill (AB) 1195, which states that as of July 1, 2006, all Category 1 CME activities that relate to patient care must include a cultural diversity/linguistics component. It has also passed AB 241, which states that as of January 1, 2022, all continuing education courses for a physician and surgeon **must** contain curriculum that includes specified instruction in the understanding of implicit bias in medical treatment.

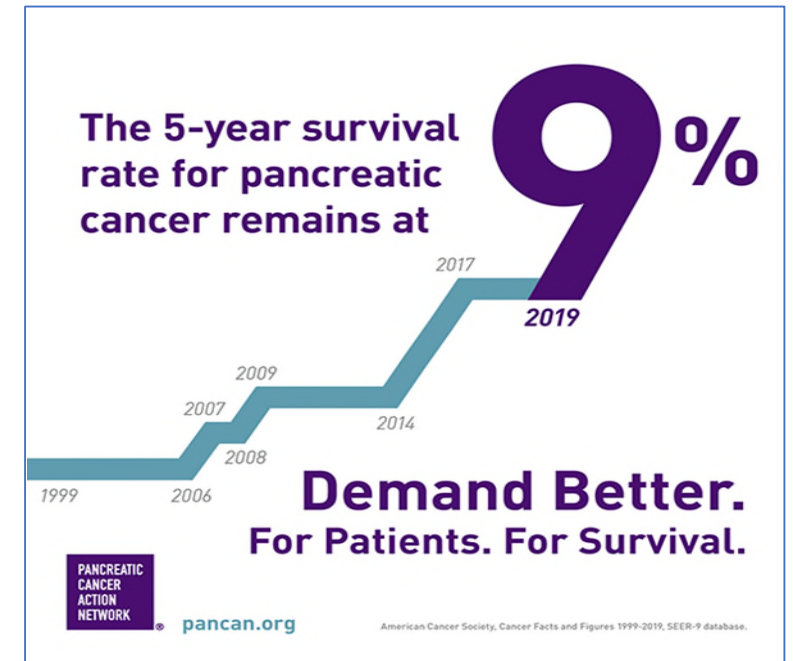
The cultural and linguistic competency (CLC) and implicit bias (IB) definitions reiterate how patients' diverse backgrounds may impact their access to care.

EXEMPTION:

Business and Professions Code 2190.1 exempts activities which are dedicated solely to research or other issues that do not contain a direct patient care component.

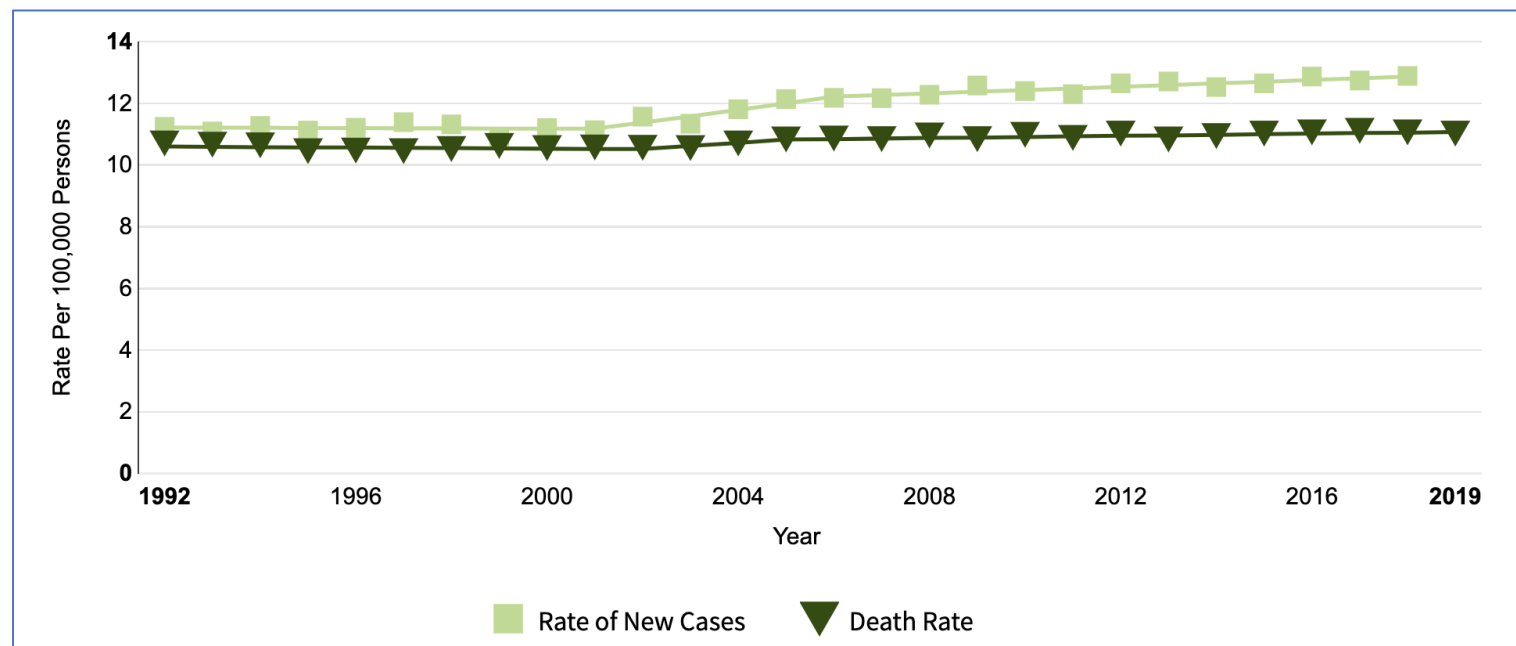
This presentation is dedicated solely to research or other issues that do not contain a direct patient care component.

PDAC has dire prognosis



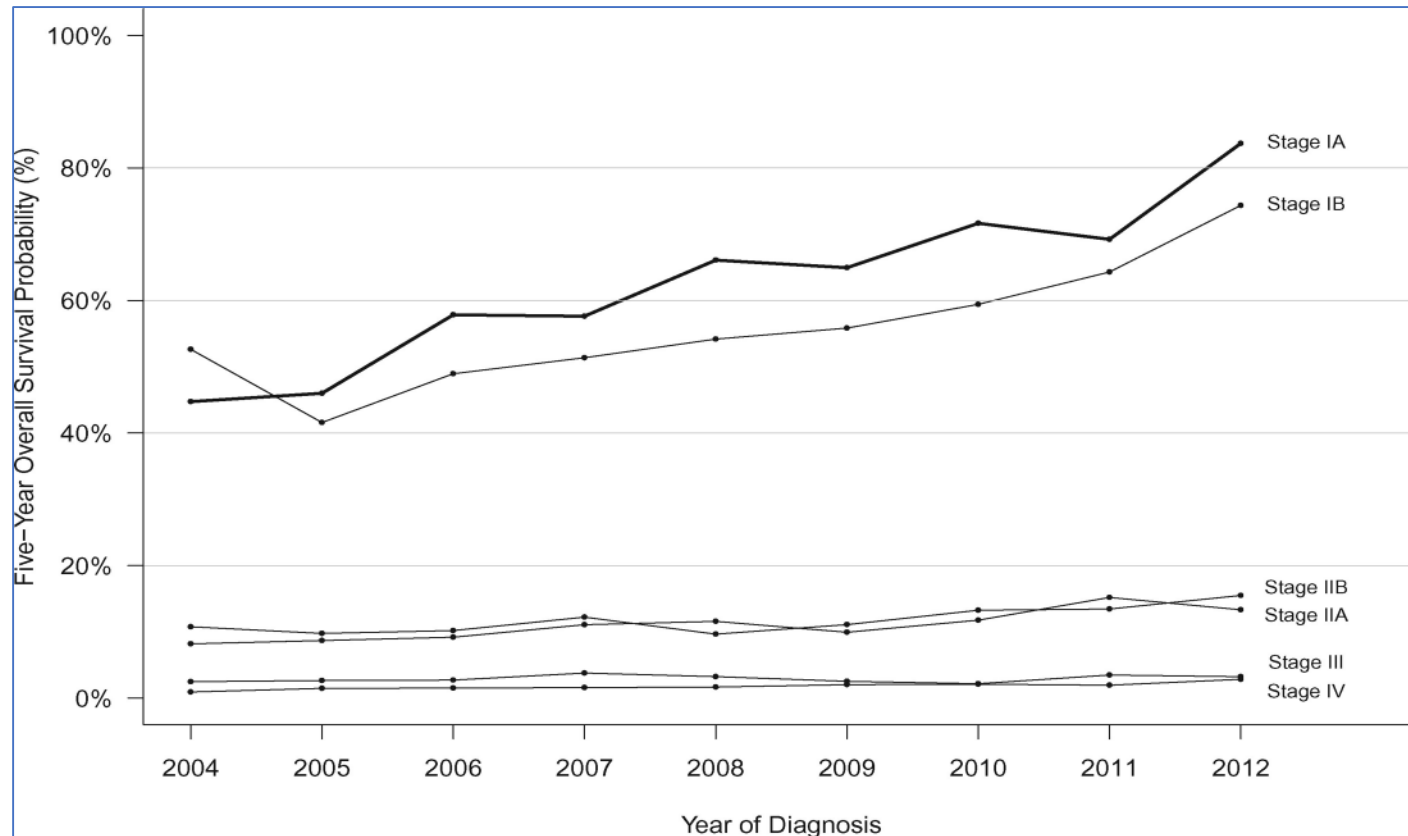
PDAC has dire prognosis

- Top cause of cancer-related deaths
- Almost uniformly fatal:
 - deaths = incidence
- Substantial differences
 - Stage I : 26-months
 - Stage IV: 4-8-months
- Urgent need to improve outcomes



PDAC has dire prognosis

- Top cause of cancer-related deaths
- Almost uniformly fatal:
 - deaths = incidence
- Substantial differences
 - Stage I : 26-months
 - Stage IV: 4-8-months
- Urgent need to improve outcomes



Early Detection: Highest potential to improve outcomes*

Opportunity

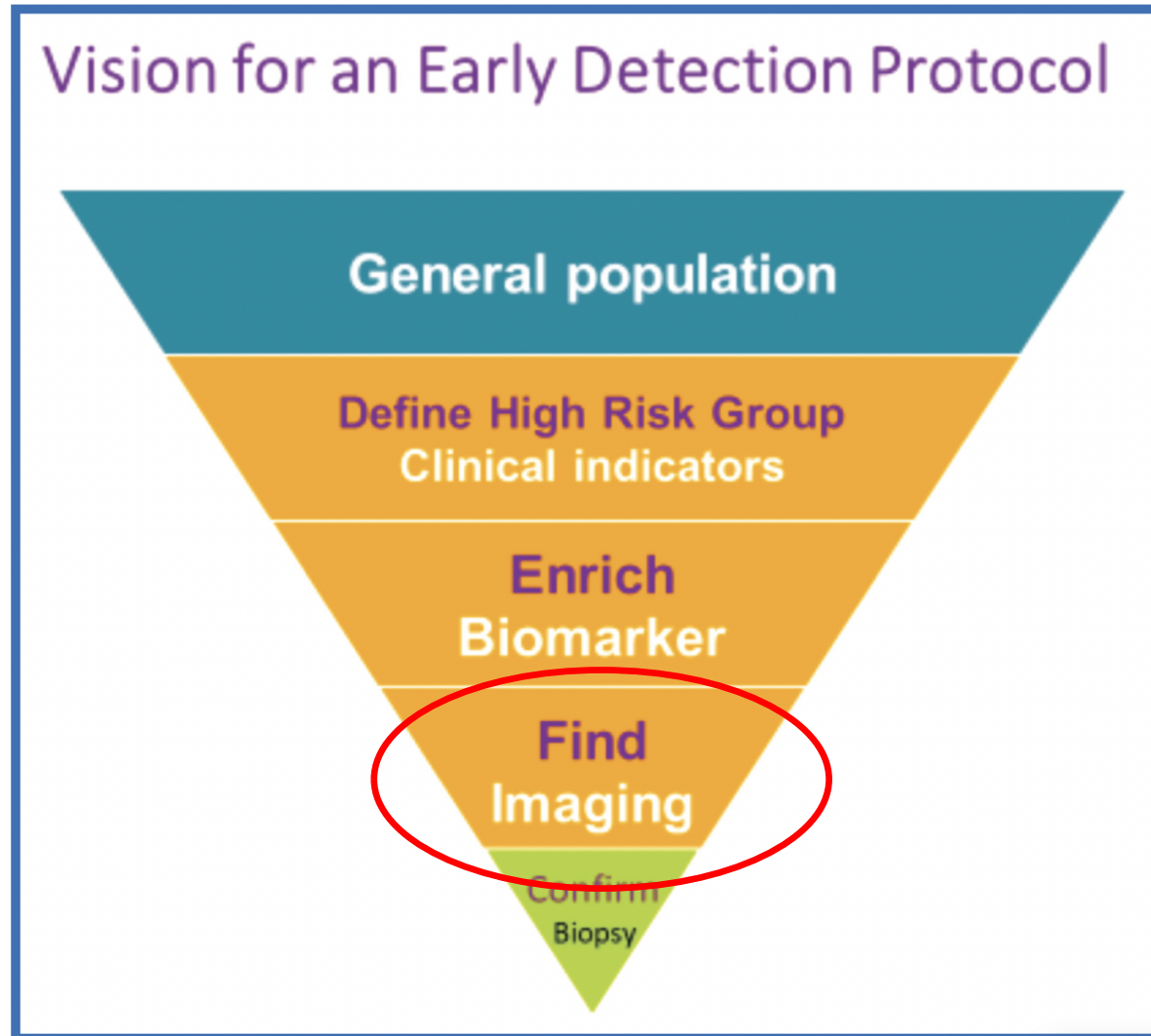
- Survival benefit beyond lead time
- Tumors are smaller in volume & more likely to be resectable
- Increases prospect of surgical resection prior to cancer-induced cachexia

Challenges

- **Nonspecific early symptoms**
- **Rapid progression to death after symptoms: Small window of opportunity**
- **Imaging cannot detect early PDAC**
- **Lower incidence: ~38 per 100,000**

**Goenka AH, Chari ST, et al. Pancreatology. 2020 Oct;20(7):1495-1501*

The D (define) E (enrich) F (find) approach



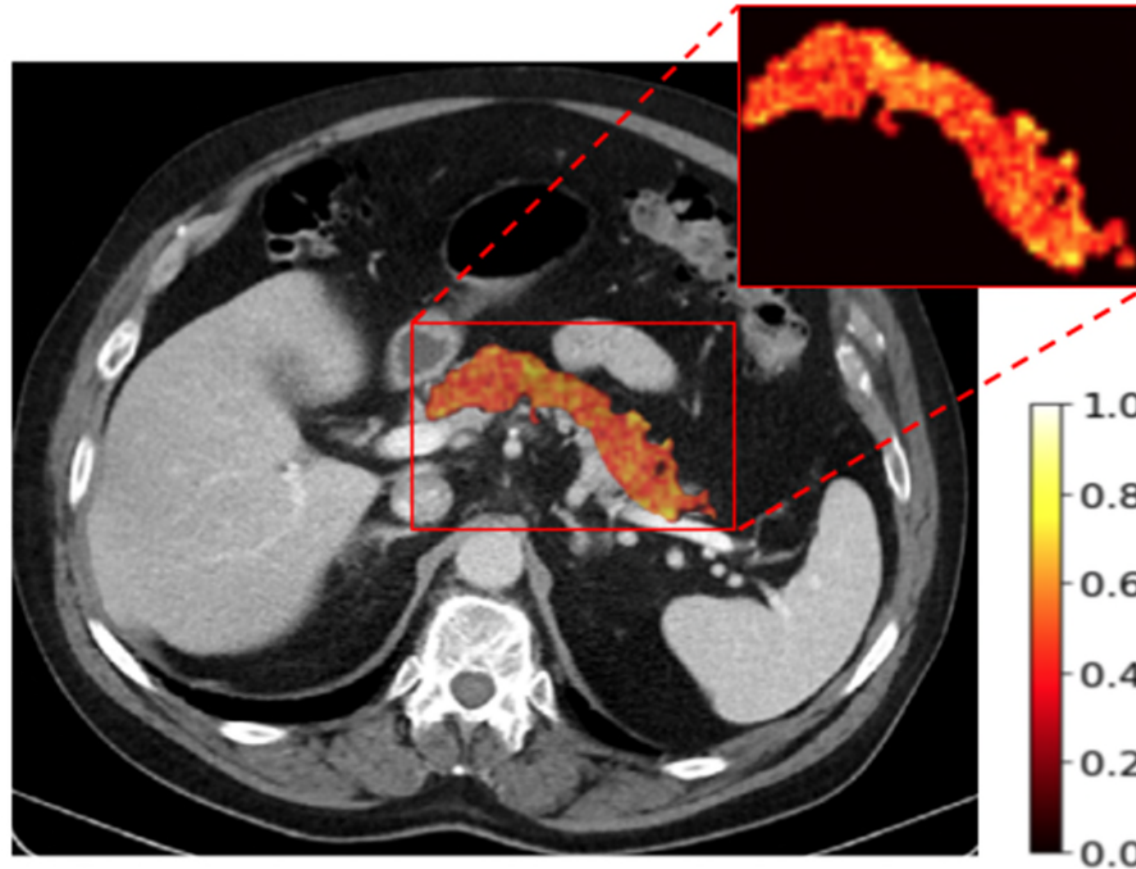
Imaging: The Final Frontier

~40% of PDAC < 2-cm can be missed on imaging

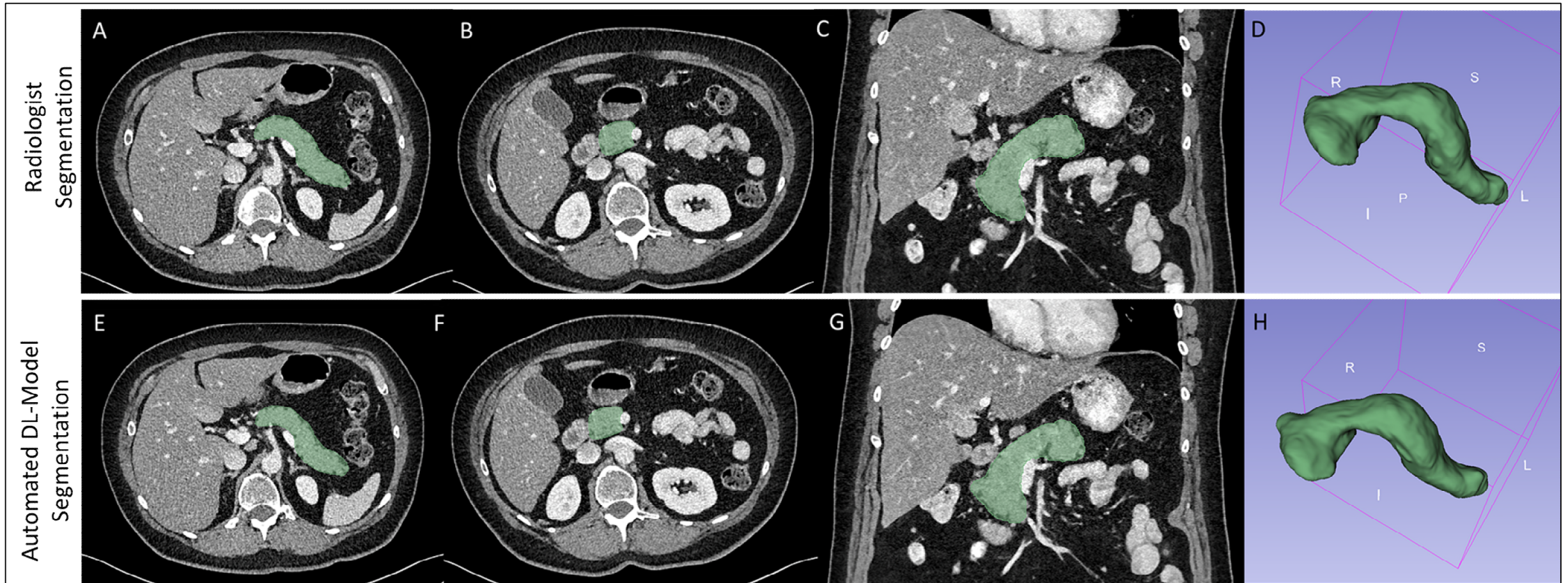
Even in later stages, sensitivity of CT/MR: 76-92%

Critical need to augment our imaging capabilities

Can we use AI to detect Visually Occult Pre-invasive PDAC?



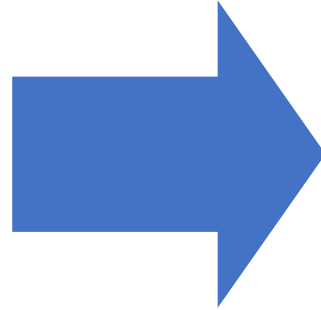
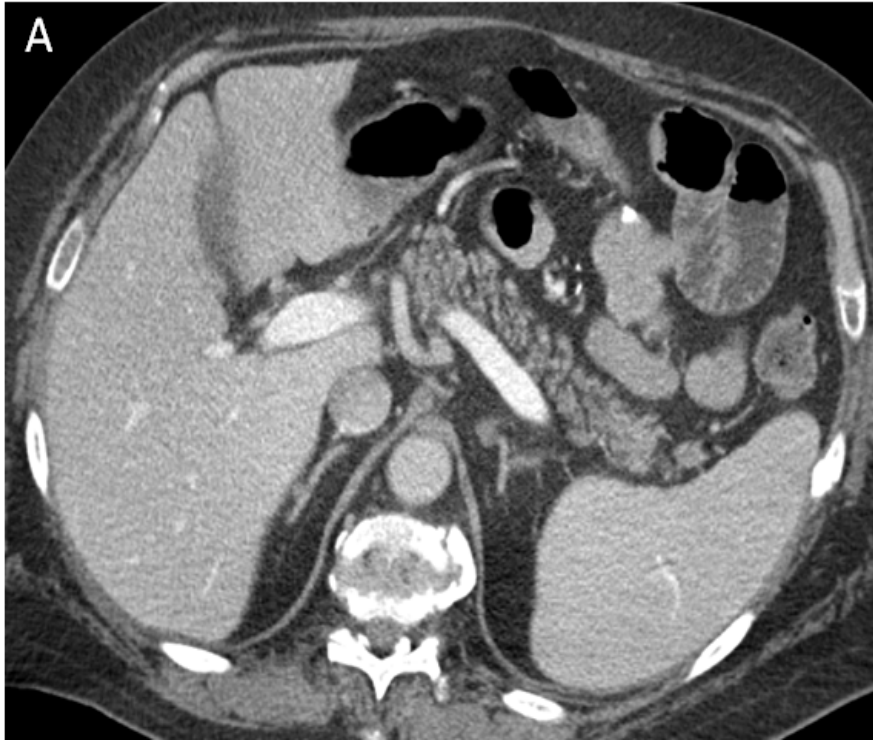
Volumetric Pancreas Segmentation: Fully automated



A Two-Stage AI Model for Fully Automated Volumetric Pancreas Segmentation on CT

Goenka AH, et al. Med Phys. 2021 May;48(5):2468-2481

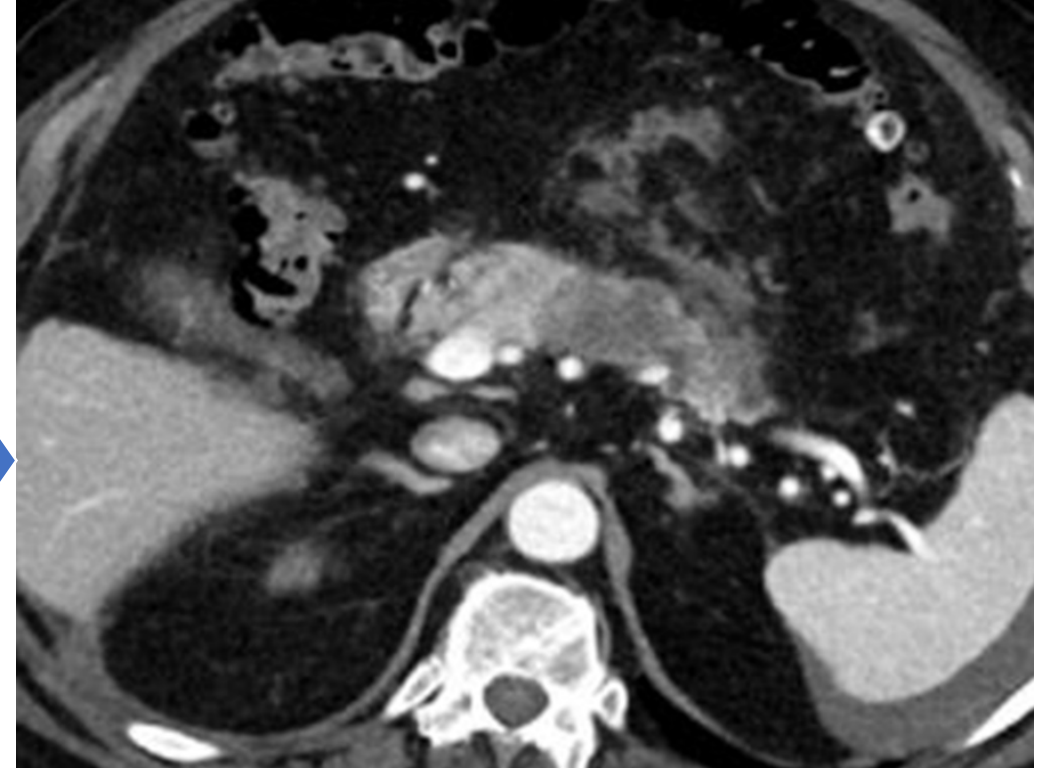
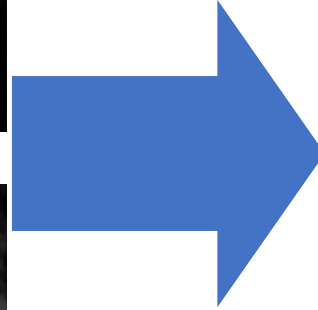
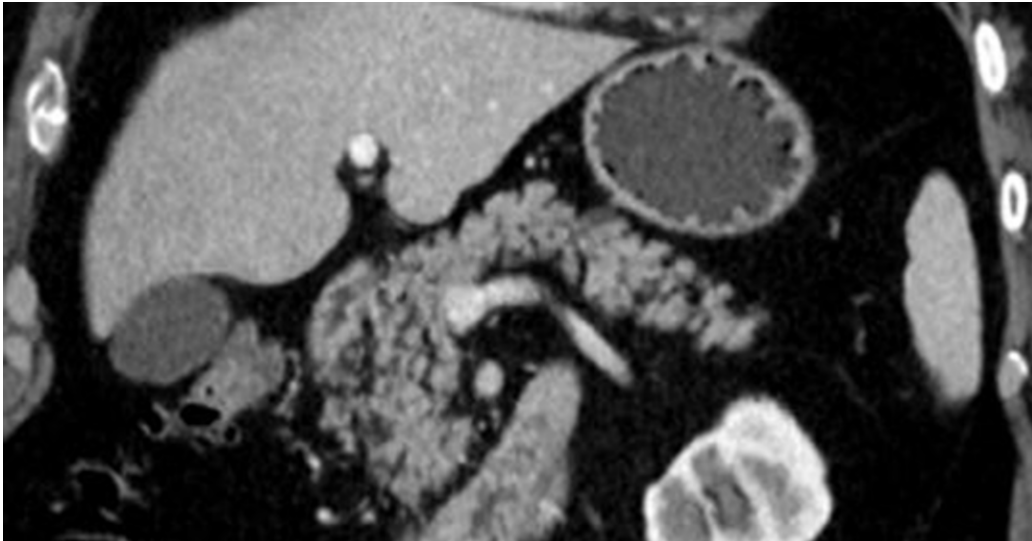
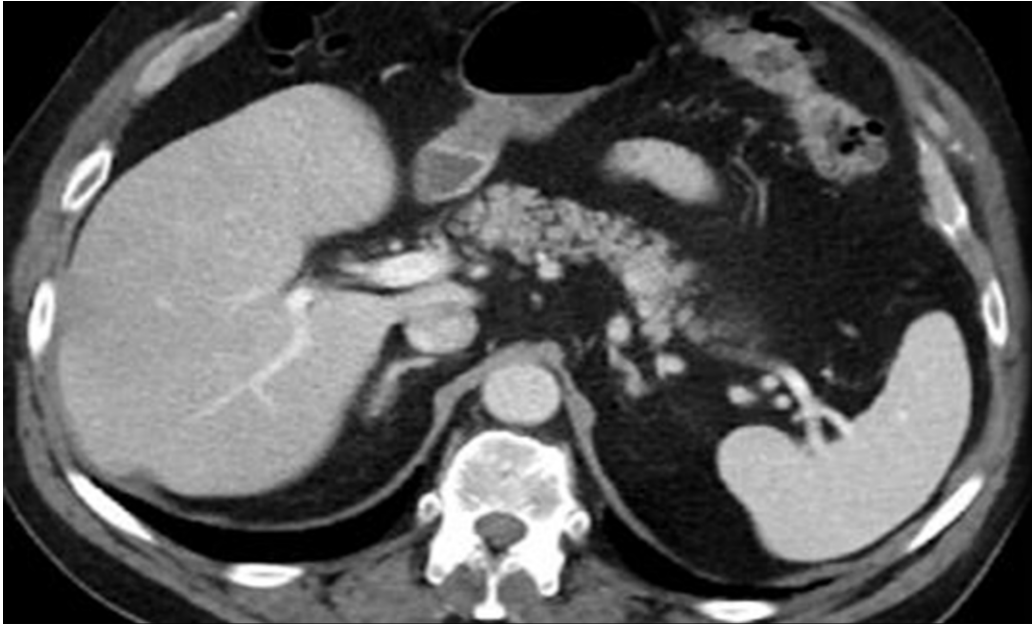
Pre-Invasive PDAC: Visually Occult at 3-to-36-months prior to clinical diagnosis*



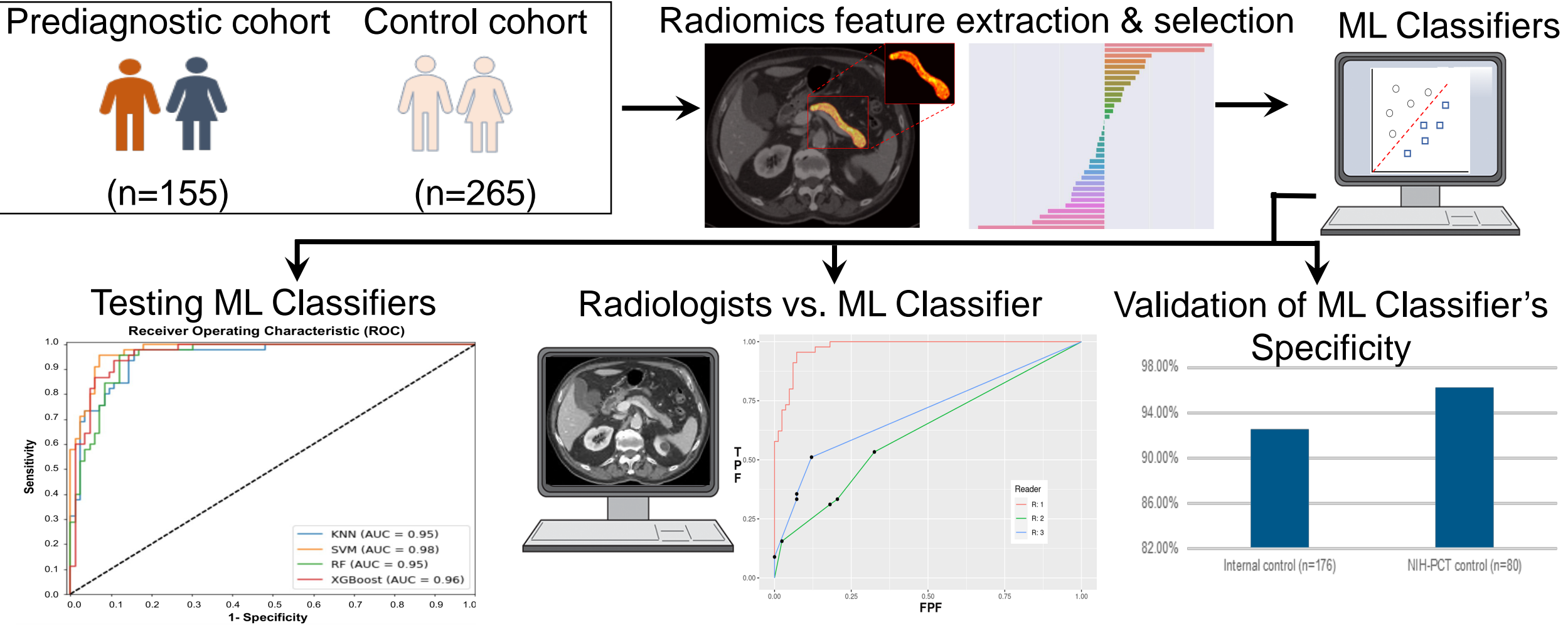
Pancreas tends to be normal on pre-diagnostic CTs

* Chari ST, et al. *Pancreatology*. 2020 Oct;20(7):1495-1501; Goenka AH et al. *Med Phys*. 2021 May;48(5):2468-2481

Subclinical changes can be detected with radiomics

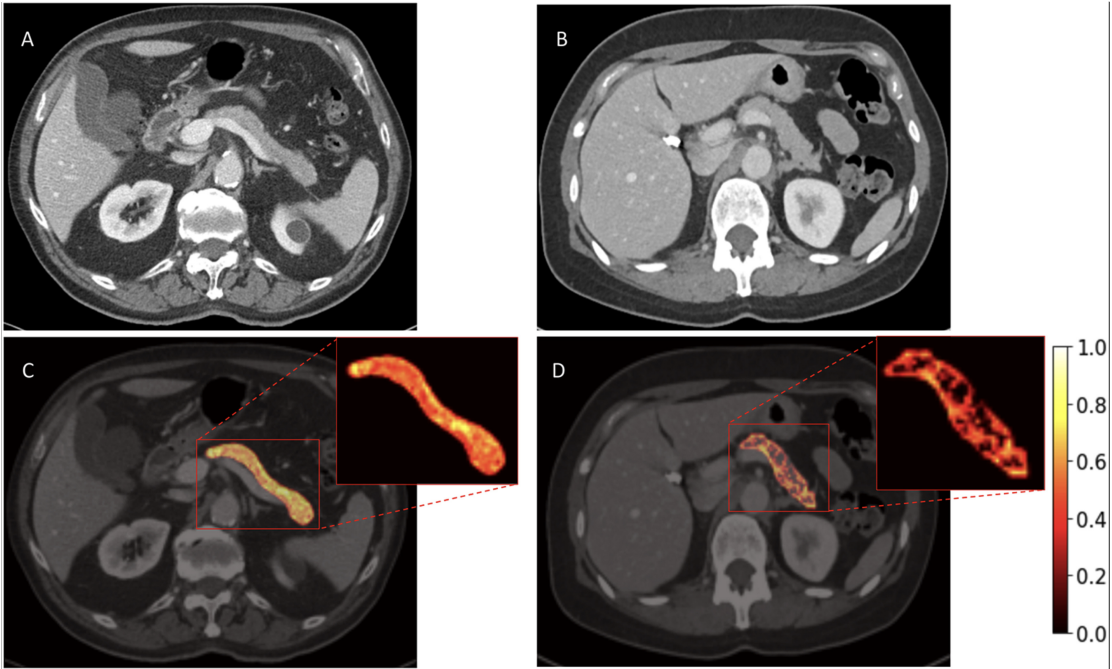
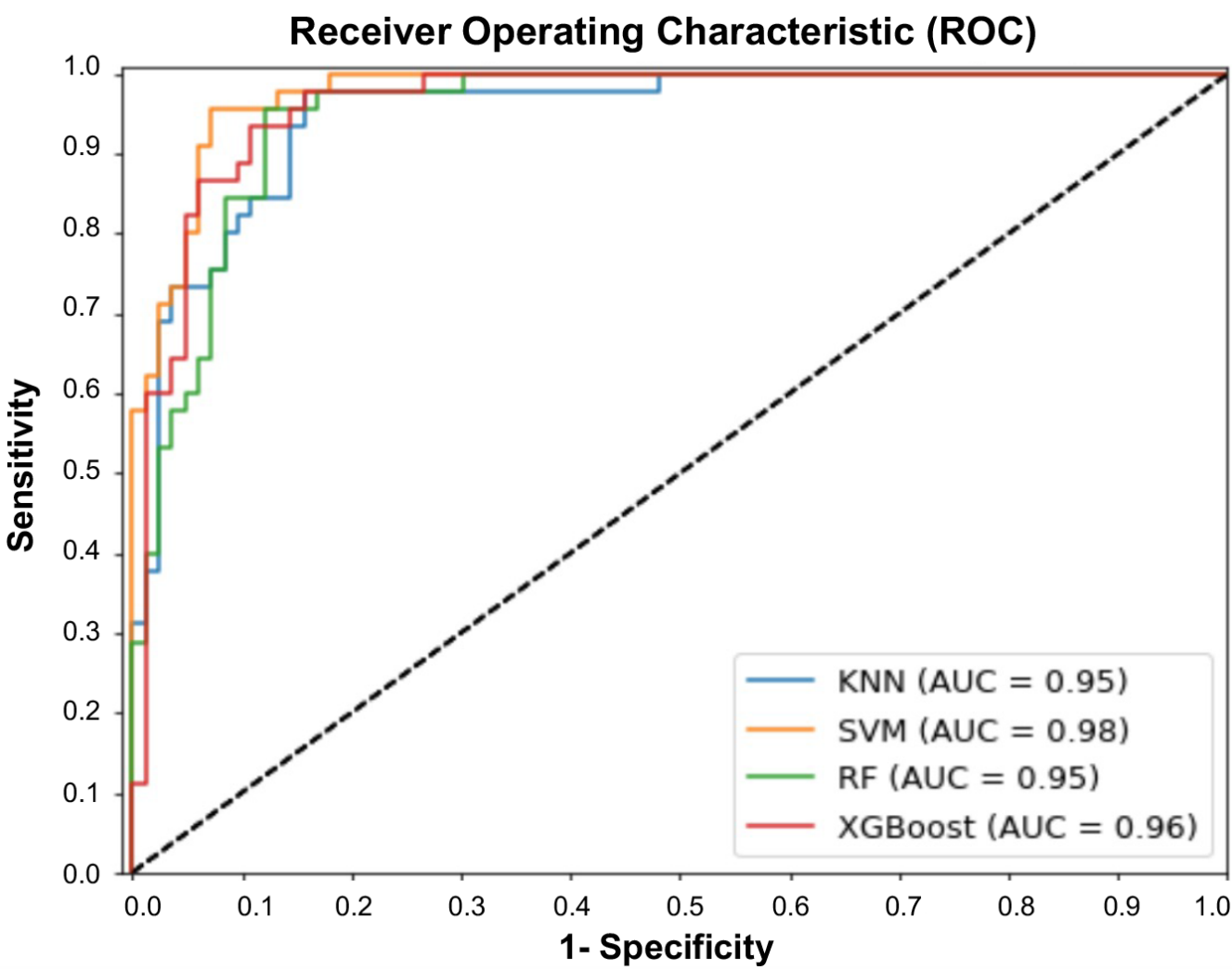


Radiomics-based Machine-learning Models Can Detect Pancreatic Cancer on Prediagnostic CT at a Substantial Lead Time Before Clinical Diagnosis

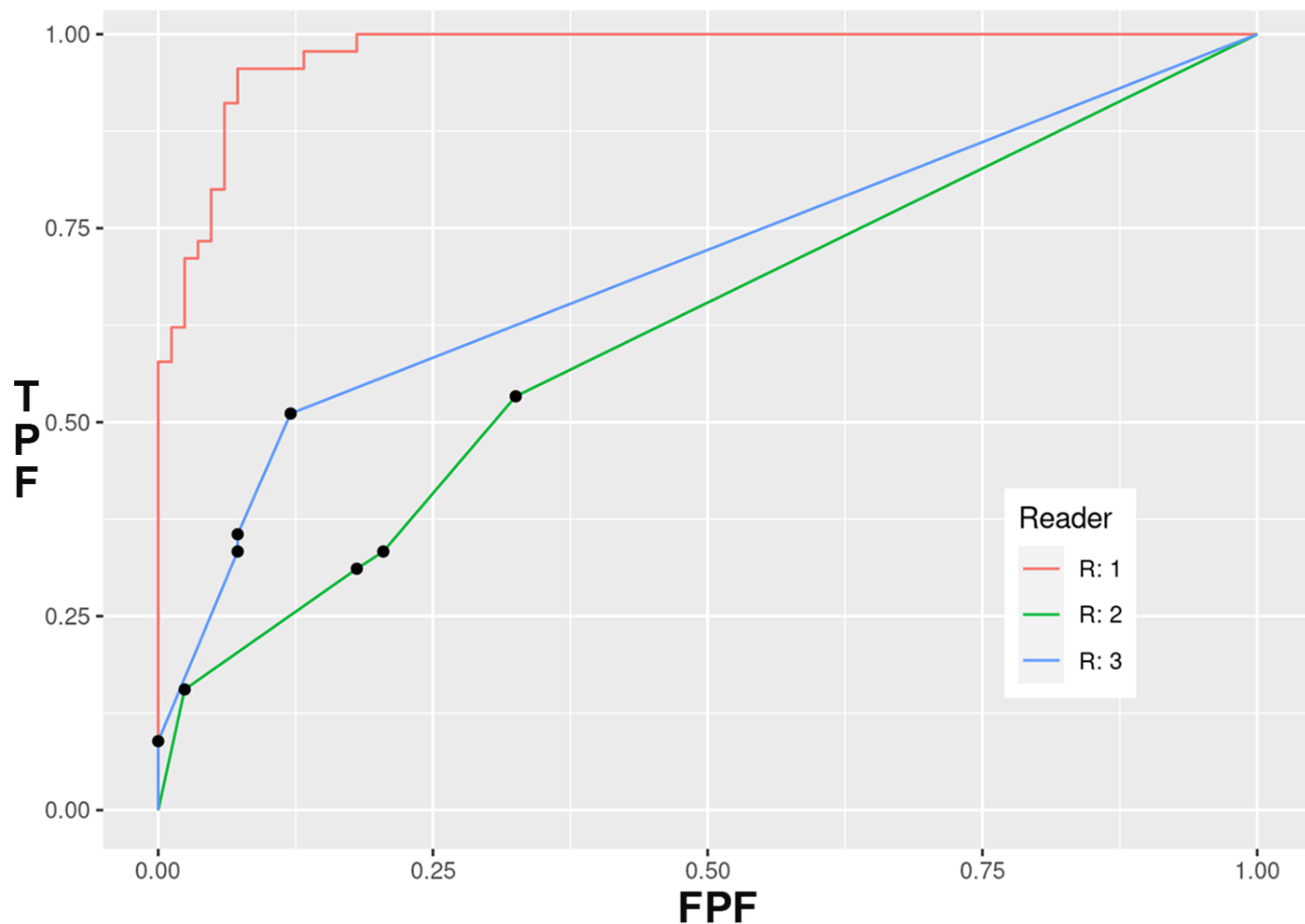


*Goenka AH, et al. *Gastroenterology*. 2022 Nov;163(5):1435-1446.e3.

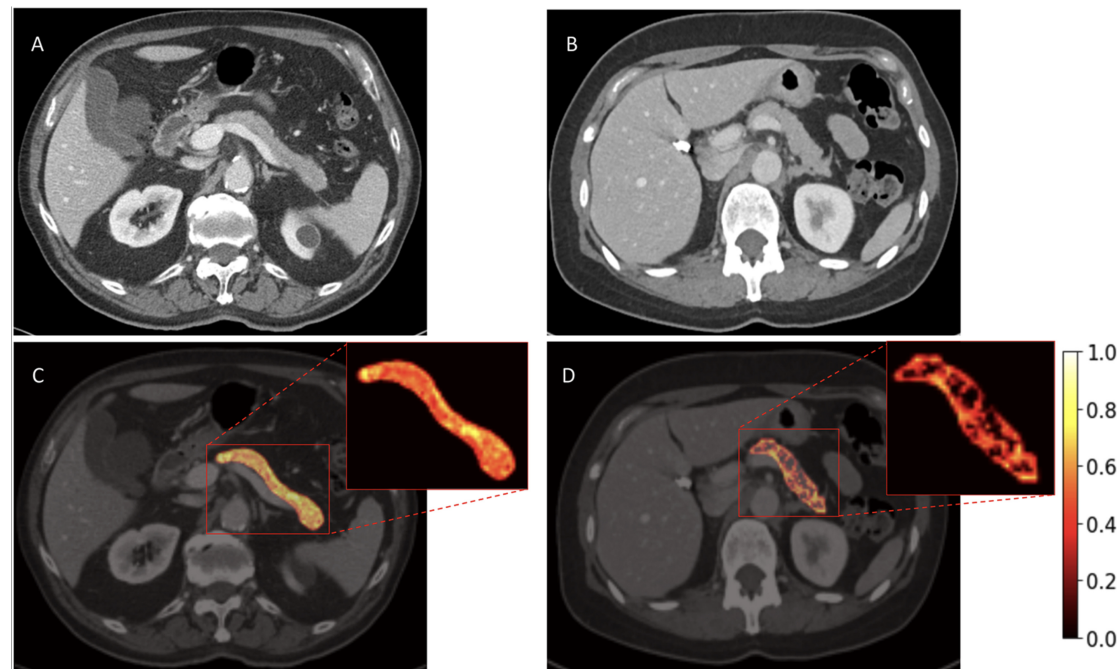
Detection at a substantial lead time [386 (97-1092) days] prior to clinical diagnosis



Support Vector Machine (R1) outperformed Radiologists (R2 & R3)



Which one is pre-diagnostic CT?

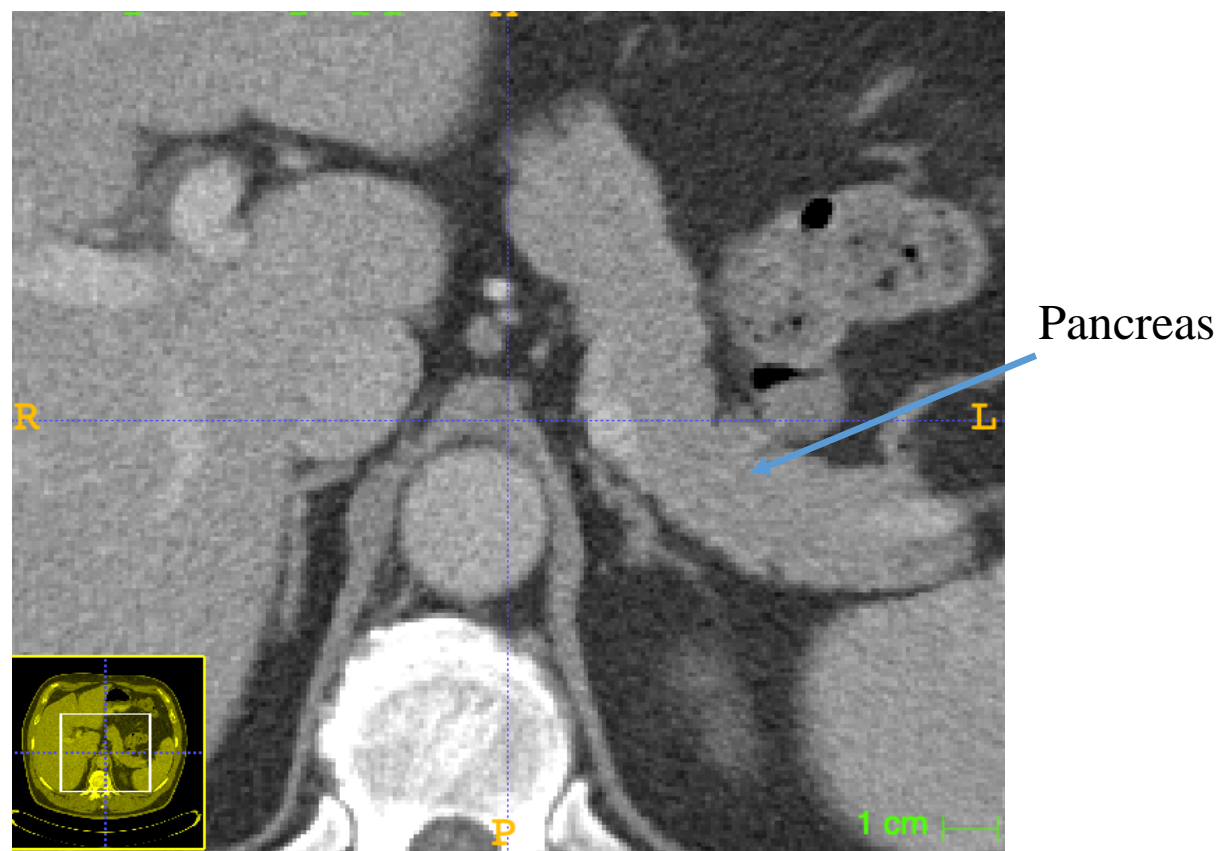


Robustness to common variations*

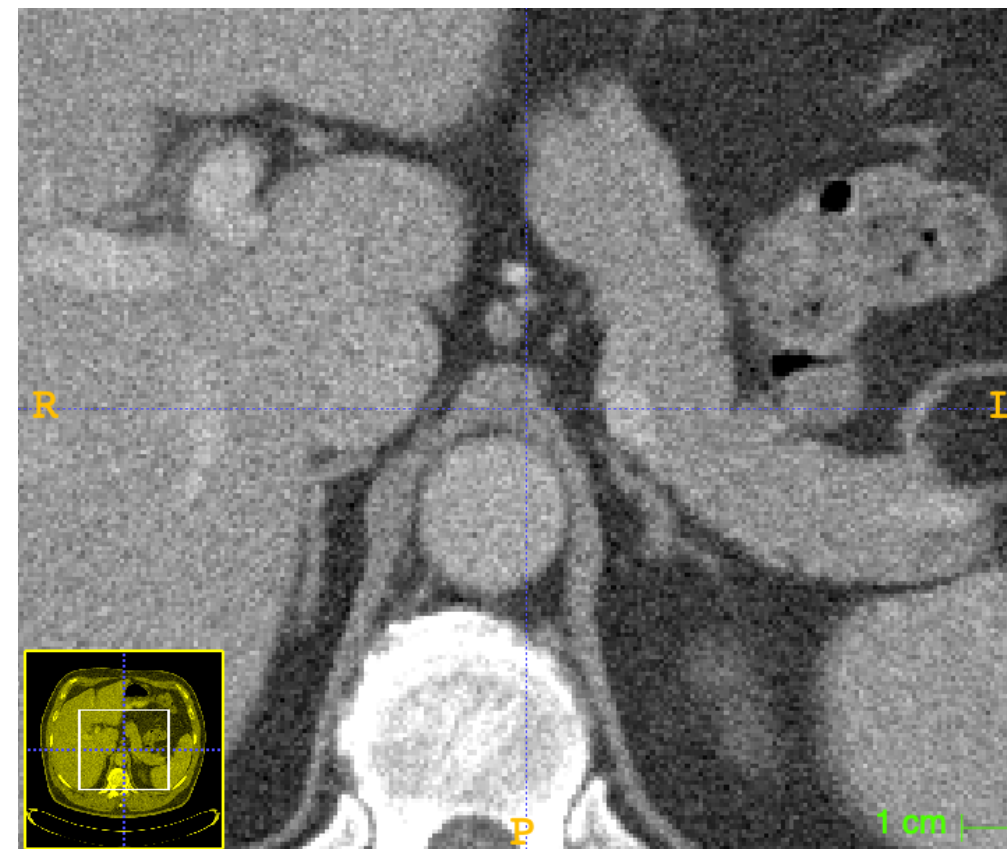
- To further assess clinical translation potential, evaluate model's robustness through image perturbations
 - Noise
 - Segmentation variability
 - Image rotation
 - Image pre-processing parameters
 - Bin-width
 - Voxel resampling

*Goenka AH, et al. *Abdominal Radiology* (accepted, in press)

Noise



Original



Noisy

Image Rotation: Variability in patient positioning



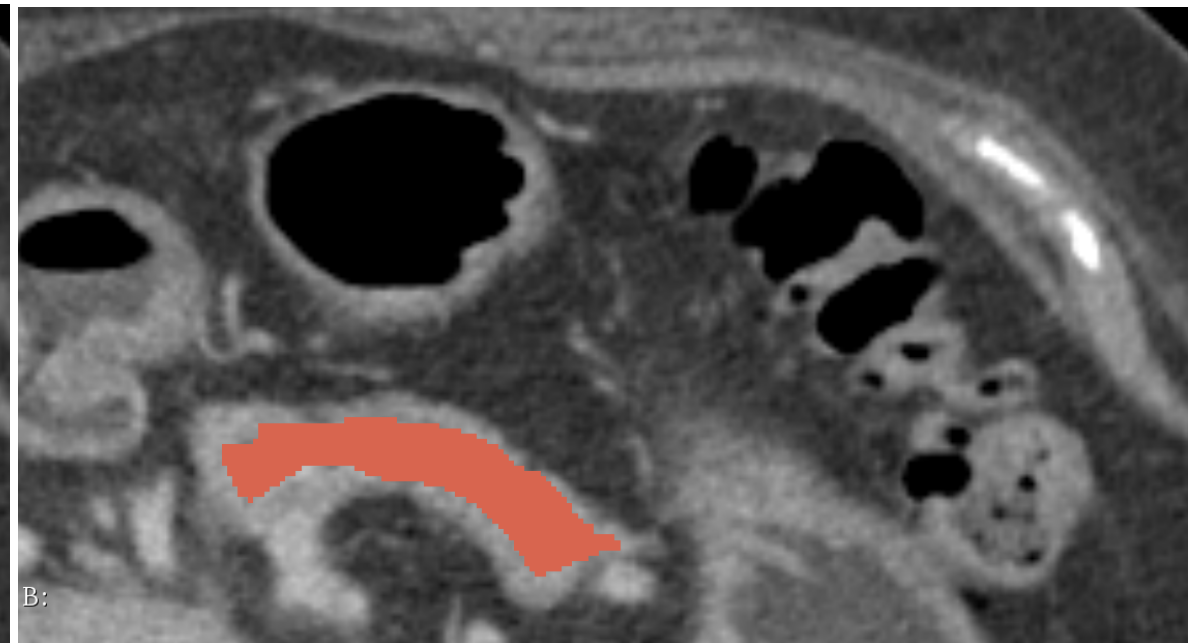
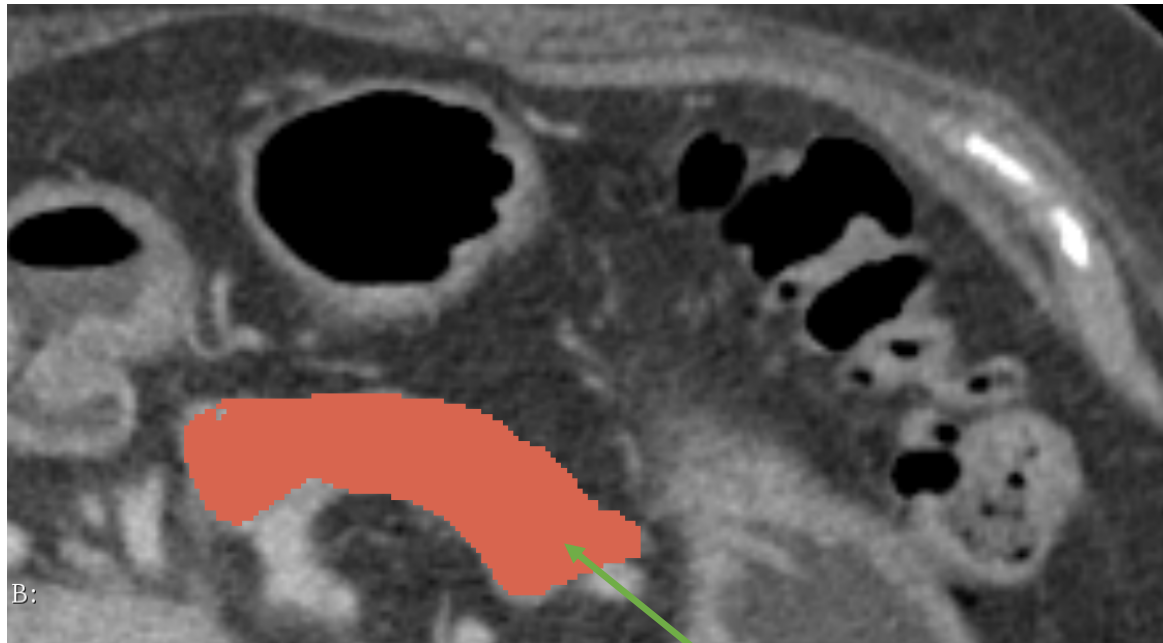
Original

Pancreas
segmentation

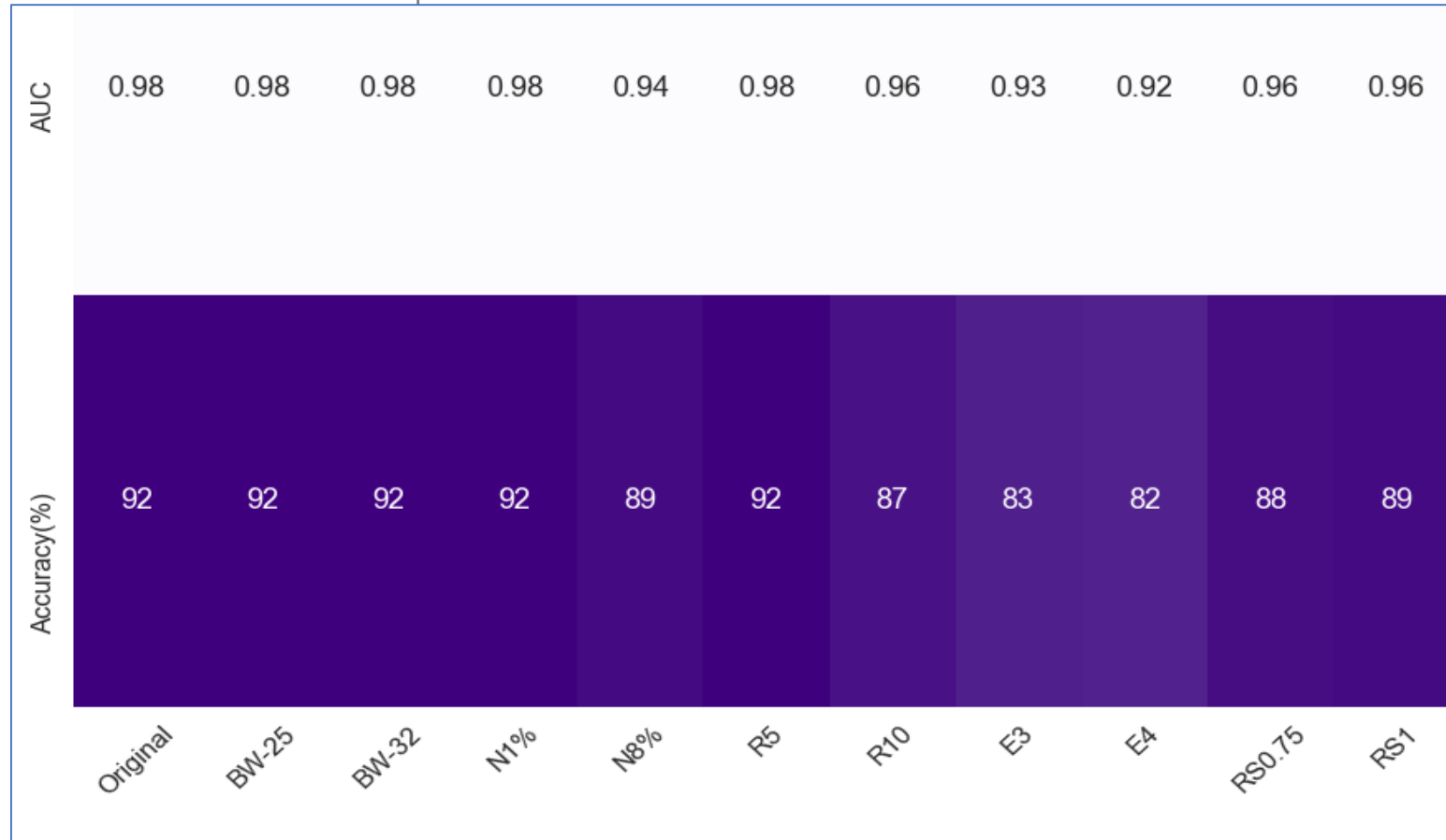


Rotation by 10°

Segmentation variability: Erosion & Dilatation



SVM model's performance



BW: Bin-width
N: Noise
R: Rotation
E: Erosion
RS: Voxel resampling

SVM model is robust to common image variations, likely due to the well-curated, diverse training dataset.



CT radiomics, AI can yield early detection of pancreatic cancer

By Erik L. Ridley, AuntMinnie.com staff writer



> [AJR Am J Roentgenol](#). 2022 Oct 5. doi: 10.2214/AJR.22.28582. Online ahead of print.

Beyond the *AJR*: CT Radiomic Features of the Pancreas Predict Development of Pancreatic Cancer

[Michael H Rosenthal](#) ^{1 2 3}, [Khoschy Schawkat](#) ^{2 3}

EDITORIALS | ARTICLES IN PRESS

A Growing Hope for Earlier Detection of Pancreatic Cancer

[Michael Rosenthal](#)   • [Khoschy Schawkat](#) • [Brian Wolpin](#)

Published: August 09, 2022 • DOI: <https://doi.org/10.1053/j.gastro.2022.07.080>

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By Deborah Borfitz



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By Joe Dangor

AI applied to prediagnostic CTs may help diagnose pancreatic cancer at earlier, more treatable stage

July 14, 2022

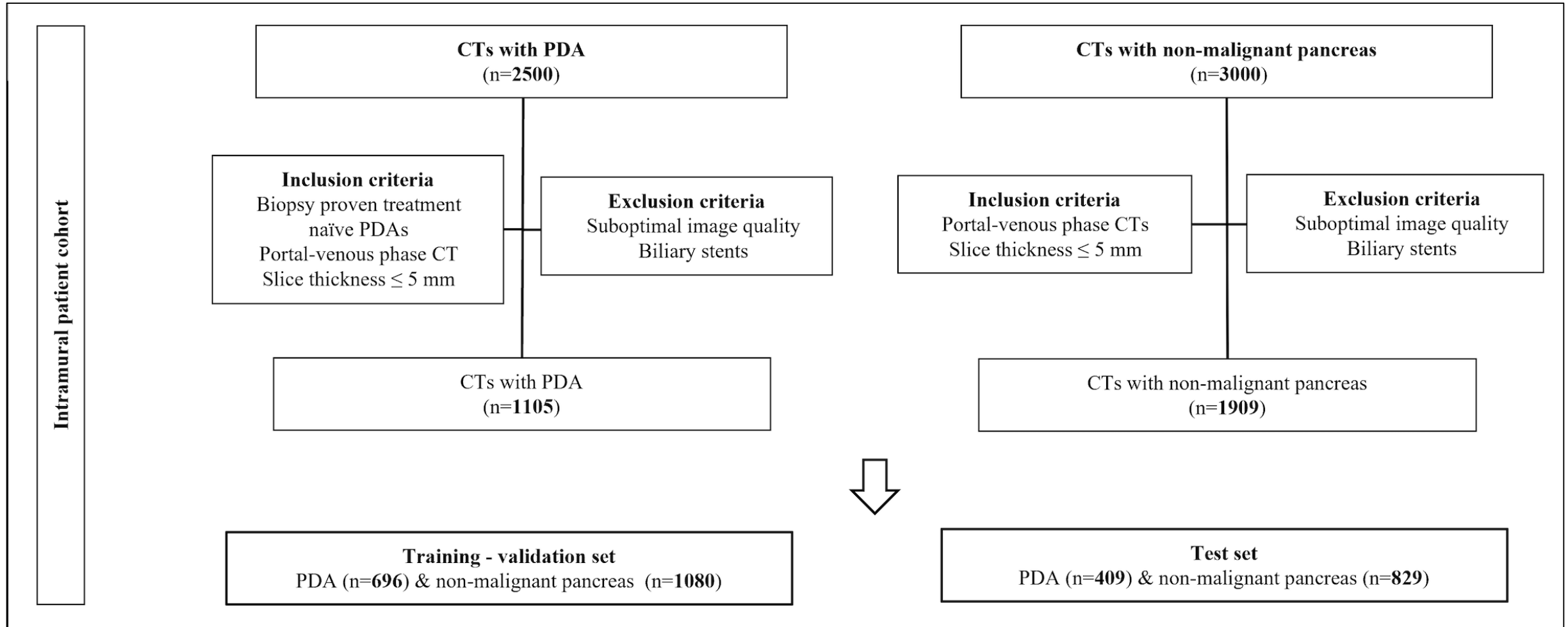
Pre-diagnostic datasets are scarce; Radiomics is not automated

➤ [Gastroenterology](#). 2023 Aug 30;S0016-5085(23)04958-2. doi: 10.1053/j.gastro.2023.08.034.
Online ahead of print.

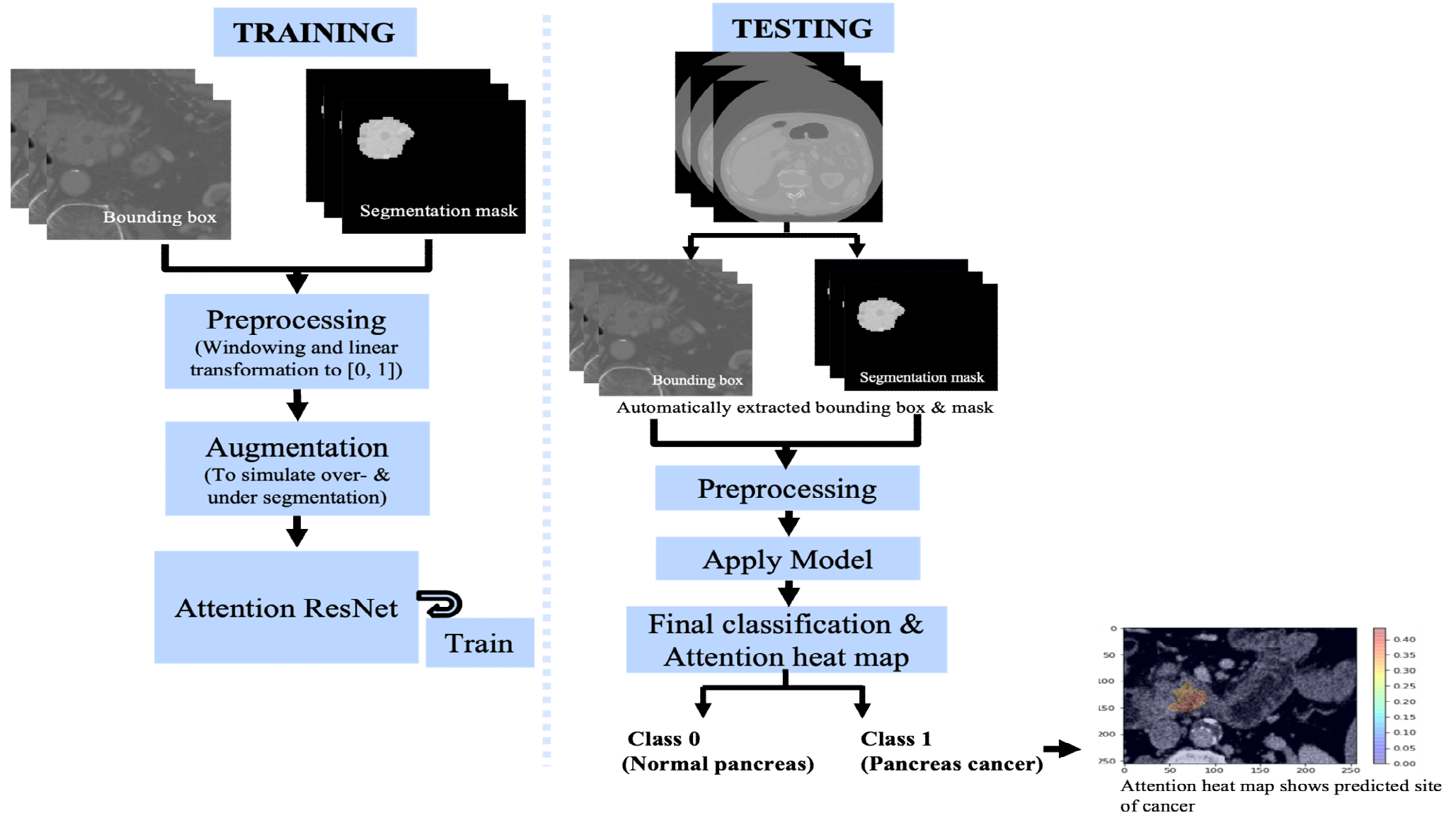
Automated Artificial Intelligence Model Trained on a Large Dataset Can Detect Pancreas Cancer on Diagnostic CTs as well as Visually Occult Pre-invasive Cancer on Pre-diagnostic CTs

Panagiotis Korfiatis¹, Garima Suman¹, Nandakumar G Patnam¹, Kamaxi H Trivedi¹,
Aashna Karbhari¹, Sovanlal Mukherjee¹, Cole Cook², Jason R Klug², Anurima Patra³,
Hala Khasawneh¹, Naveen Rajamohan¹, Joel G Fletcher¹, Mark J Truty⁴, Shounak Majumder⁵,
Candice W Bolan⁶, Kumar Sandrasegaran⁷, Suresh T Chari⁵, Ajit H Goenka⁸

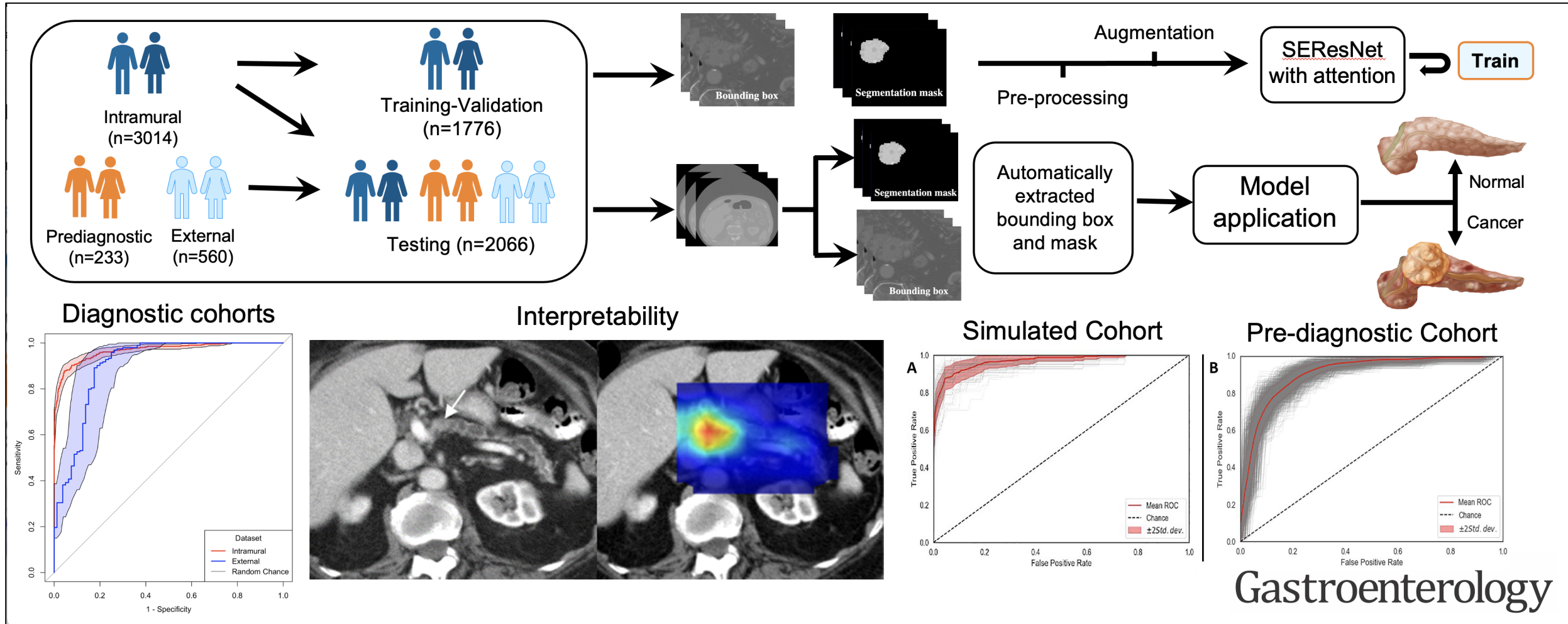
Largest & most diverse dataset ever reported in literature



Fully Automated Model: Requires no manual segmentations



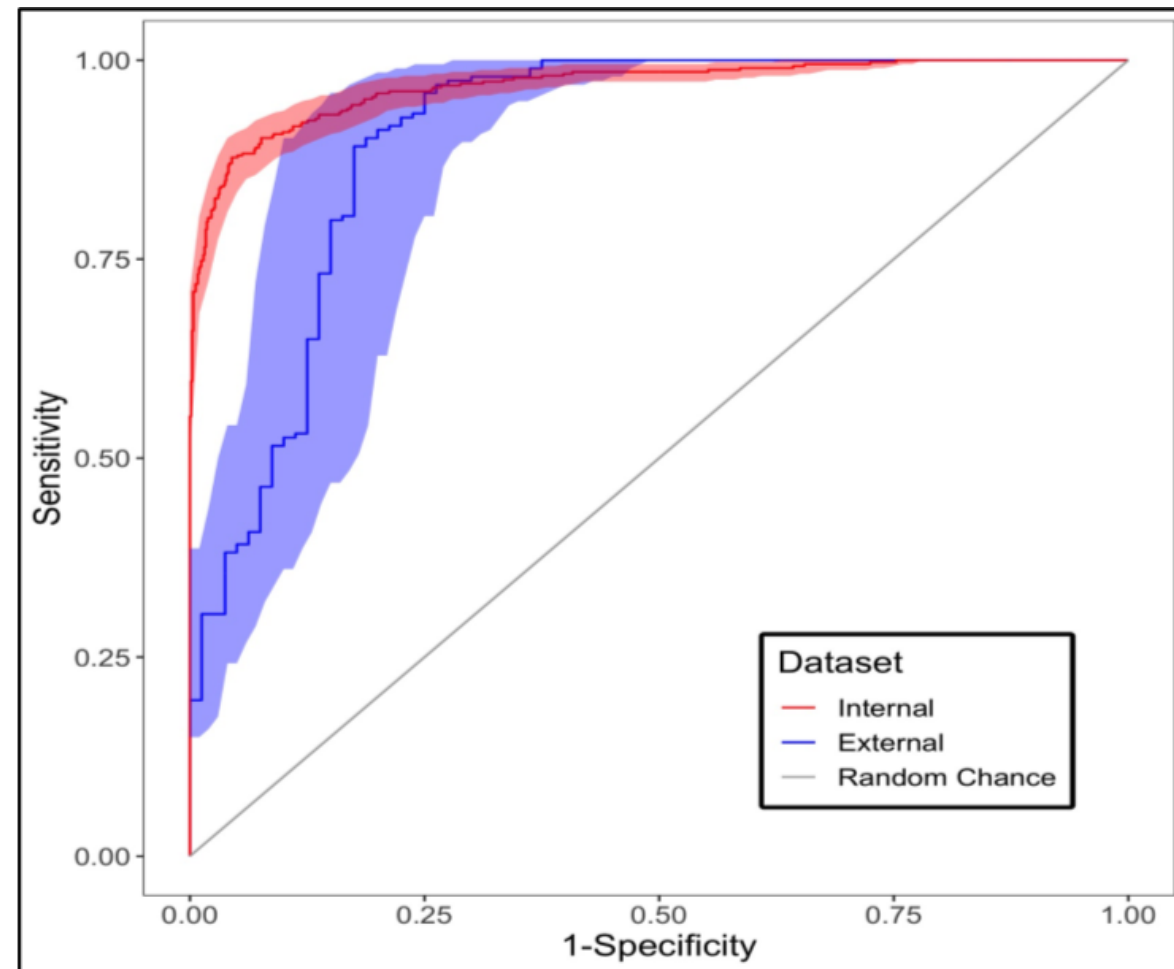
Evaluation on both diagnostic & pre-diagnostic CTs



Majority (~70%) CTs from other institutions

Intramural vs. Multi-Institutional Dataset

- Correctly classified 236/274 CTs
 - 170/194 PDA CTs
 - 66/ 80 control CTs
- **Accuracy: 0.86** (0.82-0.90)
- **AUROC: 0.90** (0.86-0.95)
- **Sensitivity: 0.88** (0.83-0.92)
- **Specificity: 0.83** (0.74-0.90)



Generalizable performance

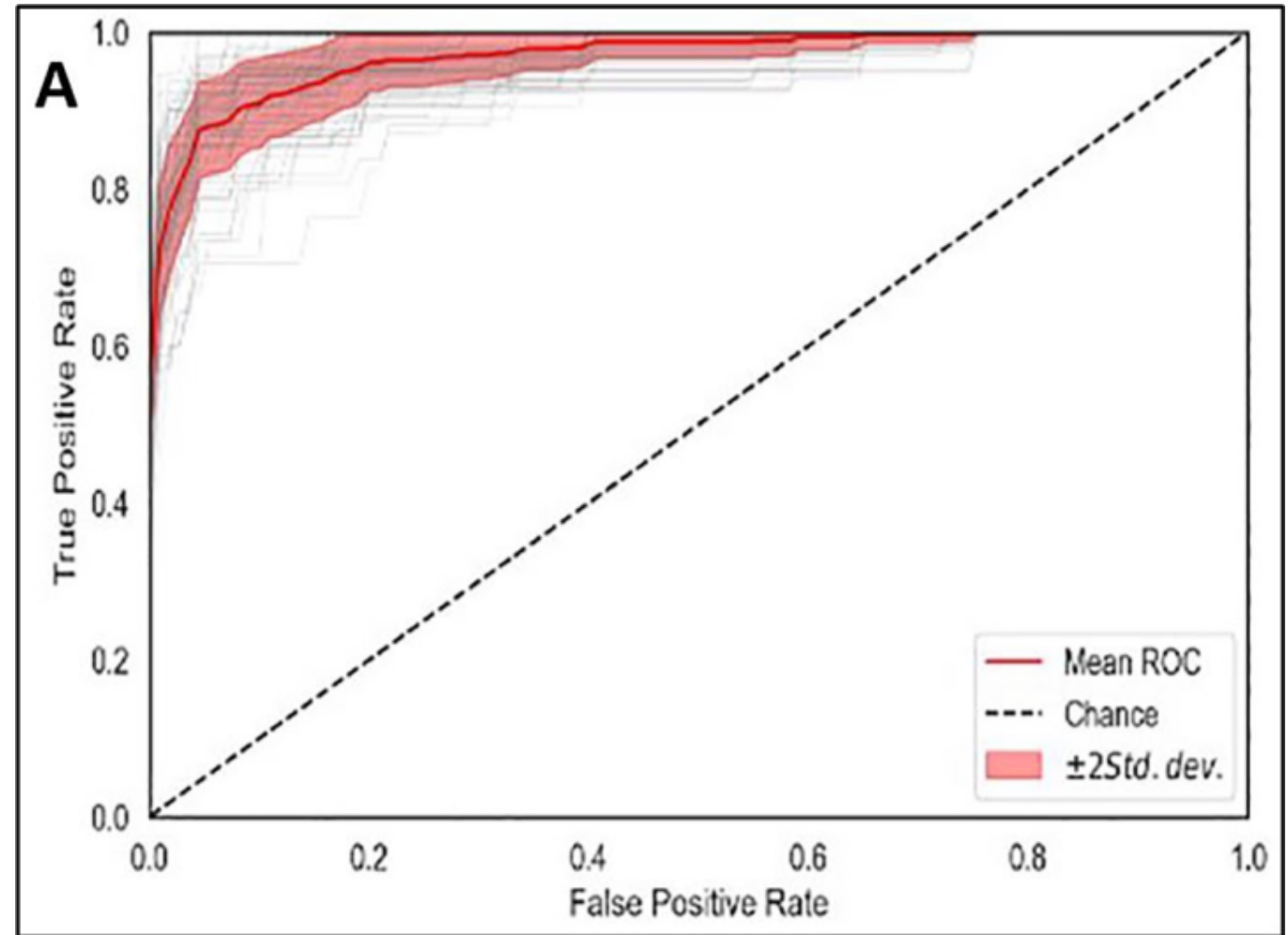
Stage-wise (Intramural & Public datasets)

	Internal test subset (409 CTs with PDA & 829 control CTs)		Metric	Public dataset (194 CTs with PDA & 80 control CTs)		Metric
Tumor stage	Total CTs with PDA (n=409)	Misclassified CTs with PDA (n=49)	Sensitivity (95% CI)	Total CTs with PDA (n=194)	Misclassified CTs with PDA (n=24)	Sensitivity (95% CI)
1	35 (9%)	7 (14%)	0.80 (0.66-0.91)	25 (13%)	6 (25%)	0.76 (0.60-0.92)
2	291 (71%)	39 (80%)	0.87 (0.82-0.90)	113 (58%)	15 (63%)	0.87 (0.81-0.93)
3	60 (15%)	3 (<0.1%)	0.95 (0.88-1)	30 (15%)	2 (8%)	0.93 (0.83-1.00)
4	23 (6%)	0	1.00 (1.0-1.0)	26 (13%)	1 (4%)	0.96 (0.88-1.00)

Comparable performance for all tumor stages

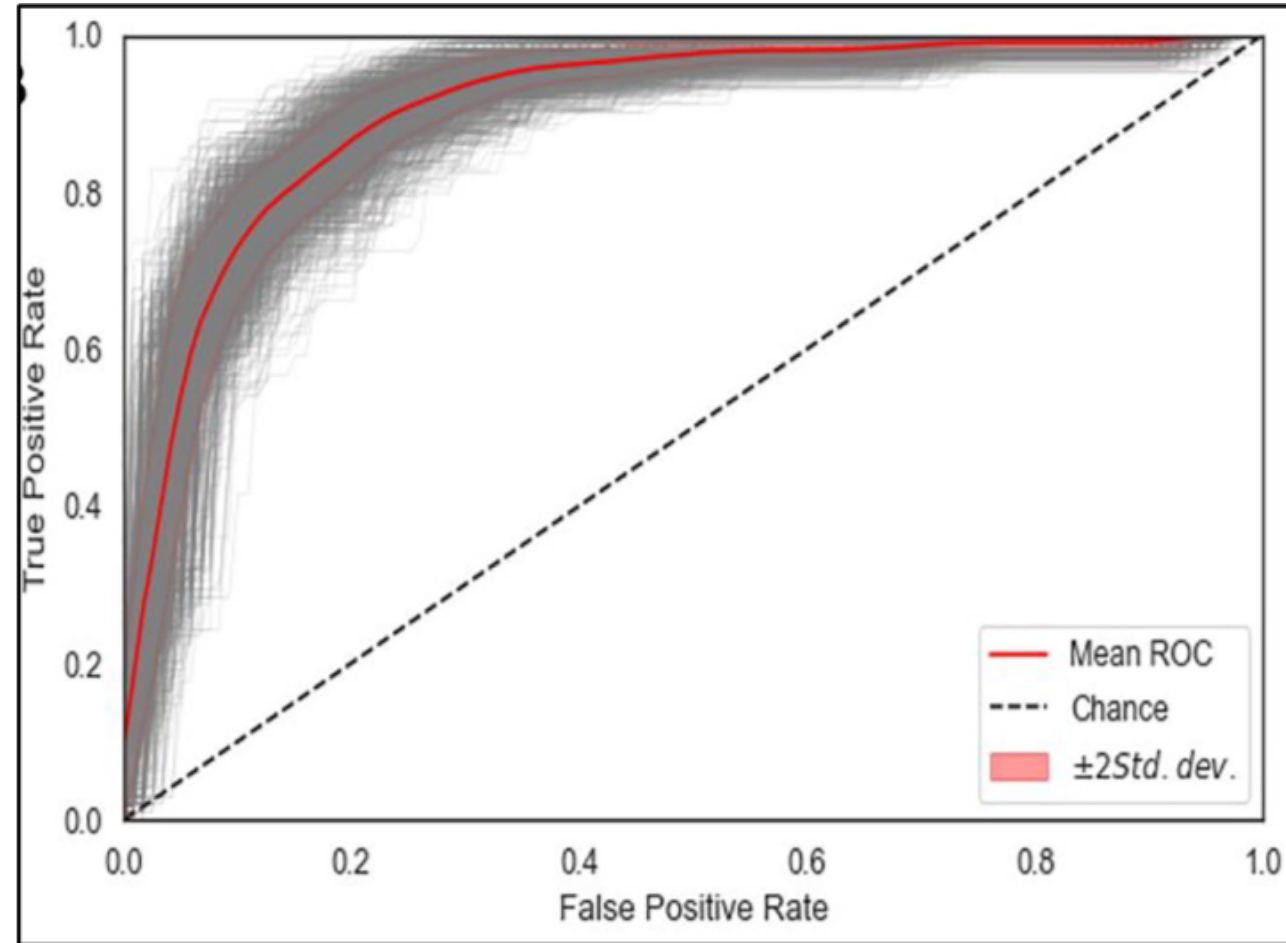
Simulated High-Risk Cohort

- Random sampling of test subset to simulate high-risk cohort
- Glycemically-defined NOD & high ENDPAC score
- Risk of PDA: 2-5%
- Accuracy: 0.95 (0.94-0.95)
- AUROC: 0.97 (0.94-0.99)



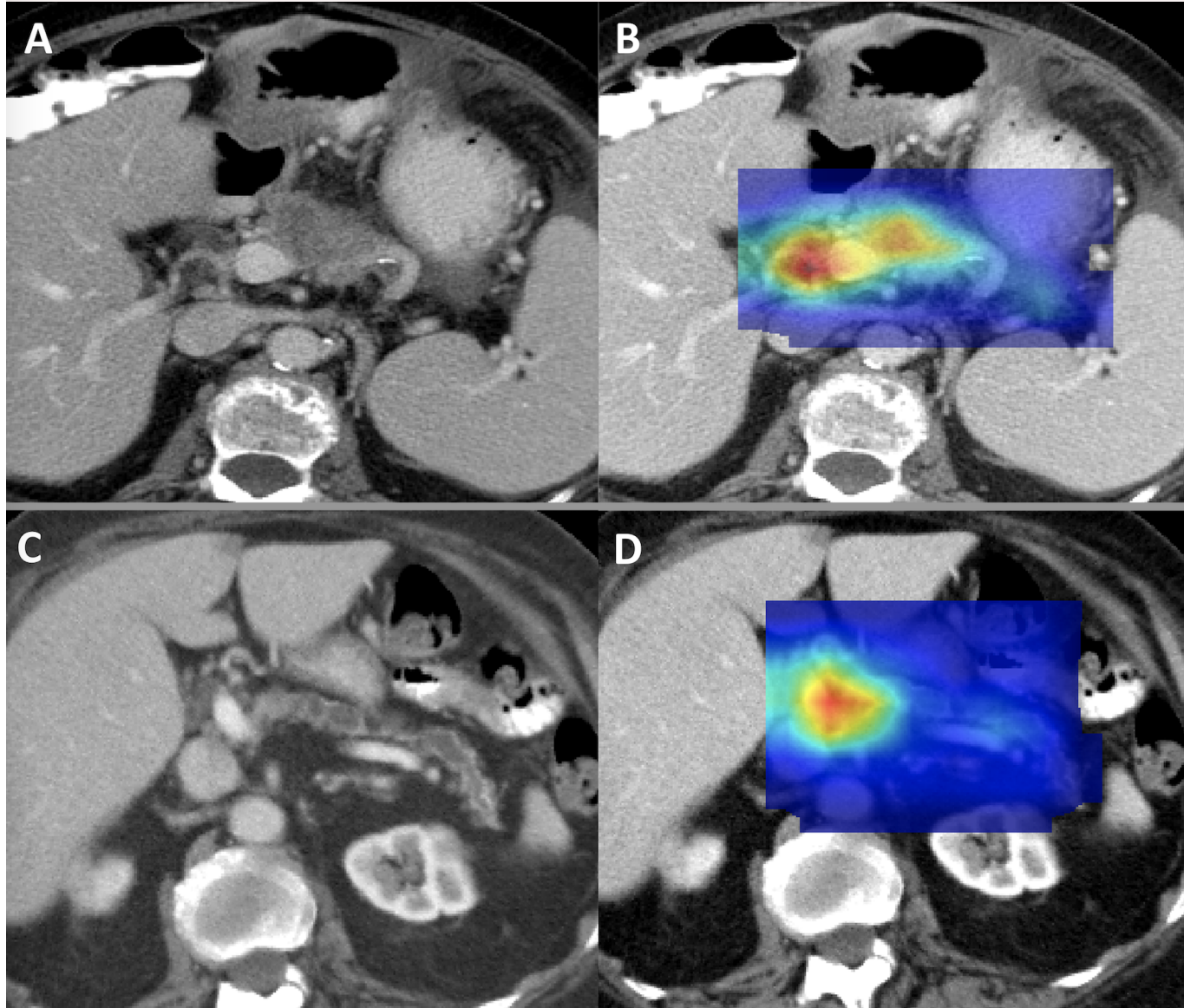
Pre-diagnostic Cohort: Visually Occult Cancer

- Correctly classified: 76/102
- Accuracy 0.84
- AUROC 0.90
- Sensitivity 0.75
- Specificity 0.90



Median: 475 days (93-1082 days) before clinical diagnosis

Black-box AI is not Clinically Translatable AI



Can we do it for my favorite GI
cancer?

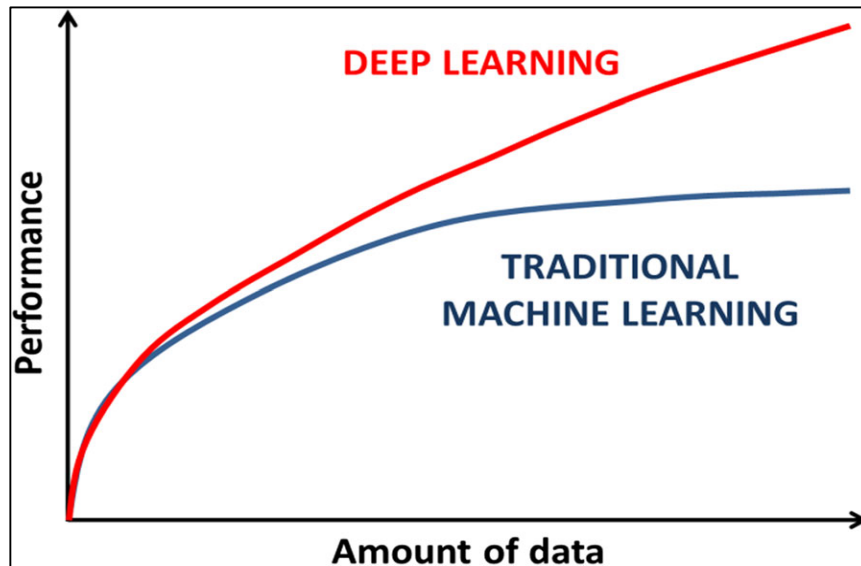


What people think AI is about



The reality

Data is the
new **oil** of the
21st century

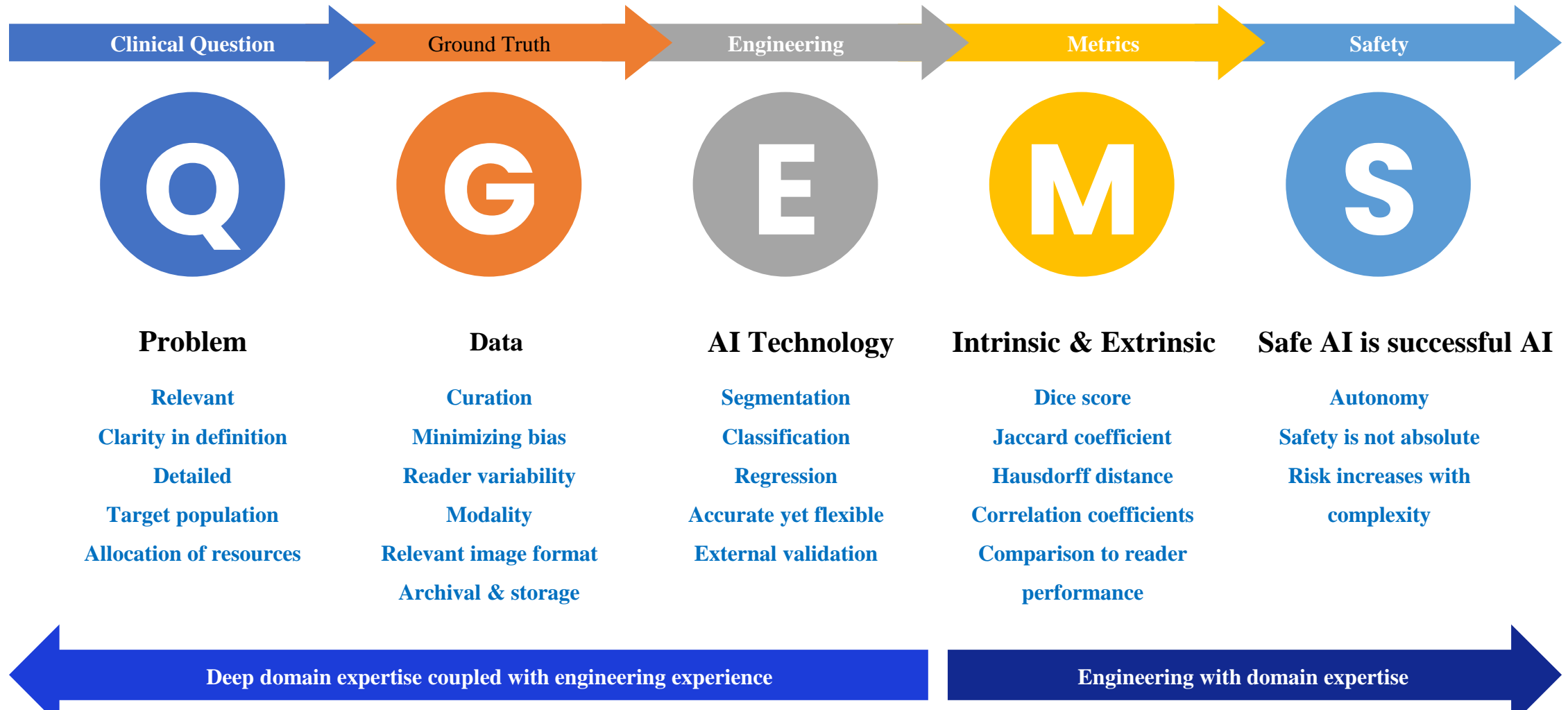


eTable 1: Model performance for different sizes of training/validation sets

Number of cases	Mean DSC	SD
200	0.74	0.13
500	0.8	0.12
800	0.82	0.09
1000	0.84	0.07
1200	0.86	0.09
1500	0.90	0.04
1628	0.91	0.03

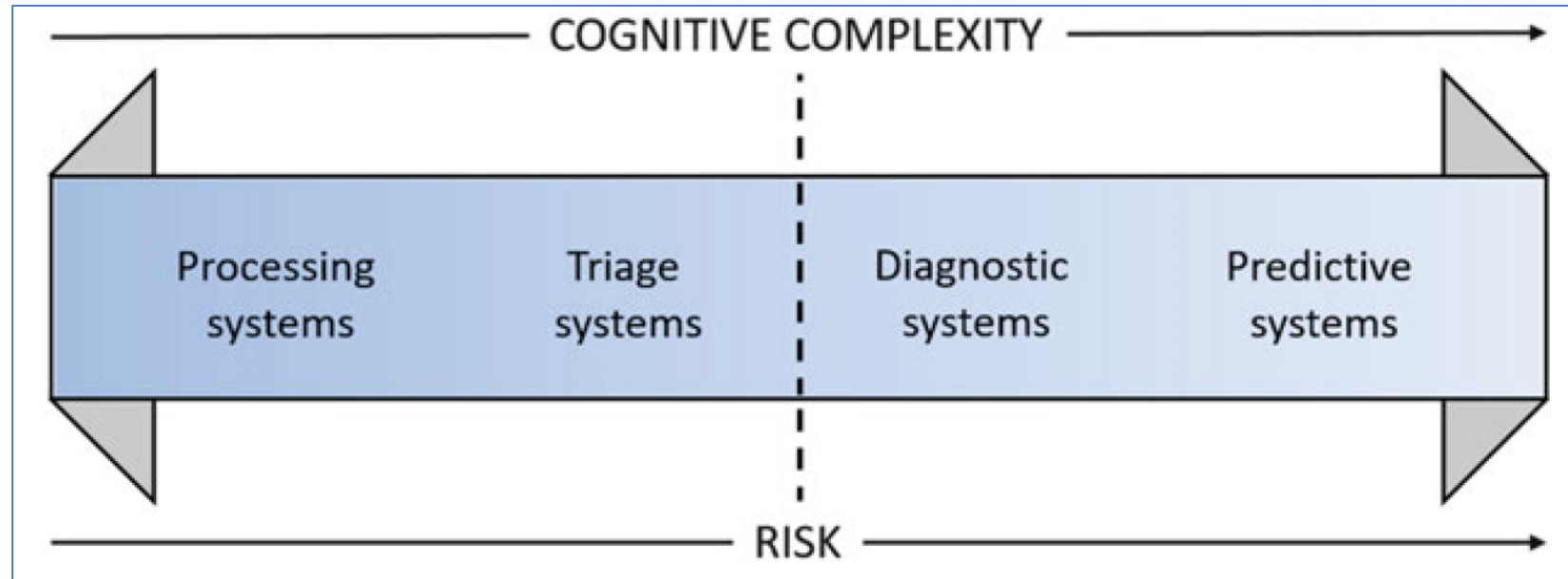
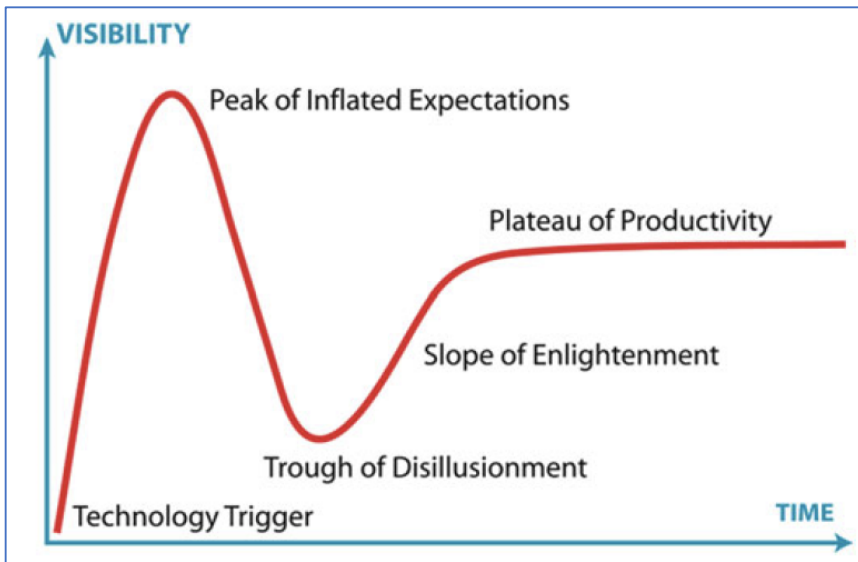
Without large curated & annotated datasets, there can be no AI

Healthcare AI Development Pipeline



Physicians are the drivers for meaningful AI development

Efficacy & Safety of Imaging AI



- Medical AI: Peak of inflated expectations
- Silicon Valley: **Move fast & break things**
 - Healthcare: **first, do no harm**

Move fast & break things: But to what end?

Google's solution to accidental algorithmic racism: ban gorillas

Google's 'immediate action' over AI labelling of black people as gorillas was simply to block the word, along with chimpanzee and monkey, reports suggest



TECHNOLOGY

Black man in New Jersey sues after false facial recognition lands him in jail



Wednesday, December 30, 2020



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A Black man is suing a New Jersey police department after a bad facial recognition match landed him in jail for a crime he did not commit.

ACLU

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NEWS & COMMENTARY

Wrongfully Arrested Because Face Recognition Can't Tell Black People Apart

It is now more urgent than ever for our lawmakers to stop law enforcement use of face recognition technology.



The New York Times

[Artificial Intelligence >](#) | [The Bot That Writes](#) [Are These People Real?](#) [Algorithms Against Suicide](#) [Robots Without Bias](#)

Facial Recognition Is Accurate, if You're a White Guy

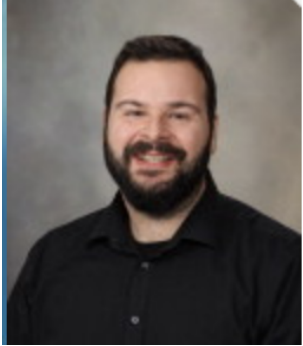
AI is a mirror of the society

Summary

Imaging: The Final Frontier For Early Detection

- **AI developed on large, well-curated, & diverse datasets**
 - Visually occult cancer prior to clinical diagnosis
 - Generalizability & address biases to avoid health disparities
- **Prospective evaluation with emerging fluid-based biomarkers for sporadic PDAC detection in high-risk cohorts**

Acknowledgements: Team & Support





Thanks for your attention

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