


## AI for breast imaging

Are the robots coming, or are they already here?






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1

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

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




2

## Disclosures

Research Agreements: Siemens Healthcare  
Canon Medical Systems

Speaking Agreements: Siemens Healthcare  
Hologic

ScreenPoint Medical is a spin-off company from my  
Department. I have no financial relationship with  
ScreenPoint.









3

## AXTI Lab (Advanced X-ray Tomographic Imaging)

Ritse Mann

Alejandro Rodriguez-Ruiz  
Nico Karssemeijer

4

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## AI for Breast Imaging

How good are they?

Faster!

Better!

Less!



5

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## Why now?



6

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## Running out of screening radiologists



7

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## DBT takes time



8

## False negatives

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



Romero Martin et al, European Radiology, 2018

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9

## False negatives

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



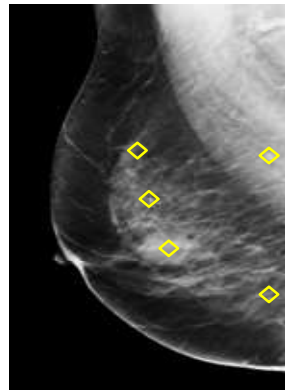
Lång et al, Br J Radiol 2014;87:20140080

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10



Confessions of a  
SLIGHTLY NEUROTIC  
HITWOMAN  
JB LYNN



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11

# How good is it?




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12

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# AI system

# Breast screening radiologists



The image shows a metallic robot head on the left and two female radiologists in white coats looking at multiple computer monitors displaying mammography images on the right.

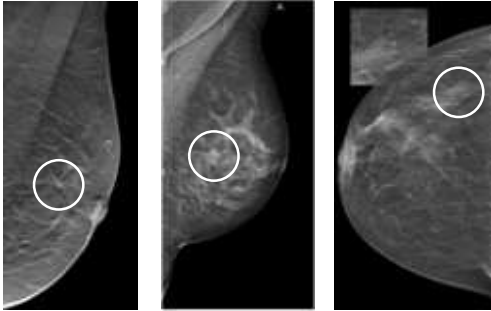
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13



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# Task: detect breast cancer in mammography



# Case level

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14

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# Digital Mammography Cases

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15

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# 9 Previous multi-reader multi-case retrospective studies



The image displays the logos for four journals: Radiology, European Radiology, Investigative Radiology, and the FDA.


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 *Rodriguez Ruiz et al, JNCI, 2019.* 


16

## Datasets



50% radiologists



50% radiologists





Varied datasets characteristics & sizes  
Different radiologists



 Rodriguez Ruiz et al, JNCI, 2019. 

17

## Breast screening radiologists

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

 Rodriguez Ruiz et al, JNCI, 2019. 



18

## Total numbers

**2,652 exams**

653 malignant (i.e. enriched sets)

50% screening/50% diagnostic

 Rodriguez Ruiz et al, JNCI, 2019. 

19

## Total numbers

**101 radiologists**



 Rodriguez Ruiz et al, JNCI, 2019. 

20

## Total numbers

**28,296 independent interpretations**



Rodriguez Ruiz et al, JNCI, 2019.



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21

## Total numbers

**4 vendors**

GE  
Hologic  
Philips  
Siemens



Rodriguez Ruiz et al, JNCI, 2019.



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# AI SYSTEM



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## AI system

Transpara 1.4.0  
(ScreenPoint Medical, Nijmegen, the Netherlands)

Based on deep learning algorithms



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## Statistical analysis

Non-inferiority hypothesis in terms of area under the ROC curve (AUC)

Margin 0.05



Rodriguez Ruiz et al, JNCI, 2019.



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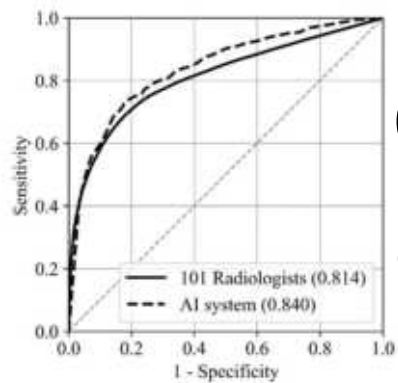
25

# RESULTS



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

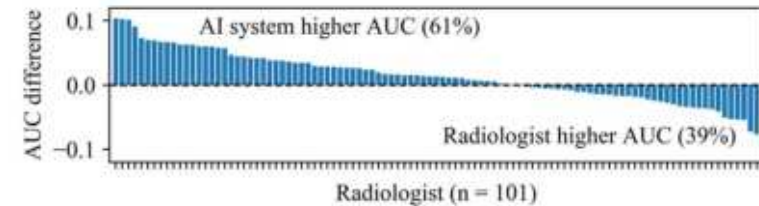


Rodriguez Ruiz et al, JNCI, 2019.



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27

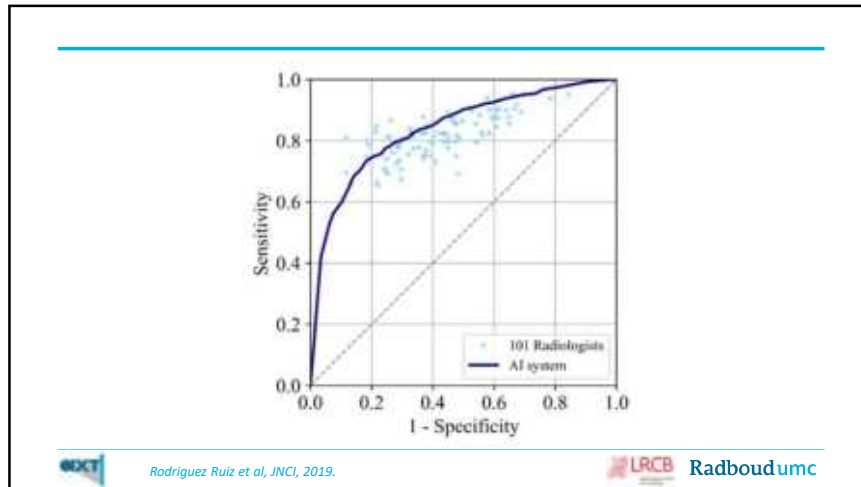


Rodriguez Ruiz et al, JNCI, 2019.

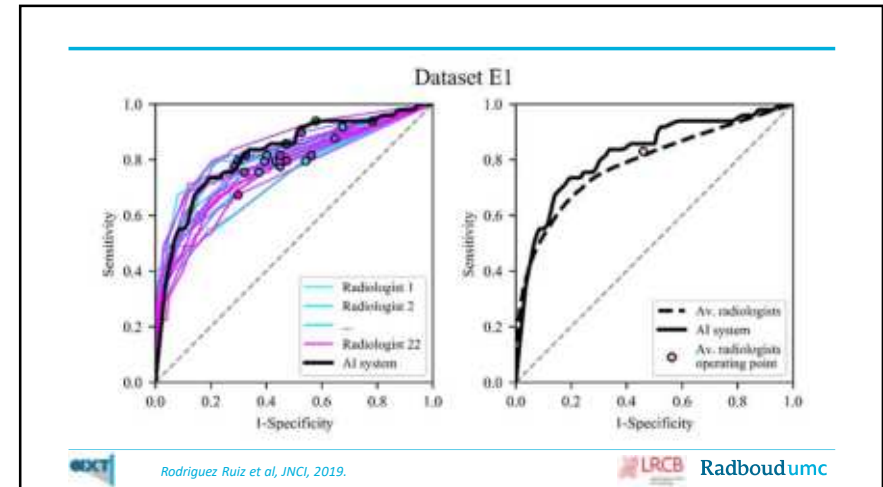


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28



29



30

## Limitations

Not all datasets were  
bilateral and with priors

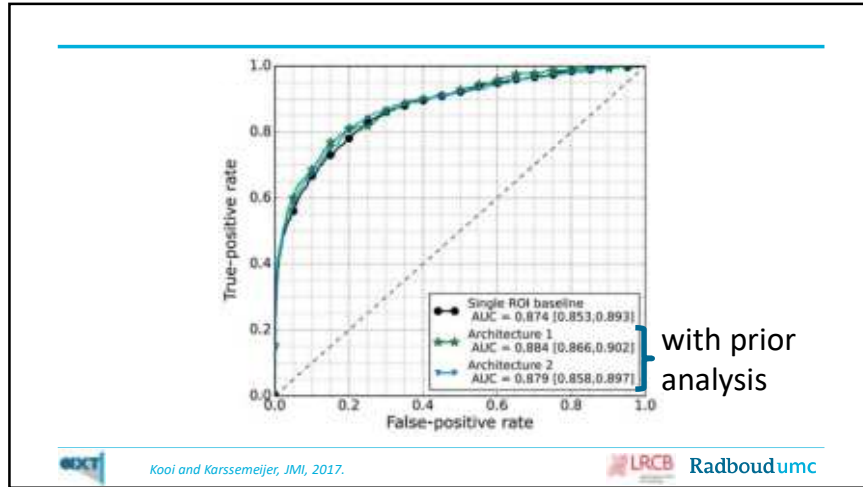
31

AI doesn't consider  
priors...

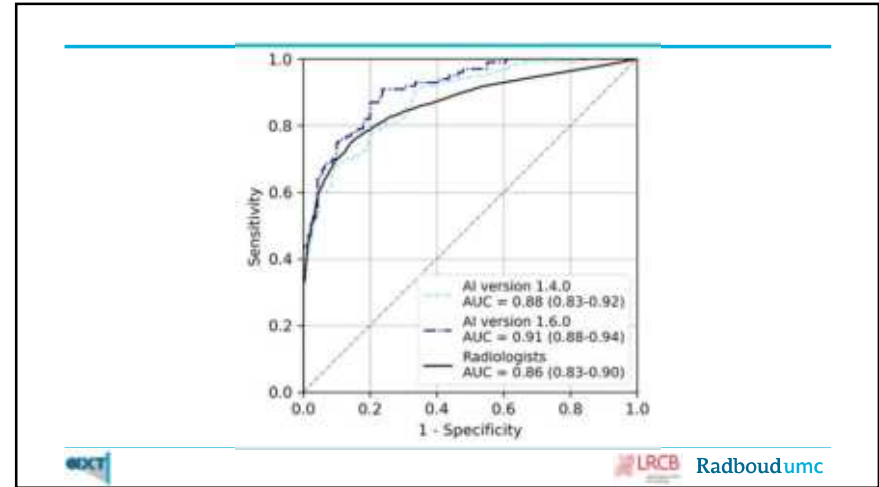
...but...

32

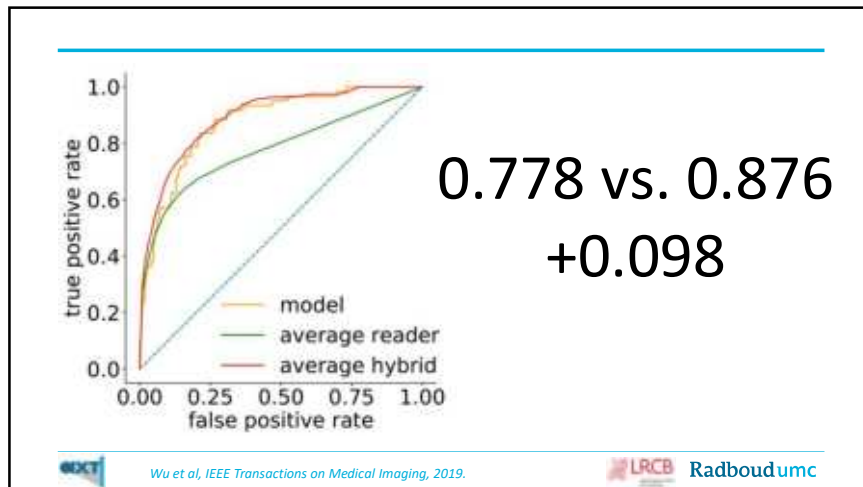




33



34



35

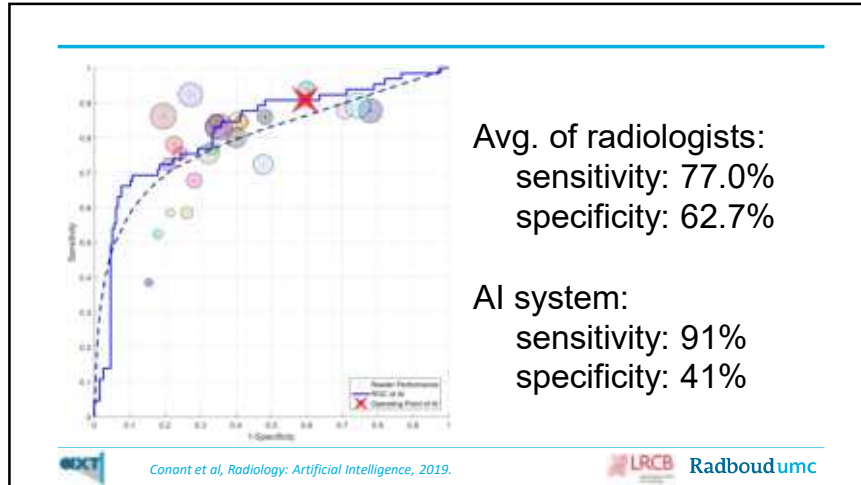
## AI for DBT vs. Radiologists

- 260 cases
  - 65 cancer cases
- 24 MQSA radiologists
- 13 breast rads

PowerLook Tomo Detection 2.0 (iCAD)

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36



37

# Enriched data sets

# Retrospective reads

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# We're on our way...

# ...to where?

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# Faster!

FASTER THAN A SPEEDING BULLET

WRONG SUPERHERO

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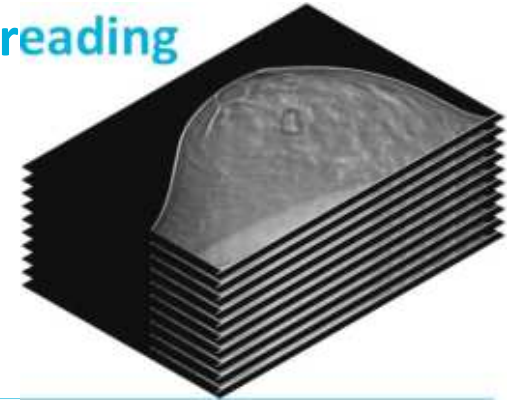
40

$$\text{RT(DBT)} = 2.0 * \text{RT(DM)}$$



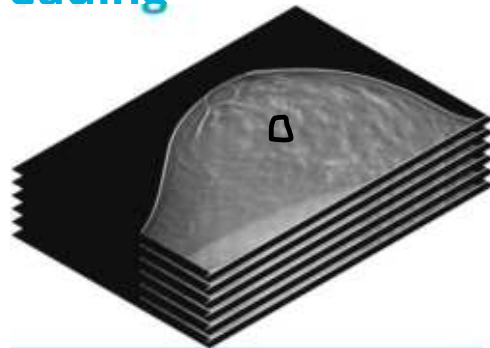
41

## AI-assisted reading



42

## AI-assisted reading



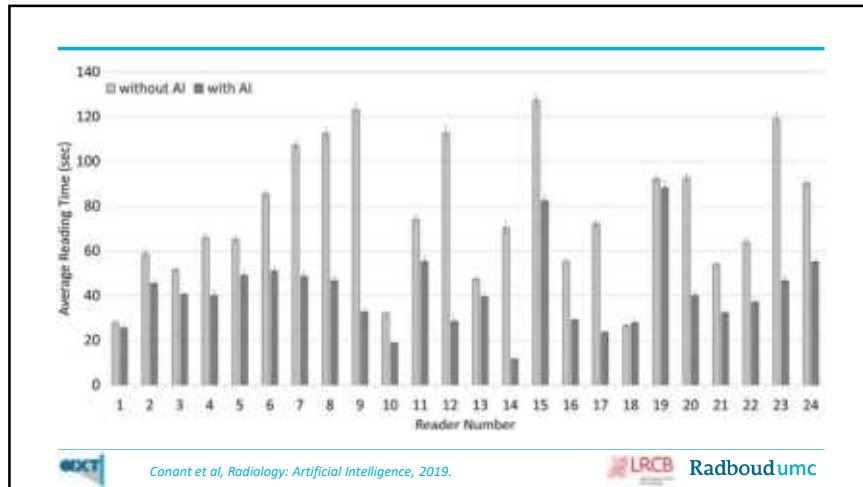
43

## Reading time reduction

64.1 s → 30.4 s  
-52.7%\*



44



45

# AI-assisted rad reading

## OR

# rad-assisted AI reading?

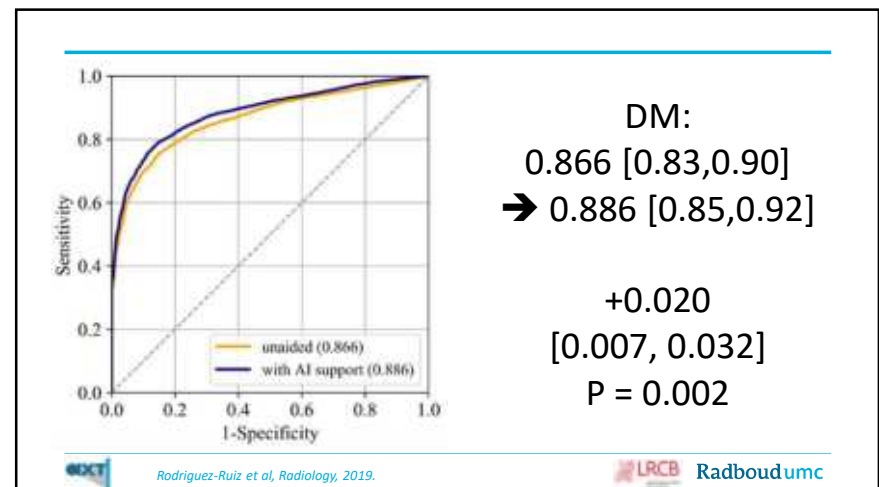
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46

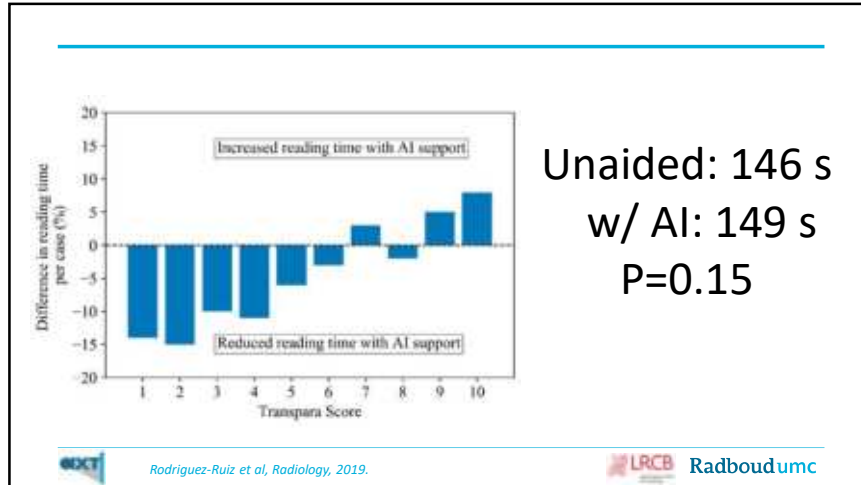
# Better!

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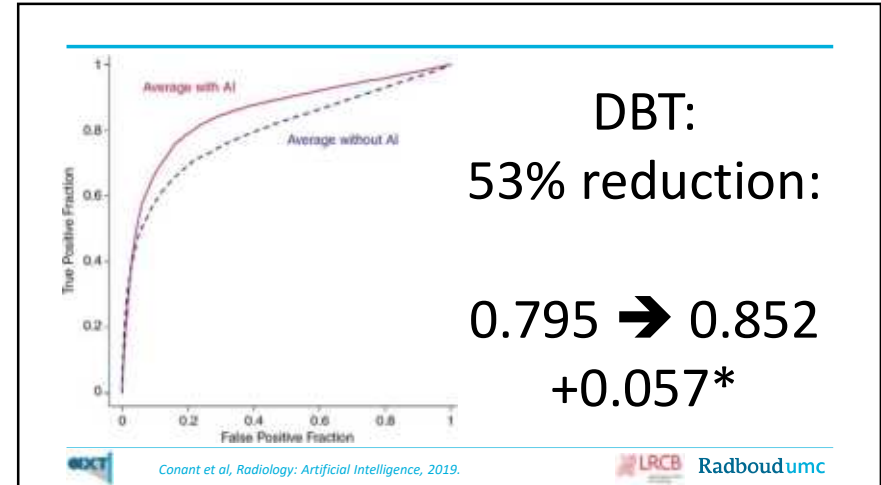
47



48



49



50

**Less!**

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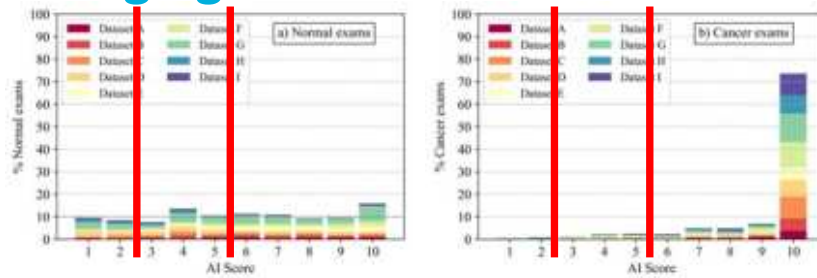
51

**AI Assisted Reading  
vs.  
Standalone AI**

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52

## Triaging AI



Rodriguez Ruiz et al, Eur Radiol, 2019.

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47% decrease in cases

➔ -7% cancers  
-27% false positives

Rodriguez Ruiz et al, Eur Radiol, 2019.

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54

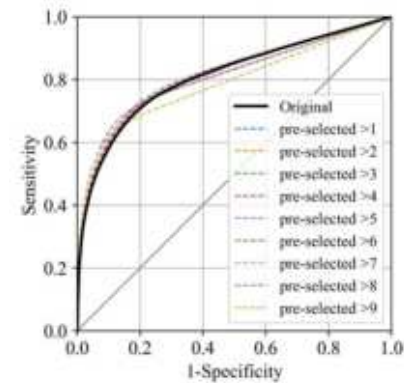
20% decrease in cases

➔ -1% cancers  
-5% false positives

Rodriguez Ruiz et al, Eur Radiol, 2019.

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55



Rodriguez Ruiz et al, Eur Radiol, 2019.

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56

All 8 missed cancers were “clearly visible”



Grab the Low Hanging Fruit

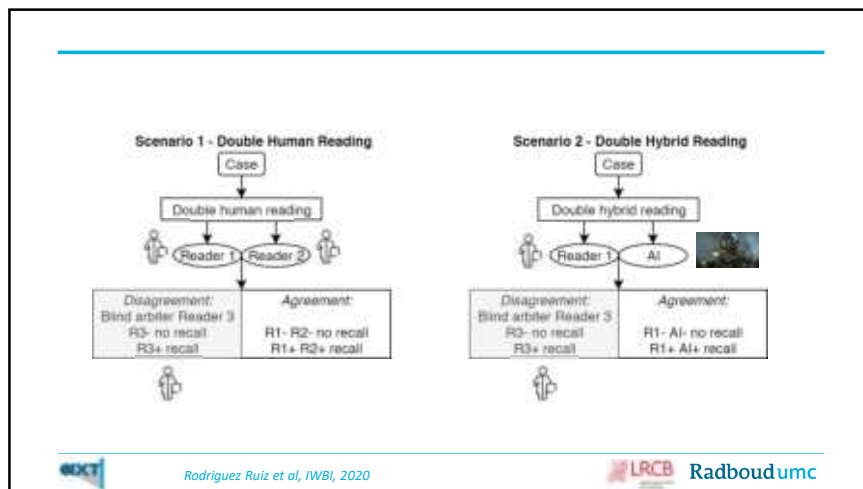
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Lång et al, European Congress of Radiology, Vienna, 2019.



57




58





59

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



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Rodriguez Ruiz et al, IWBI, 2020

60






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


*Rodriguez Ruiz et al, IWBI, 2020*
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61

# Which cancers?

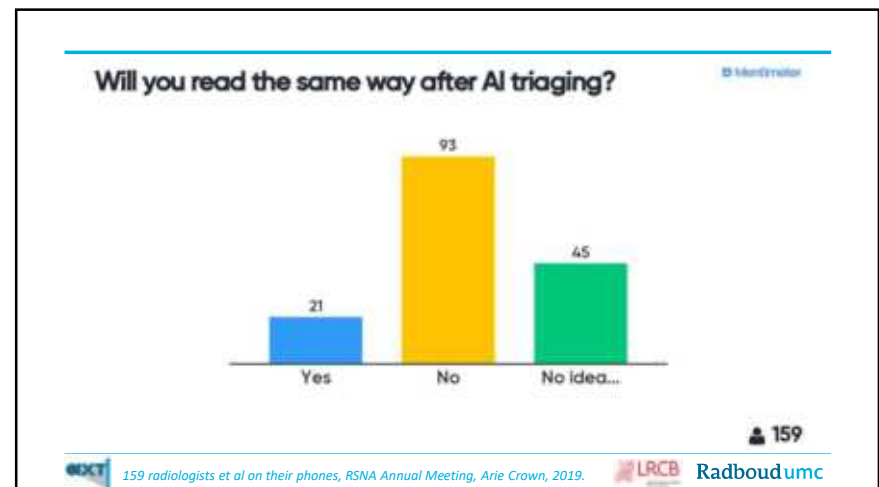

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# How will radiologists behave?


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64



## AI for breast image interpretation



65

### Better?

”lab” results say yes  
need for prospective  
screening-prevalence trials



66

### Faster?

yes!

is rad-assisted AI reading  
acceptable?



67

### Less?

triaging  
single human reading  
other...

promising results, more needed



68

## Our role...

Even with commercial software,  
**WE** are the scientists to  
 determine/prove the role of AI in  
 clinical breast imaging!

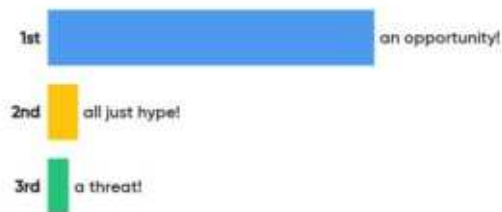


69



70

## AI for DM/DBT is....



116



71

## Thank you for your attention!

(hopefully you weren't checking your emails all this time...)

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72