

Role of Ultrasound in Evaluating for Embolic Causes of Ischemic Stroke

Ultrasound Scholarly Concentration
Case Conference #7
4/20/2022
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- I. Case
- II. Clinical Question
- III. Literature Review
- IV. Limitations of POCUS
- V. Key Points

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- 38- year old male with PMHx of CVA (2015, residual right sided weakness) and HTN who presented after sudden onset right arm numbness and worsening of pre-existing right limb weakness.
 - Social History: recently released from 8 years in prison where he had his first stroke in 2015. He reports he has not taken any medications since he was released. No smoking history.
 - Review of systems: patient reports some shortness of breath 24 hours prior to admission.
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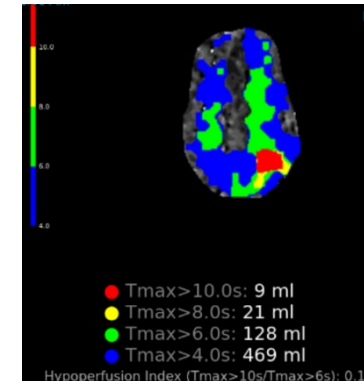
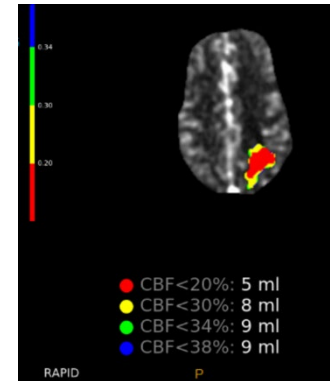
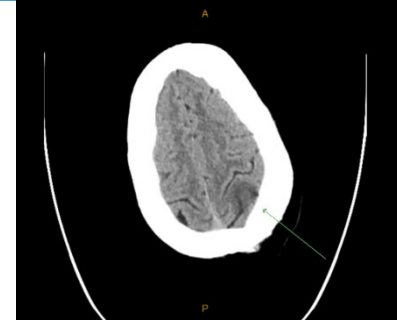
Objective Data



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- VS:
 - Temp = 36.8 °C,
 - Heart rate = 108 BPM
 - BP = 164/129 mm Hg
 - RR=21 breaths/min
 - SpO₂=90% on room air
 - BMI= 45
 - LABS:
 - WBC 15.9, Hgb 11.8, Plt 476
 - Na 127, K 3.4, BUN 41, Cr 2.00
 - BNP: 1539.5
 - HgbA1c: 8.3
 - ESR: 79
 - CRP: <0.5
 - ABG: 7.369/47.0/81/27.1
 - Lipids: Cholesterol 101, Tri 127, HDL 24, VLDL 25, LDL 52
 - UDS: + tetrahydrocannabinol
 - Covid-19: Negative
 - PE:
 - General: Well developed, obese male in no acute distress
 - HENT: sclera anicteric, EOMI, PERRLA
 - Cardiac: regular rate and rhythm, normal S1&S2, no murmurs
 - Lung: CTAB, normal respiratory effort, no accessory muscle use
 - Abdominal: 2+ pitting edema in panus, NABS, soft, nontender
 - Extremities: 1+ pitting edema BLE
 - Neuro: 4/5 strength right upper extremity, reduced sensation to light touch right upper extremity; 5/5 strength and normal sensation all other extremities, CN III-XII intact
-

- CT Head w/o Contrast (3/14/22):
 - Posterior left parietal lobe hypodensity consistent with left MCA infarct
- CTA Head and Neck (3/14/22):
 - No emergent large vessel occlusion
- Cerebral Perfusion Study (3/14/22):
 - Infarct 8 cc, Penumbra 128 cc
- MRI brain w/o Contrast (3/15/22):
 - acute infarcts in the left cerebellum and left parietal-frontal cortex





- Patient was started on tPA infusion.
 - He became acutely obtunded and hypoxic requiring emergent intubation and transfer to the ICU.
 - Investigation for an embolic source:
 - Cardiac source:
 - EKG: Normal Sinus Rhythm
 - TTE or TEE with bubble study
 - Vascular Source:
 - CTA or MRA head/neck
 - Labs:
 - Hypercoagulable Work-up
 - Lipid Panel, HgbA1c, TSH, ESR/CRP, blood culture if signs or symptoms of infection
-

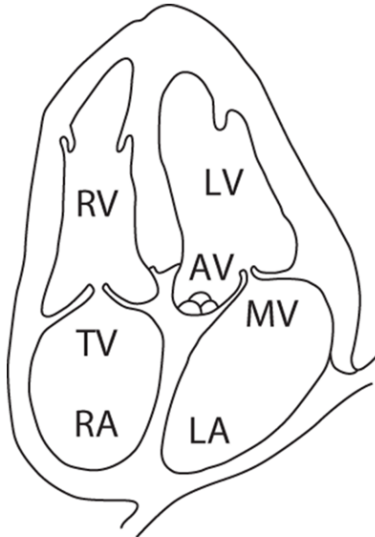
Case Imaging: Transthoracic Echocardiogram

Apical 4-Chamber View - Anatomy and Technique



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Anatomy



RV: Right Ventricle
LV: Left Ventricle
TV: Tricuspid Valve
AV: Aortic Valve
MV: Mitral Valve
RA: Right Atrium
LA: Left Atrium

Source: C. M. Baston, C. Moore, E. A. Krebs, A. J. Dean, N. Panebianco:
Pocket Guide to POCUS: Point-of-Care Tips for Point-of-Care Ultrasound, 1st edition.
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Technique



- Probe indicator faces the patient's left axilla.
- Place at point of maximal impulse (PMI).
- *TIP: Place patient in the left lateral decubitus position.*

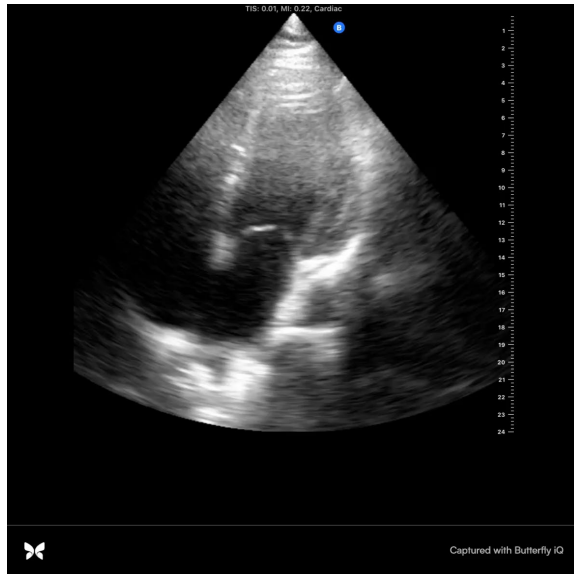
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Case Imaging US Apical 4-Chamber

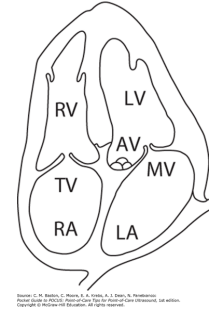
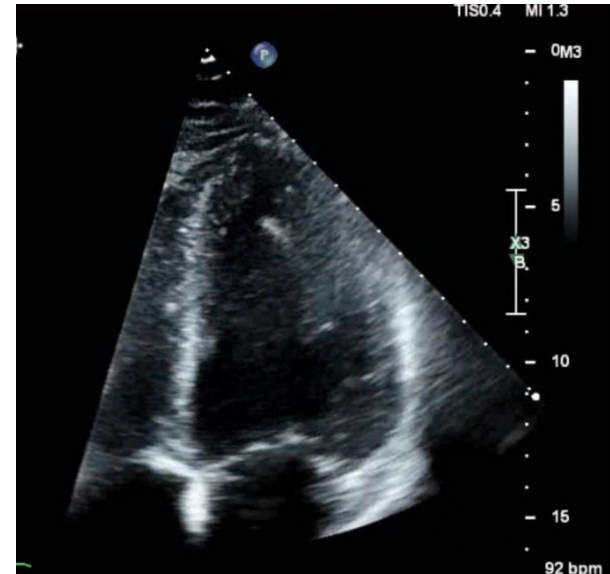


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POCUS



Formal Echo

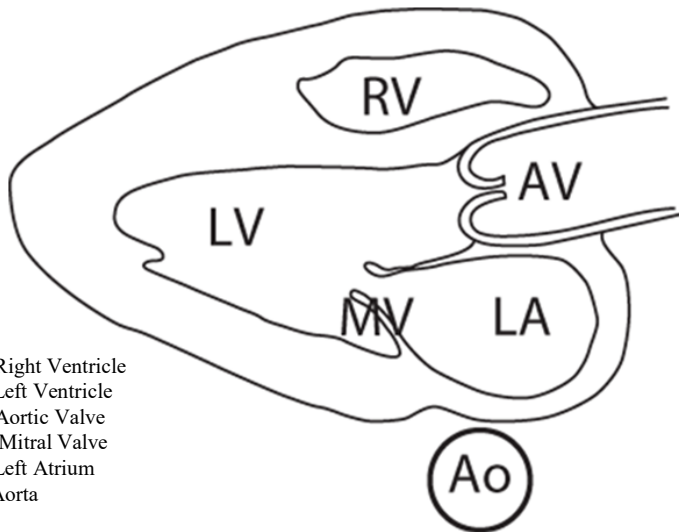


Case Imaging: Transthoracic Echocardiogram Parasternal Long View - Anatomy and Technique



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Anatomy



RV: Right Ventricle
LV: Left Ventricle
AV: Aortic Valve
MV: Mitral Valve
LA: Left Atrium
Ao: Aorta

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Technique

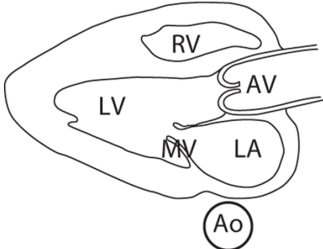
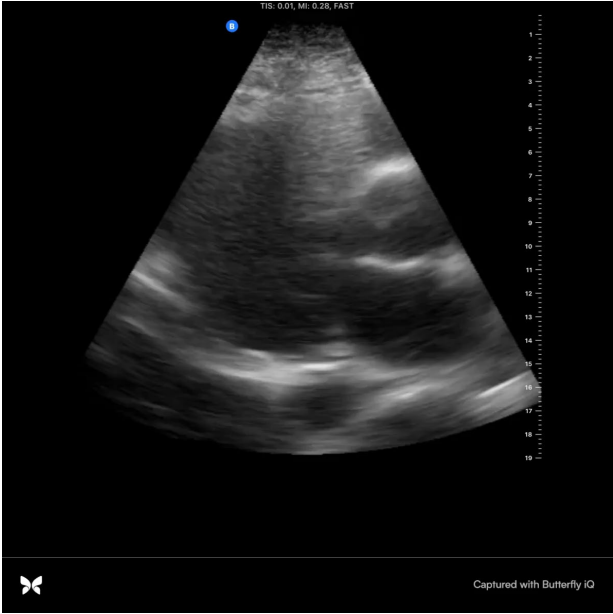


- Probe indicator faces the patient's right shoulder.
- Place in 3rd-5th intercostal space close to the sternum.

Source: C. M. Baston, C. Moore, E. A. Krebs, A. J. Dean, N. Panebianco:
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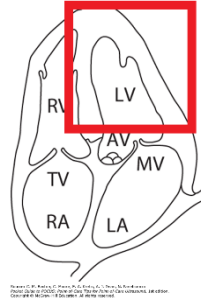
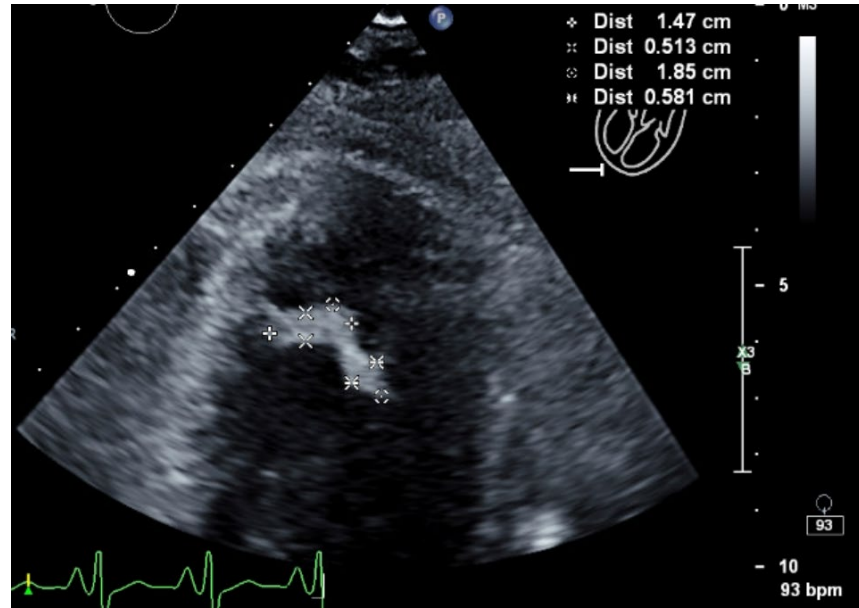
POCUS



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Thrombus Measurement





- Official Echocardiogram Results:
 - 1.) 20x7 mm mobile hyperechoic mass on narrow stalk in the LV near the apex most likely representing thrombus but cannot rule out malignancy
 - 2.) LVEF 40%
 - 2.) Left ventricular global hypokinesis
 - 3.) Normal Right ventricle function
 - 4.) Mildly dilated right and left atria
 - 5.) Normal valvular function
-



Full Hypercoagulable Work-up:

Factor V Leiden - Negative

Anti-thrombin 3 - Negative

Protein C&S - Negative

ANA - Negative

ANCA – MPO/PR3 - Negative

Anti DS DNA - Negative

Antiphospholipid - Negative

MTHFR mutation - Negative

CRP <0.5

ESR 79 mm/h

Case progression: Pt developed significant infarcts in his left posterior parietal lobe, cerebellum, and posterior hypothalamus.

- Heparin gtt
- Antibiotics for aspiration PNA
- Sedation with propofol while on mechanical ventilation

PE: dysconjugate gaze, negative dolls eye reflex, negative menace, unresponsive to painful stimuli, but initiating spontaneous breaths when taken off PRVC.

Pt was found to have cerebral edema on hospital day 4, mostly involving the left cerebellum compressing the 4th ventricle.

- Started on Hypertonic Saline



How reliable is TTE for detecting an intracardiac thrombus?



Detection of LV Thrombus in ESUS: American Heart Association

Table 2. Detection of LV Thrombus by TTE and CE-CMR in 60 Patients With Acute Stroke

Examination	Location of LV Thrombus	
	Apex	Lateral or Posterior Wall
TTE	1/60	0/60
CE-CMR	9/60	3/60

Of 12 LV thrombi (in 12 patients) detected on CE-CMR, TTE detected only 1 large apical thrombus. CE-CMR indicates contrast-enhancement cardiac magnetic resonance; LV, left ventricular; and TTE, transthoracic echocardiography.

Study Design: Prospective

Inclusion Criteria: Acute Ischemic Stroke, Hx MI or LVEF <50%

Total Participants: 797 with acute ischemic stroke, only 105 with LVEF <50% or hx MI - 45 excluded for renal disease and other factors

Results: “CE-CMR detected LV thrombi in the apex (n=9) and on the lateral or posterior wall (n=3), whereas TTE could not identify 8 small (<1 cm) apical thrombi and 3 lateral or posterior mural thrombi.”

“Hays et al demonstrated that even moderate LV dysfunction (LVEF \geq 30%) increased stroke risk, suggesting that not only severe but also moderate LV dysfunction could lead to thrombosis in the LV cavity. Our results strongly support this interpretation because \approx 40% of stroke patients with LV thrombus on CE-CMR had LVEF \geq 30%.”



Detection of LV Thrombus via TTE vs TEE vs CE-CMR

	Total (n = 106)	MRI Detection		TTE Detection		TEE Detection (n = 100)
		n = 67	n = 55*	n = 101	n = 89*	
Any thrombus	106	58/67 (87%)	49/55 (89%)	27/101 (27%)	24/89 (27%)	39/100 (39%)
Size						
Small (<1 cm)	36/106 (34%)	15/22 (68%)	11/17 (65%)	3/33 (10%)	3/29 (10%)	7/36 (19%)
Moderate (1-2 cm)	34/106 (32%)	24/25 (96%)	22/22 (100%)	8/33 (24%)	7/29 (24%)	13/31 (42%)
Large (>2 cm)	36/106 (34%)	19/20 (95%)	16/16 (100%)	16/35 (46%)	14/33 (42%)	19/33 (58%)
Location						
Apical location	75/106 (71%)	43/51 (84%)	35/41 (85%)	18/71 (25%)	16/64 (25%)	29/73 (40%)
Proximal location	31/106 (29%)	15/16 (94%)	14/14 (100%)	9/30 (30%)	8/25 (32%)	10/27 (37%)
Pathologic characteristics						
Recent clot	16/76 (21%)	10/10 (100%)	8/8 (100%)	2/16 (13%)	2/15 (13%)	4/15 (27%)
Organizing clot	39/76 (51%)	24/27 (89%)	23/25 (92%)	12/37 (32%)	11/36 (31%)	15/36 (42%)
Chronic organized clot	21/76 (28%)	10/10 (100%)	9/9 (100%)	9/21 (43%)	9/18 (50%)	12/20 (60%)

*Numbers refer to subgroup analysis of patients with imaging study performed within 30 days of surgical or pathological confirmation.

Table III. Sensitivity and specificity for subgroup with all 3 imaging modalities

	Total (n)	MRI	TTE	TEE
Sensitivity	48	88% (79%-97%)	23% (11%-35%)	40% (26%-54%)
Specificity	112	99% (97%-100%)	96% (92%-99.6%)	96% (92%-99.6%)

Ninety-five percent confidence intervals are shown in parentheses.

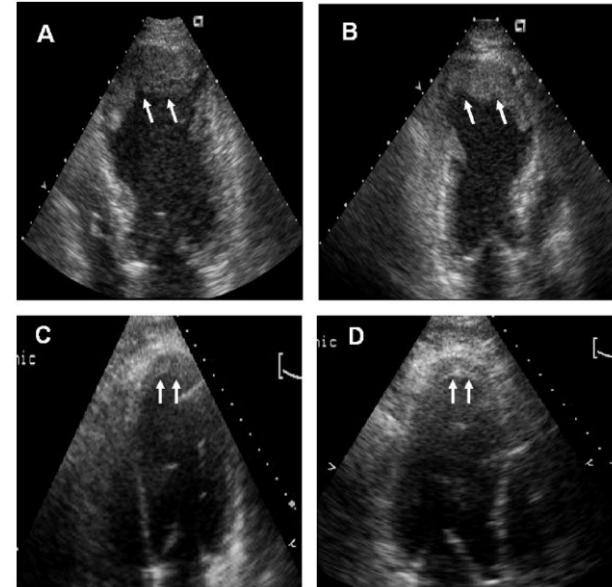
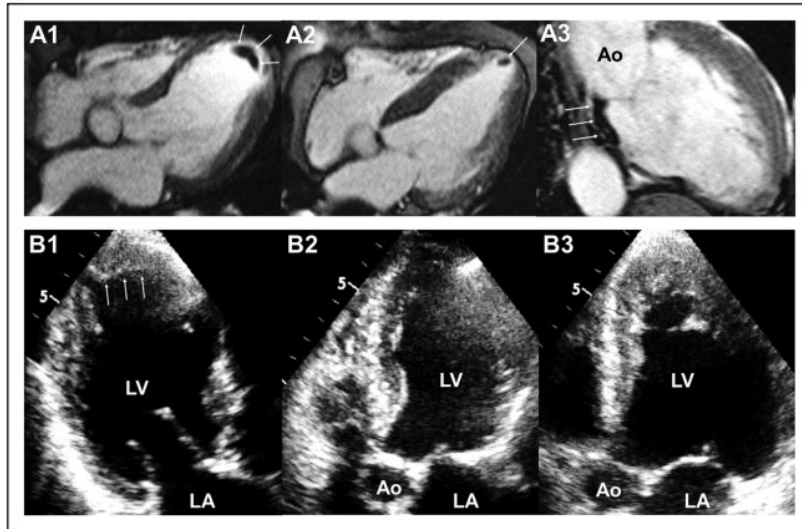
Srichai, Monvadi B., et al. "Clinical, imaging, and pathological characteristics of left ventricular thrombus: a comparison of contrast-enhanced magnetic resonance imaging, transthoracic echocardiography, and transesophageal echocardiography with surgical or pathological validation." *American heart journal* 152.1 (2006): 75-84.

Study Design: Retrospective

Inclusion Criteria: Ischemic Heart Disease with hx of remote MI >8 weeks ago, surgical or pathological confirmation of presence or absence LV thrombus

Total Participants: 361 patients

Results: "In comparison, TTE correctly identified 11 of 48 confirmed LV thrombus and 108 of 112 confirmed absent thrombus with an overall **sensitivity of 23%** and **specificity of 96%**, and TEE correctly identified 19 of 48 confirmed LV thrombus and 108 of 112 confirmed absent thrombus with an overall sensitivity of 40% and specificity of 96%"



Transthoracic echocardiography images in 4-chamber and 3-chamber views from 2 separate patients with obvious (A, B) and subtle (C, D) findings of LV thrombus (arrows). Both patients were found to have a large apical organizing thrombus at the time of surgical LV reconstruction.

Srichai, Monvadi B., et al. "Clinical, imaging, and pathological characteristics of left ventricular thrombus: a comparison of contrast-enhanced magnetic resonance imaging, transthoracic echocardiography, and transesophageal echocardiography with surgical or pathological validation." *American heart journal* 152.1 (2006): 75-84.



LV Systolic Dysfunction and the Risk of Ischemic Stroke

Stroke

Volume 37, Issue 7, 1 July 2006; Pages 1715-1719
<https://doi.org/10.1161/01.STR.0000227121.34717.40>

ORIGINAL CONTRIBUTIONS

Left Ventricular Systolic Dysfunction and the Risk of Ischemic Stroke in a Multiethnic Population

Allison G. Hays, MD, Ralph L. Sacco, MD, Tanja Rundek, MD, Robert R. Sciacca, EngScD, Zhezhen Jin, PhD, Rui Liu, MD, Shunichi Homma, MD, and Marco R. Di Tullio, MD



Study Design: Prospective

Inclusion Criteria: First time stroke patients part of the NOMAS study in Manhattan NY

Control: Never diagnosed with stroke, over 39, resided in northern Manhattan for 3 months
- age, gender, race/ethnicity matched

Total Participants: 558 patients (270 stroke patients, 288 control patients)

Results: A decreased ejection fraction was associated with ischemic stroke even after adjusting for other stroke risk factors. The adjusted odds ratio for any degree of LVD was 3.92 (95% CI, 1.93 to 7.97). The **adjusted odds ratio** for mild LVD was 3.96 (95% CI, 1.56 to 10.01) and for **moderate/severe LVD 3.88 (95% CI, 1.45 to 10.39).**"

LV Ejection Fraction as defined in this study: Normal – 50%, Mild: 41-50%, Moderate 31-40%, Severe ≤30%



Limitations of Transthoracic Echocardiogram:

- 1.) Size (<1-2cm)
- 2.) Location
 - poor near field resolution (apical thrombus)
 - posterior or lateral wall
 - atrial chamber or appendage (favor TTE)
- 3.) Immobile
- 4.) Non-protuberant and adherent to LV wall
- 5.) Recently formed clot



- POCUS can be an effective tool for rapid assessment of cardiac function and a large, mobile, and protuberant LV thrombus.
 - Sensitivity is ~23% compared to TEE (40%) and CE-CMR (88%).
 - If high suspicion for cardioembolic stroke based on history of recent MI, dyskinetic wall regions, LV aneurysm, or low EF consider CE-CMR.
 - Even moderate LV dysfunction ($LVEF \geq 30\%$) can increase risk of LV thrombus and stroke.
-