



UT Southwestern
Medical Center

Cardiogenic Shock Principles & Case Based Education

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Outline

Cardiogenic shock definitions

Cardiogenic shock fundamentals

Scales (SCAI vs INTERMACs)

Demographics & Outcomes

Management

Question 1

A 35-year-old woman with a history of moderate-to-severe mitral stenosis presents with worsening shortness of breath, sinus tachycardia (HR 140 bpm), and a blood pressure of 150/80 mmHg. She is noted to have an acute kidney injury (creatinine 1.0 --> 2.5), elevated lactate and elevated liver function tests (previously normal). An echocardiogram is notable for normal right and left ventricular systolic function with significant mitral stenosis. The **most appropriate immediate management** of her cardiogenic shock includes:

- A. Intravenous diuretics and therapeutic anticoagulation
- B. Intravenous diuretics and ACE-inhibitor administration
- C. Intravenous diuretics and hydralazine administration
- D. Intravenous diuretics and beta-blocker administration
- E. ACE-inhibitor administration and beta-blocker administration

Question 2

A 45-year-old man with a history of CAD with myocardial infarction and ischemic cardiomyopathy presents with several days of lower extremity swelling, shortness of breath, chest pain and vomiting. At rest, he appears unwell, tachypneic (respiratory rate >20 breaths/minute), tachycardic (130 bpm) and hypotensive (BP 75/50). His labs are notable for a lactic acidosis, acute kidney injury and elevated liver function tests. A point of care cardiac ultrasound is notable for a left ventricular fraction <20%. An ECG does not demonstrate ST elevation or depression. The **most appropriate immediate management** of her cardiogenic shock includes:

- A. Initiation of dobutamine and beta-blocker administration
- B. Initiation of dobutamine and intravenous diuretics
- C. Initiation of milrinone and intravenous diuretics
- D. Intravenous diuretics and ACE-inhibitor administration
- E. Intravenous diuretics and beta-blocker administration

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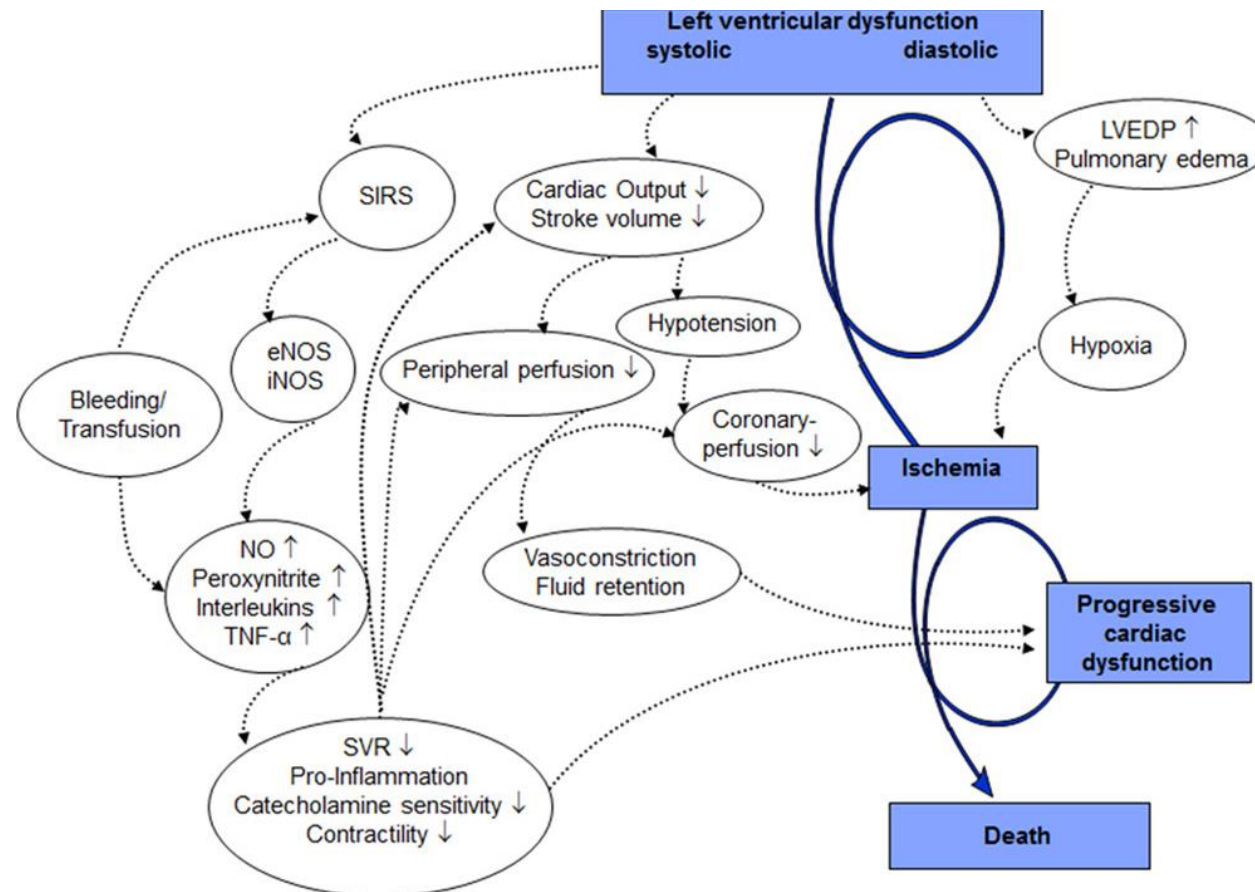
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Cardiogenic Shock Definition

Physiologic definition: reduced cardiac output resulting in inadequate tissue perfusion, often with elevated intravascular filling pressures, resulting in end-organ injury.



Cardiogenic Shock Definition

Table 1. Pragmatic and Clinical Trial Definitions of CS (Table view)

Clinical Definition	SHOCK Trial ^{9*}	IABP-SHOCK II ^{1†}	ESC HF Guidelines ¹⁵
Cardiac disorder that results in both clinical and biochemical evidence of tissue hypoperfusion	Clinical criteria: SBP <90 mm Hg for ≥30 min OR Support to maintain SBP ≥90 mm Hg AND End-organ hypoperfusion (urine output <30 mL/h or cool extremities) Hemodynamic criteria: CI of $\leq 2.2 \text{ L} \cdot \text{min}^{-1} \cdot \text{m}^{-2}$ AND PCWP ≥ 15 mm Hg	Clinical criteria: SBP <90 mm Hg for ≥30 min OR Catecholamines to maintain SBP >90 mm Hg AND Clinical pulmonary congestion AND Impaired end-organ perfusion (altered mental status, cold/clammy skin and extremities, urine output <30 mL/h, or lactate >2.0 mmol/L)	SBP <90 mm Hg with adequate volume and clinical or laboratory signs of hypoperfusion Clinical hypoperfusion: Cold extremities, oliguria, mental confusion, dizziness, narrow pulse pressure Laboratory hypoperfusion: Metabolic acidosis, elevated serum lactate, elevated serum creatinine

Cardiogenic Shock Definition

Clinical trial definition: Cardiac index <1.8 (or <2.0 with support), LVEDP >18 , and systolic blood pressure <90 mmHg for >30 minutes.

Limitations (many):

Not a sensitive definition

Acute pathology is more likely present with hypotension

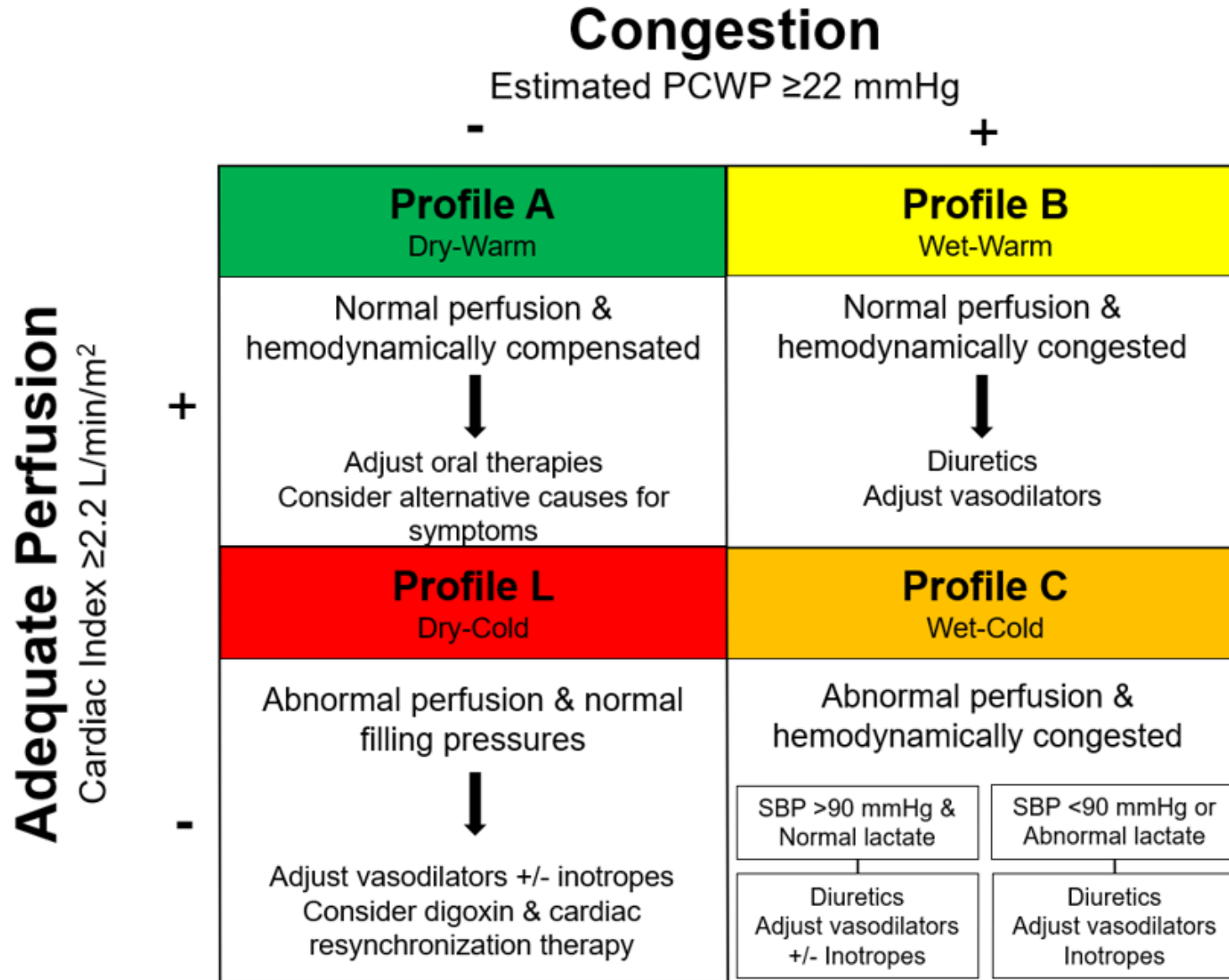
Patients on GDMT more likely to be hypotensive

There is no blood pressure that a patient cannot be in cardiogenic shock

*Note elevated lactate is NOT necessary

There is no comprehensive definition of cardiogenic shock

Management – Physical Exam



Cardiogenic shock – Physical Exam

Table 2: Utility of Clinical Exam Findings in ADHF

	Exam Finding	Sensitivity	Specificity	PPV	NPV	(+) LR	(-) LR
Perfusion*	S3 Gallop	62	32	61	33	0.92	0.85
	SBP <100 mmHg	42	66	77	29	1.24	1.14
	PPP <25%	10	96	88	28	2.54	1.07
	Cool Extremities	20	88	82	28	1.68	1.10
	"Cold" Profile	33	86	87	32	2.33	1.28
Congestion**	Ascites	21	92	81	40	2.44	1.15
	Rales >1/3	15	89	69	38	1.32	1.04
	Edema >2+	41	66	67	40	1.20	1.11
	Orthopnea >2 pillows	86	25	66	51	1.15	1.80
	JVP >12 mmHg	65	64	75	52	1.79	1.82
	HJR	83	27	65	49	1.13	1.54
<p>*Cardiac index <2.2 L/min/m². **Pulmonary capillary wedge pressure >22 mmHg. Abbreviations: HJR, hepatojugular reflux; JVP, jugular venous pressure; LR, likelihood ratio; NPV, negative predictive value; PPP; proportional pulse pressure; PPV, positive predictive value; SBP, systolic blood pressure. Adapted with permission from Drazner et al. <i>Value of clinician assessment of hemodynamics in advanced heart failure: the ESCAPE trial</i>. <i>Circ Heart Fail</i>. 2008;1(3):170-7.</p>							

Clinical Diagnosis of Cardiogenic Shock

$$\text{MAP} - \text{RAP} = \text{CO} \times \text{SVR}$$



Abnormal cardiac function (e.g., severe valvular disease, reduced systolic dysfunction, etc.)

Cardiac congestion – elevated left and/or right heart filling pressures (e.g., CXR with congestion, etc.)

Evidence of inadequate cardiac output – acute liver injury, acute kidney injury, elevated lactate, nausea, altered mental status, low central venous/PA saturation (at least 2)

‡ Hypotension, sinus tachycardia, narrow pulse pressure

**Cardiac index <2.1 L/min/m²

*MAP, mean arterial pressure; RAP, right atrial pressure; CO, cardiac output; SVR systemic vascular resistance. ‡ Supportive of shock, but not mandatory.

Classic Hemodynamics of Cardiogenic Shock

$$\text{MAP} - \text{RAP} = \text{CO} \times \text{SVR}$$

	PCWP	CO	SVR
Distributive (septic, neurogenic)	↓	↑	↓
Cardiogenic	↑	↓	↑
Hemorrhagic	↓	↓	↑

Reality:

BP 140/120 (126); JVP 20 mmHg → $(126-20)/(3.5 \text{ L/min}) = 2420$

BP 75/50 (58); JVP 20 mmHg → $(58-20)/(3.5 \text{ L/min}) = 870$

*ACEi/ARB/ARNI; obesity, liver disease, sepsis, advanced (deep) shock

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Fundamentals

Support the body



Optimize cardiac hemodynamics



Optimize Coronary Flow

Maintain MAP
Maintain body perfusion
Vasopressors & inotropes
MCS

Diuretics versus fluids
Vasopressors, inotropes
MCS if necessary

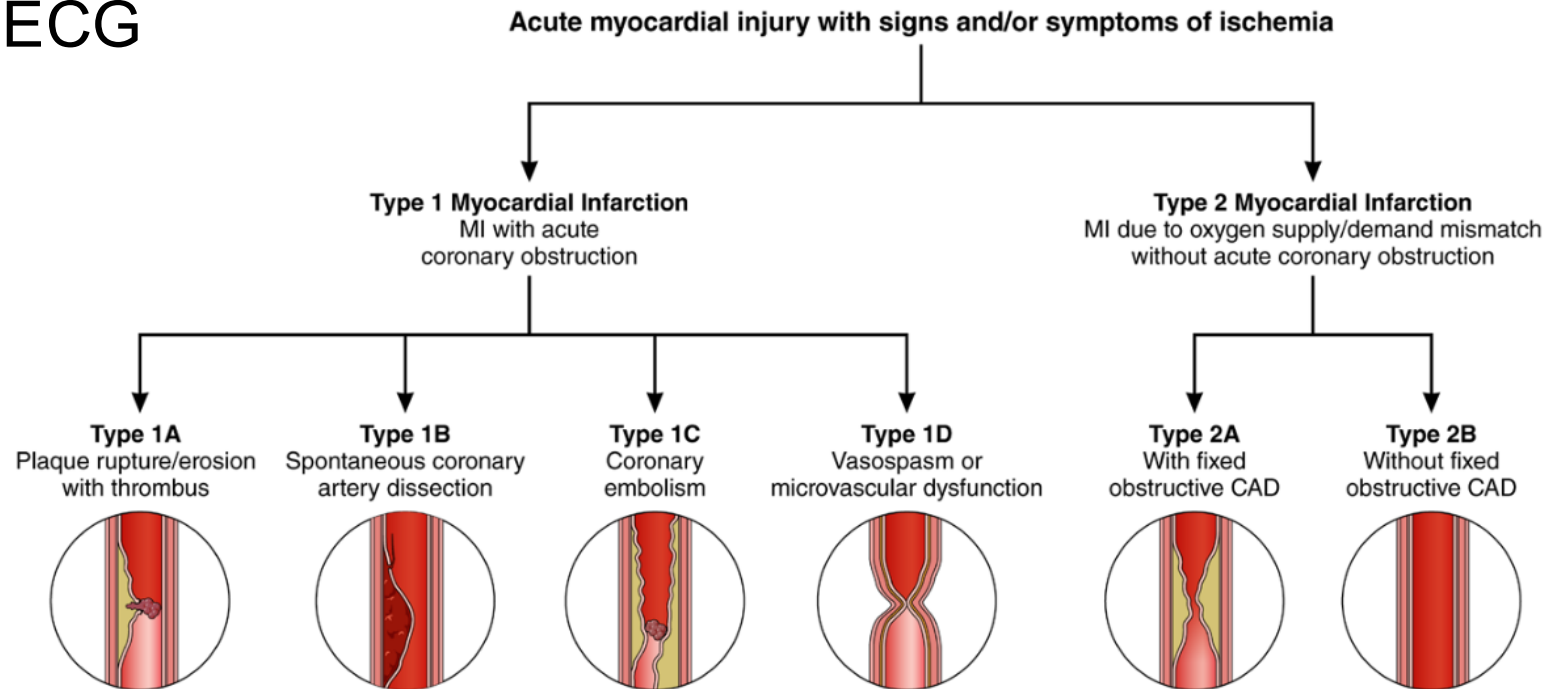
PCI/tPA if necessary

Correct recipe depends on the patient in front of you
(e.g. ACS vs critical AS vs ADHF)

Optimize coronary flow

All patients with cardiogenic shock should be assessed for an acute coronary syndrome (e.g., STEMI, NSTEMI)

- Trend troponin
- Assess for clinical symptoms of a myocardial infarction
- Obtain ECG



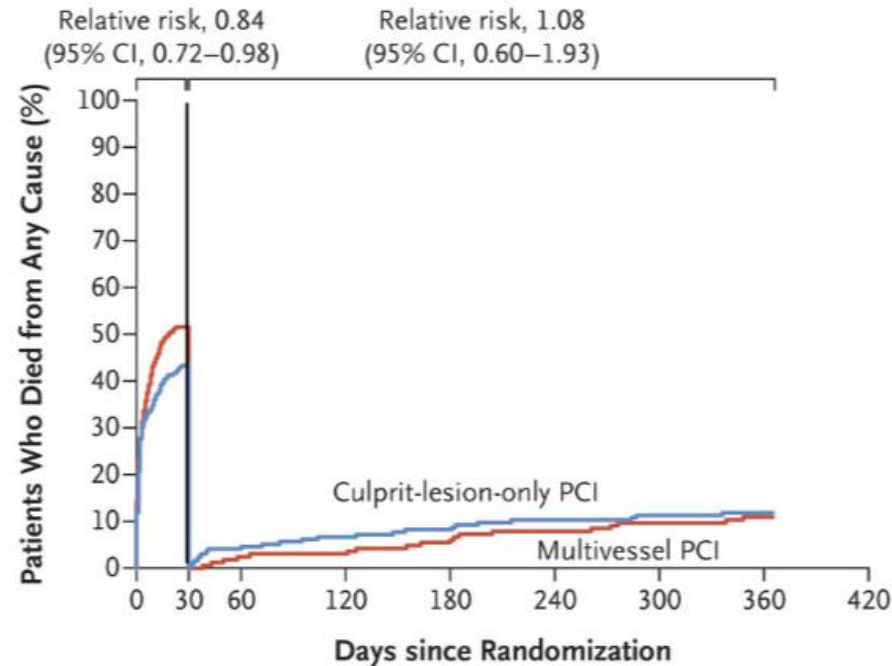
Optimize coronary flow

Coronary revascularization for STEMI or NSTEMI in shock

STEMI or NSTEMI

- Urgent revascularization of culprit lesion or tPA
- Address remaining lesions electively

B Landmark Analysis



CULPRIT SHOCK
N=706
Culprit-only PCI versus
multivessel PCI

No. at Risk

Multivessel PCI	165	161	160	156	152	149	131
Culprit-lesion-only PCI	195	186	181	178	174	172	147

Stahli et al. NEJM 2023. PMID 37634190.
Thiele et al. NEJM 2018. PMID 30145971

Support the body

MAP target – generally 65-80 mmHg

- If >80 mmHg consider oral/IV reduction
- If <65 mmHg add vasoactive mediations

$$\text{MAP} - \text{RAP} = \text{CO} \times \text{SVR}$$

Cardiac output – general goal >2.0 L/min/m²

Inotropes

Mechanical support

Oxygen delivery (Fick equation)

Goal hemoglobin >7 g/dL (>8 if NSTEMI/STEMI)

Goal SPO₂ >90% or PO₂ 80-120 (higher may be worse with myocardial infarction)

Adequate cardiac output (general goal >2.0 L/min/m²)

Support the body – Inotropes

	Perks	Limits
Dobutamine	Mixed clearance Mild SVR reduction	Proarrhythmic
Milrinone	PVR & SVR reducing 8-hour half-life Concomitant BB use	Renal clearance May cause hypotension Proarrhythmic
Epinephrine	Supports SVR & CO	Proarrhythmic
Dopamine	Supports SVR & CO	Proarrhythmic
Nitroprusside	No increased mortality Very short half-life Not proarrhythmic	Requires ICU care Limited use in advanced CKD Coronary steal

Support the body - Inotrope

Milrinone vs. Dobutamine in Cardiogenic Shock

DOUBLE-BLIND, RANDOMIZED TRIAL



192

Patients admitted to the cardiac ICU with cardiogenic shock

Milrinone

N=96



Dobutamine

N=96



In-hospital death from any cause, TIA, stroke, or cardiovascular or renal events

49%

47 patients

54%

52 patients

Relative risk, 0.90; 95% CI, 0.69–1.19; P=0.47

No between-group difference was observed in the primary composite outcome or in important secondary outcomes.

Support the body – Inotrope

End Point ^a	Milrinone (n=96)	Dobutamine (n=96)	Relative risk (95% CI)
Arrhythmia requiring medical team intervention ^b	48 (50%)	44 (46%)	1.09 (0.81-1.47)
Atrial arrhythmia requiring medical team intervention	43 (45%)	36 (38%)	1.19 (0.85-1.68)
Ventricular arrhythmia ^c	14 (15%)	17 (18%)	0.82 (0.43-1.57)
Need for oral or intravenous anti-arrhythmic therapy	43 (45%)	41 (43%)	1.05 (0.76-1.45)
Need for up-titration or addition of vasopressor therapy	94 (98%)	93 (97%)	1.01 (0.97-1.06)
Sustained hypotension with systolic blood pressure less than 90mmHg for at least 30 minutes or requiring intervention	96 (100%)	96 (100%)	-

a- Values are reported as no. (%). All analyses performed using the intention-to-treat principle. CI denotes confidence interval.

b- Defined as electrical/chemical cardioversion or any intravenous anti-arrhythmia medication administration

c- Defined as monomorphic or polymorphic ventricular tachycardia greater than 30 seconds, or hemodynamically unstable ventricular arrhythmia requiring intervention, or ventricular fibrillation

Support the body – Mechanical Support

	Inotrope	IABP	Impella	VA-ECMO
Cardiac Output	0.5-1.0 L/min	0.5-1.0 L/min	2.5-5.0 L/min	3-6 L/min
Myocardial oxygen demand	Increase	Decrease	Decrease	Increase
LV unloading	Yes	Yes	Yes	No
Complication Rate	**	**	***	****
Cost	\$	\$	\$\$\$\$	\$\$\$

All mechanical support devices lack high quality data supporting use for cardiogenic shock.

Optimize cardiac hemodynamics

Cardiac output = heart rate x stroke volume

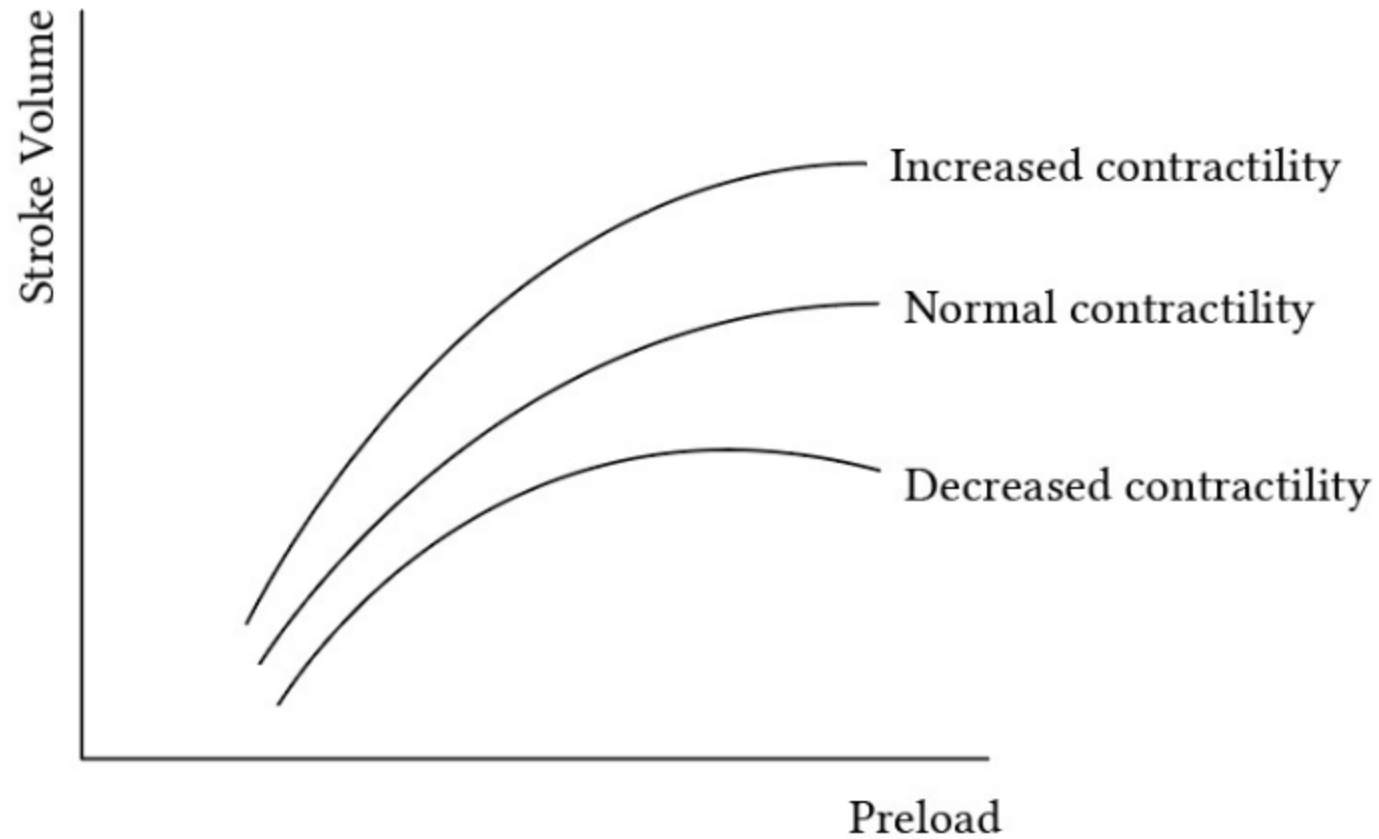
Cardiac filling pressures

Heart rate

Stroke volume – severe valvular lesions

Frank-Starling Relationship

Left ventricular end-diastolic pressure (PCWP) [Preload]

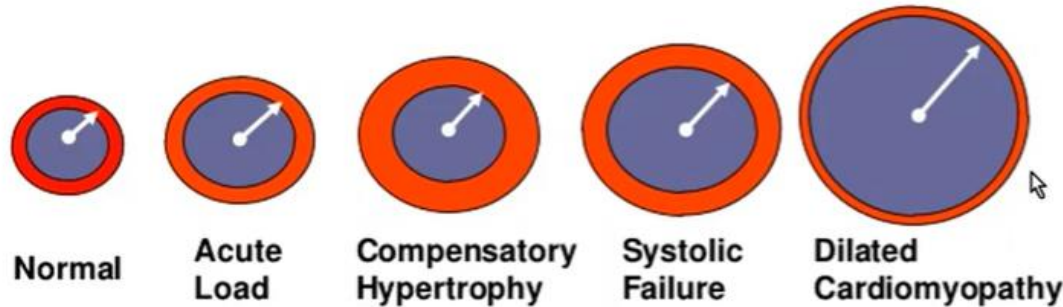


Frank-Starling Relationship

Left ventricular end-diastolic pressure (PCWP) [Preload]

La Place law of the heart

Pressure and Volume Govern Cardiac Function



La Place law for myocardial O₂ demand

$$VO_2 \propto \text{wall tension}$$

Primary Target of Heart Failure Therapy: Reduce LV Wall Stress

$$\text{Laplace's Law: Wall stress} = \frac{\text{Pressure} \times \text{Radius}}{2 \times \text{Wall Thickness}} = \frac{\text{Pressure} \times \text{Volume}}{\text{LV Mass}}$$

Wall Stress

Cardiac filling pressures

Left ventricular end-diastolic pressure (PCWP) [Preload]

Normal	<12 mmHg
Dilated cardiomyopathy	10-18 mmHg
Restrictive cardiomyopathy	15-20 mmHg
Severe aortic stenosis	15-20 mmHg

Right ventricular end-diastolic pressure (CVP)

Normal	<8 mmHg
Goal	5-10 mmHg

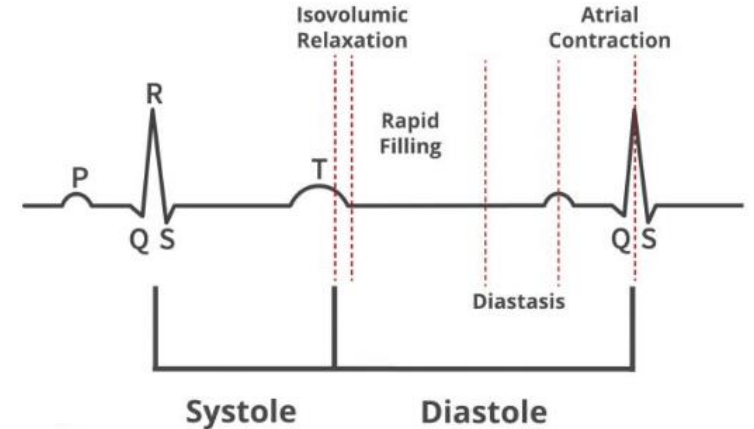
Use diuretics and blood pressure control to achieve goals

Optimize cardiac hemodynamics – heart rate

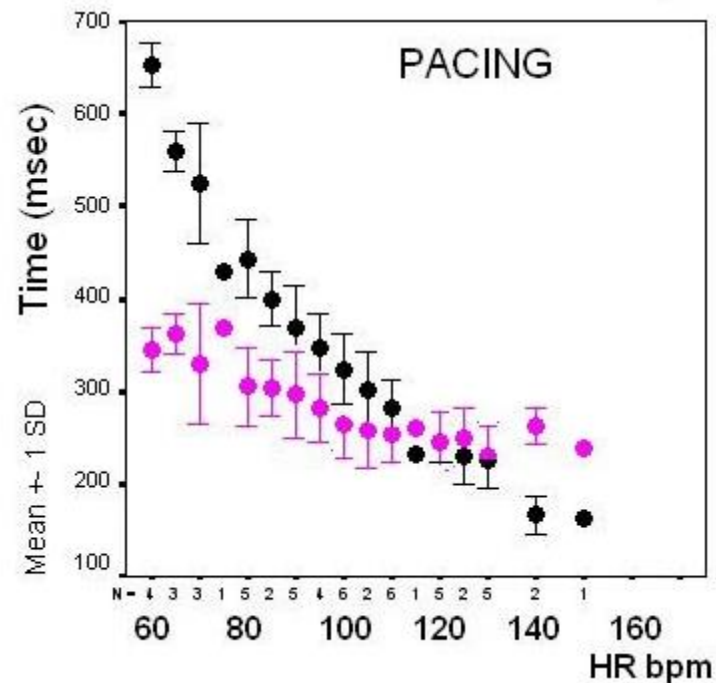
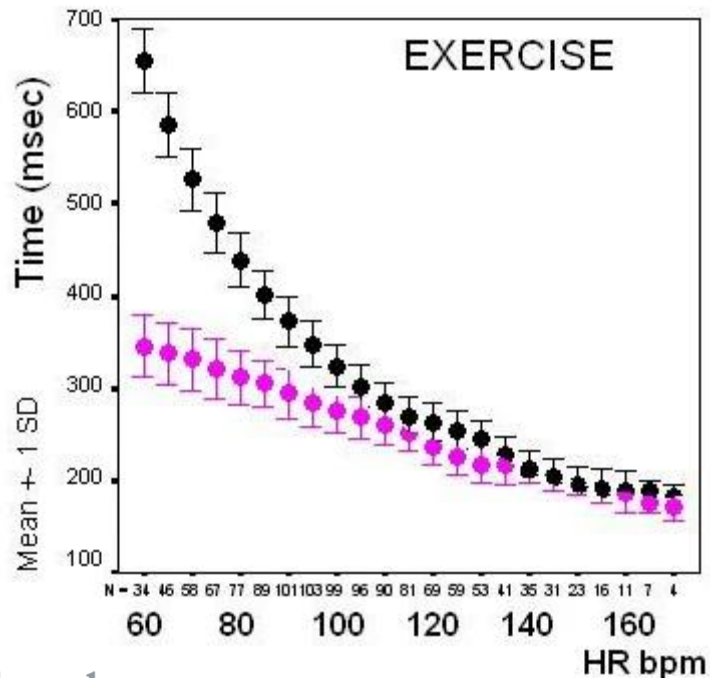
Faster heart rate = less diastolic filling time

Good for severe aortic regurgitation

Bad for severe mitral stenosis



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Black = Diastolic filling time

Pink = Systolic filling time

Optimize cardiac hemodynamics – heart rate

Goal heart rate in shock – 70-120 bpm in sinus rhythm



Cardiogenic Shock Patients - Concepts

Acute Problems:

Myocardial infarction (STEMI, NSTEMI)
Acute AR or MR
Myocarditis (viral, chemotherapy)
Stress cardiomyopathy

Cardiac Index: 3.0 → 1.8 (60%)



Acute on Chronic Problems:

Systolic heart failure
Chronic AS or MS
Chronic AR or MR

Cardiac Index: 2.0 → 1.8 (90%)



Concepts – Weaning Inotropes

$$\text{MAP} - \text{RAP} = \text{CO} \times \text{SVR}$$

Dobutamine, milrinone,
or nitroprusside

Dose

ACEi, ARB or
hydralazine-
isosorbide

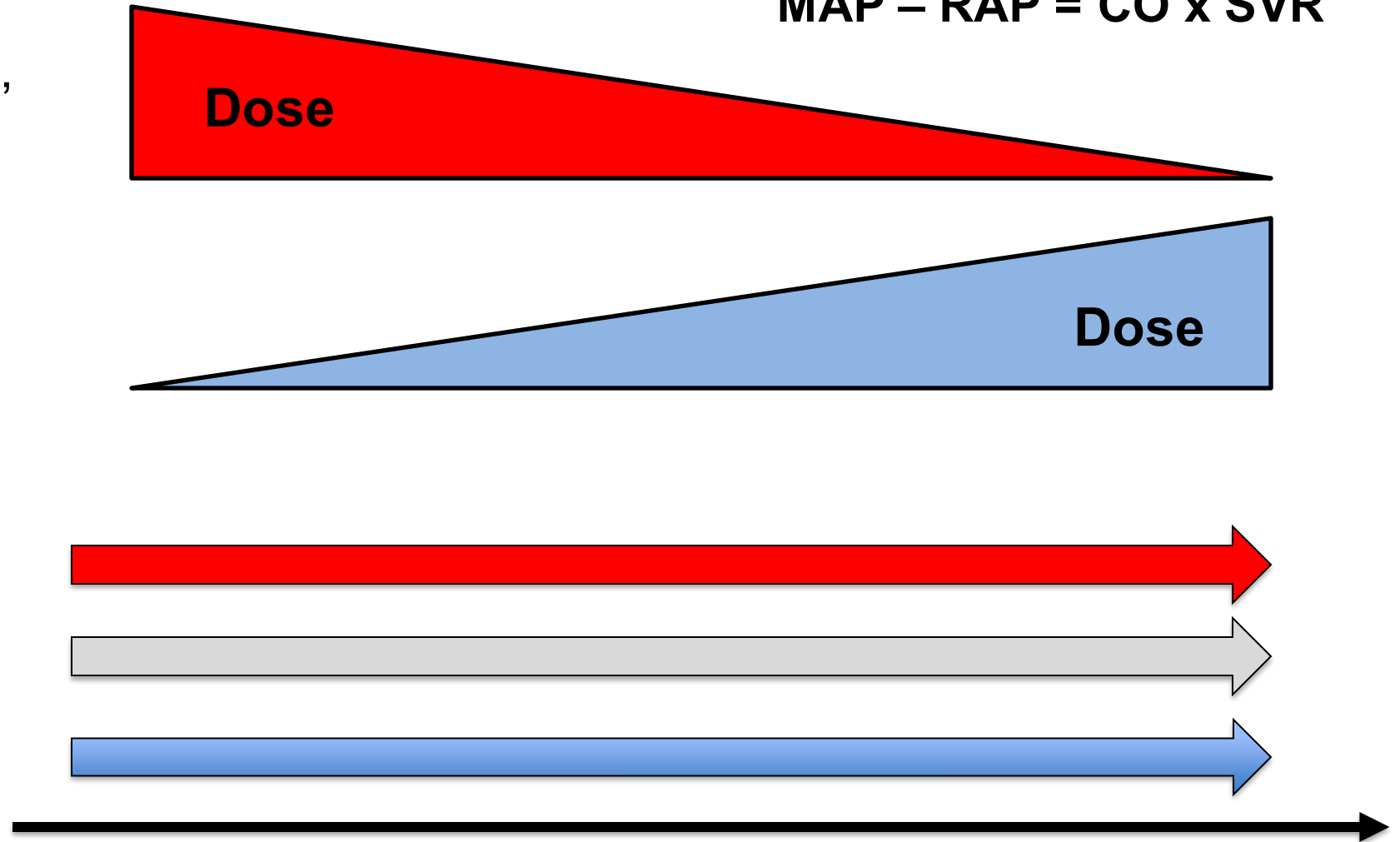
Dose

CI (>2.0)

MAP (>65)

SVR

Time



Concepts – Weaning Inotropes

$$\text{MAP} - \text{RAP} = \text{CO} \times \text{SVR}$$

Dobutamine, milrinone,
or nitroprusside

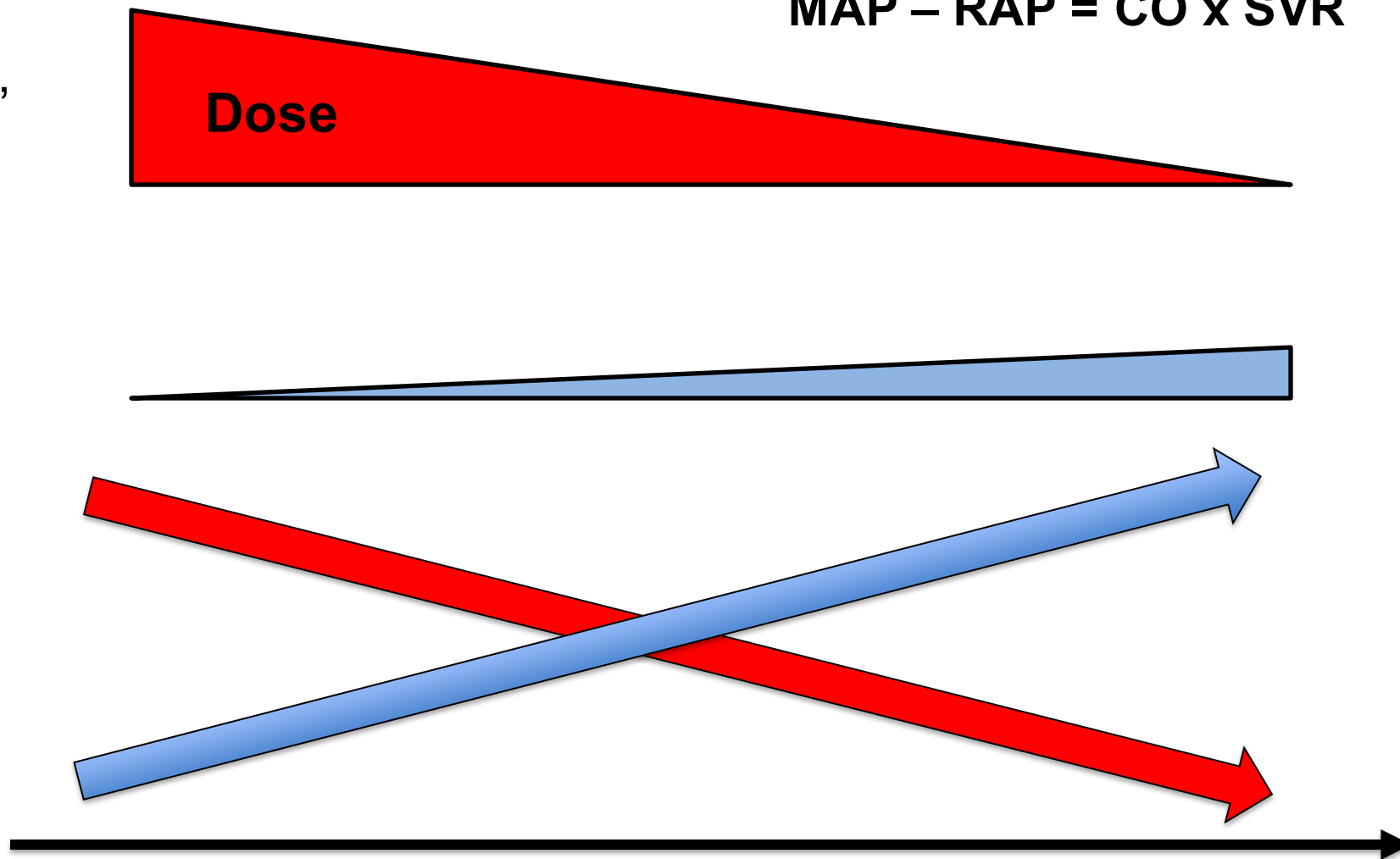
Dose

ACEi, ARB or
hydralazine-
isosorbide

CI (>2.0)

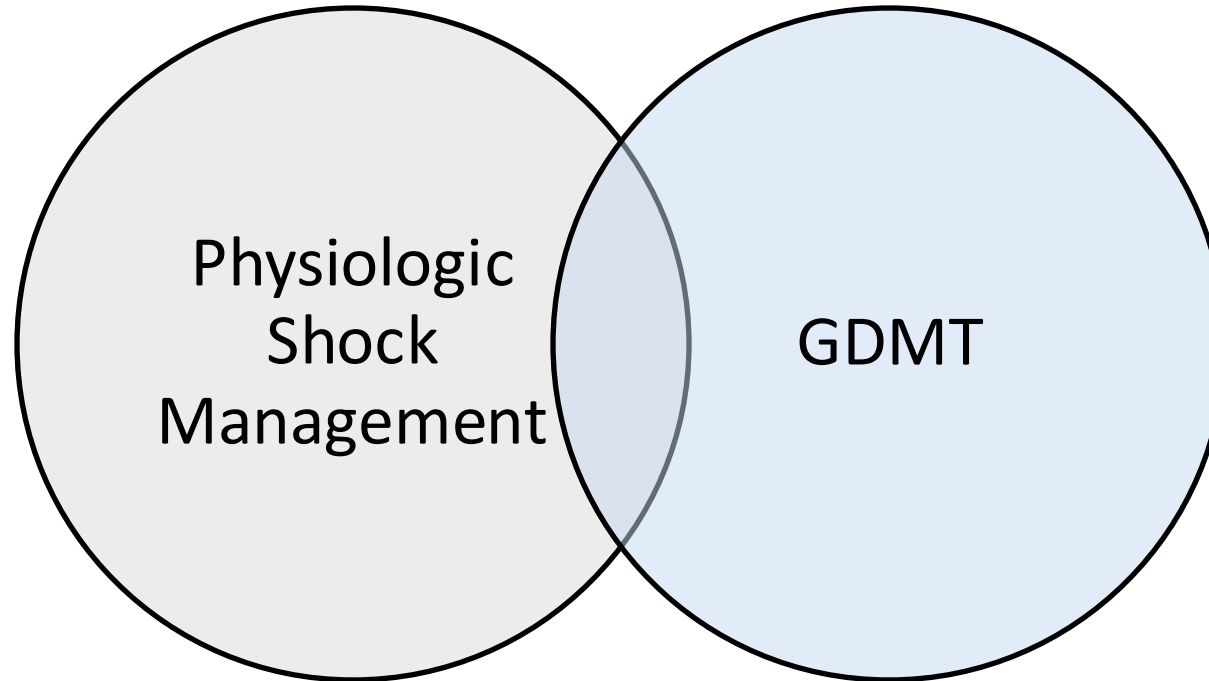
MAP (>65)

SVR



Time

Concepts – Weaning Inotropes



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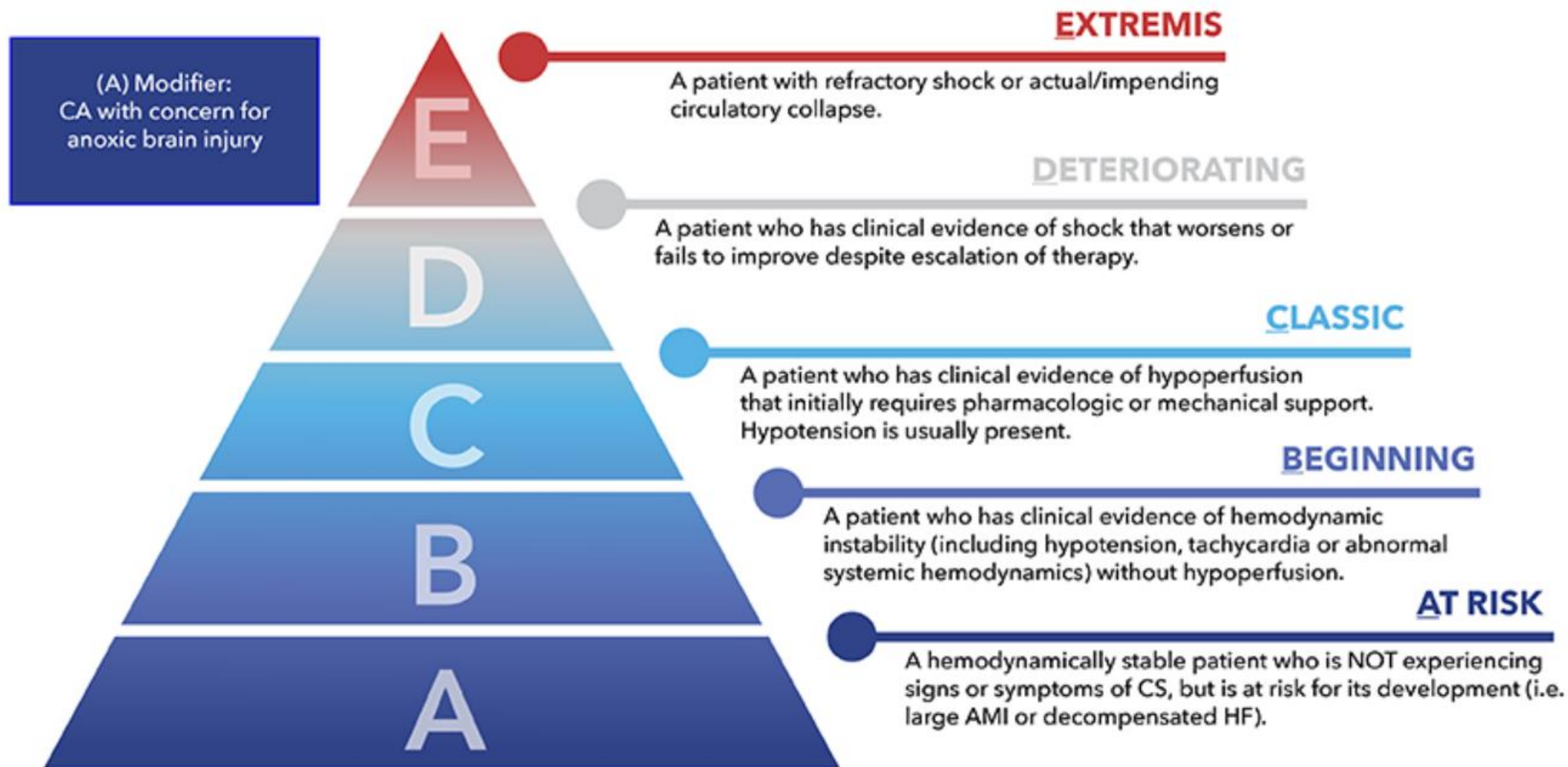
Management

INTERMACs Stages of Shock

Profile	Description	Temporary circulatory support (TCS)	Arrhythmia (A)	Frequent flyer (FF)
1.	Critical cardiogenic shock	X	X	
2.	Progressive decline on inotropic support	X	X	
3.	Stable but inotrope dependent	X (in hosp)	X	X (if home)
4.	Resting symptoms home on oral therapy		X	X
5.	Exertion intolerant		X	X
6.	Exertion limited		X	X
7.	Advanced NYHA Class III symptoms		X	

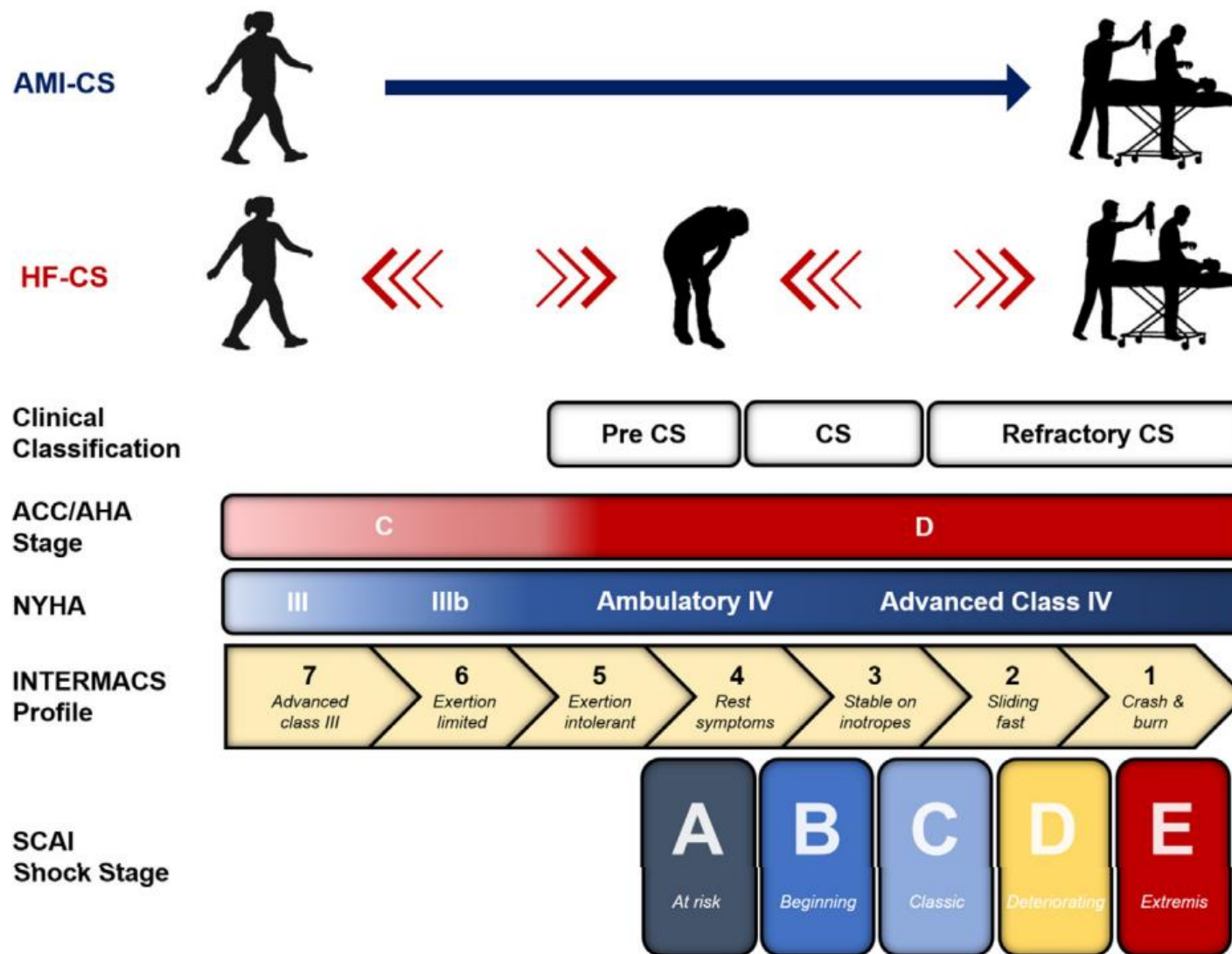
NYHA, New York Heart Association Classification.

SCAI Stages of Shock

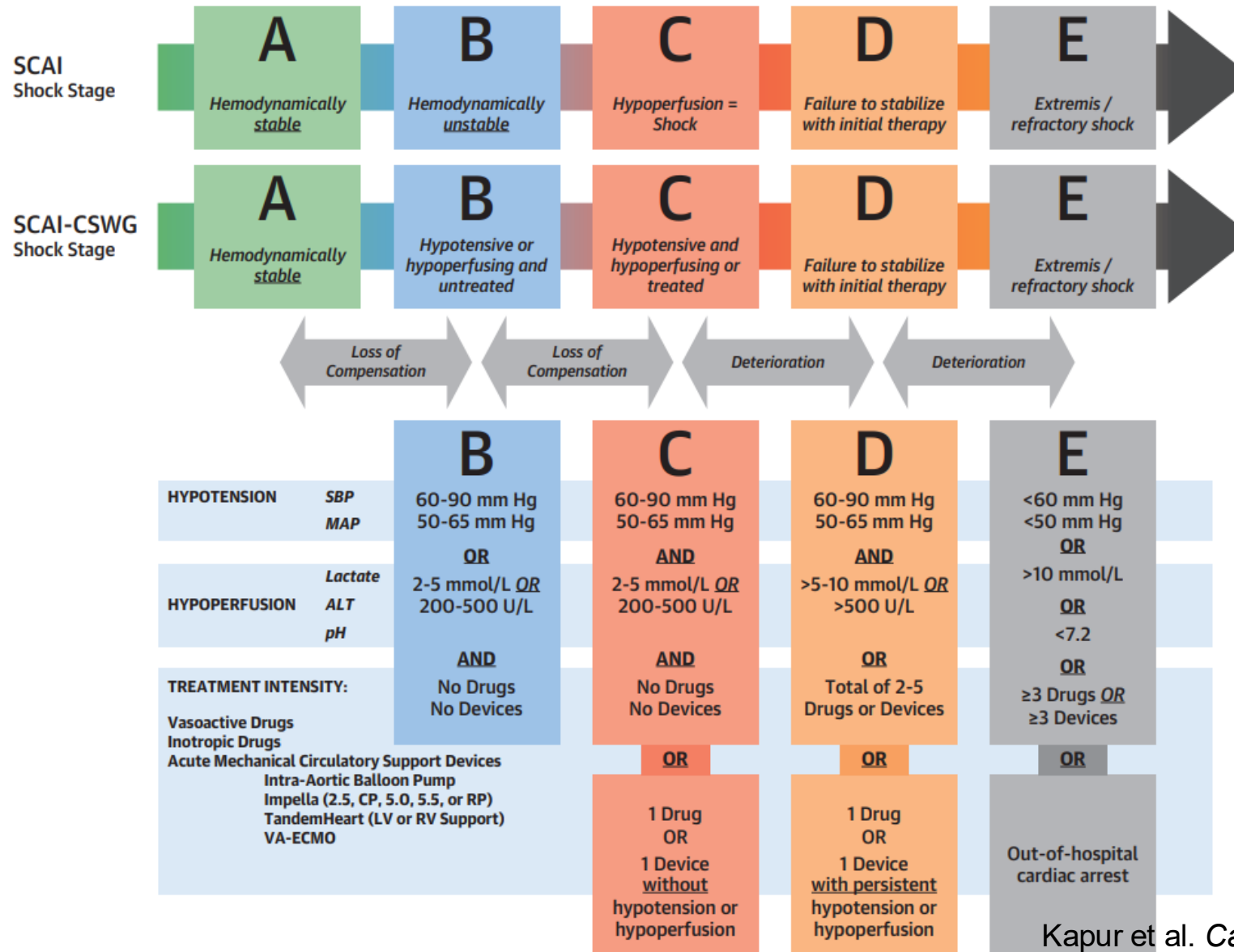


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SCAI Stages of Shock



SCAI Stages of Shock



Outline

Cardiogenic shock definitions

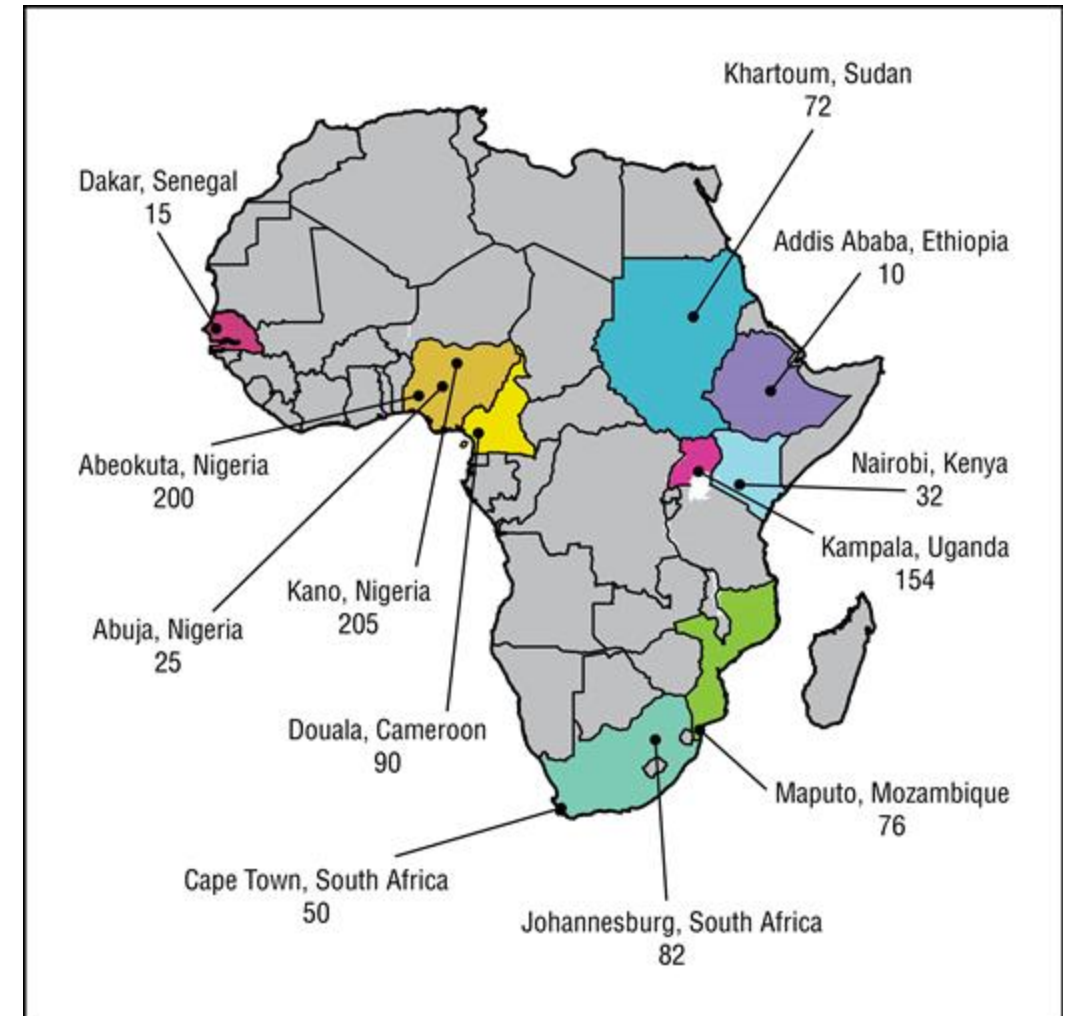
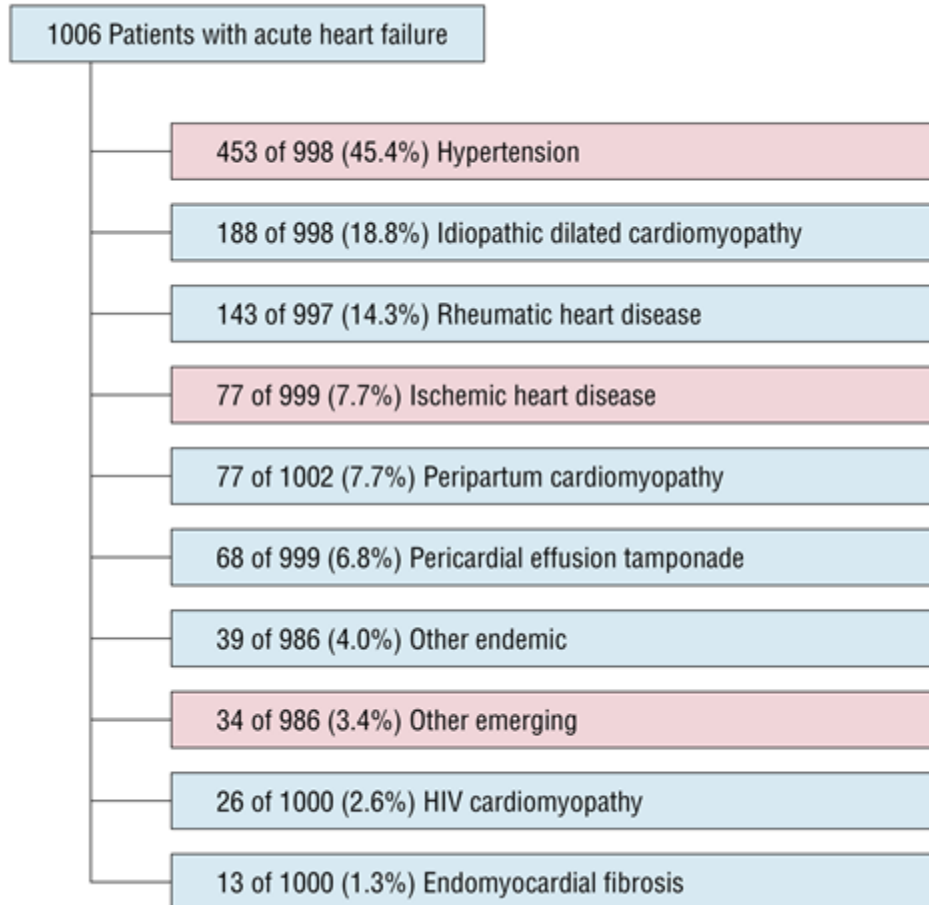
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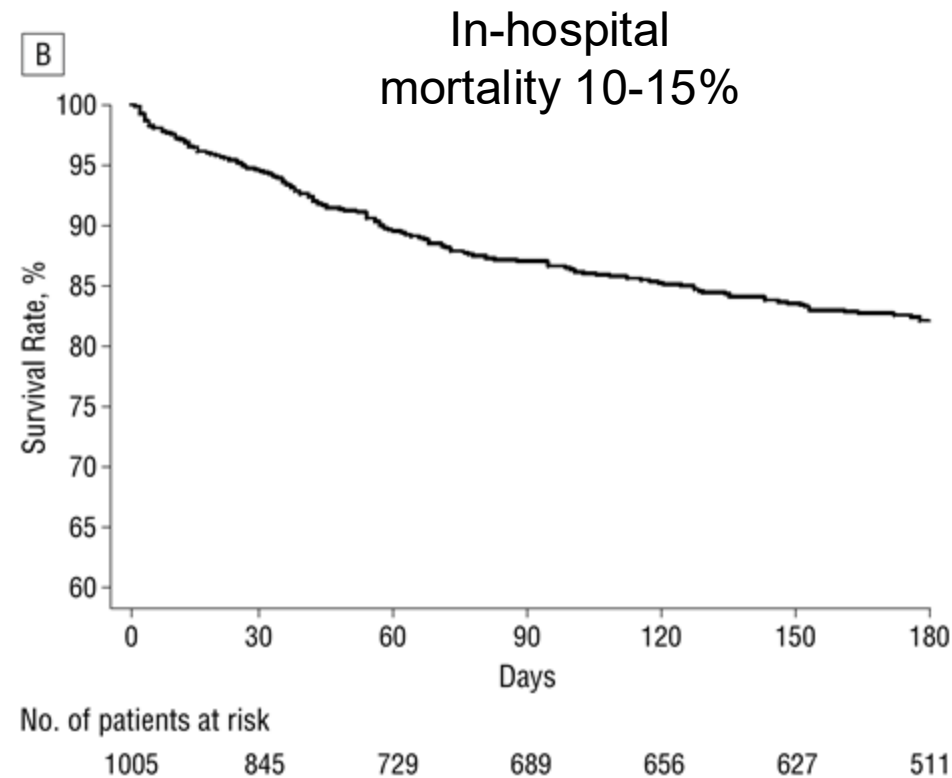
Hospitalized Heart Failure in Africa



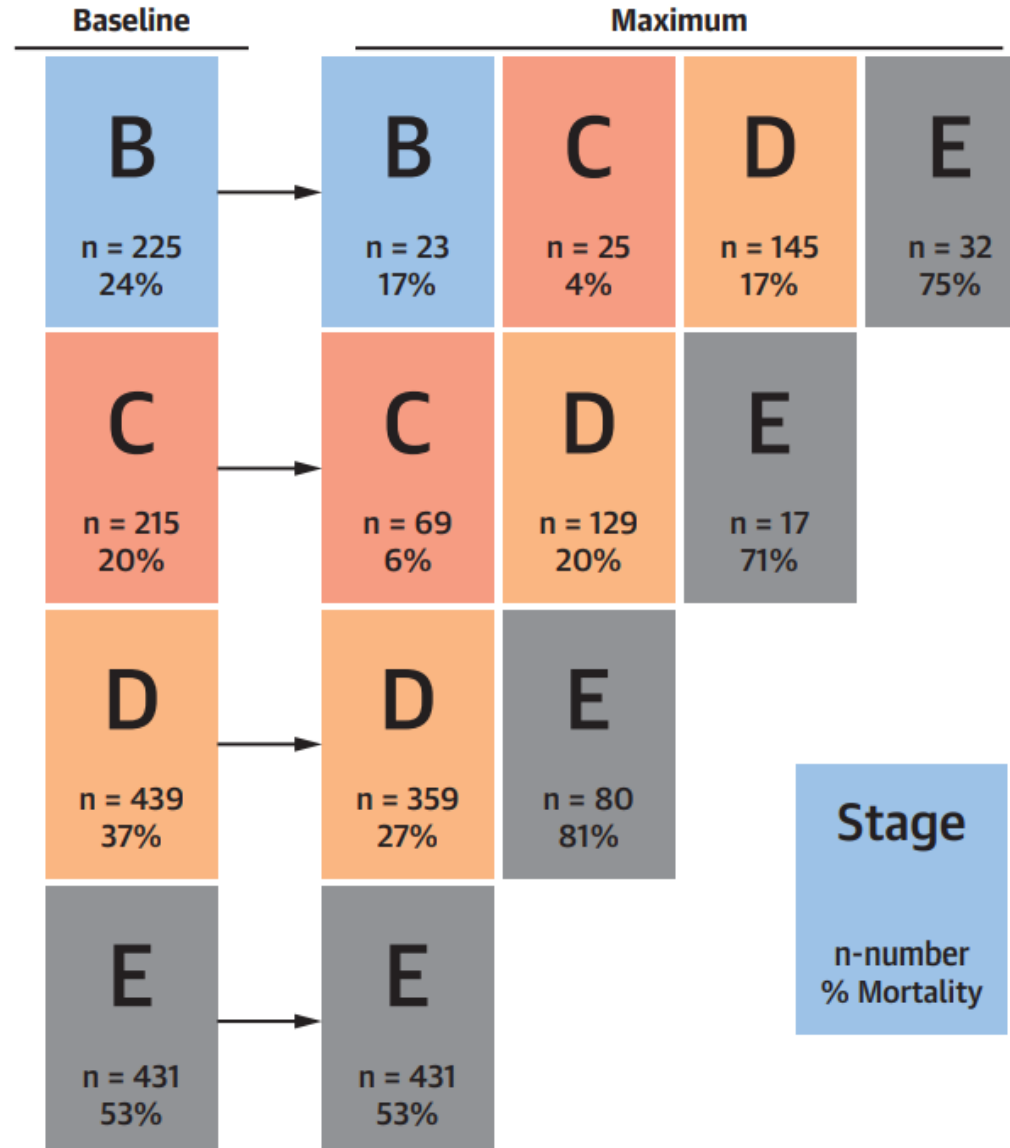
Hospitalized Heart Failure in Africa

Table 1. Demographic and Clinical Presentation^a

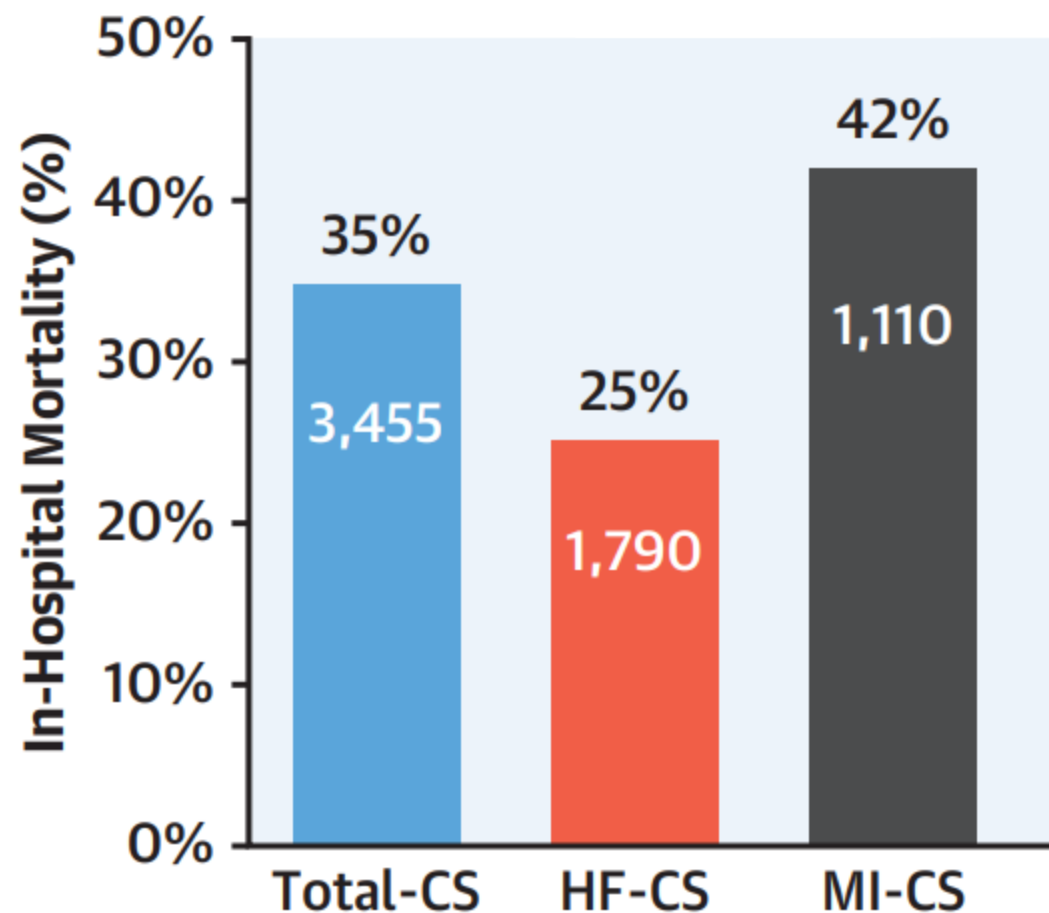
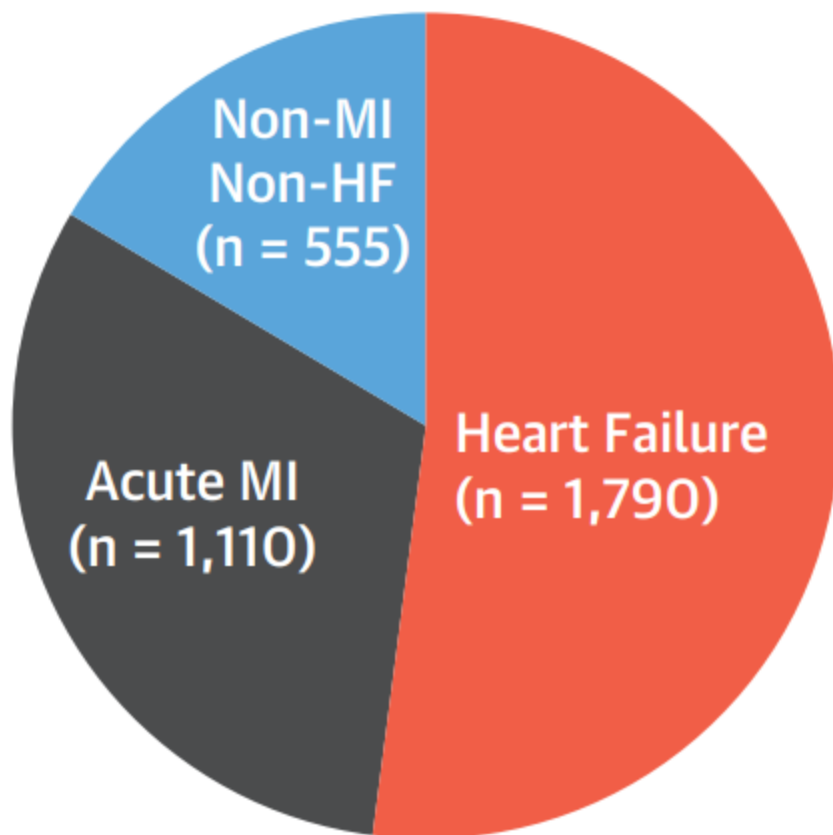
Characteristic	All (N=1006)	Men (n=494)	Women (n=511)	P Value
Age, y				
Mean (SD)	52.3 (18.3)	54.0 (16.9)	50.7 (19.5)	.005
Median (IQR)	55.0 (39.0-67.0)	55.0 (43.0-67.0)	53.0 (33.0-67.0)	
Black African, No. (%)	984 (98.5)	486 (98.8)	497 (98.2)	.47
Atrial fibrillation, No. (%)	184 (18.3)	77 (15.7)	107 (21.1)	.03
No. of AHF admissions in last 12 mo				
Mean (SD)	0.37 (0.78)	0.41 (0.77)	0.34 (0.78)	.15
Median (IQR)	0 (0-0)	0 (0-1)	0 (0-0)	
Hyperlipidemia, No. (%) ^b	90 (9.2)	52 (10.8)	38 (7.6)	.09
History of smoking, No. (%)	98 (9.8)	85 (17.3)	13 (2.6)	<.001
History of hypertension, No. (%)	556 (55.5)	296 (60.0)	259 (51.0)	.004
History of diabetes mellitus, No. (%)	114 (11.4)	58 (11.8)	56 (11.0)	.68
Body mass index ^c				
Mean (SD)	25.2 (9.0)	24.7 (4.9)	25.7 (11.6)	.08
Median (IQR)	24.0 (20.9-28.1)	24.0 (21.2-27.6)	23.9 (20.5-28.6)	
Systolic blood pressure, mm Hg				
Mean (SD)	130.4 (33.5)	132.4 (33.7)	128.4 (33.3)	.06
Median (IQR)	126.5 (106.0-150.0)	130.0 (110.0-151.0)	120.0 (102.0-150.0)	
Diastolic blood pressure, mm Hg				
Mean (SD)	84.3 (20.9)	85.5 (21.2)	83.2 (20.7)	.08
Median (IQR)	80.0 (70.0-100.0)	82.0 (70.0-100.0)	80.0 (70.0-96.0)	
Heart rate, bpm				
Mean (SD)	103.7 (21.6)	101.6 (21.4)	105.7 (21.6)	.003
Median (IQR)	104.0 (90.0-116.0)	100.0 (88.0-112.0)	108.0 (90.0-120.0)	
LVEF, %				
Mean (SD)	39.5 (16.5)	37.8 (16.2)	41.1 (16.6)	.002
Median (IQR)	38.0 (27.0-50.0)	37.0 (25.0-112.0)	40.0 (28.4-53.0)	



Management – Dynamic Process



Demographics – CSWR



Demographics – CSWR

	Overall (N = 3,455)	Shock Cause	
		MI (n = 1,110)	HF (n = 1,790)
Nonsurvivors	1,055 (30.5)	449 (40.5)	441 (24.6)
Male	2,436 (70.5)	775 (69.8)	1,296 (72.4)
Race			
White	2,043 (59.1)	636 (57.3)	1,043 (58.3)
Black	291 (8.4)	42 (3.8)	210 (11.7)
Asian	111 (3.2)	53 (4.8)	38 (2.1)
Other	120 (3.5)	23 (2.1)	73 (4.1)
Medical history			
HTN	1,872 (54.2)	721 (65.0)	914 (51.1)
DM	1,245 (36.0)	482 (43.4)	631 (35.3)
Atrial fibrillation/flutter	898 (26.0)	125 (11.3)	681 (38.0)
CKD, any stage	538 (15.6)	106 (9.6)	391 (21.8)
PVD	236 (6.8)	86 (7.8)	116 (6.5)
COPD	380 (11.0)	104 (9.4)	232 (13.0)
CVA/TIA	409 (11.8)	123 (11.1)	249 (13.9)
Valvular disease	654 (18.9)	80 (7.2)	475 (26.5)
PCI	673 (19.5)	297 (26.8)	308 (17.2)
CABG	369 (10.7)	92 (8.3)	217 (12.1)
ICD	763 (22.1)	44 (4.0)	665 (37.2)
OHCA	293 (8.5)	147 (13.2)	103 (5.8)

Demographics – CSWR

	Overall (N = 3,455)	Shock Cause	
		MI (n = 1,110)	HF (n = 1,790)
Demographics			
Age, y	61.6 ± 14.6 (3,450)	65.6 ± 12.5 (1,109)	60.3 ± 14.5 (1,790)
Weight, kg	84.4 [71.0-100.6] (1,883)	82.6 [71.5-98.9] (593)	85.0 [70.8-102.1] (1,051)
BMI, kg/m ²	28.4 [24.4-33.1] (1,872)	28.2 [24.6-32.3] (588)	28.4 [24.0-33.2] (1,047)
Metabolic			
ALT, /L	46.0 [22.0-141.0] (2,443)	64.0 [29.0-153.0] (858)	35.0 [19.0-114.0] (1,268)
BUN, mg/dL	27.0 [19.0-43.0] (2,960)	23.0 [17.0-35.0] (1,017)	32.0 [21.0-48.0] (1,518)
Lactate, mmol/L	2.6 [1.5-5.7] (1,942)	3.0 [1.7-6.3] (703)	2.2 [1.4-4.5] (986)
HCO ₃ , mEq/L	22.0 [18.0-26.0] (2,147)	20.0 [17.0-23.0] (819)	24.0 [20.0-27.0] (1,020)
SCr, mg/dL	1.5 [1.1-2.1] (3,232)	1.3 [1.0-1.9] (1,050)	1.6 [1.2-2.3] (1,750)
pH	7.3 [7.2-7.4] (1,541)	7.3 [7.2-7.4] (652)	7.4 [7.3-7.4] (634)

Demographics – CSWR

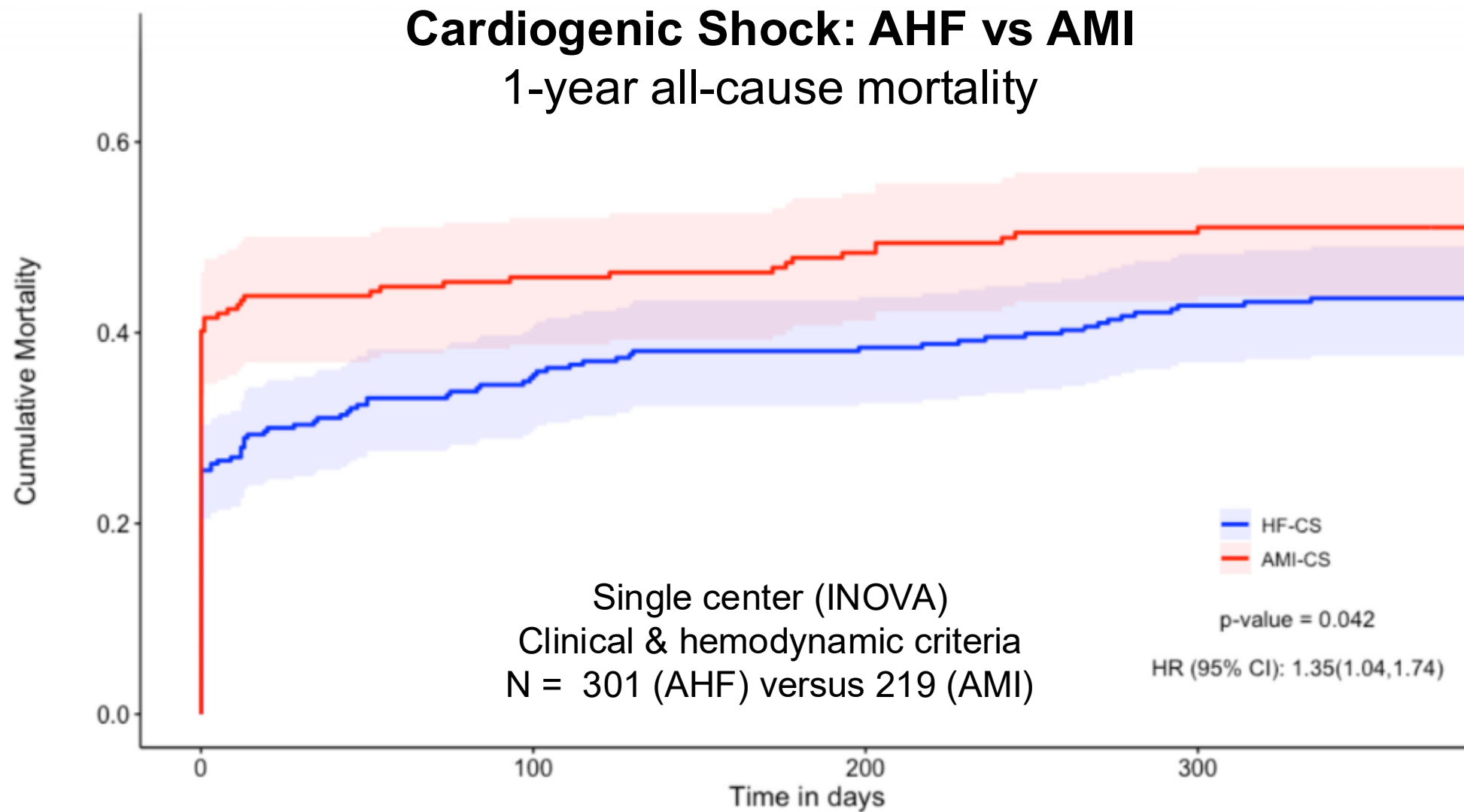
	Overall (N = 3,455)	Shock Cause	
		MI (n = 1,110)	HF (n = 1,790)
Hemodynamic			
EF, %	22.5 [15.0-37.0] (2,490)	27.5 [17.5-40.0] (803)	20.0 [14.0-30.0] (1,379)
RAP, mm Hg	14.0 [9.0-18.0] (1,261)	14.0 [10.0-17.0] (403)	14.0 [9.0-18.0] (724)
PCWP, mm Hg	24.4 ± 8.8 (912)	24.0 ± 9.2 (300)	24.8 ± 8.7 (517)
Mean PAP, mm Hg	31.7 [25.7-38.7] (1,312)	29.0 [23.3-35.0] (439)	34.3 [27.3-41.0] (733)
CO, L/min	3.6 [2.9-4.4] (1,243)	3.6 [2.9-4.6] (412)	3.6 [2.8-4.3] (714)
CPO, W	0.6 [0.5-0.8] (1,177)	0.6 [0.5-0.8] (396)	0.6 [0.5-0.7] (667)
Heart rate, beats/min	91.0 [76.0-107.0] (3,213)	90.0 [74.0-107.0] (1,015)	92.0 [77.0-108.0] (1,724)
Cardiac index	1.9 [1.5-2.2] (1,251)	1.9 [1.6-2.3] (415)	1.8 [1.4-2.1] (722)
MAP, mm Hg	80.5 ± 18.0 (3,272)	81.5 ± 20.5 (1,053)	80.1 ± 16.0 (1,737)
SBP, mm Hg	106.9 ± 24.4 (3,185)	109.6 ± 28.4 (1,002)	104.9 ± 20.9 (1,714)
PAPi	1.3 [0.8-2.0] (188)	1.4 [1.0-2.1] (80)	1.4 [0.8-2.1] (86)

Demographics – Cardiogenic Shock

Table 2. In-Hospital Device Therapy and Outcomes in Cardiogenic Shock Patients ([Table view](#))

Parameter	AMI-CS; N=219	HF-CS; N=301	Total; N=520	P value
AMI-CS management				
Percutaneous revascularization	150 (68.5%)	N/A	N/A	
Culprit/single-vessel	123 (82.0%)	N/A	N/A	
Multivessel	27 (18.0%)	N/A	N/A	
Surgical revascularization	30 (13.7%)	N/A	N/A	
Medical management	39 (17.8%)	N/A	N/A	
MCS utilization	167 (76.3%)	105 (34.9%)	272 (52.3%)	<0.001
IABP	98 (44.8%)	34 (11.3%)	132 (25.4%)	<0.001
Escalation from IABP	40 (40.8%)	10 (29.4%)	50 (37.9%)	0.31
pVAD only	79 (36.1%)	43 (14.3%)	122 (23.5%)	<0.001
VA-ECMO only	15 (6.9%)	19 (6.3%)	34 (6.5%)	0.86
pVAD+VA-ECMO	33 (15.1%)	22 (7.3%)	55 (10.6%)	0.156
Impella 5.0+VA-ECMO	0 (0.00%)	2 (9.1%)	2 (3.6%)	
Impella CP+VA-ECMO	33 (100%)	20 (90.9%)	53 (96.4%)	

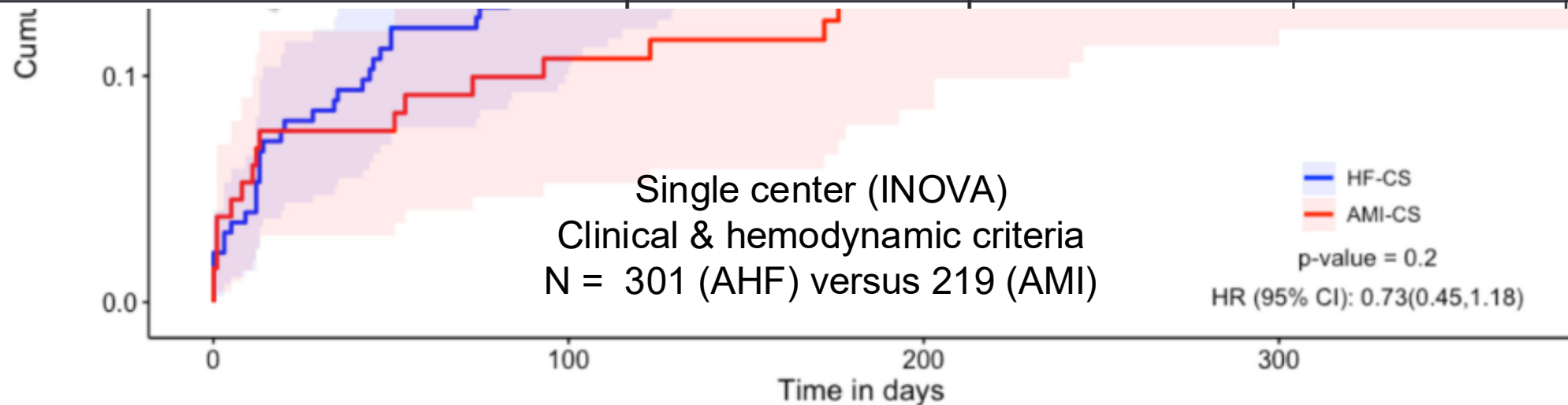
Outcomes – Cardiogenic Shock



Outcomes – Cardiogenic Shock

Cardiogenic Shock: AHF vs AMI 1-year all-cause mortality (conditional)

Parameter	AMI-CS; N= 133	HF-CS; N= 229	Total; N=362	P value
30-d mortality*,†	10 (7.7%)	14 (6.4%)	24 (6.9%)	0.67
6-mo mortality*†	18 (14.4%)	36 (16.8%)	54 (15.9%)	0.65
1-y mortality*†	24 (19.7%)	51 (23.5%)	75 (22.1%)	0.41



Outcomes – CSWR

Total CS (MI + HF)

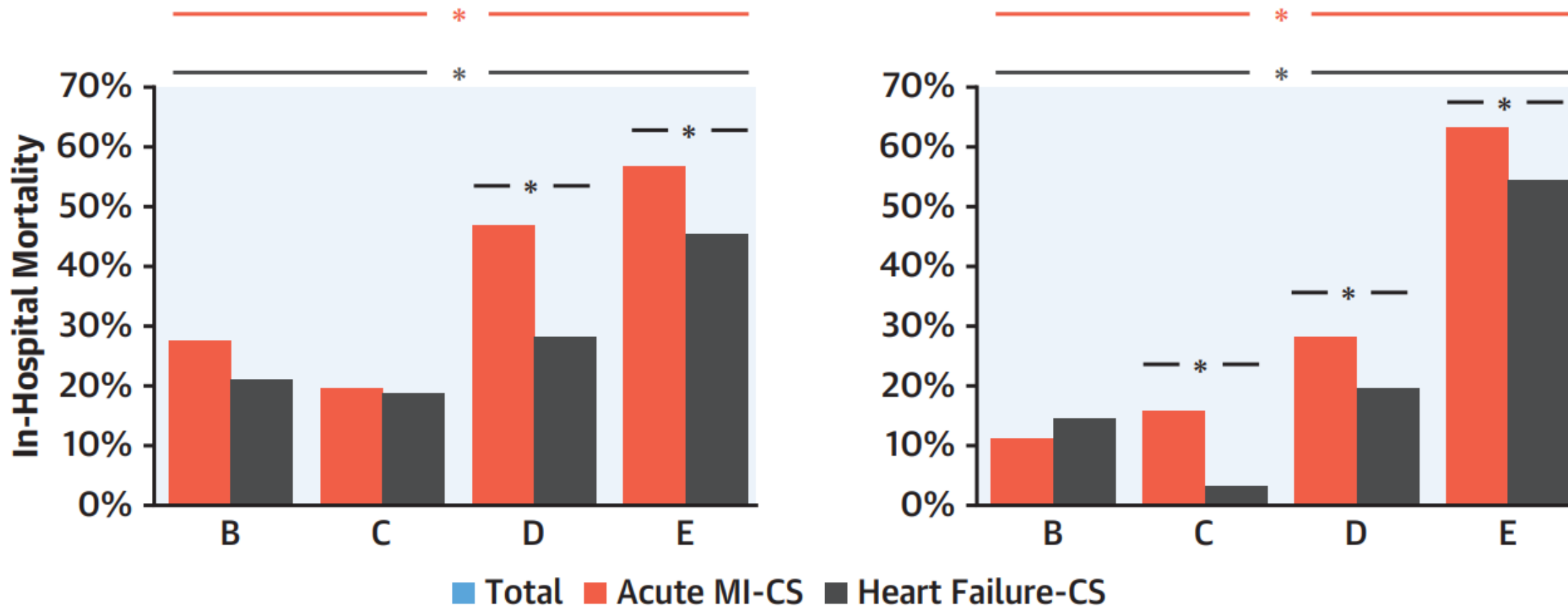
Number of Devices

Number of Drugs	% Mortality (n-number)	Number of Devices				
		0	1	2	3	4+
0	7.4% (95)	12.6% (206)	26.1% (23)	N/A	N/A	
1	11.0% (620)	19.3% (462)	29.4% (102)	21.4% (14)	N/A	
2	37.6% (173)	31.5% (365)	40.3% (149)	40.9% (22)	44.4% (9)	
3	59.1% (93)	44.9% (225)	50.9% (169)	59.2% (49)	40.0% (5)	
4+	85.1% (47)	60.9% (161)	68.0% (122)	79.6% (44)	66.7% (12)	

* * * *

Outcomes – CSWR

In-hospital mortality by initial (left) and maximal (right) SCAI shock stage



Outline

Cardiogenic shock definitions

Cardiogenic shock fundamentals

Scales (SCAI vs INTERMACs)

Demographics & Outcomes

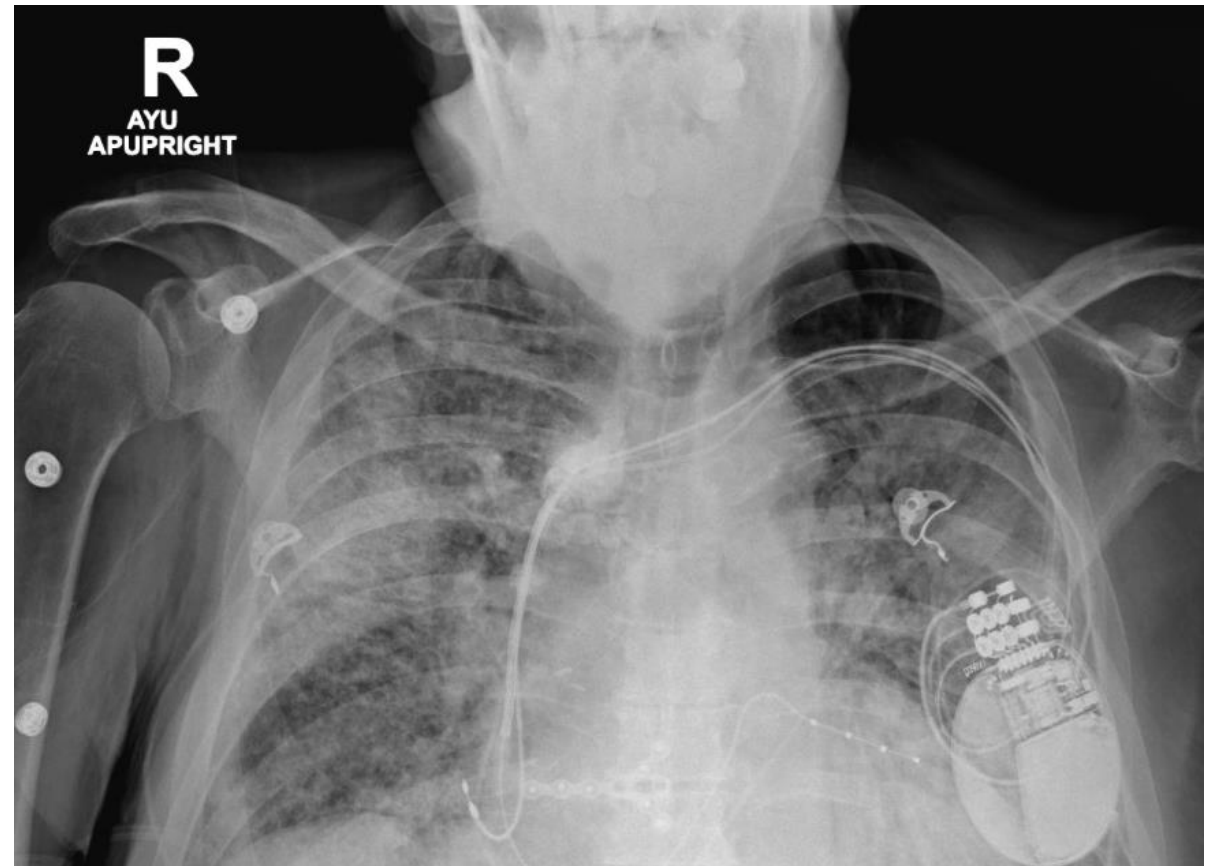
Management

Case 1 –

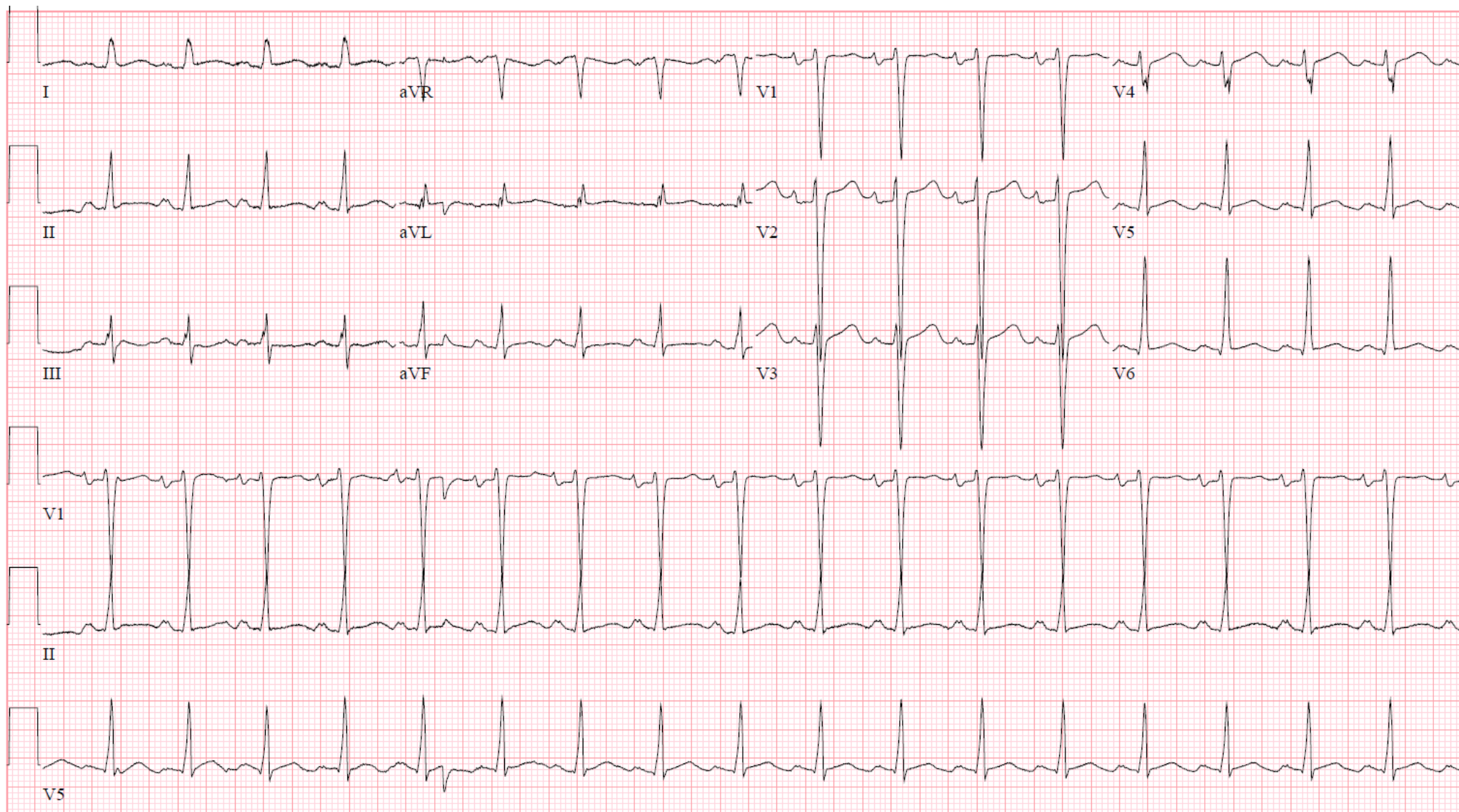
A 45-year-old man with a history of CAD with myocardial infarction presents with several days of lower extremity swelling, shortness of breath, chest pain and vomiting.

At rest, he appears unwell, tachypneic (RR >20 breaths/minute), tachycardic (130 bpm) and hypotensive (BP 75/50). 3+ lower extremity swelling and elevated JVP.

His labs are notable for a lactic acidosis, acute kidney injury and elevated liver function tests.



Case 1 – ECG

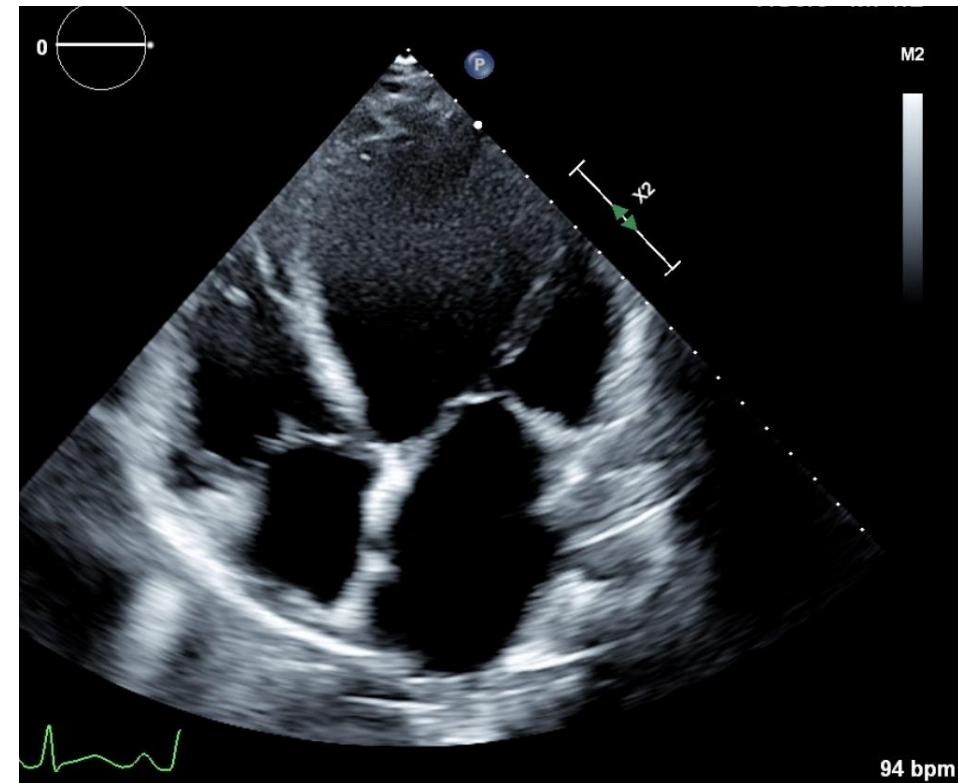
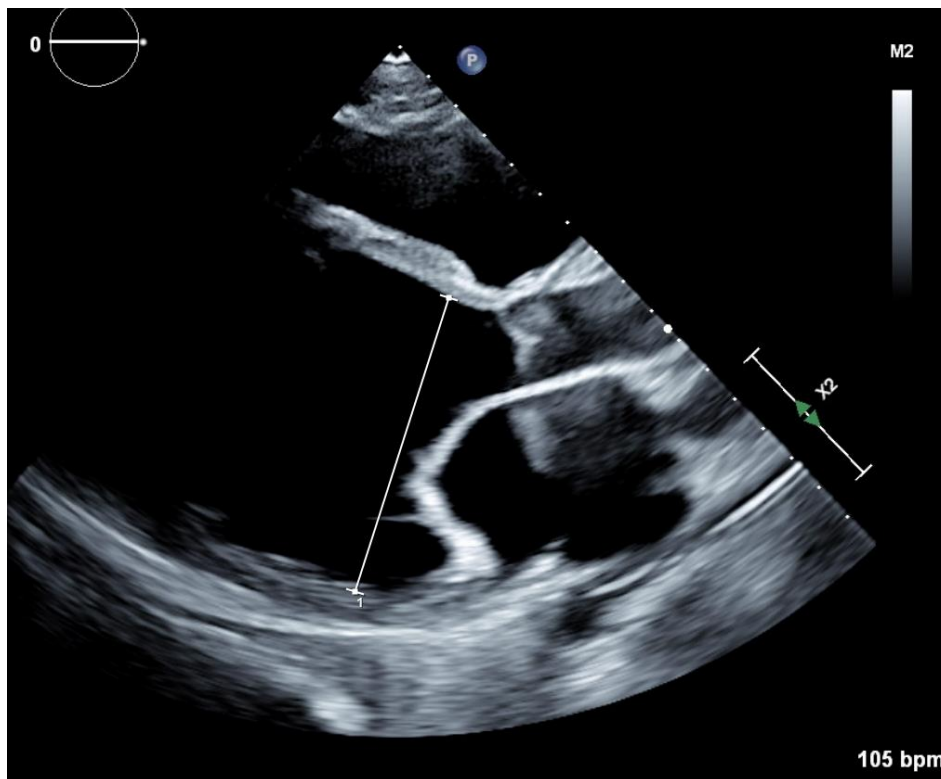


Case 1 –

Point of care cardiac ultrasound

LVEF ~15%, severely dilated (7.5 cm LVEDD)

Aortic and mitral valve open well



Case 1 –

Diagnosis – Dilated cardiomyopathy with cardiogenic shock

Immediate treatment

IV diuretics

Start IV dobutamine

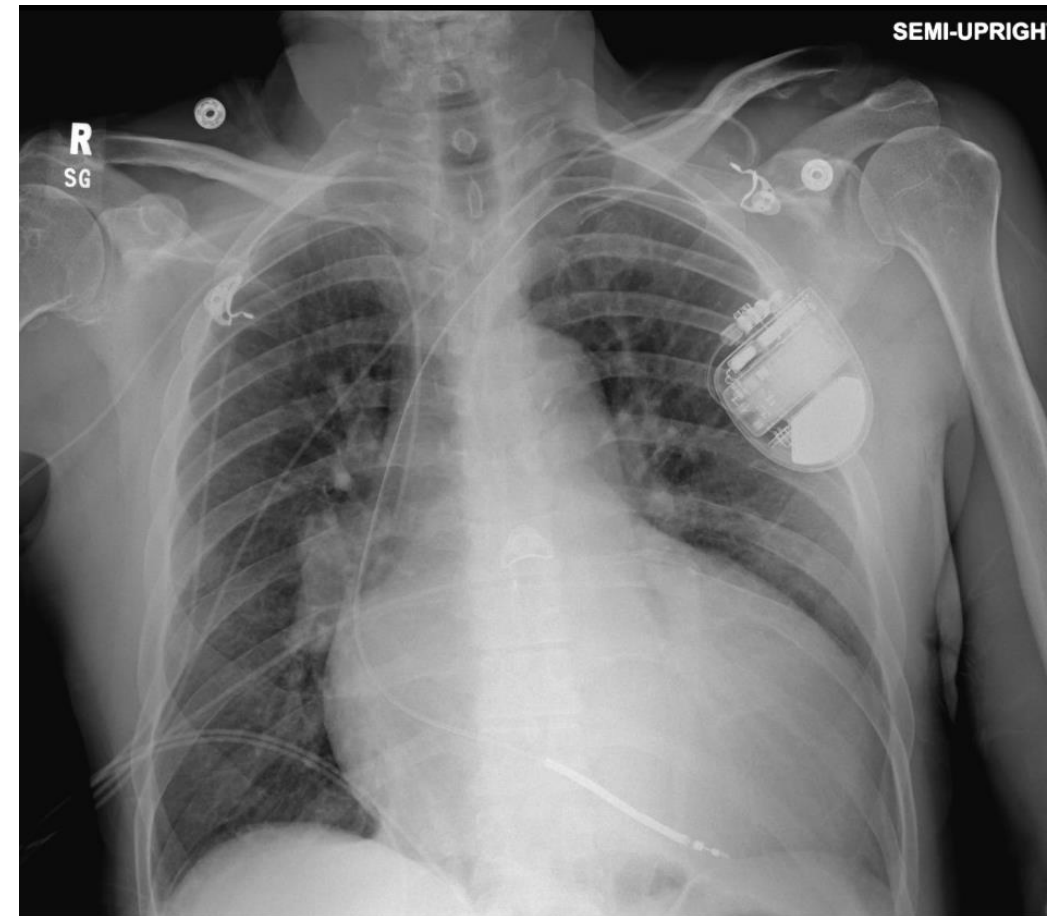
Add norepinephrine or vasopressin if MAP is <65 mmHg

Cases 2 –

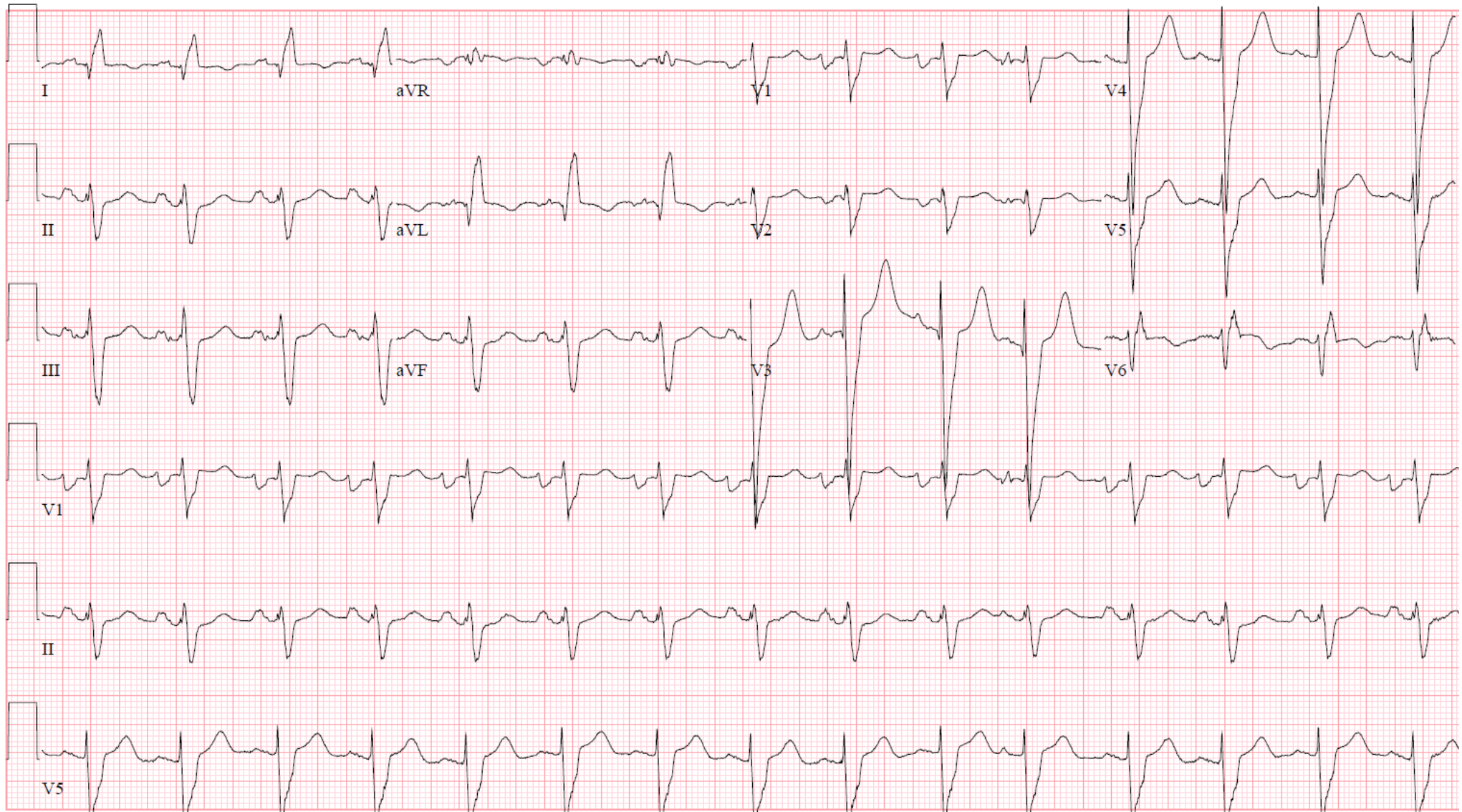
A 65-year-old man with a history of hypertension presents with several weeks of lower extremity swelling, shortness of breath, chest pain and abdominal pain.

At rest, he appears restless, tachypneic (RR >20 breaths/minute), tachycardic (110 bpm) and normotensive (BP 175/130). +S4, lower extremity swelling and elevated JVP.

His labs are notable for an acute kidney injury and elevated liver function tests.



Case 2 – ECG

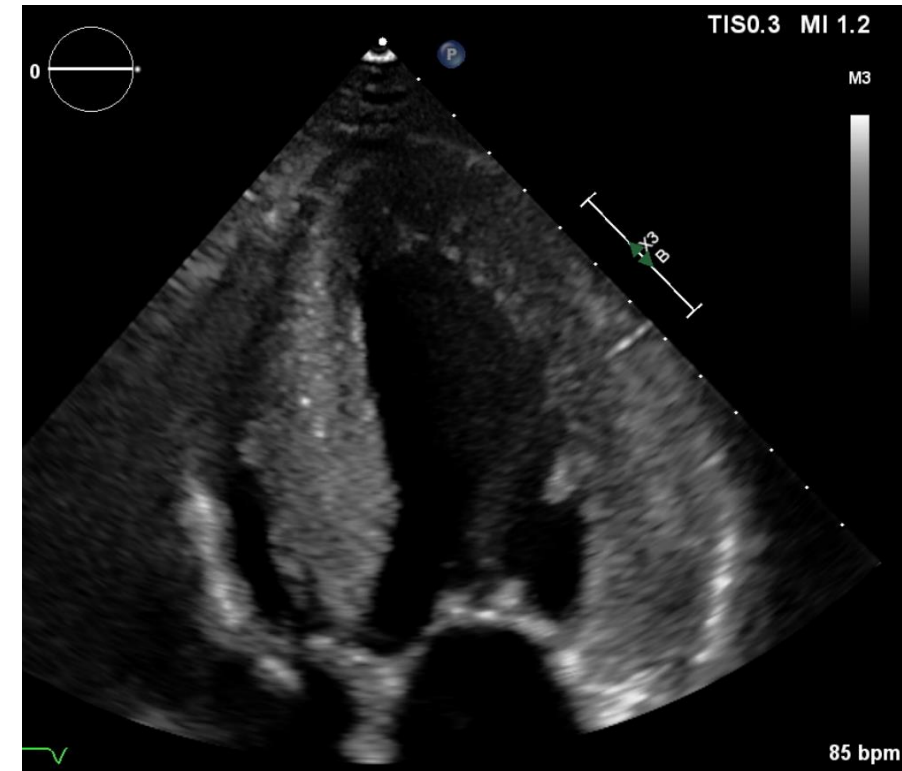
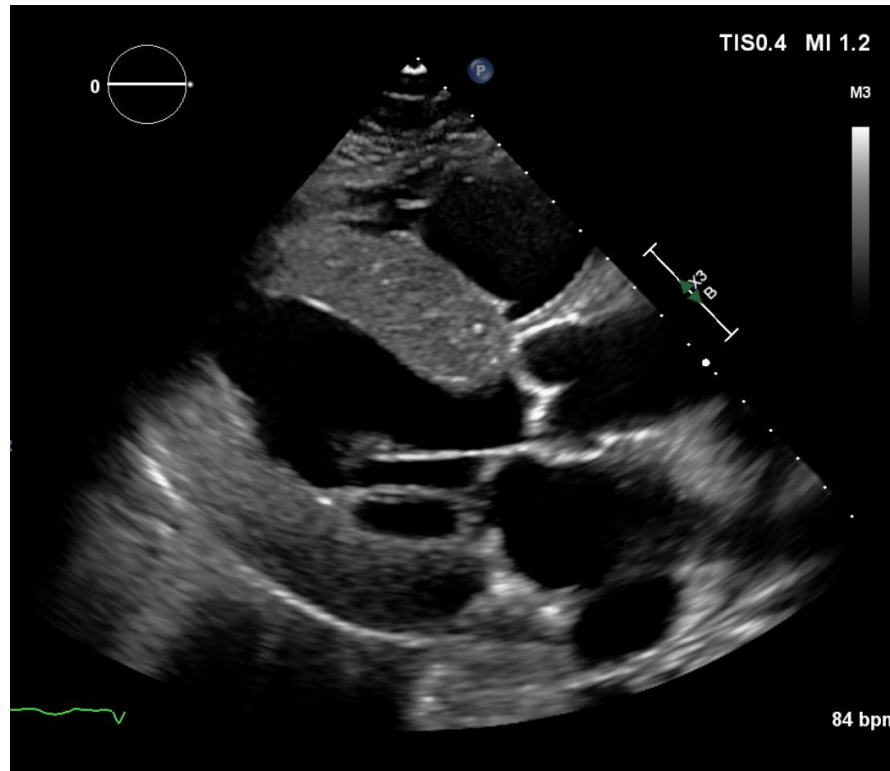


Case 2 –

Point of care cardiac ultrasound

LVEF ~30%, severe concentric hypertrophy (thickening)

Aortic and mitral valve open well



Case 2 –

Diagnosis – Restrictive cardiomyopathy (severe thickening)
Related to hypertension or hATTR

Immediate treatment

IV diuretics

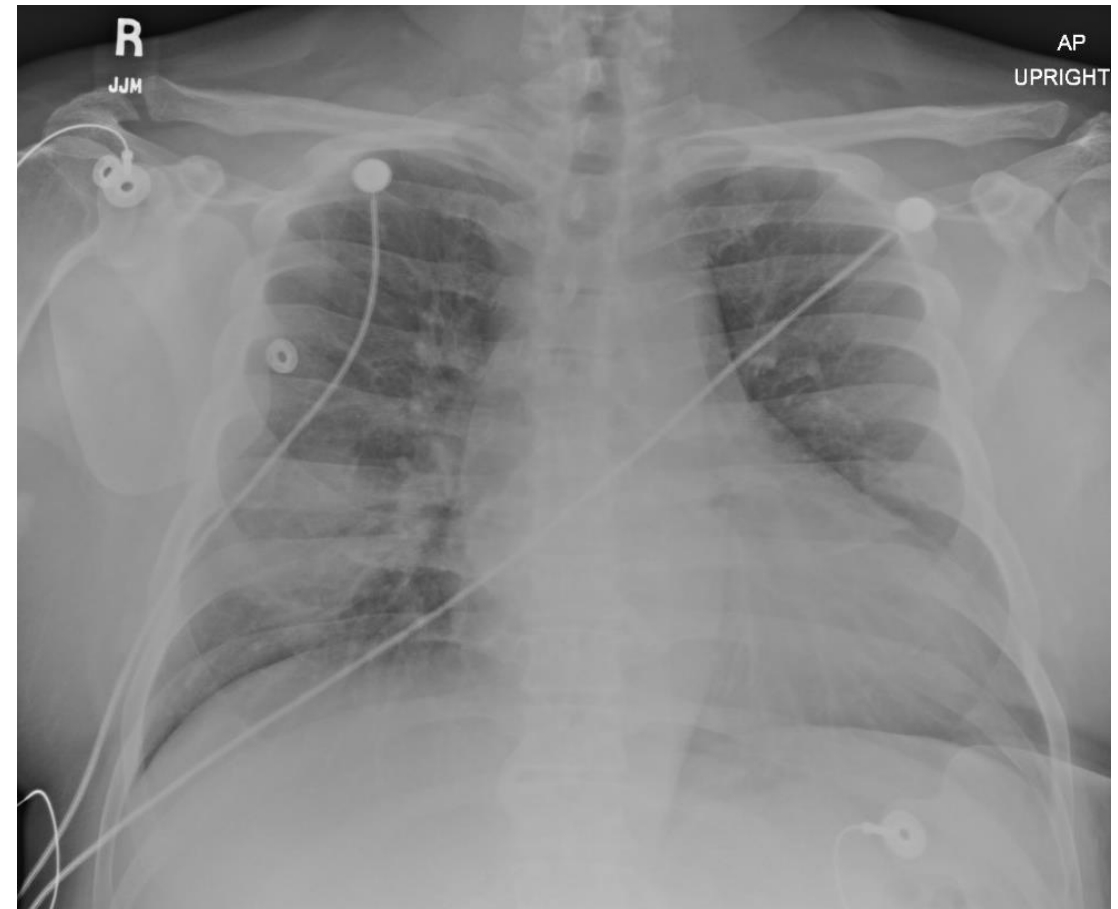
Medications to reduce blood pressure (ACE/ARB)

Case 3 –

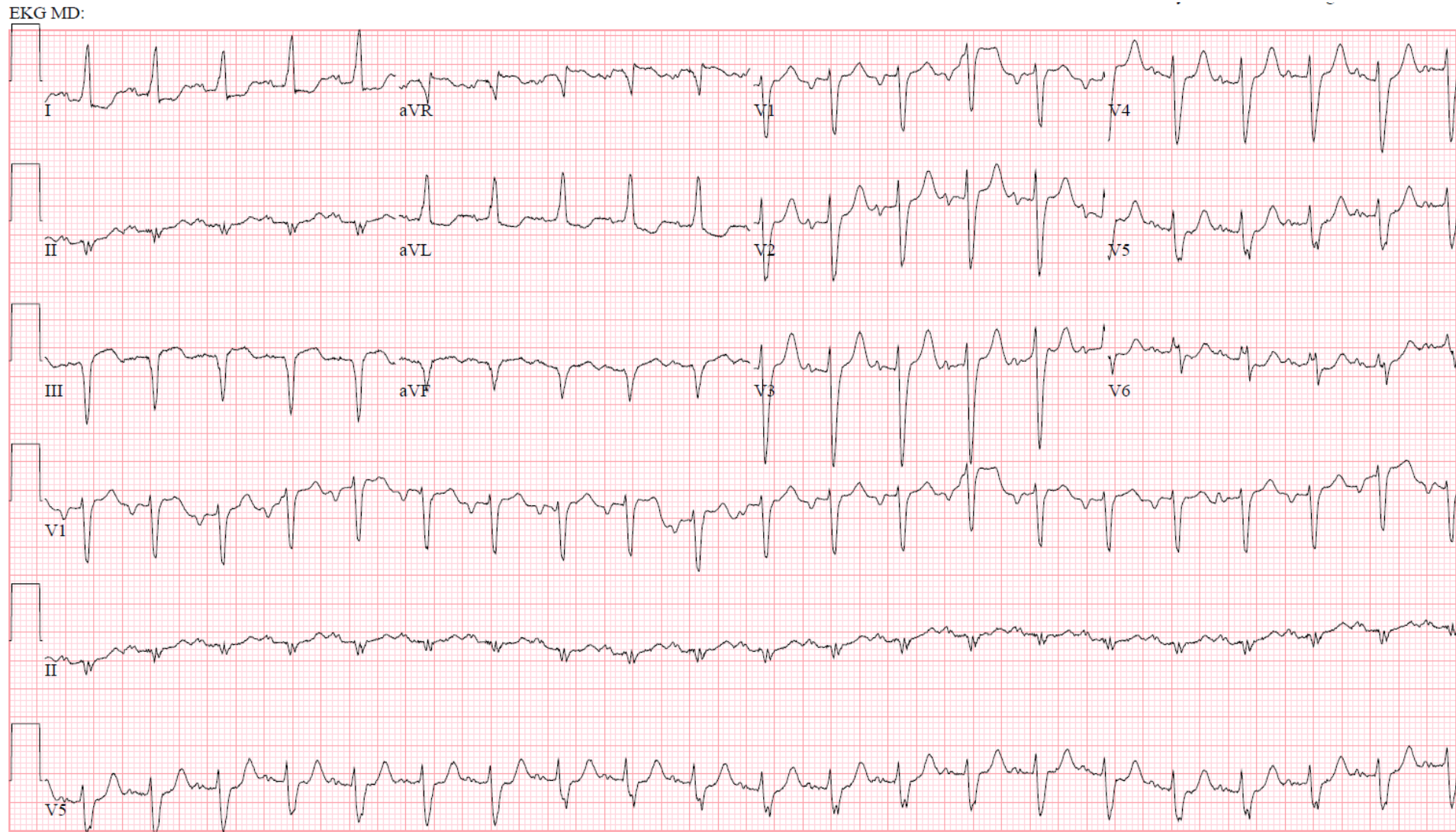
A 55-year-old man with a history of hypertension and smoking presents with 2 hours of chest pain, shortness of breath, and nausea.

At rest, he appears uncomfortable with normal sinus rhythm (HR 80 BPM), and hypotensive (BP 75/30). +Rales, no lower extremity swelling and normal JVP.

His labs are pending.

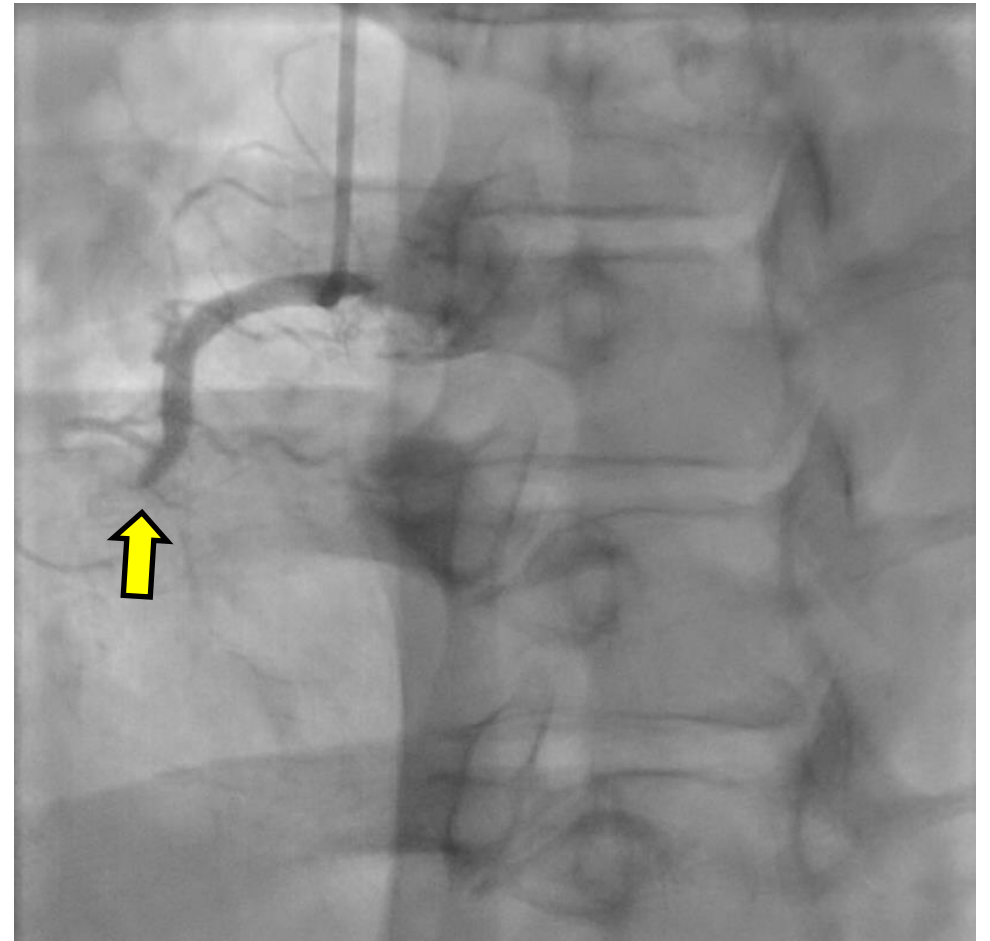
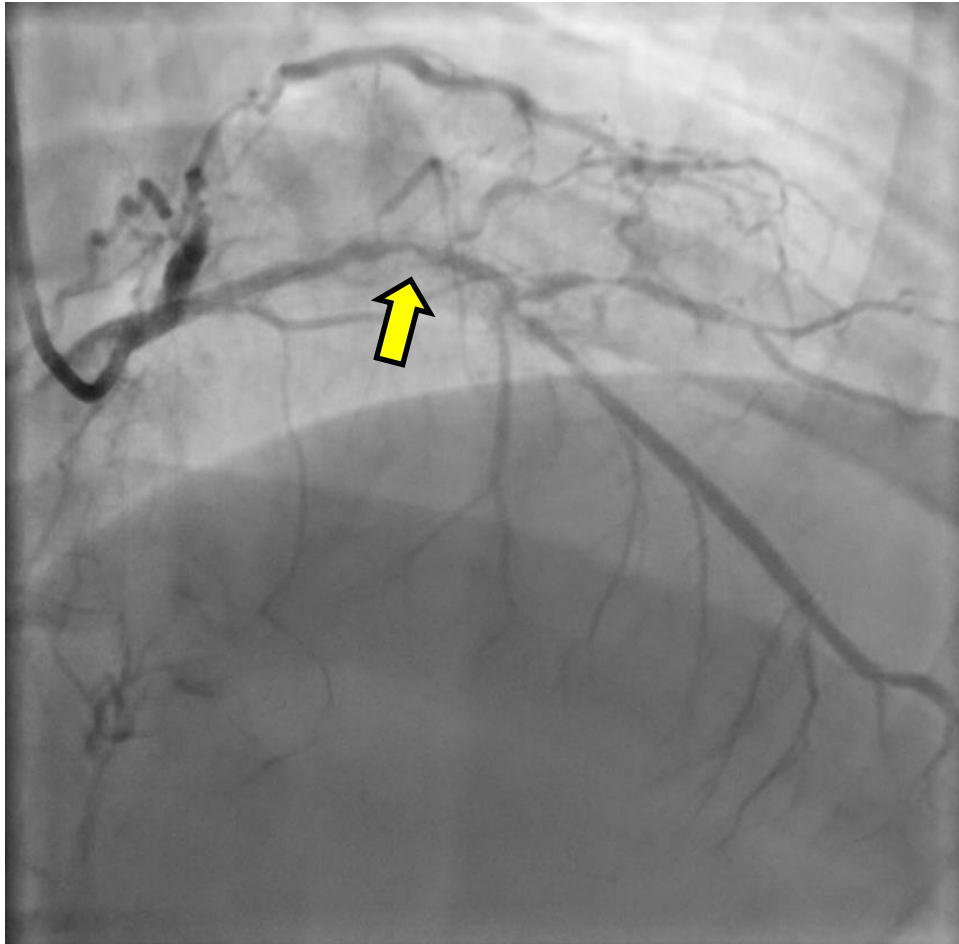


Case 3 – ECG



Case 3 – Coronary angiography

LAD with severe stenosis in mid portion (left image)
Right coronary artery totally occluded (right image)



Case 3 –

Diagnosis – ST elevation myocardial infarction

Immediate treatment

Emergent reperfusion – left heart catheterization or tPA

IV diuretics (rales)

Norepinephrine or vasopressin if MAP <65 mmHg

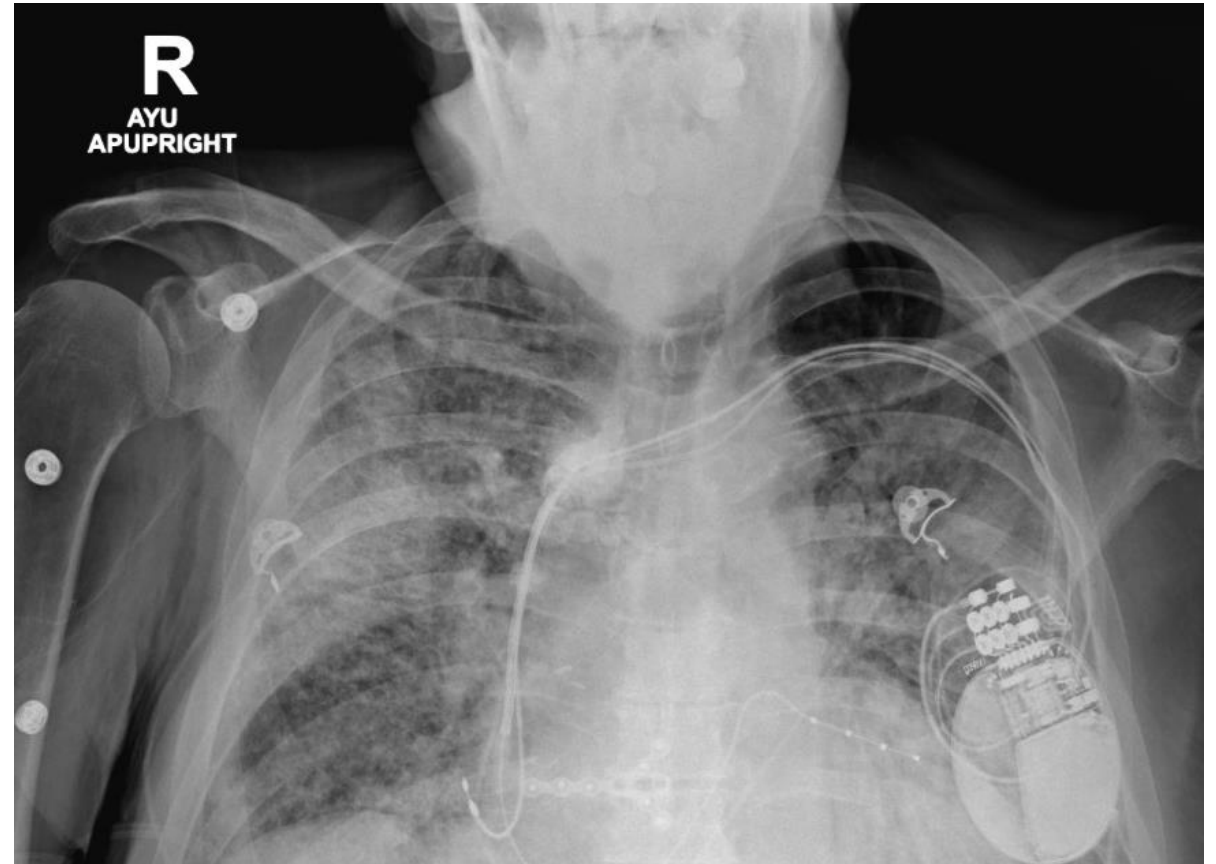
If shock post reperfusion, dobutamine or intra-aortic balloon pump

Case 4 –

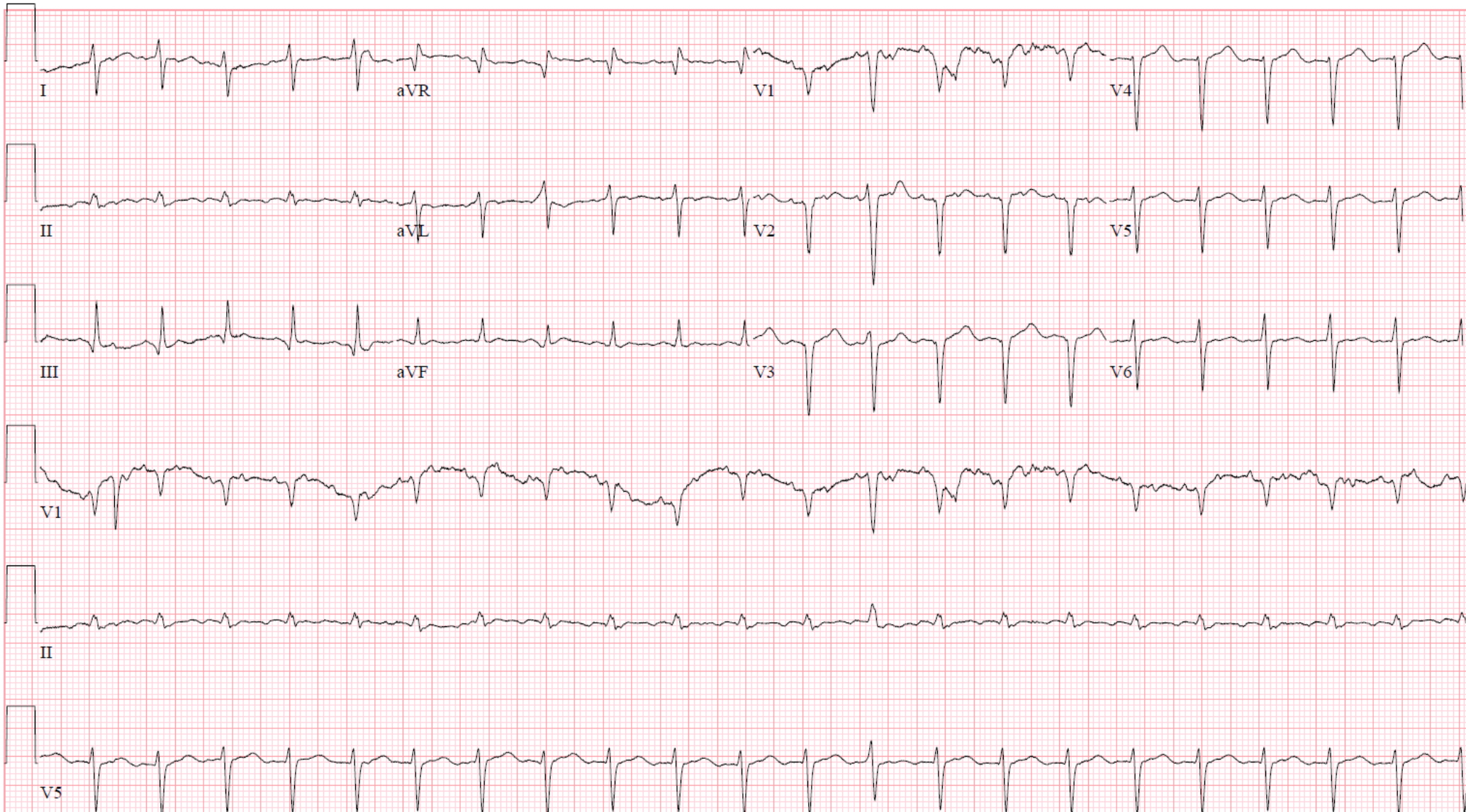
A 60-year-old woman with a history of hypertension presents with 2 months of chest pain, shortness of breath, and nausea.

At rest, she appears uncomfortable with atrial flutter at 2:1 (HR 145 BPM), and normotensive (BP 115/95). +Rales, 2+ lower extremity swelling and elevated JVP.

His labs are notable for lactate of 2.5, acute liver injury and elevated creatinine (~2.5).



Case 4 – ECG



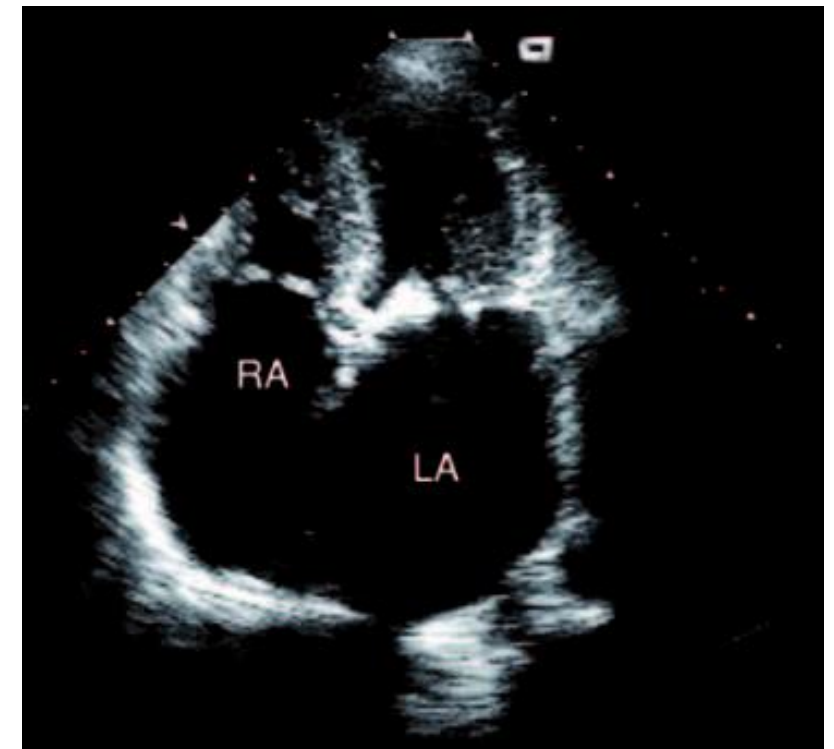
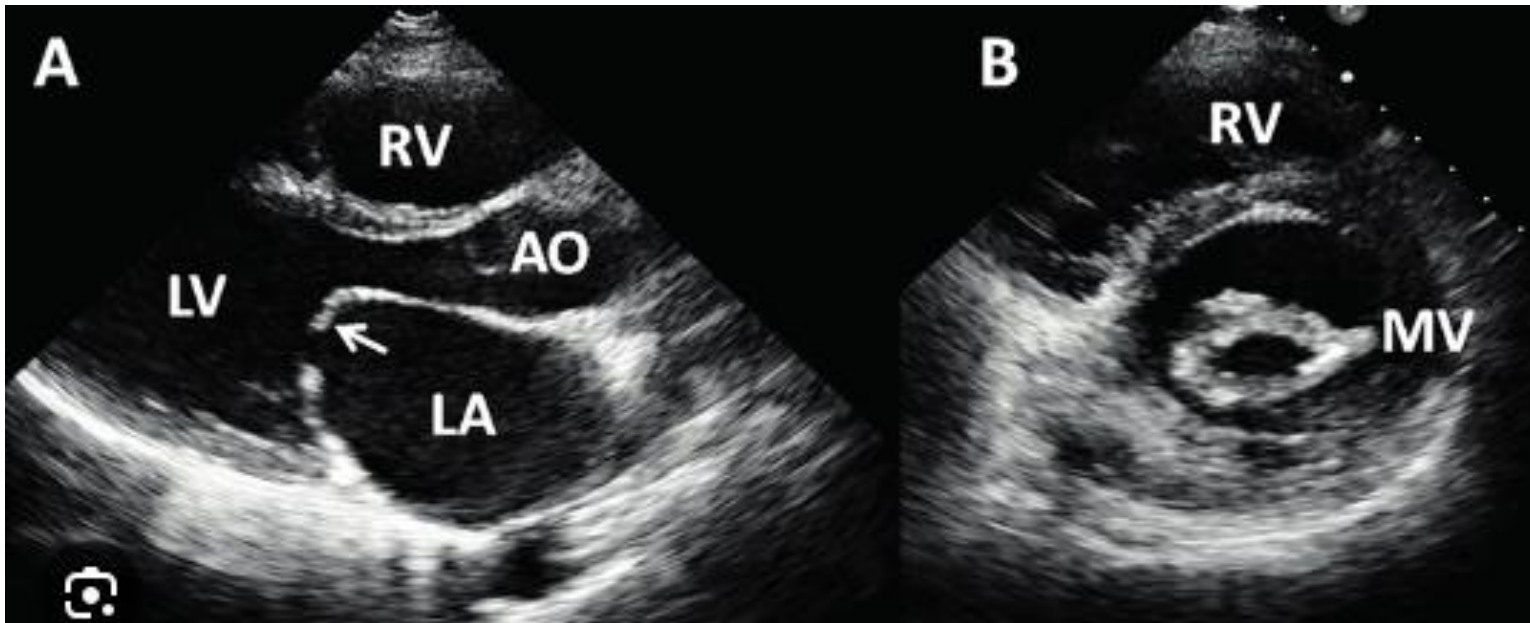
Case 4 –

Point of care cardiac ultrasound

LVEF ~50%, concentric hypertrophy (thickening)

Aortic valve opens well. Mitral valve is heavily calcified with small opening

Massive left atrium



Case 4 –

Diagnosis – Severe mitral stenosis with cardiogenic shock (rheumatic valve)

Immediate treatment

IV diuretics

Beta-blockers to slow heart rate

Amiodarone to slow heart rate & rhythm control (ideally <70 bpm)

Therapeutic anticoagulation (for possible cardioversion)

Consider cardioversion

Outline

Cardiogenic shock definitions

Cardiogenic shock fundamentals

Scales (SCAI vs INTERMACs)

Demographics & Outcomes

Management

Summary

Diagnosis of cardiogenic shock can be tricky

Relying on lactate is a sometimes fool's errand (it can be helpful)

Recipe to shock management highly dependent on the patient

Urgent *correct* treatment (within 2 hours) is needed

ACS shock carries a higher mortality relative to ADHF

In-patient shock mortality ~40-50%

Question 1

A 35-year-old woman with a history of moderate-to-severe mitral stenosis presents with worsening shortness of breath, sinus tachycardia (HR 140 bpm), and a blood pressure of 150/80 mmHg. She is noted to have an acute kidney injury (creatinine 1.0 --> 2.5), elevated lactate and elevated liver function tests (previously normal). An echocardiogram is notable for normal right and left ventricular systolic function with significant mitral stenosis. The **most appropriate immediate management** of her cardiogenic shock includes:

- A. Intravenous diuretics and therapeutic anticoagulation
- B. Intravenous diuretics and ACE-inhibitor administration
- C. Intravenous diuretics and hydralazine administration
- D. Intravenous diuretics and beta-blocker administration**
- E. ACE-inhibitor administration and beta-blocker administration

Question 2

A 45-year-old man with a history of CAD with myocardial infarction and ischemic cardiomyopathy presents with several days of lower extremity swelling, shortness of breath, chest pain and vomiting. At rest, he appears unwell, tachypneic (respiratory rate >20 breaths/minute), tachycardic (130 bpm) and hypotensive (BP 75/50). His labs are notable for a lactic acidosis, acute kidney injury and elevated liver function tests. A point of care cardiac ultrasound is notable for a left ventricular fraction <20%. An ECG does not demonstrate ST elevation or depression. The **most appropriate immediate management** of her cardiogenic shock includes:

- A. Initiation of dobutamine and beta-blocker administration
- B. Initiation of dobutamine and intravenous diuretics
- C. Initiation of milrinone and intravenous diuretics
- D. Intravenous diuretics and ACE-inhibitor administration
- E. Intravenous diuretics and beta-blocker administration



UT Southwestern
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Questions or Comments?!