Biophysical Assessments for Lymphedema Detection in Patients with Breast Cancer before and ~~One Year~~ 1.5 Years after Breast Cancer Surgery

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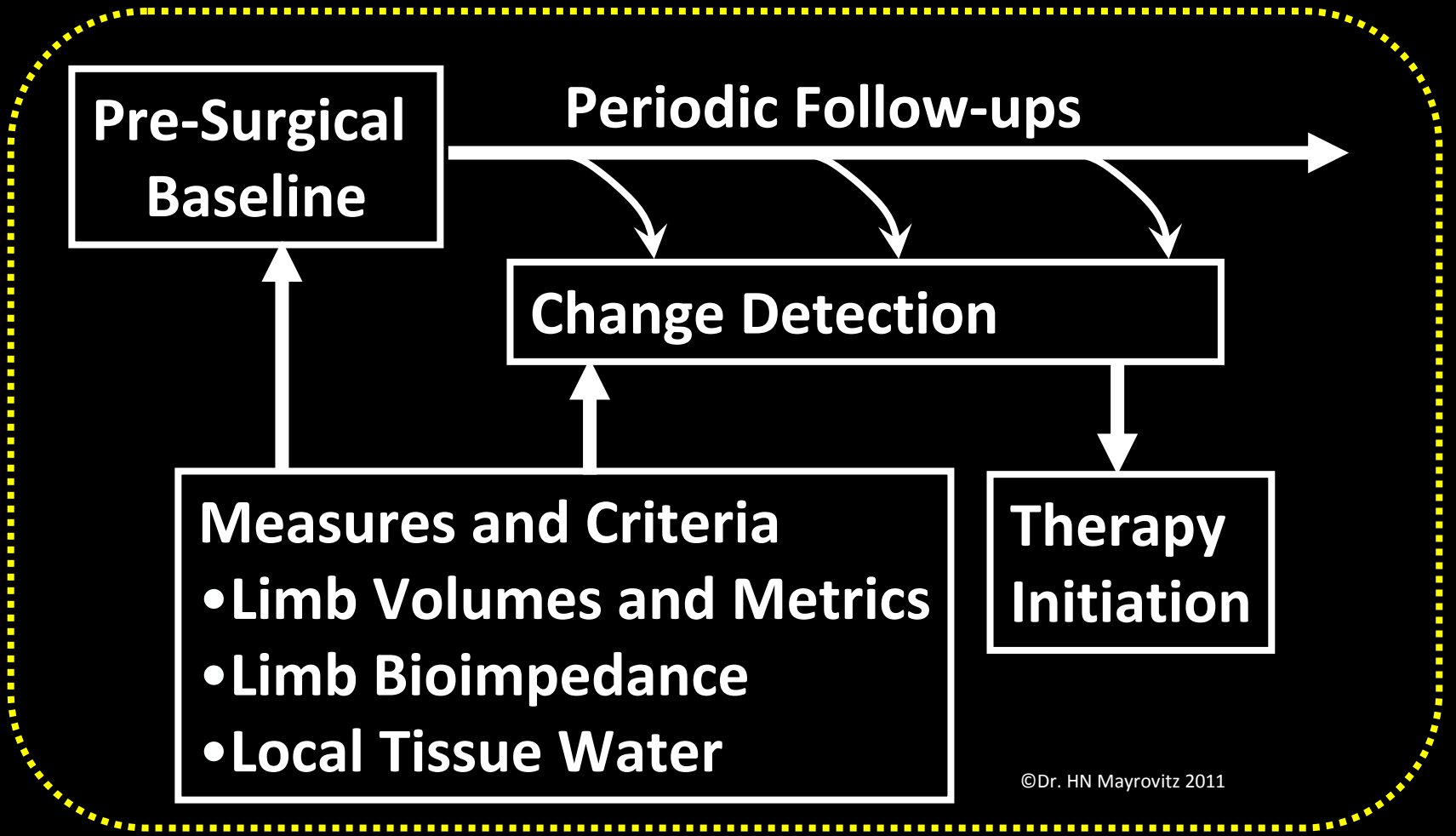
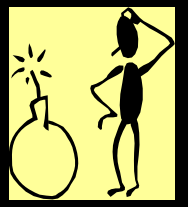
Goal: Earlier Detection and Intervention Women Diagnosed with Breast Cancer

A Rationale and Sensible Approach

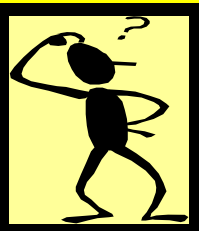


Goal: Earlier Detection and Intervention



Not Often Done

Can We Estimate Impact?



Pre-Surgical Baseline

Periodic Follow-ups

3 months

3 months

Change Detection?

N=71

Measures and Criteria
- Limb Volumes and Metrics
- Limb Bioimpedance
- Local Tissue Water

Therapy Initiation

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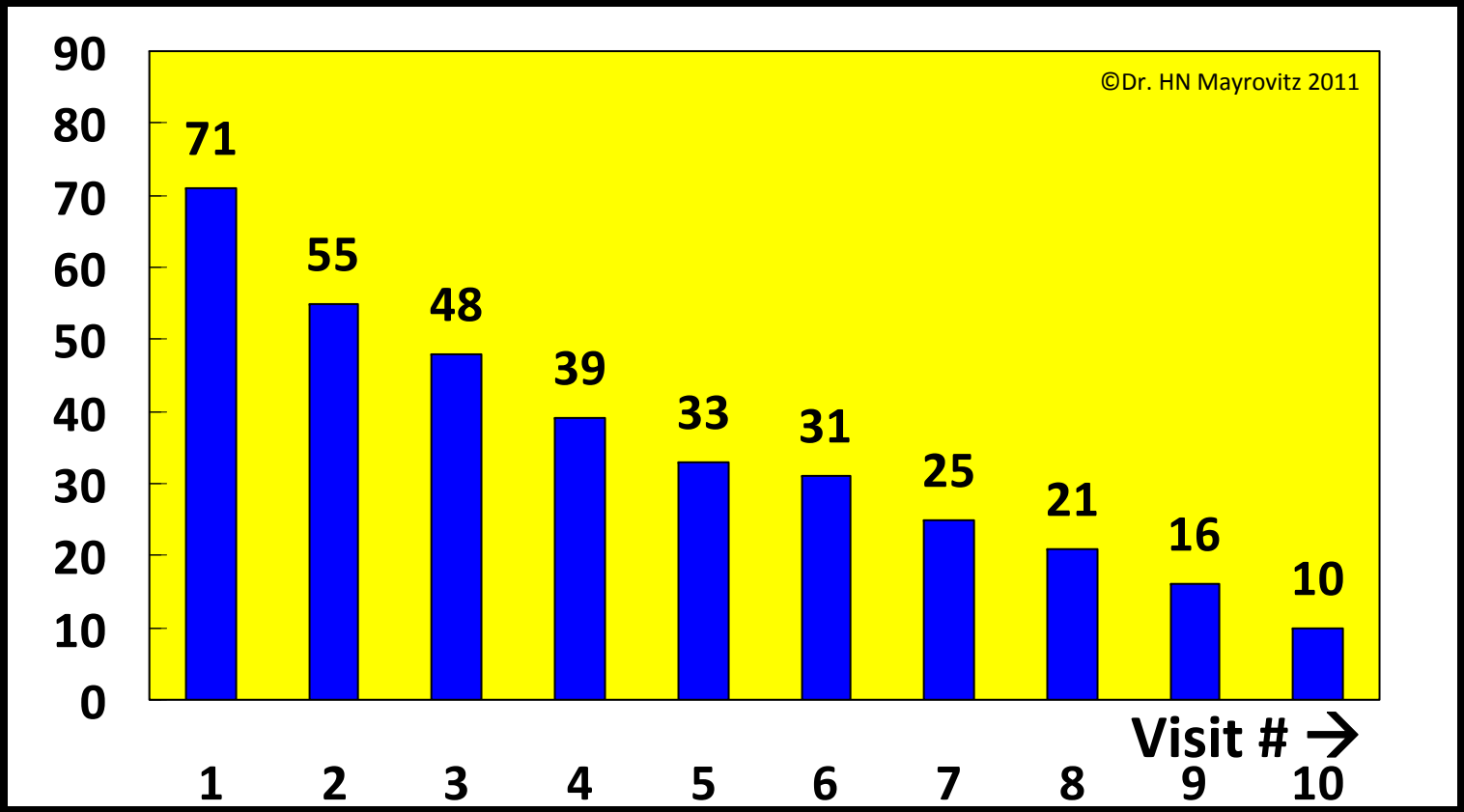
Unilateral Breast Cancer Patients (6/6/11)



Age range: 28 – 82 (59.7 ± 13.4 years)

BMI range: 17.8 – 48.1 (28.3 ± 6.4 Kg/m^2)

Cancer: Dominant Arm Side 34/71 (47.9%)

Measurement Methods

Girth and Limb Volume Measurements

Girth at 4 cm intervals

Segment Length (cm)	Total # Segments	Right Proximal	Right Distal	Left Proximal	Left Distal
4					
0	12	1390	722	1390	731

Full Screen | Reset Screen

Proximal - Distal Option

Limb Volumes	Right	Left	Edema	%Edema
Total Volume (ml)	2112	2122	-10	-0.5
Limb only (ml)	2112	2122	1	
Hand only (ml)	0	0		

Arm Volumes

Visit 3

Affected Limb: Right Limb

Limb Length: 48

From data there are 12 full segments plus one partial segment of length = 0

Enter Circumferences in yellow cells below (columns C and D)

Note that the first circumference pair to be entered for "0" cm corresponds to either the wrist or ankle

cm from wrist or ankle	Circumferences (cm) Right	Circumferences (cm) Left	segment number	Volume (ml) Right	Volume (ml) Left
0	15.2	15.6			
4	15.3	15.4	1	74	77
8	16.5	16.6	2	81	82
12	19.4	19.5	3	103	104
16	21.7	21.9	4	135	137
20	22.9	23	5	158	161
24	23.5	23.5	6	171	172
28	24.7	24.5	7	185	183
32	25.5	25.5	8	201	199
36	26.4	26.2	9	214	213
40	28.4	28.1	10	239	235
44	29.2	30	11	264	269
48	30.8	30.5	12	287	291

Segment Length (cm): 4

Total # Segments: 12

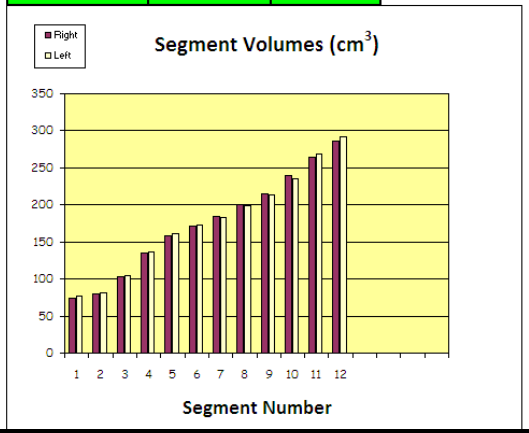
Right: Proximal 1390, Distal 722

Left: Proximal 1390, Distal 731

Full Screen | Reset Screen

Proximal - Distal Option

Limb Volumes	Right	Left	Edema	%Edema
Total Volume (ml)	2112	2122	-10	-0.5
Limb only (ml)	2112	2122	1	
Hand only (ml)	0	0		



www.limbvolumes.org

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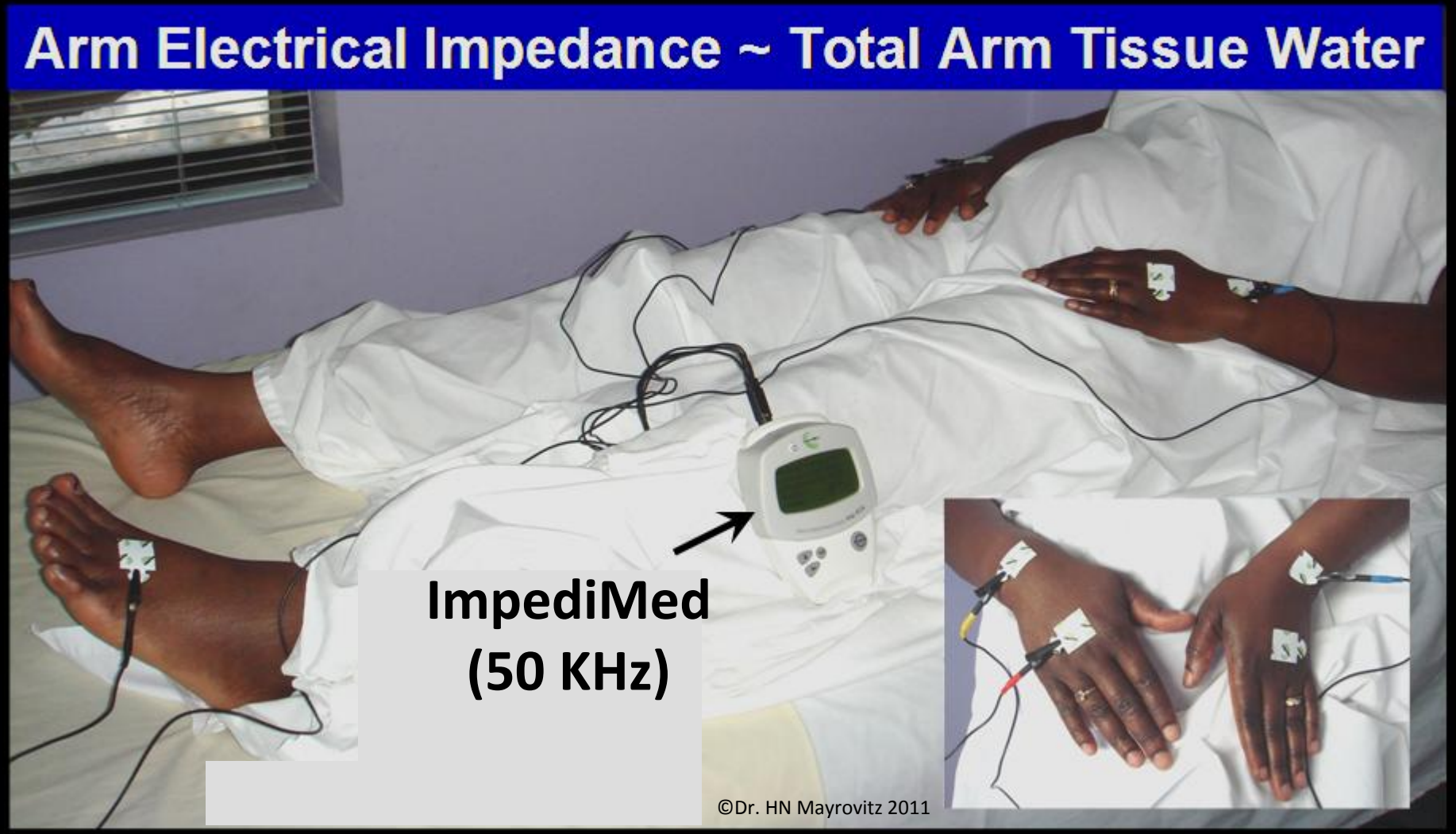
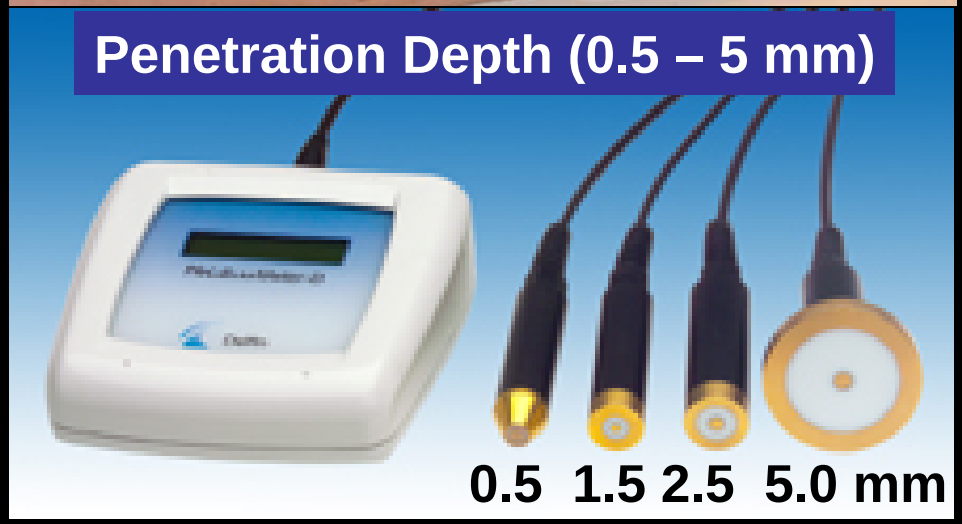
Bioimpedance Measurements

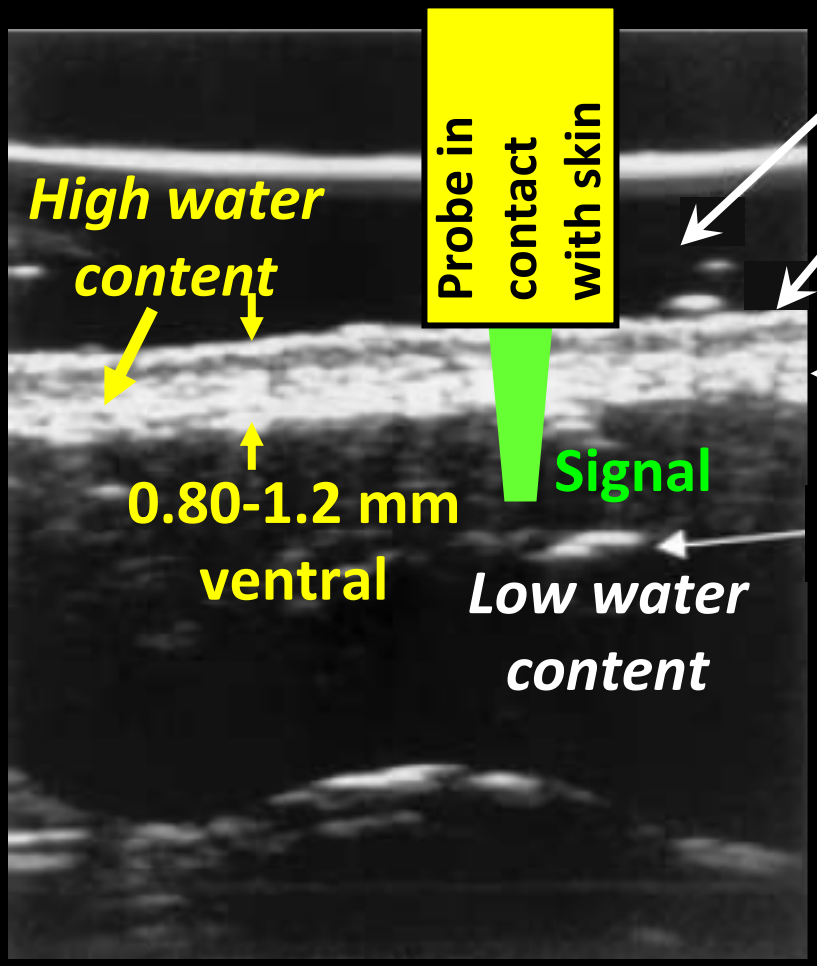


Tissue Water via Dielectric Constant (TDC)



- Low power 300 MHz incident wave
- Reflected wave depends on the tissue's dielectric constant
- Dielectric constant depends on total tissue water (free + bound)
- Pure water has a dielectric constant of about 78
- Can measure at almost any anatomic site

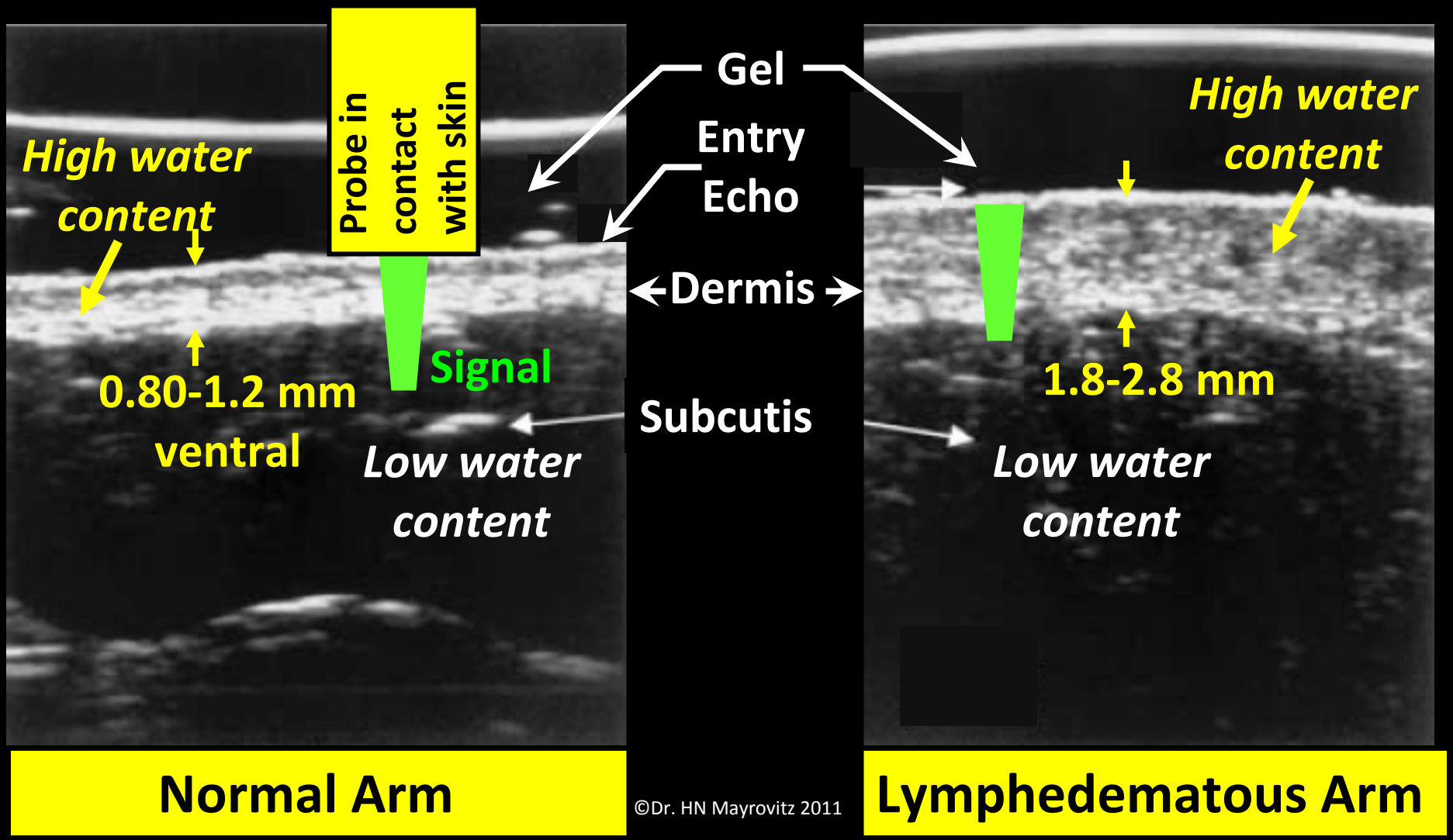
TDC: Tissue Sampling Principle



Normal Arm

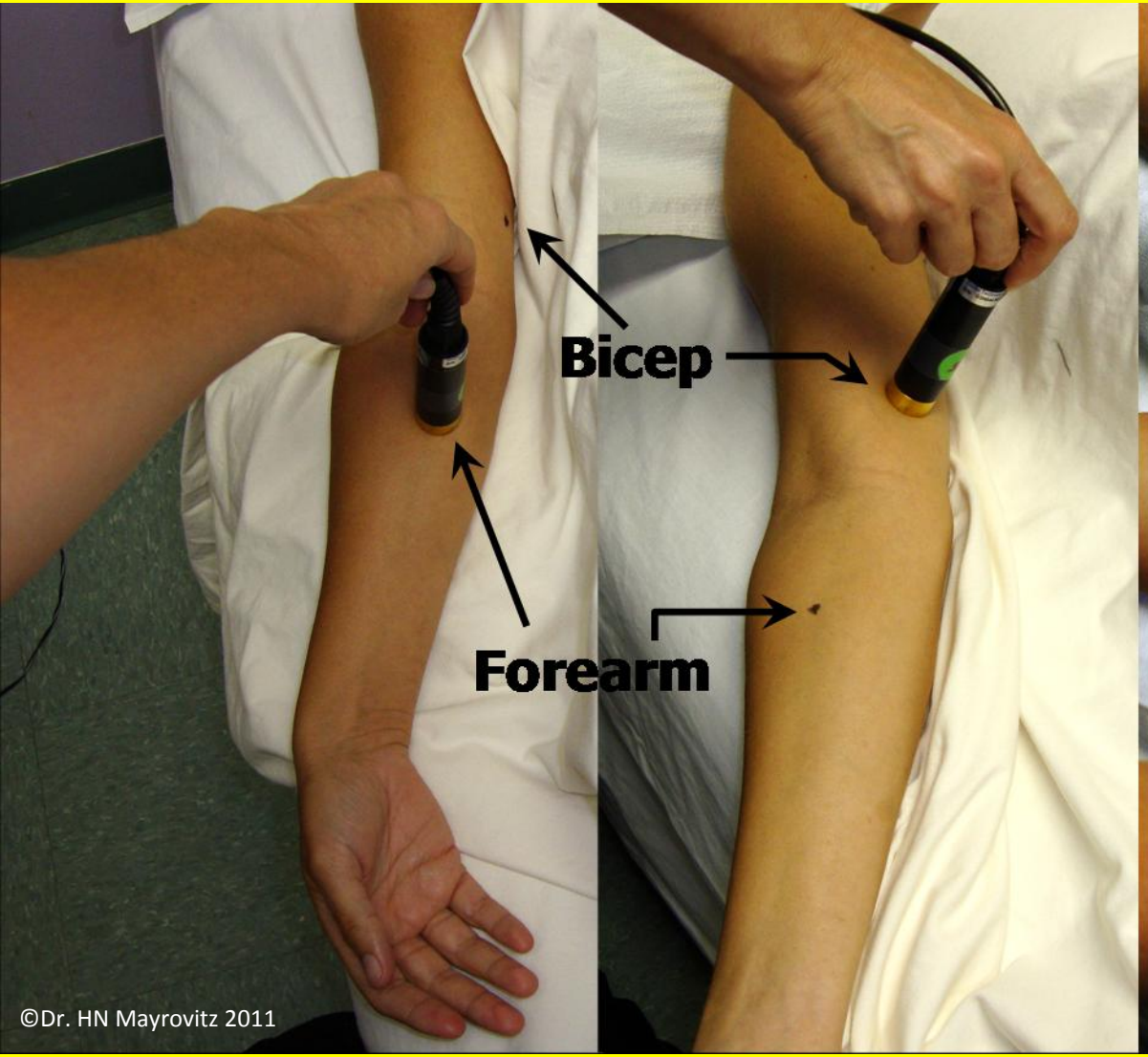
Ultrasound images (20 MHz) modified from Mellor et al. 2004 (The Breast Journal, 2004;10:496-503)

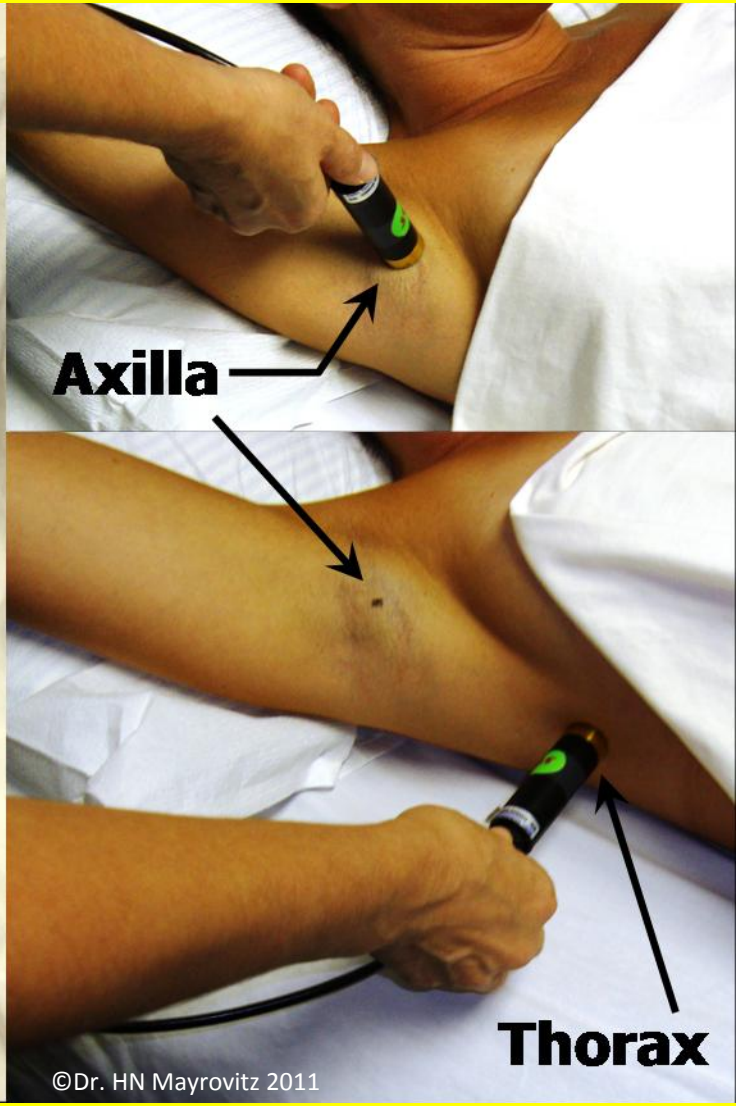
TDC: Tissue Sampling Principle



Ultrasound images (20 MHz) modified from Mellor et al. 2004 (The Breast Journal, 2004;10:496-503)

TDC Measurement Sites





Each site to an effective depth of 2.5 mm

Forearm site to effective depths of 0.5, 1.5, 2.5 and 5.0 mm

Pre-Surgery Measurement Results

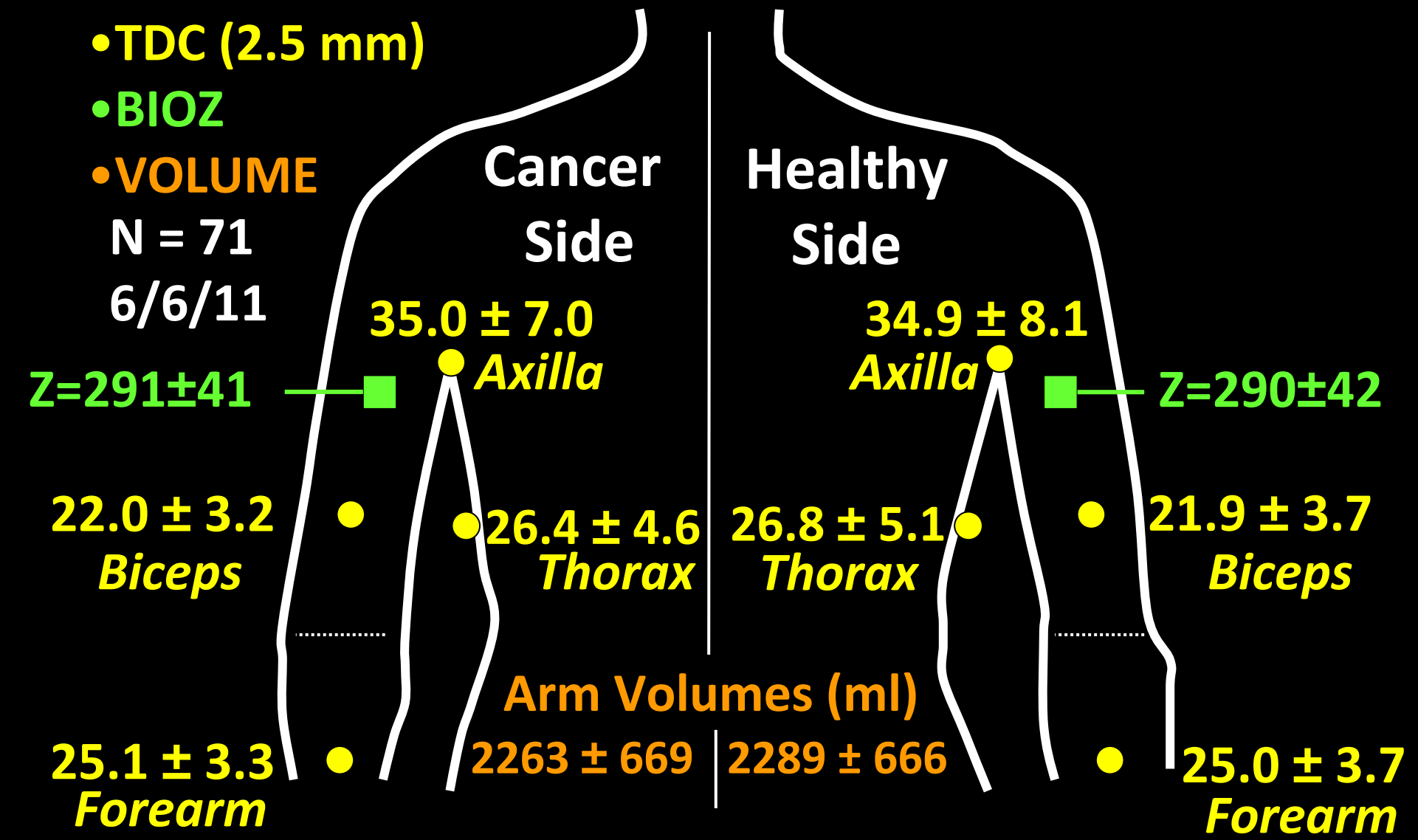
By Site

No significant differences between sides

- TDC (2.5 mm)
- BIOZ
- VOLUME

N = 71

6/6/11



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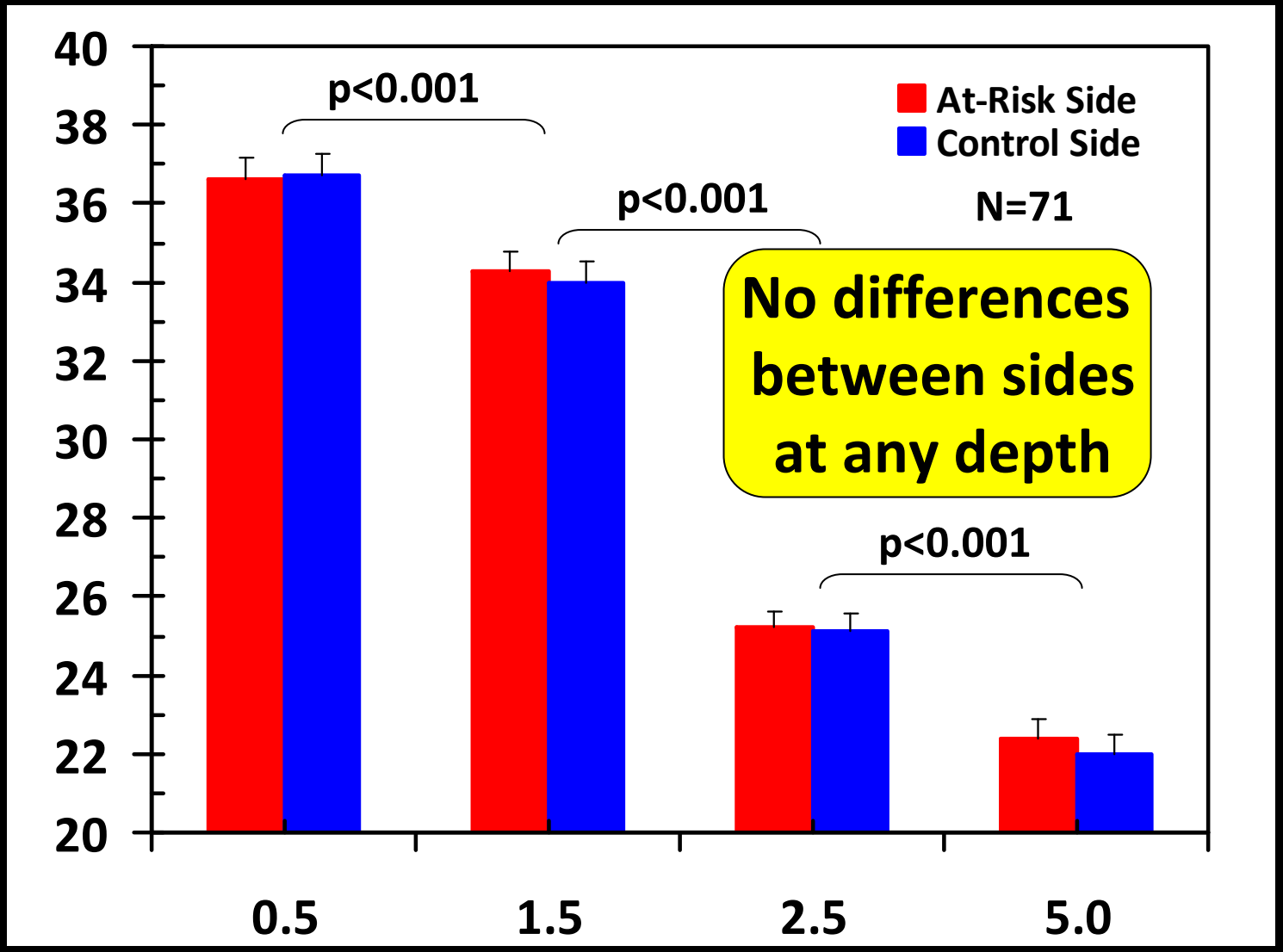
Forearm TDC by Depth

Significant differences among depths



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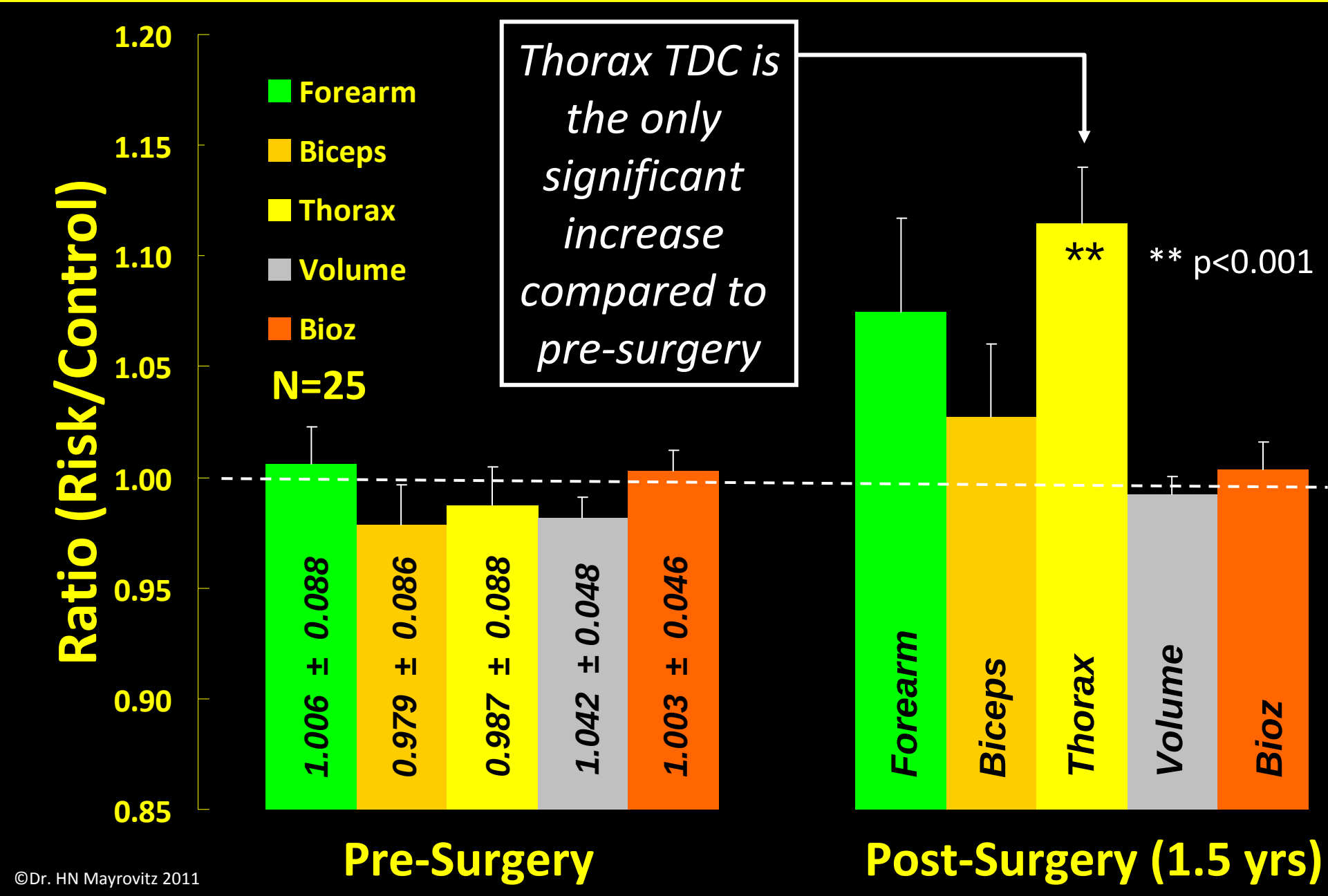
Changes in Risk/Control →1 .5 yrs



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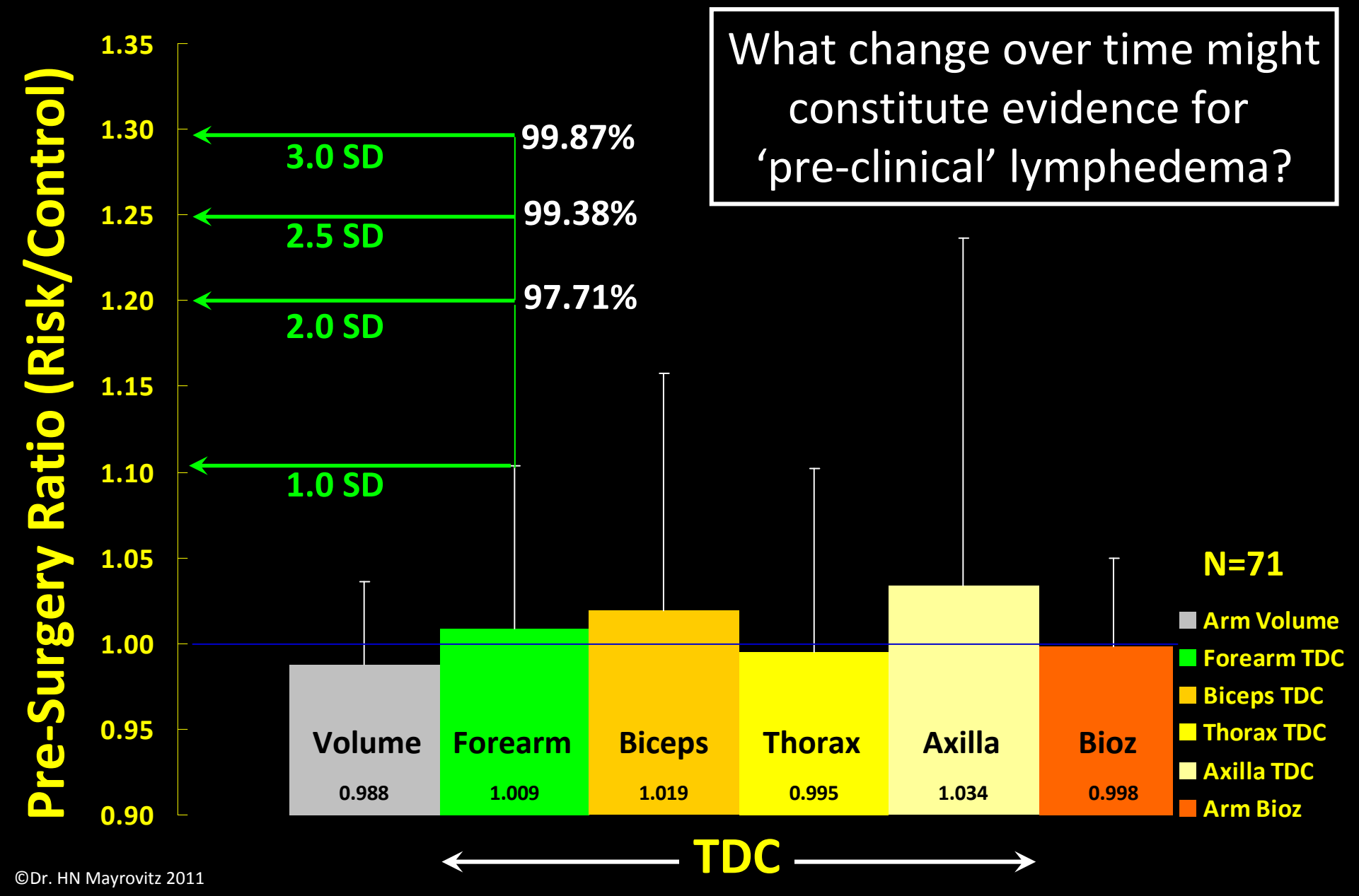
Possible Thresholds via Risk/Control Ratio



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TDC Thresholds (Risk/Control)

2.5 mm Effective Measurement Depth

Threshold Level	Forearm	Thorax	Biceps	Axilla
2 SD (97.7%)	1.20	1.21	1.30	1.44
2.5 SD (99.38%)	1.25	1.27	1.37	1.55
3.0 SD (99.87%)	1.30	1.32	1.44	1.64

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Threshold Comparison (Risk/Control)

Threshold Level	Forearm 2.5 TDC	Thorax 2.5 TDC	Volume	Bioz
2 SD (97.7%)	1.20	1.21	1.10	1.11
2.5 SD (99.38%)	1.25	1.27	1.12	1.14
3.0 SD (99.87%)	1.30	1.32	1.15	1.16

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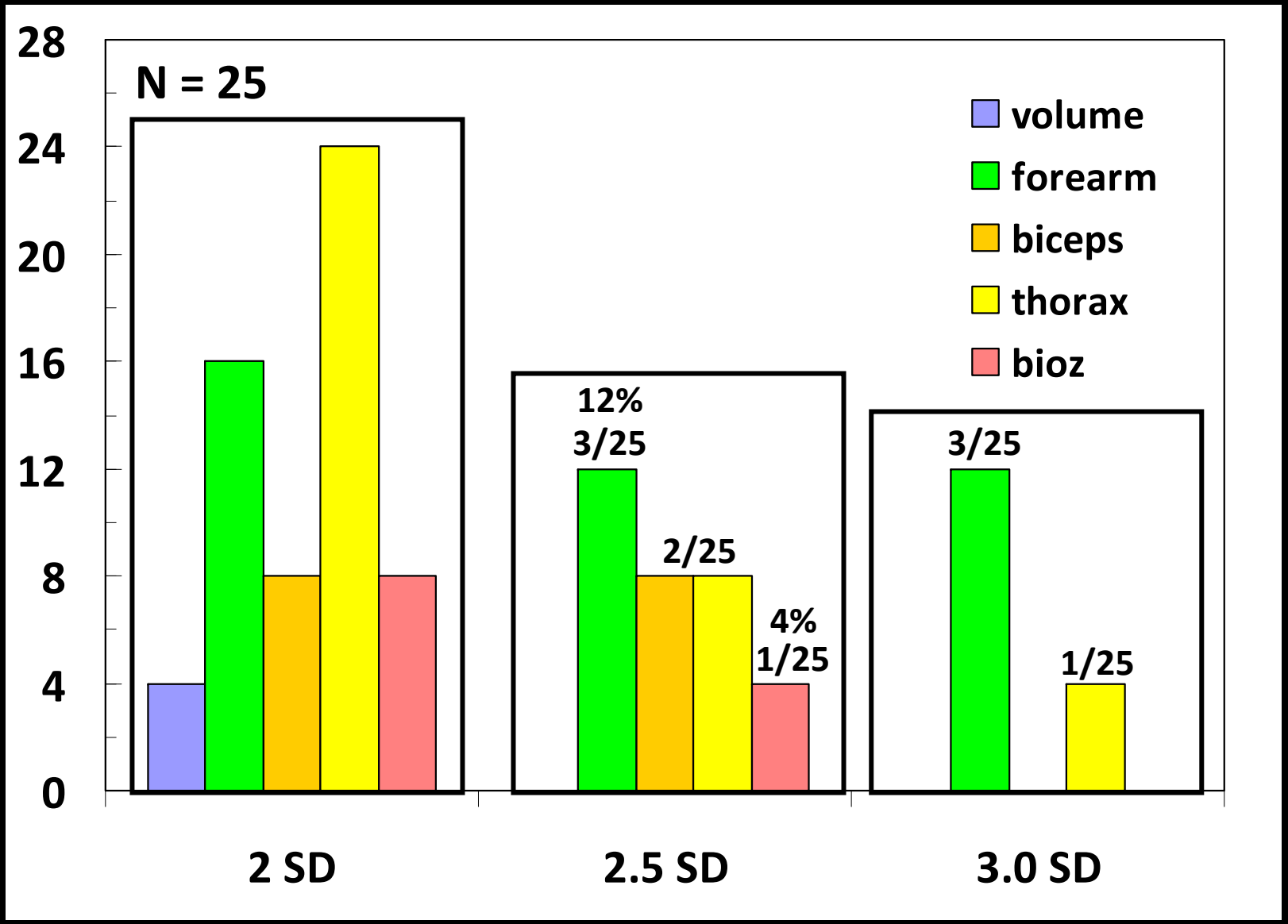
Exceed Threshold at 1.5-Year Post-surgery



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Main Points Summary

- In 71 newly diagnosed breast cancer patients, biophysical measures showed no difference between cancer and control sides prior to surgery.

- In 25 pts followed for 1.5 years a significant increase was found only in TDC of at-risk thorax suggesting early increased thorax tissue water.

- Exploratory lymphedema thresholds based on pre-surgery variances indicate thresholds are exceeded in 4-12% of patients by 1.5 years.

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Main Point Conclusions

- Pre-surgery side-to-side similarities suggest that if pre-surgery data are unavailable, differentials measured later can still be diagnostically useful.

- Tracking of thorax tissue water changes via TDC measurements emerges as a potentially new and useful parameter to detect incipient lymphedema.

- The validity of the exploratory lymphedema thresholds is not yet established but depends on method, TDC site and its measurement depth.

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Thanks for your Attention