COVID-19 Myocarditis

St. Louis Shock Symposium
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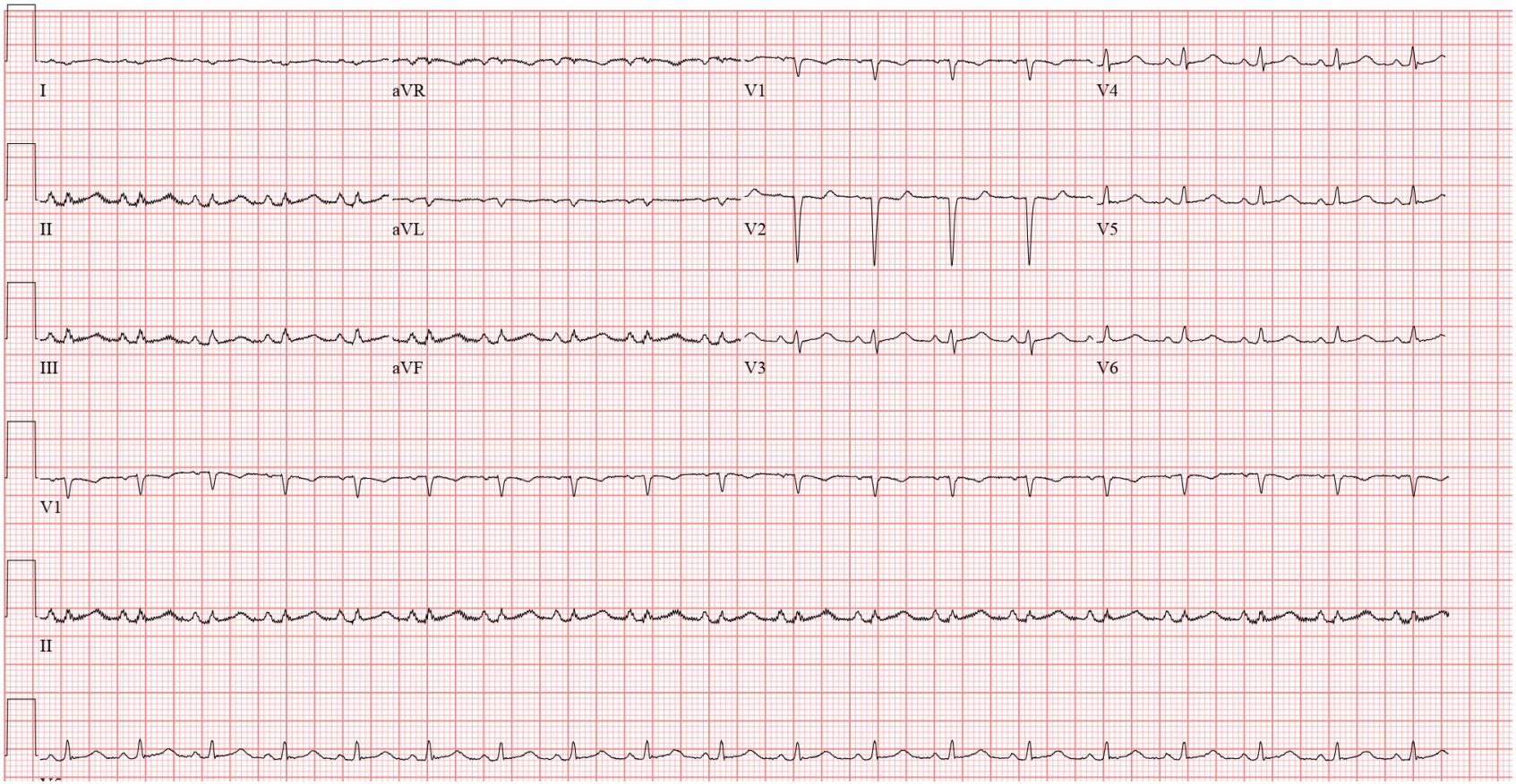
Disclosures

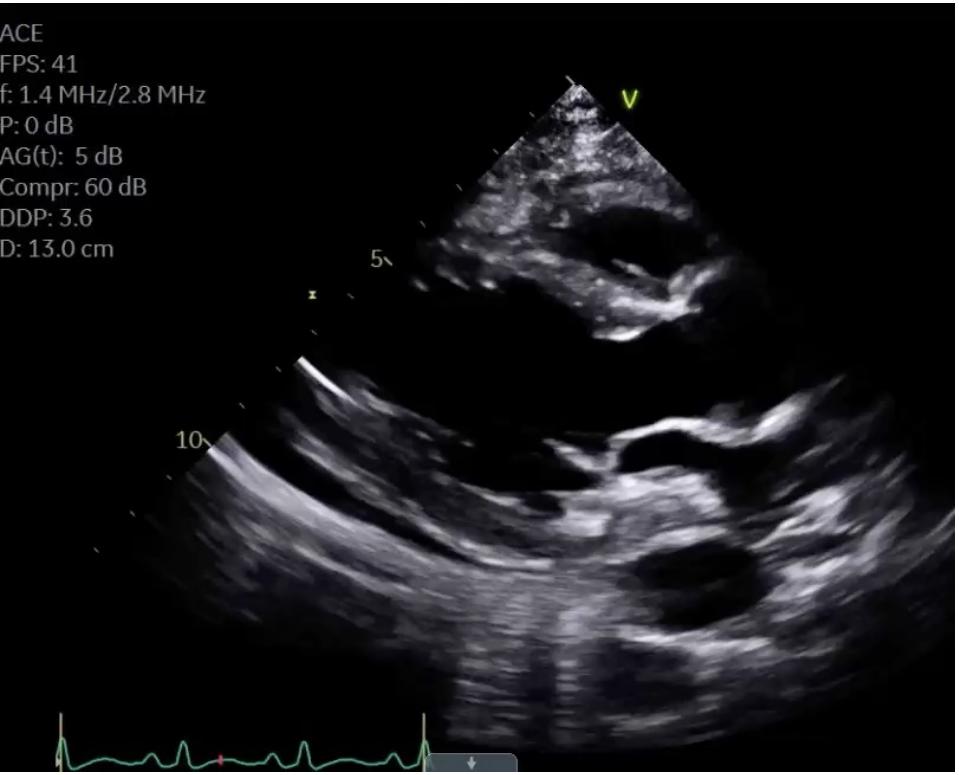
- None

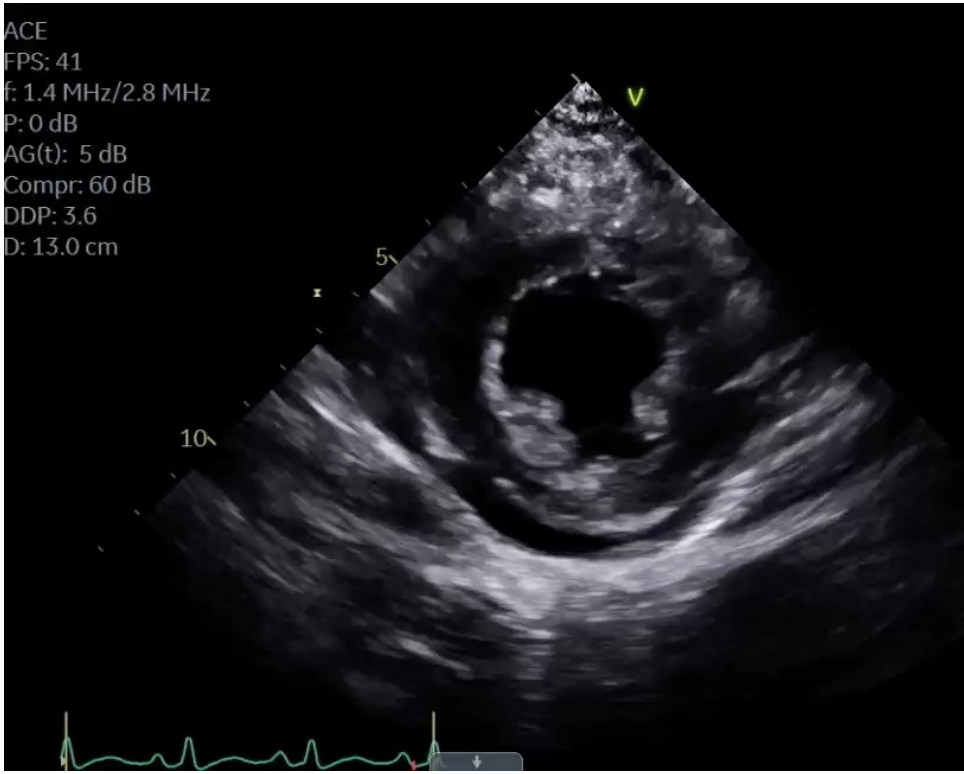
Case Example

- 48 yo F with 5 days of sore throat, fevers, myalgia, nausea and vomiting
- Husband with similar symptoms, treated for strep throat and improved
- Developed chest pain and dyspnea
- Rapid SARS-CoV-2 PCR negative at outside hospital
- HR 112, BP 102/52, T 36.4, SpO2 97% on RA

Verma AK, Olagoke, Moreno, Rezaee, Ma, Liu, Javaheri, Lavine, Masood, Lin. SARS-CoV-2-associated myocarditis: A case of direct myocardial injury. In press.


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II


ACE
FPS: 41
f: 1.4 MHz/2.8 MHz
P: 0 dB
AG(t): 5 dB
Compr: 60 dB
DDP: 3.6
D: 13.0 cm
5
10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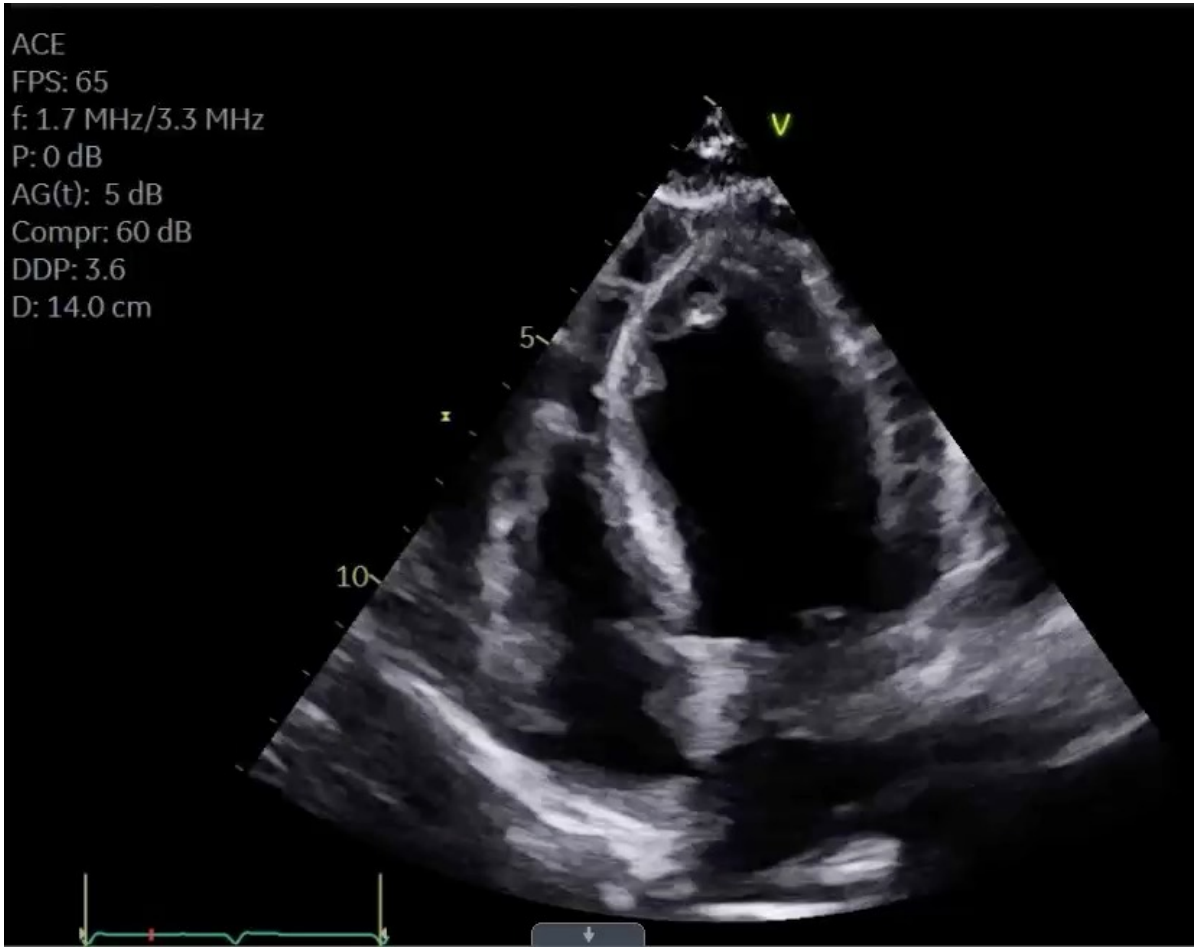
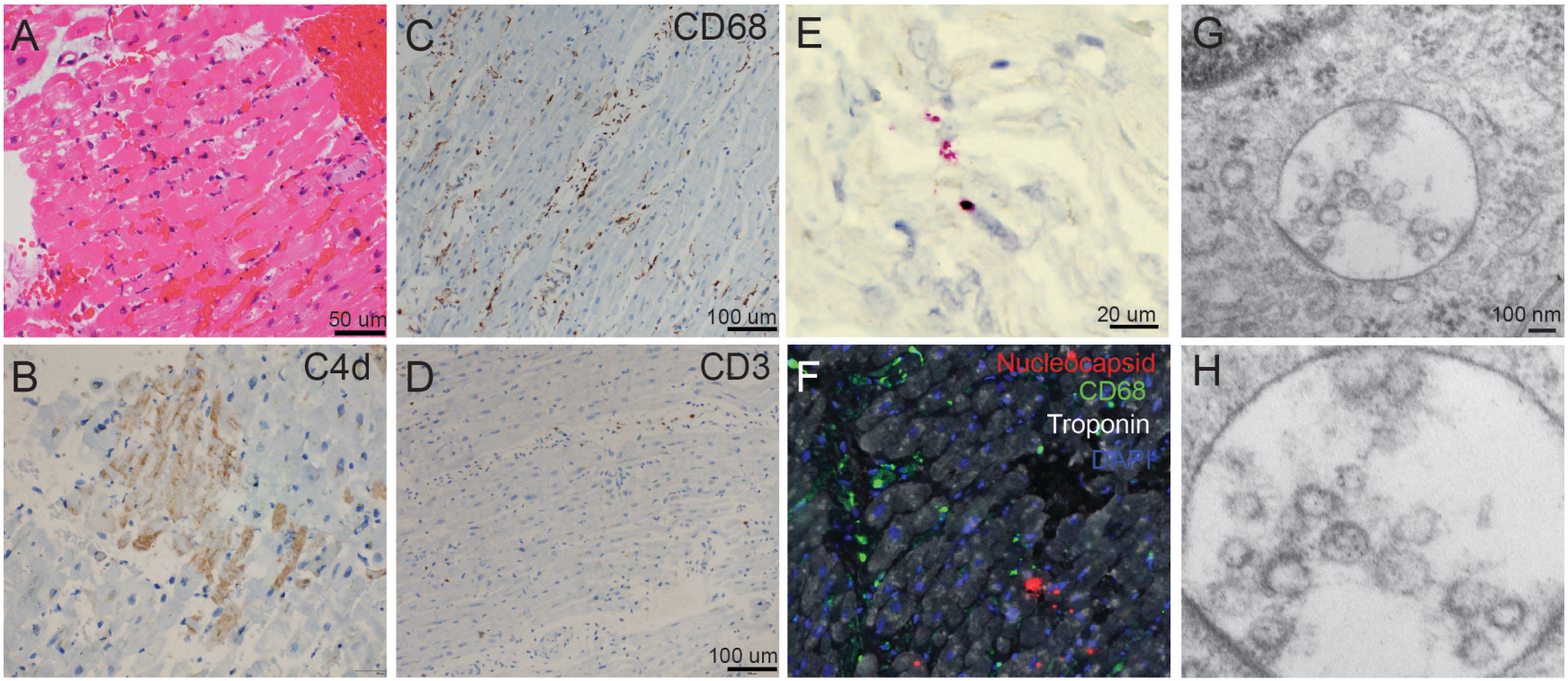

ACE
FPS: 65
f: 1.7 MHz/3.3 MHz
P: 0 dB
AG(t): 5 dB
Compr: 60 dB
DDP: 3.6
D: 14.0 cm
V
5
10

Case Example

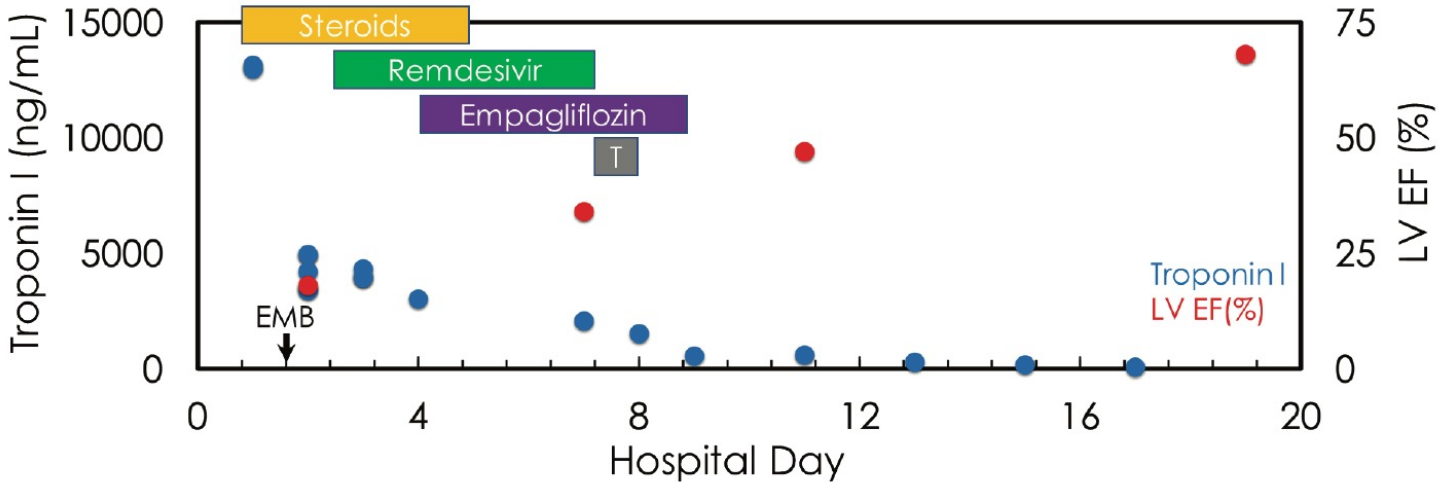
- LHC unremarkable
- RHC with cardiac output of 1.4L/min
- Impella CP placed, transferred to Barnes Jewish Hospital
- Rapid decompensation with rising vasopressor requirements
- Bedside VA-ECMO cannulation

A repeat SARS-CoV-2 PCR test was positive

Biopsy proven COVID-19 myocarditis



B


Steroids
Remdesivir
Empagliflozin
T
EMB
Troponin I
LV EF(%)
Troponin I (ng/mL)
LV EF (%)
Hospital Day
15000
10000
5000
0
75
50
25
0
0
4
8
12
16
20

Cardiovascular complications of COVID-19

- Acute myocardial injury (~20% of hospitalized patients)[1,2]
  - More likely in patients with underlying cardiovascular disease/comorbidities
  - Elevated troponin associated with higher NT-proBNP, hsCRP, creatinine; lower PaO_2, FiO_2, lymphocyte count, platelet count
  - Worse outcomes: higher rates of mechanical ventilation, ARDS, AKI, death
- Arrhythmias[3-6]
  - Atrial > ventricular
  - Higher incidence in ICU
  - Risk factors: elevated inflammatory markers, myocardial injury, intubation, vasopressor requirement, steroids
  - Associated with increased mortality

[1] Shi et al. Association of cardiac injury with mortality in hospitalized patients with COVID-19 in Wuhan, China. JAMA Cardiol. July 2020.
[2] Kang et al. Cardiovascular manifestations and treatment considerations in COVID-19. Heart. August 2020.
[3] Dherange et al. Arrhythmias and COVID-19: A Review. JACC Clin Electrophys. Sep 2020.
[4] Guo et al. Cardiovascular implications of fatal outcomes of patients with coronavirus disease 19 (COVID-19). JAMA Cardiol. July 2020.
[5] Goyal et al. Clinical characteristics of COVID-19 in New York City. NEJM. June 2020.
[6] Musikantow DR et al. Atrial fibrillation in patients hospitalized with COVID-19: incidence, outcomes, and comparison to influenza. JACC EP. Sept 2021.

Cardiovascular complications of COVID-19

- Acute coronary syndrome[1]
  - Usually underlying substrate
  - Higher mortality compared to non-COVID patients
  - Imbalance of myocardial oxygen supply/demand, less frequent GDMT, delayed presentation/time to perfusion; issues with hypercoagulability, microthrombi, systemic inflammation
- Heart Failure
  - Worsening of underlying HF
  - Ischemia
  - RV failure due to PE
  - Stress induced/Takotsubo
  - **Myocarditis**

[1]Numasawa Y. Impact of Concomitant Novel Coronavirus Disease 2019 in Patients with ST-Elevation Acute Myocardial Infarction.*Circulation Journal*. Sept 2021.

COVID-19 Myocarditis

- Per CDC, risk 0.146% with COVID-19 vs 0.009% (~16x)
- Typically associated with respiratory failure
- Mortality rate ~14%
- Early shock state – usually on presentation (non-myocarditis COVID-19 shock typically days to weeks after initial presentation)
- Improvement with corticosteroid administration (methylprednisolone)
  - Usually combined with other immunomodulators – tocilizumab

[1]Castiello T et al. COVID-19 and myocarditis: a systematic review and overview of current challenges. Heart Fail Rev. March 2021.
[2]Haussner W et al. COVID-19 associated myocarditis: A systematic review. Am J Emerg Med. Jan 2022. [online Oct 2021]
[3]Kamarullah W et al. Corticosteroid Therapy in Management of Myocarditis Associated with COVID-19; a Systematic Review of Current Evidence. Arch Acad Emerg Med. April 2021.

Shock

Management of COVID-19-Related Respiratory Failure *Via* Artificial Cardiopulmonary Support Strategies

Isolated Respiratory Failure	Cardiopulmonary—RV Support	Cardiopulmonary—LV or BiV Support
V-V ECMO Peripheral cannulation Consider bi-femoral strategy to limit exposure near the endotracheal tube	Single cannula-based RVAD (*e.g.* Protek Duo) with gas exchanger V-V ECMO plus catheter-mounted RVAD (*e.g.* Impella RP) If volumetric flow rates low, in highly selected cases, consider surgical RVAD plus gas exchanger In selected case, V-A ECMO (See Right Column; some issues typically not relevant when used for RV dysfunction)	V-A ECMO in highly selected cases with clear evidence of LV dysfunction Similar high threshold for catheter-mounted, percutaneously cannulated paracorporeal, and surgical LVAD support, with or without gas exchanger ("modular" V-A ECMO if gas exchanger) Need to be able to achieve high volumetric flow rates Relative advantages of peripheral cannulation are less, but yet easier LV distension complicating V-A ECMO: LV venting (catheter-mounted LVAD such as Impella is easiest) Differential hypoxemia complicating V-A ECMO: hybrid V-V/V-A ECMO with (or Impella addition may help with mixing)

BiV, biventricular; COVID-19, coronavirus disease 2019; ECMO, extracorporeal membrane oxygenation; LV, left ventricle; LVAD, left ventricular assist device; RV, right ventricle; RVAD, right ventricular assist device.

Rajagopal K et al. Advanced Pulmonary and Cardiac Support of COVID-19 Patients: Emerging Recommendations from ASAIO –A "Living Working Document." ASAIO J. May 2020.

Post-COVID myocarditis

JAMA Cardiology | Original Investigation

Outcomes of Cardiovascular Magnetic Resonance Imaging in Patients Recently Recovered From Coronavirus Disease 2019 (COVID-19)

Valentina O. Puntmann, MD, PhD; M. Ludovica Carerj, MD; Imke Wieters, MD; Masia Fahim; Christophe Arendt, MD; Jedrzej Hoffmann, MD; Anastasia Shchendrygina, MD, PhD; Felicitas Escher, MD; Mariuca Vasa-Nicotera, MD; Andreas M. Zeiher, MD; Maria Vehreschild, MD; Eike Nagel, MD

ORIGINAL RESEARCH

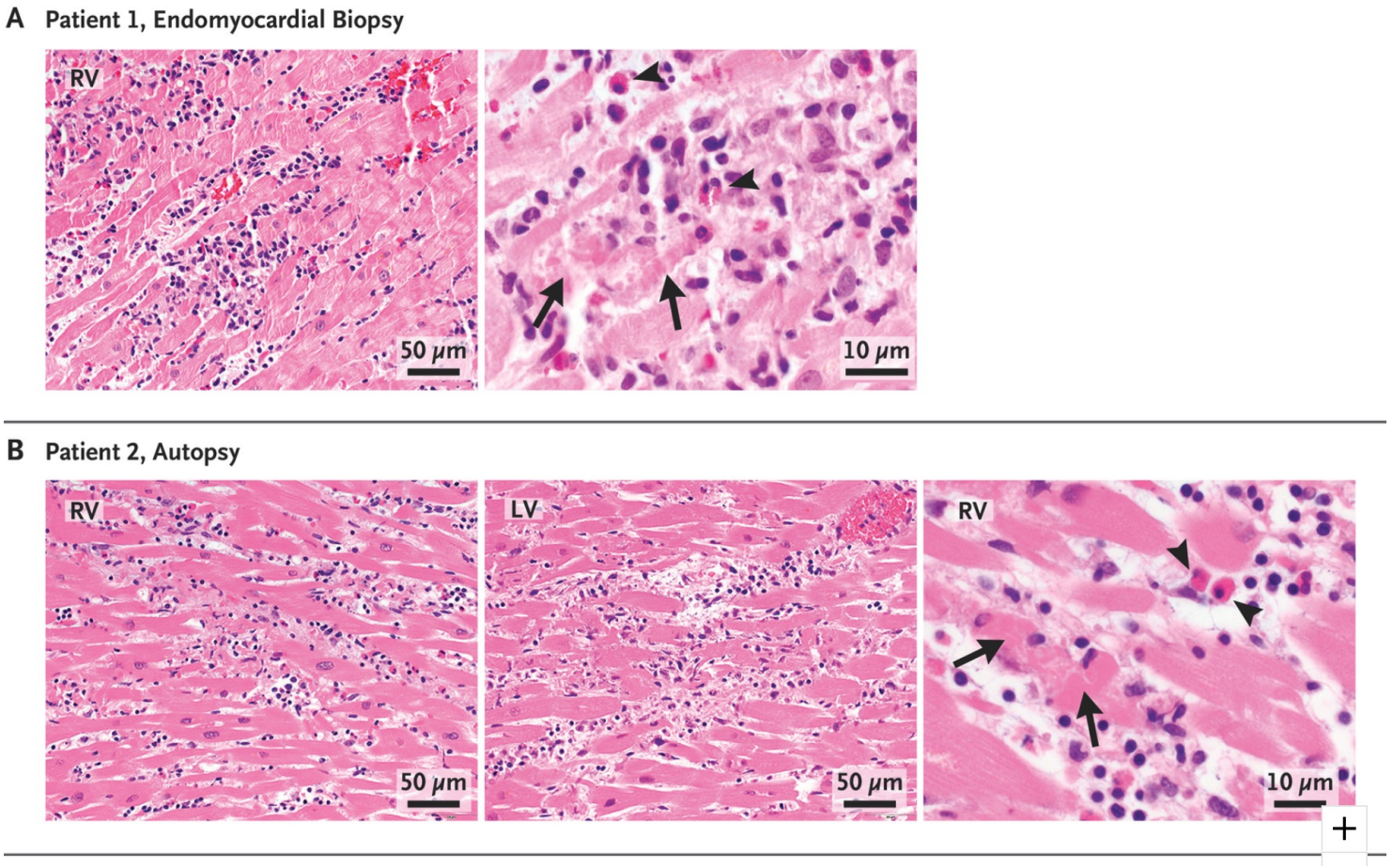
Cardiac Involvement in Patients Recovered From COVID-2019 Identified Using Magnetic Resonance Imaging

Lu Huang, MD, PhD,[a,*] Peijun Zhao, MD,[a,*] Dazhong Tang, MS,[a] Tong Zhu, MD,[a] Rui Han, MD,[b] Chenao Zhan, MD, PhD,[a] Weiyong Liu, MD, PhD,[c] Hesong

RESEARCH LETTER

Cardiovascular Magnetic Resonance Findings in Competitive Athletes Recovering From COVID-19 Infection

Myocarditis after COVID-19 vaccination



Verma AK, Lavine KJ, Lin C-Y. Myocarditis after COVID-19 mRNA Vaccination. NEJM. September 2021.

Vaccination and adverse cardiac events

- mRNA vaccination predominant
- Data from CDC
  - As of 8/18/2021 - 2574 reports
    - Myopericarditis 1903
    - Pericarditis alone 671

Manufacturer	Reports after dose 1	Reports after dose 2	Reports after unknown dose
Pfizer-BioNTech (n=1,282)	169	922	191
Moderna (n=557)	133	339	85
Janssen (n=49)	33	1	15
Not reported (n=15)	2	9	4
Total (N=1,903)	**337**	**1,271**	**295**

Doses administered (6/11/2021)	Approx 296 million
Myocarditis	• 1226 cases reported • Median age 26 (12-94) • Median time to symptoms 3 days (0-179) • 58% <30 years of age • 76% males • 76% occurring after 2nd dose

Frequency and risk of myocarditis in the U.S. (2020-2021)

- Risk of myocarditis from vaccination: 0.0004%
- Risk of myocarditis from infection: 0.146%
- Risk of myocarditis in patients without COVID-19: 0.009%

Benefits >>>> Risks

Vaccine	Benefits: COVID-19 outcomes prevented				Harms: adverse events†	
Sex/Age group, yrs	Cases	Hospitalizations	ICU admissions	Deaths	GBS	TTS
Janssen (Johnson & Johnson) COVID-19 vaccine§						
Females						
18–29	8,900	700	50	5	1	4–5
30–49	10,100	900	140	20	6–7	8–10
50–64	12,100	1,600	350	120	7–8	3–4
≥65	29,000	5,900	1,250	840	8–10	0
Males						
18–29	6,600	300	60	3	2	2–3
30–49	7,600	650	150	25	7–8	1–2
50–64	10,100	1,800	480	140	14–17	1–2
≥65	36,600	11,800	3,300	2,300	7–8	0
mRNA (Pfizer-BioNTech or Moderna) COVID-19 vaccine¶					**Myocarditis**	
Females						
18–29	12,800	750	50	5	3–4	
30–49	14,600	950	140	20	1–2	
50–64	17,500	1,700	375	125	1	
≥65	32,000	6,200	1,300	900	<1	
Males						
18–29	9,600	300	60	3	22–27	
30–49	11,000	700	160	25	5–6	
50–64	14,700	1,900	500	150	1	
≥65	52,700	12,500	3,500	2,400	1	

Rosenblum HG et al. Use of COVID-19 Vaccines after Reports of Adverse Events Among Adult Recipients of Janssen (Johnson & Johnson) and mRNA COVID-19 Vaccines (Pfizer-BioNTech and Moderna): Update from the Advisory Committee on Immunization Practices—United States, July 2021. Morbidity and Mortality Weekly Report.

Questions?

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