




AI for breast imaging

The robots can be our friends!

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Disclosures

Research Agreements: Siemens Healthcare
 Canon Medical Systems
 ScreenPoint Medical
 Volpara Solutions
 Sectra Benelux





Speaking Agreements: Siemens Healthcare
 ScreenPoint Medical
 Hologic

ScreenPoint Medical is a spin-off company from my Department, but I have no personal stake in the company.

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Thank you!!!!!!










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AXTI Lab

(Advanced X-ray Tomographic Imaging)



Ritse Mann
 Alejandro Rodriguez-Ruiz
 Nico Karssemeijer

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***“Radiologists who do AI will
replace radiologists who don't”***

*- A certain Dutch radiologist
(...and many others)*

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Why now?

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AI for Breast Imaging

How good are they?
Faster!
Better!
Less!

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Breast tomosynthesis takes time

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Running out of breast radiologists

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False negatives

	DBT/DM positive	DBT/DM negative
DM positive	35	0
DM negative	20	10

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False negatives

	Tomo + Mammo -	Tomo - Mammo +
Visibility	13	0
Radiographic appearance	3	1
Interpretative error	3	6



Ling et al, Br J Radiol 2014;87:20140080



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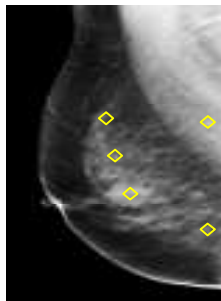
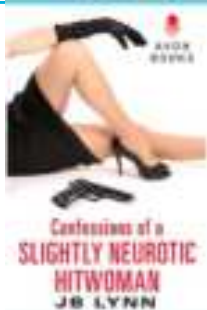
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How good is it?



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AI system

Breast screening radiologists



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9 Previous multi-reader multi-case retrospective studies

Radiology

European
Radiology

INVESTIGATIVE
RADIOLOGY

FDA

Rodriguez Ruiz et al, JNCI, 2019.

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Breast screening radiologists

Varied experience
with screening:
1-45 years
avg. 10 years

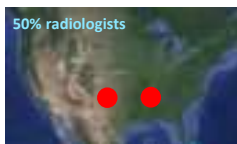


Rodriguez Ruiz et al, JNCI, 2019.

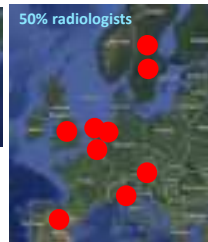
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Datasets



50% radiologists



50% radiologists

Varied datasets characteristics & sizes
Different radiologists

Rodriguez Ruiz et al, JNCI, 2019.

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Total numbers

2,652 digital mammo exams

653 malignant (i.e. enriched sets)

50% screening/50% diagnostic

Rodriguez Ruiz et al, JNCI, 2019.

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Total numbers

101 radiologists




Rodriguez Ruiz et al, JNCI, 2019.  Radboudumc

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Total numbers

4 vendors


- GE
- Hologic
- Philips
- Siemens

Rodriguez Ruiz et al, JNCI, 2019.  Radboudumc

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Total numbers

28,296 independent interpretations

Rodriguez Ruiz et al, JNCI, 2019.  Radboudumc

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AI SYSTEM

Rodriguez Ruiz et al, JNCI, 2019.  Radboudumc

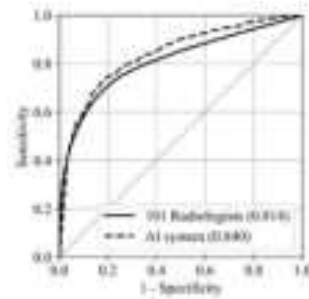
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AI system

Transpara 1.4.0
(ScreenPoint Medical, Nijmegen, the Netherlands)

Based on deep learning algorithms

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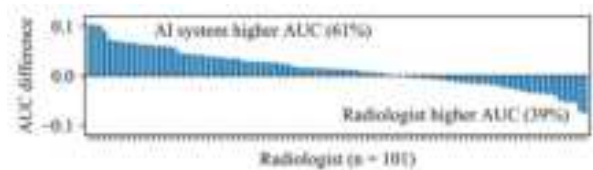


0.814 vs. 0.840
+0.026
95% CI: -0.003, +0.055

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RESULTS

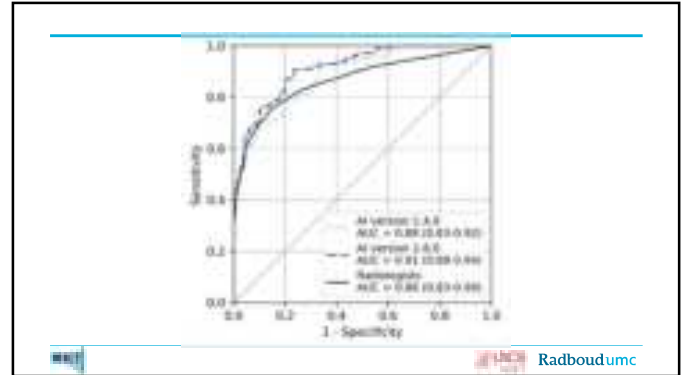
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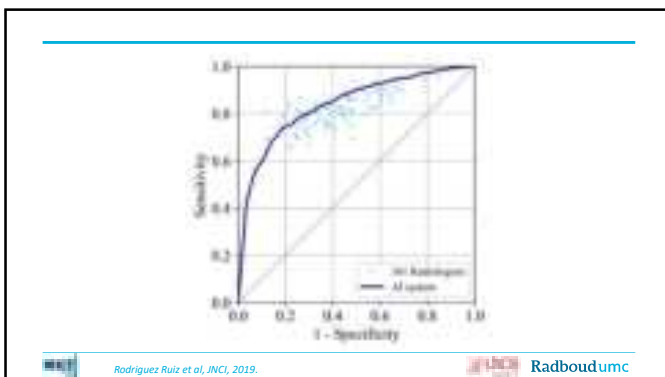
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AI for DM vs. radiologists

720 cases (1,440 breasts)

62 malignant breasts

14 readers

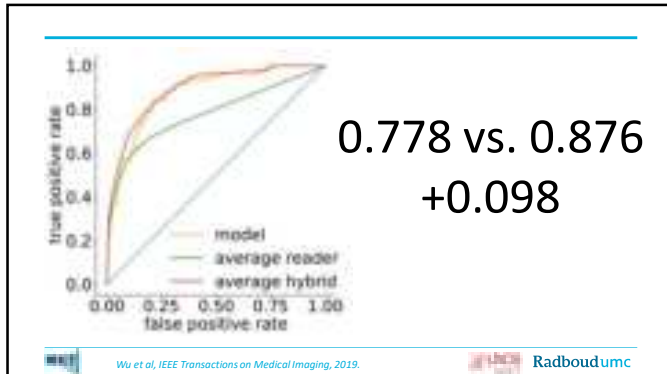
12 radiologists

2 DM vendors (4 models)

Wu et al, IEEE Transactions on Medical Imaging, 2019.

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Retrospective reads

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Enriched data sets

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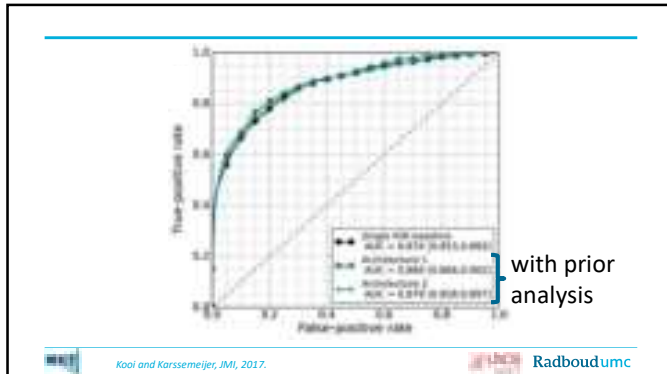
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No prior reading

but...

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We're on our way...

...to where?

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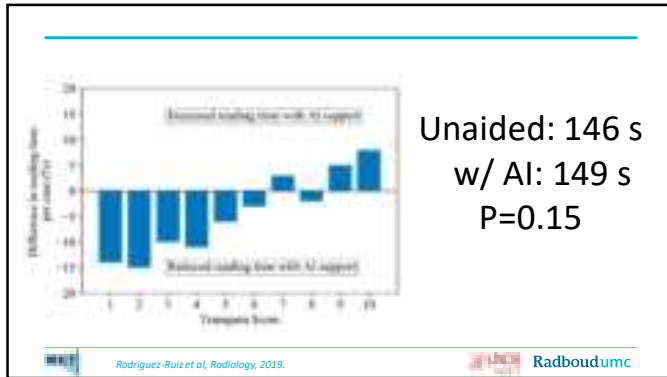
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AI-assisted DM reading

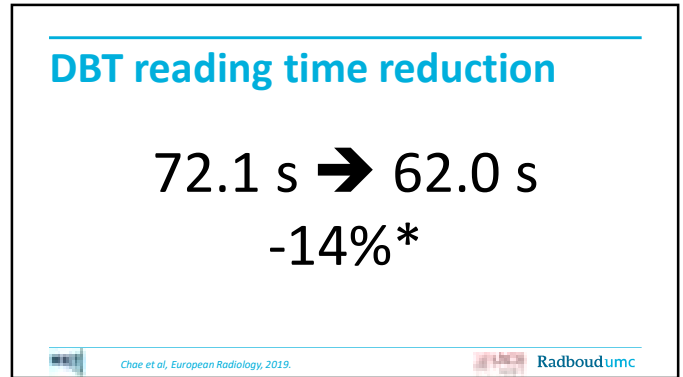
- 240 cases
- 100 cancer cases
- 14 MQSA radiologists
- Transpara 1.4.0 (ScreenPoint Medical)

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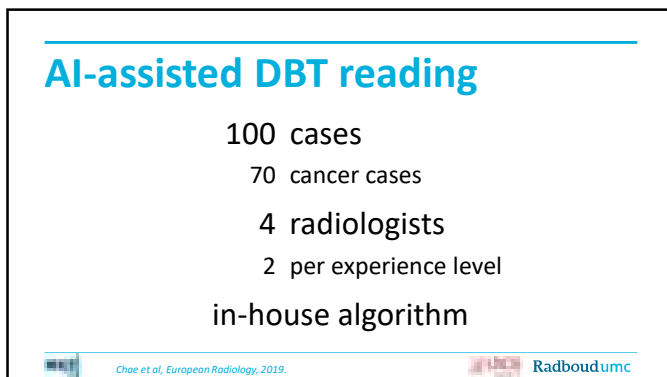
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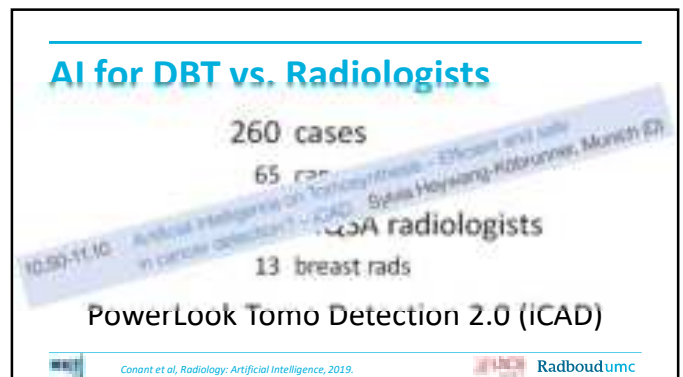
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DBT reading time reduction

64.1 s → 30.4 s
-52.7%*



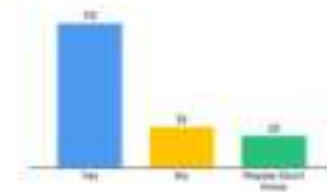
Conant et al, Radiology: Artificial Intelligence, 2019.



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Is a 50% reduction in time only possible if we give up human search?



170 radiologists et al on their phones, RSNA Annual Meeting, Arie Crown, 2019.



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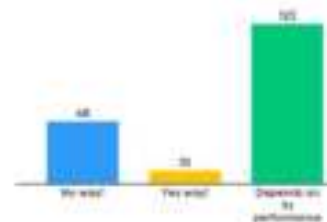
AI-assisted rad reading
OR
rad-assisted AI reading?



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Is it acceptable for only the AI to do the search?



181 radiologists et al on their phones, RSNA Annual Meeting, Arie Crown, 2019.



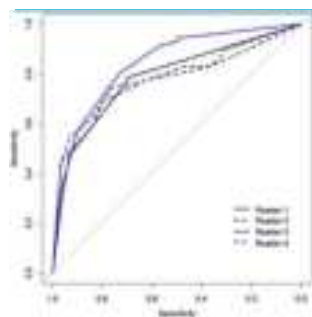
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Better!



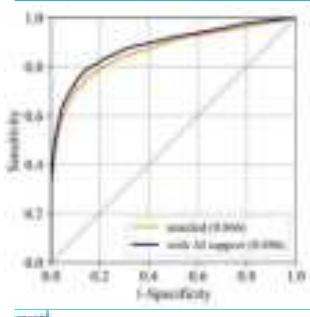
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DBT
14% reduction:
0.778 → 0.776
p=0.924




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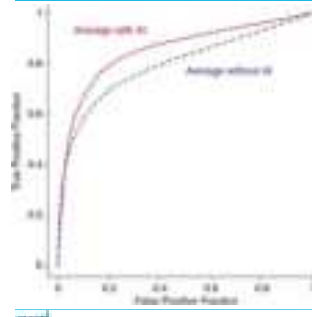


DM:
0.866 [0.83,0.90]
→ 0.886 [0.85,0.92]


+0.020
[0.007, 0.032]
P = 0.002



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DBT
53% reduction:
0.795 → 0.852
+0.057*



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Material and method

Reader review

- Two experienced breast radiologists assessed interval cancers in consensus
 - ▶ Interval cancer types (true negative, minimal signs, false negative)
 - ▶ Correctly localized CAD mark
 - ▶ Clinical information: diseased or generalized breast cancer, breast density, prior surgery, breast implants, time to diagnosis (1 or 2 year)

kristina.lang@med.lu.se Lång et al, European Congress of Radiology, Virtual Vienna, 2020

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Results

Potential reduction of interval cancer

Interval cancer classified as minimal signs or false negative + AI risk score 10 + correctly localized CAD mark

All interval cancer (n=429)

19.3% (95% CI 15.9-23.4)

Interval cancer with grave outcome (n=35)

22.9% (95% CI 12.1-39.0)

Recall thresholds: 4% → 11.2% (95% CI 8.5-14.5)
1% → 4.7% (95% CI 3.0-7.1)

kristina.lang@med.lu.se Lång et al, European Congress of Radiology, Virtual Vienna, 2020

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Results

Distribution of AI risk score

All interval cancer (n=429)

33.3%

Interval cancer with grave outcome (n=35)

28.6%

kristina.lang@med.lu.se Lång et al, European Congress of Radiology, Virtual Vienna, 2020

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Less!

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AI Assisted Reading vs. Standalone AI



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47% decrease in cases
 → -7% cancers
 -27% false positives



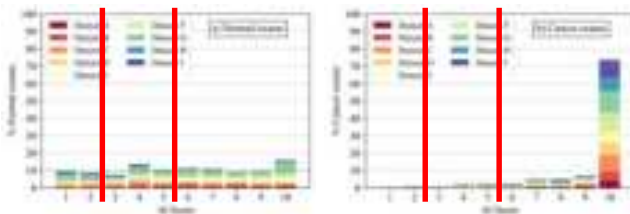
Rodríguez Ruiz et al, Eur Radiol, 2019.



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AI Pre-selection



Rodríguez Ruiz et al, Eur Radiol, 2019.



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20% decrease in cases
 → -1% cancers
 -5% false positives

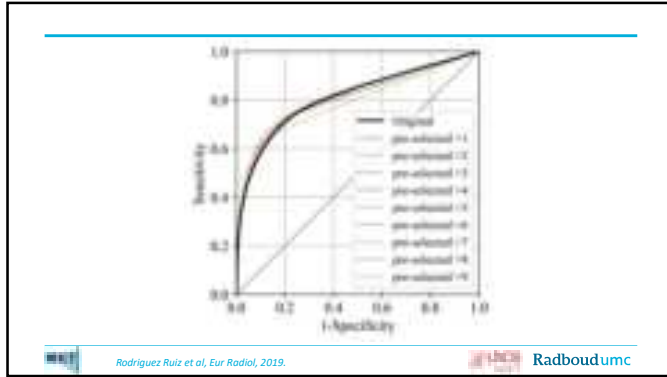


Rodríguez Ruiz et al, Eur Radiol, 2019.

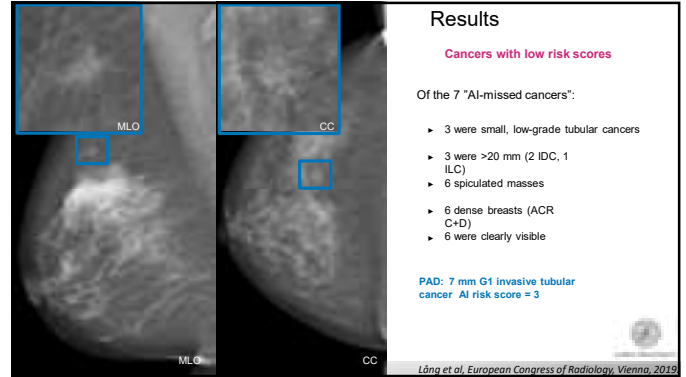


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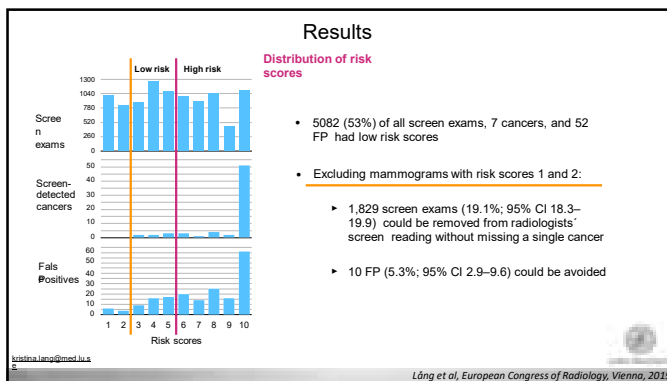
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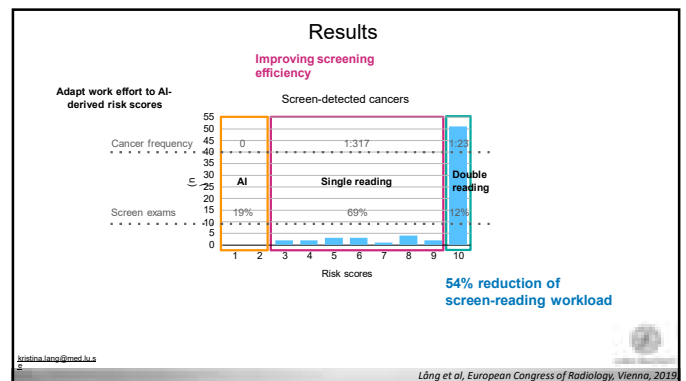
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63



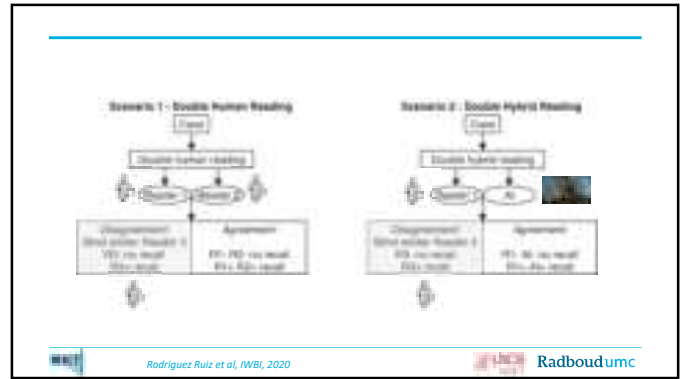
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64



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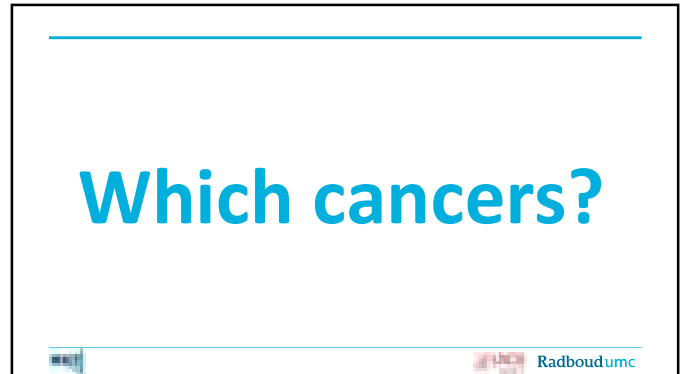
	Double Human Reading	Double Hybrid Reading	Difference
Workload (%)	100	56 (55, 57)	-44 (-42, -45) P<0.001

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	Double Human Reading	Double Hybrid Reading	Difference
Sensitivity (%)	81.5 (75.8, 87.3)	81.4 (75.3, 87.2)	-0.1 (-4.1, 3.9) P = 0.88
Specificity (%)	69.9 (68.4, 71.5)	75.2 (73.8, 76.7)	+5.3 (4.0, 6.7) P<0.001

Rodriguez Ruiz et al, IWB, 2020

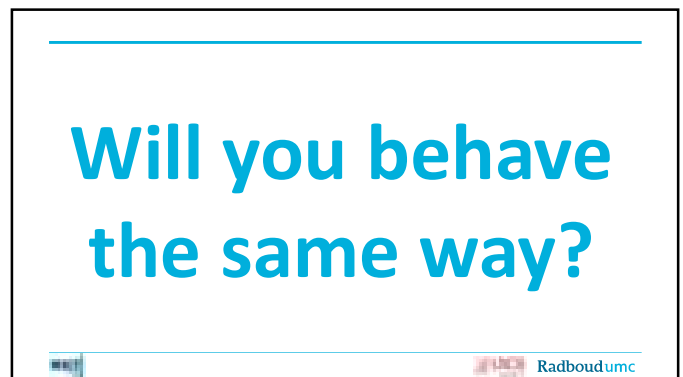
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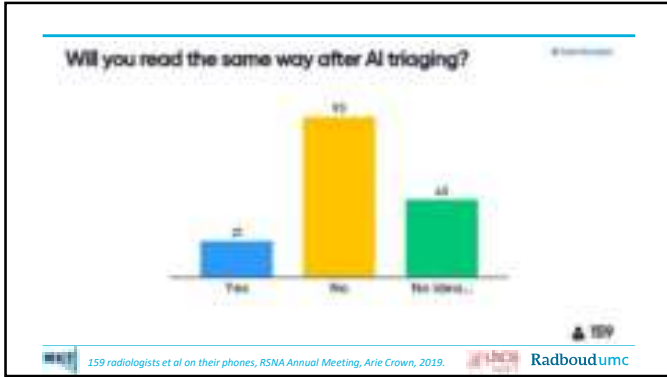
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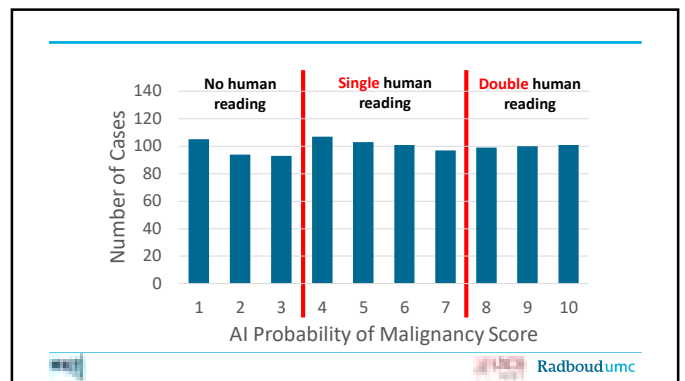
aiREAD
Accurate and Intelligent Reading for EARlier breast cancer Detection

KWF NMD Radboudumc

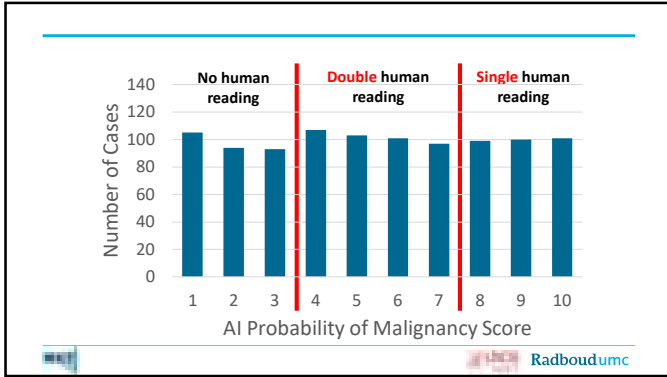
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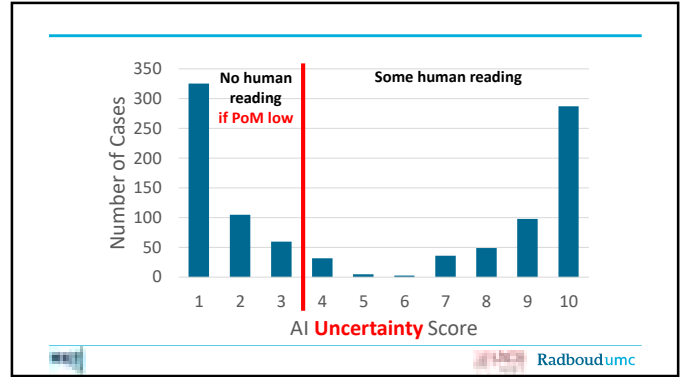
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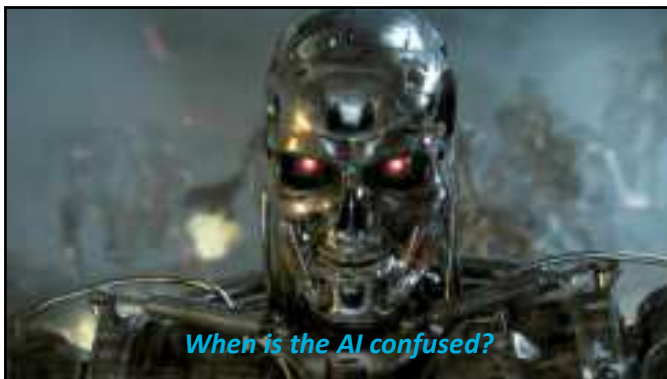
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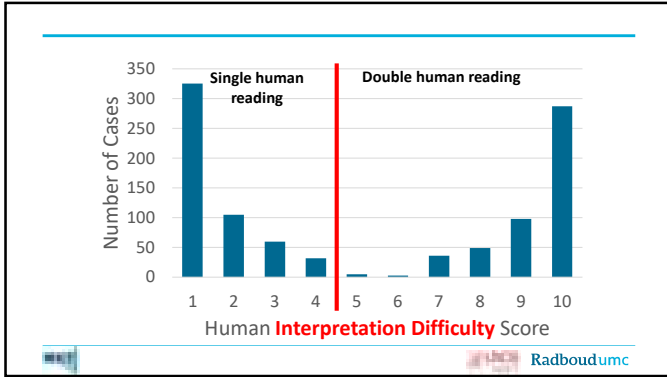
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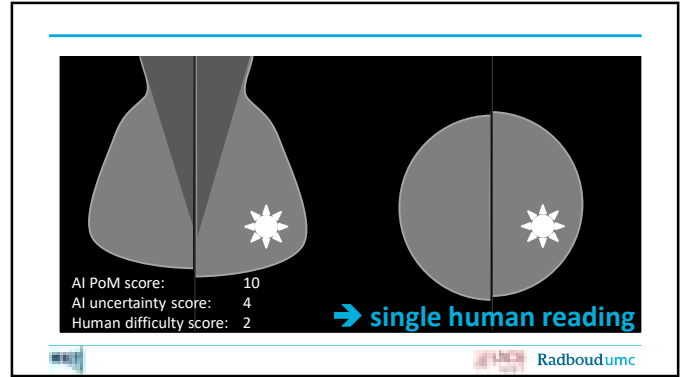
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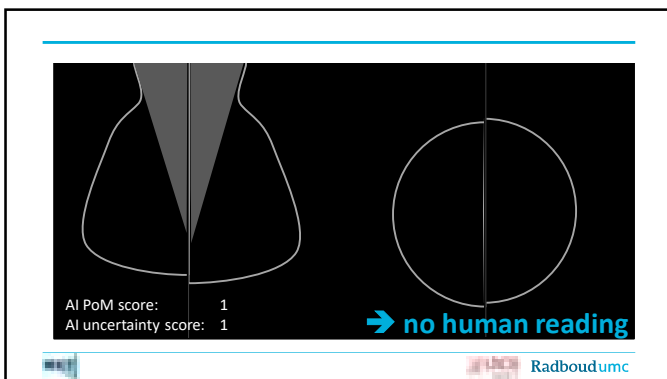
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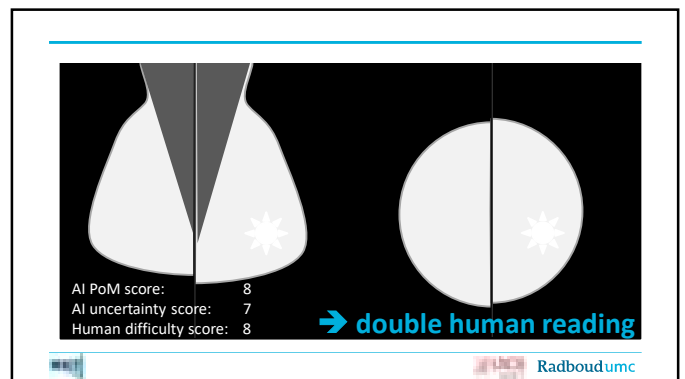
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AI for breast image interpretation



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Faster?

yes!

is rad-assisted AI reading acceptable?



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Better?

“lab” results say yes
reduction in missed cancers

need for prospective screening-
prevalence trials



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Less?

pre-selection
single human reading
other...

promising results, more needed



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Thank you for your attention!

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