COVID-19 Epidemiology in Children

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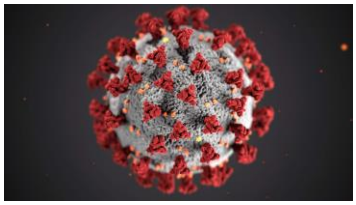
Disclosure

- I have no relevant financial relationships with the manufacturers(s) of any commercial products(s) and/or provider of commercial services discussed in this CME activity
- I do not intend to discuss an unapproved/investigative use of a commercial product/device in my presentation.

Outline

- What is a coronavirus?
- Where did SARS-CoV-2 come from?
- What is the epidemiology of COVID-19 disease?
- What are the symptoms of COVID-19 in children?
- What is happening with COVID-19 variants?
- What is the epidemiology of MIS-C?

What is a coronavirus?

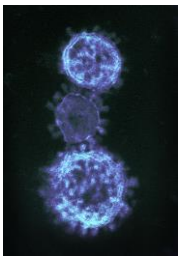


Terminology

- CoV: Coronavirus
- SARS: Severe Acute Respiratory Syndrome
- SARS-CoV-2: The virus causing COVID-19
- COVID-19 (coronavirus disease 2019): The disease caused by SARS-CoV-2

Coronavirus

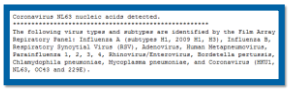
- Largest group of viruses causing respiratory and GI illness
- Enveloped, single-stranded RNA virus
- 4 distinct genera
- Named after crown-like projections
- Host specific, infecting humans and animals



CDC PHIL (NIAID). MERS-CoV. 2014

Common coronaviruses

- 4 most common HCoV-
  - NL63, 229E, OC43, HKU1
- Winter-spring respiratory disease
- Infection early in childhood
  - Re-infection can occur
- Spread via droplets and direct/indirect contact
- GI symptoms less common



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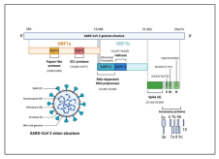
Where did SARS-CoV-2 come from?



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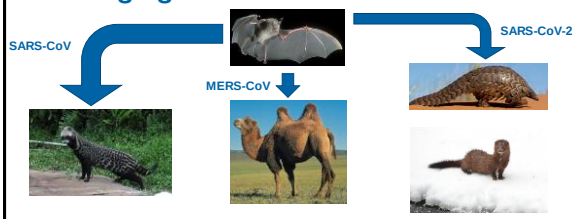
Emerging coronaviruses



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Anderson KG, et al. *Nature Medicine*.2020
Zhao J, et al. Front Microbiol.2020
Rasmussen, AL. *Nature Medicine*.2021

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Emerging coronaviruses

	SARS-CoV	MERS-CoV	SARS-CoV-2
First reported	November 2002	September 2012 (April)	December 2019 (Nov)
Initial location	Southern China	Saudi Arabia (Jordan)	Wuhan, China
Cases/deaths	8,096/774 (9.5%)	1,733/678 (34.4%)	31,764,062 / 568,104 (1.8%) 142, 378, 883 / 3,041,841 (2.1%)

As of 4/20/21

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CDC
Johns Hopkins Coronavirus Resource Center

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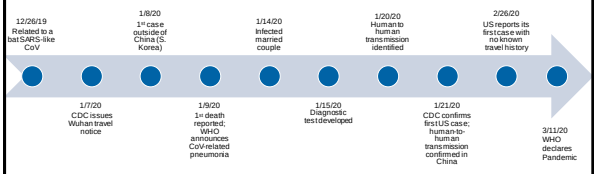
Timeline



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https://www.who.int/emergencies/diseases/novel-coronavirus-2019/interactive-timeline

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What is the epidemiology of COIVD-19 disease?

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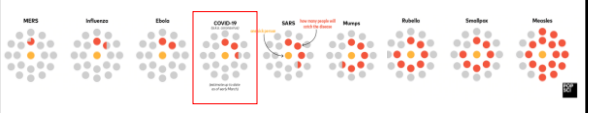
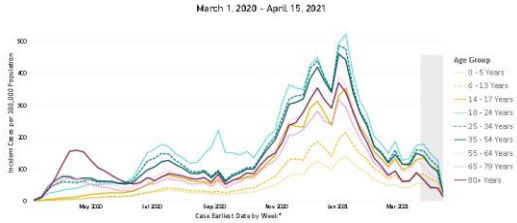
R0- a measure of infectivity



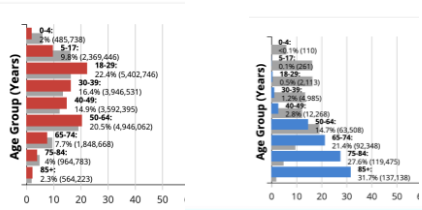
https://www.popsci.com/storyhealth/how-diseases-spread

LOVE WILL. CDC March 19, 2021 Children's Mercy

COVID-19 Weekly Cases US

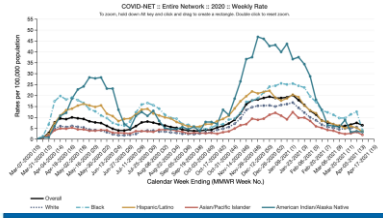


Children represent a small proportion of COVID-19 cases and deaths nationally



LOVE WILL. https://covid.cdc.gov/covid-data-tracker/#demographics Children's Mercy

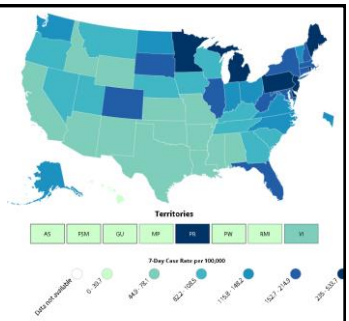
Black, Hispanic/Latino, and AI/AN cases are disproportionately high



LOVE WILL. https://covid.cdc.gov/covid-data-tracker/index.html#covidnet-hospitalization-network Children's Mercy

COVID-19 Cases by State

Kansas:
- 305,861 cases
- 9,944 hospitalizations
- 4,953 deaths
- 1,348,960 tested

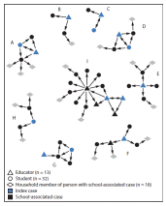


Children can transmit SARS-CoV-2

LOVE WILL. Lopez AS et al. MMWR Weekly. September 18, 2020. Pray IW et al. MMWR Weekly. October 30, 2020. Children's Mercy

Clusters of SARS-CoV-2 Infection Among Elementary School Educators and Students in One School District — Georgia, December 2020–January 2021

Early Release / February 22, 2021 / 70



- 9 clusters of 13 educators and 32 students
- 2 clusters with educator-to-educator transmission
  - Resulted in half of cases
- All clusters with "less than ideal distancing" (<3 feet)
- 5/9 clusters with inadequate mask usage by students

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Gold JAW et al. MMWR. 2021

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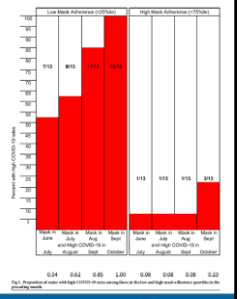
Masks Work



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PLoS ONE 16(4): e0249891.

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What are the symptoms of COVID-19 in children?

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Symptoms are different than adults

Table 2. Reported Symptoms at Time of Testing for Patients With a Positive Severe Acute Respiratory Syndrome Coronavirus 2 Test

Symptom	Total (n = 424)
Fever or cough or shortness of breath, n (%)[a]	318 (75.0)
Fever, n (%)	217 (51.2)
Cough, n (%)	221 (52.1)
Shortness of breath, n (%)	62 (14.6)
Congestion or rhinorrhea, n (%)	133 (31.4)
Headache, n (%)	76 (17.9)
Gastrointestinal symptoms, n (%)[a]	74 (17.5)
Sore throat, n (%)	59 (13.9)
Myalgias, n (%)	57 (13.4)
Fatigue, n (%)	26 (6.1)
Ageusia, n (%)	24 (5.7)
Anosmia, n (%)	24 (5.7)
Chest pain, n (%)	24 (5.7)
Chills, n (%)	16 (3.8)
Asymptomatic, n (%)	54 (12.7)

TABLE. Signs and symptoms among 291 pediatric (age <18 years) and 10,944 adult (age 18–64 years) patients* with laboratory-confirmed COVID-19 — United States, February 12–April 2, 2020

	No. (%) with sign/symptom	
Sign/Symptom	Pediatric	Adult
Fever, cough, or shortness of breath†	213 (73)	10,167 (93)
Fever§	163 (56)	7,794 (71)
Cough	158 (54)	8,775 (80)
Shortness of breath	39 (13)	4,674 (43)
Myalgia	66 (23)	6,713 (61)
Runny nose¶	21 (7.2)	757 (6.9)
Sore throat	71 (24)	3,795 (35)
Headache	81 (28)	6,335 (58)
Nausea/Vomiting	31 (11)	1,746 (16)
Abdominal pain**	17 (5.8)	1,329 (12)
Diarrhea	37 (13)	3,353 (31)

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MMWR Morb Mortal Wkly Rep 2020;69:422–426.
Otto W. JPIDS. November 2020

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Teenagers' symptoms are similar to adults

Supplementary Table 2: Symptoms of children with a positive SARS-CoV-2 test, by age

	0-12 months (n=70)	1-5 years (n=96)	6-11 years (n=77)	12-17 years (n=134)	18-21 years (n=47)
Fever or cough or shortness of breath	56 (80.0%)	77 (80.2%)	58 (75.3%)	91 (67.9%)	36 (76.6%)
Fever	45 (64.3%)	54 (56.2%)	42 (54.5%)	59 (44.0%)	17 (36.2%)
Cough	37 (52.9%)	52 (54.2%)	36 (46.8%)	66 (49.3%)	30 (63.8%)
Shortness of Breath [a]	12 (17.1%)	5 (5.2%)	8 (10.4%)	24 (17.9%)	13 (27.7%)
Congestion	42 (60.0%)	35 (36.5%)	13 (16.9%)	26 (19.4%)	17 (36.2%)
Sore Throat	0 (0.0%)	4 (4.2%)	14 (18.2%)	26 (19.4%)	15 (31.9%)
Agueusia	0 (0.0%)	0 (0.0%)	1 (1.3%)	11 (8.2%)	12 (25.5%)
Anosmia	0 (0.0%)	0 (0.0%)	2 (2.6%)	9 (6.7%)	13 (27.7%)
Chest pain	0 (0.0%)	0 (0.0%)	3 (3.9%)	16 (11.9%)	5 (10.6%)
Myalgias	0 (0.0%)	2 (2.1%)	10 (13.0%)	30 (22.4%)	15 (31.9%)
Chills	0 (0.0%)	3 (3.1%)	1 (1.3%)	8 (6.0%)	4 (8.5%)
Headache	0 (0.0%)	3 (3.1%)	19 (24.7%)	37 (27.6%)	17 (36.2%)
Gastrointestinal symptoms [b]	14 (20.0%)	21 (21.9%)	17 (22.1%)	17 (12.7%)	5 (10.6%)
Fatigue	2 (2.9%)	2 (2.1%)	5 (6.5%)	10 (7.5%)	7 (14.9%)
Asymptomatic	8 (11.4%)	15 (15.6%)	10 (13.0%)	19 (14.2%)	2 (4.3%)

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Otto W. JPIDS. 2020

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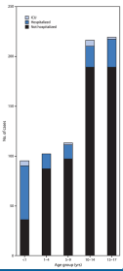
COVID-19 Severity in Children

- Most children have mild or asymptomatic infection
- Hospitalization is uncommon ~12%
- 20-30% of hospitalized children required ICU care
- No difference in hospitalization by race/ethnicity
- Death is rare 0.01% of infected children



LOVE WILL.

MMWR Morb Mortal Wkly Rep. 2020;69:422–426. *JAMA Network Open.* 2021;4(4):e216556.
MMWR Morb Mortal Wkly Rep. 2020;69:1081–1088. *JAMA Network Open.* 2021;4(4):e215298

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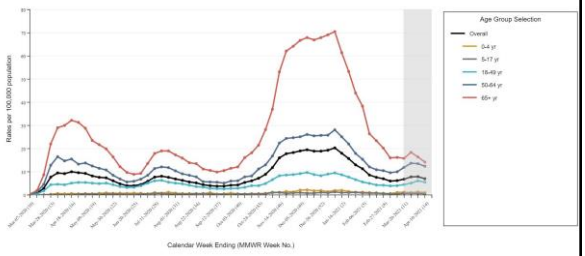
Laboratory-Confirmed COVID-19-Associated Hospitalizations

Preliminary weekly rates as of Apr 10, 2021



https://www.cdc.gov/coronavirus/2019-ncov/covid-data/covidview/index.html

Identifying high-risk children

Underlying medical condition[a]	
No underlying condition	30 (24.8)
≥1 underlying condition	91 (75.2)
≥2 underlying conditions	54 (44.6)
Chronic lung disease**	34 (28.1)
Obesity*	33 (27.3)
Neurologic and developmental[††]	26 (21.5)
Cardiovascular disease[§§]	22 (18.2)
Cancer or immunosuppressive condition***	17 (14.0)
Diabetes mellitus[†††]	11 (9.1)
Chronic kidney disease	5 (4.1)
Chronic liver disease	3 (2.5)
Other[¶¶¶]	37 (30.6)

Characteristic	Severe acute COVID-19 (n = 577)
Age, median (IQR), y	11.7 (1.2-16.6)
Sex, No. (%)	
Male	307 (53.2)
Female	270 (47.8)
Race/ethnicity, No. (%)[f]	
No.	529
White, non-Hispanic (n = 174)	108 (19.0)
Black, non-Hispanic (n = 310)	129 (22.7)
Hispanic or Latino (n = 455)	262 (45.5)
Other, non-Hispanic (n = 67)	40 (7.1)
Underlying medical conditions, No. (%)	
At least 1 underlying condition[c]	358 (62.1)
Obesity[d]	176 (41.8)
Respiratory	151 (26.2)
Other[e]	223 (38.6)
Neurological/neuromuscular	104 (18.0)
Cardiovascular	57 (9.8)

LOVE WILL. Bixler D et al. MMWR Morb Mortal Wkly Rep 2020;69:1324–1329 Children's Mercy

Bixler D et al. MMWR Morb Mortal Wkly Rep 2020;69:1324–1329Lee LR et al. JAMA. March 16, 2021

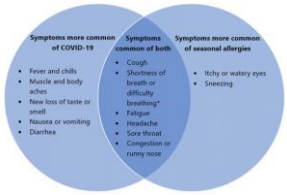
Older children and children of color have higher mortality rates

TABLE. Demographic and clinical characteristics of SARS-CoV-2–associated deaths among persons aged <21 years — United States, February 12–July 31, 2020[a]

Characteristic	No. (%)
Total	121 (100)
Age group, yrs	
<1	12 (9.9)
1–4	11 (9.1)
5–9	13 (10.7)
10–13	12 (9.9)
14–17	23 (19.0)
18–20	50 (41.3)
Race/Ethnicity	
Hispanic	54 (44.6)
American Indian/Alaska Native, non-Hispanic	5 (4.1)
Asian or Pacific Islander, non-Hispanic	5 (4.1)
Black, non-Hispanic	35 (28.9)
White, non-Hispanic	17 (14.0)
Multiple/Other*	2 (1.7)
Missing/Unknown	3 (2.5)

LOVE WILL. Bixler D et al. MMWR Morb Mortal Wkly Rep 2020;69:1324–1329 Children's Mercy

Overlap of COVID-19 and allergies



LOVE WILL. https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/infographic-overlap-symptoms.html Children's Mercy

What is happening with the COVID-19 variants?

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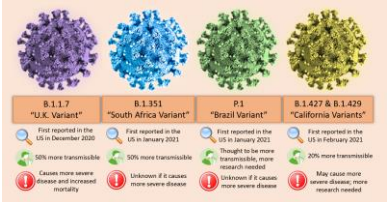
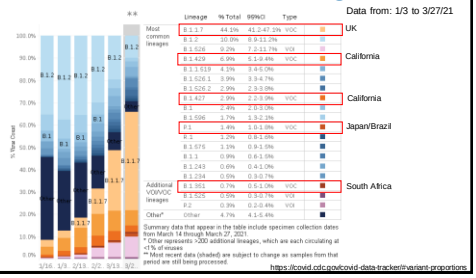
Variant classifications & definitions

- Variants of interest
- Variants of concern
- Variants of high consequence



LOVE WILL. https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/variant-surveillance/variant-info.html Children's Mercy

SARS-CoV-2 Variants Circulating in US



	ORIGINAL VIRUS	B.1.1.7	B.1.351	P.1
Pfizer-BioNTech	95%	Same efficacy	Reduced antibody levels	Same efficacy
Moderna	94%	Same efficacy	Reduced antibody levels	More data needed
J&J	72%*	Same efficacy	Reduced efficacy (in South Africa trials)	Reduced efficacy (in Latin America trials)
AstraZeneca	60-90%	Same efficacy	Reduced efficacy	Same efficacy

Note: *In US trials. Average of 66% efficacy with South Africa and Latin America trials included.

Source: UW Medicine; Reuters; Lancet; Lancet Preprint; Biorxiv; Moderna; Nature; New England Journal of Medicine; Imperial College London; CDC/CoV-lineages.org

INSIDER

What is the epidemiology of MIS-C?

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MIS-C Case Definition

Case Definition for Multisystem Inflammatory Syndrome in Children (MIS-C)

- An individual aged <21 years presenting with fever[1], laboratory evidence of inflammation[2], and evidence of clinically severe illness requiring hospitalization, with multisystem (>2) organ involvement (cardiac, renal, respiratory, hematologic, gastrointestinal, dermatologic or neurological); AND
- No alternative plausible diagnoses; AND
- Positive for current or recent SARS-CoV-2 infection by RT-PCR, serology, or antigen test; or COVID-19 exposure within the 4 weeks prior to the onset of symptoms

LOVE WILL. https://www.cdc.gov/mis-c/cases/index.html Children's Mercy

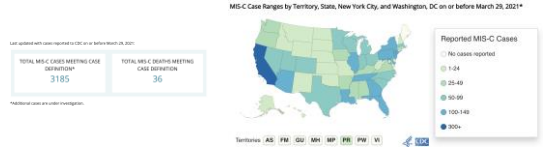
Most children do not have a preceding history of COVID-19

Table 1. Characteristics of Patients With MIS-C by Age Group, United States, March 2020 to January 2021

Variable	All MIS-C cases (N = 1733), No. (%)	Age, No. (%), y[a] 0-4 (n = 445)	5-9 (n = 588)	10-14 (n = 451)	15-17 (n = 191)	18-20 (n = 55)	P value[b]
Preceding COVID-19–like illness[c]	265 (24.7)	50 (18.1)	62 (16.4)	86 (30.7)	50 (43.9)	17 (63)	<.001
Incidence per 100 000 children	2.1	2.3	2.9	2.2	1.5	0.4	<.001

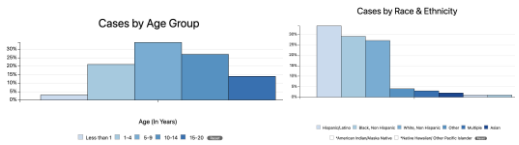
LOVE WILL. Belay E et al. JAMA Peds 2021 Children's Mercy

MIS-C cases across the U.S.



LOVE WILL. https://www.cdc.gov/mis-c/cases/index.html Children's Mercy

Most children are school-aged and Hispanic/Latino or Black



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Differentiating between MIS-C and severe acute COVID-19

Table 1. Baseline Characteristics of Patients With MIS-C and Severe Acute COVID-19 and Initial Laboratory Values Within 48 Hours of Admission[a,b,c]

Characteristic	Study cohort from the Overcoming COVID-19 registry (N = 1116)	
	MIS-C (n = 539)	Severe acute COVID-19 (n = 577)
Age, median (IQR), y	8.9 (4.7-13.2)	11.7 (1.2-16.6)
Race/ethnicity, No. (%)[d]		
No.	421	529
White, non-Hispanic (n = 174)	66 (13.3)	108 (19.0)
Black, non-Hispanic (n = 310)	181 (34.7)	129 (22.7)
Hispanic or Latino (n = 455)	193 (35.9)	262 (45.5)
Other, non-Hispanic (n = 67)	27 (5.5)	40 (7.1)
Underlying medical conditions, No. (%)		
At least 1 underlying condition[e]	167 (30.9)	358 (62.1)
Organ systems involved, median (IQR)[f]	4.0 (3.0-5.0)	2.0 (1.0-3.0)
Symptoms and signs on presentation, No. (%)[c]		
Constitutional	536 (99.4)	472 (81.8)
Gastrointestinal	486 (90.2)	332 (57.5)
Mucocutaneous	360 (66.8)	59 (10.2)
Lower respiratory	232 (43.0)	359 (62.2)

LOVE WILL. Feldstein LR et al. JAMA. March 16, 2021 Children's Mercy

GI symptoms are common

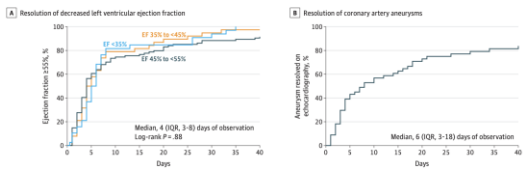
Table 1. Characteristics of Patients With MIS-C by Age Group, United States, March 2020 to January 2021

Variable	All MIS-C cases (N = 1733), No. (%)	Age, No. (%), y[a] 0-4 (n = 445)	5-9 (n = 588)	10-14 (n = 451)	15-17 (n = 191)	18-20 (n = 55)	P value[b]
Signs and symptoms							
Abdominal pain[c]	1153 (66.5)	187 (42)	475 (80.8)	330 (73.2)	123 (64.4)	37 (67.3)	<.001
Vomiting	1114 (64.3)	233 (52.4)	426 (72.4)	305 (67.6)	121 (63.4)	27 (49.1)	<.001
Diarrhea	931 (53.7)	218 (49)	331 (56.3)	246 (54.5)	105 (55)	30 (54.5)	.22
Rash	963 (55.6)	303 (68.1)	354 (60.2)	221 (49)	65 (34)	20 (36.4)	<.001
Conjunctival hyperemia	929 (53.6)	248 (55.7)	362 (61.6)	250 (55.4)	58 (30.4)	10 (18.2)	<.001
Cough	490 (28.3)	111 (24.9)	131 (22.3)	145 (32.2)	76 (39.8)	27 (49.1)	<.001
Shortness of breath[d]	475 (27.4)	67 (15.1)	141 (24)	153 (33.9)	84 (44)	29 (52.7)	<.001
Chest pain or tightness[e]	252 (14.5)	6 (1.3)	57 (9.7)	100 (22.2)	66 (34.6)	23 (41.8)	<.001
Clinical findings							
Hypotension	880 (50.8)	160 (36)	297 (50.5)	283 (62.7)	109 (57.1)	29 (52.7)	<.001
Shock	638 (36.8)	110 (24.7)	218 (35.7)	207 (45.9)	88 (46.1)	22 (40)	<.001

LOVE WILL. Belay E et al. JAMA Peds April 6, 2021 Children's Mercy

Most children with MIS-C recover

Figure 4. Cardiovascular Outcomes of Patients With MIS-C[a]



LOVE WILL. Feldstein LR et al. JAMA. March 16, 2021 Children's Mercy

Conclusions

- CoV can infect animals and humans
- Children can transmit the virus that causes COVID-19
- Children less commonly infected than adults; & are often mild or asymptomatic
- Variant viruses develop with ongoing virus replication
- A small proportion of children get severe acute COVID-19
- Children who get MIS-C may not have had significant COVID-19 infection

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Questions?

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