Infective Endocarditis

Role of Echocardiography in Diagnosis and Management

William K. Freeman, MD, FACC, FASE

DISCLOSURES

Relevant Financial Relationship(s)

None

Off Label Usage

None

Infective Endocarditis

Diagnosis

Major Duke Criteria

- **Positive blood cultures**
- **Evidence of endocardial involvement**

Durack DT, et al. Am J Med 1994; 96: 200

Infective Endocarditis: Microbiology

Organism	Native valve				Prosthetic valve	
	Community-acquired IE; %, (n = 1,201) (ref. 11, 20)	Healthcare-associated IE; %		Intravenous-drug users with IE; % (n = 237) (ref. 1)	Early IE*; % (n = 140) (ref. 21-23)	Late IE*; % (n = 390) (ref 21,23)
		Nosocomial (n = 370) (ref. 11, 20)	Non-nosocomial (n = 254) (ref. 11)			
Staphylococcus aureus	21	**45**	**42**	**68**	**34**	19
Coagulase-negative staphylococci	6	12	15	3	28	**20**
Enterococcus	10	14	16	5	10	13
Viridans streptococci	**26**	10	6	10	1	11
Streptococcus bovis	10	3	3	1	1	7
HACEK	3	0	0	0	0	2
Fungi	0	2	2	1	6	3
Other	13	7	10	7	6	15
Negative blood culture	11	7	6	5	14	10

Data obtained from Murdoch et al.(1), Benito et. al. (11), Hill et. al (20,23) Wang et. al.(21), and Lopez et.al.(22).

Baddour LM, Freeman WK. Braunwald's Heart Disease, 10th Ed 2015

Infective Endocarditis

Major Duke Criteria: Endocardial Involvement

Positive Echo for IE (Vegetation)

Oscillating intracardiac mass, without alternative anatomic explanation, involving:

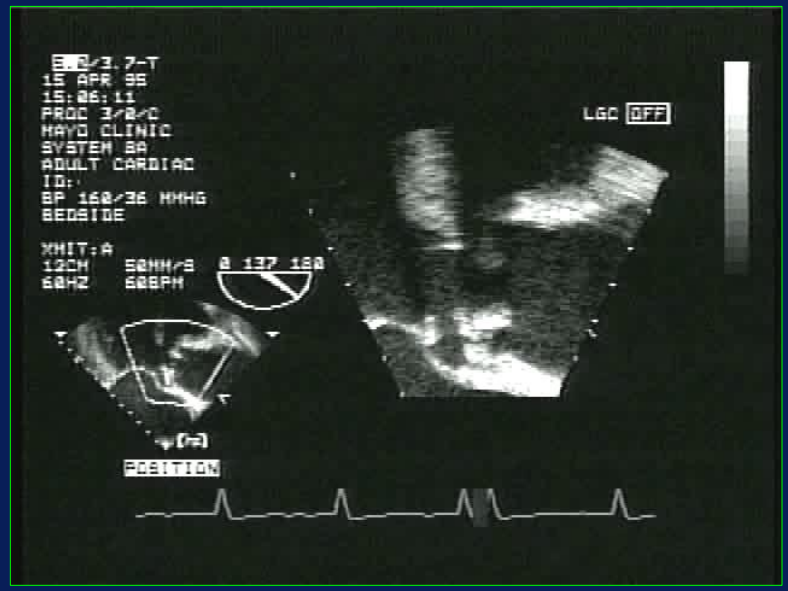
- Valve
- Support structure
- Prosthetic/implanted device
- Path of regurgitant jet

Durack DT, et al. Am J Med 1994; 96: 200

Infective Endocarditis

Major Duke Criteria: Echocardiography

- Vegetation
- Peri-valvular abscess
- New partial dehiscence of prosthetic valve, or new regurgitation



Durack DT, et al. Am J Med 1994; 96: 200

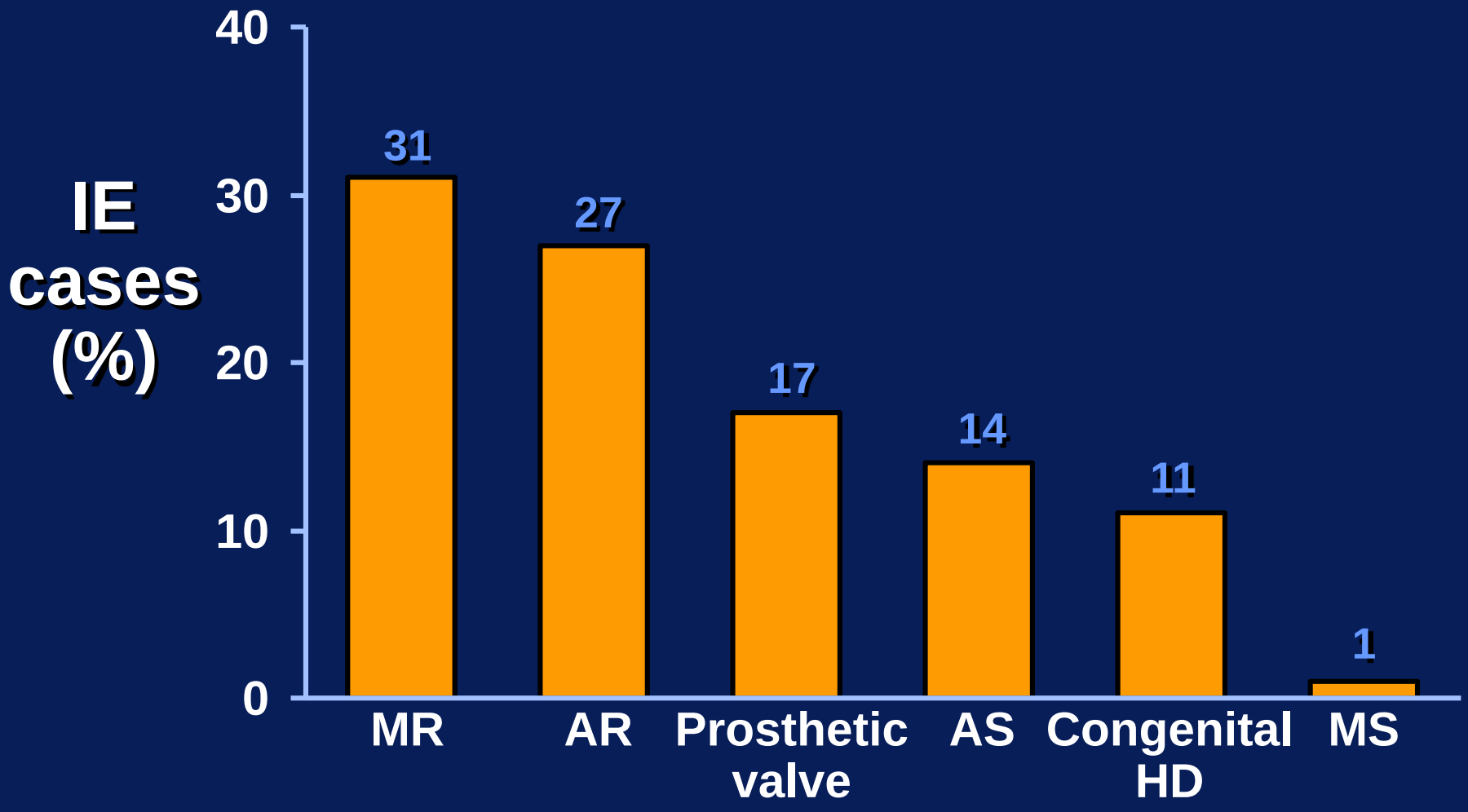
Infective Endocarditis

Minor Duke Criteria:

1. Predisposing cardiac conditions
2. IV drug abuse (also #1 cause for recurrent IE)
3. Fever ≥ 38.0°C; persistent, and otherwise unexplained
4. Blood culture positivity (Not meeting major criteria)

Durack DT, et al. Am J Med 1994; 96: 200

Conditions Predisposing to Infective Endocarditis



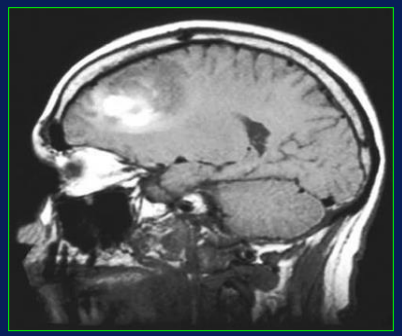
Otto CM: Valvular Heart Disease, 2011

Infective Endocarditis

Minor Duke Criteria:

5. Vascular Phenomena

- Conjunctival hemorrhage
- Janeway lesions
- Systemic arterial embolism
- Pulmonary embolism / infarction
- Mycotic aneurysm
- Intracranial hemorrhage



Durack DT, et al. Am J Med 1994; 96: 200

Infective Endocarditis
Minor Duke Criteria:
6. Immunologic Phenomena

- Diffuse glomerulonephritis
- Osler's nodes
- Roth spots
- Rheumatoid factor +

Durack DT, et al. Am J Med 1994; 96: 200

Infective Endocarditis

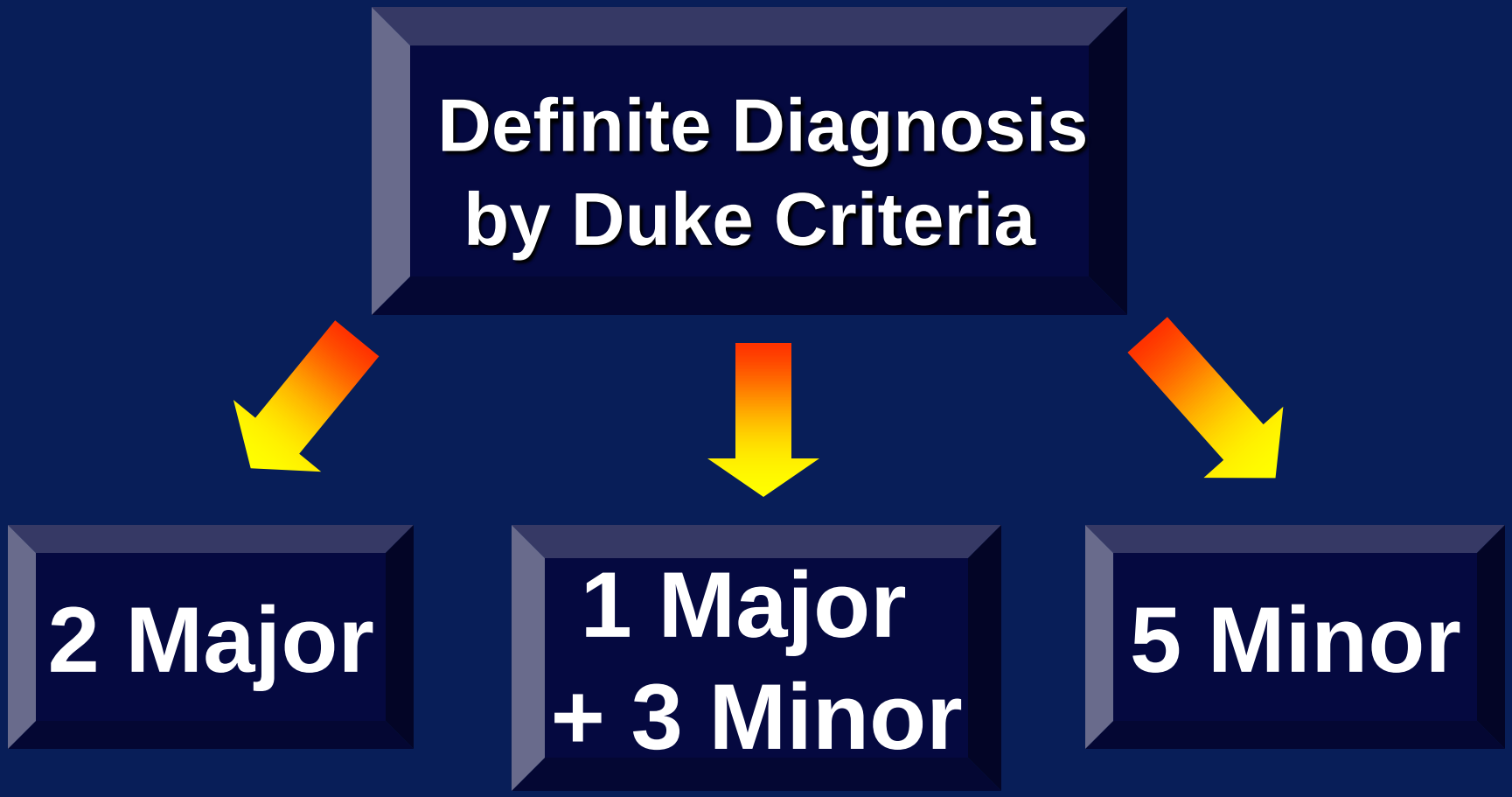
Physical Exam

Fever	80 - 90%
Murmur	70 - 80%
New or changing murmur	10 - 40%
Splenomegaly	10 - 40%
Neurologic deficit	20 - 30%
Peripheral stigmata of IE (Osler's nodes, Janeway lesions, splinter hemorrhages, Roth spots)	<5 - 10%

Murdoch DR, et al Arch Int Med 2009;169:463

Lopez J, et al. Circulation 2010; 121: 892

Infective Endocarditis



Durack DT, et al. Am J Med 1994; 96: 200

Infective Endocarditis

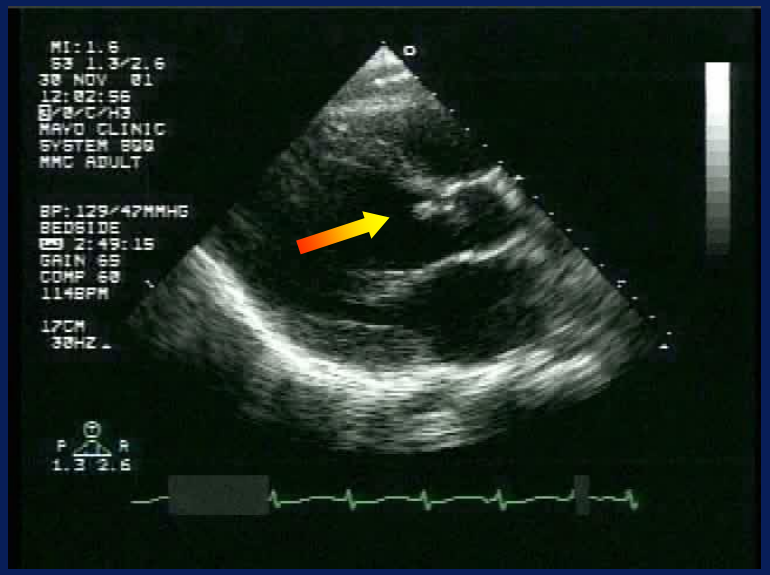
Possible Diagnosis by Duke Criteria

1 Major + 1 Minor

3 Minor

Durack DT, et al. Am J Med 1994; 96: 200

Detection of Vegetations
Transthoracic Echo (TTE)

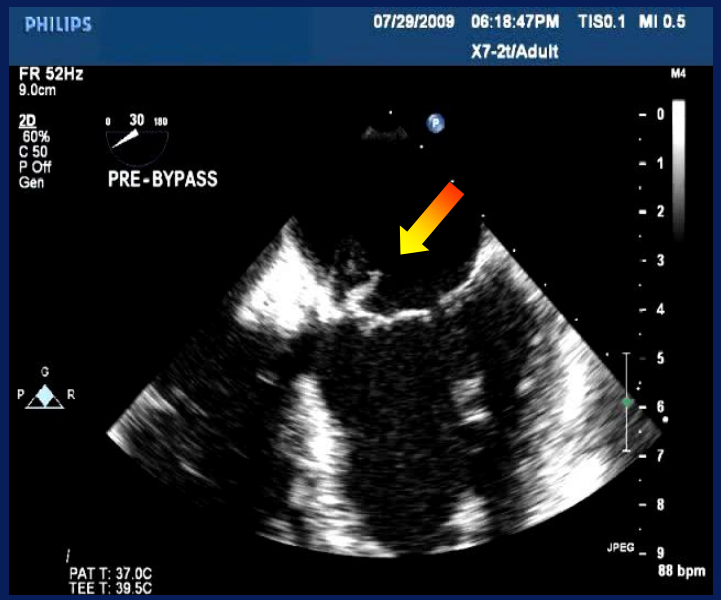


Resolution size: 3 - 4 mm

Sensitivity: 62% - 82%*
Specificity: 91% - 100%

Pederson WR, et al. Chest 100:351, 1991
Jacob, S et al. Curr Opin Cardiol 17:478, 2002
*Casella, F et al. Echocardiography 26: 900, 2009

Detection of Vegetations
Transesophageal Echo (TEE)

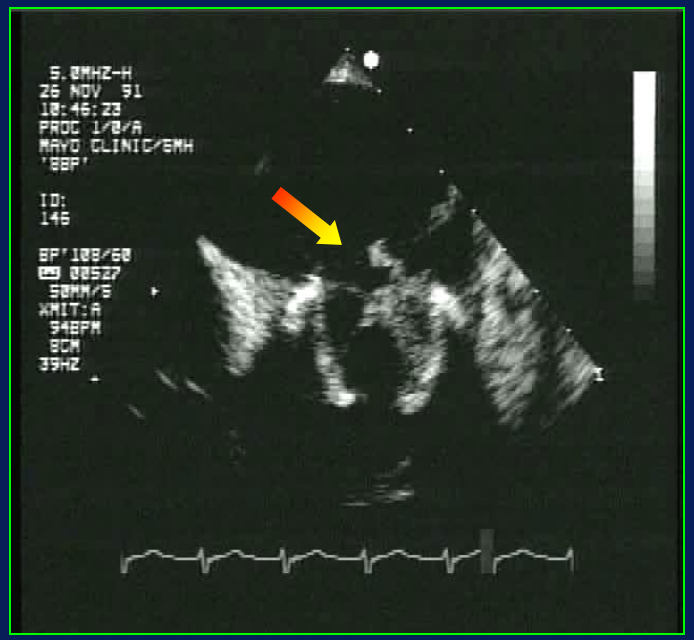


Resolution size: 1 - 2 mm

Sensitivity: 87% - 100%
Specificity: 91% - 100%

Jacob, S et al. Curr Opin Cardiol 2002;17: 478
*Kini, V et al. J Am Soc Echocardiogr 2010; 23: 396

Detection of Prosthetic Valvular Vegetations: TTE vs. TEE



Sensitivity

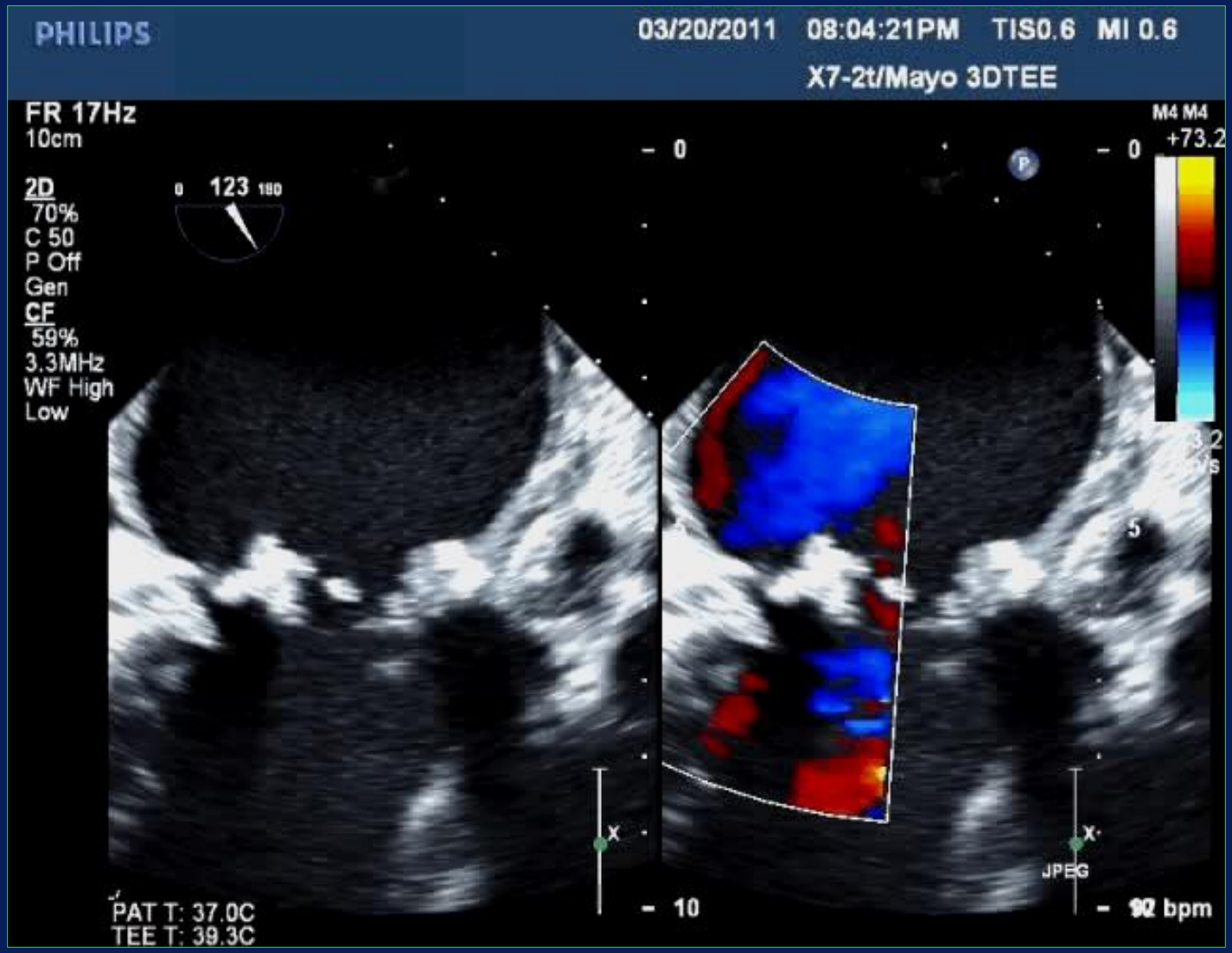
TTE	TEE
17- 45%	82-100%

Note: 30% to 40% of cases of prosthetic valve endocarditis have no vegetations attached to the prosthesis, only peri-annular infection

Jacob, S et al. Curr Opin Cardiol 2002; 17: 478
Graupner C, et al. JACC 2002; 39: 1204
Kini V, et al. J Am Soc Echocardiogr 2010; 23: 396

51 y/o Man: Cardiogenic shock; blood cultures negative
Prior bioprosthetic MVR and AVR

51 y/o Man: Cardiogenic shock; blood cultures negative
Prior bioprosthetic MVR and AVR



51 y/o Man: Cardiogenic shock; blood cultures negative
Prior bioprosthetic MVR and AVR

51 y/o Man: Cardiogenic shock; blood cultures negative
Prior bioprosthetic MVR and AVR

Suspected Infective Endocarditis

Low Initial Patient Risk

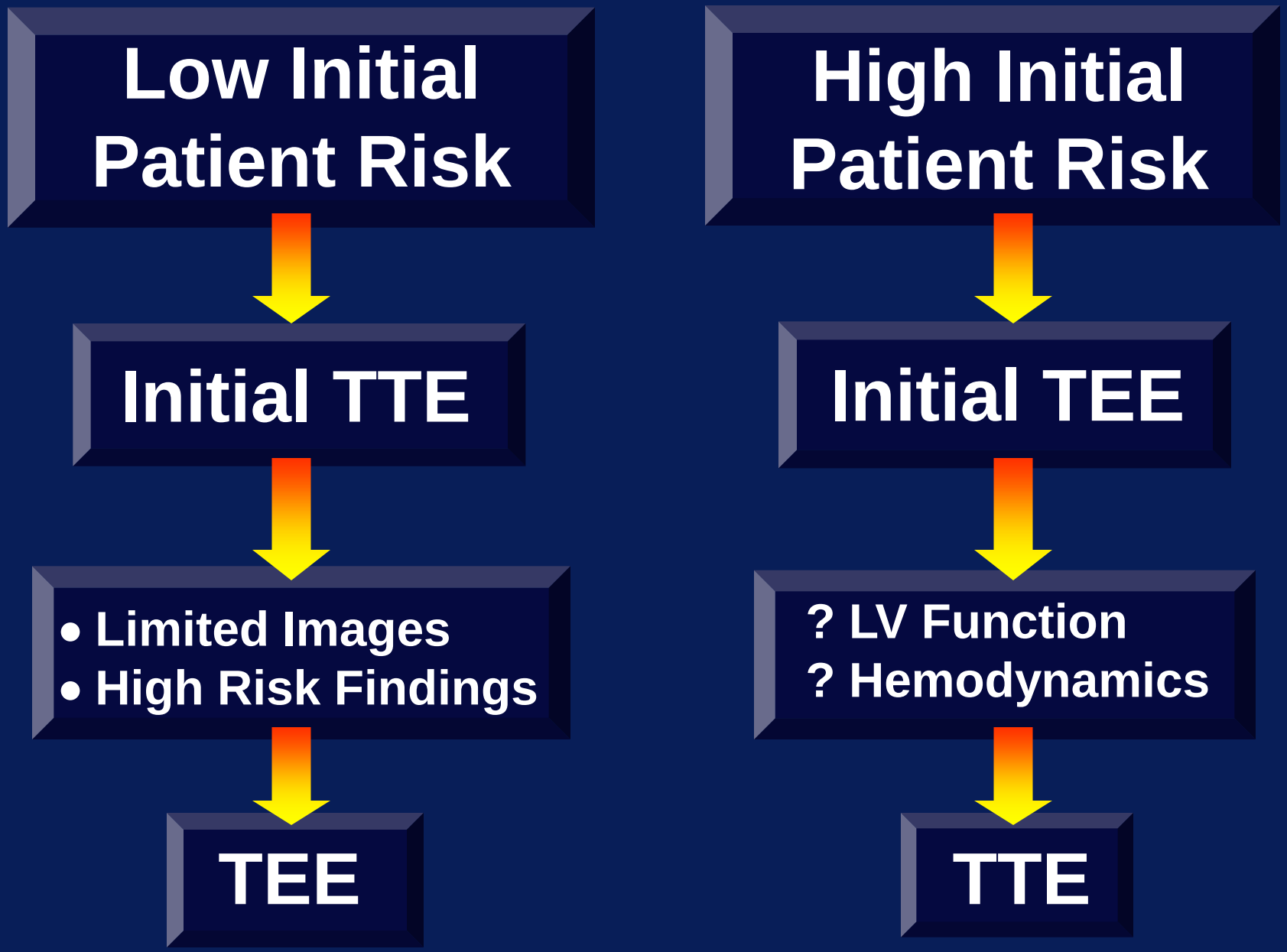
- Unexplained fever
- Chronic murmur
- No stigmata of IE
- No high risk anatomy
- No prosthesis or device

High Initial Patient Risk

- Significant new murmur
- New heart failure
- Prosthetic valve/CIED
- Stigmata of IE / Prior IE
- High risk anatomy
- Staph aureus

MAYO CLINIC

Baddour LM, et al. Circulation 2005; 111:3167



MAYO CLINIC

Nishimura RA, CM Otto, et al. JACC 2014; 63: e57
Baddour LM, et al. Circulation 2005; 111:3167

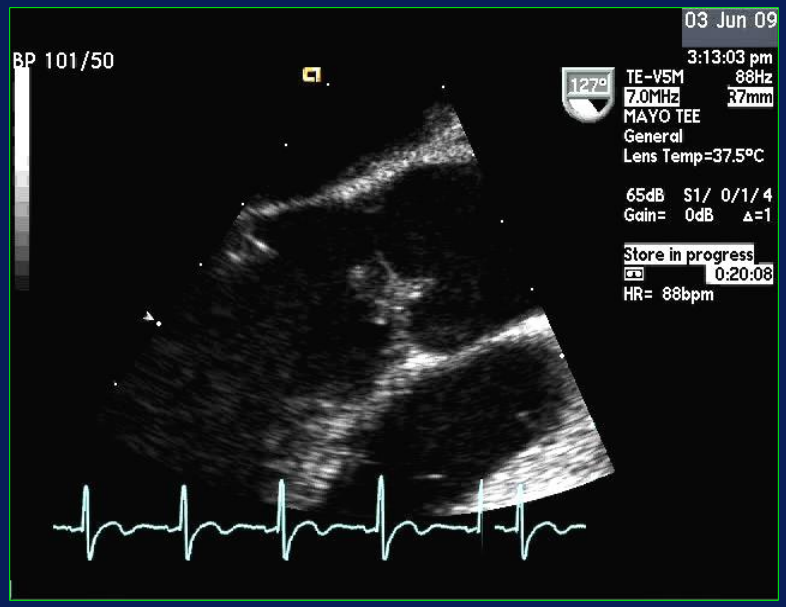
High risk TTE Findings

- Large / Mobile Vegetations
- ? Perivalvular extension of infection
- Grade III-IV/IV Regurgitation
- New LV dysfunction

Nishimura RA, CM Otto, et al. JACC 2014; 63: e57
Baddour LM, et al. Circulation 2005; 111:3167

Which patient most likely has infective endocarditis?

1.



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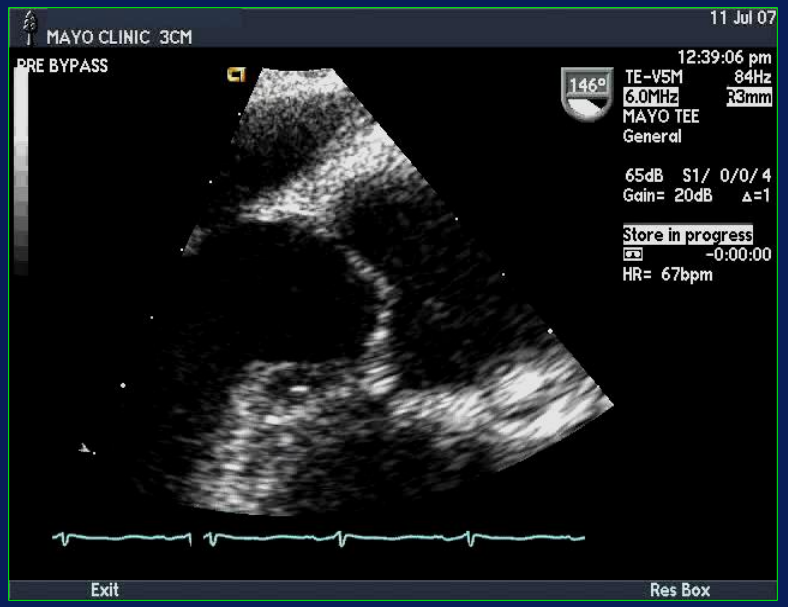

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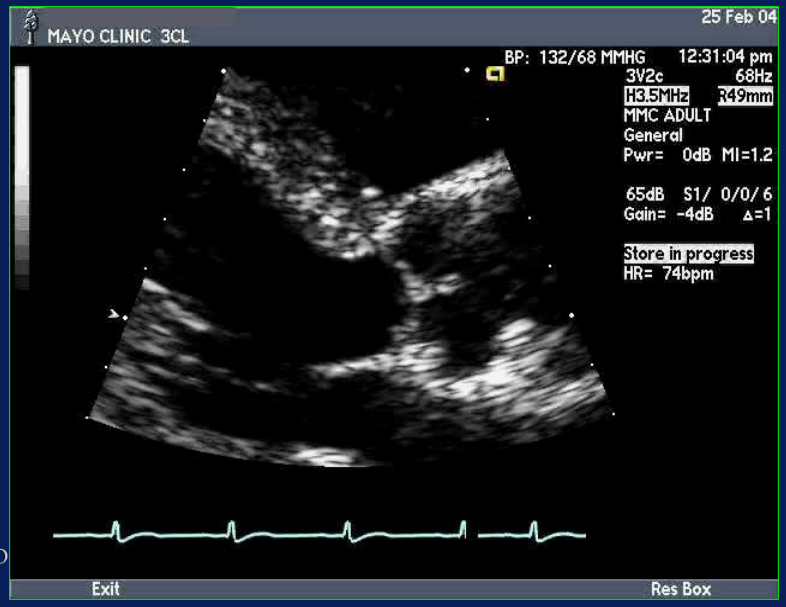
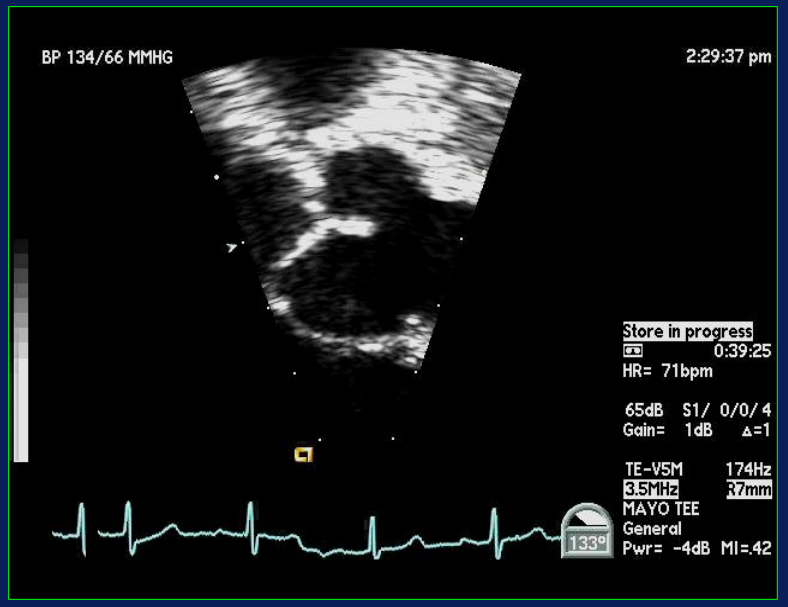
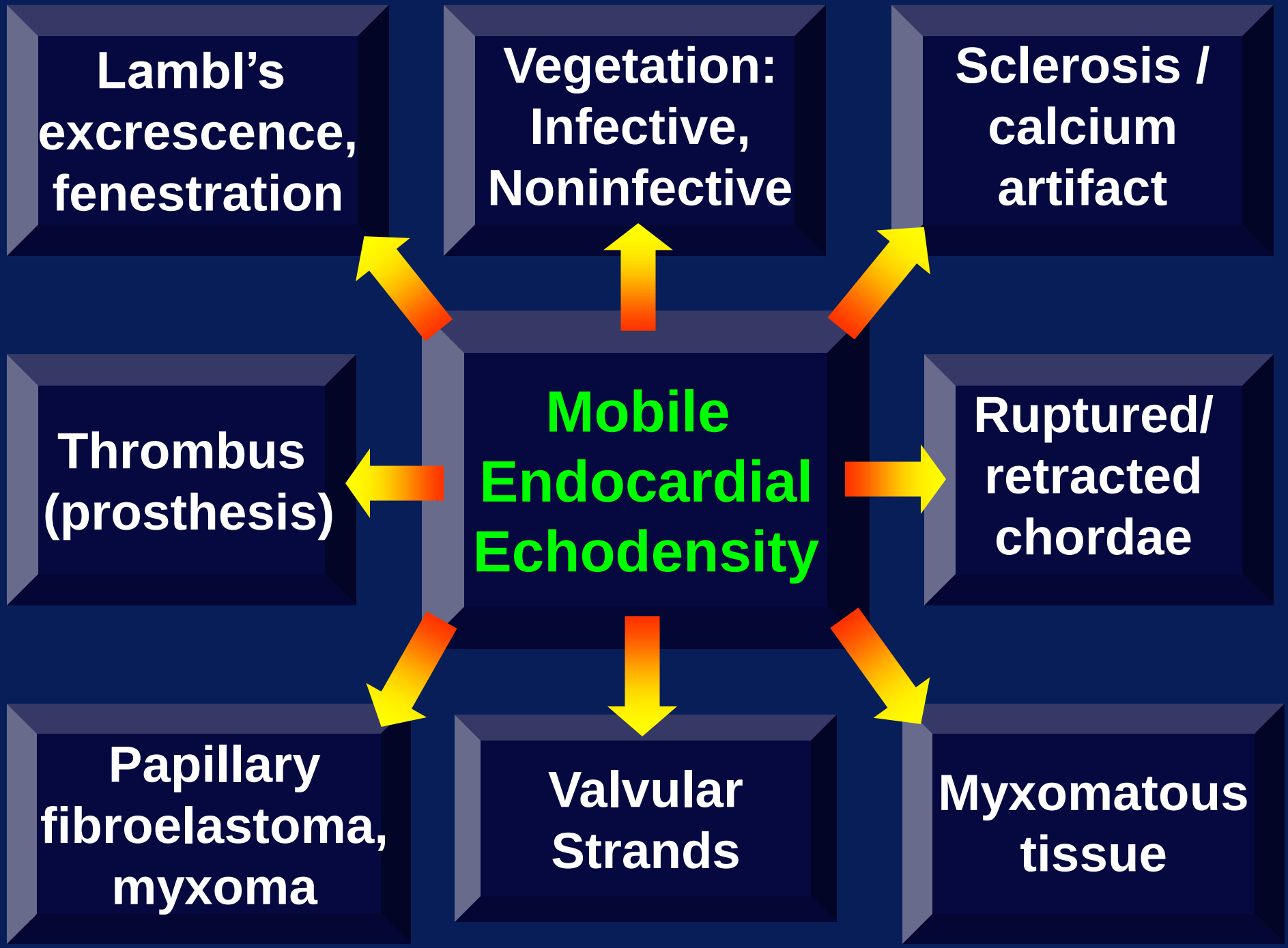


4.



MAYO

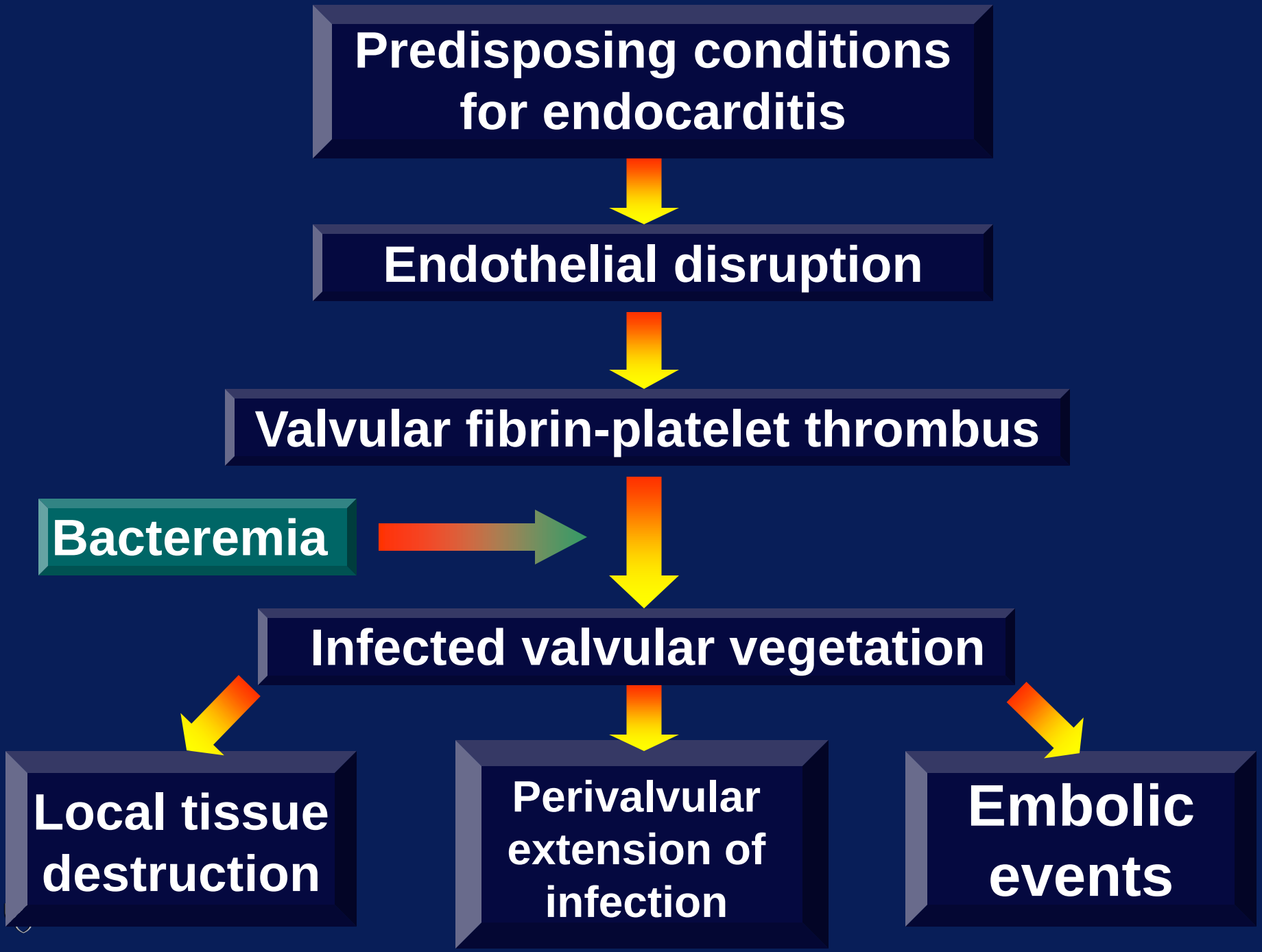

Lambl's excrescence, fenestration
Vegetation: Infective, Noninfective
Sclerosis / calcium artifact
Thrombus (prosthesis)
Mobile Endocardial Echodensity
Ruptured/ retracted chordae
Papillary fibroelastoma, myxoma
Valvular Strands
Myxomatous tissue

Echocardiographic Diagnosis of Vegetation

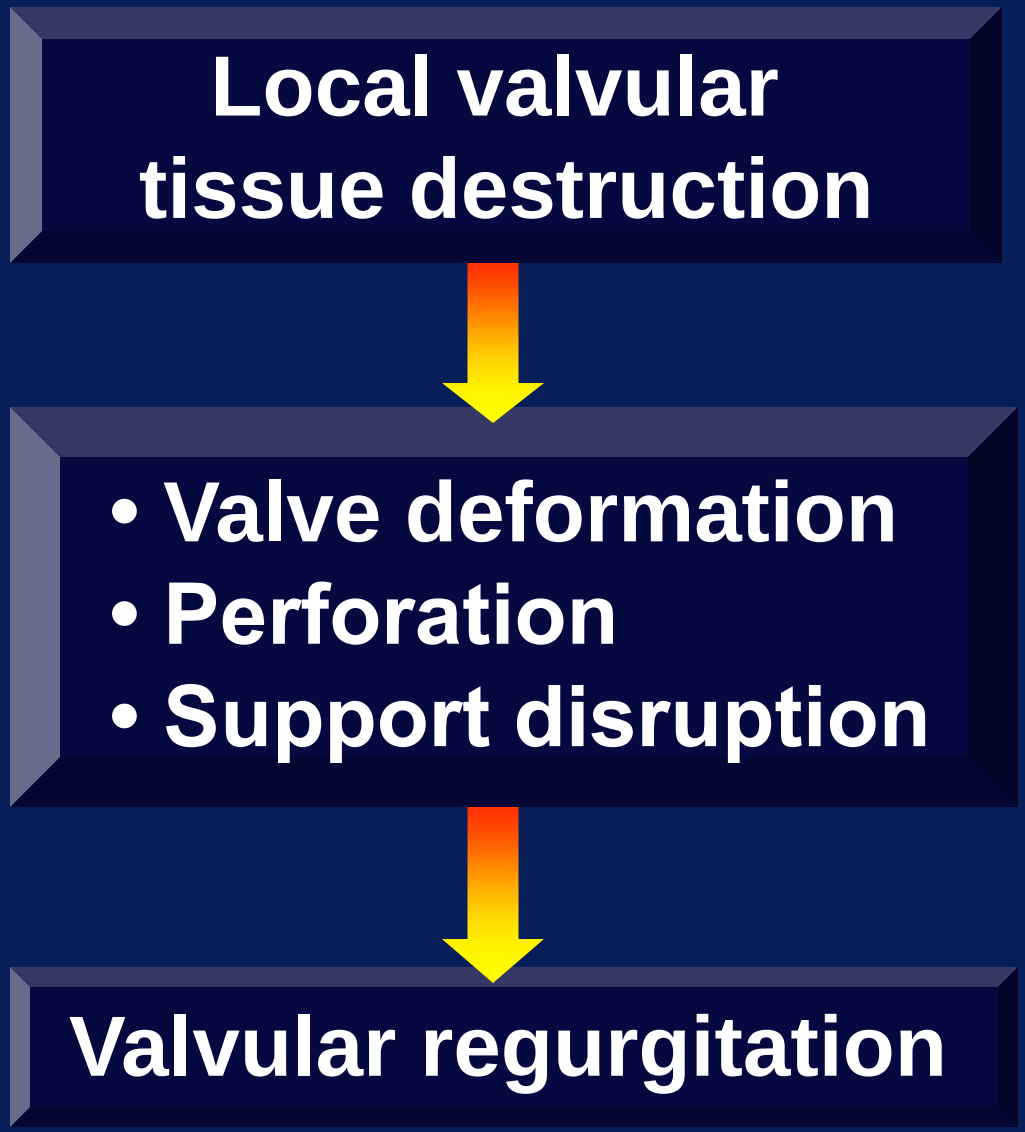
	Probable Vegetation	Improbable Vegetation
Texture:	tissue density	hyperrefractile
Location:	upstream side of valve; in jet trajectory	downstream side of valve

Echocardiographic Diagnosis of Vegetation

	Probable Vegetation	Improbable Vegetation
Shape:	lobulated to amorphous, multiple	filamentous, discrete nodule
Assoc'd findings:	regurgitation, peri-valvular complications	none


Predisposing conditions for endocarditis
Endothelial disruption
Valvular fibrin-platelet thrombus
Bacteremia
Infected valvular vegetation
Local tissue destruction
Perivalvular extension of infection
Embolic events

Complications of Infective Endocarditis



Local Valvular Destruction in Infective Endocarditis (IE)

NYHA Class III-IV heart failure complicating native valve IE:

Aortic	30%
Mitral	20%
Tricuspid	<10%

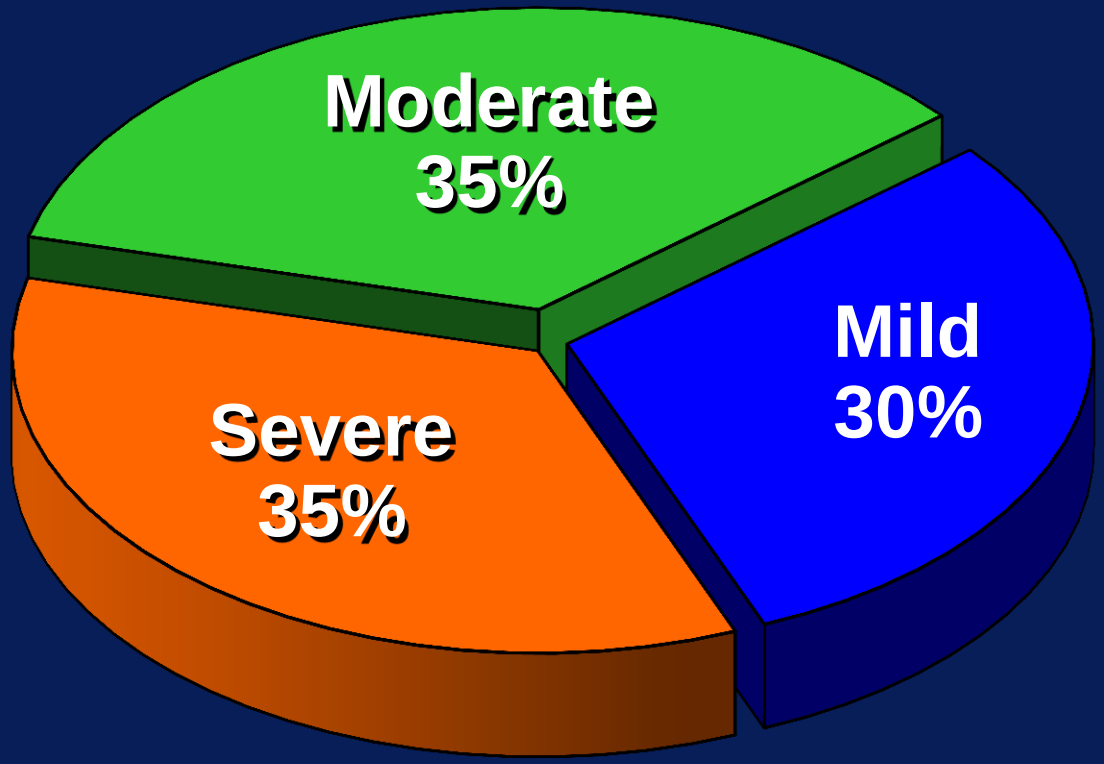
	In-Hospital Mortality
Medical	50 – 60%
Surgical	20 – 25%

MAYO CLINIC

Baddour LM ,et al. Circulation 2005;111:e394 Kiefer T, et al. JAMA 2011; 306:2239

Infective Endocarditis

Valvular Regurgitation at Presentation

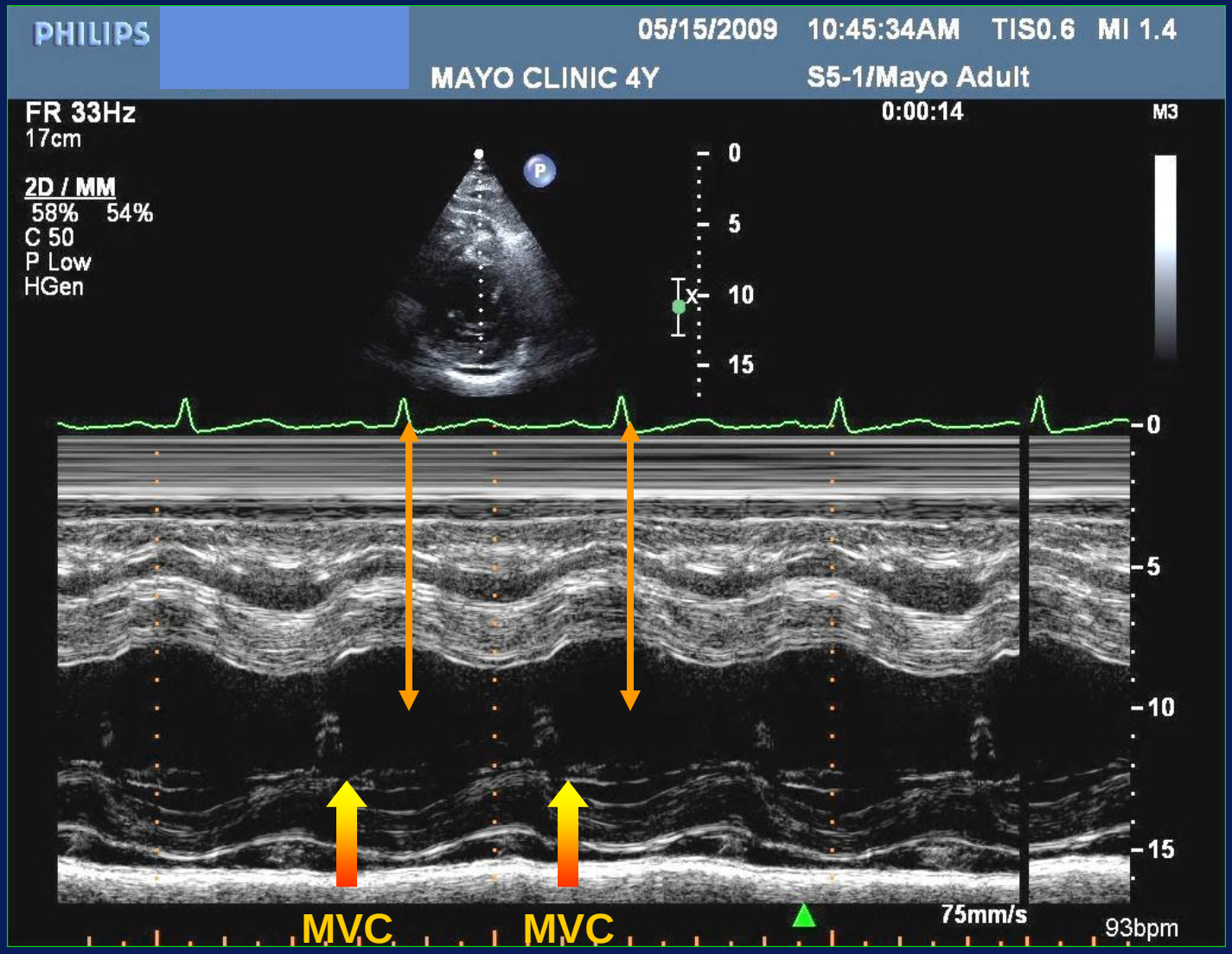


Lopez J, et al. Circulation 2010; 121:892

47 y/o Man: Staphylococcal bacteremia and shock

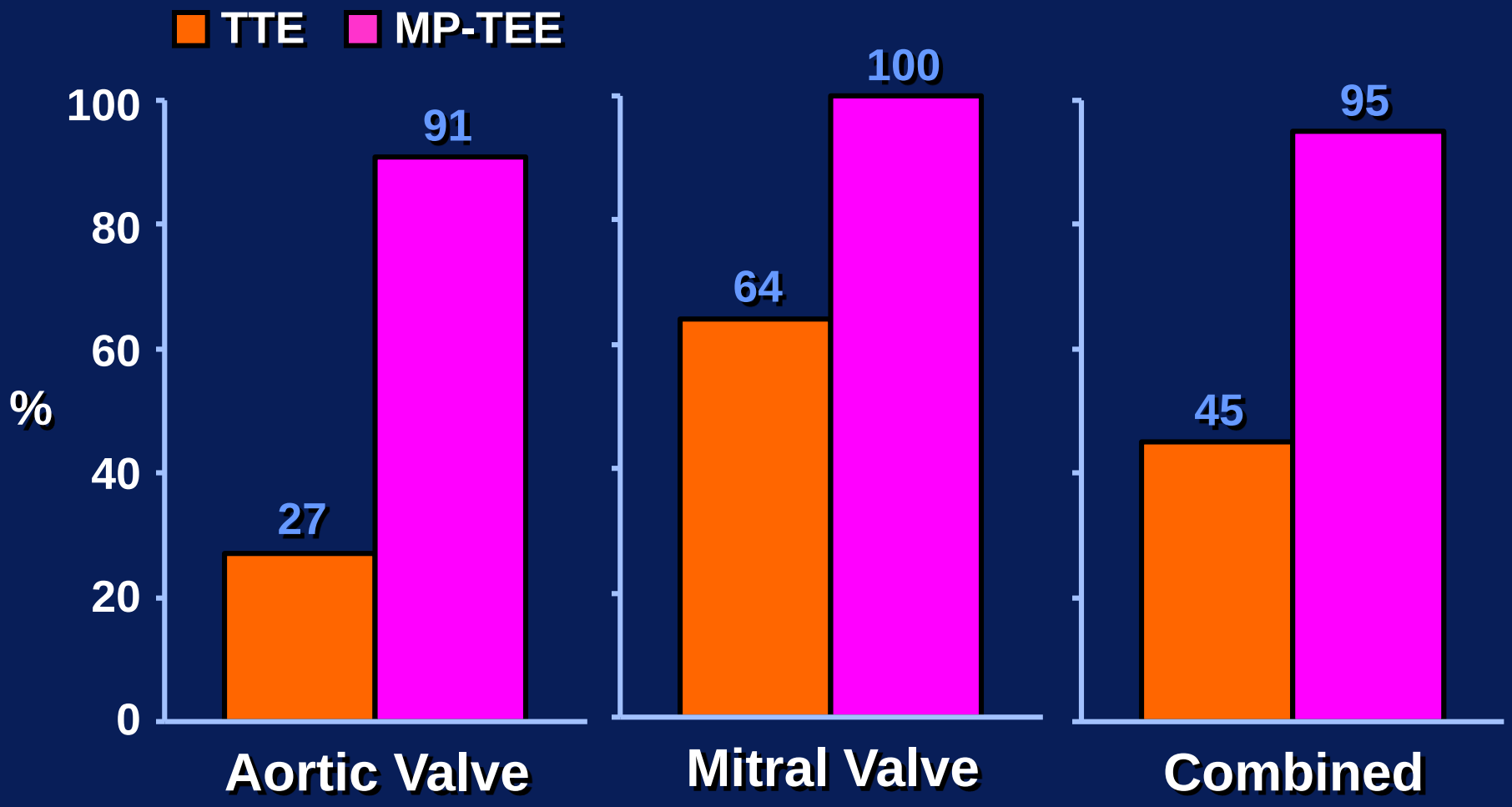
47 y/o Man: Staphylococcal bacteremia and shock

Acute Severe AR: Early mitral valve closure



Valvular Perforation in Infective Endocarditis

Sensitivity of TTE vs MP-TEE



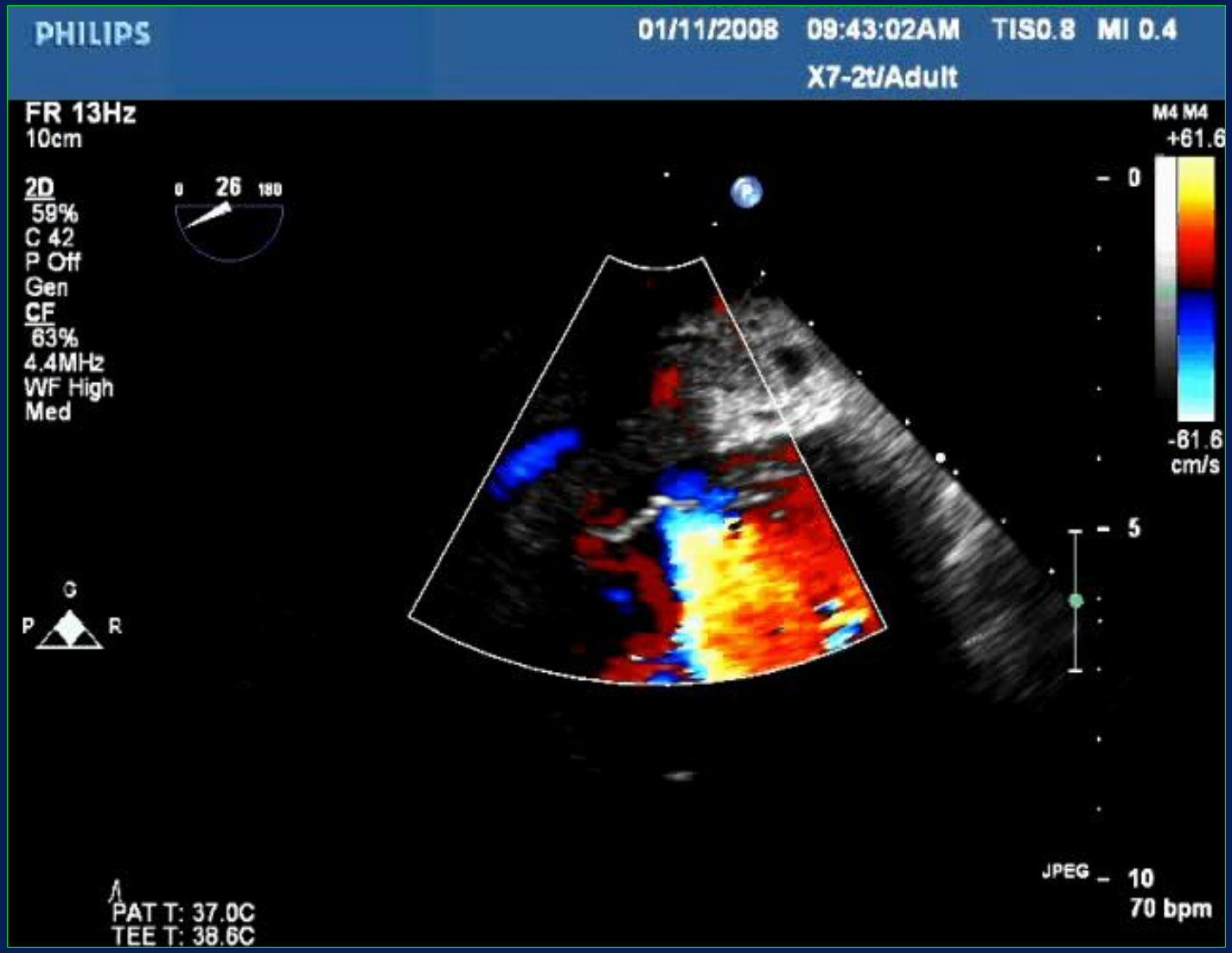
Combined specificity: 98% for both TTE and MP-TEE

MAYO CLINIC

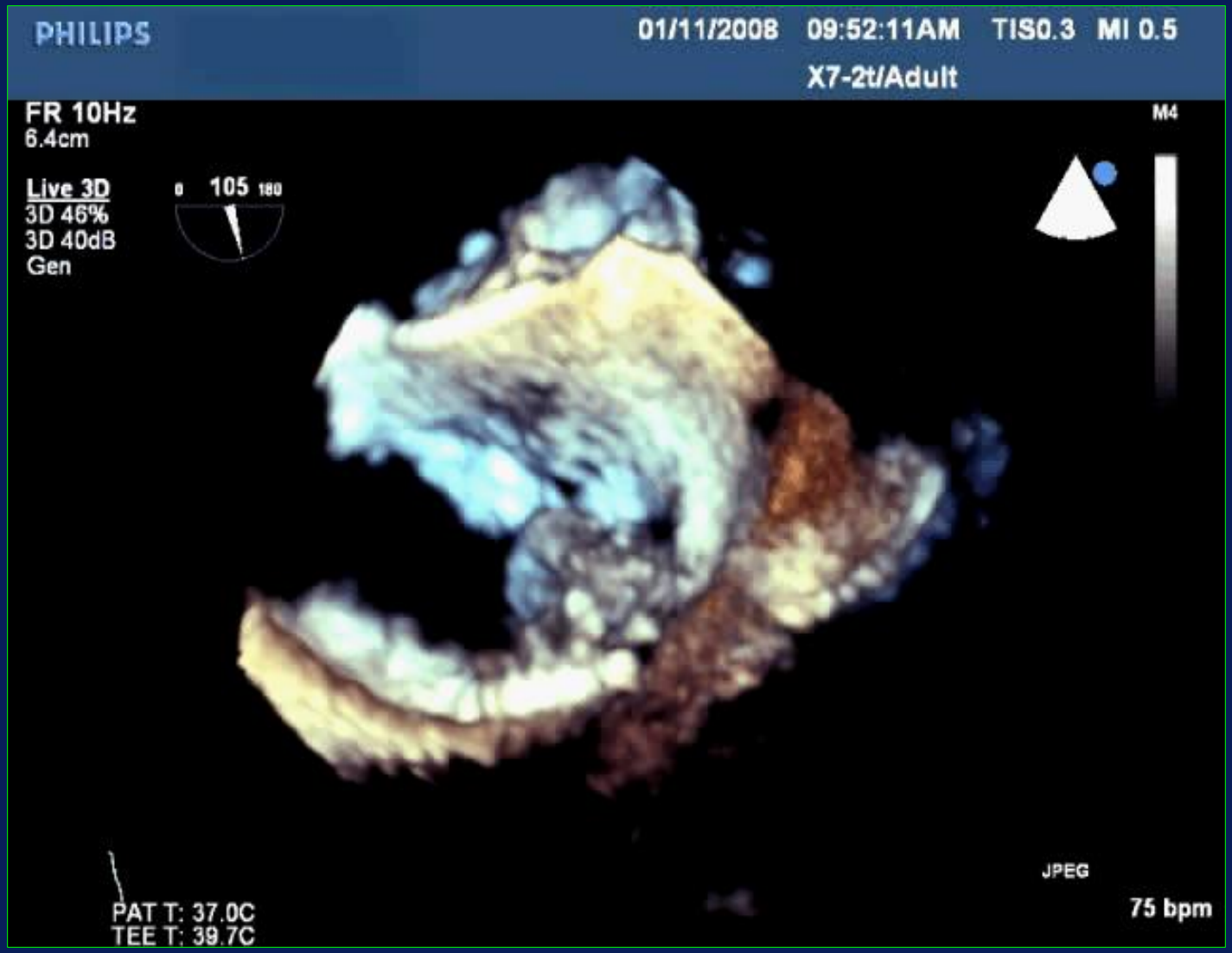
DeCastro, S et al: Clin Infect Dis 30:825, 2000

77 y/o Male: E. Coli septic shock after abdominal surgery

77 y/o Male: E. Coli septic shock after abdominal surgery



77 y/o Male: E. Coli septic shock after abdominal surgery



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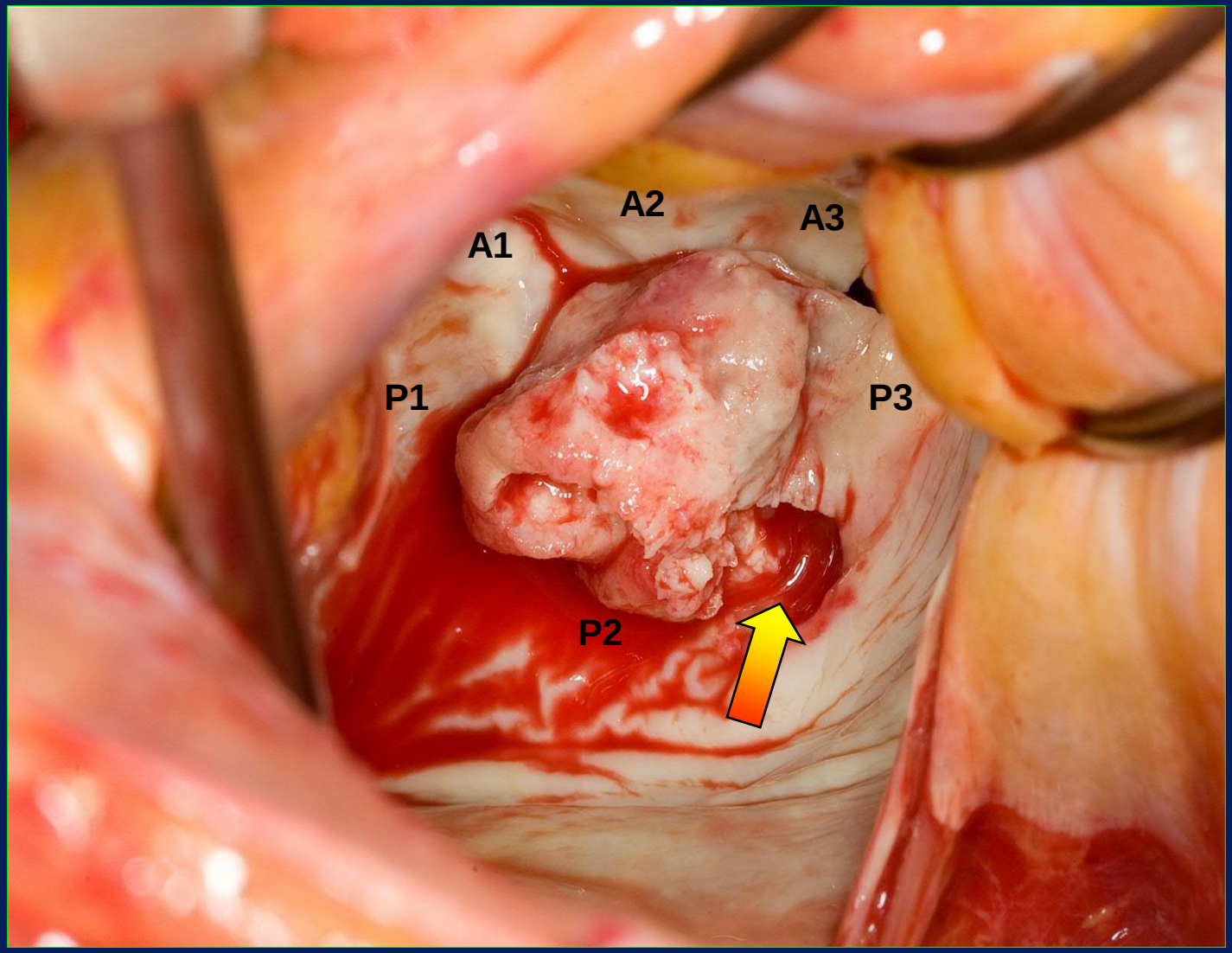


Valvular Dysfunction Complicating Infective Endocarditis

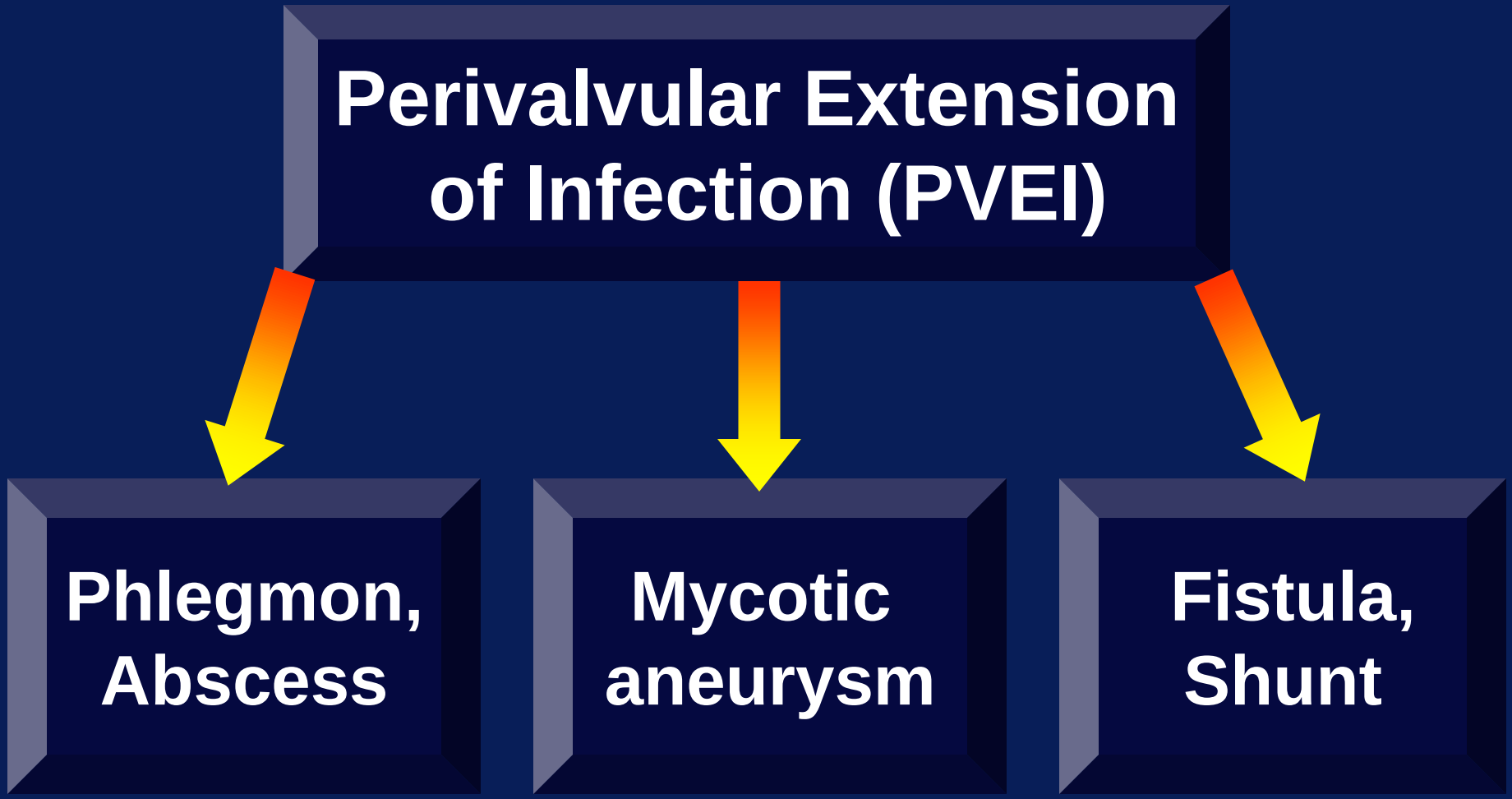
Class I Indication for Surgery

Early surgery* is indicated in patients with IE who present with valve dysfunction (usually severe regurgitation) resulting in symptoms of heart failure

(*during initial hospitalization before completion of a full therapeutic course of antibiotics)

Nishimura RA, CM Otto, et al. JACC 2014; 63: e57

Complications of Infective Endocarditis



Perivalvular Extension of Infection (PVEI)

Native valve IE	10 - 30%
Prosthetic valve IE	30 - 55%

Independent risk factors for PVEI:

- Aortic position
- Prosthetic valve
- Staphylococcal infection

Increased in-hospital mortality: 2-3 x

Habib G, et al. Eur Heart J 2009; 2369

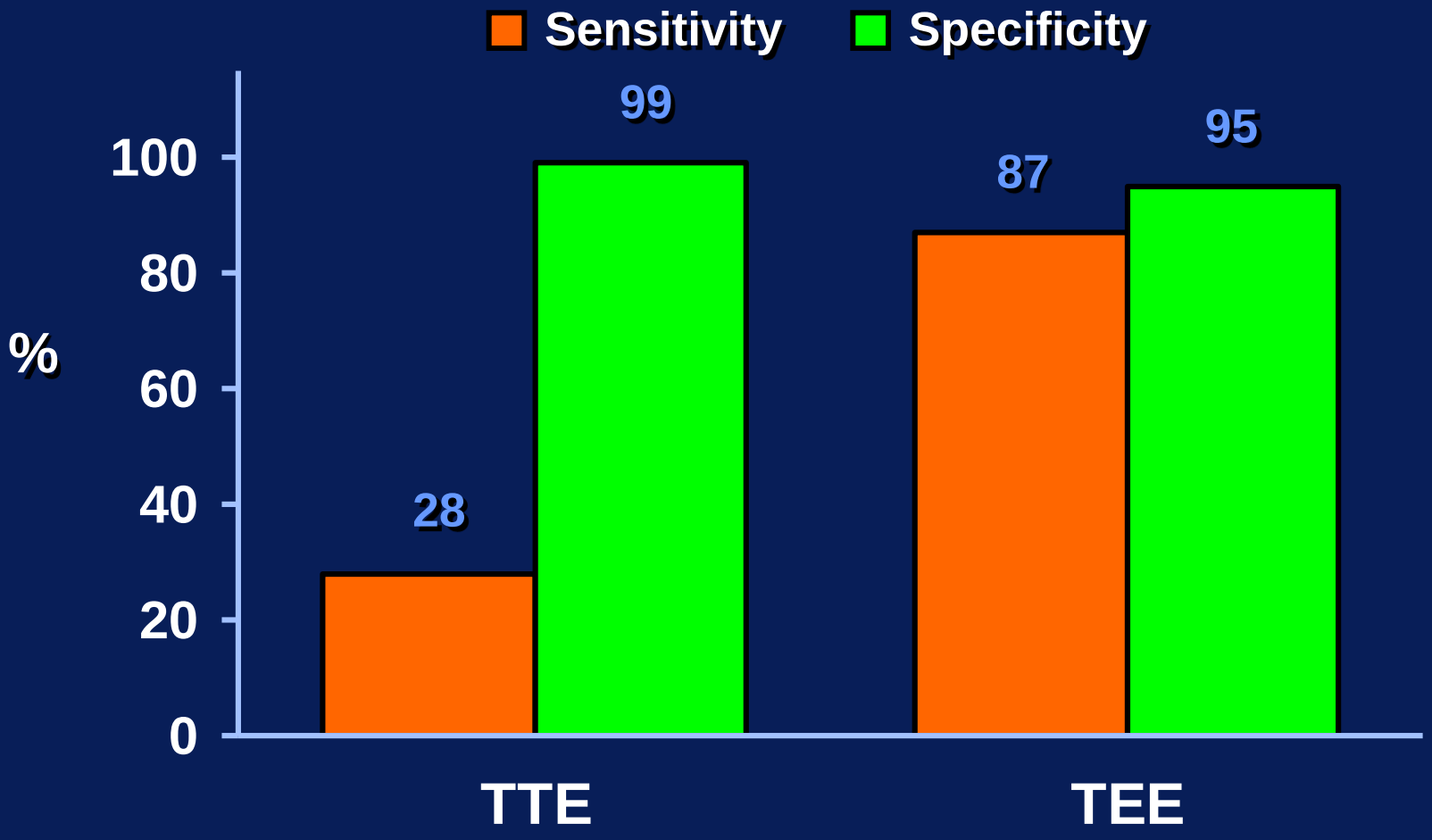
Lopez J, et al. Circulation 2010; 121:892

Murdoch DR, et al Arch Int Med 2009;169:463

Graupner C, et al. JACC 2002; 39:1204

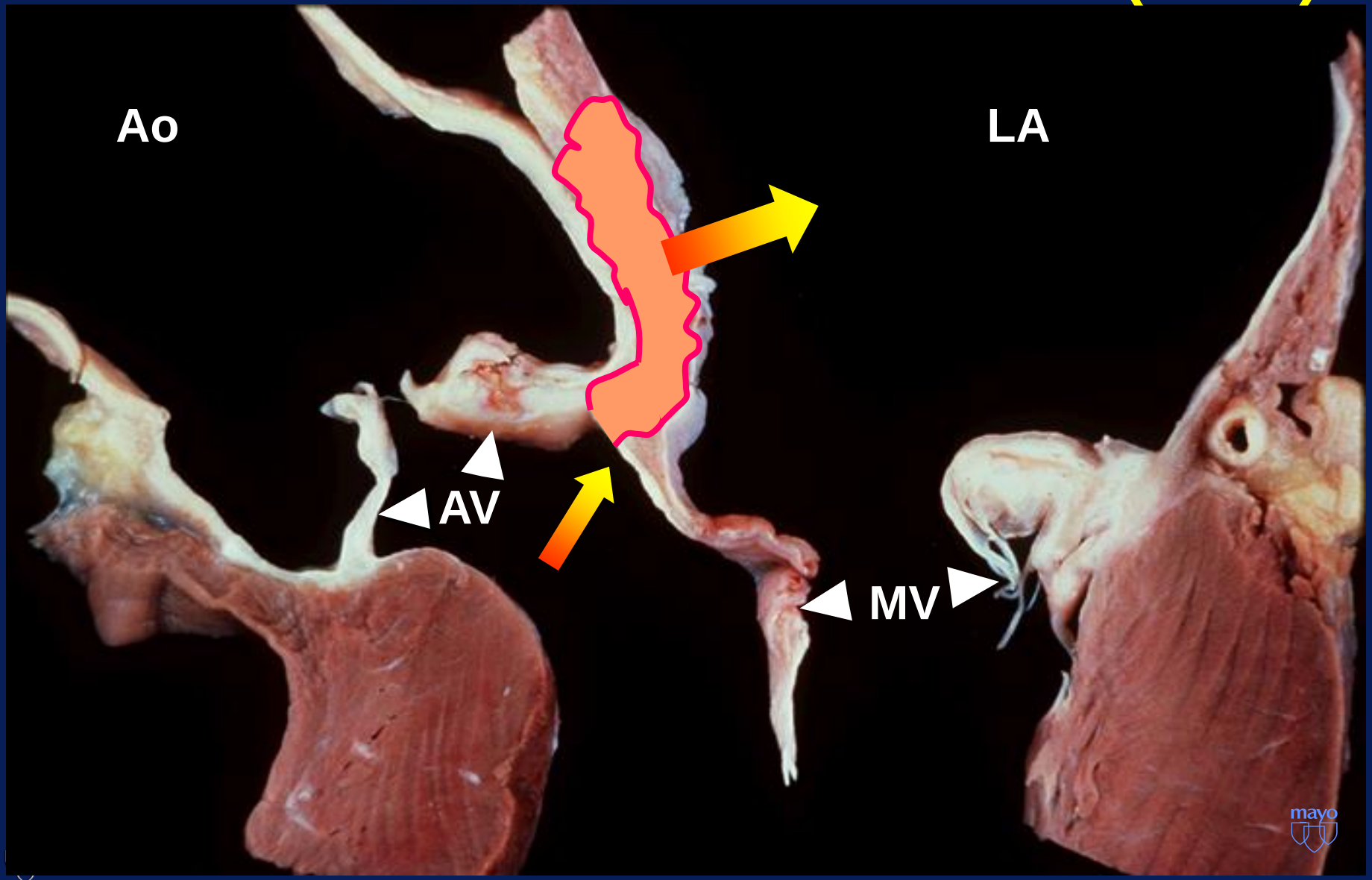
Perivalvular Extension of Infection

TTE vs TEE (118 Patients)



Daniel, WG et al: NEJM 1991; 324: 795

Peri-valvular Extension of Infection:
Mitral - Aortic Intervalvular Fibrosa (MAIF)



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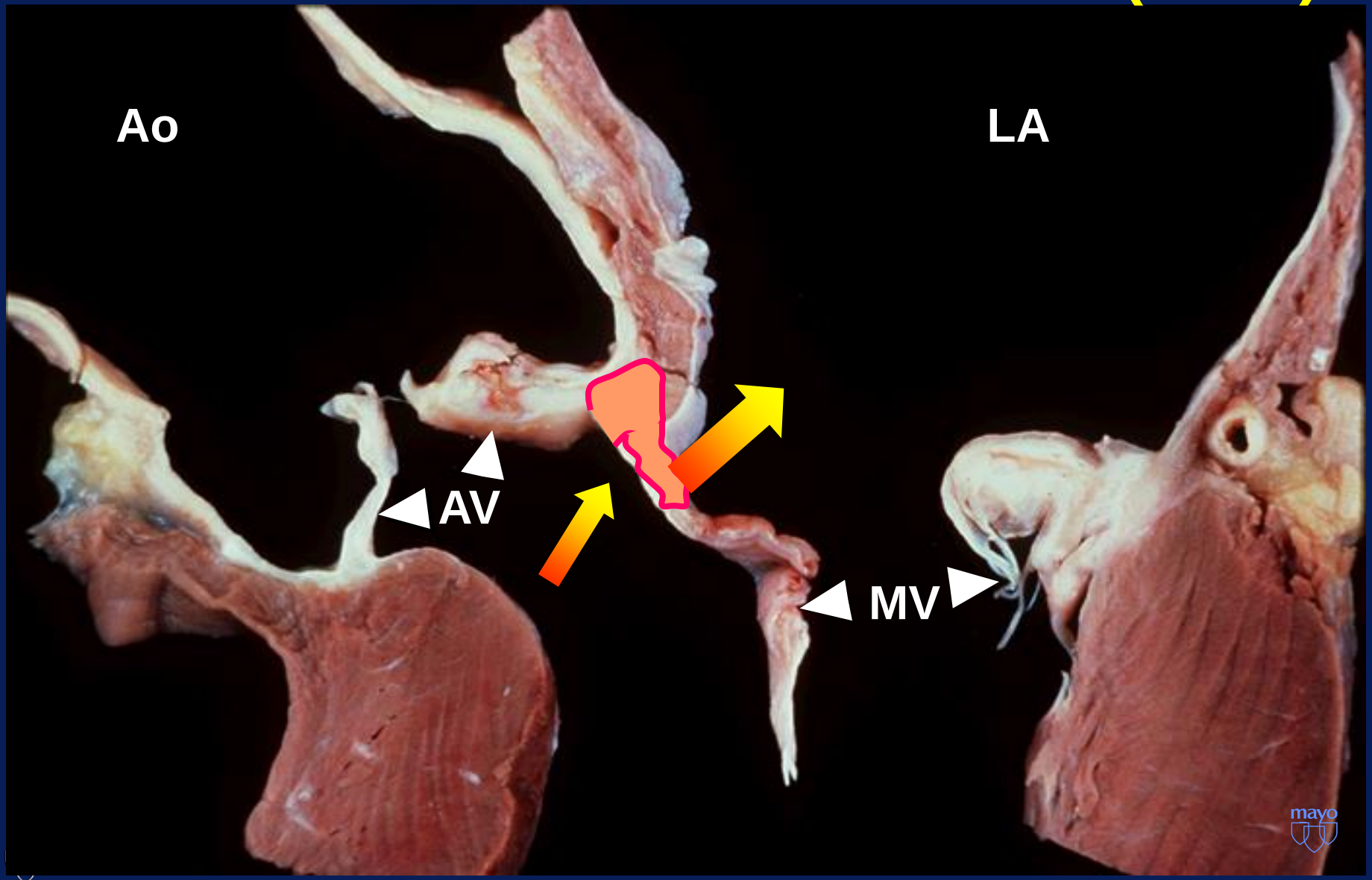

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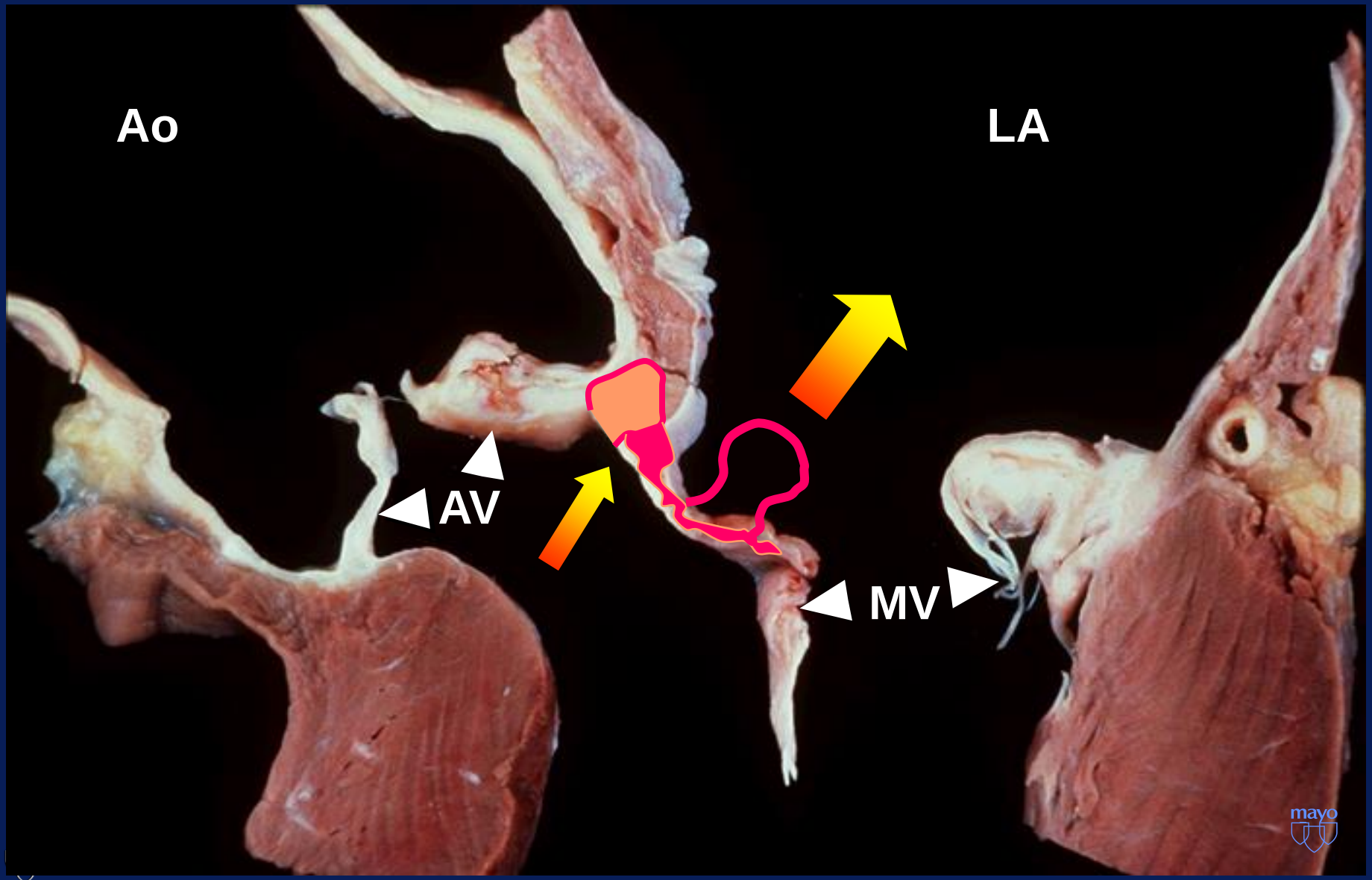
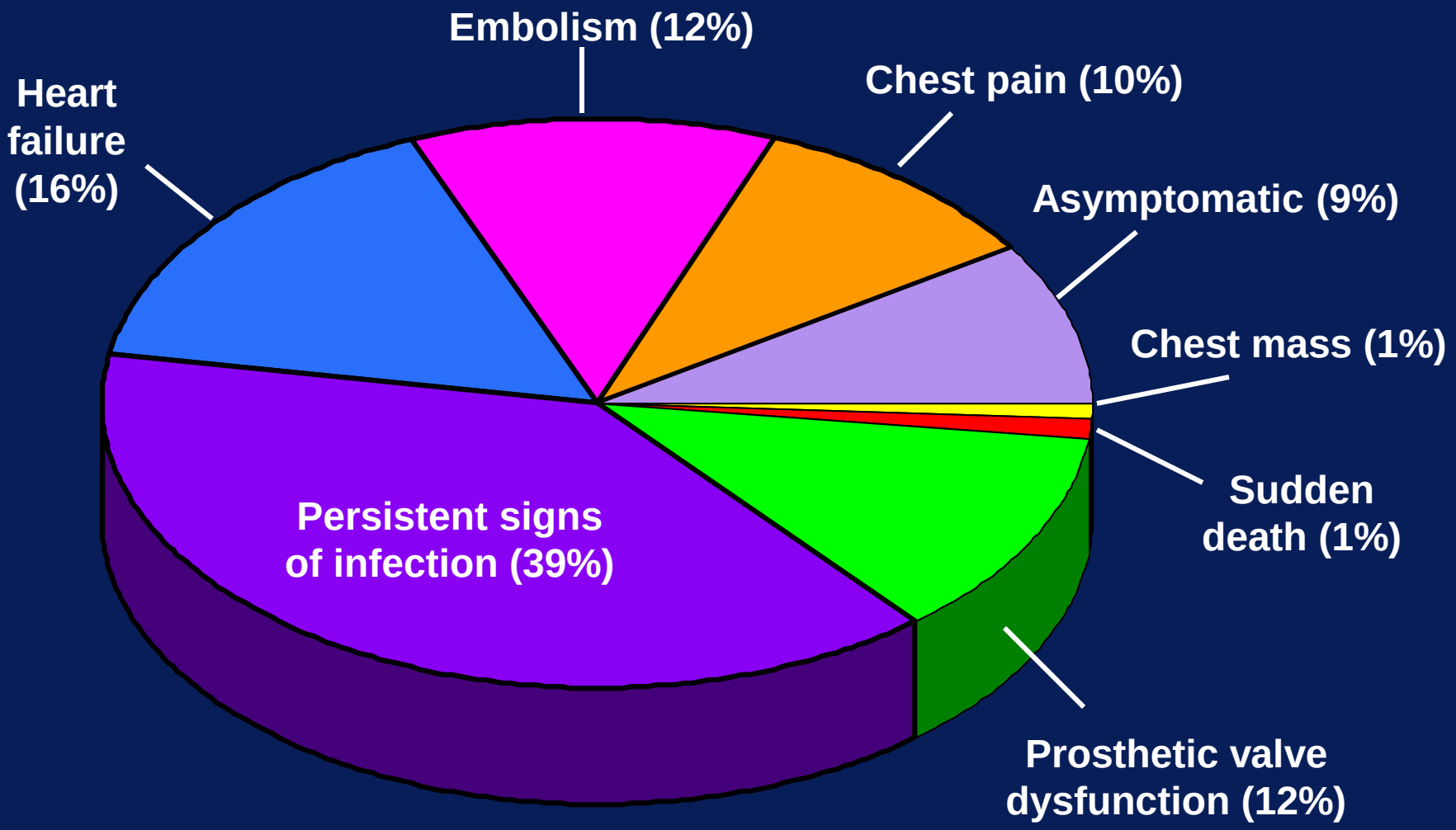


Mitral - Aortic Intervalvular Fibrosa (MAIF)
Mycotic Pseudoaneurysm: Presentation

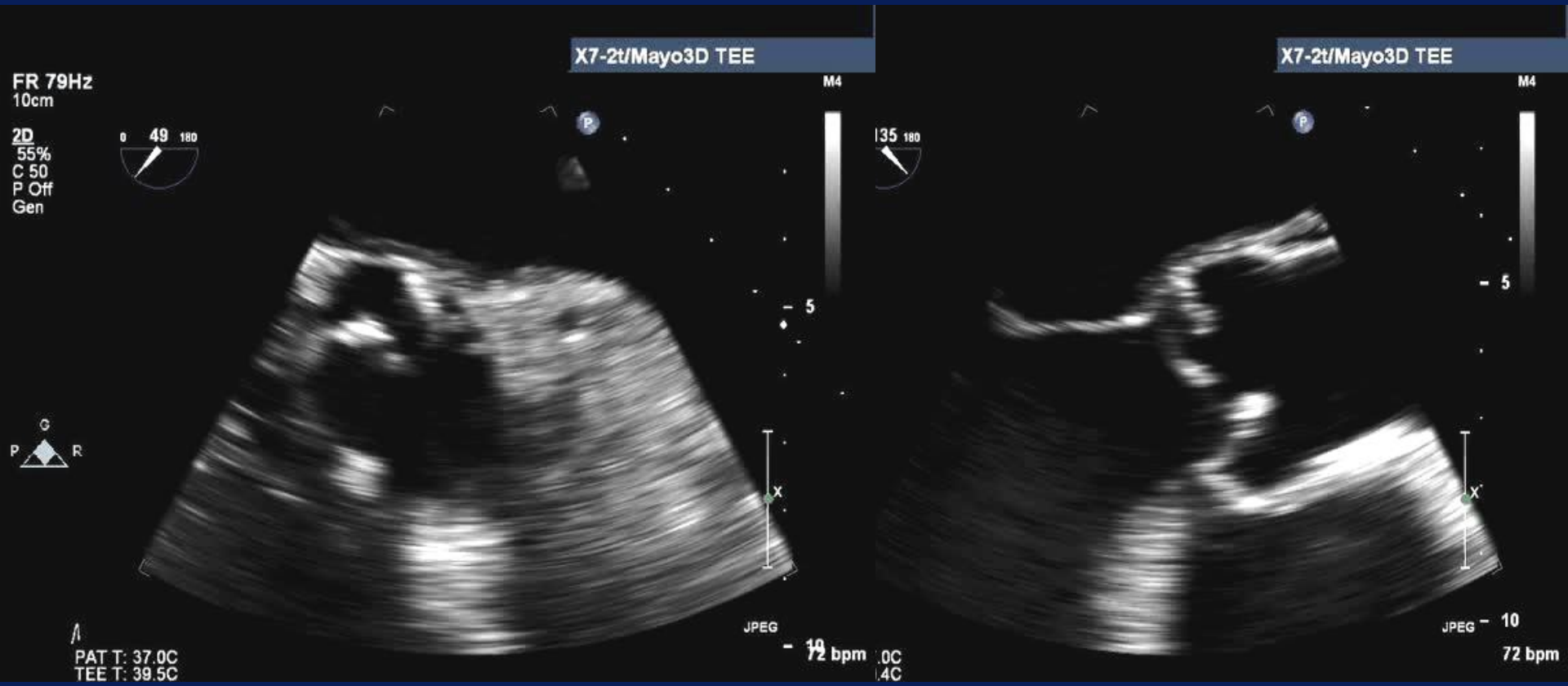


Sudhakar, S et al. J Am Soc Echocardiogr 23:1009, 2010

Bioprosthetic AVR: Coag Negative Staph bacteremia

MAIF phlegmon

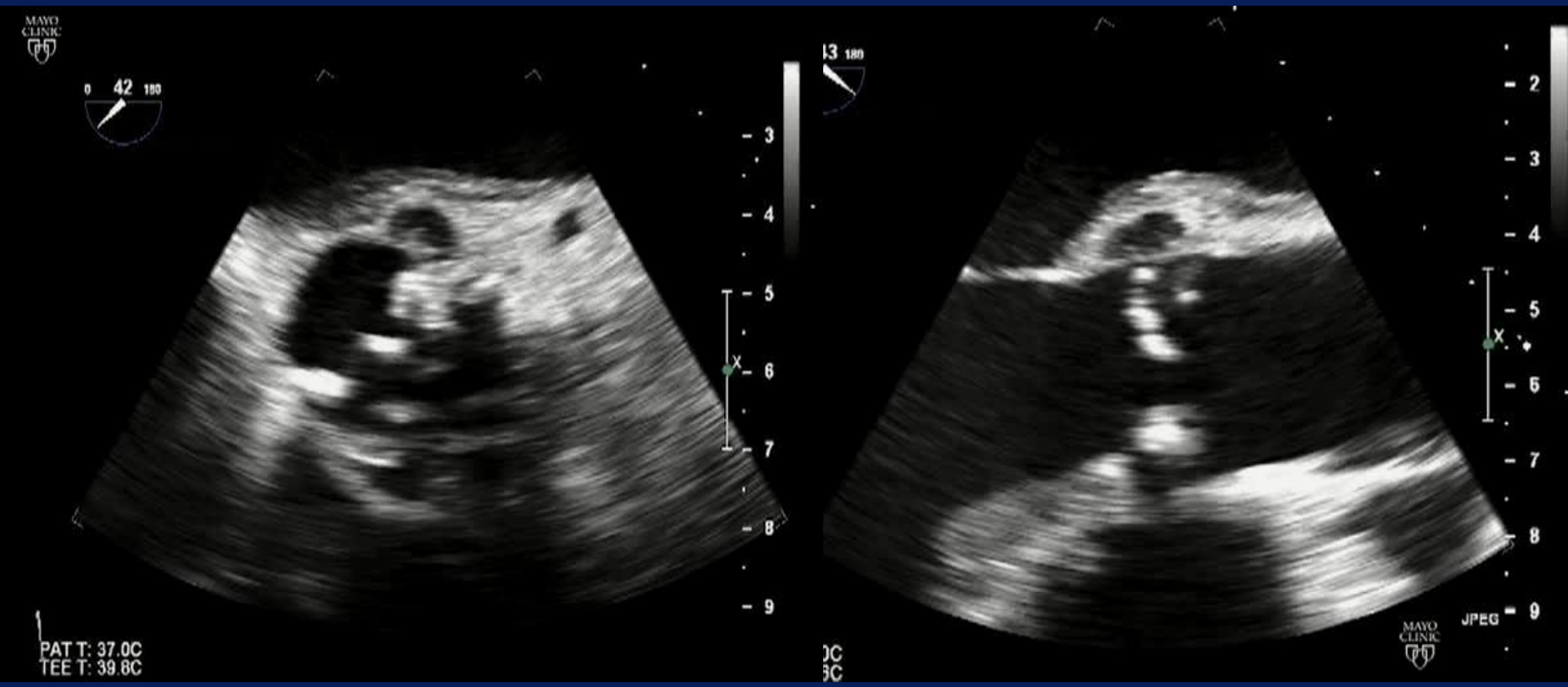
53 y/o Male: Fever, weight loss, and dyspnea; Aggregatibacter Aphrophilus bacteremia



10/22/13

53 y/o Male: Fever, weight loss, and dyspnea; Aggregatibacter Aphrophilus bacteremia

Persistent fever despite antibiotic therapy



10/30/13

Infective Endocarditis: Follow-up Imaging Reevaluation with TEE/TTE

Class I Indications

- A significant change in symptoms and/or clinical findings
- Evidence of persistent infection after ≥5 days of appropriate antibiotic therapy
- Initial imaging evidence of extensive/high risk infection (i.e., large, mobile vegetations)
- Infection with aggressive/resistant organisms (staphylococcal, enterococcal, fungal)

Nishimura RA, CM Otto, et al. JACC 2014; 63: e57

48 y/o Man: Fever and syncope s/p Carbomedics AVR one month ago; enterococcal bacteremia

MAIF mycotic aneurysm

52 y/o IV Drug Abuser: Prior CE AVR, fever/chills x 3 wks, H. Parainfluenza bacteremia

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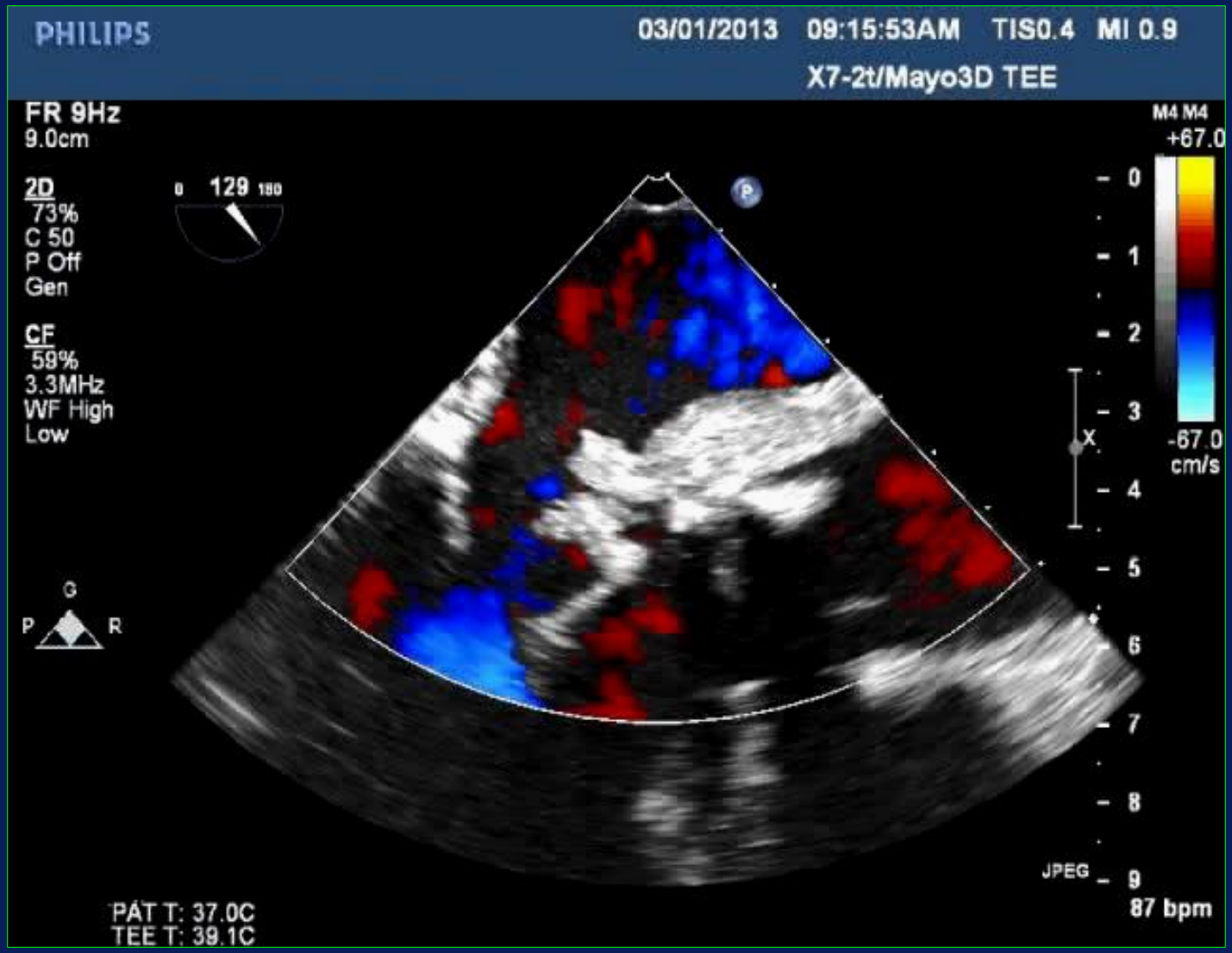


Fever x 4 wks, SJ AVR (2005); Propionibacterium bacteremia

Fever x 4 wks, SJ AVR (2005); Propionibacterium bacteremia

Fever x 4 wks, SJ AVR (2005); Propionibacterium bacteremia

Perivalvular Extension of Infection Complicating Infective Endocarditis

Class I Indication for Surgery

Early surgery* is indicated in patients with IE complicated by heart block, annular or aortic abscess, or destructive penetrating lesions

(*during initial hospitalization before completion of a full therapeutic course of antibiotics)

Nishimura RA, CM Otto, et al. JACC 2014; 63: e57

Persistent Infection Complicating Infective Endocarditis

Class I Indication for Surgery

Early surgery* for IE is indicated in patients with evidence of persistent infection as manifested by persistent bacteremia or fever lasting longer than 5 days after onset of appropriate antimicrobial therapy

(*during initial hospitalization before completion of a full therapeutic course of antibiotics)

Nishimura RA, CM Otto, et al. JACC 2014; 63: e57

Aggressive or Resistant Organisms Complicating Infective Endocarditis

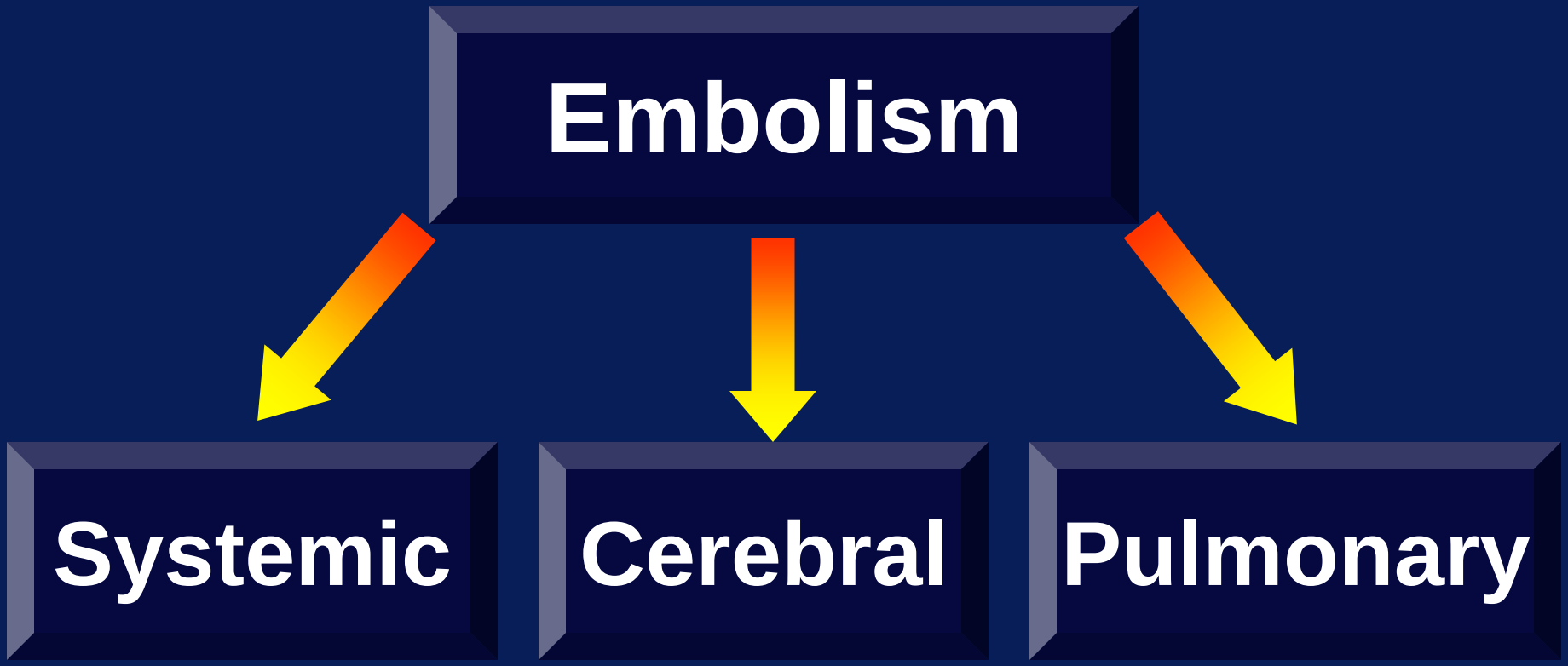
Class I Indication for Surgery

Early surgery* is indicated in patients with left-sided IE caused by *S. aureus*, fungal, or other highly resistant organisms (e.g., Pseudomonas species, VRE, Brucella)

(*during initial hospitalization before completion of a full therapeutic course of antibiotics)

Nishimura RA, CM Otto, et al. JACC 2014; 63: e57

Complications of Infective Endocarditis



Embolism in Infective Endocarditis

Incidence of embolic events: 20 – 50%

Clinically silent embolism: 15 – 25%

Clinically evident stroke: 10 – 20%

Habib G, et al. Eur Heart J 2009; 2369

Murdoch DR, et al Arch Int Med 2009;169:463

Baddour LM ,et al. Circulation 2005;111:e394

Thuny F, et al. Circulation 2005; 112:69

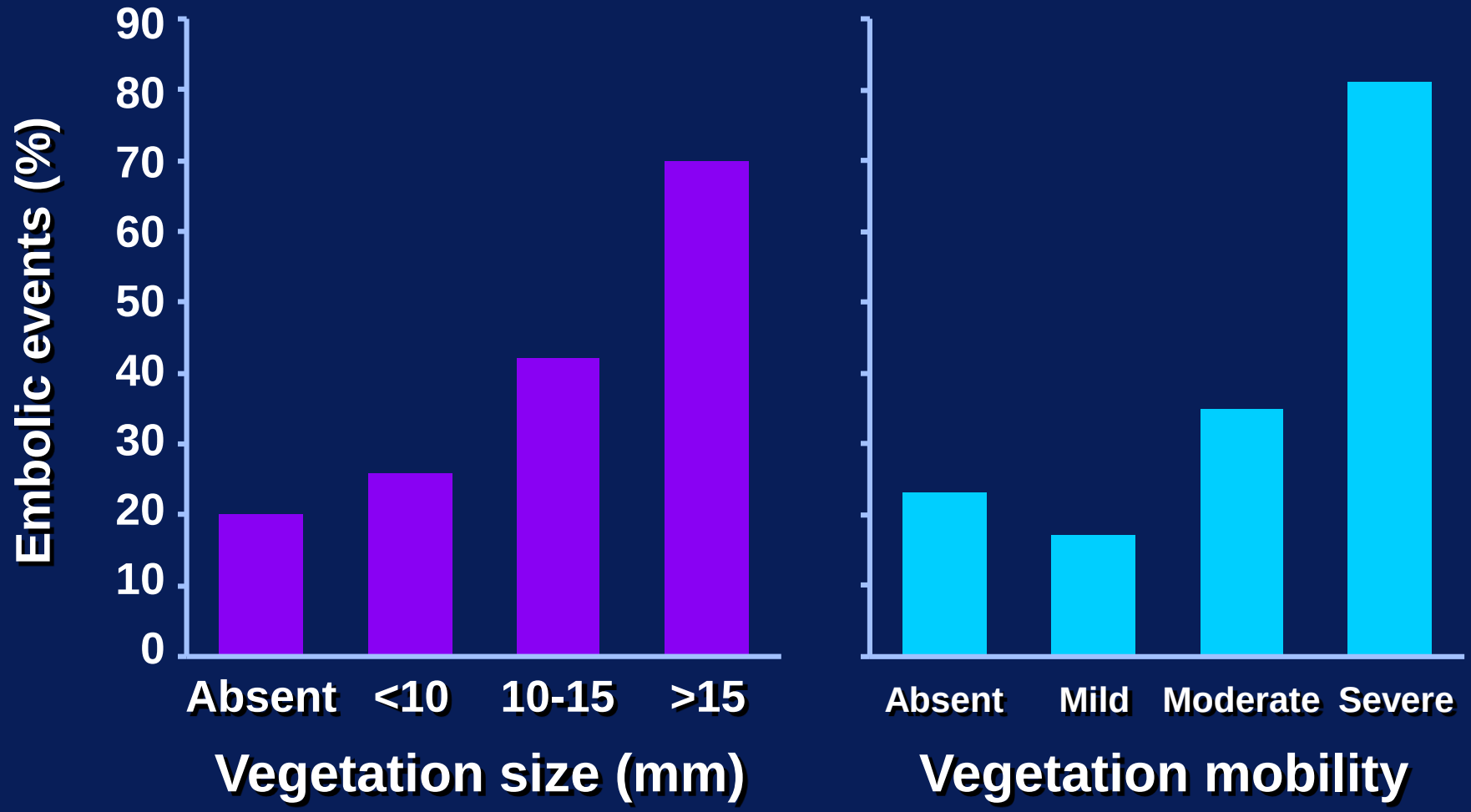
Screening brain MRI (12% with CNS Sxs)

Acute ischemic lesions - 52%, mycotic aneurysm – 8%

Duval X, et al. Ann Intern Med 2010; 152: 497

Embolic Event Risk in Infective Endocarditis

Multiplane TEE (178 Patients)



Di Salvo G et al: JACC 2001; 37: 1069

Embolic Event Risk in Infective Endocarditis

Independent structural predictors:

- Large vegetations (length > 10 mm)
- Highly mobile vegetation(s)
- Anterior mitral valve leaflet location

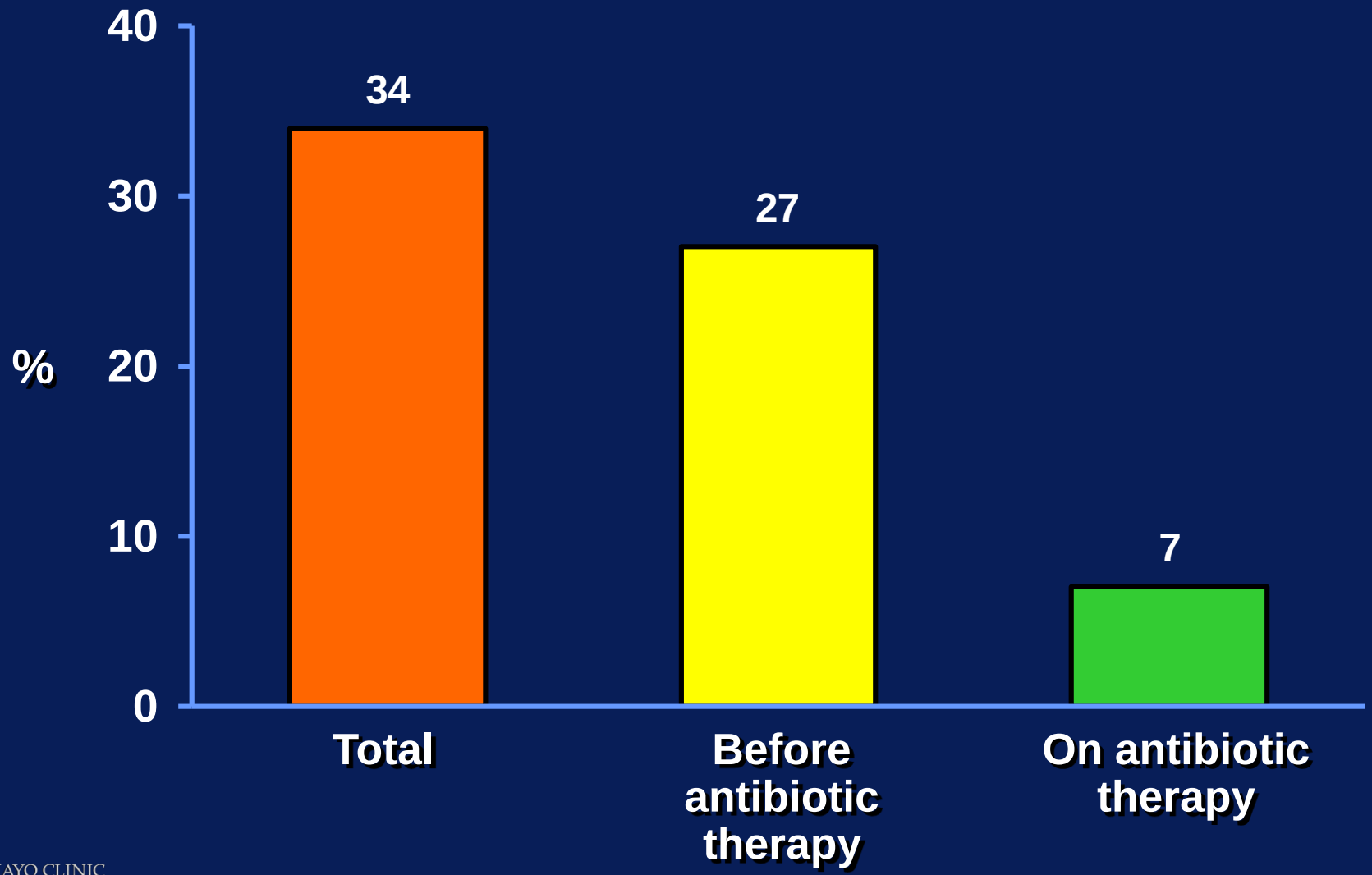
Independent microbiologic predictors:

- Staph aureus or Strep bovis infection
- Delay in <u>appropriate</u> antibiotic therapy

Habib G, et al. Eur Heart J 2009; 30:2369
Thuny F et al: Circulation 112:69, 2005
Vilacosta I et al: JACC 39:1489, 2002
Di Salvo G et al: JACC 37:1069, 2001

Embolism Complicating Infective Endocarditis

Multicenter European Study (384 Patients)



MAYO CLINIC

Thuny F et al: Circulation 2005; 112: 69

Systemic Embolism Complicating Infective Endocarditis

Class IIa Indication for Surgery

Early surgery* is reasonable in patients with IE who present with recurrent emboli and persistent vegetations despite appropriate antibiotic therapy

(*during initial hospitalization before completion of a full therapeutic course of antibiotics)

Nishimura RA, CM Otto, et al. JACC 2014; 63: e57

Early Surgery vs. Conventional Treatment for Infective Endocarditis (EASE)

- 76 Patients with left-sided native valve IE and vegetations >10 mm in size randomized to early surgery vs. conventional therapy

- No patient had another indication for early surgical intervention

- Evidence of embolism (cerebral and other sites) detected in 30% of all patients on admission

Kang DH, et al. NEJM 2012; 366: 2466

Early Surgery vs. Conventional Treatment for Infective Endocarditis (EASE)

	Conventional Therapy (n=39)	Early Surgery (n=37)
Embolic event at 6 wks	**21%**	**0%**
In-hospital death	**3%**	**3%**
Infecting organism		
Streptococcal species	56%	57%
Staph Aureus	13%	8%
Culture negative	18%	27%
Other	13%	8%

Kang DH, et al. NEJM 2012; 366: 2466

Systemic Embolism Complicating Infective Endocarditis

Class IIb Indication for Surgery

Early surgery* may be considered in patients with native valve infective endocarditis who exhibit mobile vegetations greater than 10 mm in length (with or without clinical evidence of embolic phenomenon)

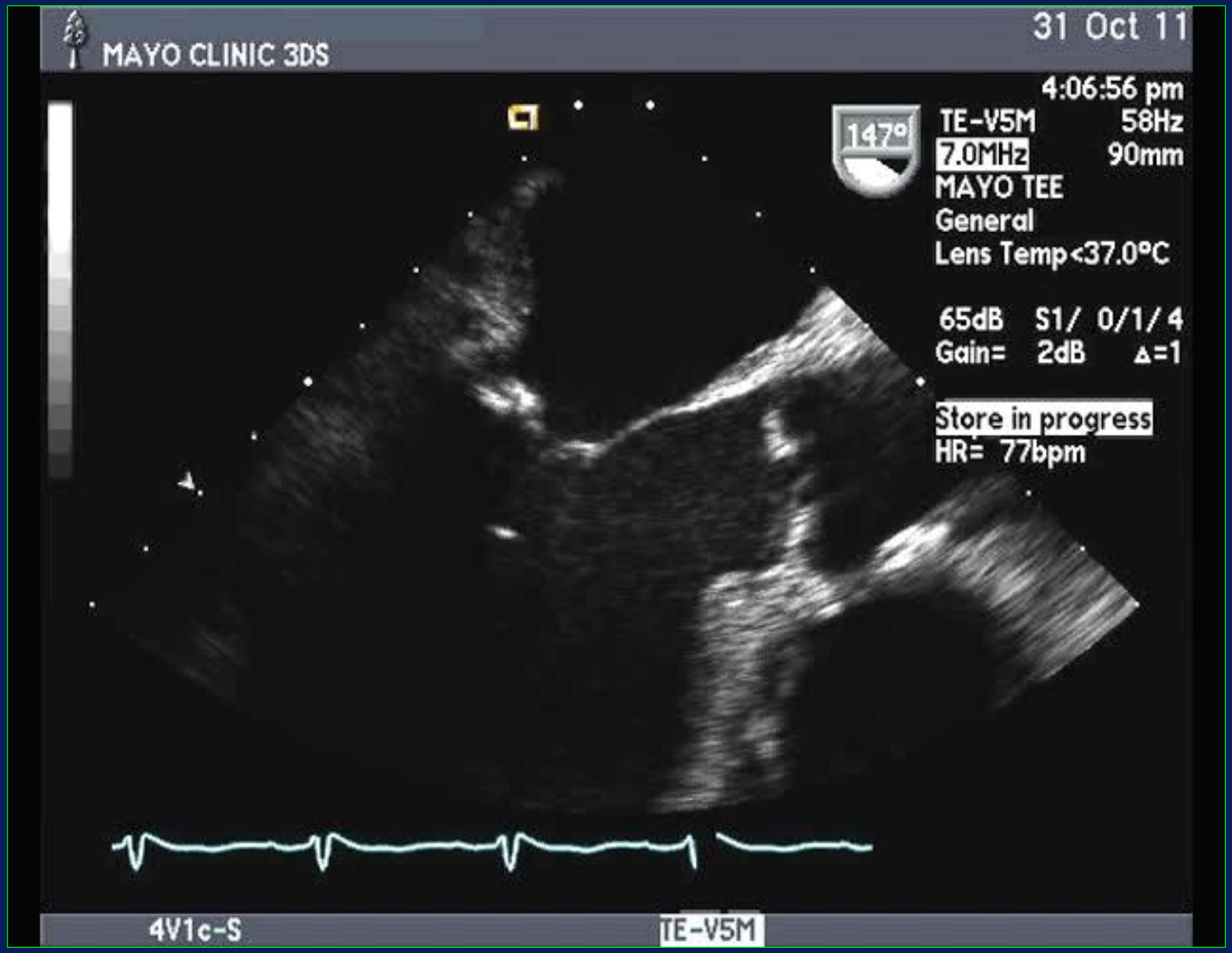
*during initial hospitalization before completion of a full therapeutic course of antibiotics

Nishimura RA, CM Otto, et al. JACC 2014; 63: e57

74 y/o Female: Postoperative abdominal wound infection, Corynebacterium bacteremia, no embolic events

74 y/o Female: Corynebacterium bacteremia cleared, day 14 of antibiotic therapy; no embolic events

74 y/o Female, readmitted 7 mos later: Abdominal panniculitis with streptococcal bacteremia; still no embolic events



Comprehensive TTE and TEE are indispensable for the evaluation and diagnosis of infective endocarditis

Echocardiography plays an pivotal role in the clinical risk stratification and management of the patient with infective endocarditis