



Myocarditis after mRNA COVID-19 vaccines in the United States: children aged ≤ 11 years, and follow up among people aged 12–29 years at least 90 days after symptom onset of myocarditis

John R. Su, MD, PhD, MPH

Immunization Safety Office

EMA virtual workshop on myocarditis post COVID-19 vaccination

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Topics

- **Myocarditis* after mRNA COVID-19 vaccination among children aged 11 years and younger, including clinical outcomes**
 - Vaccine Adverse Event Reporting System (VAERS)
 - Vaccine Safety Datalink (VSD)

- **Longer-term follow up of people aged 12–29 years with myocarditis* after mRNA COVID-19 vaccination**

* CDC Case definition from Oster, M et al. Myocarditis Cases Reported After mRNA-Based COVID-19 Vaccination in the US From December 2020 to August 2021. *JAMA* 2022;327(4):331-340.

Myocarditis after mRNA COVID-19 vaccination among children aged 11 years and younger

VAERS reporting rates of verified myocarditis per 1 million mRNA COVID-19 vaccinations (Pfizer-BioNTech and Moderna combined), days 0–7 post-vaccination^{*,†}

Age group	Dose 2 (primary series)		1 st booster dose	
	Male	Female	Male	Female
5–11 years	2.5	0.7	0.0	0.0
12–15 years	47.1	4.2	12.9	0.7
16–17 years	78.7	7.4	21.6	0.0
18–24 years	39.3	3.9	13.1	0.6
25–29 years	15.3	3.5	4.4	2.2
30–39 years	7.8	1.0	1.9	0.9
40–49 years	3.3	1.6	0.2	0.6
50–64 years	0.7	0.5	0.4	0.1
65+ years	0.3	0.5	0.7	0.2

From previous slide

* As of August 18, 2022. Reports verified to meet case definition by provider interview or medical record review.

† An estimated 1–10 cases of myocarditis per 100,000 person years occurs among people in the United States, regardless of vaccination status; adjusted for days 0–7 risk interval, this estimated background is **0.2 to 2.2 per 1 million person-day 0–7 risk interval** (peach shaded cells indicate that reporting rate exceeded estimated background incidence for the period)

VSD incidence rates of verified myocarditis/pericarditis in the 0–7 days after Pfizer-BioNTech vaccination in people ages 5–39 years, dose 2 and 1st booster*

	Dose 2 primary series Pfizer-BioNTech			1 st booster dose Pfizer-BioNTech		
	Cases	Dose 2 admin	Incidence rate/ million doses (95% CI)	Cases	1 st boosters admin	Incidence rate/ million doses (95% CI)
5-11 years						
Males	3	207,958	14.4 (3.0 – 42.2)	0	50,415	0.0 (0.0 – 59.4)
Females	0	202,596	0.0 (0.0 – 14.8)	0	49,261	0.0 (0.0 – 60.8)
12–15 years						
Males	31	205,955	150.5 (102.3 – 213.6)	5	81,613	61.3 (19.9 – 143.0)
Females	5	204,074	24.5 (8.0 – 57.2)	0	84,114	0.0 (0.0 – 35.6)
16–17 years						
Males	14	102,091	137.1 (75.0 – 230.1)	9	47,874	188.0 (86.0 – 356.9)
Females	1	107,173	9.3 (0.2 – 52.0)	2	55,004	36.4 (4.4 – 131.3)
18–29 years						
Males	27	331,889	81.4 (53.6 – 118.4)	7	166,973	41.9 (16.9 – 86.4)
Females	2	400,321	5.0 (0.6 – 18.0)	1	240,226	4.2 (0.1 – 23.2)
30–39 years						
Males	5	341,527	14.6 (4.8 – 34.2)	3	197,554	15.2 (3.1 – 44.4)
Females	3	410,713	7.3 (1.5 – 21.3)	1	268,412	3.7 (0.1 – 20.8)

Reports to VAERS of myocarditis after Pfizer-BioNTech vaccination among children ages 5–11 years* (as of April 24, 2022; ~18.1 million doses administered)

- 20 reports verified using CDC case definition
 - Median age: 9 years (IQR: ages 7–10 years)
 - Median time to symptom onset after vaccination: 3 days (IQR: 2–3 d)
 - 4 reports with symptom onset >7 days after vaccination (8, 11, 12, and 12 days)
 - After dose 2 (n=14), after dose 1 (n=6)
 - Male cases (n=15), female cases (n=5)
 - 17/20 hospitalized; 3 treated only as outpatients
 - 14/17 recovered from symptoms at time of VAERS report
 - None reported a vaccination error involving receipt of an adult dose
 - 1 report with history of viral prodrome 3–4 days prior to symptom onset, 3 with current COVID-19 disease at time of symptom onset, no reports with a documented history of COVID-19 disease prior to symptom onset
 - 1 death in a male child with onset of fever 12 days after dose 1 and abdominal pain, vomiting, and death the following day (day 13 after dose 1); rapid clinical course, histopathologic evidence of myocarditis on autopsy, testing did not find evidence of viral infection at time of death, CDC continues to assist with case review



Safety of primary series mRNA COVID-19 vaccination among children aged 6 months – 5 years

- Most nonserious reports described adverse events consistent with those observed during preauthorization clinical trials
- Most often vaccination errors
- Most frequent adverse event among serious reports was seizure (7)*
- No reports of death or myocarditis

TABLE 3. Events* reported to the Vaccine Adverse Event Reporting System for children aged 6 months–5 years† after receipt of Pfizer-BioNTech or Moderna COVID-19 vaccine — United States, June 18–August 21, 2022

Adverse events	Vaccine, no. reporting (%)		
	Pfizer-BioNTech	Moderna	Total
Total	496	521	1,017
Vaccination errors	278 (56.0)	177 (34.0)	455 (44.7)
Error without adverse health event	248 (89.2)	162 (91.5)	410 (90.1)
Error with adverse health event [§]	30 (10.8)	15 (8.5)	45 (9.9)
Error with nonserious health event [¶]	30 (10.8)	14 (7.9)	44 (9.7)
Error with serious health event	0 (—)	1 (0.6)	1 (0.2)
Nonserious reports (excluding vaccination error MedDRA PTs)**	486 (98.0)	512 (98.3)	998 (98.1)
Fever	84 (17.3)	113 (22.1)	197 (19.7)
Rash	52 (10.7)	43 (8.4)	95 (9.5)
Vomiting	37 (7.6)	42 (8.2)	79 (7.9)
Urticaria	23 (4.7)	43 (8.4)	66 (6.6)
Fatigue	29 (6.0)	31 (6.1)	60 (6.0)
SARS-CoV-2 negative test result	24 (4.9)	33 (6.5)	57 (5.7)
Cough	17 (3.5)	34 (6.6)	51 (5.1)
Irritability	16 (3.3)	33 (6.5)	49 (4.9)
Decreased appetite	17 (3.5)	29 (5.7)	46 (4.6)
Diarrhea	19 (3.9)	26 (5.1)	45 (4.5)
Erythematous rash	13 (2.7)	28 (5.5)	41 (4.1)
COVID-19	19 (3.9)	18 (3.5)	37 (3.7)
SARS-CoV-2 positive test result	18 (3.7)	17 (3.3)	35 (3.5)

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* Estimated reporting rate <1 per 1 million doses administered † Children ages 6 months – 4 years after Pfizer-BioNTech; ages 6 months – 5 years after Moderna

Summary: Myocarditis after mRNA COVID-19 vaccination among children aged 11 years and younger, including clinical outcomes

- **Rare among children aged 5–11 years**
 - Rates slightly elevated above anticipated background rates among males aged 5–11 years
 - Most (82%) patients recovered from symptoms at time of report to VAERS
- **Myocarditis not reported among children aged 6 months – 5 years**

Longer-term follow up of patients aged 12-29 years with myocarditis after mRNA COVID-19 vaccination

Outcomes at least 90 days since onset of myocarditis after mRNA COVID-19 vaccination in adolescents and young adults in the USA: a follow-up surveillance study

www.thelancet.com/child-adolescent Published online September 21, 2022

- **512 patients verified* to meet CDC case definition of myocarditis after mRNA COVID-19 vaccination**

- 126 (25%) by patient survey
- 162 (32%) by healthcare provider survey
- 231 (45%) by both patient and healthcare provider surveys

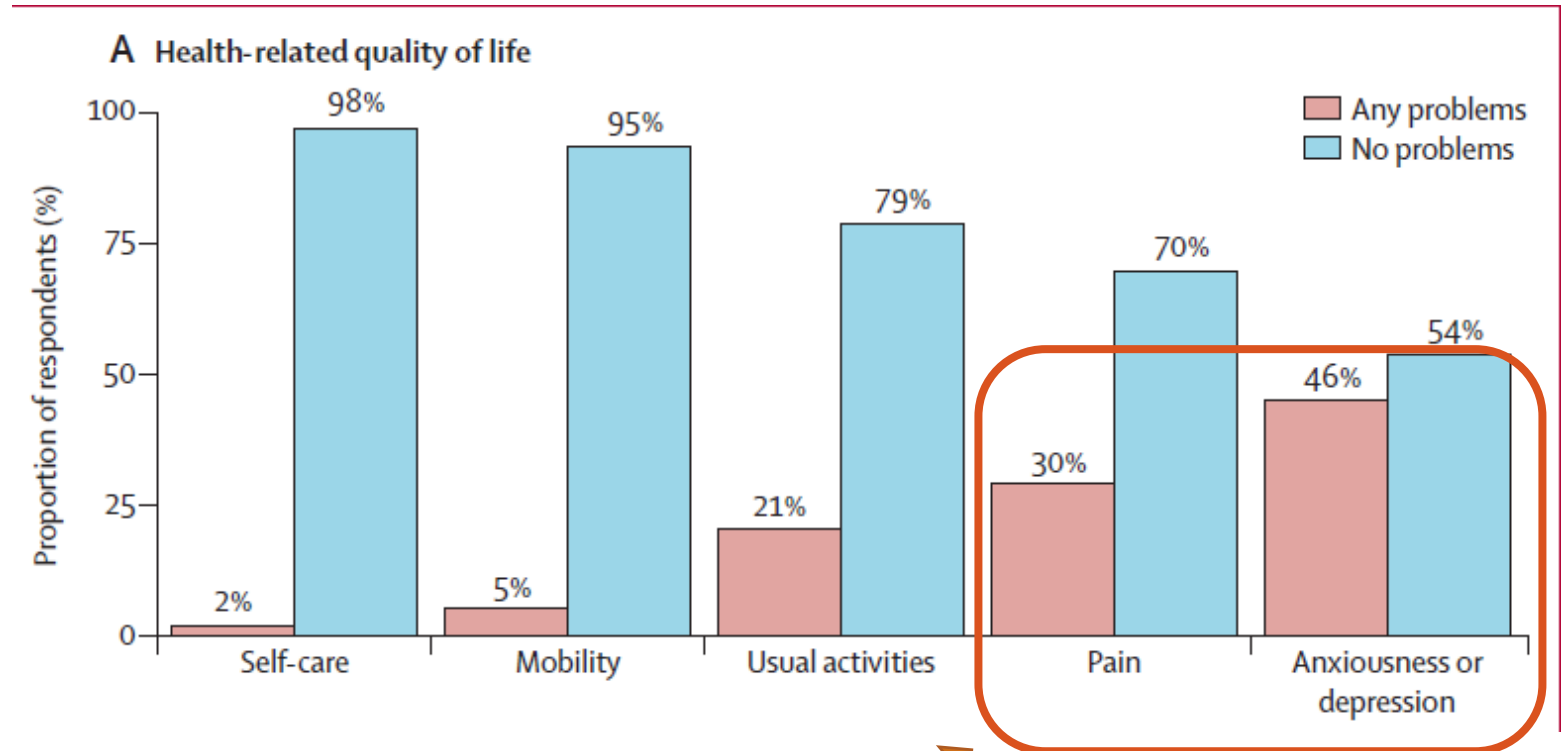
* By healthcare provider interview or medical record review

	Patients fully or probably fully recovered (n=320)	Patients not recovered (n=65)	All patients (n=519)	p value
Median age, years (IQR)	17 (15–21)	17 (15–21)	17 (15–22)	..
Age group, years				
12–14	58 (18%)	9 (14%)	92 (18%)	0.84
15–19	160 (50%)	35 (54%)	245 (47%)	..
20–24	69 (22%)	15 (23%)	120 (23%)	..
25–29	33 (10%)	6 (9%)	62 (12%)	..
Sex				
Male	290 (91%)	56 (86%)	457 (88%)	0.39
Female	30 (9%)	9 (14%)	61 (12)	..
Unknown	0	0	1 (<1%)	..
Race ethnicity				
White, non-Hispanic	182 (57%)	32 (49%)	274 (53%)	0.32
Asian, non-Hispanic	16 (5%)	1 (2%)	25 (5%)	0.33
Black, non-Hispanic	10 (3%)	2 (3%)	16 (3%)	0.71
Other race, non-Hispanic	11 (3%)	0	12 (2%)	0.22
Multiple races, non-Hispanic	10 (3%)	1 (2%)	12 (2%)	0.69
American Indian or Alaskan native, non-Hispanic	1 (<1%)	0	1 (<1%)	..
Hispanic	53 (17%)	14 (22%)	98 (19%)	0.33
Unknown	37 (12%)	13 (20%)	81 (16%)	..

Overall quality of life at least 90 days after symptom onset of myocarditis after mRNA COVID-19 vaccination comparable to pre-pandemic measures

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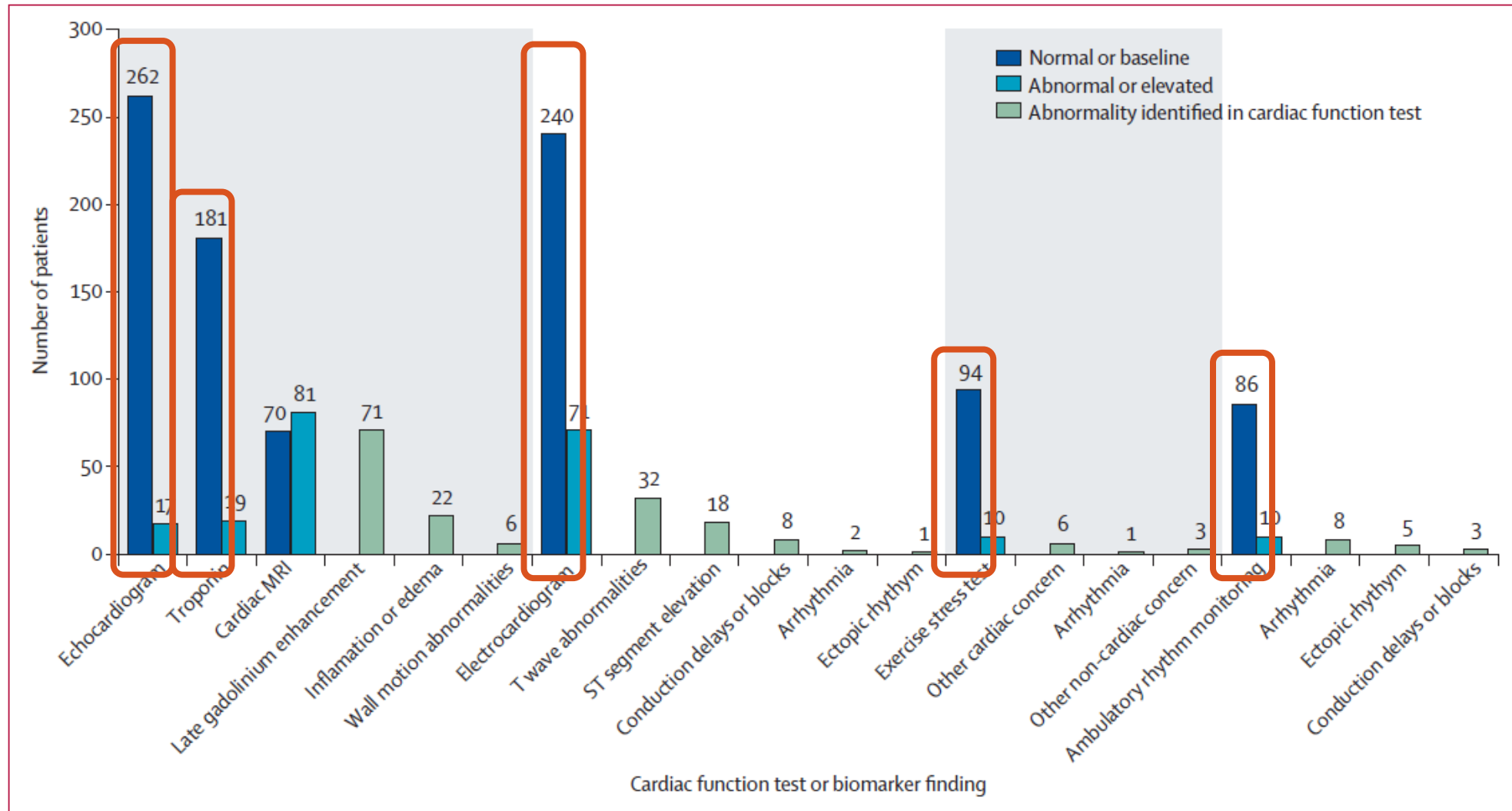
- Median interval from symptom onset to follow up (patient survey): **143 days** (IQR: 131–162)
- Median interval from symptom onset to follow up (healthcare provider survey): **191 days** (IQR: 170–216)
- Overall quality of life (as measured via EuroQol 5-dimension, 5-level metric) comparable to pre-pandemic measures



Pre-pandemic*: pain/discomfort = 33%; anxiety or depression = 42%

* Jiang R, Janssen MFB, Pickard AS. US population norms for the EQ-5D-5L and comparison of norms from face-to-face and online samples. *Qual Life Res* 2021; 30: 803–16.

Most patients with improved diagnostic markers and imaging data



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- Of 393 patients with biomarkers and/or imaging findings, 77–94% had normal or baseline values

Most patients with improved diagnostic markers and imaging data at least 90 days after symptom onset of myocarditis following mRNA COVID-19 vaccination (cont'd)

- **Per healthcare provider survey, 381 (97%) patients were improved or recovered**
 - 320 (81%) were “recovered”; 61 (16%) were “improved”
 - Most (60%) of recovered patients cleared for all physical activity
- **Follow up cardiac MRI among 151 patients was consistent with improvement**
 - 70 (46%) with normal findings
 - 47 (31%) with late gadolinium enhancement (LGE) only
 - Median time from symptom onset to follow up: 109 days (IQR: 58–163)
 - 20 (13%) with evidence of ongoing myocarditis (LGE + edema, per modified Lake Louise criteria*)
 - Median time from symptom onset to follow up: **26 days** (IQR: 9–94)
- **Longer-term follow up is ongoing**

Summary

Summary

- **Myocarditis after mRNA COVID-19 vaccines rare among children aged 11 years and younger**
 - Rates highest among males aged 6–11 years after dose 2 (14.4 per million doses administered), slightly above background
 - 14/17 hospitalized children had recovered at time of report to VAERS
 - No myocarditis reported among children aged 6 months–4 years (Pfizer-BioNTech) or 5 years (Moderna)
- **Observations at least 90 days after symptom onset among patients aged 12-29 years indicate most improve**
 - Overall quality of life comparable to pre-pandemic measures
 - Most patients with biomarker and/or imaging data had baseline or normal levels
 - Patients with ongoing myocarditis followed up sooner (median = 26 days) relative to patients with LGE only on cardiac MRI (median = 109 days)
 - Most patients were improved or recovered per health care provider assessment
 - Most recovered patients were cleared for all physical activity

Thanks!

For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

