Oct. 20 EANM 2014, Luncheon-symposium 13:00-

What is BSI?
Its history and technique

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Disclosure Statement
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Consultant (No), Speakers bureau (No), Honoraria and/or Stockholder (No)

Acquisition conditions for bone scan

	EU (EANM 2003)	USA (ACR-SNM 2014)	UK (BNMS 2014)	Japan (JSNMT2008)
Activity (^{99m}Tc iv-injection)	300-740 MBq	555-1110 MBq (obese: 1480 MBq)	600 MBq	740MBq
Radiophar-maceutical	MDP, HMDP or HEDP	MDP, HDP or comparable	MDP, HMDP or HDP	MDP, HMDP
Labelling efficiency	>95%	.	.	.
Time delay	2 - 5 hrs	2 - 4 hrs	>2.5 hrs	2 - 3 hrs
Views	Ant +Post	Ant + Post	Ant + Post	Ant + Post
Collimator	LEHR	LEHR/ultra-HR	LEHR/caridac-HR	LEHR
Energy window	140 keV (±10%)	.	140 keV (±10%)	140 keV (±10%)
Matrix	256 x 1024	.	256 x 1024	256 x 1024
Counts/view	>1.5 million (scan speed adjusted to)	>1 million (scan speed 8-15 cm/min)	. (scan speed 10 cm/min)	. (scan speed <15 cm/min)

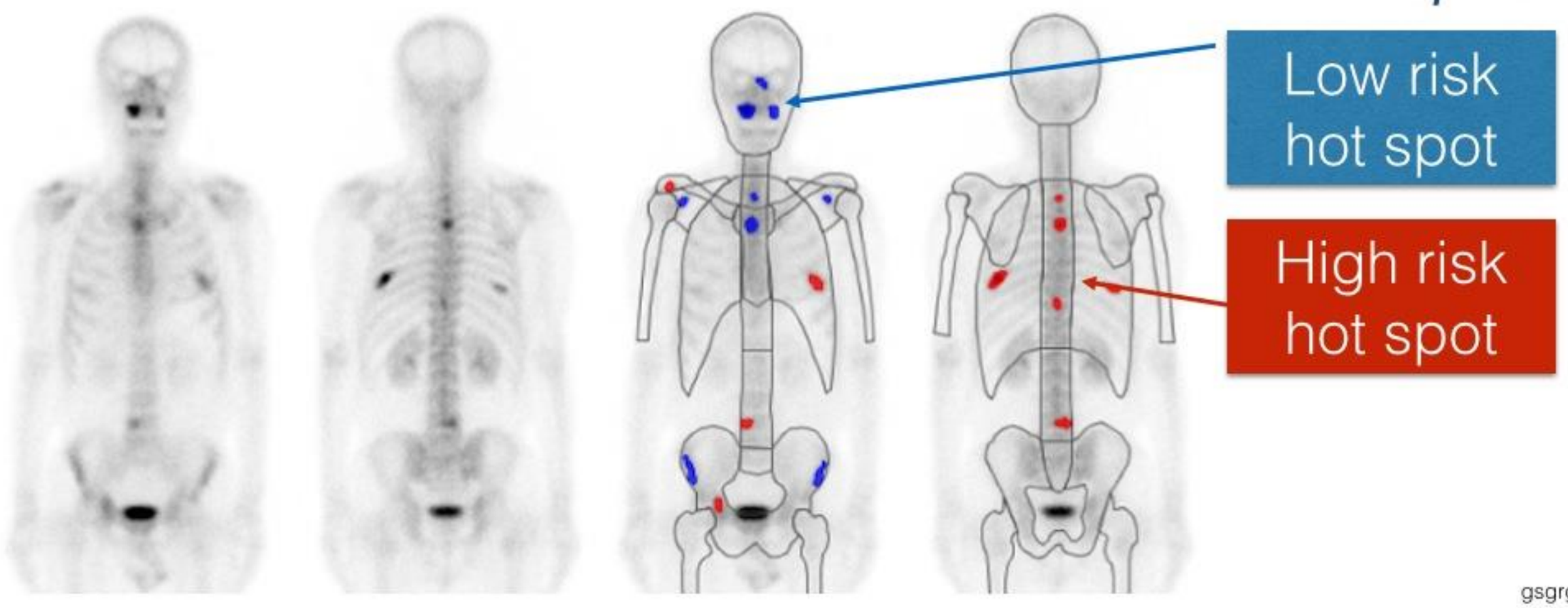
Parameters from EXINI bone/BONENAVI

Three major indices of ANN, BSI and HSn

ANN	BSI	HSn
Artificial Neural Network	Bone Scan Index (%)	Number of hot spots

ANN	BSI (%)	Hs(n)
0.99	0.59	9

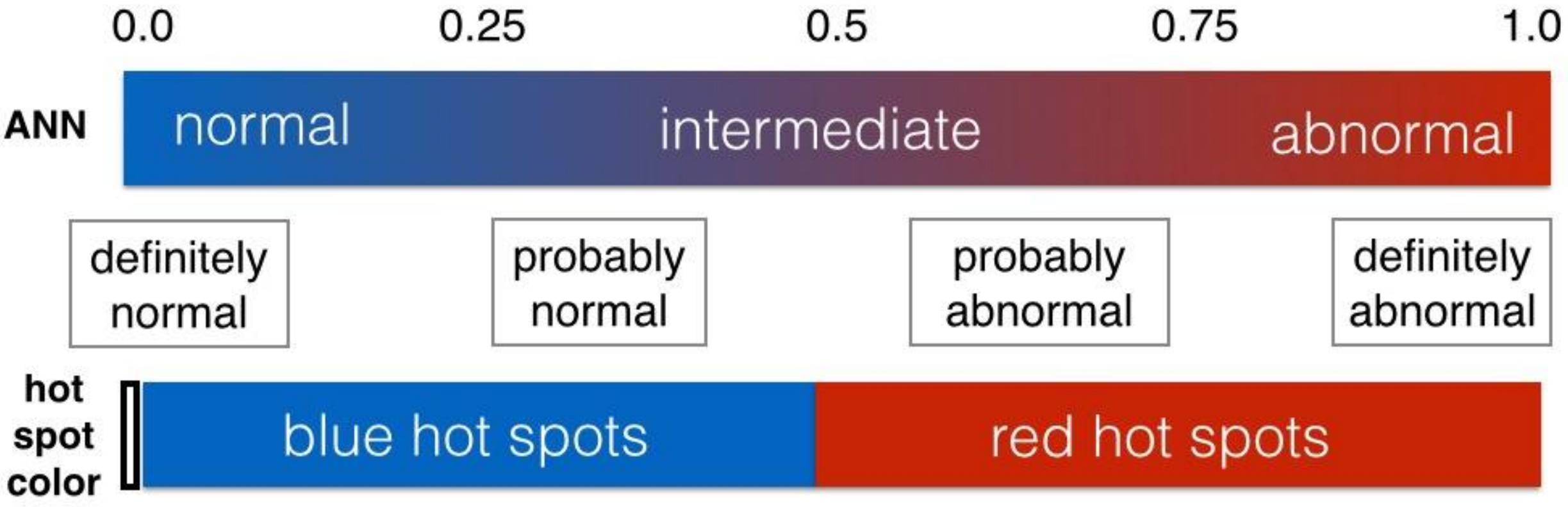
Two colors of hot spots



gsgrg

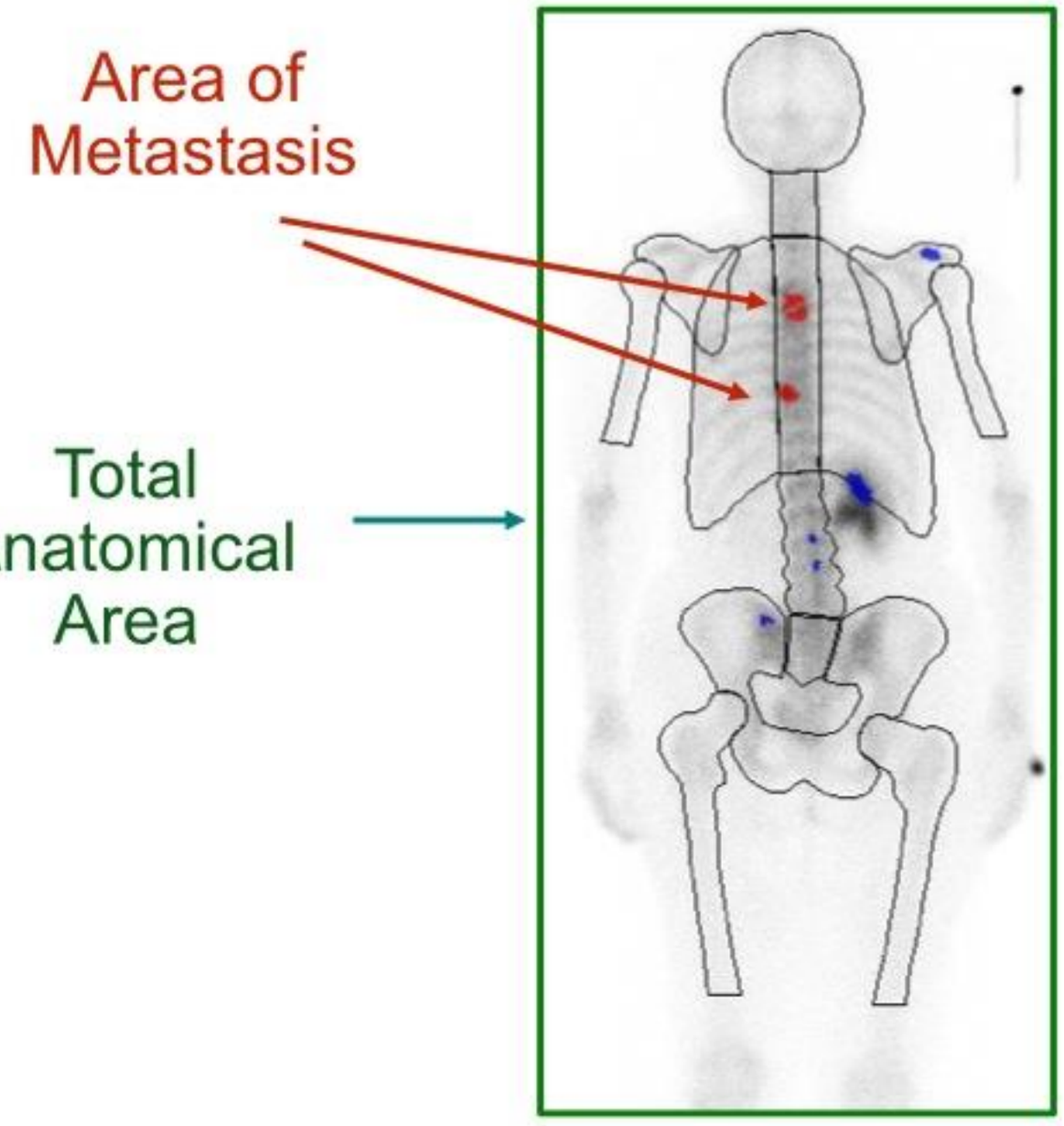
What is ANN (artificial neural network) value?

- ANN system was trained to mimic assessment of experienced readers
- ANN values indicate probability of abnormality
- ANN is calculated for each hot spot. Appropriate threshold of ANN depends on locations.



What is BSI?

- Amount of bone metastasis / whole body skeletal mass
- Summed only when ANN > 0.5



$$BSI = \frac{\sum \text{Area of Metastases} * C}{\text{Total Anatomical Area}}$$

C = Anatomical Area Coefficient

Erdi et al, J Nucl Med 1997;38:1401

BSI from Memorial Sloan Kettering Cancer Center

JNM1997

Quantitative Bone Metastases Analysis Based on Image Segmentation

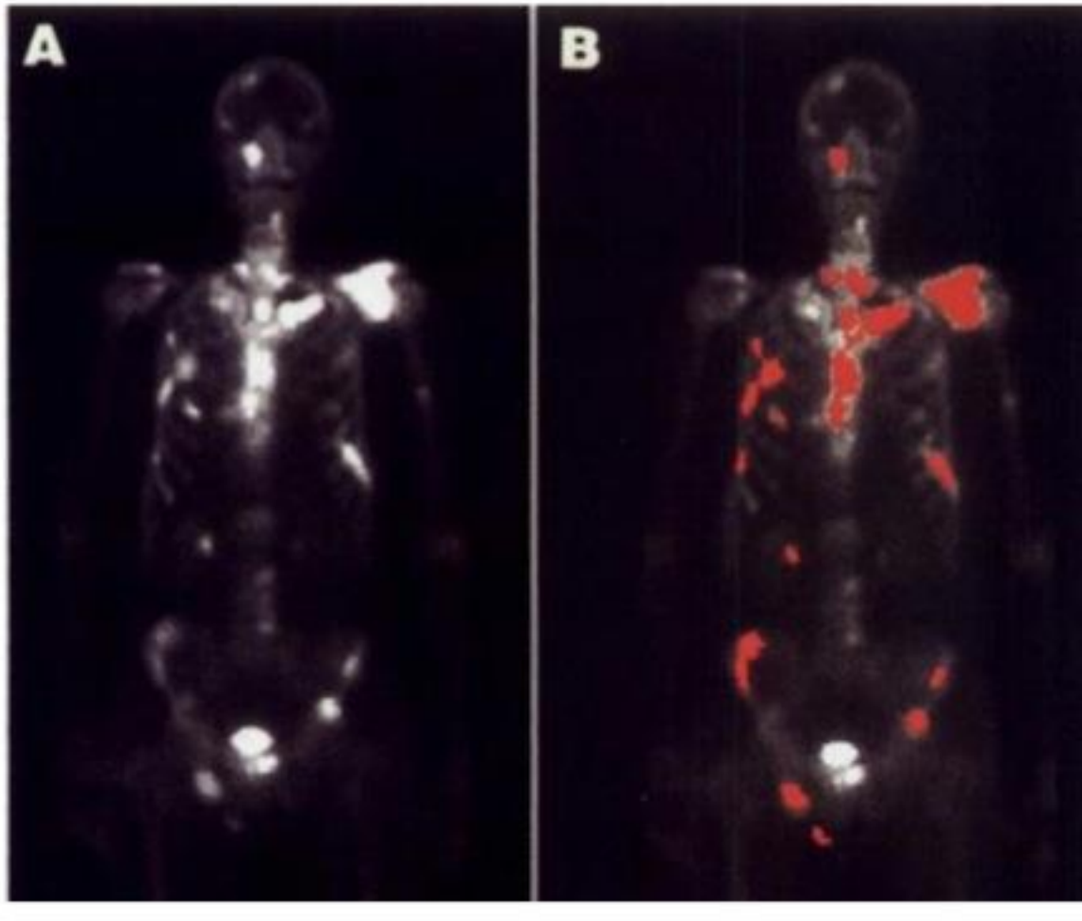
Yusuf E. Erdi, John L. Humm, Massimo Imbriaco, Henry Yeung and Steven M. Larson
Department of Medical Physics, Nuclear Medicine Service, Department of Radiology, Memorial Sloan–Kettering Cancer Center, New York, New York

Clin. Cancer Res 1998

A New Parameter for Measuring Metastatic Bone Involvement by Prostate Cancer: The Bone Scan Index[1]

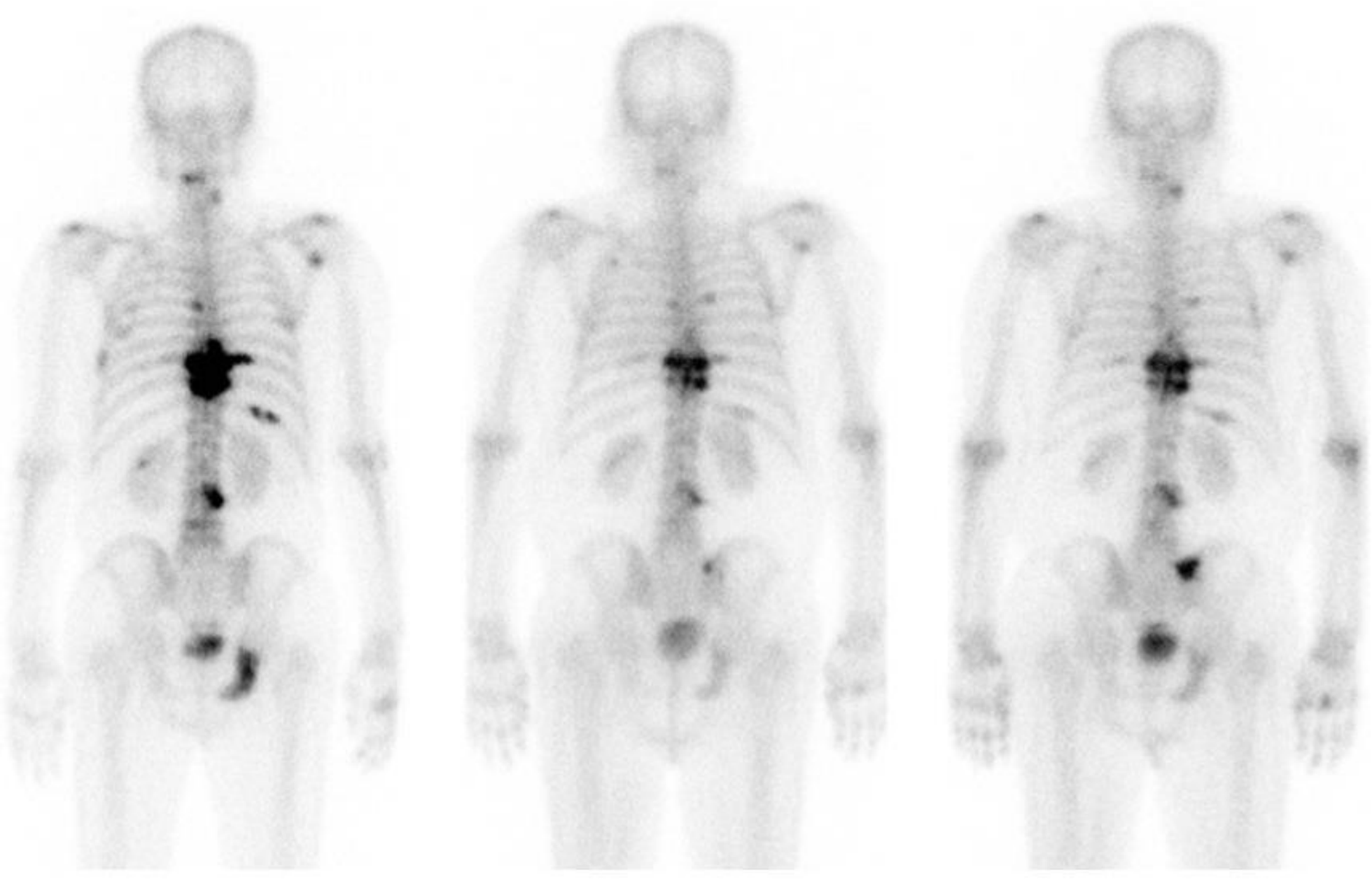
Massimo Imbriaco, Steven M. Larson,[2] Henry W. Yeung, Osama R. Mawlawi, Yusuf Erdi, Ennpadam S. Venkatraman, and Howard I. Scher

- The fractional involvement of each bone by tumor was estimated visually from bone scan

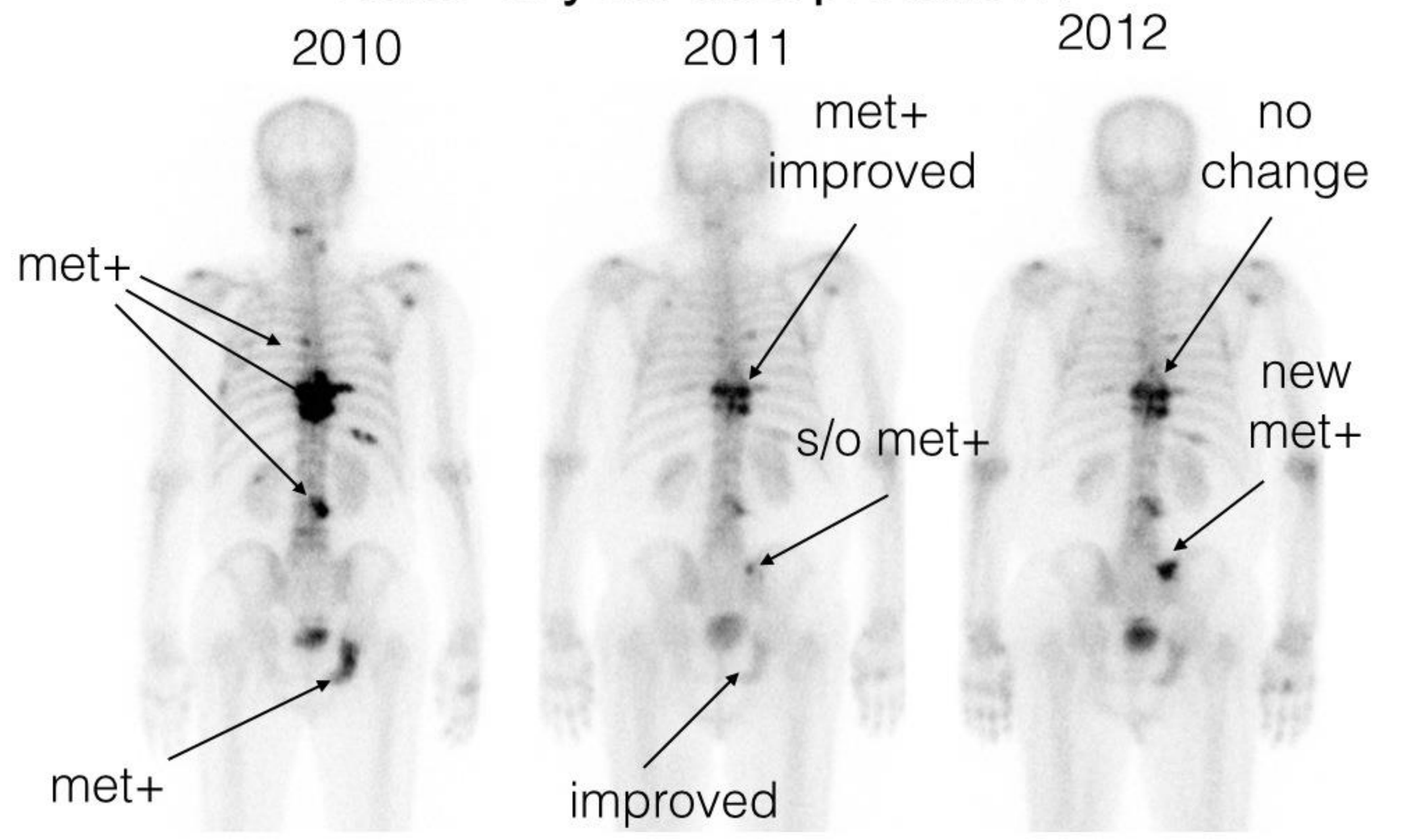


A patient with prostate cancer
What is your interpretation?

2010 2011 2012

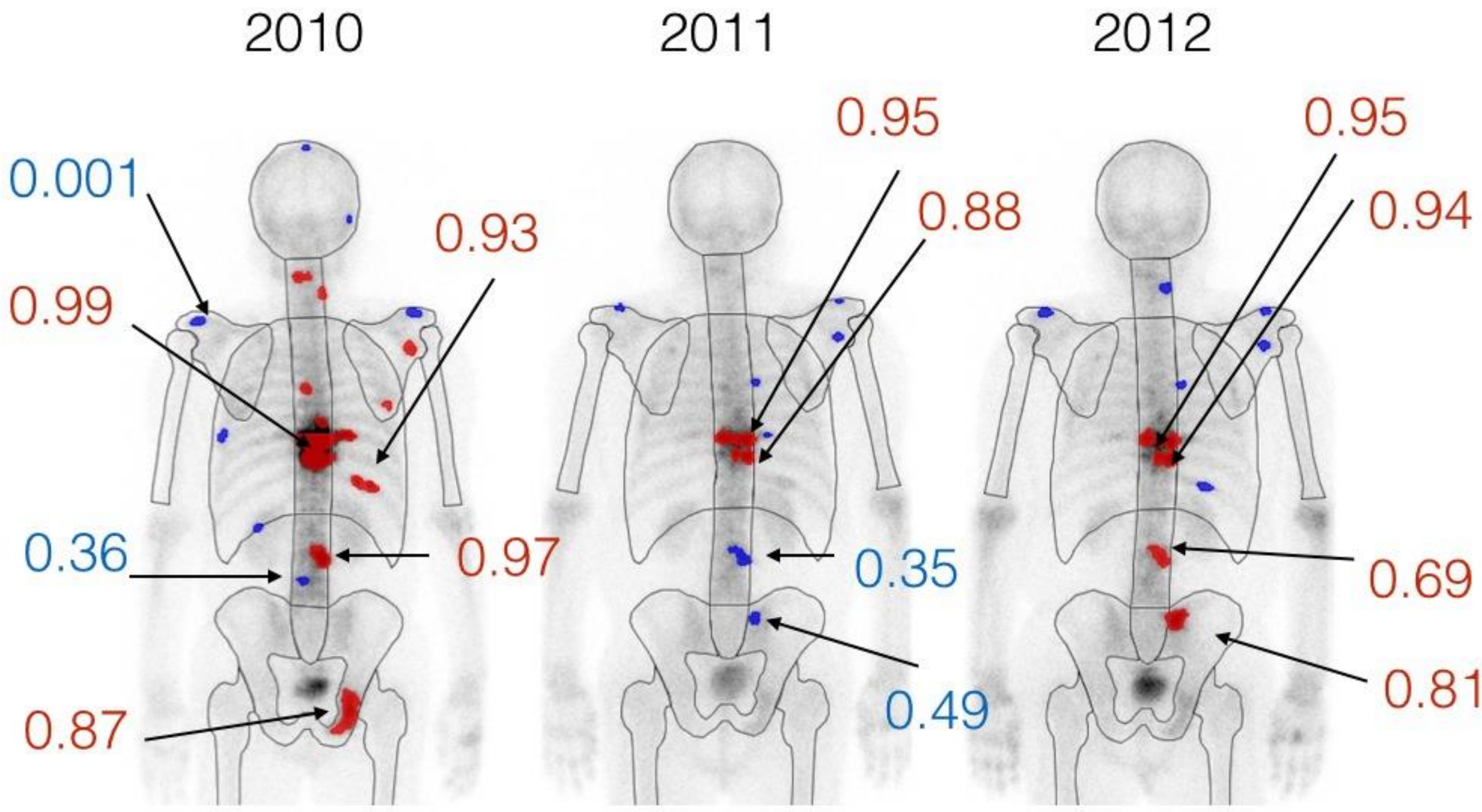


A patient with prostate cancer
What is your interpretation?



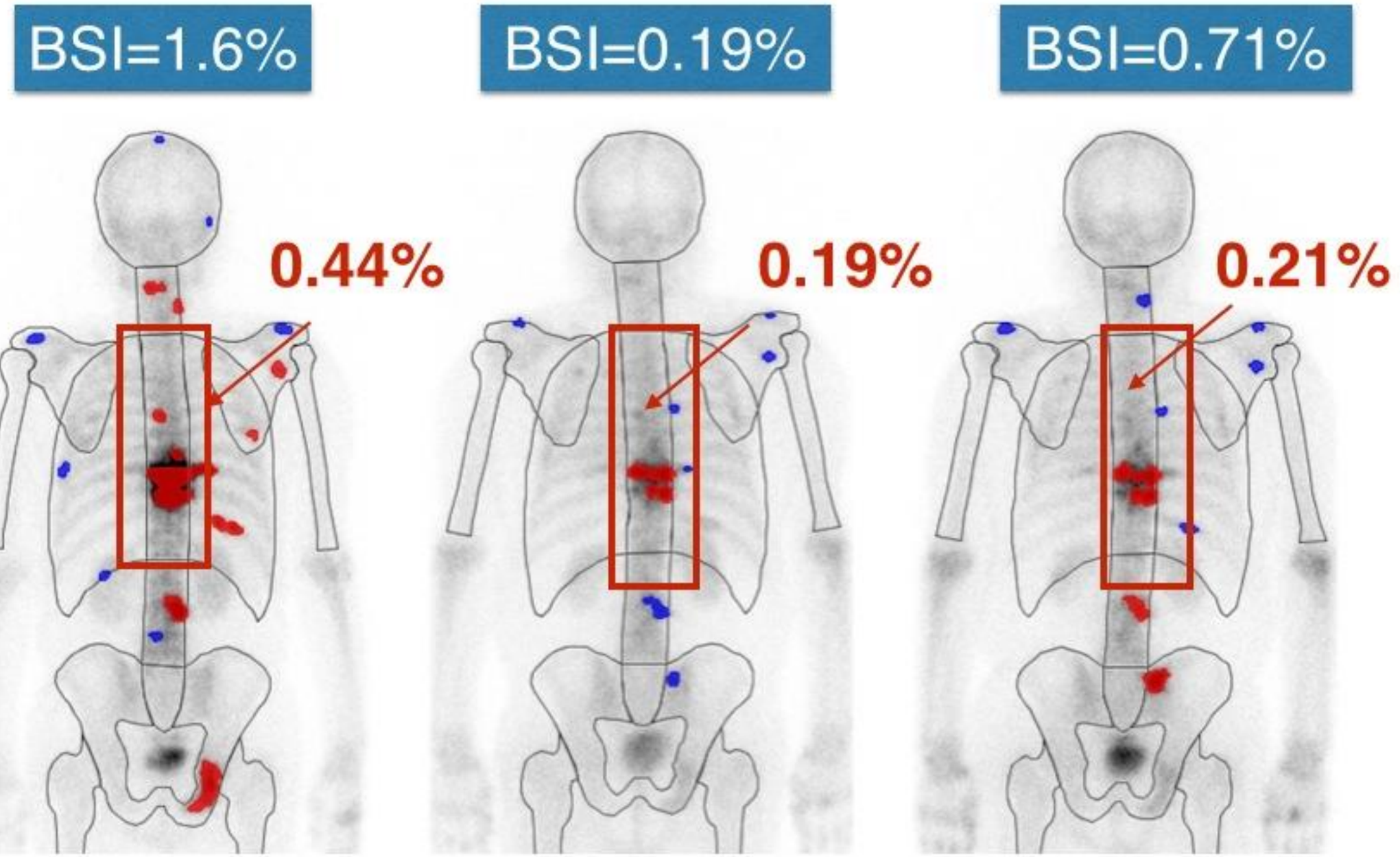
How does the computer think using ANN?

Regional ANN: probability of metastasis in each hot spot



How does the computer estimate total amount of metastasis using BSI?

Total BSI and regional BSI (if required)

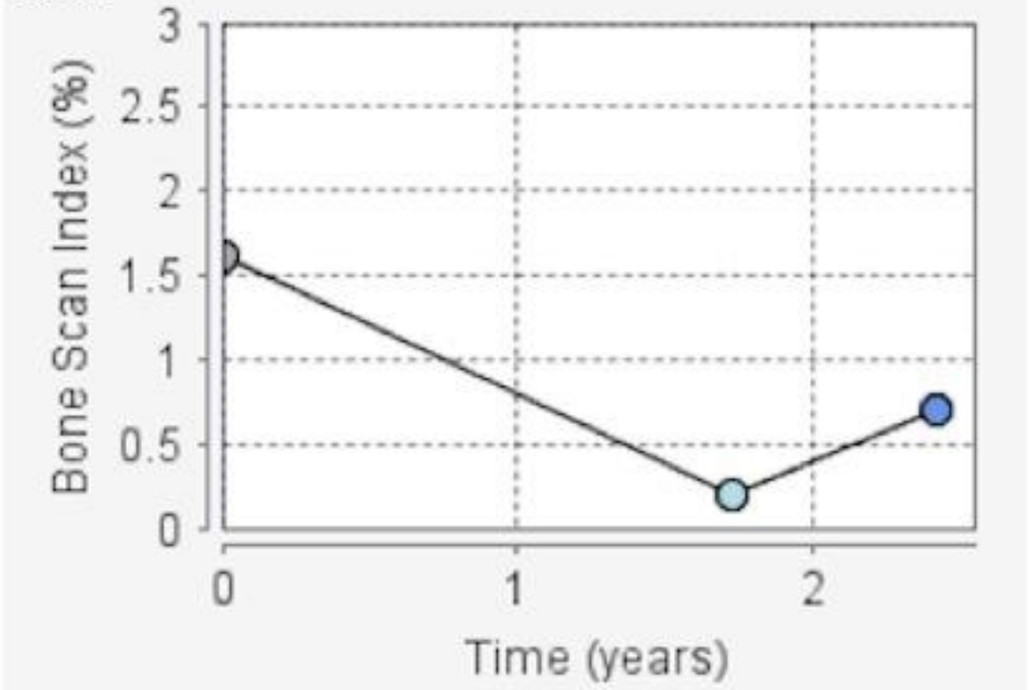


Follow-up summary using BSI and HSn using EXINI bone / BONENAVI

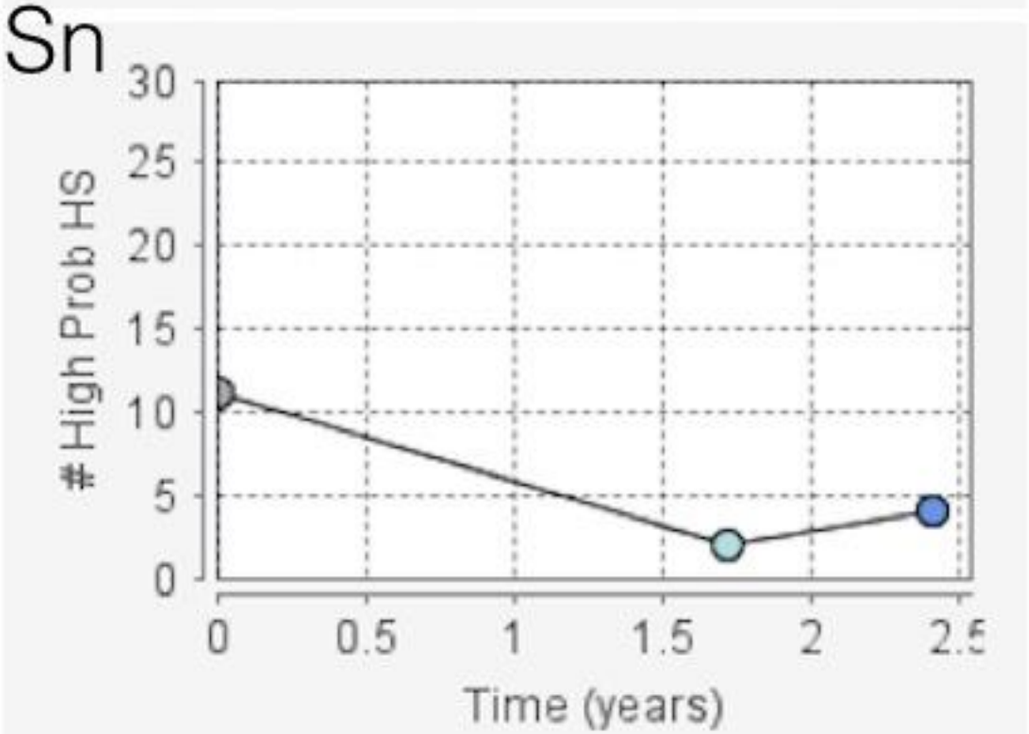
	BSI	No. of HS
2010	**1.62%**	11
2011	**0.19%**	2
2012	**0.71%**	4

- Instead of reporting “patly improved, partly worsened, essentially no change …”

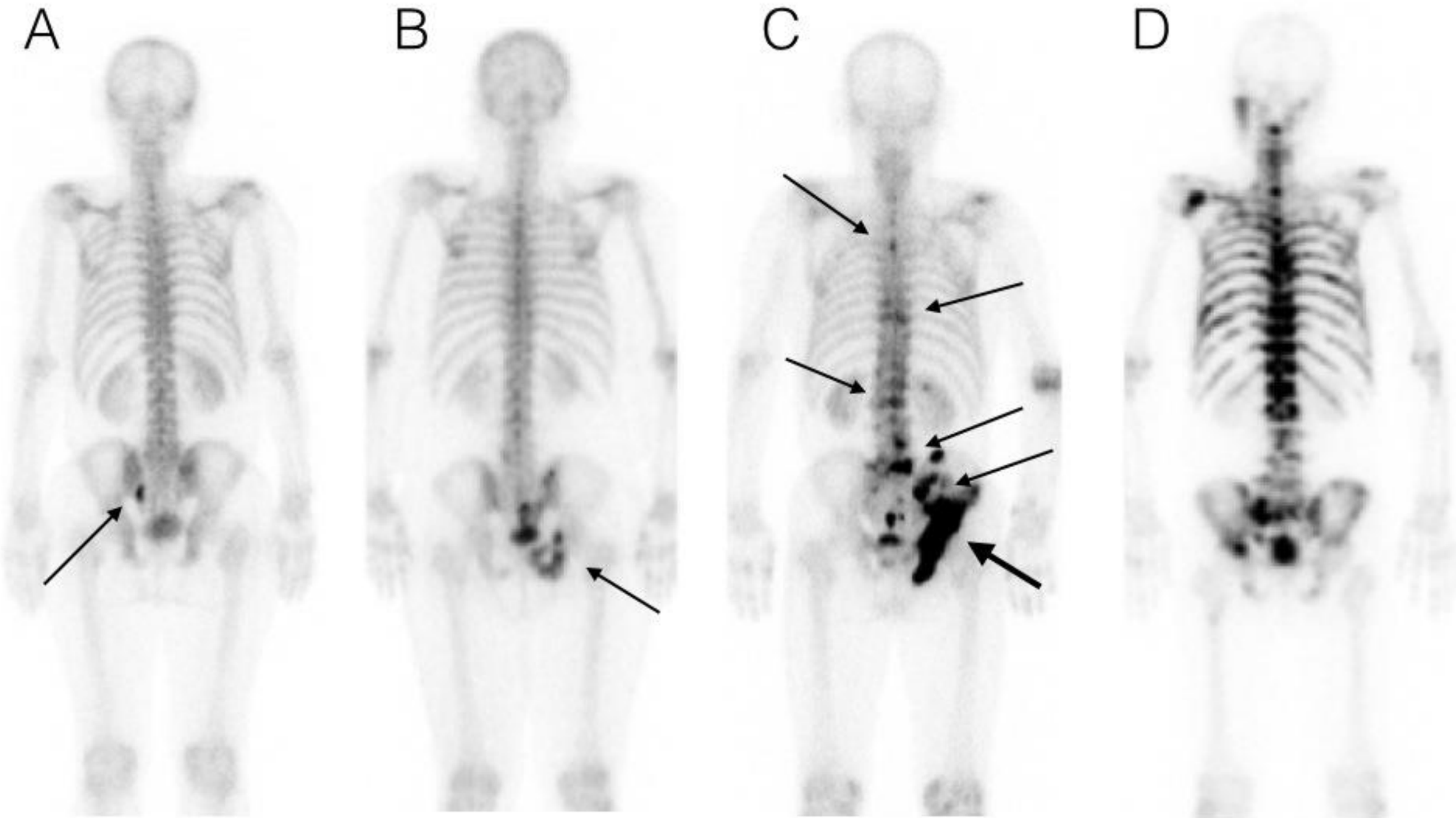
BSI



HSn



Let's understand severity using BSI



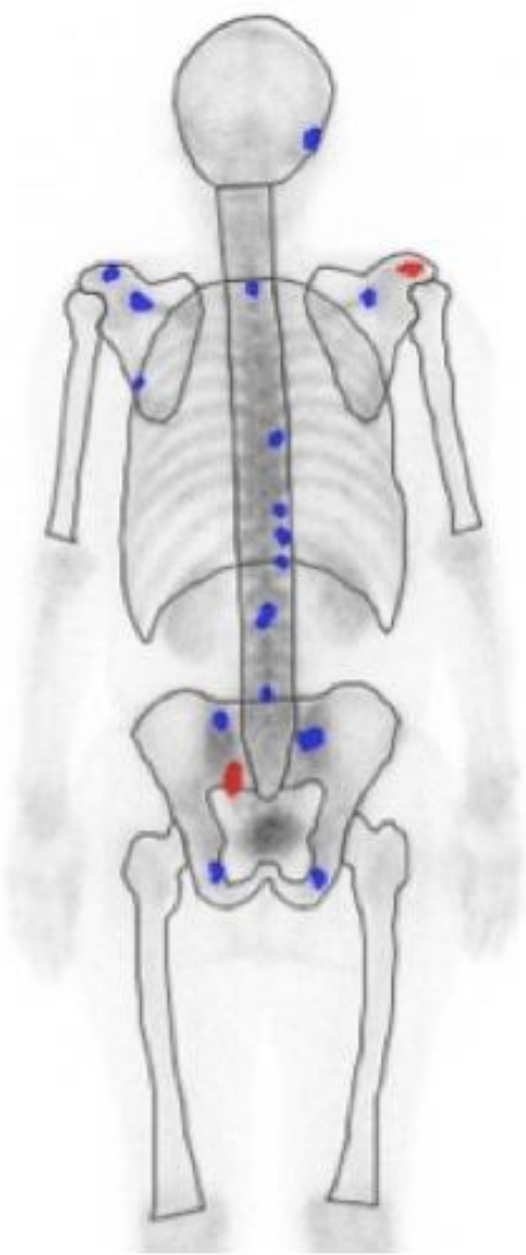
small

definite met+ localized

definite met+ many hot spots

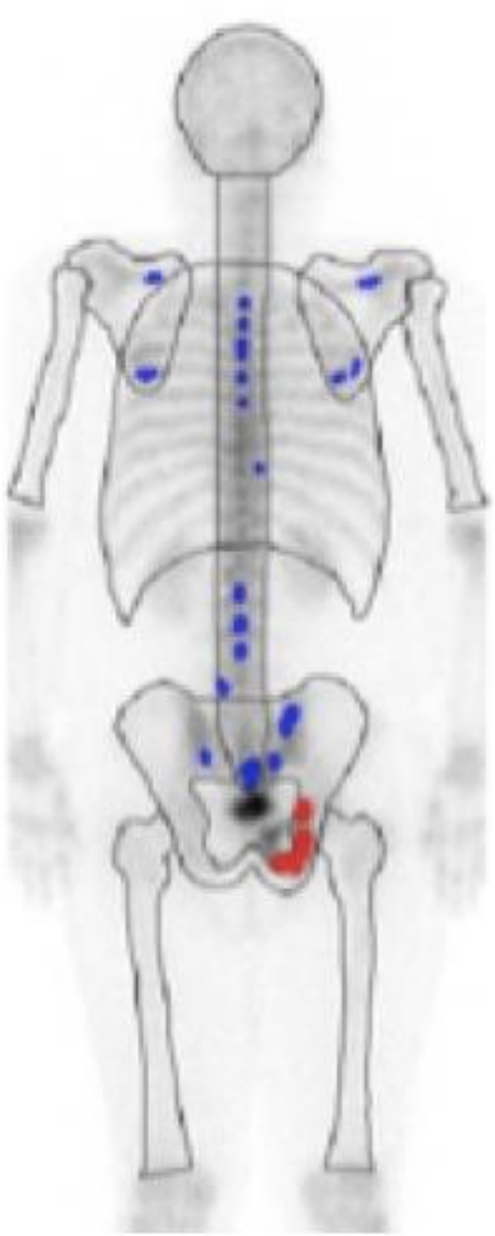
multiple mets: super scan

Your impression is supported by BSI quantitatively



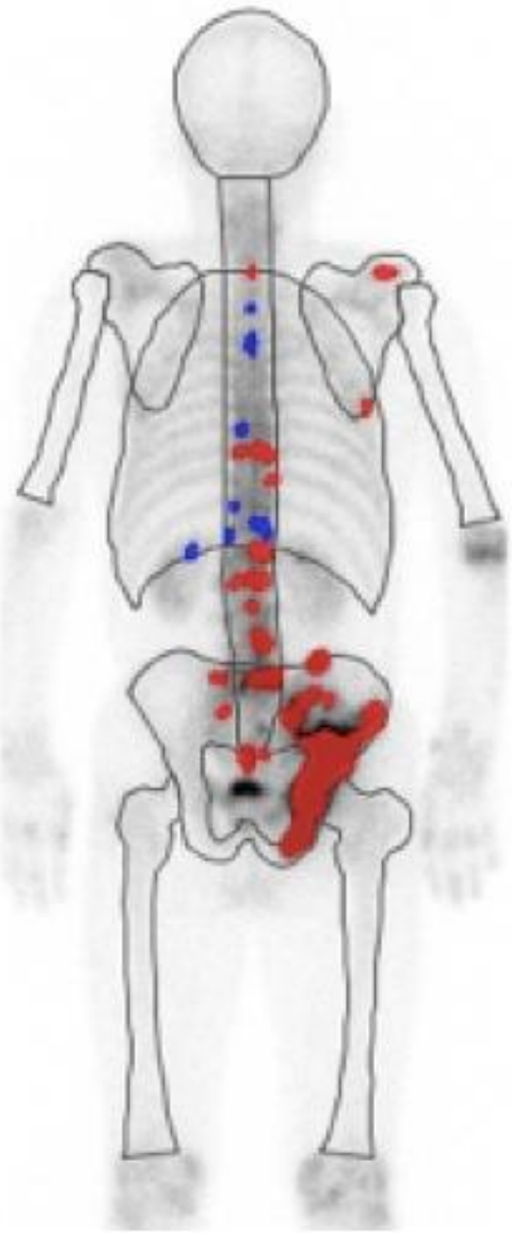
BSI 0.2

minimal



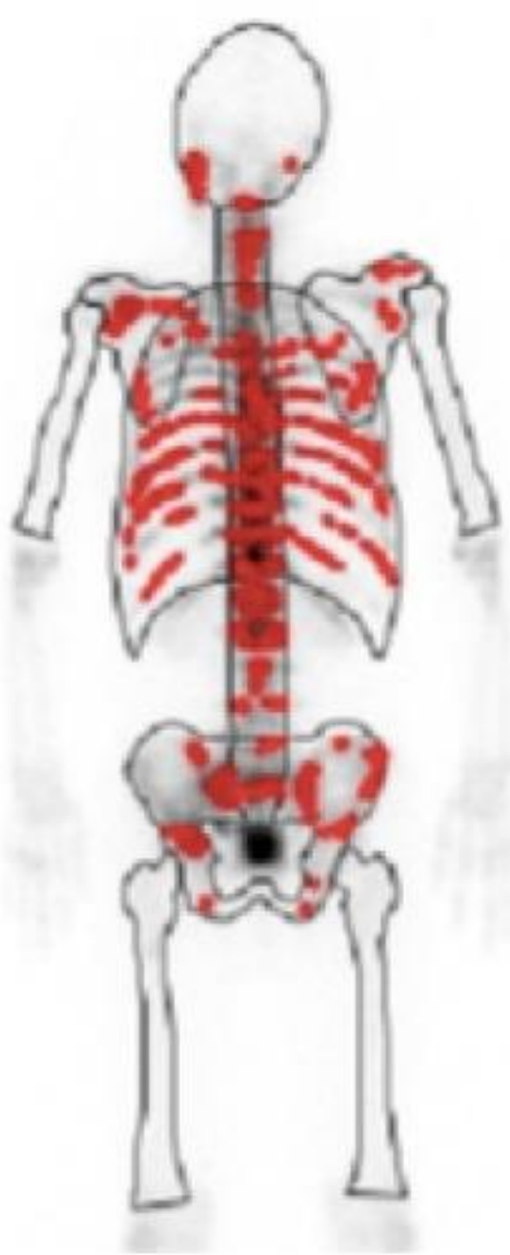
BSI 0.9

some



BSI 4.5

many



BSI 9.6

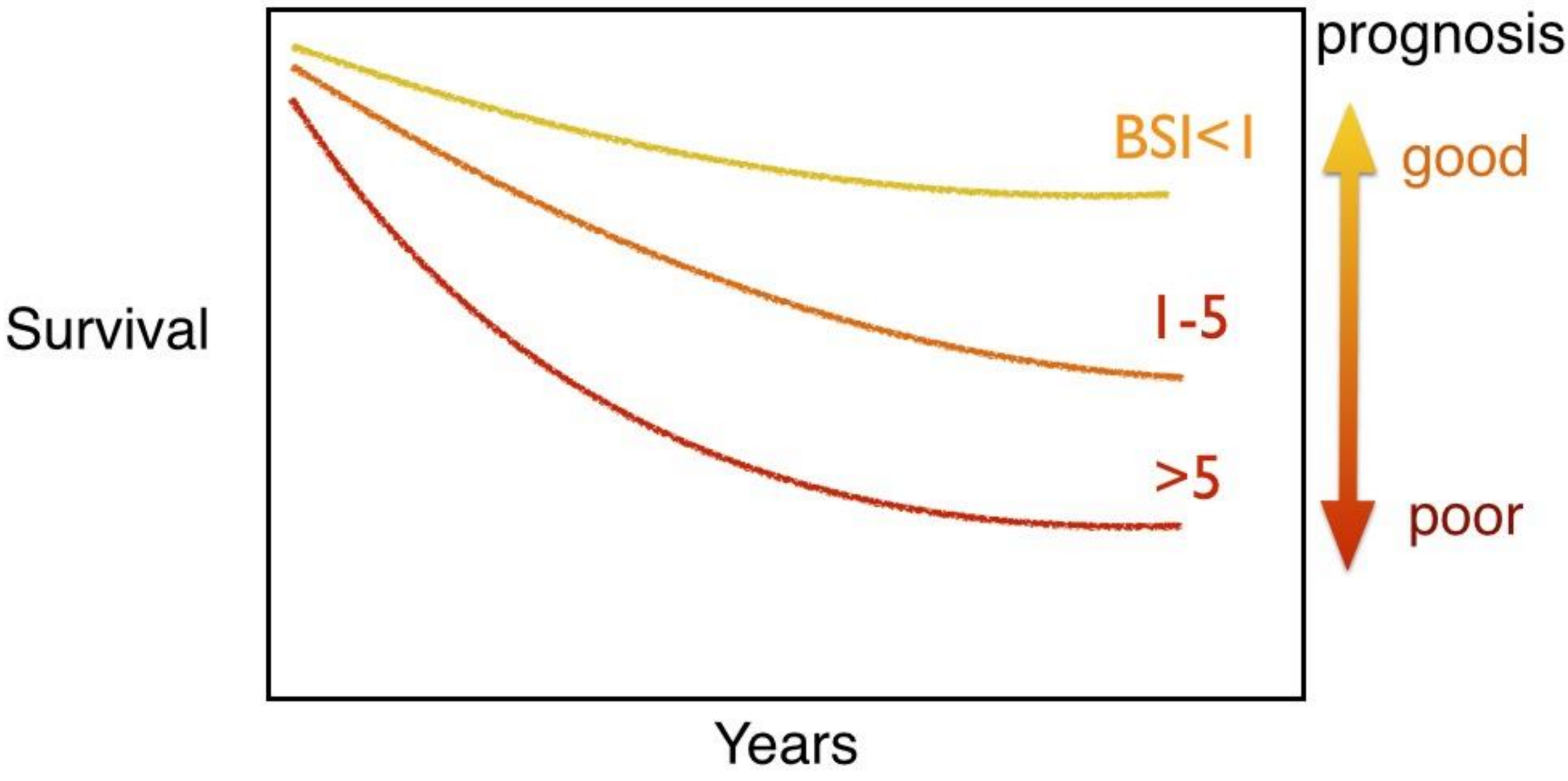
severe-super

The purpose of BSI is:

- Not to decide specific hot spot is metastasis or not
- But to summarize the whole amount of metastasis

- **Diagnostic guide**
- **Treatment effects**
- **Prognosis**

Bone Scan Index: Prognostic use is one of the most important applications



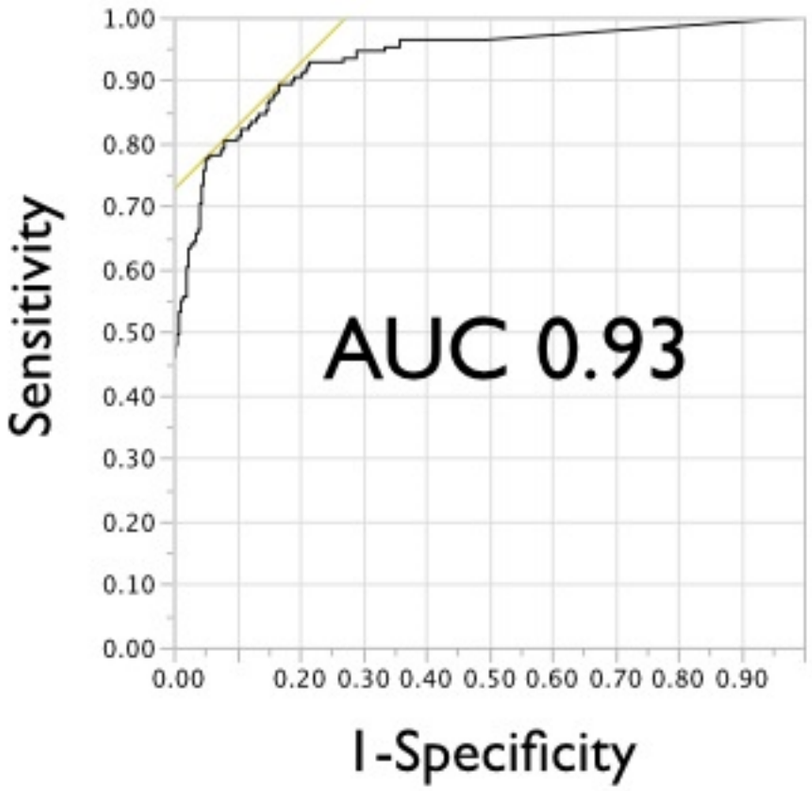
Automatic processing

- **What is time for processing?**
  - <10 seconds for calculation
  - 1-2 min from retrieving data to output page
- **High reproducibility**
  - Minimal manual processing for accepting red/blue areas, excluding contamination, etc
  - AutoBSI (without manual adjustment) can be used for prognostic purpose

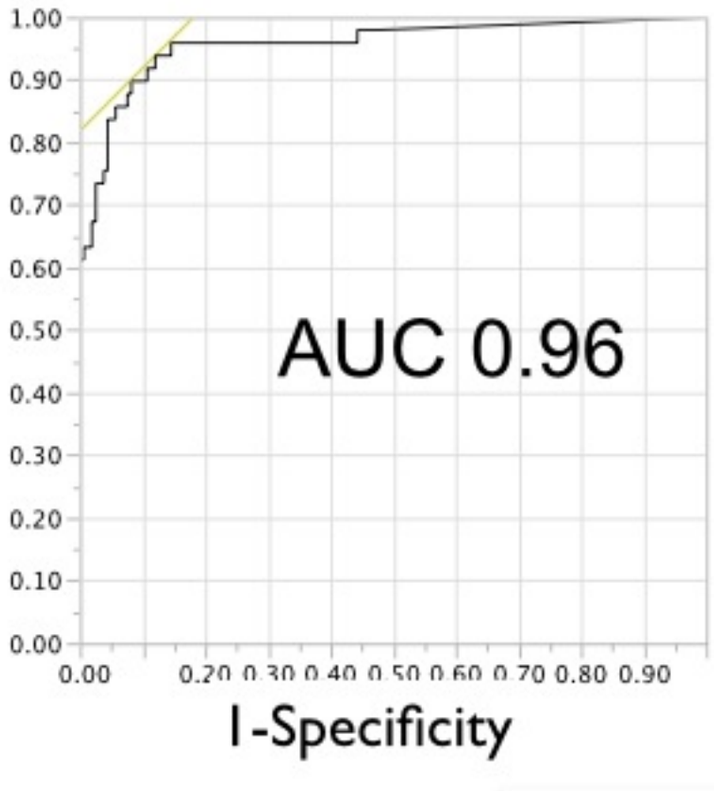
Japanese multi-center database project: Improved diagnostic accuracy for any cancer types

Trained by Japanese database with definitive diagnosis of metastasis (n=1532)

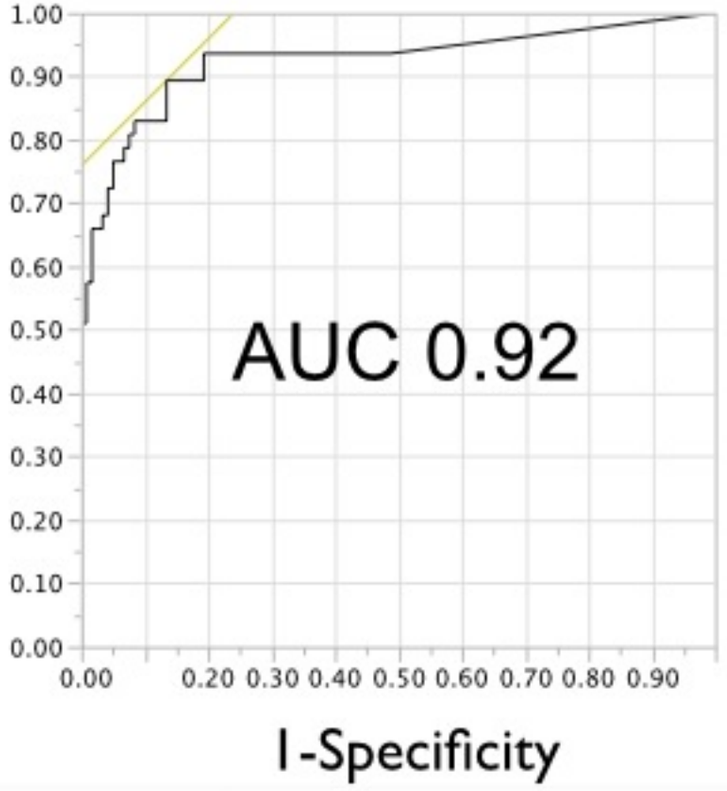
Total



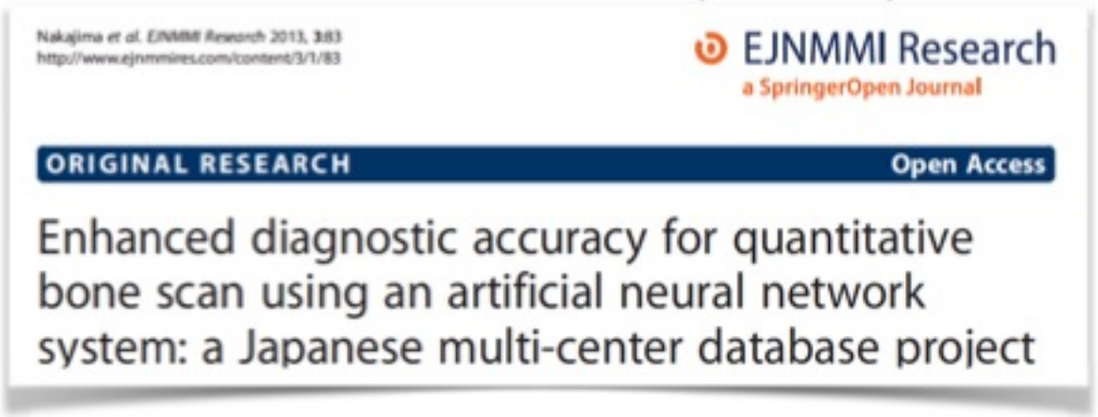
Prostate cancer



Breast cancer



Nakajima, et al. EJNMMI Res 2013, 3:83


Nakajima et al. EJNMMI Research 2013, 3:83
http://www.ejnmmires.com/content/3/1/83

EJNMMI Research
a SpringerOpen Journal

ORIGINAL RESEARCH Open Access

Enhanced diagnostic accuracy for quantitative bone scan using an artificial neural network system: a Japanese multi-center database project

Why is quantification required?

Initial Dx

- Blue and red hot spots help nuclear medicine physicians to evaluate abnormality efficiently, and find total amount of metastasis.

Follow-up

- It is convenient as serial changes are sometimes associated with mixed improvement and worsening.

Therapy

- Treatment effects can be easily understood.

Prognosis

- Prognosis is poor in high-BSI patients, and it may change treatment strategy.

Multicenter clinical trial

- Convenient for inter-institutional comparison and multicenter study using uniform diagnostic criteria and quantification.