Bridging AI and Healthcare

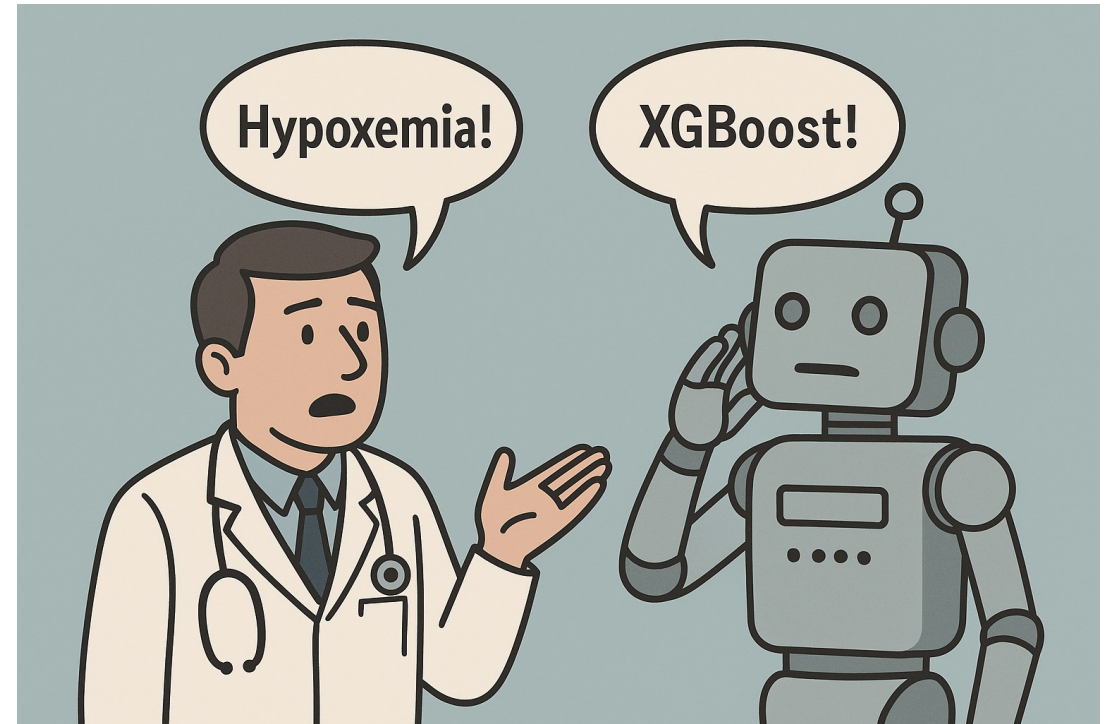Understanding Disease Heterogeneity through Multimodal Learning

Jiho Shin
Final year MEng Biomedical Engineering, Imperial College London
Research centred around AI in healthcare
PhD Candidate 2026

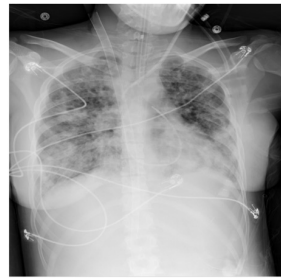# Language Barrier Between AI and Medicine

Research aim:

Help them understand each other

- Using interpretable AI

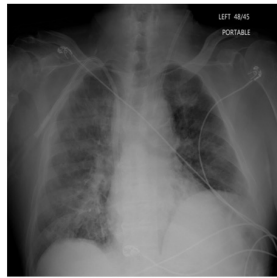- Producing AI that matches

  clinical needs

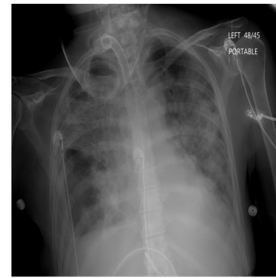# Current research: Understanding ARDS, A Heterogenous Syndrome

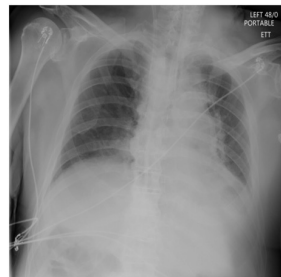**Heterogeneity, Variable Response, Clinical Complexity**

ARDS, Scores [1, 8, 8, 8]
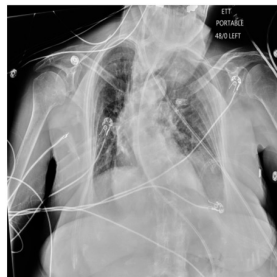Avg. Score 6.25, Uncertainty 3.03

ARDS, Scores [1, 6, 8, 8]
Avg. Score 5.75, Uncertainty 3.36

ARDS, Scores [8, 8, 8, 8]
Avg. Score 8.00, Uncertainty 0.00

Non-ARDS, Scores [1, 2, 3, 8]
Avg. Score 3.50, Uncertainty 3.44

Non-ARDS, Scores [1, 1, 2, 2]
Avg. Score 1.50, Uncertainty 1.00

Non-ARDS , Scores [1, 1, 1, 1]
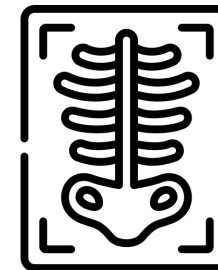Avg. Score 1.00, Uncertainty 0.00

Solution: **Multimodal AI** combining
- Imaging
- Physiological data
- Clinical data

Gao, Zijun, Emily Wittrup, and Kayvan Najarian. 2024. "Leveraging Multi-Annotator Label Uncertainties as Privileged Information for Acute Respiratory Distress Syndrome Detection in Chest X-ray Images" Bioengineering 11, no. 2: 133. https://doi.org/10.3390/bioengineering11020133

Proposed Workflow

Chest X-rays

Clinical data & Physiological data
- Vitals, labs, demographics, etc

Image Foundation Models
- MedImageInsight
- CXR-Foundation

Image embeddings
→ Vector format

Fusion via VAEs
- Concatenate multimodal information

Contrastive learning
+
Graph-based clustering

Patient subtypes
(clinically interpretable groups)

MedImageInsight [Microsoft-Research, 2024]; CXR-Foundation [Google-Research, 2023]; VAE [Kingma & Welling, 2013]; SimCLR [Chen et al., 2020]; Leiden [Traag et al., 2019]; MIMIC-CXR [Johnson et al., 2019]; NIH-CXR14 [Wang et al., 2017]

Illustrative Demo: ARDS patient subtypes

Simulated ARDS Patient Clusters (for illustration)
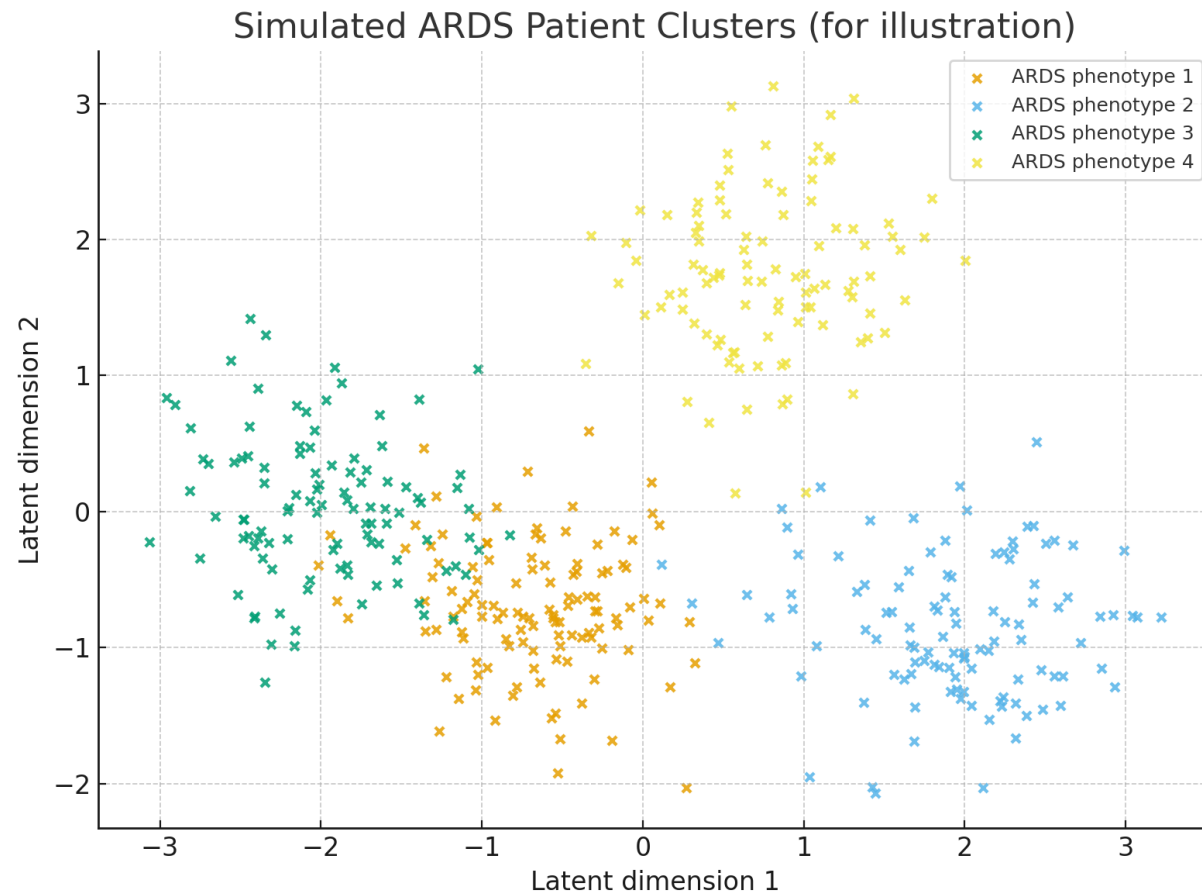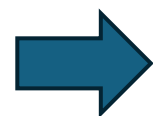
1) Lower inflammation/better PEEP response
2) Hyperinflammatory
3) Intermediate metabolic stress
4) Hyperinflammatory + severe hypoxemia.

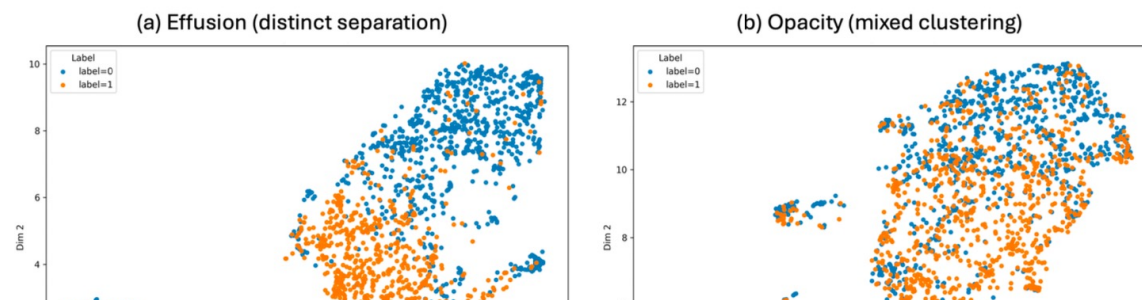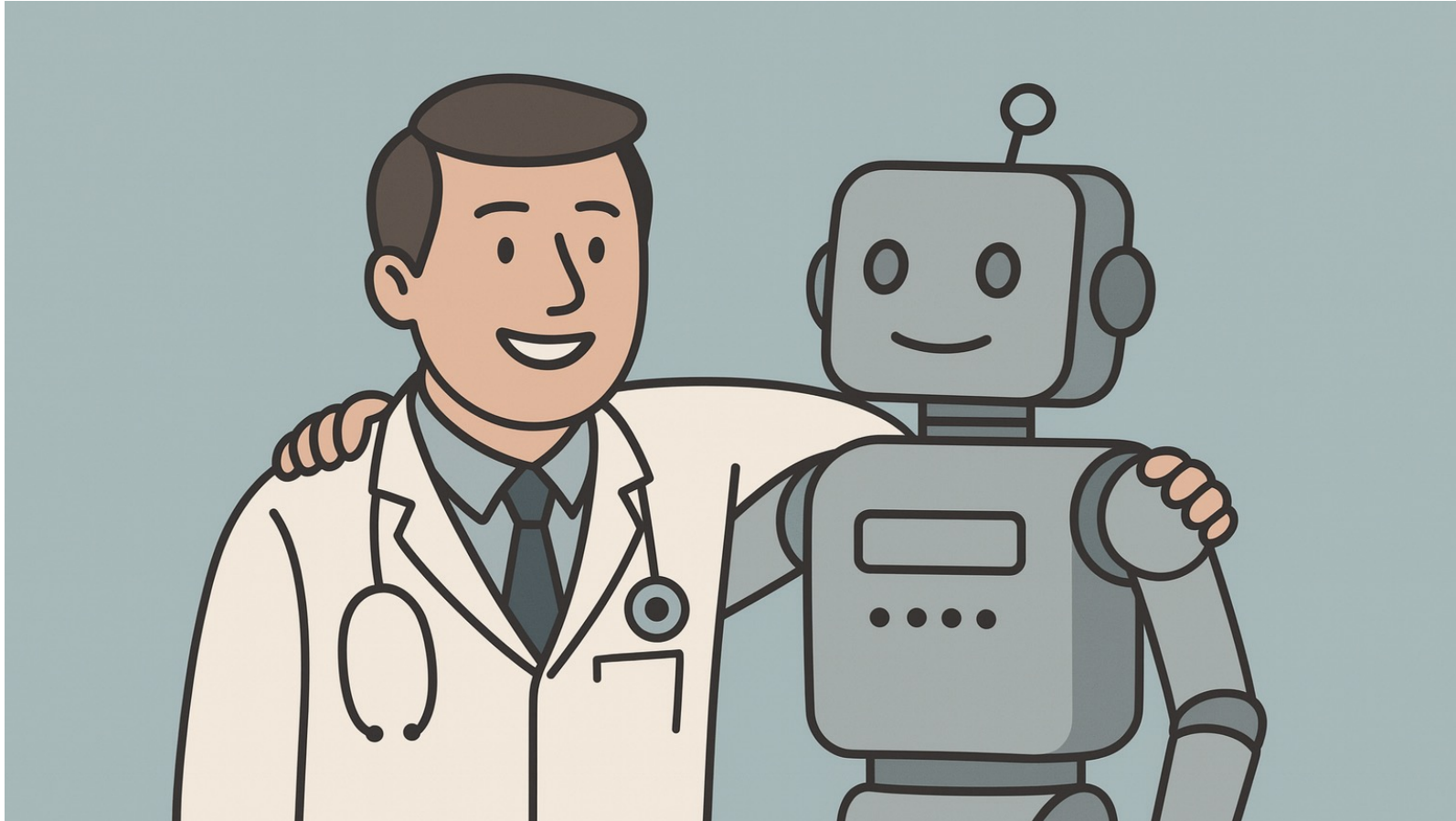# Current Benchmarking Results:

X-ray image embeddings

➡ Future Steps:
- Integrating clinical & physiological data
- Explore ARDS clinical subtypes

Table 1: Benchmark of **MedImageInsight** vs. **CXR-Foundation** on MIMIC-CXR and NIH ChestX-ray14. Values are mean ± 95% CI.

Task		AUROC		F1	
Disease	Dataset	MedImageInsight	CXR-Foundation	MedImageInsight	CXR-Foundation
Atelectasis	MIMIC	0.833 ± 0.007	0.823 ± 0.013	0.755 ± 0.007	0.751 ± 0.008
	NIH	0.863 ± 0.008	0.822 ± 0.012	0.782 ± 0.015	0.744 ± 0.014
Edema	MIMIC	0.918 ± 0.011	0.924 ± 0.014	0.841 ± 0.014	0.847 ± 0.014
	NIH	0.921 ± 0.012	0.911 ± 0.006	0.853 ± 0.016	0.831 ± 0.013
Effusion	MIMIC	0.958 ± 0.011	0.941 ± 0.014	0.906 ± 0.013	0.877 ± 0.010
	NIH	0.901 ± 0.012	0.901 ± 0.006	0.828 ± 0.014	0.826 ± 0.008
Opacity	MIMIC	0.782 ± 0.019	0.775 ± 0.017	0.702 ± 0.016	0.704 ± 0.023
	NIH	0.922 ± 0.012	0.955 ± 0.006	0.851 ± 0.019	0.889 ± 0.013

(a) Effusion (distinct separation)   (b) Opacity (mixed clustering)

Thank you!