



HARVARD MEDICAL SCHOOL  
TEACHING HOSPITAL

# COVID and the Heart

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*Disclosures: Research grant from Anumana; Consultant for Abbott, Bristol-Myers Squibb, NeuTrace, WorldCare Clinical, Medtronic, Moderna, Pfizer*



MASSACHUSETTS  
GENERAL HOSPITAL

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HEART CENTER**

# Objectives

- #1:** Better understand the physiology of COVID-19 infection.
- #2:** Identify the most common cardiac issues in patients hospitalized with COVID-19.
- #3:** Better understand the impact of heart disease on COVID-19 outcomes.

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# Clinical Case Description

## HPI:

72-year-old man with paroxysmal AF with PVI in 2017 and subsequent recurrence, maintained on sotalol. Reports productive cough, dyspnea, and diarrhea starting on 1/10/2021. Admitted to MGH 1/14/21.

## PMH:

- PAF, PVI in 2017 with subsequent recurrence and initiation of sotalol
- Bicuspid aortic valve

# Clinical Case Description

## Vital signs:

T = 36.4C BP = 116/80mmHg HR = 95 bpm RR= 28 SpO2 = 100% NRB

## Physical Exam:

- General: Patient is awake and alert. Patient is oriented x3. Patient is nontoxic appearing.
  - Head: The head is normocephalic and atraumatic.
  - Eyes: The pupils are equal sized and reactive to light. The extraocular muscles are intact.
  - ENT: Patient's airway is intact.
  - Neck: Supple. Full ROM.
  - Chest/Respiratory: Respiratory effort is increased. Inspiratory wheezes appreciated.
  - Cardiovascular: The heart sounds have a normal S1/S2. The heart has a regular rate and rhythm.
  - GI/Abdomen: Abdomen is soft. The abdomen is nontender and nondistended.
  - Musculoskeletal: Patient does not have edema. Full range of motion of all extremities.
- Skin: The patient's skin is intact.
- Neurologic: The neurological exam shows no focal deficits.

# Clinical Case Description

## Labs at admission:

NTproBNP 2,444 (↑)

hs-TnT 15 (↑)

D-dimer 5,614 (↑)

Otherwise unremarkable

## TTE:

LVEF 50%

Bicuspid aortic valve, mild aortic insufficiency, aortic root size normal

Admission  
CXR



# Clinical Case Description

## Initial Treatment:

Dexamethasone: started at admit, 7-day course<sup>1</sup>

Remdesivir: started day after admit, 4-day course<sup>2</sup>

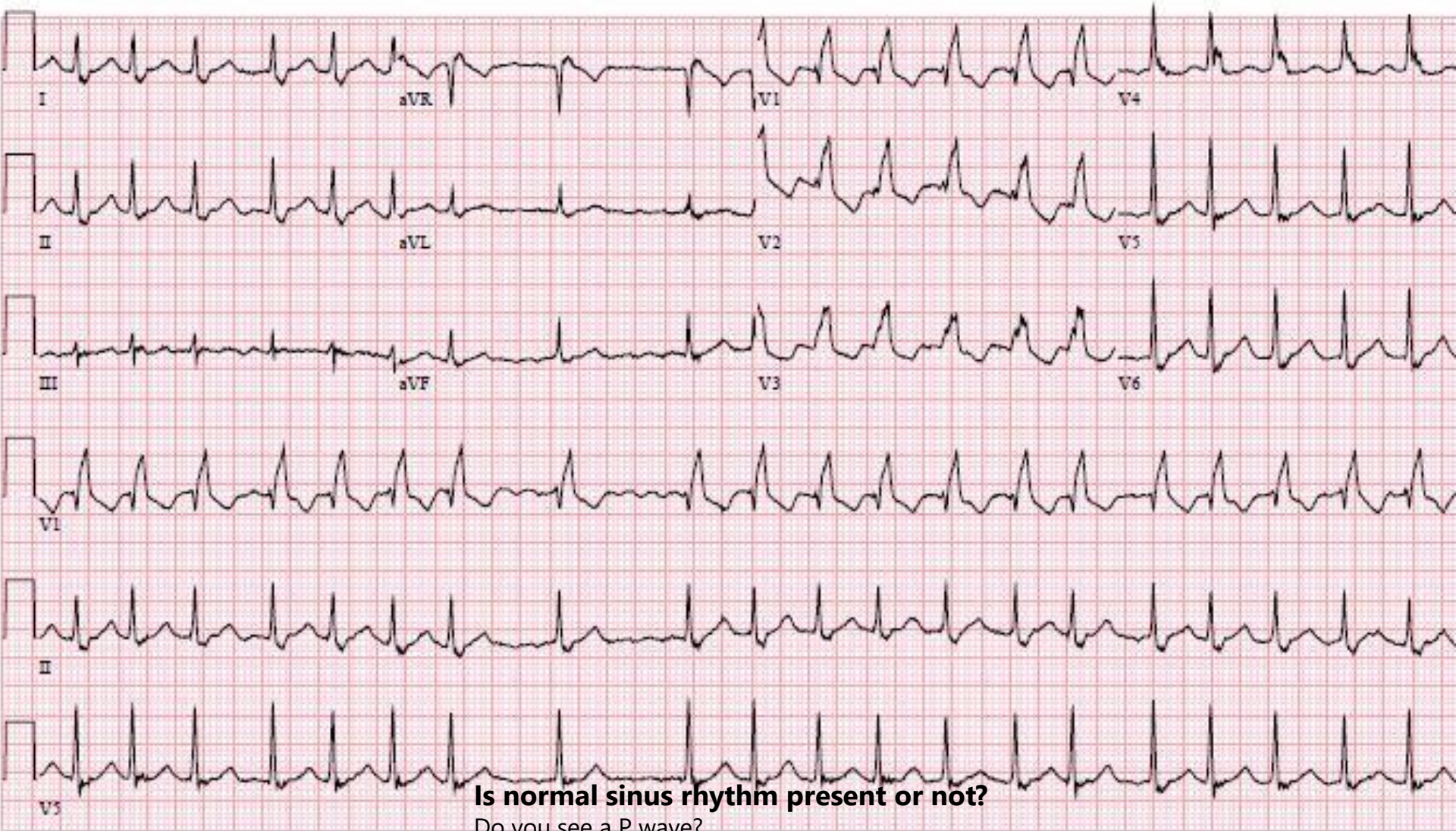
Supplemental O2 administered via NC (4L/min), O2 sats >95%

1. The RECOVERY Collaborative Group, NEJM 2020; 17 Jul: DOI: 10.1056/NEJMoa2021436

2. Beigel et al, NEJM 2020;383:1813-1826



# ECG Performed on HD#4



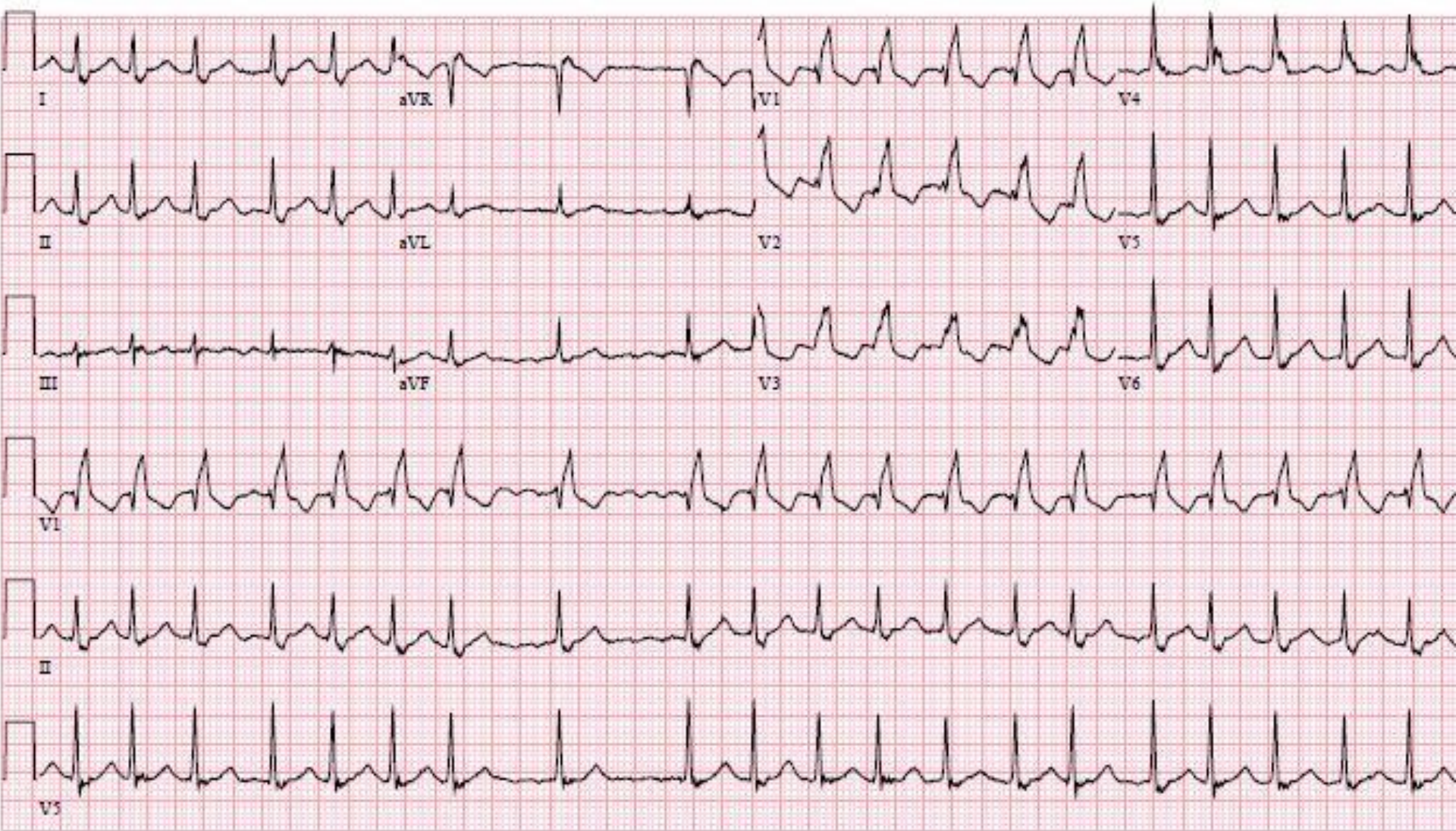
**Is normal sinus rhythm present or not?**

Do you see a P wave?

Does every P have a QRS and does every QRS have a P?

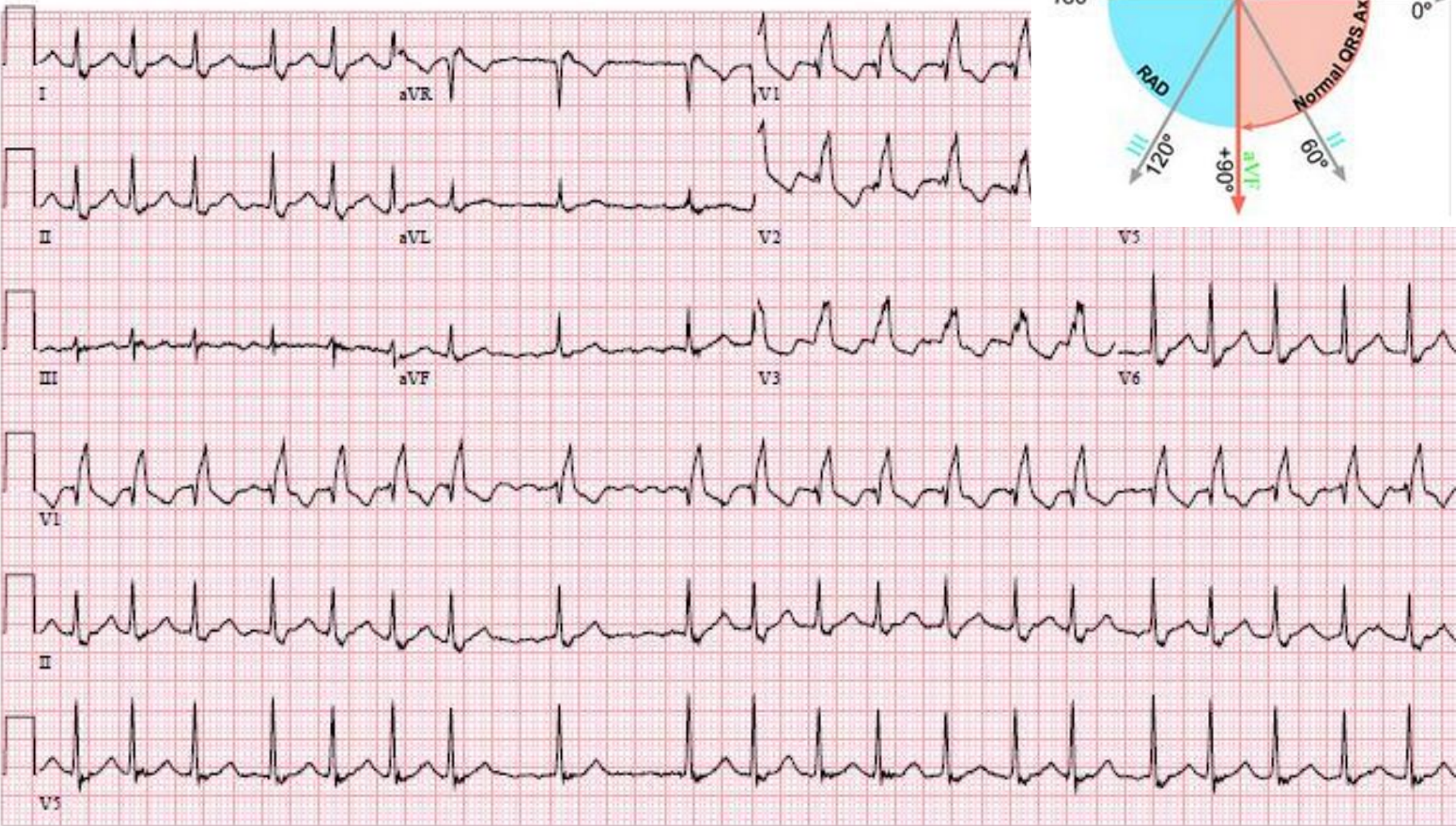
Is the axis of the P wave normal (upright in I and II)?

# ECG Performed on HD#4



**AF with RVR rate 120 bpm**

# ECG Performed on HD#4



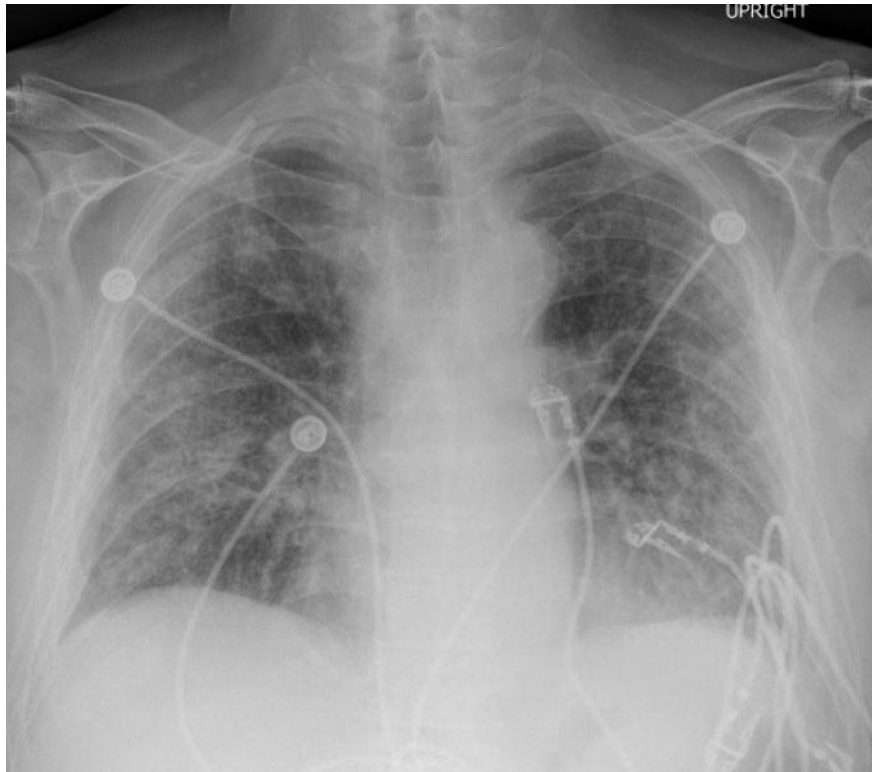
RBBB, normal axis

# Response to Treatment

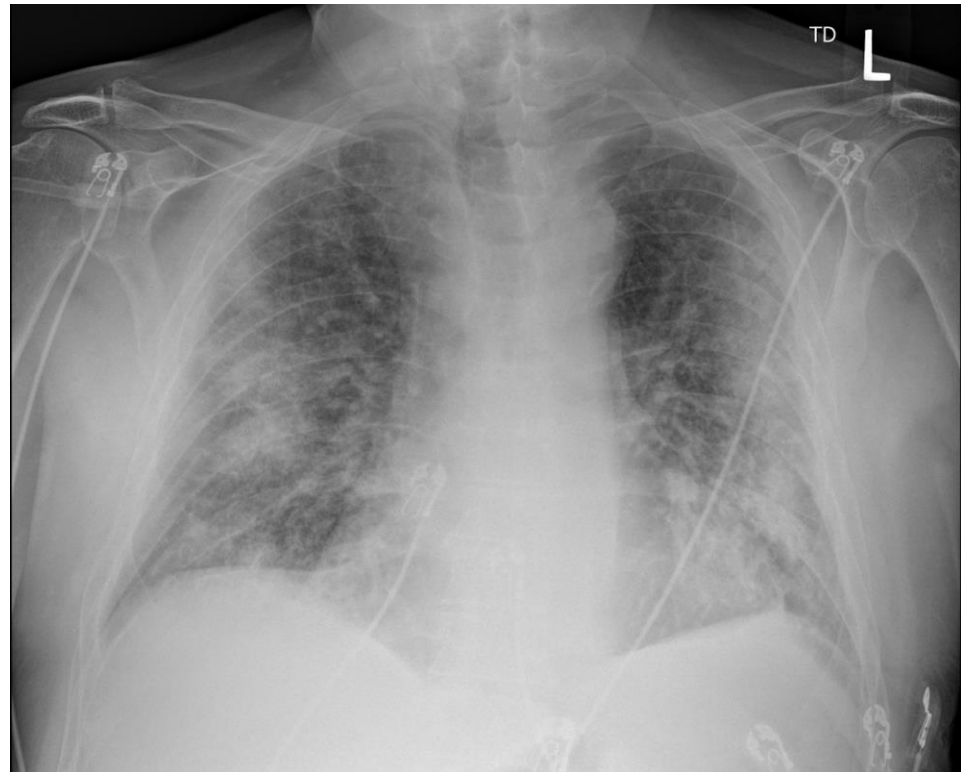
- HD#1: moderate COVID symptoms were noted
  - Supplemental O2 administered via NC (4L/min) with Os sats maintained >95%
  - Normal work of breathing
- HD#4: Atrial fibrillation recurrence noted: rates initially well-controlled but within 24 hours of admission his heart rates increased
  - Sotalol discontinued due to AKI
  - Metoprolol administered for rate control
- HD#5: Presence of AF RVR associated with progressive decline
- HD#7: acute respiratory decompensation was noted: a Rapid Response was initiated and the patient was transferred to the Cardiac Step-Down Unit

# Progressive Respiratory Decline

Admit CXR



HD#7 CXR



# Initial SDU Treatment

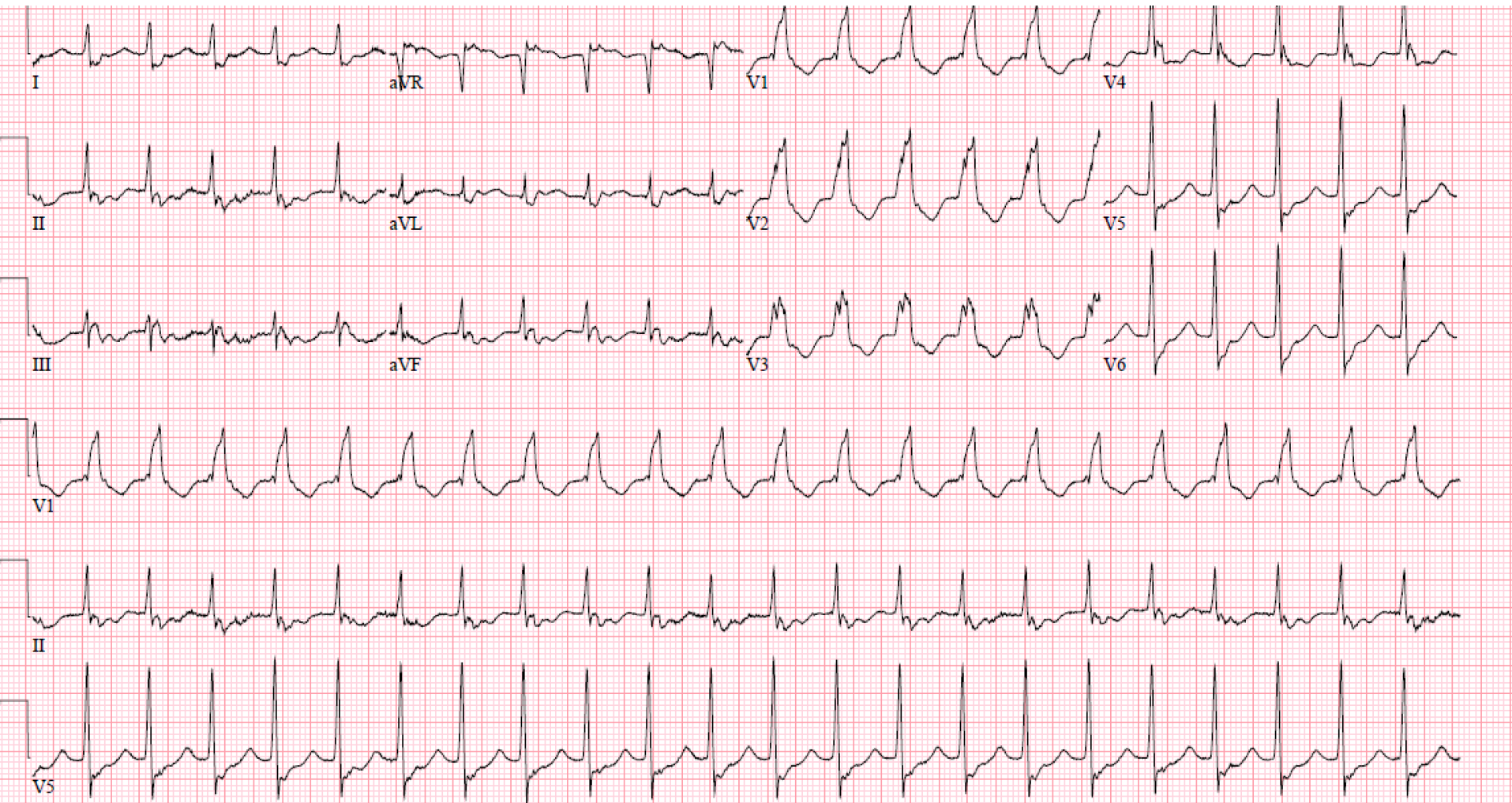
## At time of arrival:

- Decreased BP noted in the context of AF (130s/90s baseline -> 90s/60s in AF)
- Reduced O2 sats noted with increasing O2 requirement (91% on 6L NC)
- Increased work of breathing, worsening breath sounds

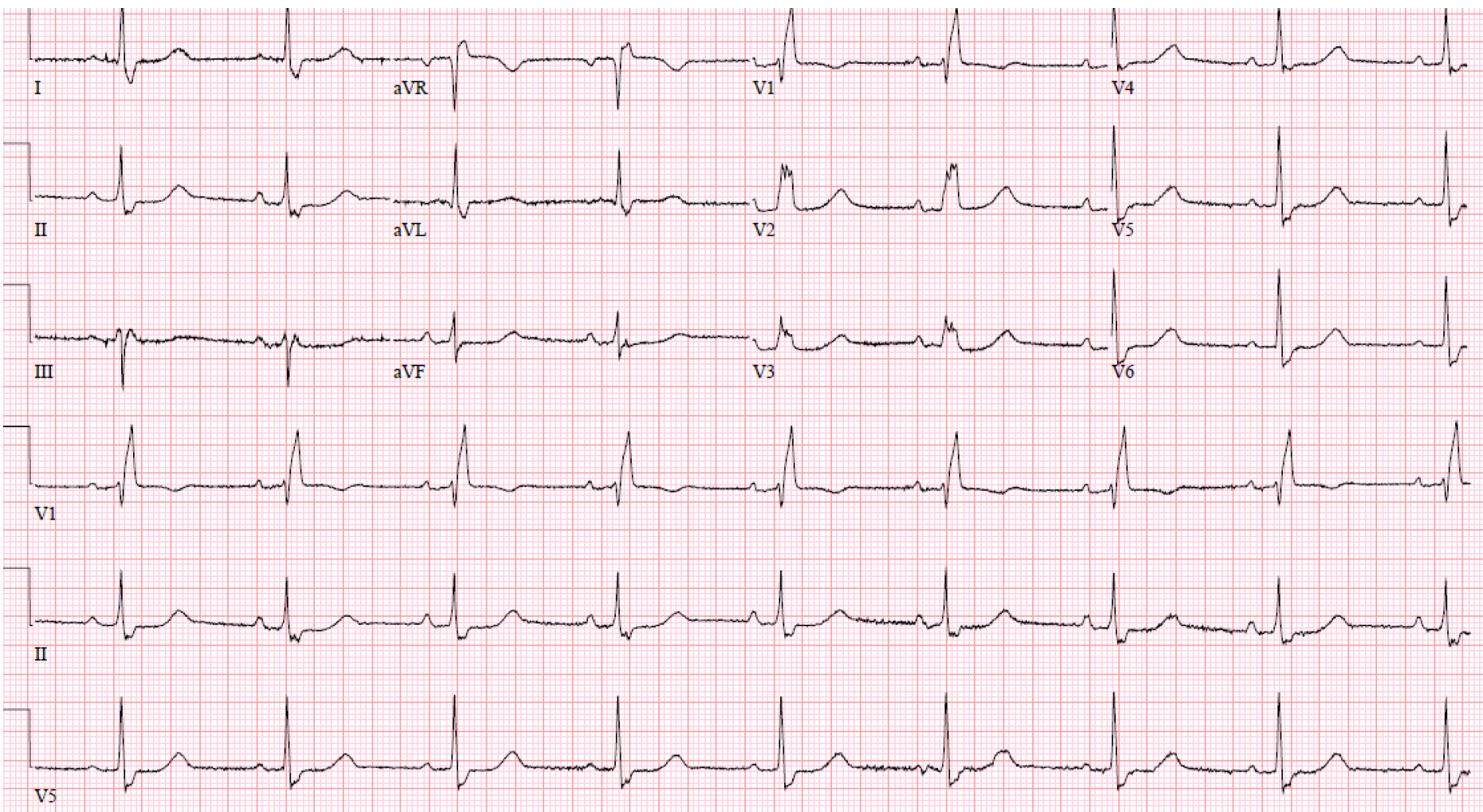
## Amiodarone IV bolus administered:

- Change in rhythm was noted

# HD#7 ECG



# HD#8 ECG



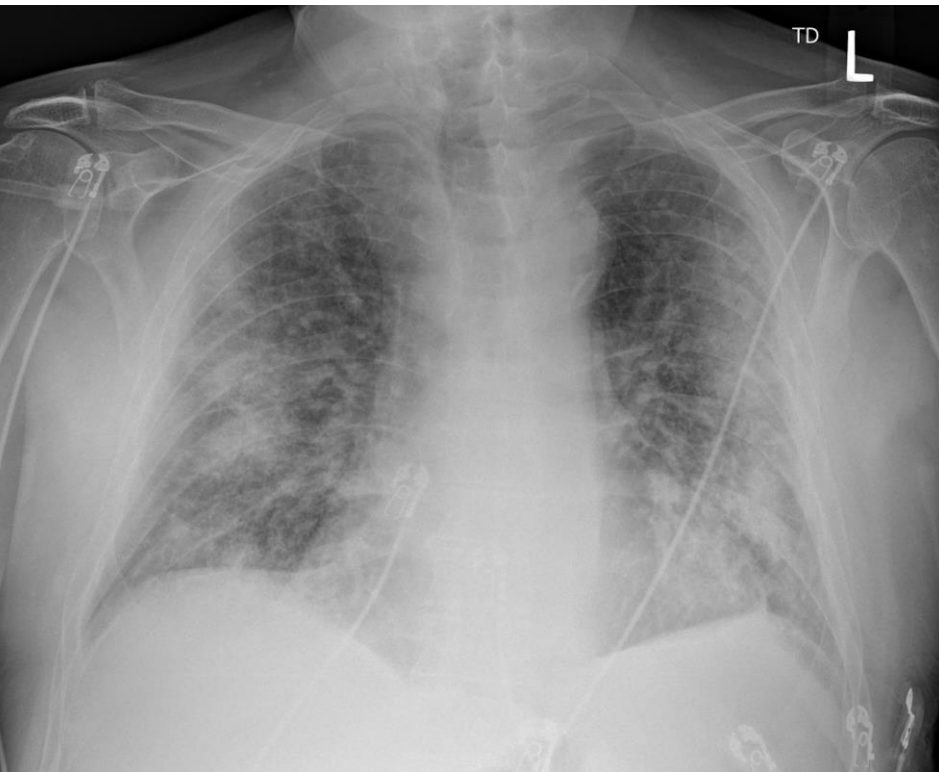


# SDU Treatment Summary

- **Amiodarone 150mg IV bolus with IV drip**
  - Remained in AFL initially with improved HR (110s-120s)
  - Brief periods of sinus rhythm observed, but AFL was predominant
  - Reduced O2 sats noted with increasing O2 requirement (91% on 6L NC)
  - Increased work of breathing, worsening breath sounds
  - Decreased BP noted in the context of AFL (130s/90s baseline -> 90s/60s in AFL)
- **Repeat amiodarone IV bolus administered**
  - Sinus rhythm restored
  - Hypotension resolved and diuresis was successful
  - Oxygen requirement decreased (on room air within 48 hours)

# Clinical Improvement in Sinus Rhythm

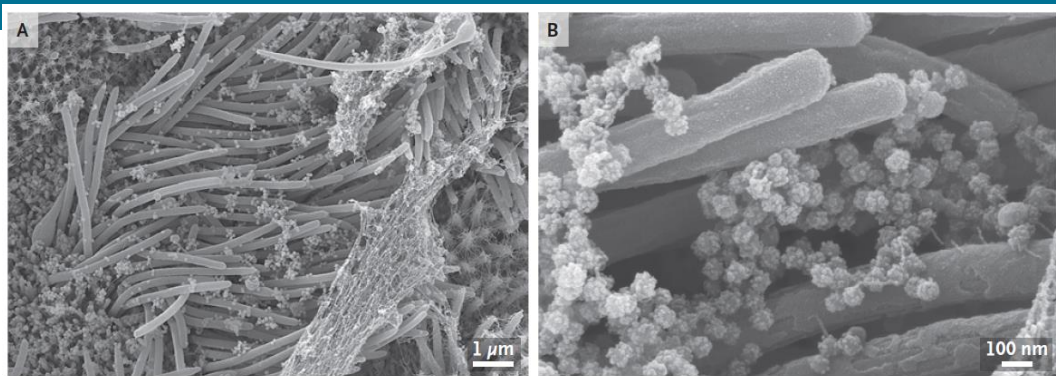
HD#7 CXR



HD#10 CXR

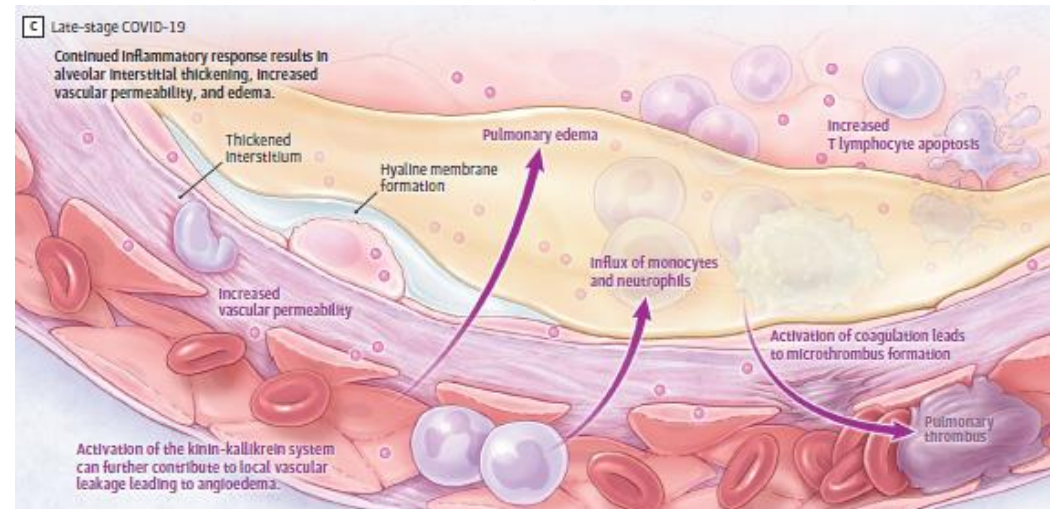


# Pathophysiology of SARS-CoV-2



Ehre C NEJM 2020: DOI 10.1056/NEJMicrm2023328

Virus infection leads to “leaky” respiratory and vascular endothelial cells



Multifocal PNA

Vascular events

- PE
- DVT
- MI
- CVA



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**#1:** Better understand the physiology of COVID-19 infection.

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# Question 1

Which of the following cardiac and pulmonary issues have been associated with COVID infection?

- A. Atrial fibrillation
- B. Ventricular tachycardia
- C. Myocarditis
- D. Pulmonary embolism
- E. All of the above

# Question 1

Which of the following cardiac and pulmonary issues have been associated with COVID infection?

- A. Atrial fibrillation
- B. Ventricular tachycardia
- C. Myocarditis
- D. Pulmonary embolism
- E. **All of the above**

# Question 2

Which of the following best describes the proportion of patients hospitalized with COVID who present with myocardial injury:

- A. 10%
- B. 25%
- C. 50%
- D. Greater than 50%

## Question 2

Which of the following best describes the proportion of patients hospitalized with COVID who present with myocardial injury:

- A. 10%
- B. 25%
- C. 50%
- D. **Greater than 50%**



# Question 3

Which of the following best describes the mortality rate for patients hospitalized with COVID who develop evidence of myocardial injury:

- A. 5%
- B. 10%
- C. 25%
- D. 35%

# Question 3

Which of the following best describes the mortality rate for patients hospitalized with COVID who develop evidence of myocardial injury:

- A. 5%
- B. 10%
- C. 25%
- D. 35%

# Question 4

Which of the following best describes the proportion of patients hospitalized with COVID who develop and atrial arrhythmia:

- A. 5%
- B. 10%
- C. 15%
- D. 20%

# Question 4

Which of the following best describes the proportion of patients hospitalized with COVID who develop and atrial arrhythmia:

- A. 5%
- B. 10%
- C. 15%
- D. 20%

# Key Cardiac Issues in this Patient


- Myocardial injury/NSTEMI
- Atrial fibrillation/flutter
- Heart failure

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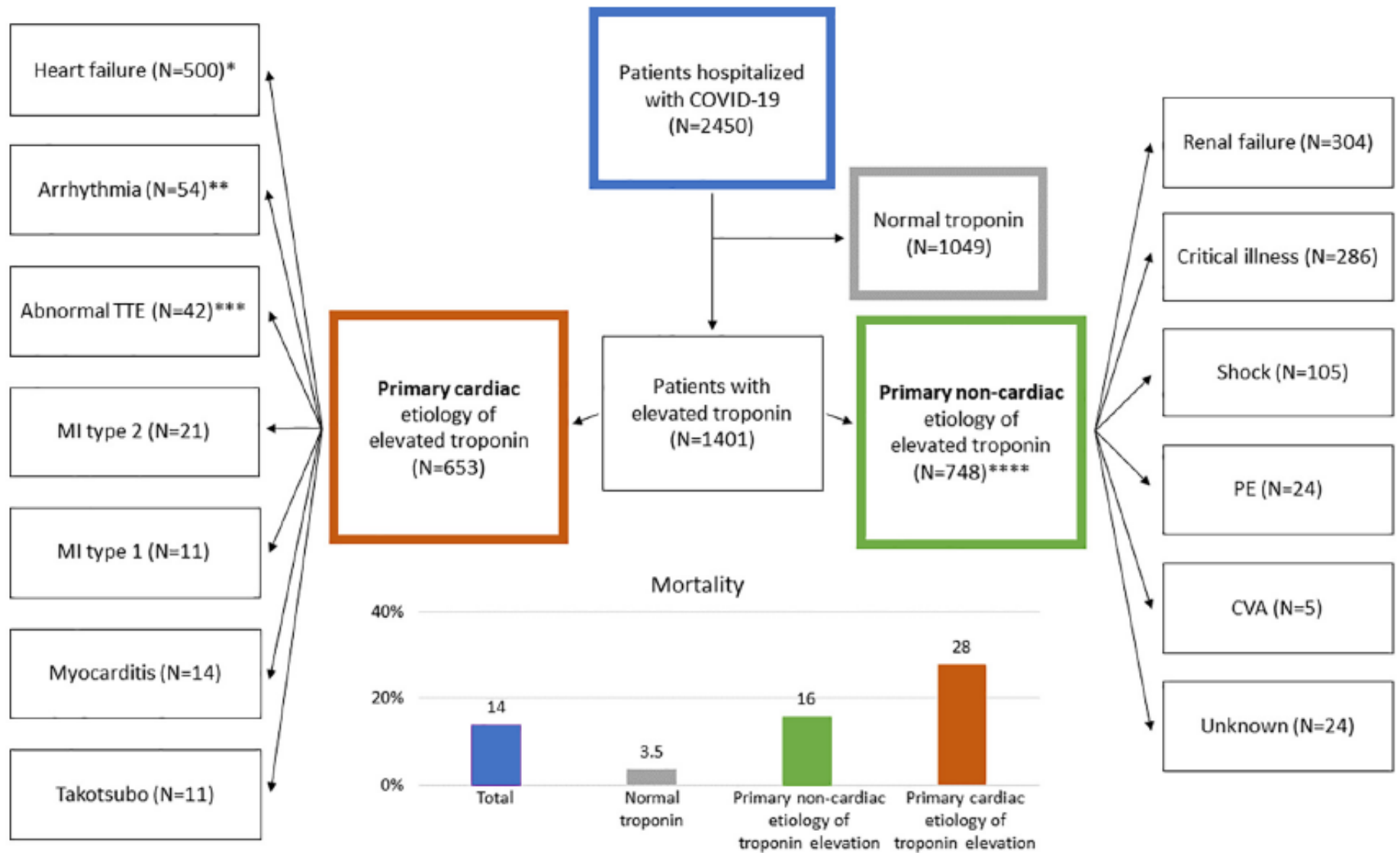
# Myocardial Injury is Common in COVID

62%



	Overall (N = 305)	Myocardial Injury (n = 190)	No Myocardial Injury (n = 115)	p Value
Demographics				
Age, yrs	63 (53-73)	66 (56-74)	58 (47-70)	0.0008
Male	205/305 (67.2)	132 (69.5)	73 (63.5)	0.28
Race				
White	174/305 (57.1)	98 (51.6)	76 (66.1)	0.10
Black	43/305 (14.1)	30 (15.8)	13 (11.3)	
Asian	27/305 (8.9)	20 (10.5)	7 (6.1)	
Unknown	61/305 (20.0)	42 (22.1)	19 (16.5)	
Hispanic ethnicity	84/304 (27.6)	56 (29.5)	28 (24.6)	0.35
Body mass index, kg/m <sup>2</sup>	28 (24.5-32.8)	29.1 (24.6-33.2)	26.5 (24.3-31.2)	0.13

Giustino G et al JACC 2020;76:2043-2055



\* Patients with acute heart failure who were not categorized as having acute MI, Myocarditis, Takotsubo or abnormal echocardiographic findings.

\*\* Patients in whom tachyarrhythmia was the only evidence of cardiac etiology.

\*\*\* Patients with echocardiographic abnormalities without another cardiac problem.

\*\*\*\* Patients with critical illness, respiratory failure or sepsis.



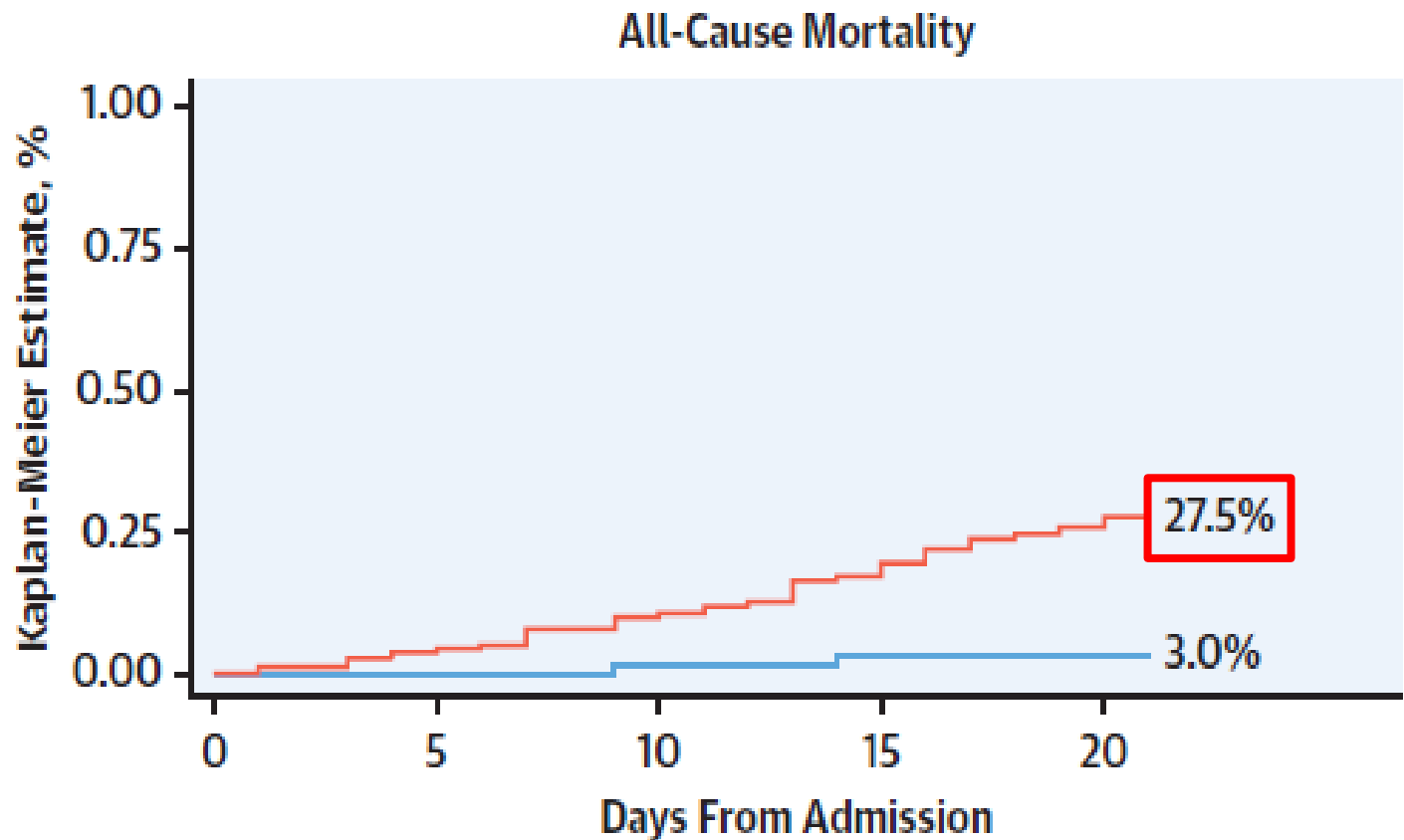
# Objectives

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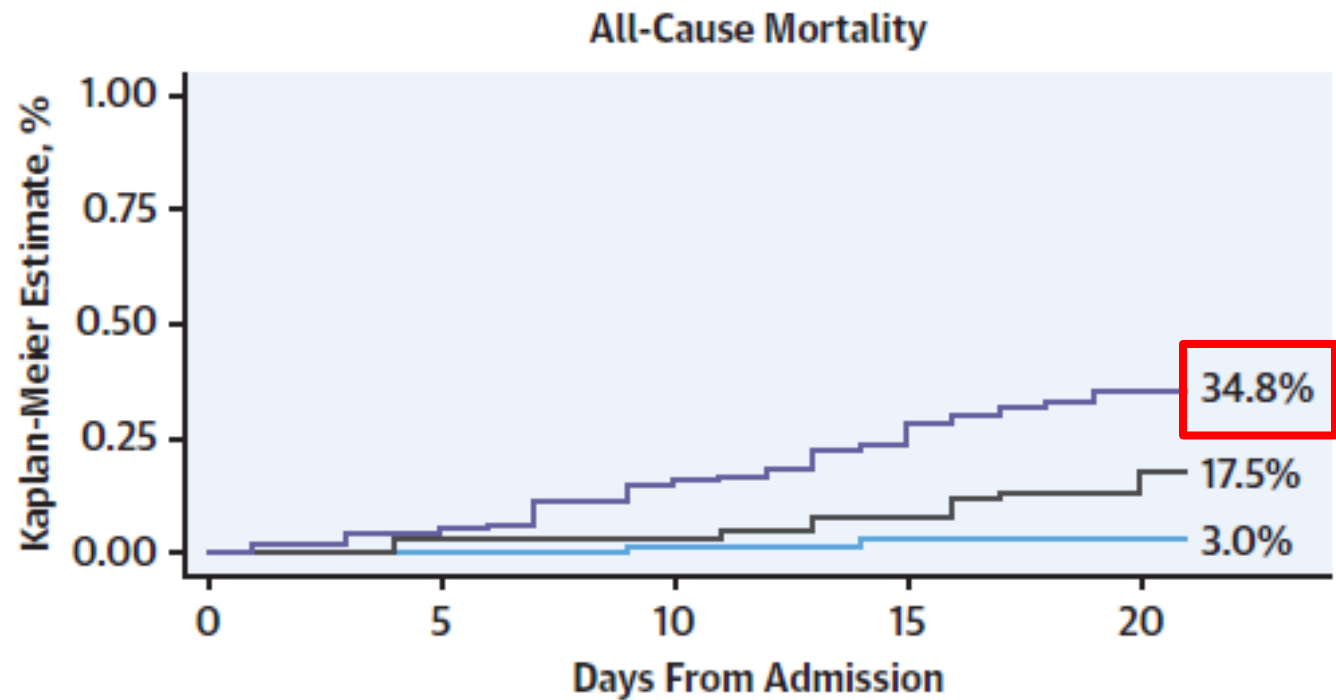
**#3:** Better understand the impact of heart disease on COVID-19 outcomes.

# Cardiac Injury in COVID Increases Mortality



<i>No. at risk</i>						
—	No Myocardial Injury	115	99	76	50	42
—	Myocardial Injury	190	173	136	103	76

# Cardiac Injury in COVID Increases Mortality



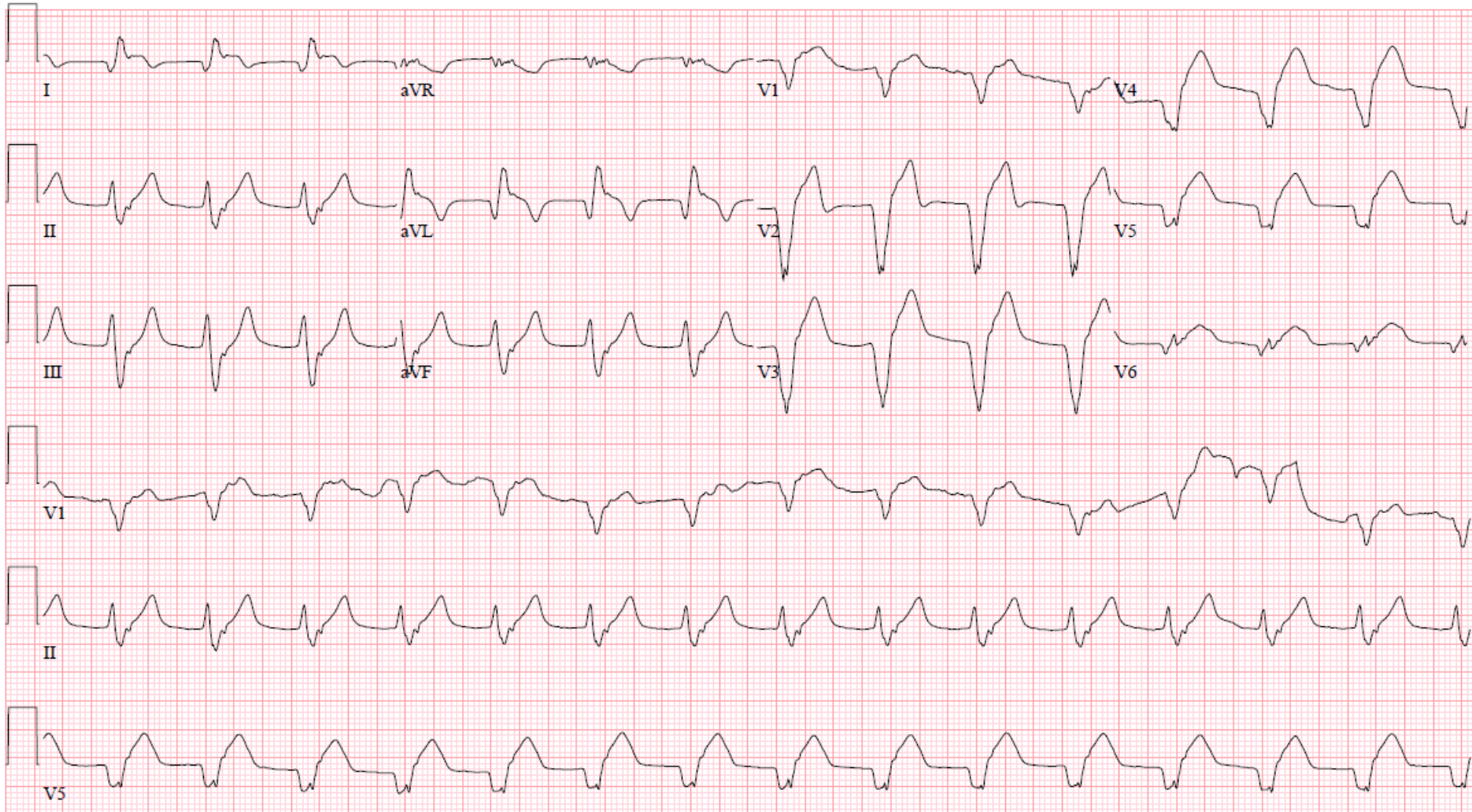
	<i>No. at risk</i>				
— No Myocardial Injury	115	99	76	50	42
— Myocardial Injury without TTE Abnormalities	70	66	63	52	40
— Myocardial Injury with TTE Abnormalities	120	107	73	51	36

# Acute Myocardial Infarction in COVID

- Myocardial injury is common in COVID-19.
- The pattern of myocardial injury/infarction in COVID-19 can be distinct from typical acute coronary syndrome.

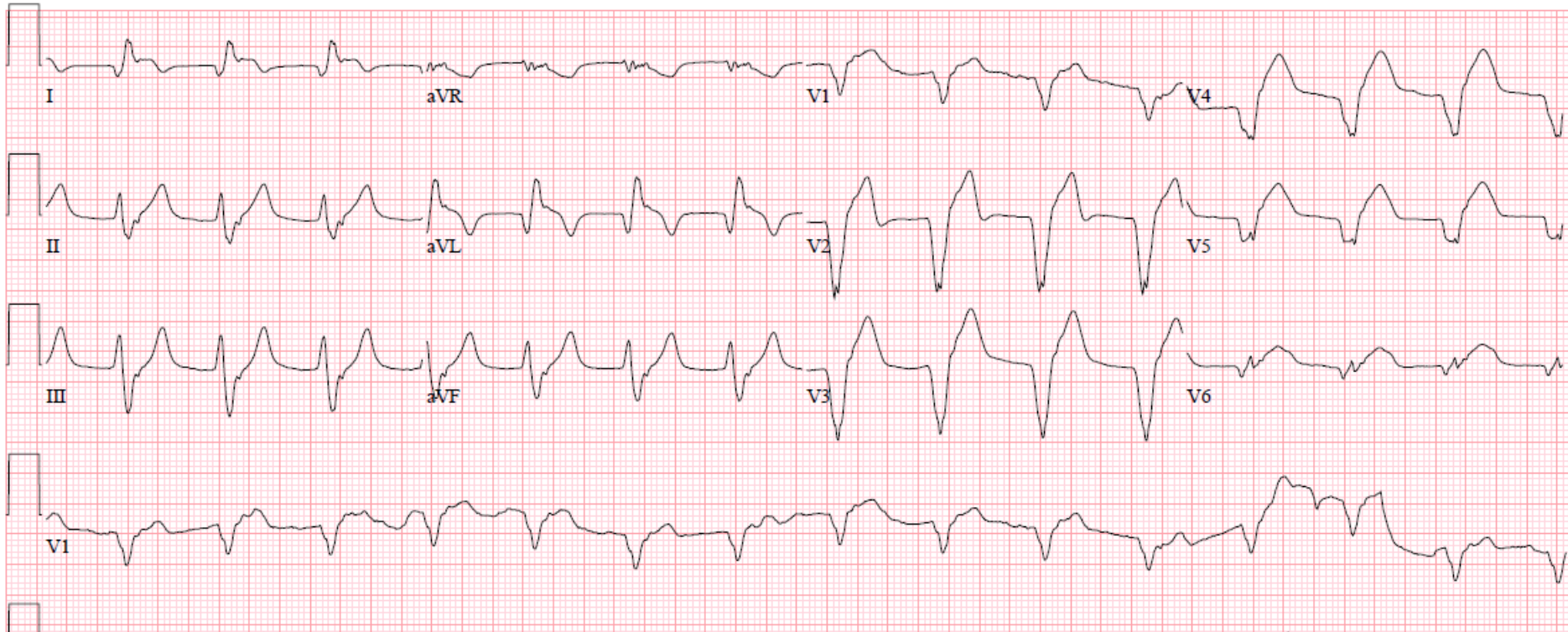
# Typical STEMI:

## 44-year-old man with sudden-onset chest pain



# Typical STEMI:

44-year-old man with sudden-onset chest pain



## ESC/ACC/AHA/WHF Criteria:

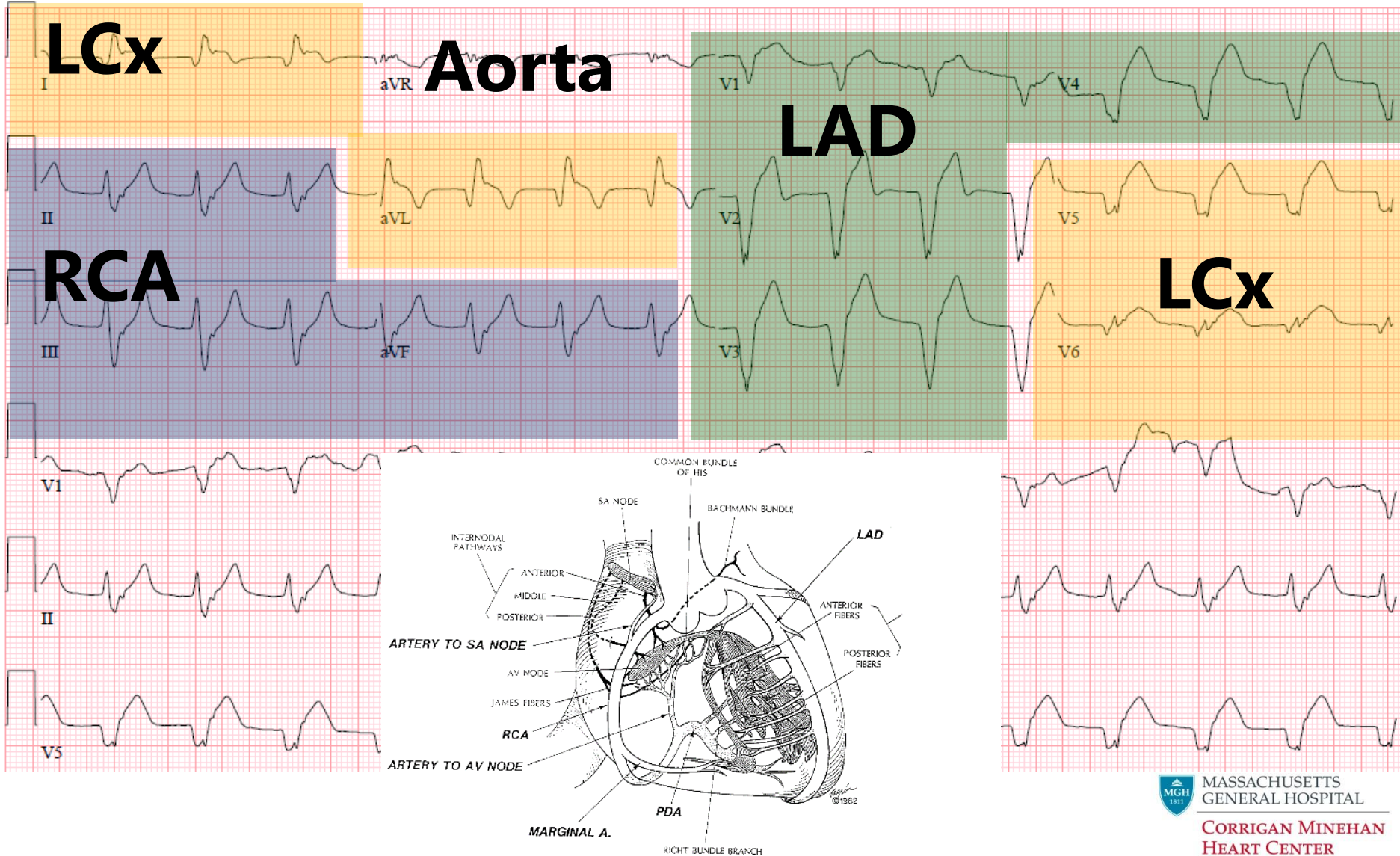
ST Elevation:  $\geq 0.1\text{mV}$  (1mm) in two adjoining leads, except V2, V3

In V2, V3:  $\geq 1.5\text{mm}$  in women  
 $\geq 2\text{mm}$  in men  $\geq 40$  years  
 $\geq 2.5\text{mm}$  in men  $< 40$  years



# Typical STEMI:

## 44-year-old man with sudden-onset chest pain

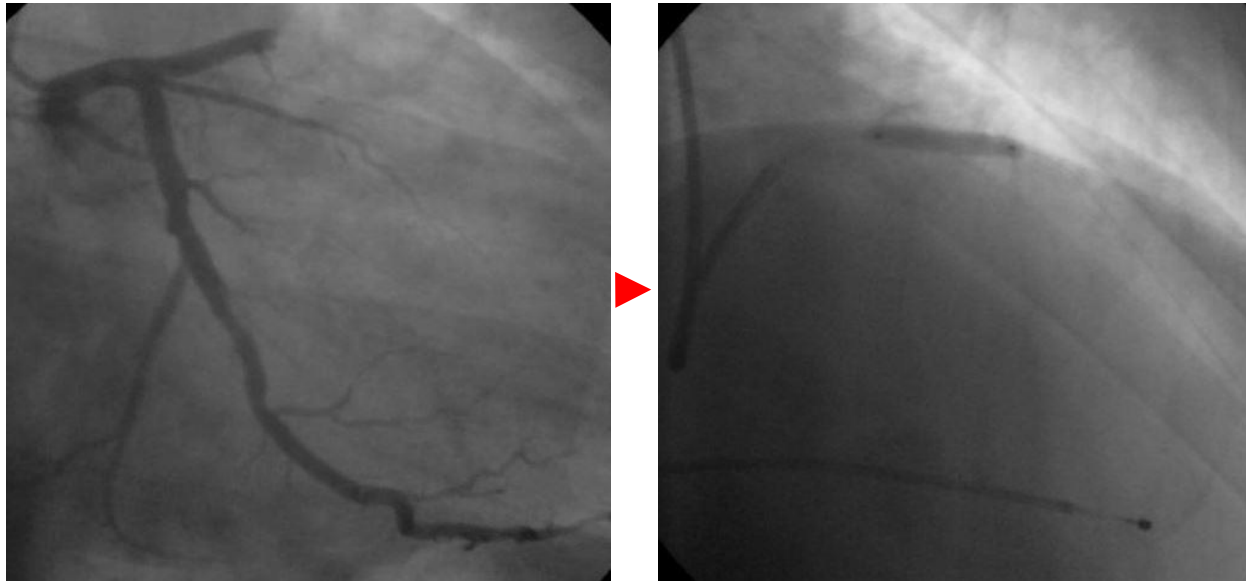


# Intervention for Typical STEMI

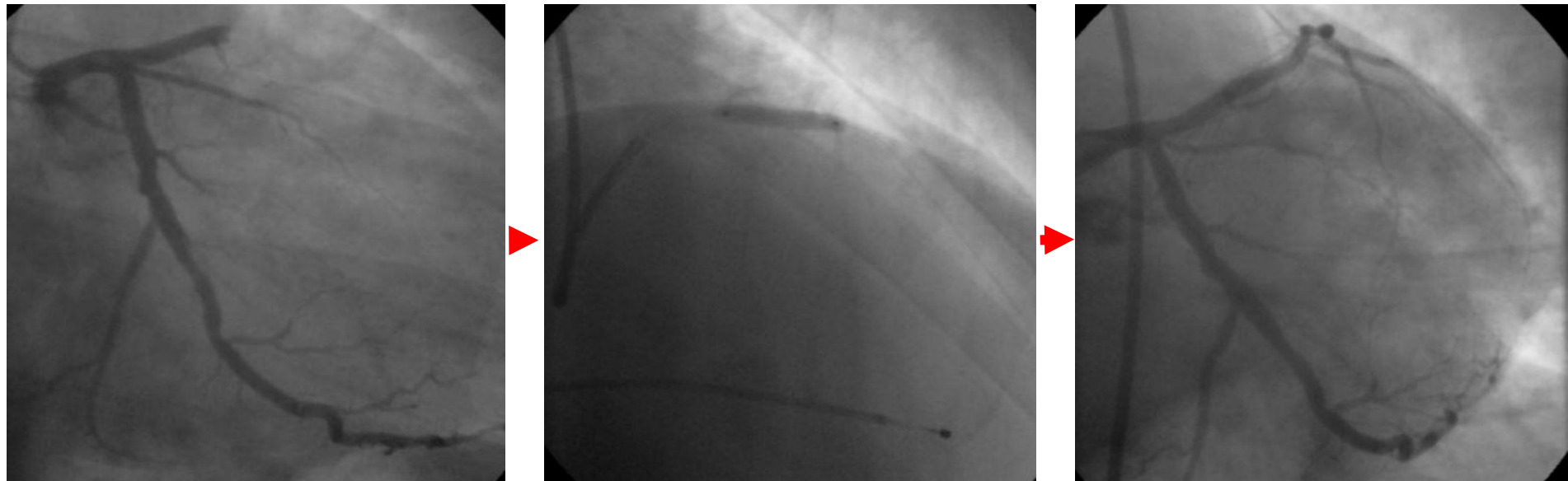




# Intervention for Typical STEMI



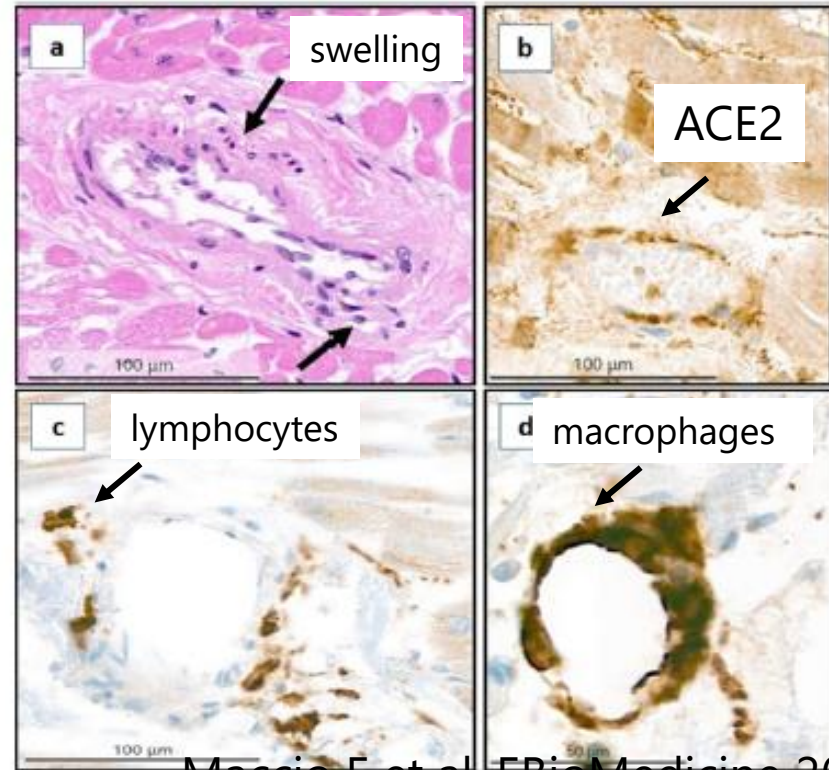
# Intervention for Typical STEMI



Single culprit lesion responsible for localized ST elevations

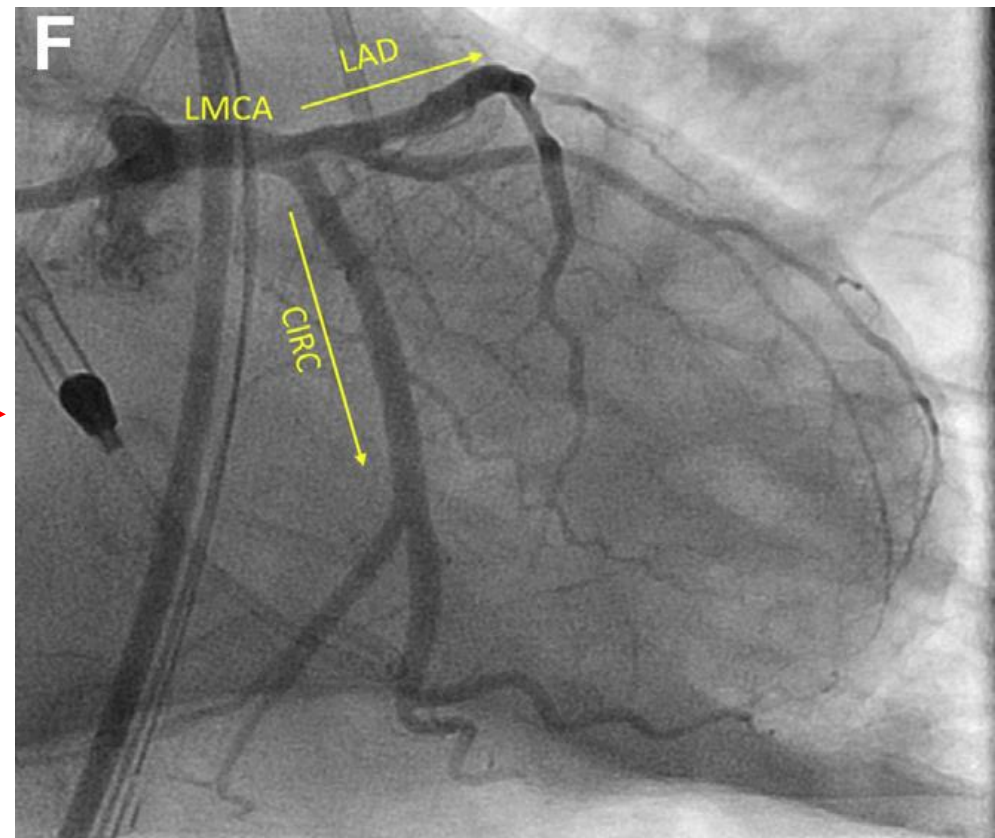
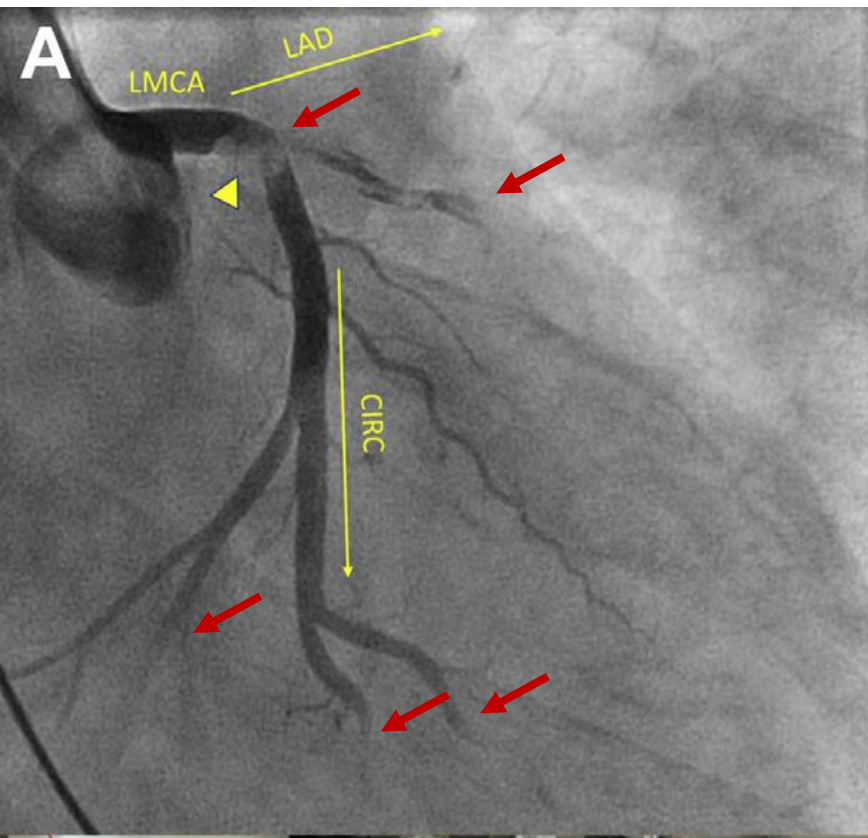
# COVID-19 Leads to Inflammation of Vascular Endothelium

- SARS-CoV-2 infection leads to inflammation of the endothelial lining of veins and arteries.
- Endothelial dysfunction secondary to inflammation may contribute to the clinical manifestations of COVID-19.
- The result is diffuse inflammation and vascular endothelial dysfunction



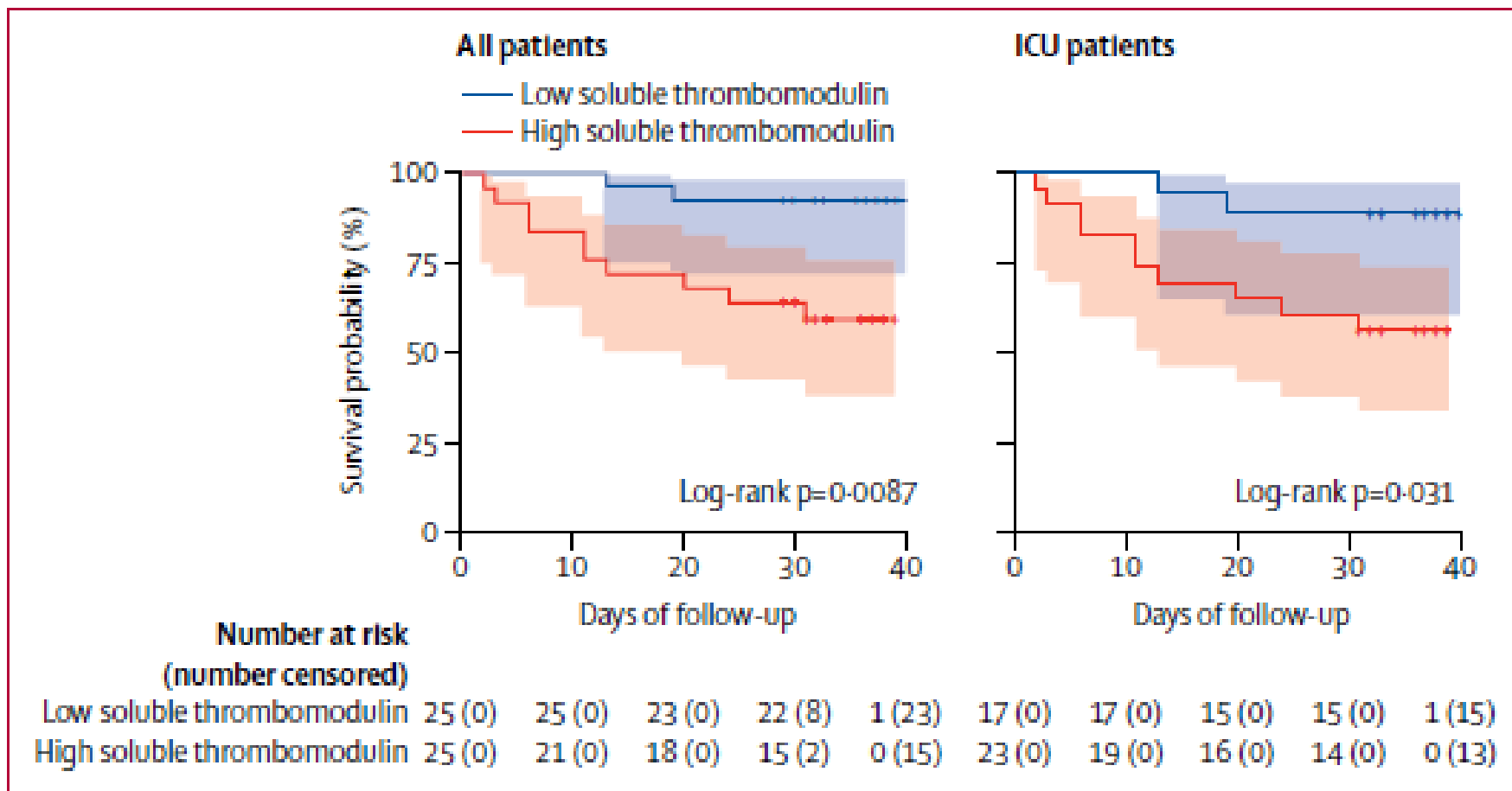
Maccio E et al, EBioMedicine 2020

# Acute Myocardial Infarction in COVID



Diffuse thrombosis and vessel occlusion:  
distribution of ST elevations may resemble myocarditis  
(Yerasi C et al, JACC:CI 2021)

# Vascular Inflammation in COVID is Associated with Disorders of Blood Clotting



Goshua G et al, Lancet Haematology 2020;7:e575-e582

# Key Cardiac Issues in this Patient

- Myocardial injury/NSTEMI
- Atrial fibrillation/flutter
- Heart failure

# Atrial Arrhythmias are Common in COVID-19

19%



	AF/ AFL (n = 166)	No AF/ AFL (n = 887)	p Value
Age, year, mean	74.5 ± 13.0	60.1 ± 17.0	<.001

Peltzer B et al J Cardiovasc Electrophysiol 2020;31:3077-3085

# Atrial Arrhythmias are Common in COVID-19

## Association of atrial arrhythmias with 30-day all-cause mortality

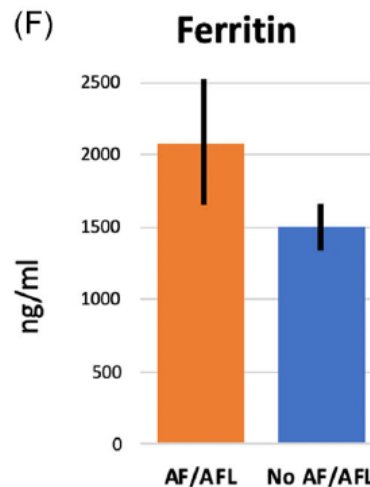
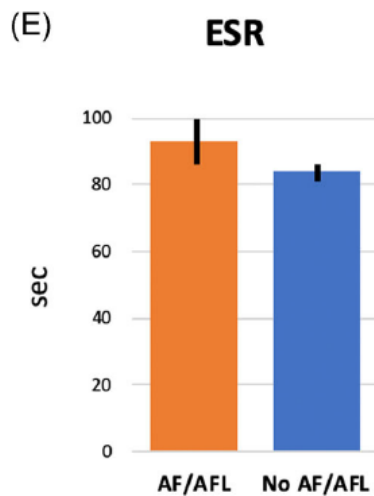
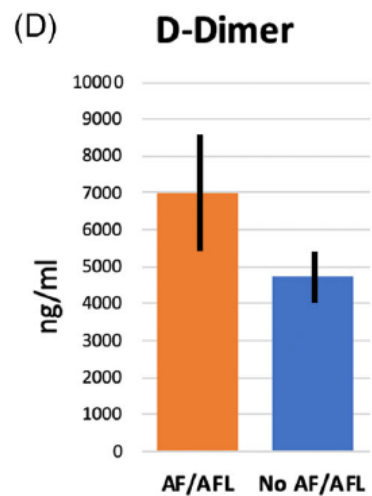
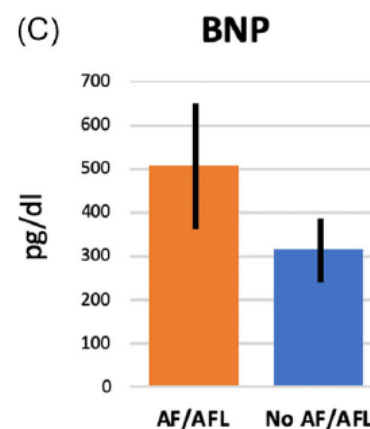
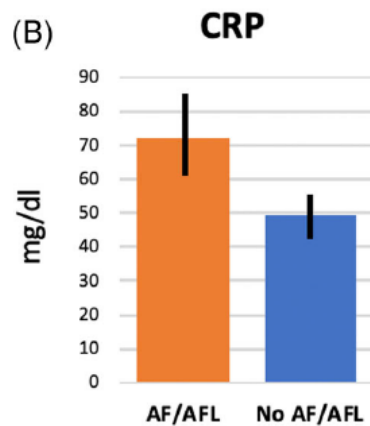
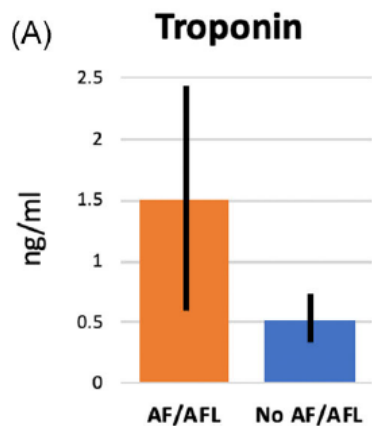
Arrhythmia	Event rates based on arrhythmia (%)		Unadjusted OR (95% CI)	p Value	Adjusted OR (95% CI) <sup>a</sup>	p Value
	Yes	No				
Atrial fibrillation (AF)	37.7	12.8	4.12 (2.82–6.02)	<.001	2.16 (1.33–3.52)	.002
AFL	22.5	16.2	1.50 (0.70–3.22)	.293	0.65 (0.27–1.55)	.335
Any AF/AFL	35.5	12.9	3.74 (2.57–5.43)	<.001	1.93 (1.20–3.11)	.007
Newly detected AF/AFL	36.6	14.3	3.47 (2.23–5.41)	<.001	2.87 (1.74–4.74)	<.001



Mortality rate increases 2- to 3-fold in the context of atrial arrhythmia.



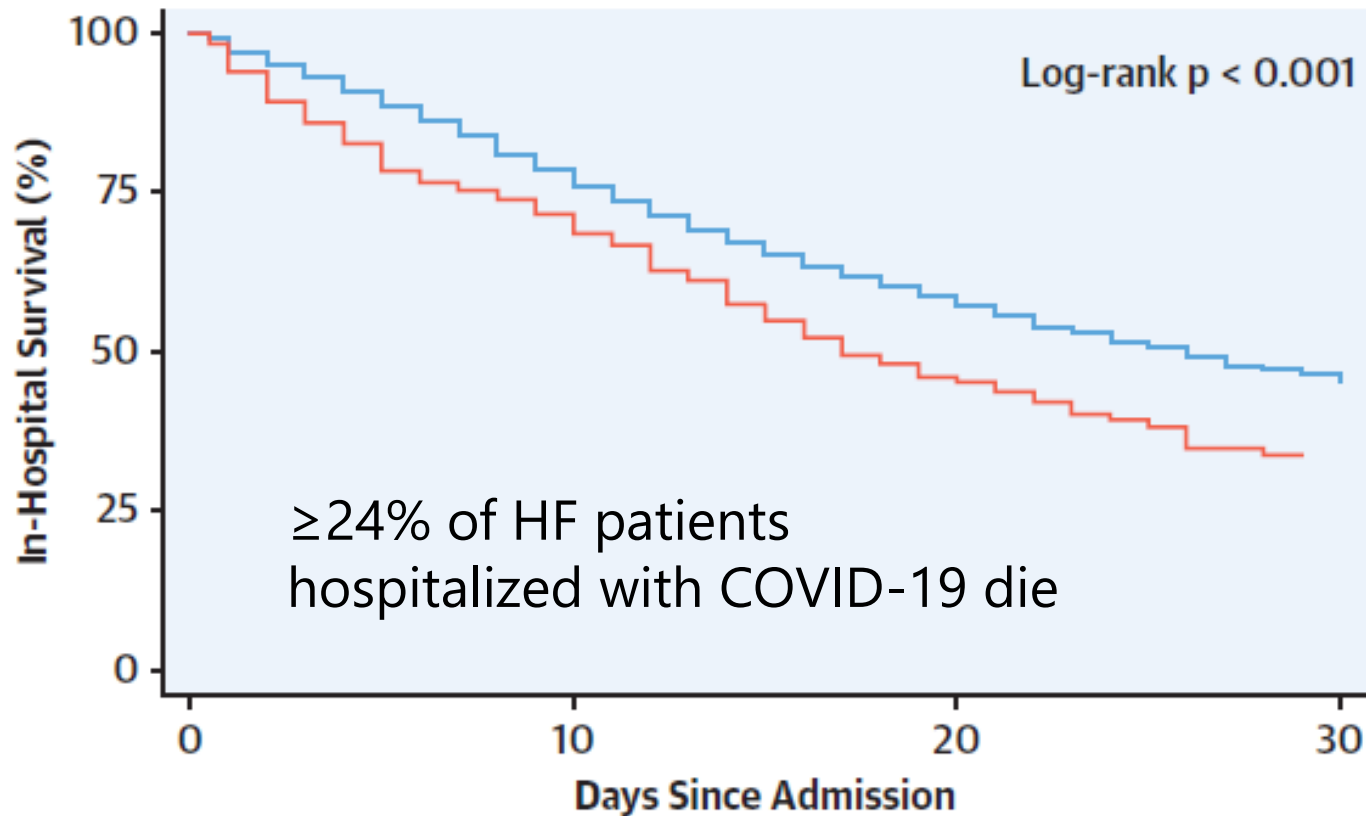
# AF/AFL Associated with Myocardial Injury in COVID



# Key Cardiac Issues in this Patient

- Myocardial injury/NSTEMI
- Atrial fibrillation/flutter
- Heart failure

# HF increases the risk of COVID-related death



No. at risk

— Non-HF	6,017	1,977	796	458
— HF	422	166	61	28



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# Objectives

**#1:** Better understand the physiology of COVID-19 infection.

- Diffuse endothelial inflammation
- Cardiac issues are common

**#2:** Identify the most common cardiac issues in patients hospitalized with COVID-19.

- Myocardial injury (myocarditis, acute MI)
- Arrhythmias
- Heart failure

**#3:** Better understand the impact of heart disease on COVID-19 outcomes.

- History of heart disease (especially CHF) increases the risk of mortality in patients with COVID.
- New, COVID-related heart issues also increase mortality



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Thank you



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