

Challenges for radiology in 2030: can artificial intelligence help?

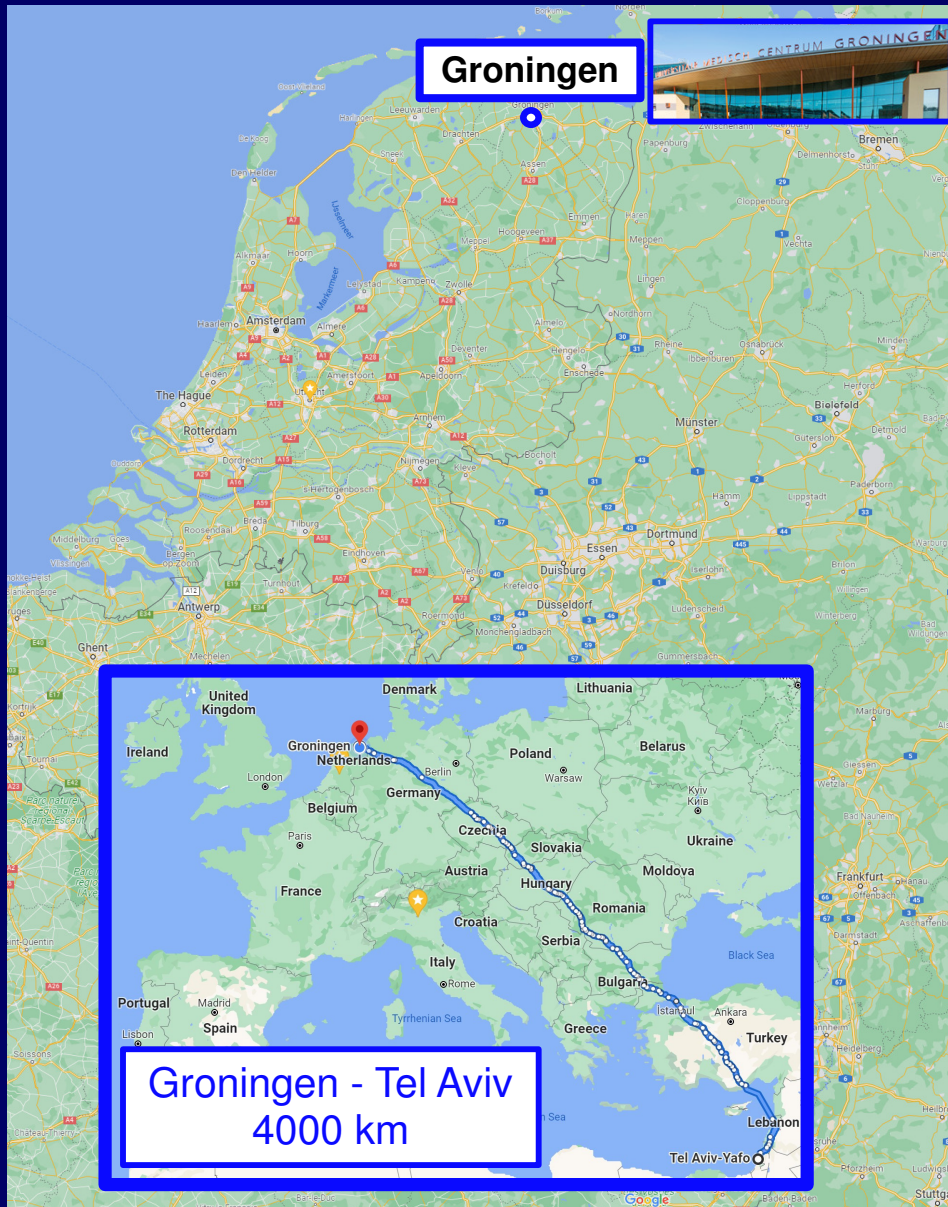
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University Medical Center Groningen
The Netherlands

Conflicts of interest

NONE

About myself



- Radiologist
- Scientist
(oncology, healthcare management)
- Associate professor
- Vice-chair department

What we will discuss

- A radiologist's job
- Increasing workload
- Diagnostic errors
- Burnout
- AI
 - what we need
 - what we don't need
- Summary

A radiologist's job

Interpretation of diagnostic studies



Other tasks

- Consultation with referring clinicians
- Protocolling studies
- Performing diagnostic studies
- Performing interventions
- Attending multidisciplinary meetings
-

A radiologist's job

Interpretation of diagnostic studies



Other tasks

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....

A radiologist's job

A radiologist



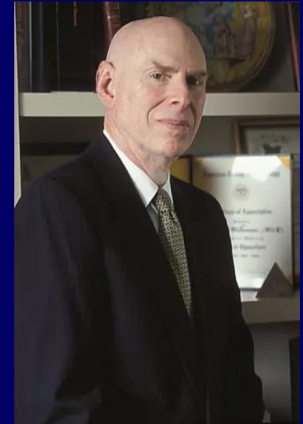
A pilot



What is the difference?

Increasing workload

BACK IN 2007



EDITORIAL

BRUCE J. HILLMAN, MD

Everyone is Working Harder

*Work expands so as to fill the time available
for its completion.*

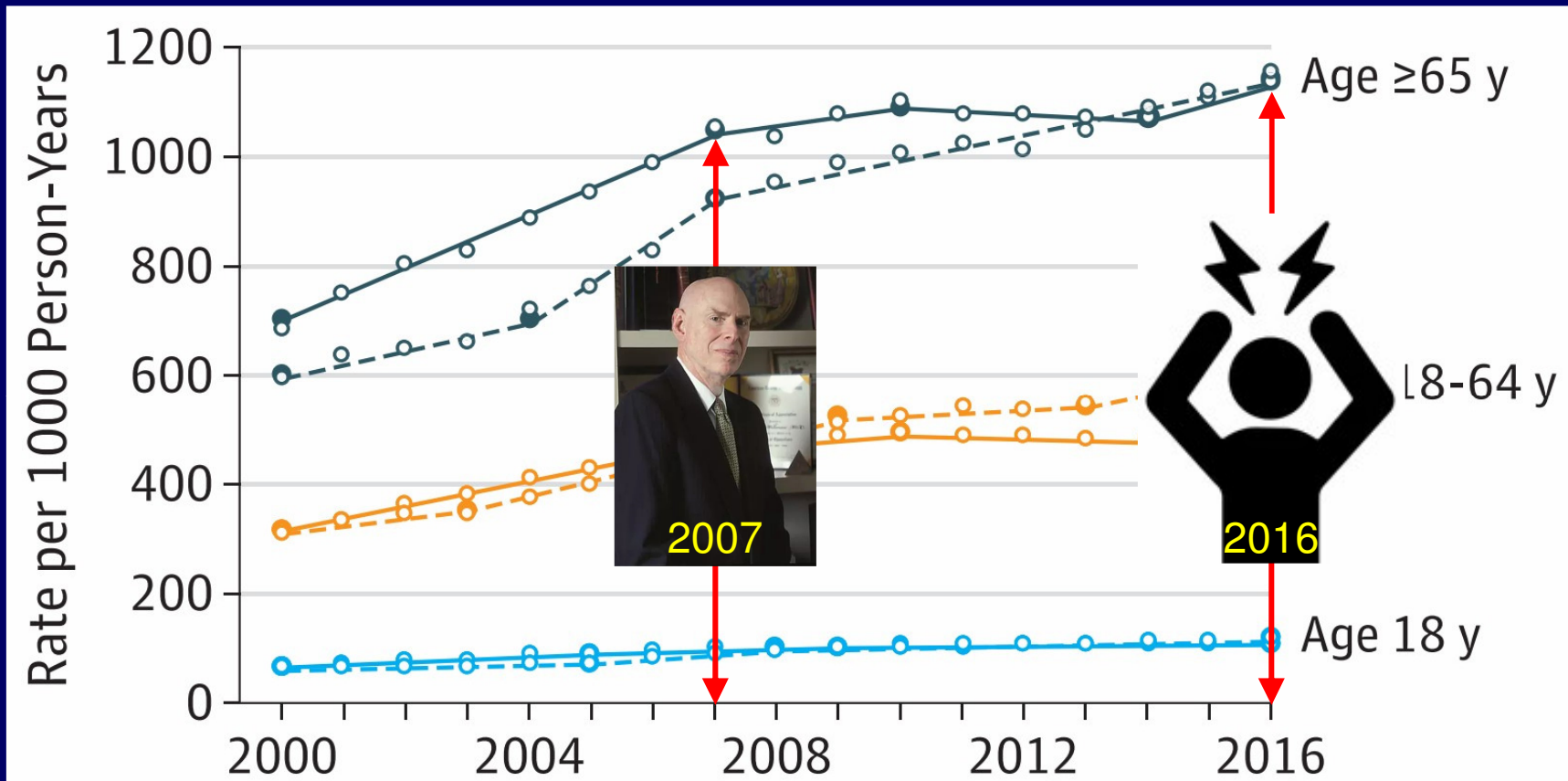
—C. Northcote Parkinson

J Am Coll Radiol 2007;4(3):143-144

“Everyone involved in medical imaging is working harder”

Increasing workload

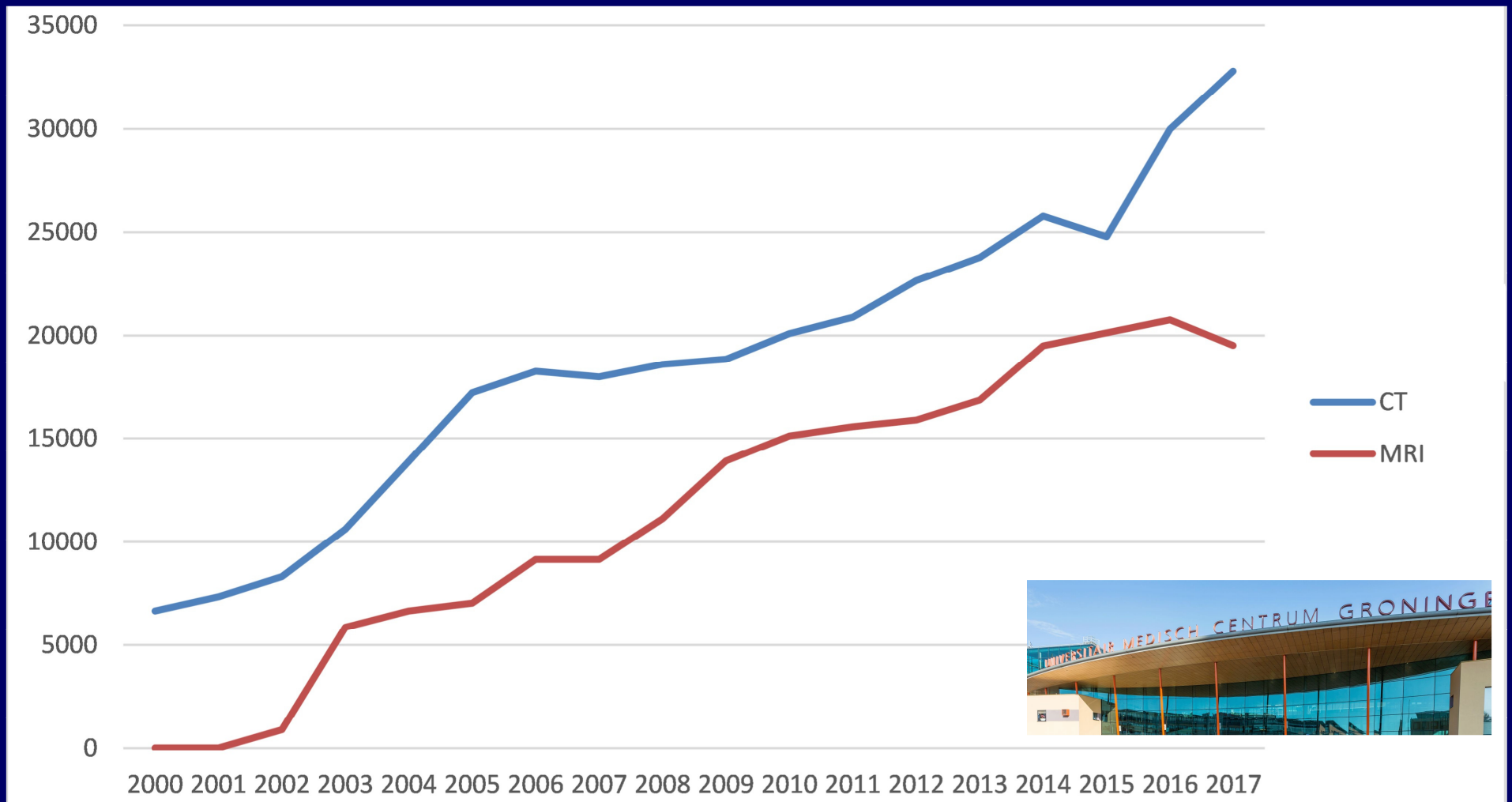
Trends in use of medical Imaging in **USA and Ontario**, 2000-2016



Particularly growth in CT and MRI utilization in adults

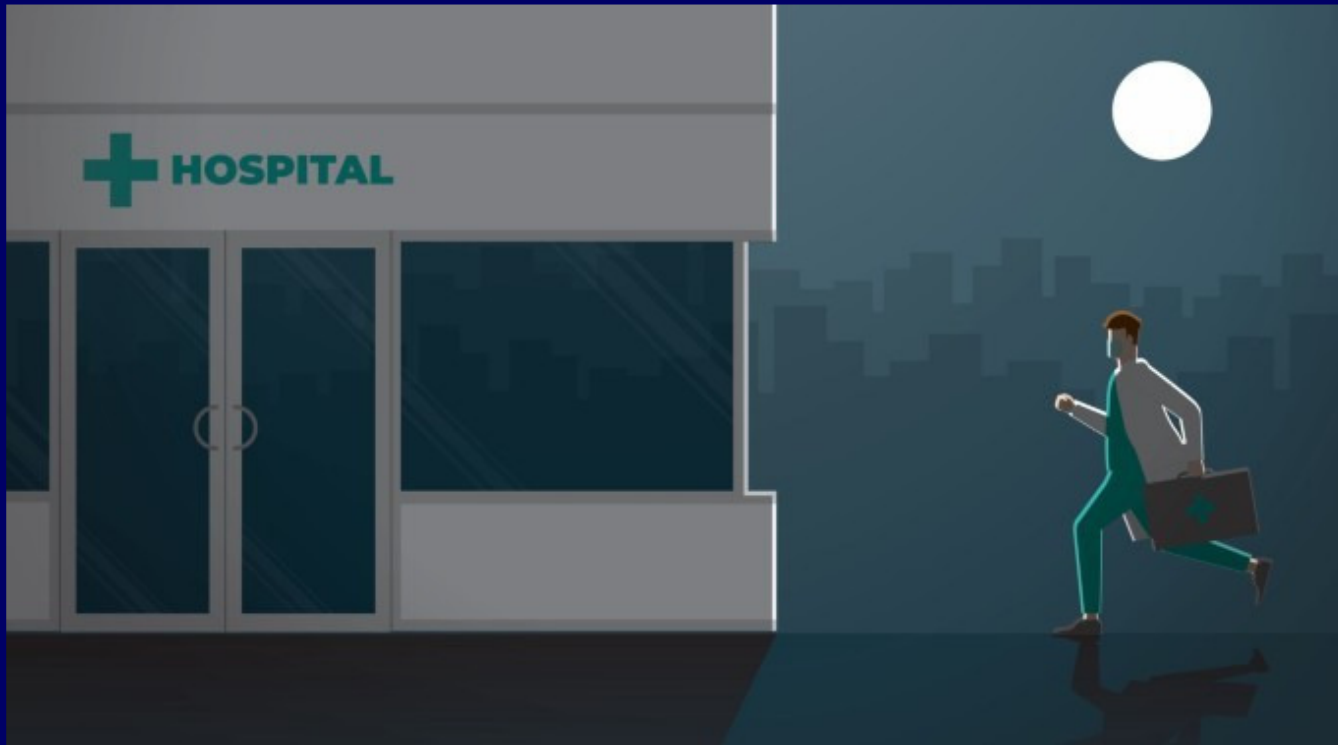
Increasing workload

Trends in use of medical Imaging in UMC Groningen 2000-2017



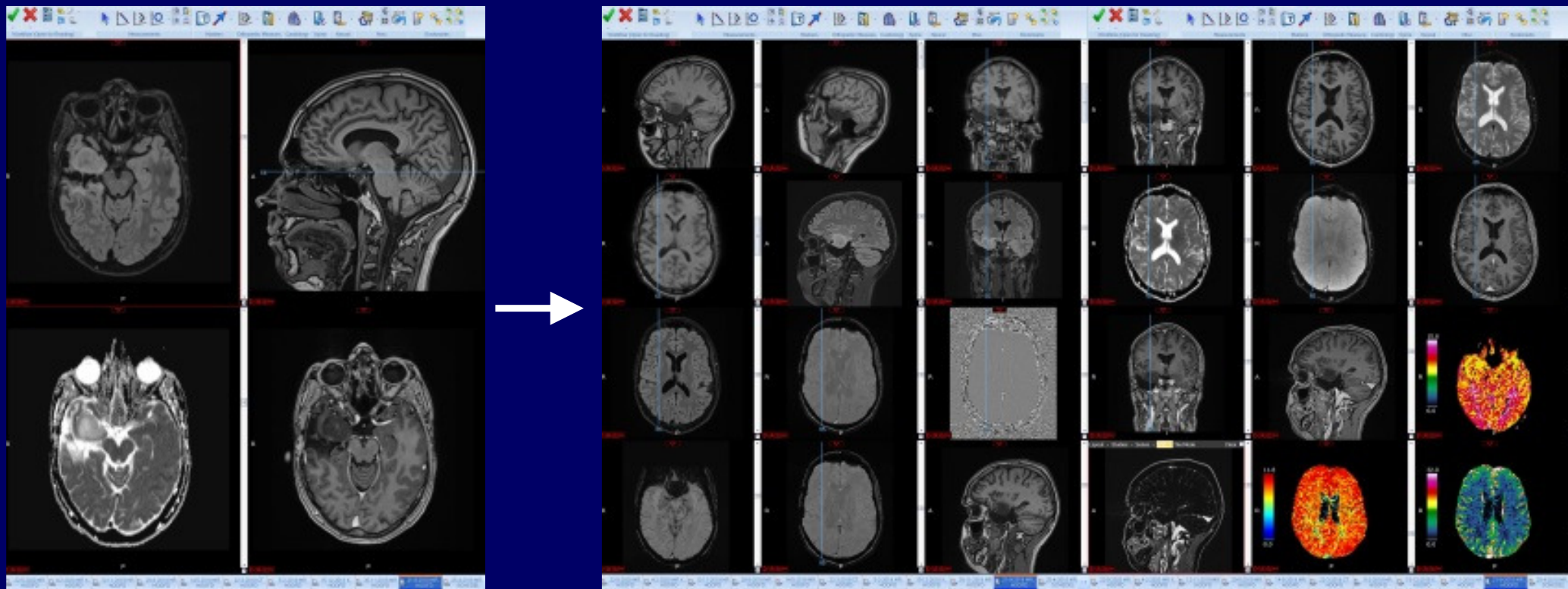
Increasing workload

Workload for radiologists during on-call hours: dramatic increase in the past 15 years



The overall workload in terms of relative value units during on-call hours has **quadrupled**

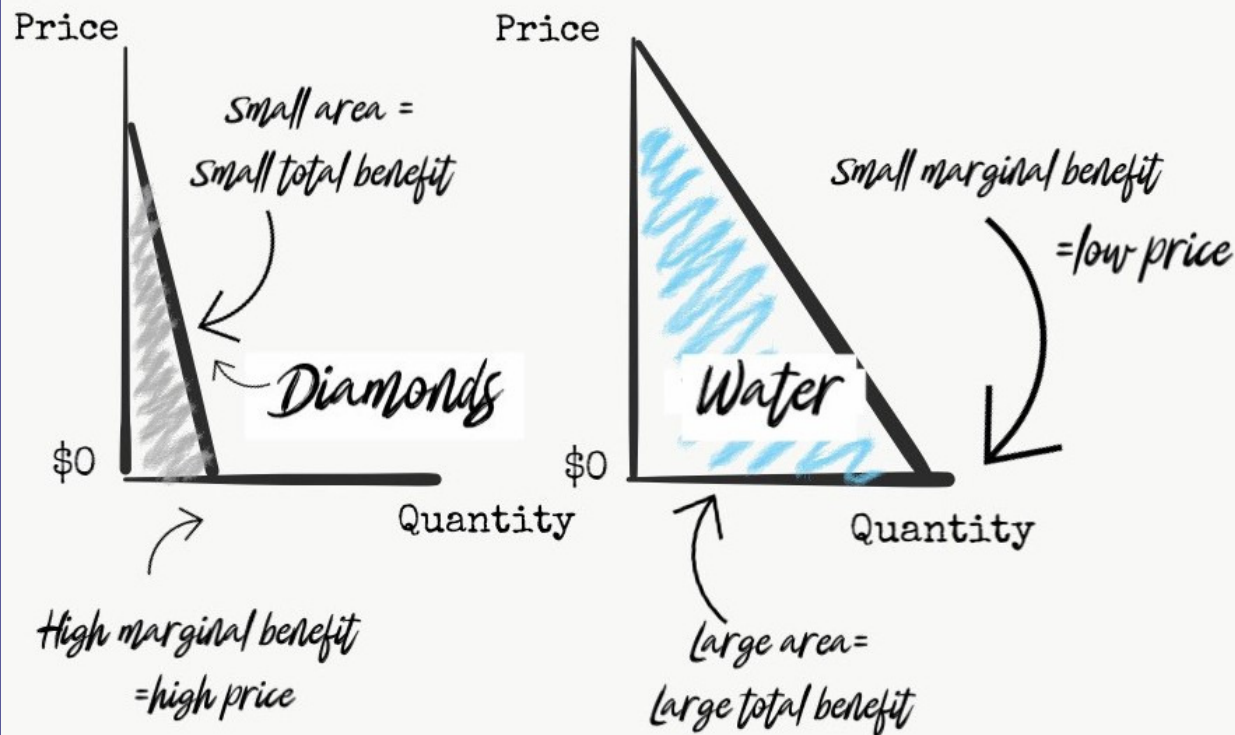
Increasing workload



- The number of images requiring interpretation per minute increased from **3** to **16** between 1999 and 2010
- A radiologist must interpret **1 CT or MR image every 3-4 seconds** in an 8-hour workday to meet workload demands (2010)

Increasing workload

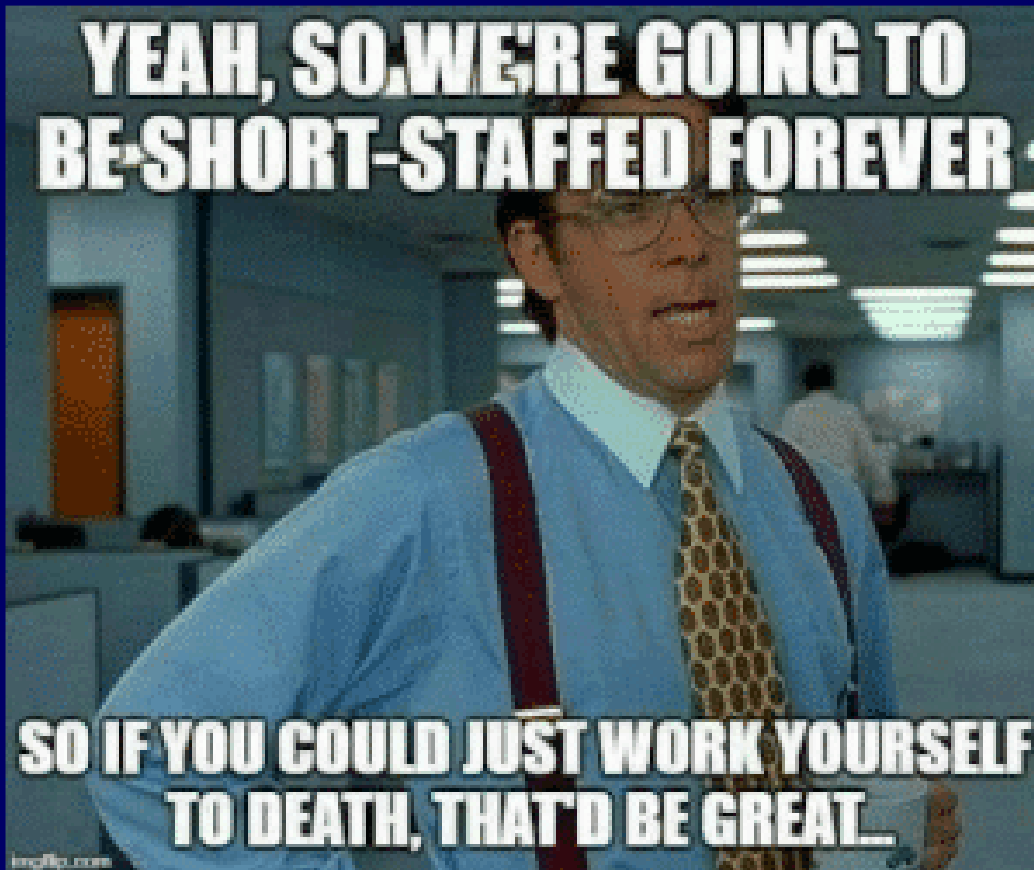
The Diamonds–Water Paradox



Water is more useful than diamonds, but cheaper, because water is ubiquitous and diamonds are scarce

Imaging is becoming as ubiquitous as water

Increasing workload



Radiologists remain relatively scarce because they are costly to train

Imaging reimbursements are declining

“Do more with less”

Increasing workload

EDITORIAL

BRUCE J. HILLMAN, MD

Everyone is Working Harder

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for its completion.*

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J Am Coll Radiol 2007;4(3):143-144

There are two ways we could address greater workloads:

- 1) We could extend our hours, or
- 2) We could manage more work in the same period of time

Increasing workload

Determinants of Radiologists' Desired Workloads

Cristian Meghea, PhD, Jonathan H. Sunshine, PhD

J Am Coll Radiol 2007;4(3):166-179

Radiologists prefer working more efficiently rather than extending their working hours to handle greater workloads

Increasing workload



Turkey: 2 minutes of interpretation time per (breast) MRI

A radiologist's job

A radiologist



A pilot



What is the difference?

Diagnostic errors

A radiologist



diagnostic error rate of 3-5%
40.000-80.000 fatalities
(USA, 2020)

A pilot



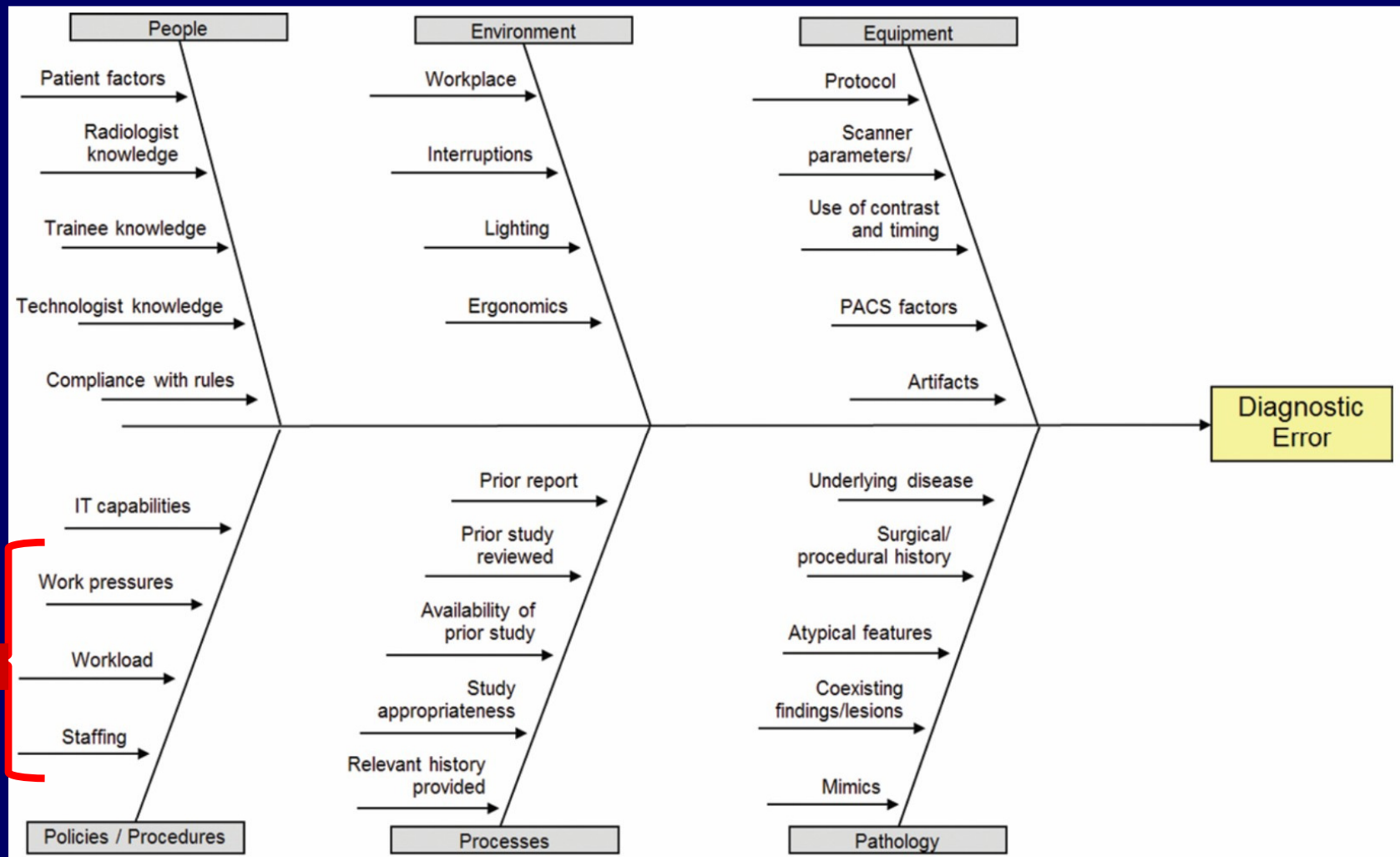
11 accidents
0 fatalities
(USA, 2020)

Leape L. *JAMA* 2002;288:2405

Itri J. *Radiographics* 2018;38:1845-1865

<https://www.airlines.org/dataset/safety-record-of-u-s-air-carriers>

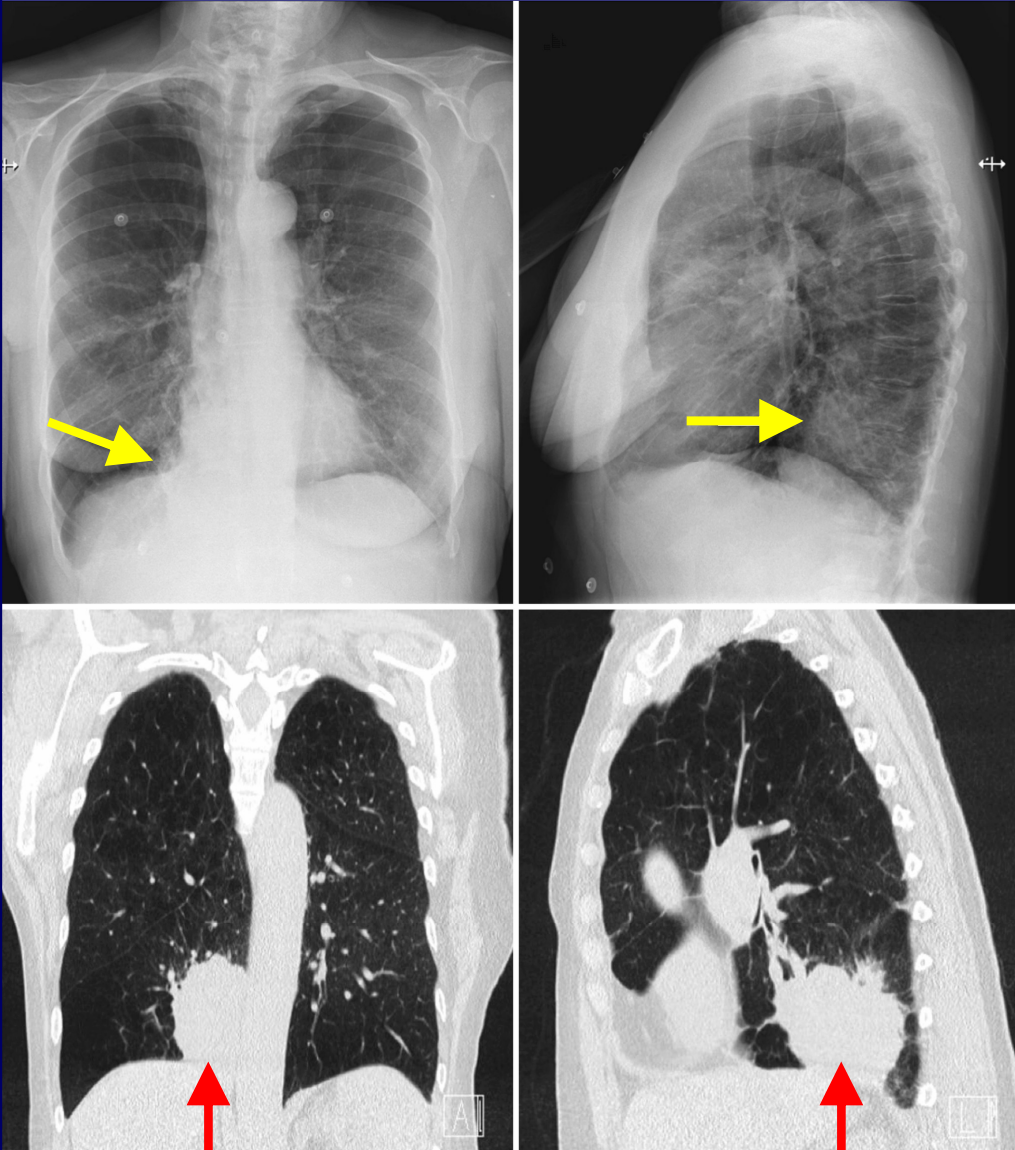
Diagnostic errors



Workload is associated with diagnostic error

Diagnostic errors

Example of missed lung cancer



Patient harm

Medicolegal consequences

Costs

Psychological distress

Burnout

ORIGINAL ARTICLE

CLINICAL PRACTICE MANAGEMENT



Burnout of Radiologists: Frequency, Risk Factors, and Remedies: A Report of the ACR Commission on Human Resources

Jay A. Harolds, MD^{a,b}, Jay R. Parikh, MD^c, Edward I. Bluth, MD^{d,e}, Sharon C. Dutton, MD, MPH^f, Michael P. Recht, MD^g

J Am Coll Radiol 2016;13:411-416. Copyright © 2016 American College of Radiology

“Burnout is a serious condition that is increasing among diagnostic radiologists”

Back to aviation



“Since the beginning of commercial aviation, each successive generation of aircraft has become increasingly **automated**, and this automation has contributed to a step change in **efficiency and safety**”

Back to aviation

Automatic flight control system (AFCS)



Flight directors - Autopilots – Autothrottles – Autoland - Navigational aids

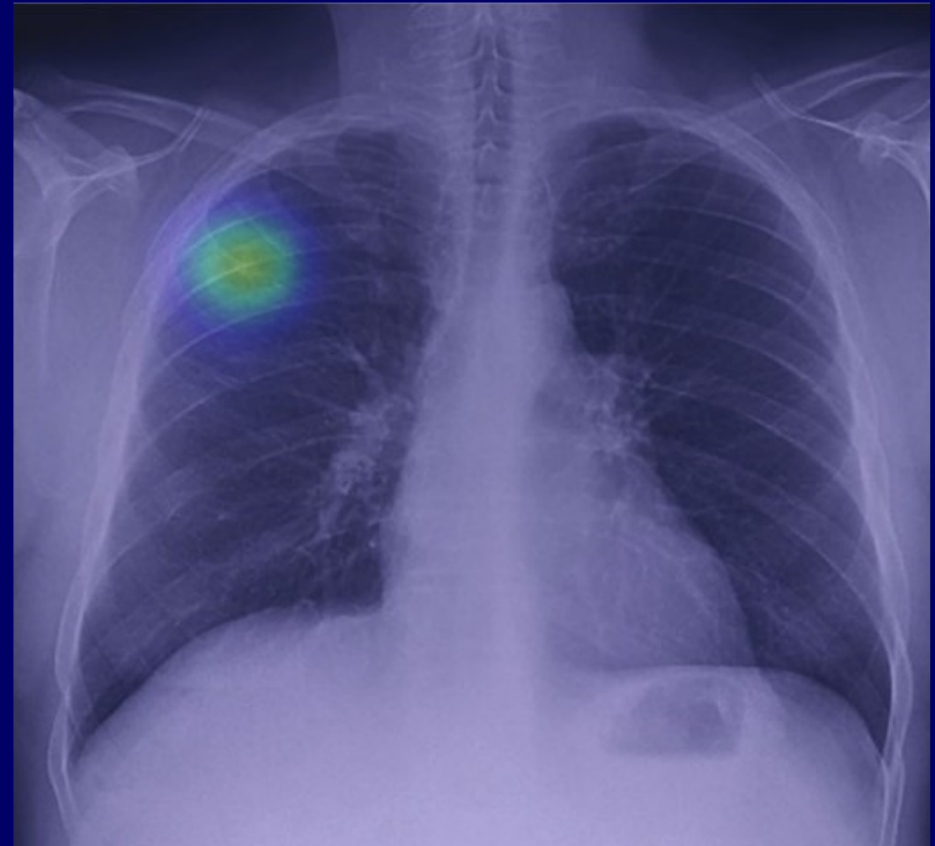
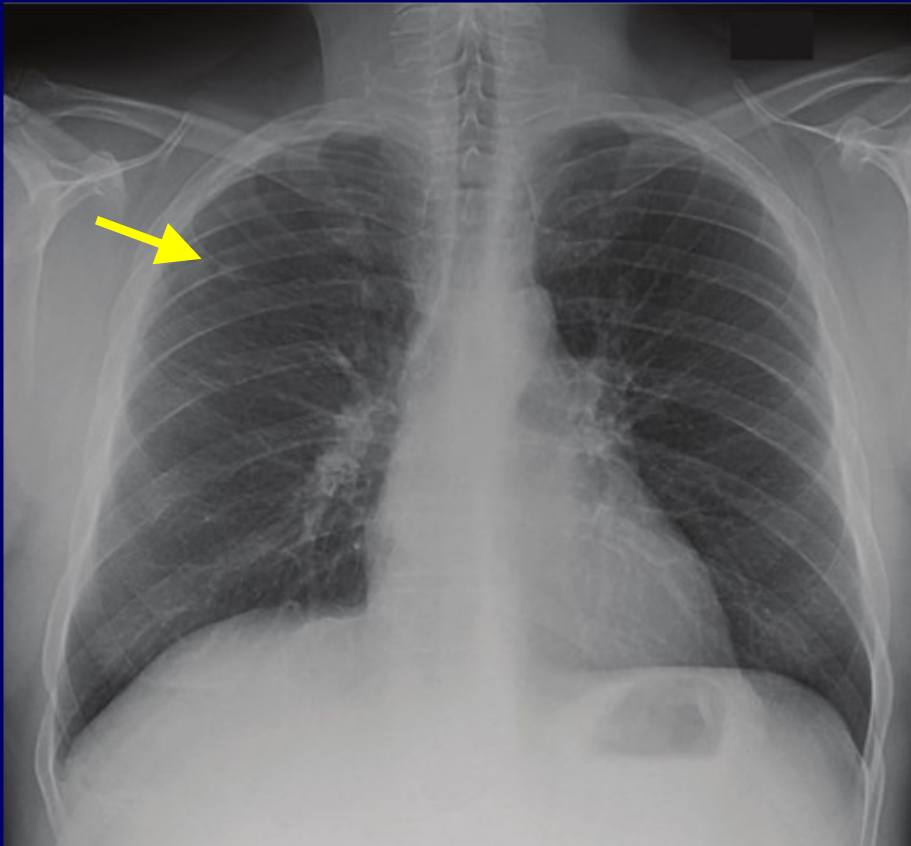
AI: what we need



AI: what we need - example

Safety

Lung cancer

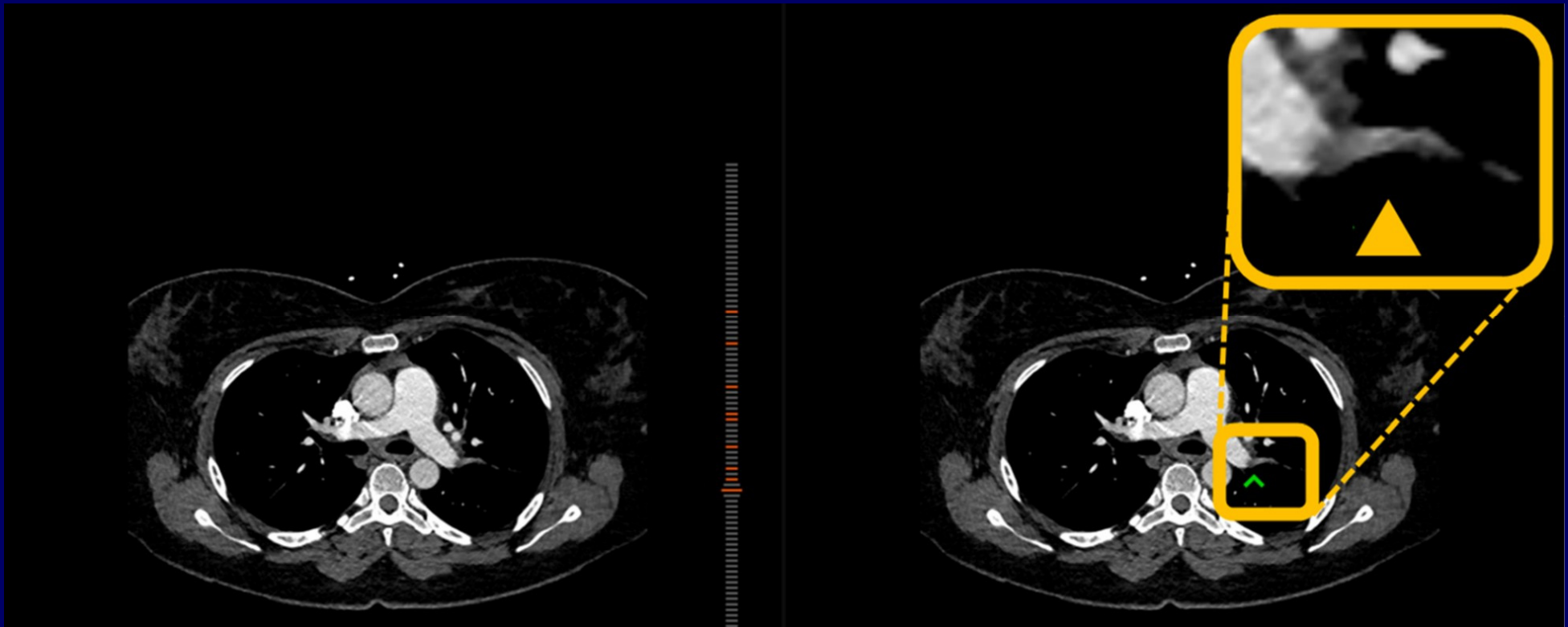


- The AI algorithm performed better than radiologists for the detection of **pulmonary nodules** on digital radiographs
- The AI algorithm may help to detect lung cancer as a **second reader**

AI: what we need - example

Safety

Pulmonary embolism



-The AI algorithm had a high degree of diagnostic accuracy for the detection of **pulmonary embolism**

-It can **automatically prioritize exams** with a high suspicion of pulmonary embolism and serve as secondary reading tool

AI: what we need - example

Safety

Pulmonary embolism

Radiology worklist

+	Status	Pt. Loc	Patient Name	Patient ID	Modality	Study Date	Study Time	Study Description	Performing Physician	PACS ID	Priority
	New	ERR	M/	R1	CT	3/4/2006	4:45 AM	CT FACIAL BONES W/O CONTRAST			HIGH
	New	ERR	AL	R1	CT	3/4/2006	10:39 AM	CT HEAD W/O CONTRAST			HIGH
	New	Observation	M/	R1	NM	3/4/2006	10:39 AM	NM CARDIAC SPECT MULTI REST +/-OR STRESS			HIGH
	New	ERR	SA	R1	CT	3/4/2006	7:43 AM	CT HEAD W/O + W/ CONTRAST			HIGH
	New	ERR	GE	R1	CT	3/4/2006	1:44 PM	CT HEAD W/O CONTRAST			HIGH
	New	ERH	SE	R1	US	3/4/2006	10:51 AM	US KIDNEY/ADRENAL COMPLETE			HIGH
	New	ERR	BR	R3	CT	3/4/2006	1:52 PM	CT HEAD W/O CONTRAST			HIGH
	New	ERH	RA	R3	CT	3/4/2006	9:39 AM	CT EXT LOWER W/O CONTRAST LEFT			HIGH
	New	ERR	PR	R4	CT	3/4/2006	1:21 PM	CT HEAD W/O CONTRAST			HIGH
	New	ERR	LA	JR	R4	CT	3/4/2006	3:59 AM	CT HEAD W/O CONTRAST		HIGH
	New	ERR	LA	JR	R4	CT	3/4/2006	4:02 AM	CT CERVICAL SPINE W/O CONTRAST + RECONS		HIGH
	New	ERR	LA	JR	R4	CT	3/4/2006	4:09 AM	CT CHEST ABDOMEN PELVIS W/ CONTRAST		HIGH
	New	ERR	TH	R4	CT	3/4/2006	9:08 AM	CT HEAD W/O CONTRAST			HIGH
	New	ERR	GR	R4	MR	3/4/2006	12:19 PM	MR BRAIN W/O + W/ CONTRAST			HIGH
	New	ERR	FR	R4	CT	3/4/2006	12:47 PM	CT ABDOMEN PELVIS W/ CONTRAST			HIGH
	New	ERR	HE	R5	CT	3/4/2006	5:00 AM	CT HEAD W/O CONTRAST			HIGH
	New	ERR	HE	R5	CT	3/4/2006	5:08 AM	CT CERVICAL SPINE W/O CONTRAST + RECONS			HIGH
	New	ERR	HE	R5	CT	3/4/2006	9:17 AM	CT FACIAL BONES W/O CONTRAST			HIGH
	New	ERR	EB	R6	CT	3/4/2006	2:53 PM	CT HEAD W/O CONTRAST			HIGH
	New	Observation	SC	R8	NM	3/4/2006	12:43 PM	NM CARDIAC SPECT MULTI REST +/-OR STRESS			HIGH
	New	73C	WI	R1	MR	3/4/2006	1:10 PM	MR BRAIN W/O + W/ CONTRAST			MED
	New	RS3	DU	R1	CT	3/4/2006	10:15 AM	CT HEAD W/O + W/ CONTRAST			LOW
	New	RS3	DU	R1	US	3/4/2006	8:37 AM	US ABDOMEN COMPLETE			LOW
	New	MOU	JO	R1	CT	3/4/2006	11:38 AM	CT ANGIOGRAPHY PE W/O + W/ CONTRAST			MED

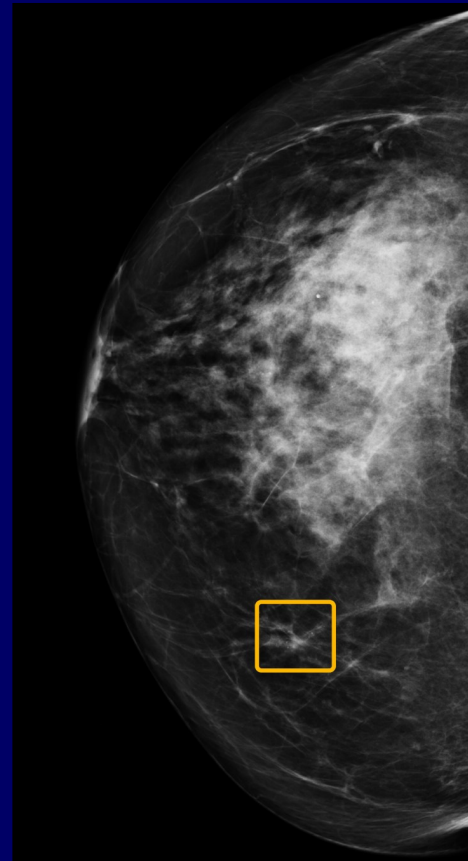
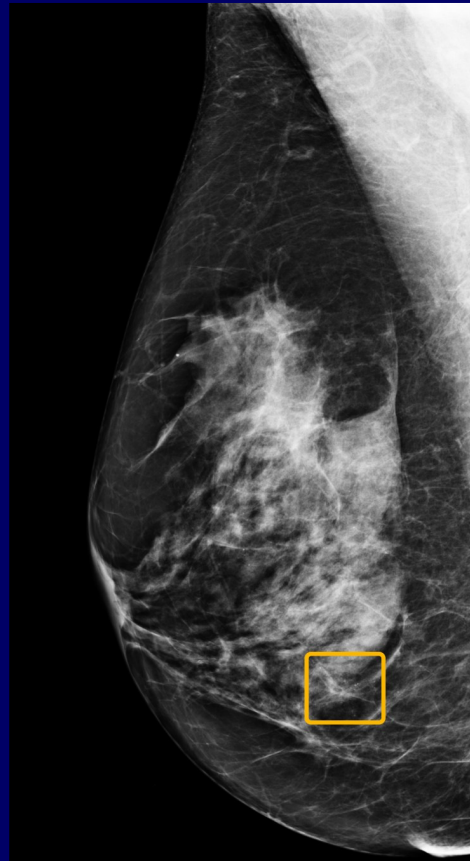
Oldest study to be reported first

If AI detects pulmonary embolism, scan will be moved to the top of the list

AI: what we need – example

Breast cancer

Safety
&
Efficiency



- In an independent study of six radiologists, the AI system **outperformed** all of the human readers in screening mammography
- The AI system could reduce the workload of the second reader by **88%**

AI: what we don't need

- Unreliable AI
 - Too many false positives
 - Too many false negatives

- Increased workload due to AI
 - Extra post-processing time
 - Extra interpretation time

AI: what we don't need

ORIGINAL ARTICLE

Open Access

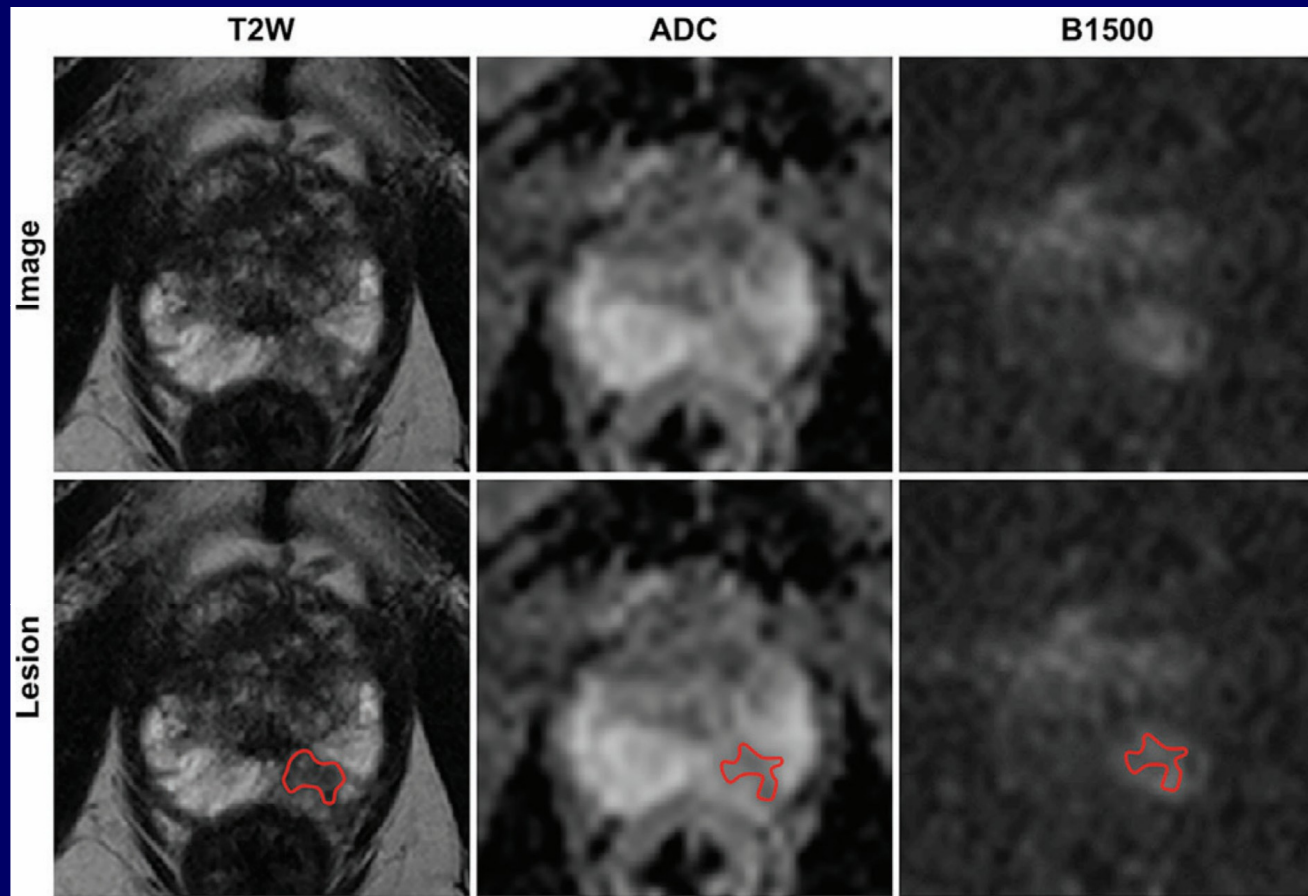


Workload of diagnostic radiologists in the foreseeable future based on recent scientific advances: growth expectations and role of artificial intelligence

“Recently published medical imaging studies often add value to radiological patient care. However, they likely increase the overall workload of diagnostic radiologists, and this particularly applies to AI studies.”

AI: what we don't need

Prostate cancer

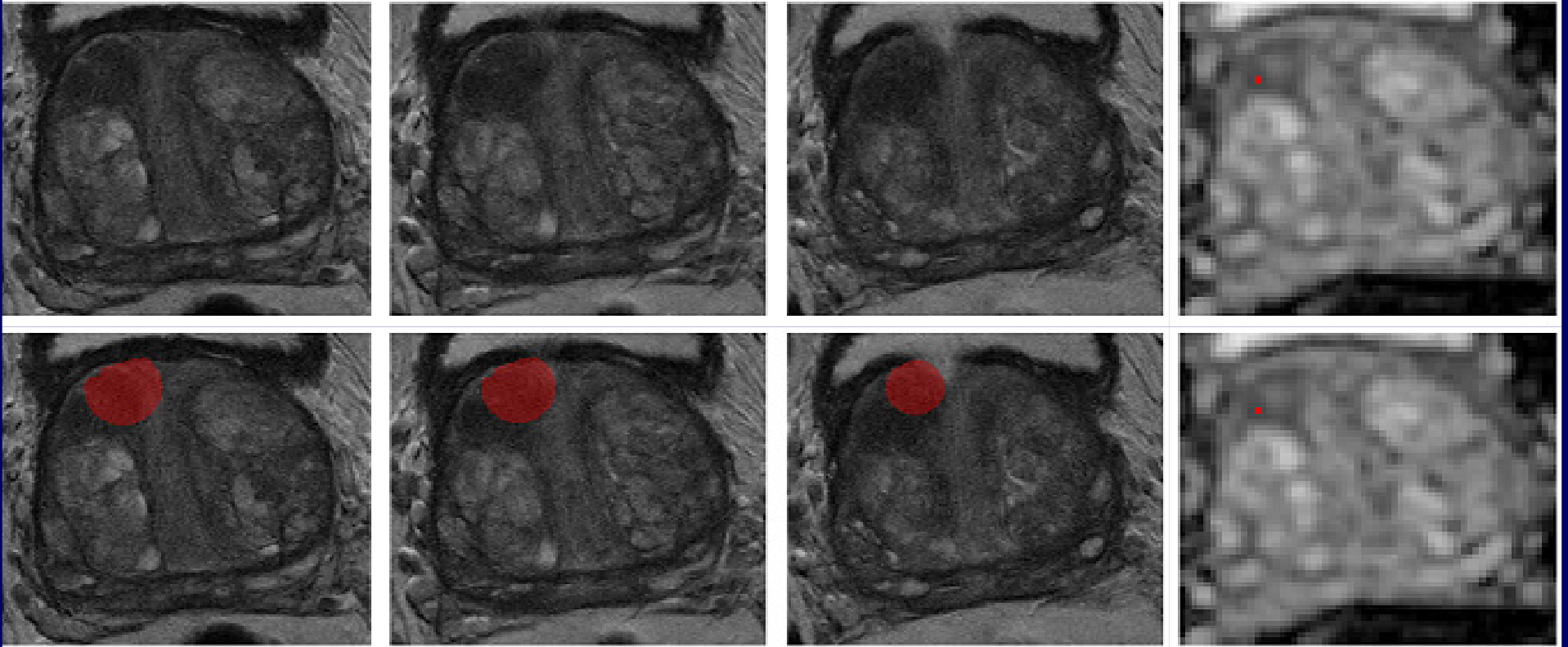


Radiomic machine learning had comparable **but not better** performance than mean ADC assessment for clinically significant prostate cancer

Laborious manual segmentation

AI: what we need

Prostate cancer



A deep learning segmentation can provide a **more accurate** radiomics diagnosis of clinically significant prostate cancer than expert manual segmentation while also reducing expert time by **more than 97%**

Summary

- A radiologist's job



More errors Less errors
Less automation More automation

- Workload ↑↑ = diagnostic errors and burnout ↑↑
- AI
 - we need: help with safety and efficiency
 - we don't need: inaccuracy and increased workload

Challenges for radiology in 2030: can artificial intelligence help?



“The best way to predict your future is to create it”

(Abraham Lincoln)

Challenges for radiology in 2030: can artificial intelligence help?

Thank you for your attention!

Thomas Kwee, radiologist
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