Chamber Quantification Guidelines Update I: Left Heart Measurements

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Disclosures

None relevant to this presentation

Goals

To teach you at least one new thing

To reinforce the things you already know

Some questions to wake you up! How many of the following statements are correct

A) One
B) Two
C) Three
D) Four
E) None

1) LV end-diastolic dimensions should always be measured at the upstroke of the QRS
2) Partition values allow you to separate the left atrium from the left ventricle
3) LV measurements taken from low parasternal windows overestimate true values
4) The diagnosis of LV hypertrophy is based on wall thickness

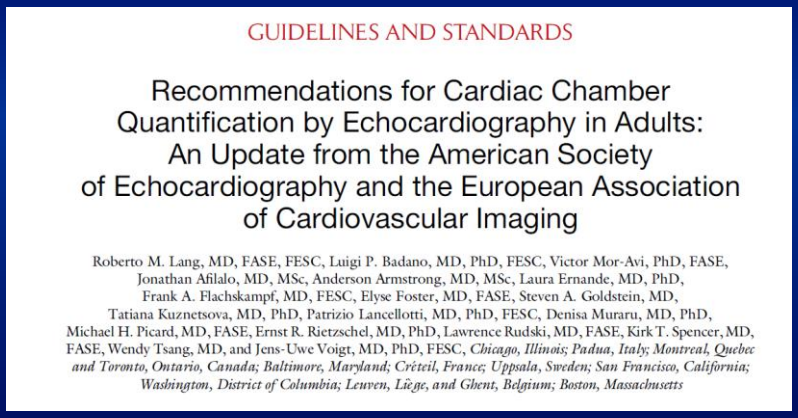
2005

ASE COMMITTEE RECOMMENDATIONS

Recommendations for Chamber Quantification: A Report from the American Society of Echocardiography's Guidelines and Standards Committee and the Chamber Quantification Writing Group, Developed in Conjunction with the European Association of Echocardiography, a Branch of the European Society of Cardiology

Members of the Chamber Quantification Writing Group are: Roberto M. Lang, MD, FASE, Michelle Bierig, MPH, RDCS, FASE, Richard B. Devereux, MD, Frank A. Flachskampf, MD, Elyse Foster, MD, Patricia A. Pellikka, MD, Michael H. Picard, MD, Mary J. Roman, MD, James Seward, MD, Jack S. Shanewise, MD, FASE, Scott D. Solomon, MD, Kirk T. Spencer, MD, FASE, Martin St John Sutton, MD, FASE, and William J. Stewart, MD

2015
asecho.org or flashdrive

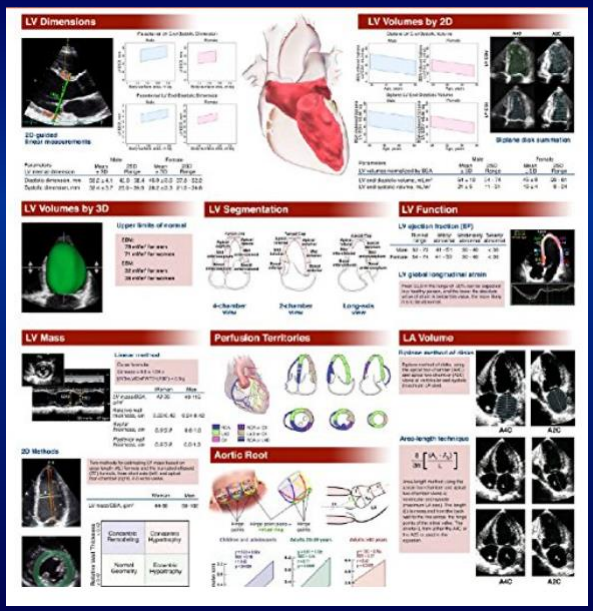


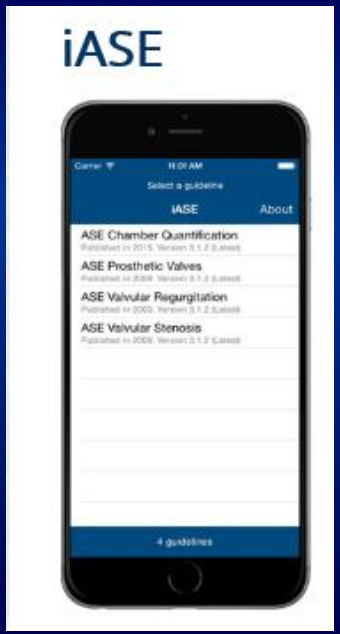
GUIDELINES AND STANDARDS

Recommendations for Cardiac Chamber Quantification by Echocardiography in Adults: An Update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging

Roberto M. Lang, MD, FASE, FESC, Luigi P. Badano, MD, PhD, FESC, Victor Mor-Avi, PhD, FASE, Jonathan Afilalo, MD, MSc, Anderson Armstrong, MD, MSc, Laura Ernande, MD, PhD, Frank A. Flachskampf, MD, FESC, Elyse Foster, MD, FASE, Steven A. Goldstein, MD, Tatiana Kuznetsova, MD, PhD, Patrizio Lancellotti, MD, PhD, FESC, Denisa Muraru, MD, PhD, Michael H. Picard, MD, FASE, Ernst R. Rietzschel, MD, PhD, Lawrence Rudski, MD, FASE, Kirk T. Spencer, MD, FASE, Wendy Tsang, MD, and Jens-Uwe Voigt, MD, PhD, FESC, *Chicago, Illinois; Padua, Italy; Montreal, Quebec and Toronto, Ontario, Canada; Baltimore, Maryland; Créteil, France; Uppsala, Sweden; San Francisco, California; Washington, District of Columbia; Leuven, Liège, and Ghent, Belgium; Boston, Massachusetts*

Also available in…


LV Dimensions
LV Volumes by 2D
LV Volumes by 3D
LV Segmentation
LV Function
LV Mass
Perfusion Territories
LA Volume
Aortic Root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Carrier
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About
ASE Chamber Quantification
ASE Prosthetic Valves
ASE Valvular Regurgitation
ASE Valvular Stenosis
4 guidelines

Why did we need an update?

Why the Update?

- New techniques (3D)
- More normative data
- Partition values
  - small, medium, large
  - mild, moderate, severe
- Consolidated right and left heart parameters
- Expanded recognition of gender differences

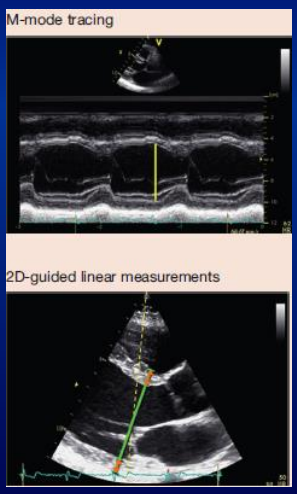
Key Concepts

- TTE = TEE
- Average over multiple beats
  - 3 in sinus, 5 in AF or "representative" beat

Partition Values

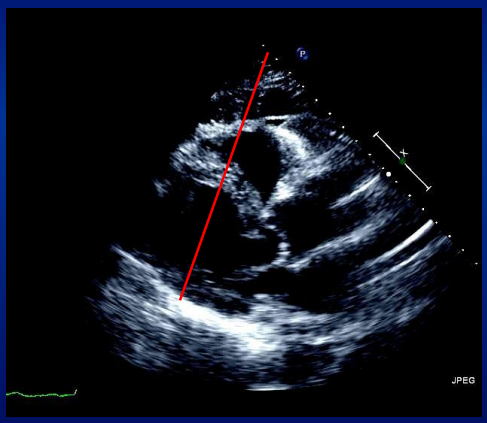
- Assume normal distribution
  - Based on SDs beyond normal range
  - BUT many measurements not normally distributed AND are not equally abnormal in "both directions"
- 95th and 99th percentiles in a population including normal and abnormals
  - BUT data not available
- Based on outcomes? (controversy over MR grading)
- Experience-based expert consensus
  - LA volume and LVEF

Linear Measurements

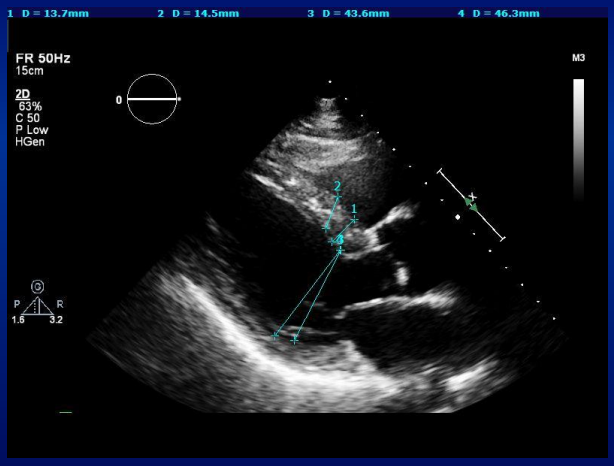


- On-axis (optimized for LV)
- Avoid RV trabeculation, mitral chordae
- At mitral leaflet tips
- End-diastole = first frame after mitral valve closure or the frame in the cardiac cycle in which the LV dimension is largest.
- End-systole = frame after aortic valve closure or the frame in which LV dimension is smallest.

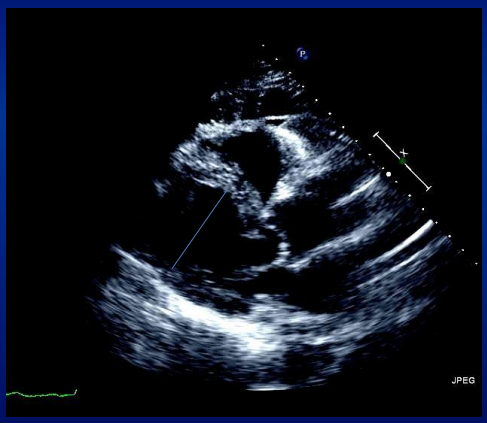
What are the LV dimensions?



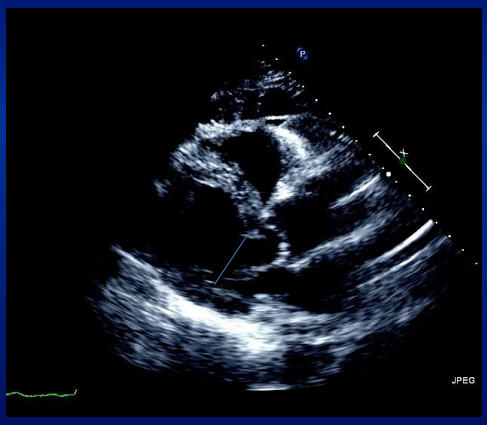
Meaurements taken from low windows will give numbers that are too large!!



What is the LVEDD?



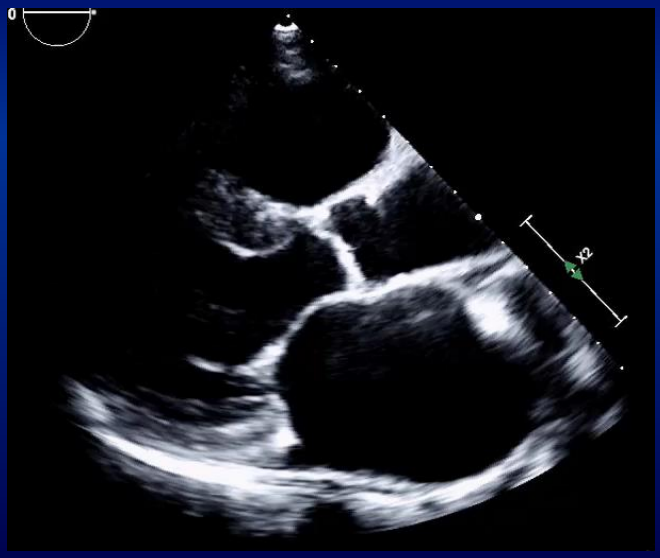
What is the LVEDD?

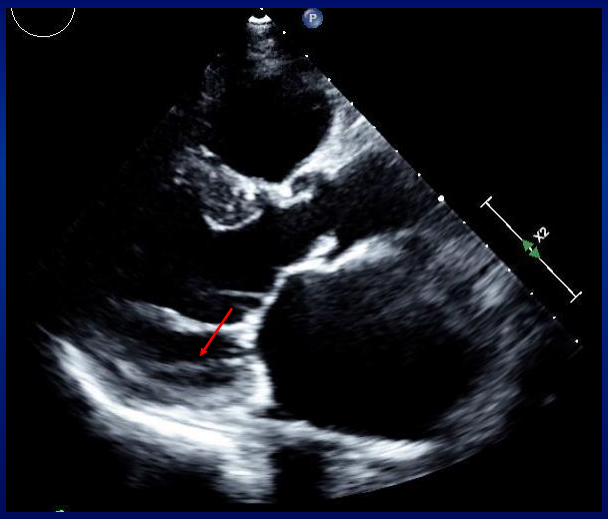


Better to say cannot be reliably measured or measurements are approximate

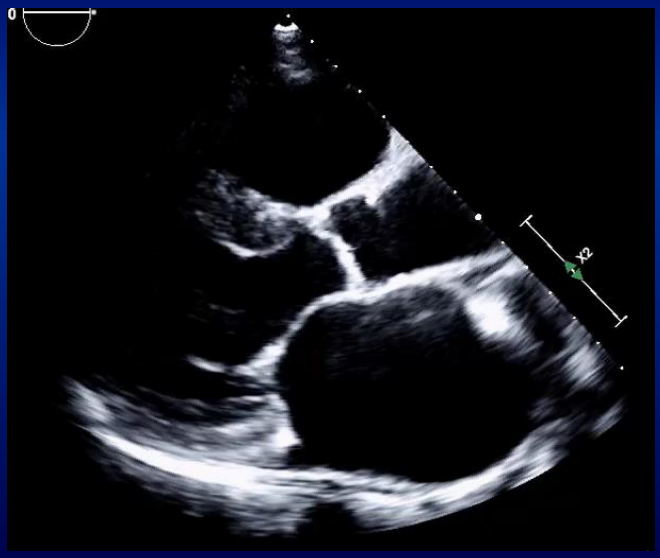
Especially in patients for whom measurements have important clinical consequences

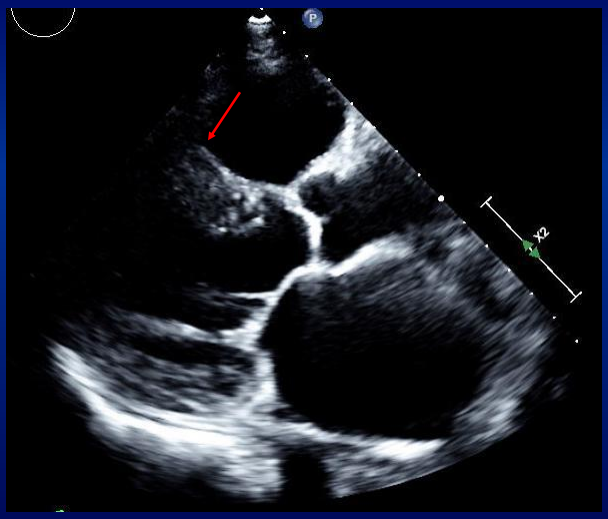
LV chordae



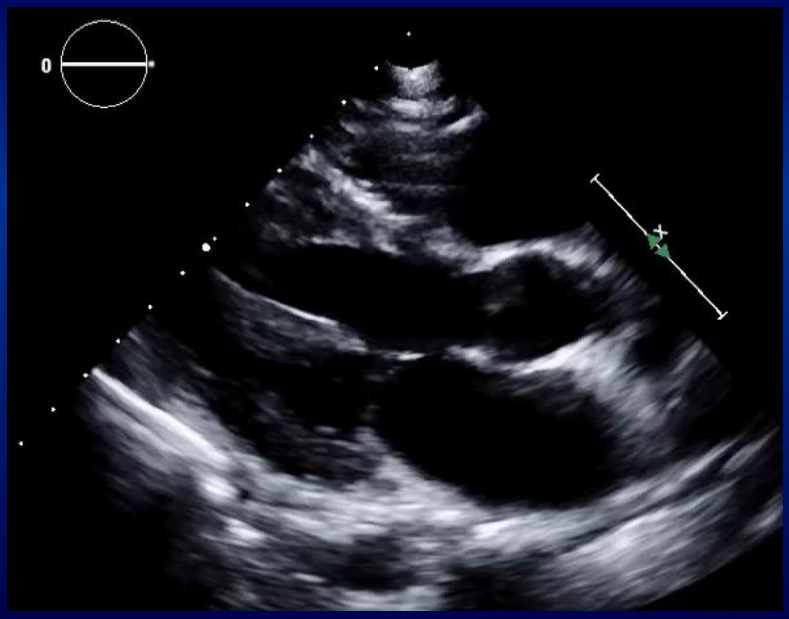


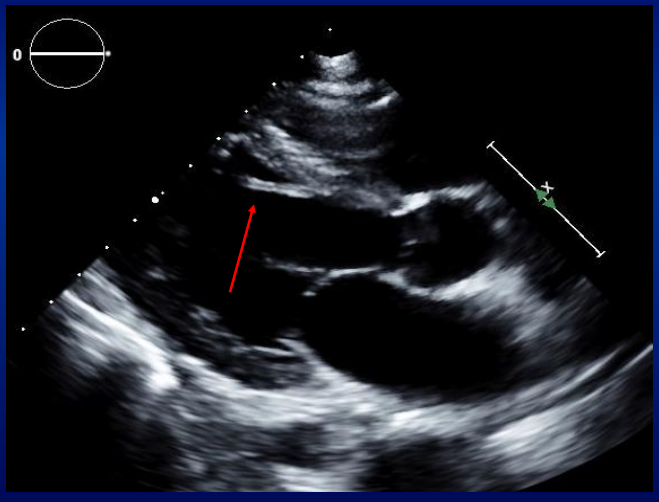
RV trabeculae





False tendon

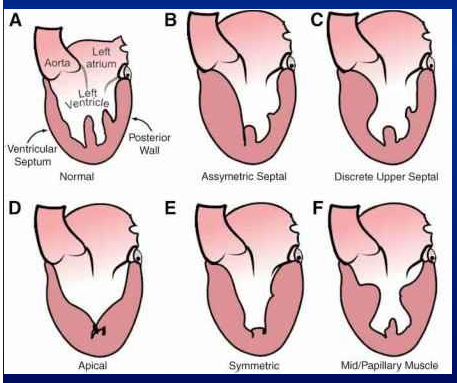




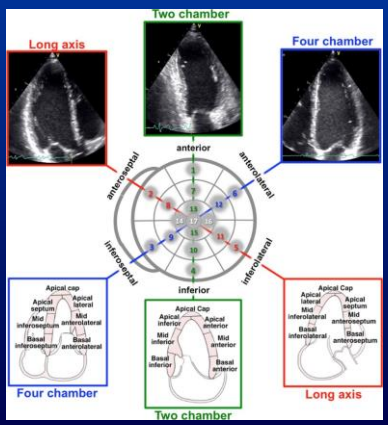
Contrast less likely to be helpful in measurements taken from parasternal views due to acoustic shadowing

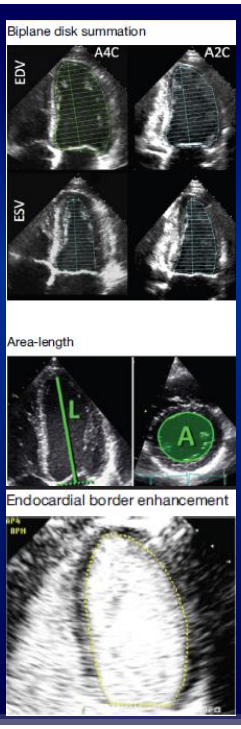
Special Circumstances
HCM/ Myocardial Infarction

Report multiple measurements



Report multiple measurements



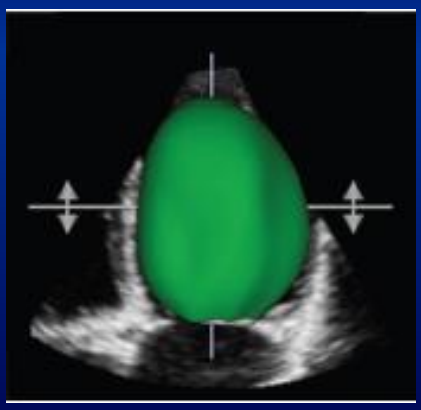


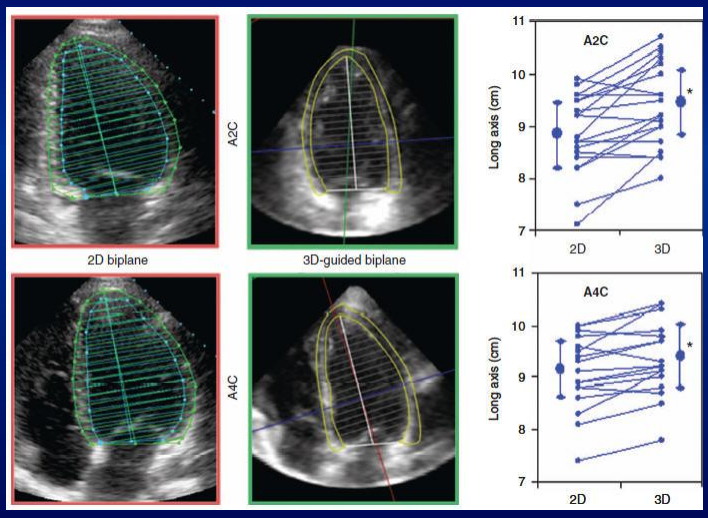
Volumes -2D

- MOD (modified Simpson's) preferred
  - Fewer geometric assumptions
- Contrast helpful
- M-mode based Teichholz and Quinones methods for calculating LV volumes from LV linear dimensions are no longer recommended for clinical use

Additional slides in handout

Volumes-3D



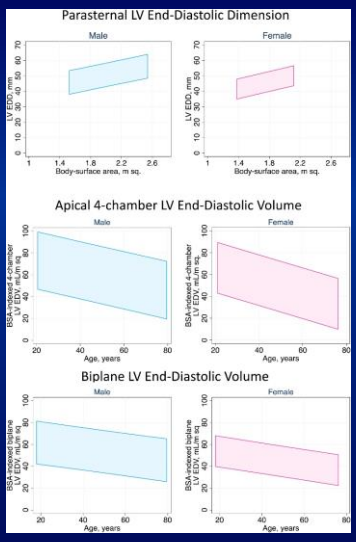

A2C
2D biplane
3D-guided biplane
A4C
Long axis (cm)
11
10
9
8
7
2D
3D
*

Normal Ranges Influenced by

- Gender
- Age
- Body size
- Race/ethnicity

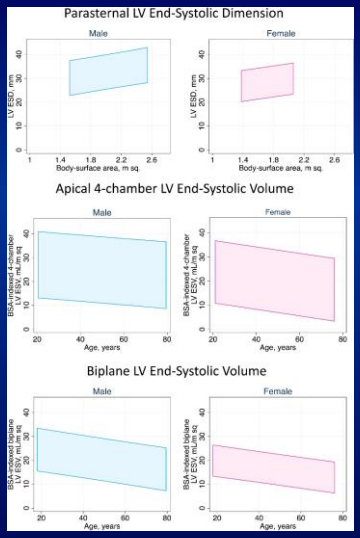
Use appropriate reference tables

Figure 1



Journal of the American Society of Echocardiography 2015 28, 1-39.e14DOI: (10.1016/j.echo.2014.10.003)

Figure 2



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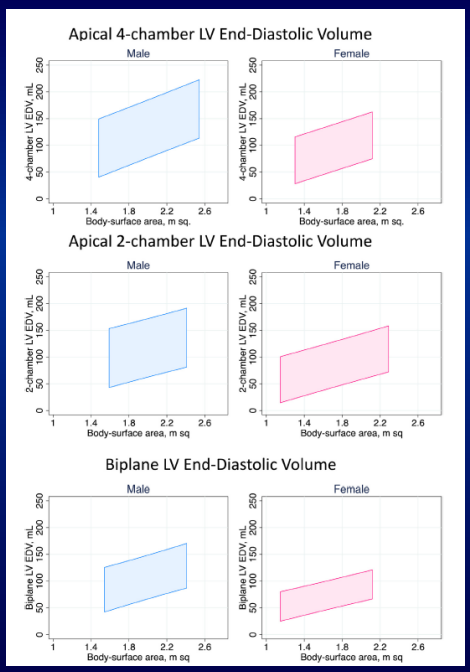


Indexing to BSA

- We do it but…
  - No consensus how to deal with indexing in obese subjects
  - Assumes linearity when we know this is not the case

Ejection Fraction
SV/EDV

Male				Female			
Normal range	Mildly abnormal	Moderately abnormal	Severely abnormal	Normal range	Mildly abnormal	Moderately abnormal	Severely abnormal
52–72	41–51	30–40	<30	54–74	41–53	30–40	<30

How do you define hypertrophy?

- Wall thickness?
- Calculated LV Mass?

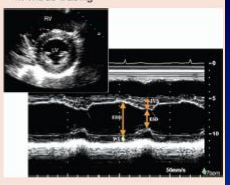
LV Mass

Linear method:
Cube formula

$$\text{LV mass} = 0.8 \cdot 1.04 \cdot [(\text{IVS} + \text{LVID} + \text{PWT})^3 - \text{LVID}^3] + 0.6\text{g}$$

Where IVS is interventricular septum; LVID is LV internal diameter, and PWT is inferolateral wall thickness.
Linear internal measurements of the LV should be acquired from the parasternal approach and carefully obtained perpendicular to the LV long axis, and measured at the level of the mitral valve leaflet tips. M-mode measurements should be obtained from a targeted SAX or a parasternal LAX view. All measurements should be performed at end-diastole.

M-mode tracing



2D

2D based formulas.
Truncated ellipsoid:

$$\text{LV mass} = 1.05\pi\left\{(b+t)^2\left[\frac{2}{3}(a+t)+d-\frac{d^3}{3(a+t)^2}\right]-b^2\left[\frac{2}{3}a+d-\frac{d^3}{3a^2}\right]\right\}$$

Parameter and method	Echocardiographic imaging

Area-length:

$$\text{LV mass} = 1.05\left\{\left[\frac{5}{6}A_1(a+d+t)\right]-\left[\frac{5}{6}A_2(a+d)\right]\right\}$$

Mean wall thickness is calculated from epicardial (A_1) and endocardial (A_2) cross-sectional areas in short-axis view at the papillary muscle level (top panel, green line) with the papillary muscles considered part of the LV cavity. The short axis radius is calculated as:

$$b\sqrt{\frac{A_2}{\pi}}$$

Then, mean wall thickness t is calculated as:

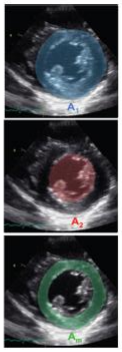
$$t = \left(\sqrt{\frac{A_1}{\pi}}\right) - b$$

and the cross sectional area of the myocardium (A_m) in short-axis view is:

$$A_m = A_1 - A_2$$

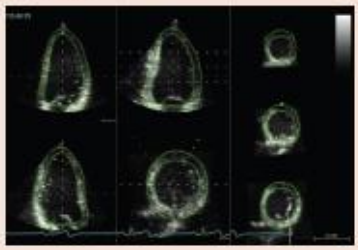
LV mass is calculated from these measurements plus the LV length measured from the level of the short axis plane to the base (d) and to the apex (a).
Key: a - distance from the minor axis to the endocardium at the LV apex; b = LV minor radius; d - distance from the minor axis to the mitral valve plane; t - mean wall thickness.

LV mass = (LV epicardial volume − LV endocardial volume). 1.05 = LV myocardial volume. 1.05



3D based formula.

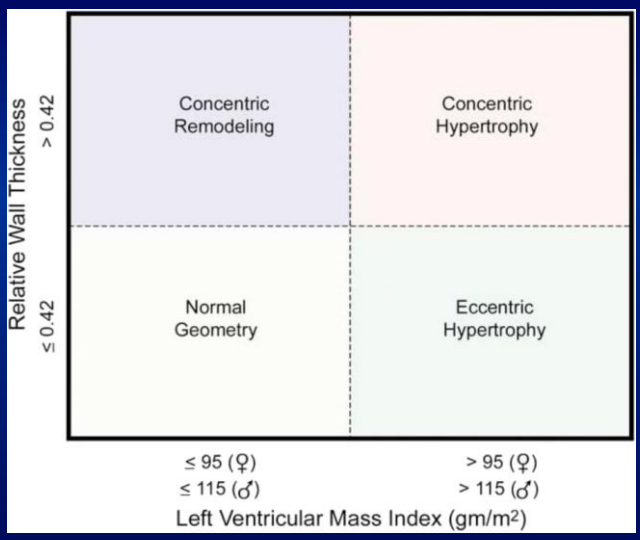
3D data set



Relative Wall Thickness

$$\frac{2 \times \text{posterior wall thickness}}{\text{LV internal diameter at end-diastole}}$$

Figure 6



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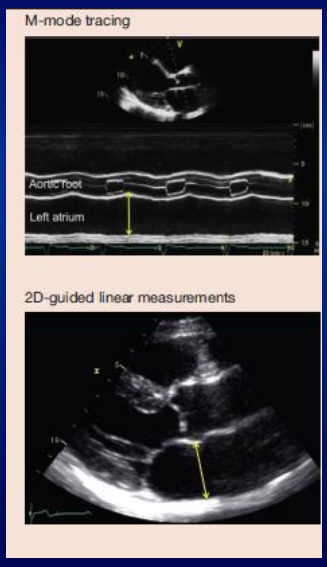
- Be aware of limitations of different approaches when there is upper septal thickening (be consistent)
- Index to BSA (or height)
- If you do not calculate LV mass, report increased wall thickness as increased wall thickness (not hypertrophy)

- Reference upper limits of normal LV mass:
  - by linear measurements = 95 g/m2 in women and 115 g/m2 in men.
  - by 2D measurements = 88 g/m2 in women and 102 g/m2 in men.

Left Atrium

Left Atrium AP diameter

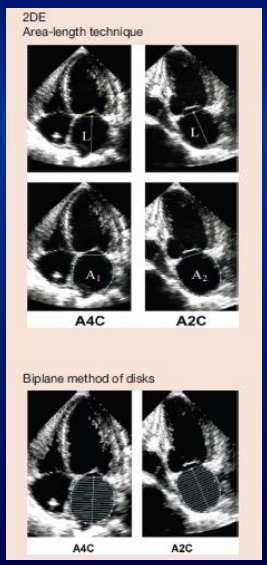


- at the level of the aortic sinuses
- leading-edge to leading-edge convention.

Left atrial area

- Exclude pulmonary veins and appendage
- Connect insertion of MV leaflets
- Frame just prior to MV opening
- Inner edge

Left Atrial Volume

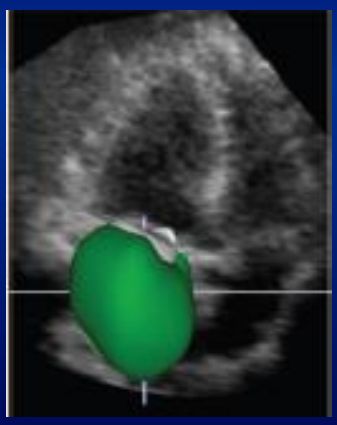


- 2-D techniques
  - Area-length
    - LA length is the shorter of the A4C and A2C values
    - Should not differ by >5mm
  - MOD is preferred
    - gives smaller numbers than area-length

LA Volumes with partition values

Male				Female			
Normal range	Mildly abnormal	Moderately abnormal	Severely abnormal	Normal range	Mildly abnormal	Moderately abnormal	Severely abnormal
16–34	35–41	42–48	>48	16–34	35–41	42–48	>48

Left-atrial volume



- Few normal data

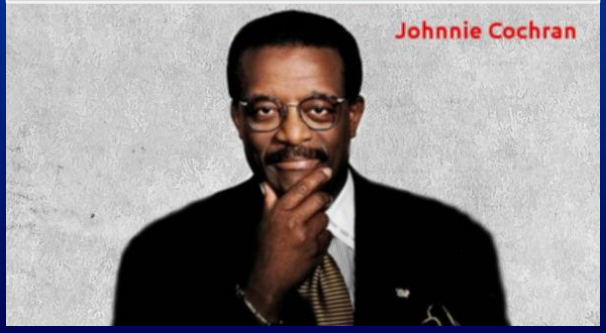
Some questions to wake you up!

1) LV end-diastolic dimensions should be measured at the upstroke of the QRS — False
2) Partition values allow you to separate the left atrium from the aortic root — False
3) LV measurements taken from low parasternal windows overestimate true values — True
4) The diagnosis of LV hypertrophy is based on wall thickness — False

Summary

- Updated guidelines:
  - provide new cutoffs for LA volumes and LVEF
  - provide tools for assessing LV and LA
  - change (for some) timing of when measurements are taken
  - Remind us of the importance of getting good images
    - On axis
    - Avoid foreshortening
    - Use contrast as needed

If you can't see it you must not measure it!



Chamber Quantification Guidelines Update I: Left Heart Measurements Technical Tips

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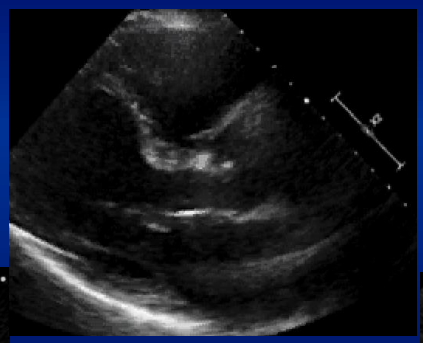
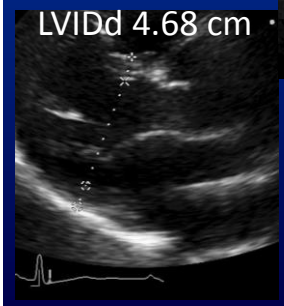
Case 1

- Male 89 yrs. old
- Chronic CHF
- Recent increasing SOB, Edema

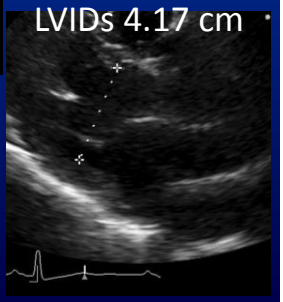
LV Size
What do you conclude from these Measurements?



LVIDd 4.68 cm



LVIDs 4.17 cm



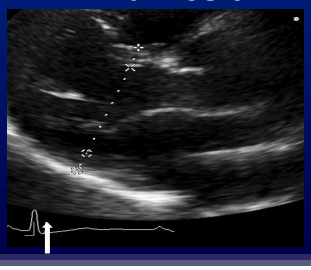
LV Size
What do you conclude from these Measurements?

1. Image is booted
2. Diameter is underestimated
3. Diameter is measured in wrong time of cardiac cycle
4. All of the above

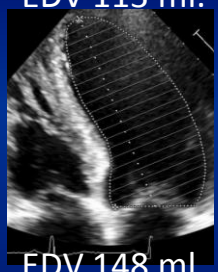
LV Size
What do you conclude from these Measurements?

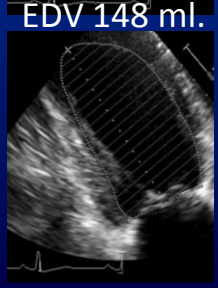
1. Image is booted True
2. Diameter is underestimated True
3. Diameter is measured in wrong time of cardiac cycle True
4. All of the above True

LVIDd 4.68 cm



LV Size
What do you conclude from these Measurements?





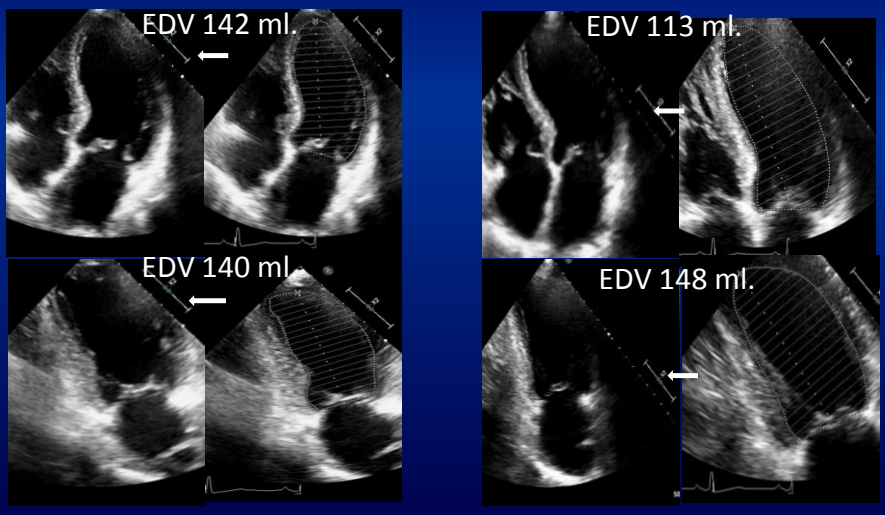
LV Size
Which one of these statements are true?

1. LV volumes are accurate
2. Discordance between LV volumes
3. Image is Foreshortened
4. Answer is 2 and 3

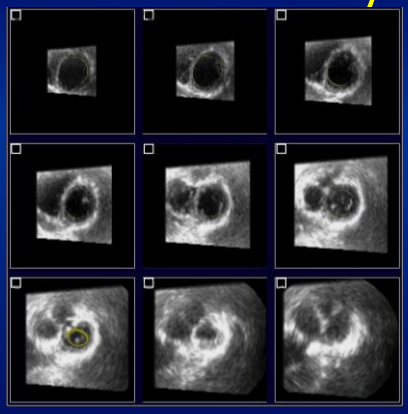
LV Size
What do you conclude from these Measurements?

1. LV volumes are accurate — False
2. Discordance between LV volumes — False
3. Image is Foreshortened — False
4. Answer is 2 and 3 — True

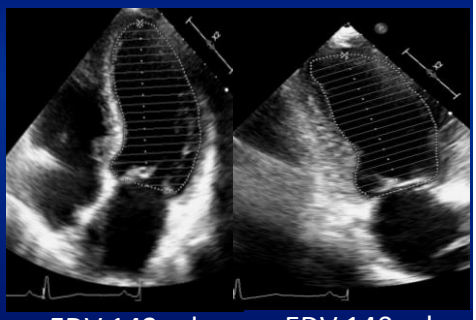
LV Volume
Optimize Image



3D Volume
Moderate Systolic Dysfunction



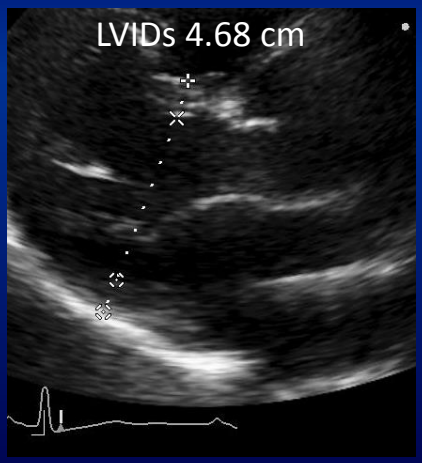
EDV 142 ml.
EF 35%



EDV 142 ml. EDV 140 ml.

EF 37%

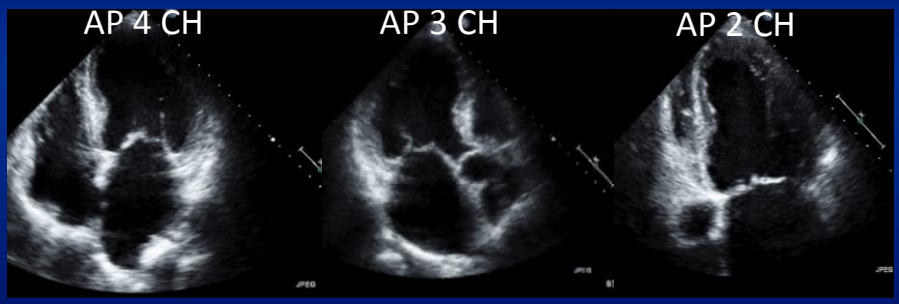
Correlate Size Between Views



Case 2

- Male 82 yrs. Old
- Previous CABG
- Recent onset of increasing SOB

What is the LV systolic function?



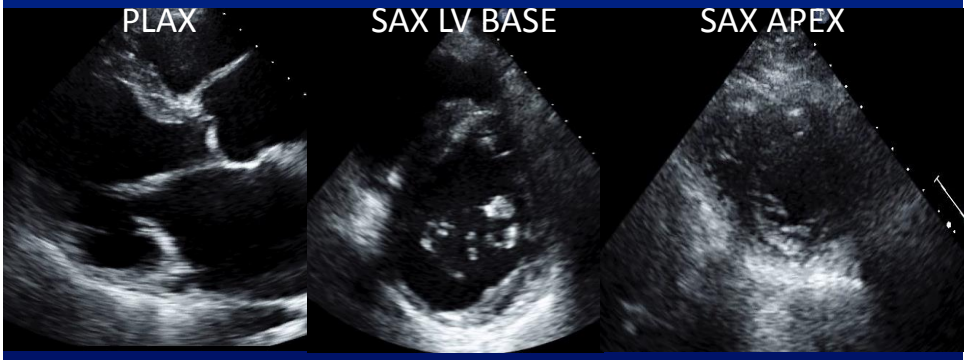
What is the LV systolic Function?

1. Normal systolic function
2. Mild global systolic dysfunction
3. Moderate global systolic dysfunction
4. Undetermined systolic function

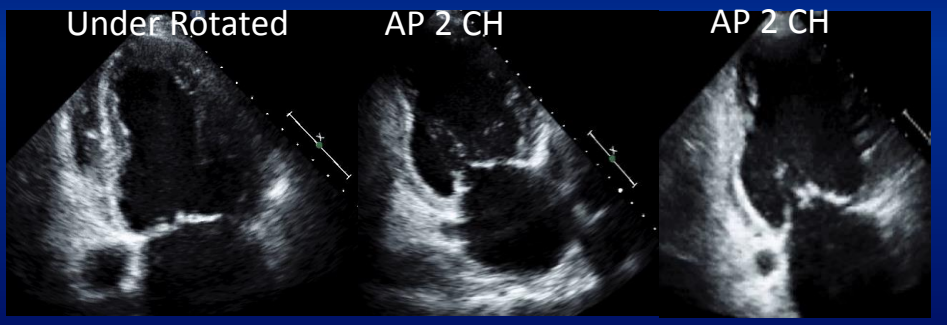
What is the LV systolic Function?

1. Normal systolic function — False
2. Mild global systolic dysfunction — False
3. Moderate global systolic dysfunction — False
4. Undetermined systolic function — True

Multiple Views
What Did We Miss?



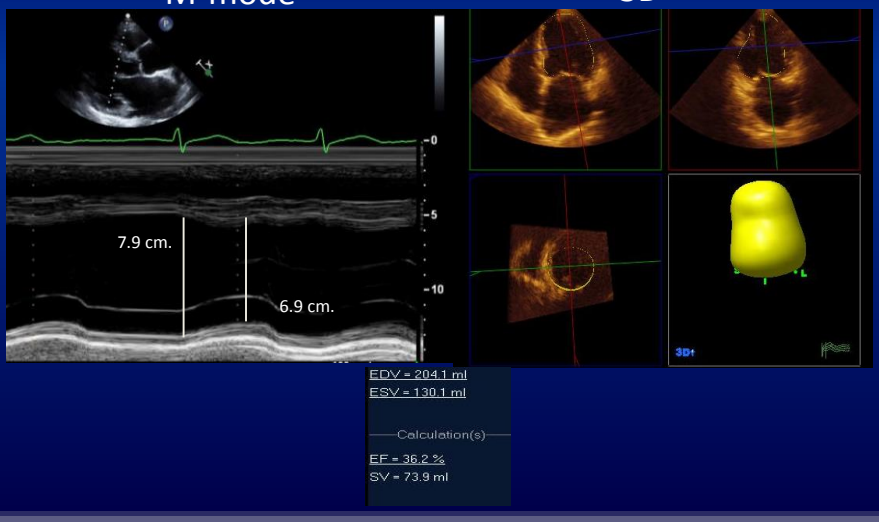
Multiple Views
What Did We Miss?



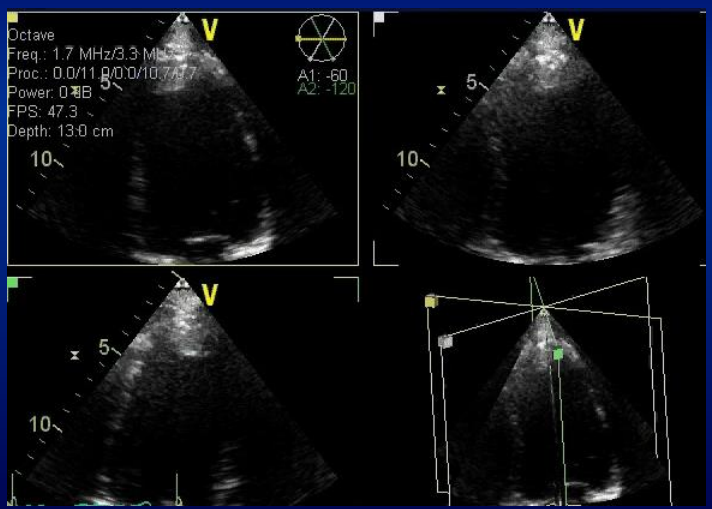
3D Volume
Moderate Systolic Dysfunction

M-mode

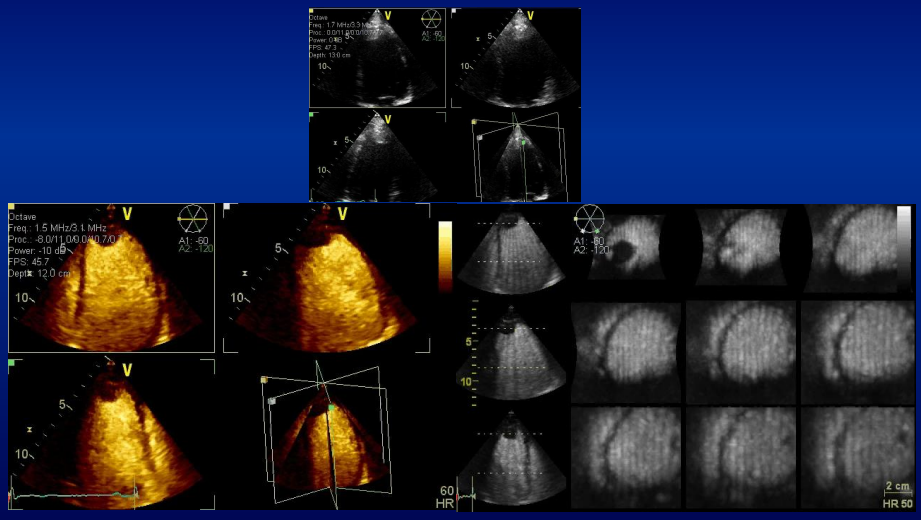
3D



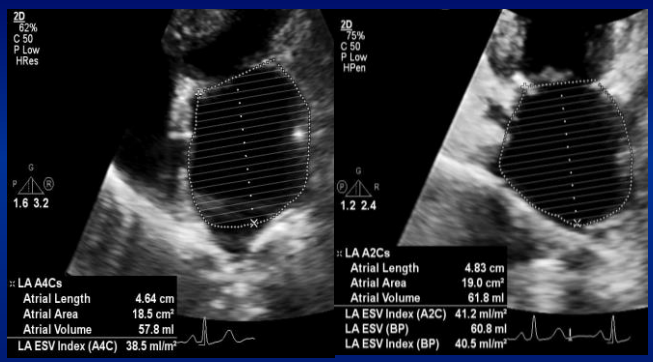
Is There An LV Thrombus?



Contrast Imaging



LA Volume



Take Home Points

- Know the advantages and limitations of techniques for the assessment of LV/LA size and function
- Recognize when there is not correlation between the numbers
- You owe it to your physicians and patients to provide the best diagnostic quality

Thank you