

RACHEL CAFFERTY, MD
JUNE 12, 2020

COVID-19 MULTISYSTEM INFLAMMATORY SYNDROME IN CHILDREN (MIS-C)

OBJECTIVES

- Review case numbers of COVID-19 in pediatrics
- Discuss clinical features of multisystem inflammatory syndrome in children (MIS-C)
 - Overlap with Kawasaki disease and toxic shock syndrome
- Review management of MIS-C and pediatric shock management



COVID-19 MULTISYSTEM INFLAMMATORY SYNDROME IN CHILDREN (MIS-C)

REVIEW OF THE NUMBERS



Total Confirmed

7,415,319

Confirmed Cases by
Country/Region/Sovereignty

2,003,930 US

772,416 Brazil

501,800 Russia

292,854 United
Kingdom

286,576 India

242,280 Spain

235,763 Italy



Global Deaths

417,514

113,038 deaths
US

41,364 deaths
United Kingdom

39,680 deaths
Brazil

34,114 deaths
Italy

◀ Global Deaths ▶

US State Level

Deaths, Recovered

30,542 deaths, **68,019**
recovered
New York US

12,377 deaths, **28,207**
recovered
New Jersey US

7,454 deaths,
recovered
Massachusetts US

◀ US Deaths, R... ▶

Total Number of Confirmed Child COVID-19 Cases in the US, Reported on 5/28/20



COVID - 19 Colorado Case Summary

Data is updated daily by about 4 p.m. and includes cases reported through the previous day.

28,499
Cases

5,035
Hospitalized

60
Counties

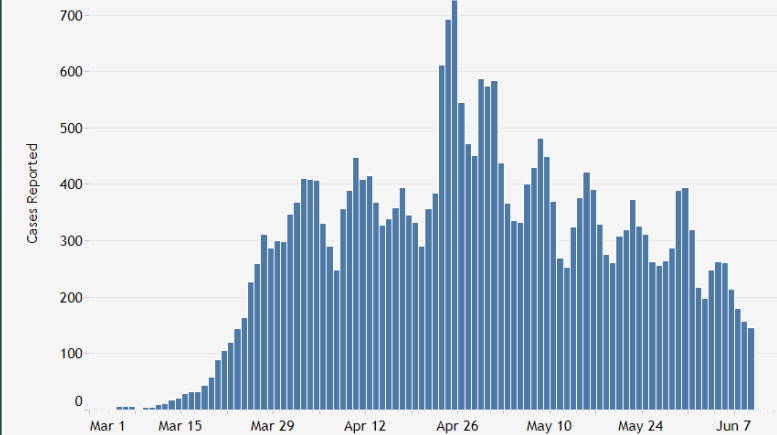
227,761
People
Tested

1,573
Deaths
Among Cases

1,328
Deaths Due
to COVID-19

306
Outbreaks

3 Day Average of COVID-19 Cases in Colorado by Date Reported to the State

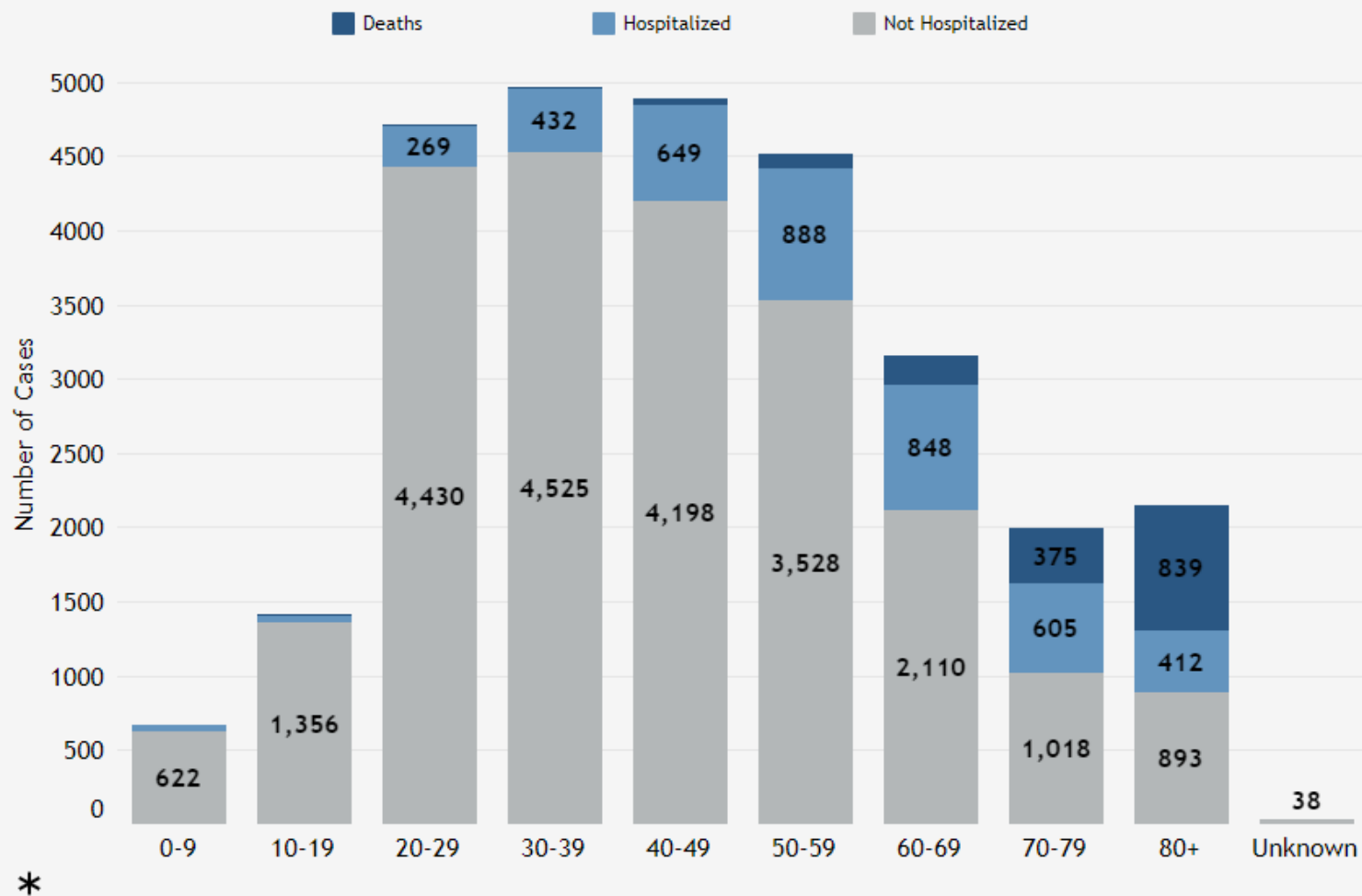


*

COVID-19 in Colorado by Age Group

	Cases	Deaths	CO
0-9	2.35%	0.00%	11.85%
10-19	4.97%	0.19%	13.11%
20-29	16.52%	0.57%	14.61%
30-39	17.43%	0.64%	14.56%
40-49	17.16%	2.73%	13.04%
50-59	15.83%	6.04%	12.67%
60-69	11.08%	12.65%	10.91%
70-79	7.01%	23.84%	6.12%
80+	7.52%	53.34%	3.13%
Unknown	0.13%	0.00%	0.00%

Cases of COVID-19 Reported in Colorado by Age Group, Hospitalization and Outcome



> JAMA. 2020 Feb 24. doi: 10.1001/jama.2020.2648. Online ahead of print.

Characteristics of and Important Lessons From the Coronavirus (COVID-19) Outbreak in China: Summary of Cases From the

> N Engl J Med. 2020 Apr 23;382(17):1663-1665. doi: 10.1056/NEJMc2005073. Epub 2020 Mar 18.

SARS-CoV-2 Infection in Children

Chi > MMWR Morb Mortal Wkly Rep. 2020 Apr 10;69(14):422-426. doi: 10.15585/mmwr.mm6914e4.

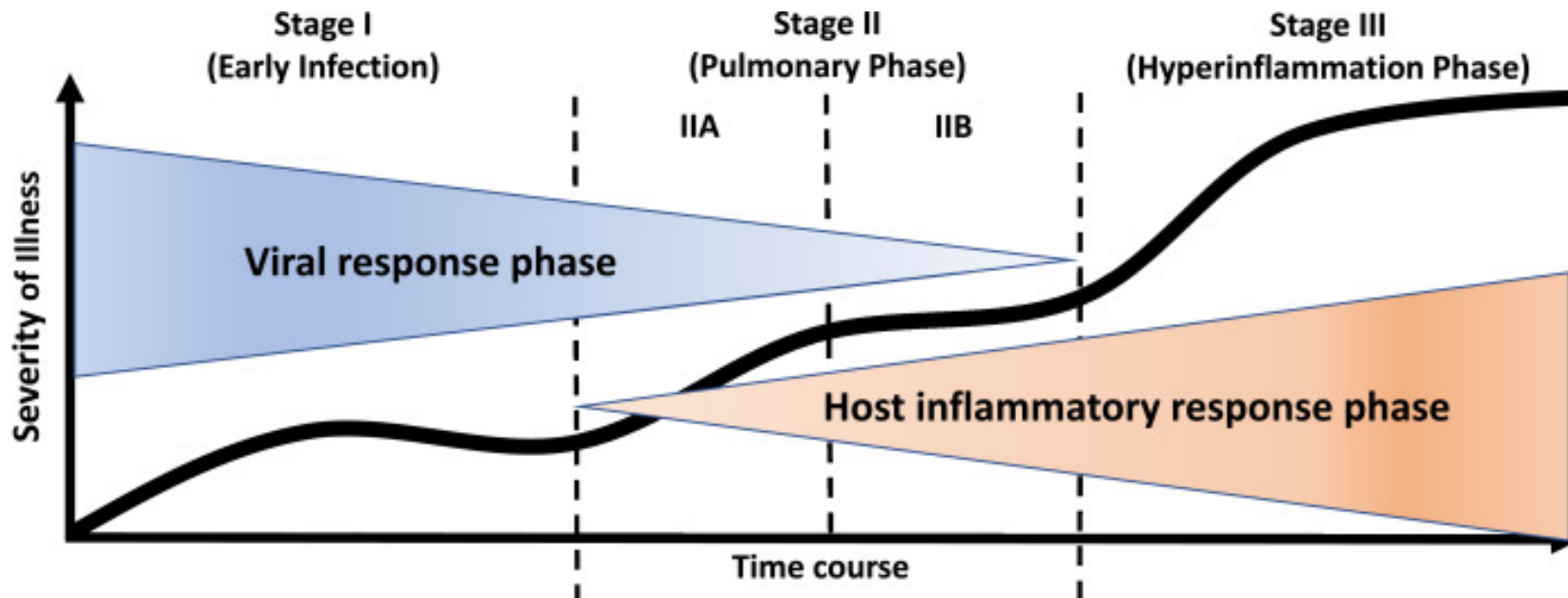
Zunyo

Coronavirus Disease 2019 in Children – United States, February 12–April 2, 2020

CDC COVID-19 Response Team

hang
inbo
a M
inese

PEDIATRIC COVID-19 INFECTIONS:



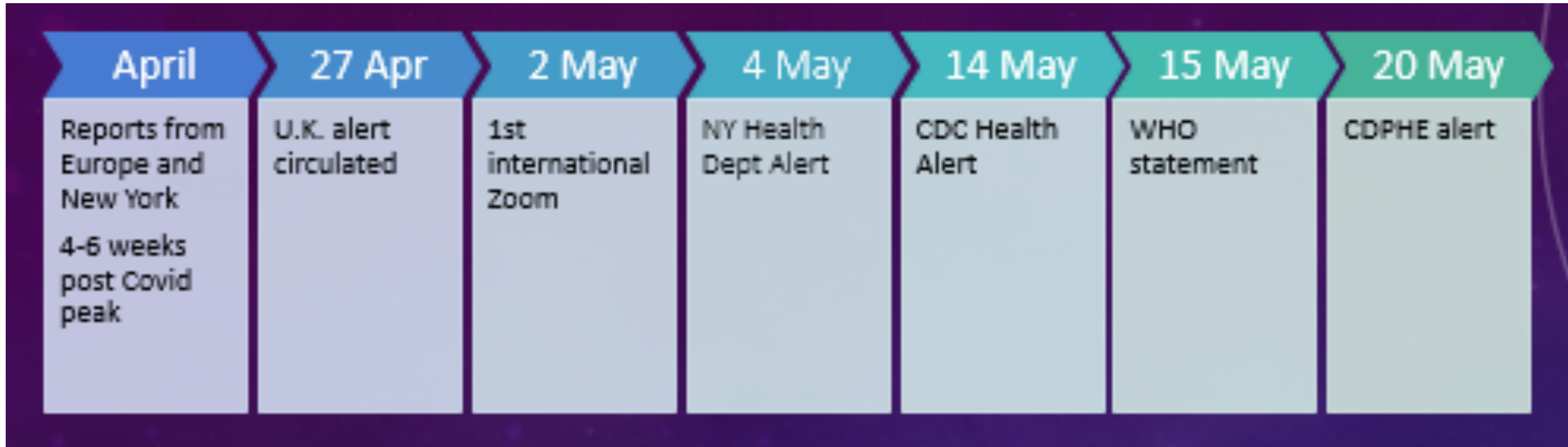
- Mild symptoms
- Asymptomatic – low viral load



COVID-19 MULTISYSTEM INFLAMMATORY SYNDROME IN CHILDREN (MIS-C)

WHAT IS MIS-C?







Guidance: Paediatric multisystem inflammatory syndrome temporally associated with COVID-19

Health experts looking at reports of coronavirus-related syndrome among children

[UK News](#) | Published: Apr 27, 2020

THE LANCET

CORRESPONDENCE | [VOLUME 395, ISSUE 10237, P1607-1608, MAY 23, 2020](#)

Hyperinflammatory shock in children during COVID-19 pandemic

[Shelley Riphagen](#) • [Xabier Gomez](#) • [Carmen Gonzalez-Martinez](#) • [Nick Wilkinson](#) • [Paraskevi Theocharis](#)

Published: May 07, 2020 • DOI: [https://doi.org/10.1016/S0140-6736\(20\)31094-1](https://doi.org/10.1016/S0140-6736(20)31094-1)

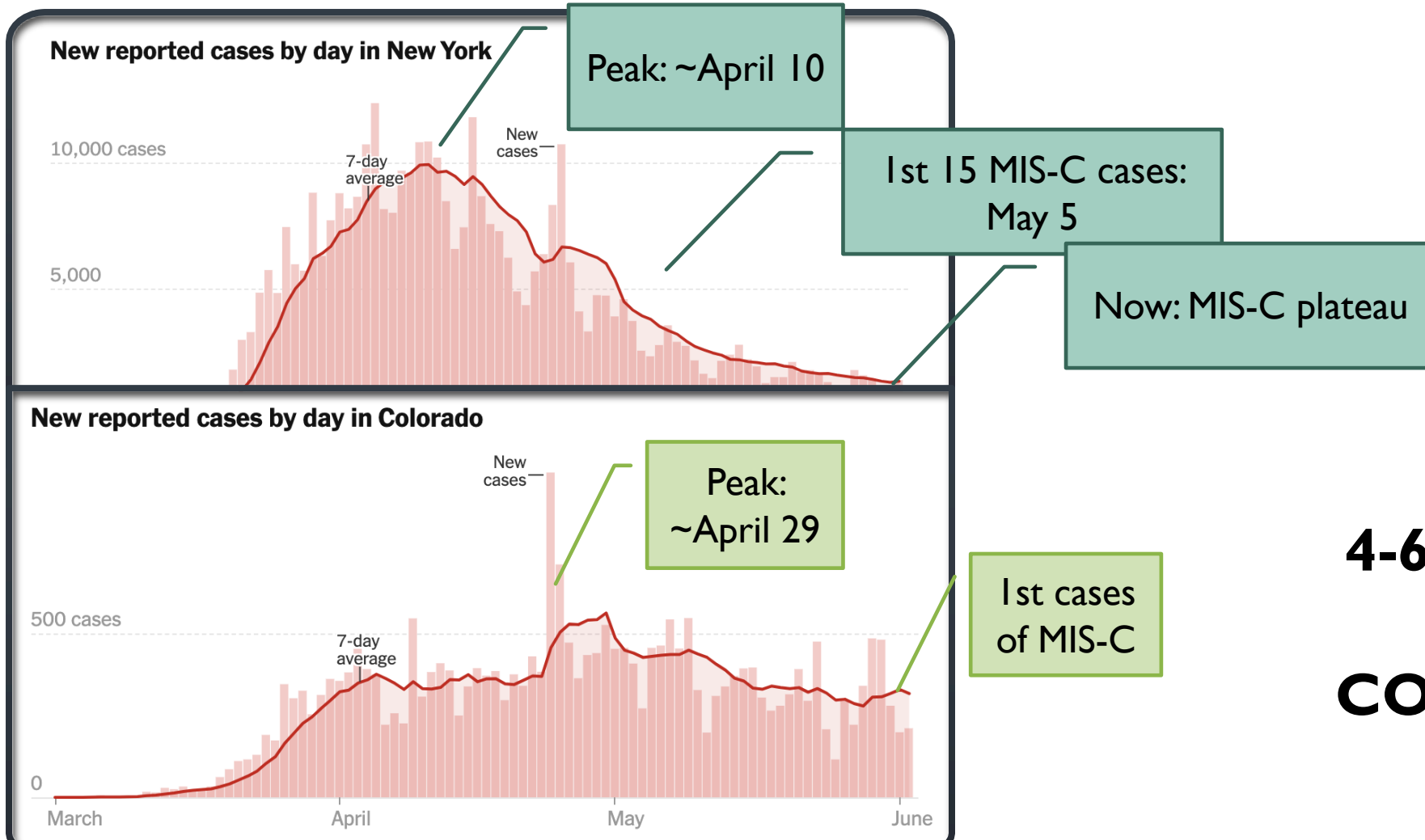
THE LANCET

ARTICLES | [ONLINE FIRST](#)

An outbreak of severe Kawasaki-like disease at the Italian epicentre of the SARS-CoV-2 epidemic: an observational cohort study

[Lucio Verdoni, MD](#) • [Angelo Mazza, MD](#) • [Annalisa Gervasoni, MD](#) • [Laura Martelli, MD](#) • [Maurizio Ruggeri, MD](#) • [Matteo Ciuffreda, MD](#) • et al. [Show all authors](#)

EPIDEMIOLOGY OF MIS-C



4-6 weeks after regional COVID-19 peak

A CASE

CC: FEVER

3 yo male referred from PCP to ED for fever x6 days. He has had a new rash on his trunk and parents have noted that his hands and feet are swollen. He has been fussy/irritable from his baseline playful self. His lips and tongue appear red, which parents attribute to being dehydrated.

He has had no recent cough, congestion, rhinorrhea, otalgias, sore throat, headache, abdominal pain, nausea/vomiting, or diarrhea.

Echocardiogram demonstrated an aneurysm of left anterior descending. Admitted for IVIG and initiated on aspirin therapy.

Diagnostic features of Kawasaki disease



CARDIAC INVOLVEMENT:

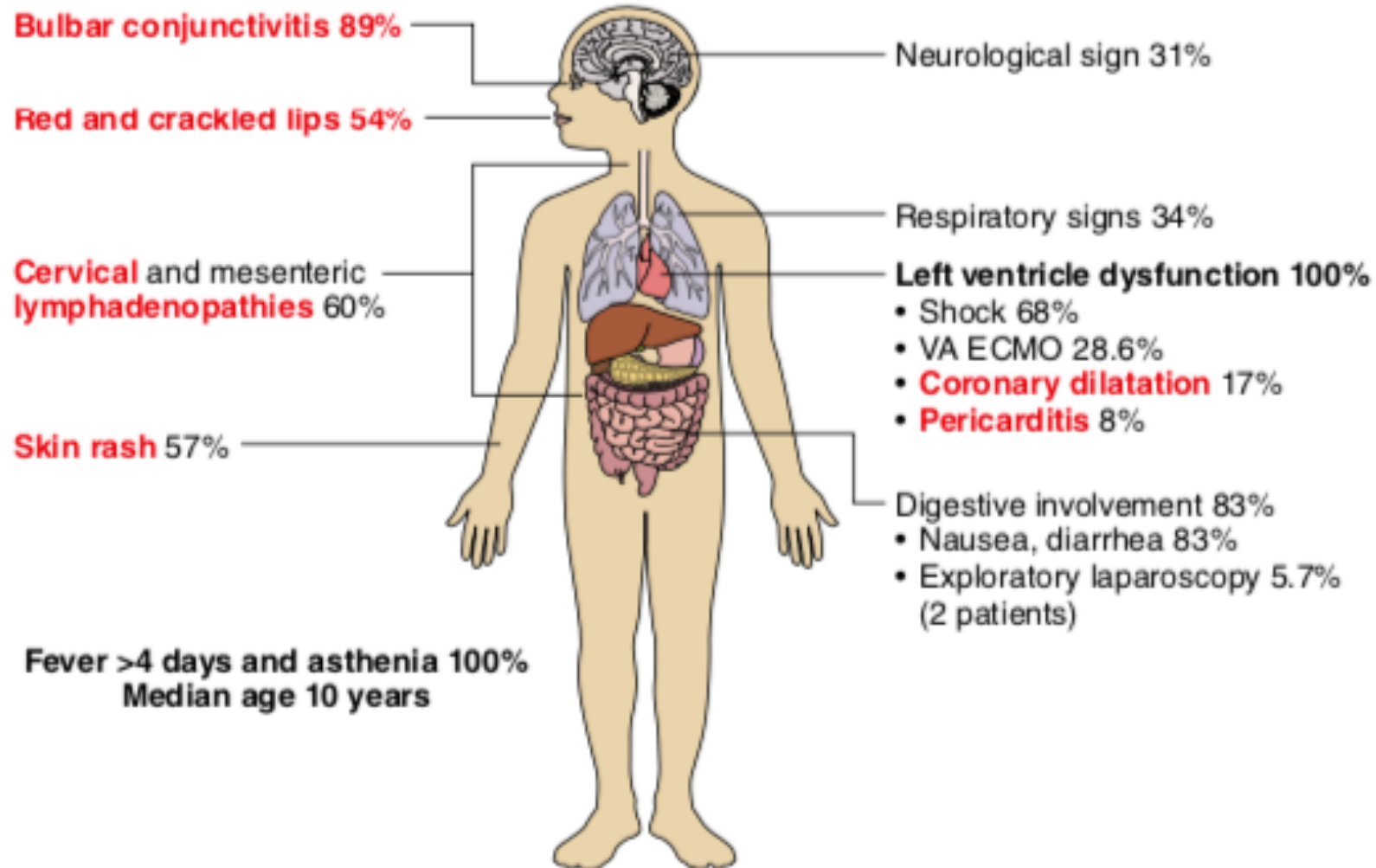
- Coronary artery dilations and aneurysms
- Thrombosis, MI, cardiac tamponade
- Myocarditis
- **Kawasaki disease is the leading cause of acquired heart disease in children in the United States.**

RASH + FEVER = MIS-C





SARS-COV-2 related multisystem inflammation



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

- An individual aged <21 years presenting with feverⁱ, laboratory evidence of inflammationⁱⁱ, 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

ⁱFever $\geq 38.0^{\circ}\text{C}$ for ≥ 24 hours, or report of subjective fever lasting ≥ 24 hours

ⁱⁱIncluding, but not limited to, one or more of the following: an elevated C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), fibrinogen, procalcitonin, d-dimer, ferritin, lactic acid dehydrogenase (LDH), or interleukin 6 (IL-6), elevated neutrophils, reduced lymphocytes and low albumin

Additional comments

- Some individuals may fulfill full or partial criteria for Kawasaki disease but should be reported if they meet the case definition for MIS-C
- Consider MIS-C in any pediatric death with evidence of SARS-CoV-2 infection

A CASE - HISTORY

- CC: Fever, Vomiting, Diarrhea
- HPI: 8 yo previously healthy male presenting with fever, vomiting, diarrhea. Fever x2-3 days with decreased po intake. Yesterday with NBNB emesis and new diarrhea. Today evaluated at OSH, where he was noted to be tachycardic, tachypneic and hypoxic.
- No headache, abdominal pain, dysuria, chest pain, dyspnea, cough/congestion.
- No ill contacts or known COVID-19 exposures

A CASE – PHYSICAL EXAM

- VS: 36.1 C, **HR 128, RR 33**, BP 96/64, SpO2 100% (1L O2)
- General: awake/alert, active, in no acute distress
- HEENT: MMM, no conjunctival injection, PERRL
- Neck: no LAD
- CV: **+Tachycardic**, regular rhythm, normal S1/S2, no murmur
- Resp: **+Rales to lower lobes bilaterally, +tachypneic**
- Abd: soft, NTND, +bowel sounds
- Skin: warm, cap refill <2sec, no rash

A CASE – ED COURSE:

- 2 view CXR reviewed – perihilar bronchial thickening
- CXR repeated - ?pneumonia – amoxicillin started
- IL O2 with persistent tachypnea (RR 28-34)
- COVID testing obtained – POSITIVE PCR
- UA: +bilirubin, +ketones, +protein
- EKG: sinus tachycardia (HR 151, afebrile)
- Febrile to 39C in ED – Tylenol, ibuprofen given
- Admit to gen peds

A CASE – HOSPITAL DAY 1

- 4 days of fever, +V/D, COVID-19 positive
- On exam in AM found to have new S3 gallop with diffuse abdominal tenderness and guarding. Labs and imaging obtained.
- **CRP: 22.9** **ESR: 51**
- **Procalcitonin 7.7**
- CMP: Na 132, Albumin 2.6 CBC: Hgb 10.9, Plt 65
- **Pro-BNP: 4,400**
- **Stat echo: low-normal EF**
- CT chest/abdomen/pelvis – eval for PE and abdominal pain – normal
- Rheum, ID, cardiology consulted → recommend IVIG due to concern for MIS-C

A CASE – HOSPITAL DAY 2

- Code/rapid response activated for worsening tachycardia and tachypnea – escalation to 8L HFNC
- Developed bilateral non-purulent conjunctival injection, mucosal erythema, and swelling of bilateral extremities as well as palmar/plantar erythema
- Transferred to PICU with concern for compensated distributive/septic shock
- **Repeat ECHO: dilated left coronary with aneurysm of the LAD, dilated right circumflex, EF 46% (mildly decreased function compared to yesterday)**

A CASE – HOSPITAL COURSE:

- IVIG and Infliximab x1
- Improvement in inflammatory markers, O₂ requirement, and fever curve
- **Repeat Echo before discharge with normal function and resolution of coronary aneurysm**
- Discharged home on hospital day 7

THE LANCET

An outbreak of severe Kawasaki-like disease at the Italian epicentre of the SARS-CoV-2 epidemic: an observational cohort study

[Lucio Verdoni, MD](#) · [Angelo Mazza, MD](#) · [Annalisa Gervasoni, MD](#) · [Laura Martelli, MD](#) · [Maurizio Ruggeri, MD](#) · [Matteo Ciuffreda, MD](#) · et al. [Show all authors](#)

Published: May 13, 2020 · DOI: [https://doi.org/10.1016/S0140-6736\(20\)31103-X](https://doi.org/10.1016/S0140-6736(20)31103-X)



KAWASAKI DISEASE PRE-COVID-19:

- 19 patients (2015-2020)
- Mean age 3 years
- Cardiac involvement: 10%
- KDSS: 0
- MAS: 0
- IVIG + steroids: 16% (3/19)

MIS-C:

- 10 patients (Feb-April 2020)
- Mean age 7.5 years
- Cardiac involvement: 60%
- KDSS: 50%
- MAS: 50%
- IVIG + steroids: 80%
- 80% positive IgM/IgG for COVID-19

TOXIC SHOCK:

MSSA and GAS:

- Fever (≥ 102.0 F)
- Rash (Erythroderma)
- Desquamation (1-2 wks)
- Hypotension
- Multisystem involvement

3 or more Organ Systems:

- GI
- Muscular (CK)
- Mucus membrane
- Renal (BUN/Cr, UA)
- Hepatic (tBili, ALT, AST)
- Hematologic (Plt $< 100k$)
- CNS



COVID-19 MULTISYSTEM INFLAMMATORY SYNDROME IN CHILDREN (MIS-C)


MIS-C CARDIAC MANIFESTATIONS



THE LANCET

CORRESPONDENCE | [VOLUME 395, ISSUE 10237, P1607-1608, MAY 23, 2020](#)

Hyperinflammatory shock in children during COVID-19 pandemic

[Shelley Riphagen](#)  • [Xabier Gomez](#) • [Carmen Gonzalez-Martinez](#) • [Nick Wilkinson](#) • [Paraskevi Theocharis](#)

Published: May 07, 2020 • DOI: [https://doi.org/10.1016/S0140-6736\(20\)31094-1](https://doi.org/10.1016/S0140-6736(20)31094-1)

- 8 children with hyperinflammatory shock and features of KD, atypical KD, or toxic shock syndrome.
- All progressed to shock, refractory to volume resuscitation, requiring pressor support.
- Cardiac findings: giant coronary aneurysms, cardiac arrhythmia, cerebrovascular infarct
- Markedly elevated cardiac enzymes

Circulation

Acute heart failure in multisystem inflammatory syndrome in children (MIS-C) in the context of global SARS-CoV-2 pandemic

Zahra Belhadjer, Mathilde Méot, Fanny Bajolle, Diala Khraiche, Antoine Legendre, Samya Abakka, Johanne Auriiau, Marion Grimaud, Mehdi Oualha, Maurice Beghetti, Julie Wacker, ... [See all authors](#) ✓

Originally published 17 May 2020 |

- Retrospective review of cases in France and Switzerland
- Children admitted to the PICU in 14 centers for: Cardiogenic shock, left ventricular dysfunction, and severe inflammatory state
- 35 children included
- Median age was 10 years (2-16 years)
- 88% SARS-CoV-2 positive by PCR or serology
- 33% of cases had LV EF <30%
- 80% of patients required inotropic support
 - 28% treated with ECMO

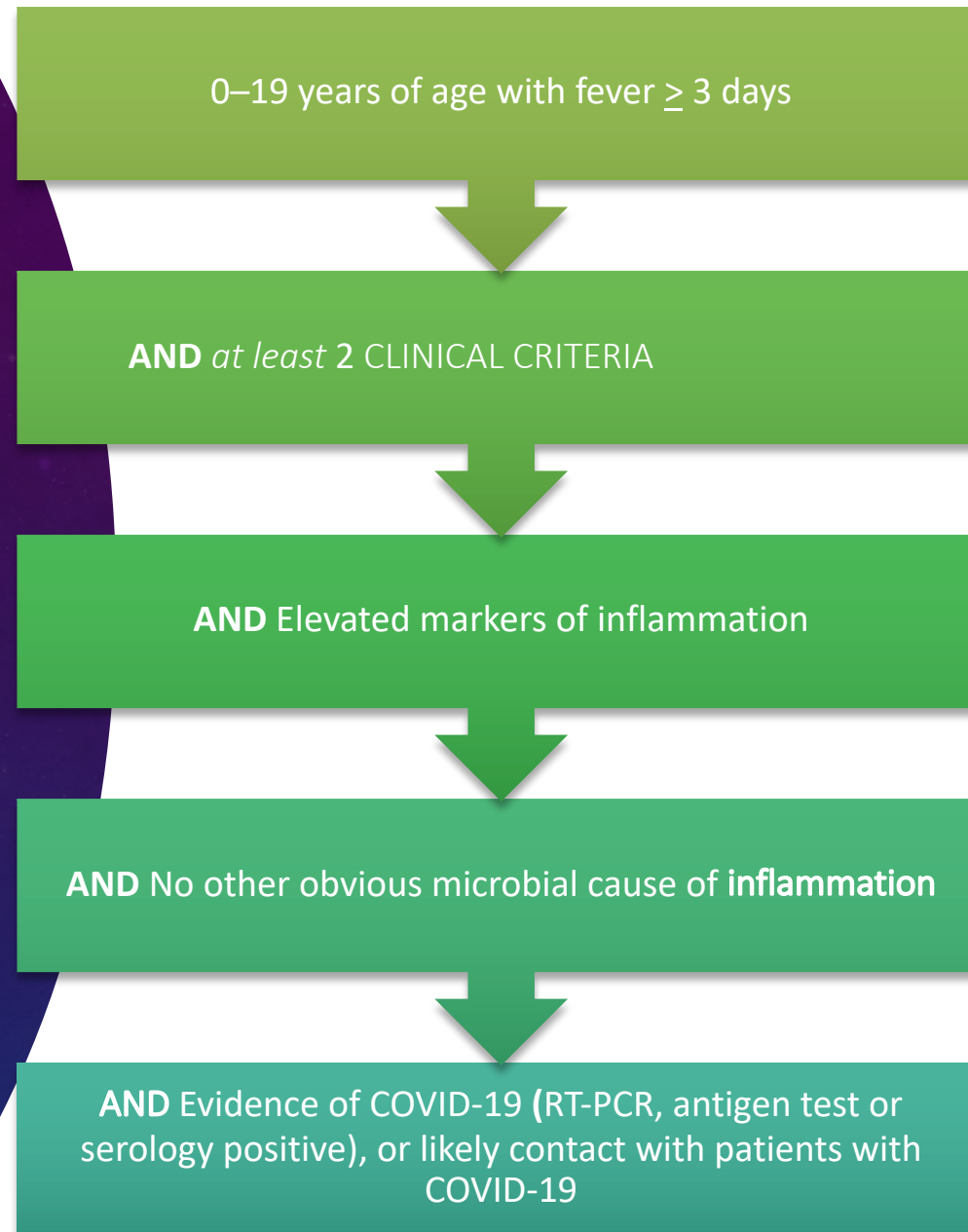


COVID-19 MULTISYSTEM INFLAMMATORY SYNDROME IN CHILDREN (MIS-C)

MANAGEMENT OF MIS-C AND PEDIATRIC SHOCK MANAGEMENT



ADAPTED
WHO
PRELIMINARY
CASE
DEFINITION



- Rash or bilateral non-purulent conjunctivitis or muco-cutaneous inflammation signs
- Hypotension or shock
- Features of myocardial dysfunction, pericarditis, valvulitis, or coronary abnormalities
- Evidence of coagulopathy
- Acute gastrointestinal problems



Multisystem Inflammatory Syndrome in Children (MIS-C) associated with Coronavirus Disease COVID-19



SICK?

1

Clinical Case Definition (CHCO), combination of CDC and WHO definitions

Children and adolescents <21 years of age with **FEVER** greater than or equal to 3 days **AND**

TWO of the following:

1. Rash or bilateral non-purulent conjunctivitis or signs of mucocutaneous inflammation (erythema and/or swelling of hands and feet, strawberry tongue, red lips)
2. Acute gastrointestinal problems (diarrhea, vomiting, and/or abdominal pain)
3. Hypotension or shock
4. Features of myocardial dysfunction, pericarditis, valvulitis, or coronary artery abnormalities (including echocardiogram findings or elevated troponin or NT-pro BNP)
5. Evidence of coagulopathy (by PT, PTT, elevated D-dimer)

Clinical diagnosis...

2

AND elevated markers of inflammation

...then confirm with labs/studies

3

Including but not limited to one or more of the following: an elevated C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), fibrinogen, procalcitonin, d-dimer, ferritin, lactic acid dehydrogenase (LDH), or interleukin 6 (IL-6), elevated neutrophils, reduced lymphocytes and low albumin

Broad ddx

4

AND no other obvious microbial cause of inflammation including bacterial sepsis, local bacterial infection (e.g. urinary tract infection, osteomyelitis, etc.), or staphylococcal and streptococcal toxic shock syndromes

AND evidence of COVID-19 (RT-PCR positive, positive serologies) **OR** likely contact with persons with COVID-19

Children and adolescents <21 years of age with **FEVER** greater than or equal to 3 days **AND**

TWO of the following:

1. Rash or bilateral non-purulent conjunctivitis or signs of mucocutaneous inflammation (erythema and/or swelling of hands and feet, strawberry tongue, red lips)
2. Acute gastrointestinal problems (diarrhea, vomiting, and/or abdominal pain)
3. Hypotension or shock
4. Features of myocardial dysfunction, pericarditis, valvulitis, or coronary artery abnormalities (including echocardiogram findings or elevated troponin or NT-pro BNP)
5. Evidence of coagulopathy (by PT, PTT, elevated D-dimer)

WHAT WE SEE IN THE ED

Fever, mucocutaneous signs, GI symptoms/signs, +/- HD stability – big DDX

Won't often know #4 and #5 on arrival



Multisystem Inflammatory Syndrome in Children (MIS-C) associated with Coronavirus Disease COVID-19



SICK?

Broad ddx

Clinical Case Definition (CHCO), combination of CDC and WHO definitions

Children and adolescents <21 years of age with **FEVER** greater than or equal to 3 days **AND**

TWO of the following:

1. Rash or bilateral non-purulent conjunctivitis or signs of mucocutaneous inflammation (erythema and/or swelling of hands and feet, strawberry tongue, red lips)
2. Acute gastrointestinal problems (diarrhea, vomiting, and/or abdominal pain)
3. Hypotension or shock
4. Features of myocardial dysfunction, pericarditis, valvulitis, or coronary artery abnormalities (including echocardiogram findings or elevated troponin or NT-pro BNP)
5. Evidence of coagulopathy (by PT, PTT, elevated D-dimer)

AND elevated markers of inflammation

Including but not limited to one or more of the following: an elevated C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), fibrinogen, procalcitonin, d-dimer, ferritin, lactic acid dehydrogenase (LDH), or interleukin-6 (IL-6), elevated neutrophils, reduced lymphocytes and low albumin

AND no other obvious microbial etiology including bacterial sepsis, local bacterial infection (e.g. urinary tract infection, osteomyelitis, etc.), or staphylococcal and streptococcal toxic shock syndromes

AND evidence of COVID-19 (RT-PCR positive, positive serologies) **OR** likely contact with persons with COVID-19

CAN BE SEPSIS or ACUTE COVID (and others)



Multisystem Inflammatory Syndrome in Children (MIS-C) associated with Coronavirus Disease COVID-19



Clinical Case Definition (CHD) - CDC and WHO definitions

Children and adolescents <21 years of age with **FEVER** greater than or equal to 3 days **AND**

TWO of the following:

1. Rash or bilateral non-purulent conjunctivitis or signs of mucocutaneous inflammation (erythema and/or swelling of hands and feet, strawberry tongue, red lips)
2. Acute gastrointestinal problems (diarrhea, vomiting, and/or abdominal pain)
3. Hypotension or shock
4. Features of myocardial dysfunction, pericarditis, valvulitis, or coronary artery abnormalities (including echocardiogram findings or elevated troponin or NT-pro BNP)
5. Evidence of coagulopathy (by PT, PTT, elevated D-dimer)

AND elevated markers of inflammation

Including but not limited to one or more of the following: an elevated C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), fibrinogen, procalcitonin, d-dimer, ferritin, lactic acid dehydrogenase (LDH), or interleukin 6 (IL-6), elevated neutrophils, reduced lymphocytes and low albumin

AND no other obvious microbial cause of inflammation including bacterial sepsis, local bacterial infection (e.g. urinary tract infection, osteomyelitis, etc.), or staphylococcal and streptococcal toxic shock syndromes

AND evidence of COVID-19 (RT-PCR positive, positive serologies) **OR** likely contact with persons with COVID-19

EARLY
THERAPY

INFECTION
CONTROL

CAN BE
SEPSIS
or
ACUTE
COVID
(and
others)

Fever ≥ 3 days **AND** ≥ 2 criteria
consistent with suspected MIS-
C based on clinical case
definition?

Yes

Hemodynamically unstable,
evidence of shock or multi-organ
dysfunction?

SICK?

SICK?
NO

Obtain Labs

- CBC with differential
- CRP, ESR
- Coagulation studies, D-dimer
- CMP, GGT
- Ferritin
- Troponin
- NT pro BNP
- Blood cultures x 2
- Urinalysis with microscopy (bag specimen similar to Kawasaki's evaluation)
- Rainbow draw for potential future labs
- SARS-CoV-2 PCR
- Consider RPP or Flu PCR
- Consider gastrointestinal pathogen panel

Any of the following lab abnormalities?

- CRP > 3.0 mg/dl
- Ferritin > 500ng/ml
- ESR > 40 mm/hr
- Troponin > 0.119 ng/ml

Yes

Further Workup

- ID consult
- Consider echocardiogram, EKG, and consult to Cardiology
 - Obtain a height for calculation of Z-score for the echocardiogram
- Consider admission to either Anschutz or Colorado Springs (COS) sites

Meets floor criteria for admission at Anschutz or COS

Yes

Admit to Floor at Anschutz or COS with ID consult for all admitted patients with MIS-C

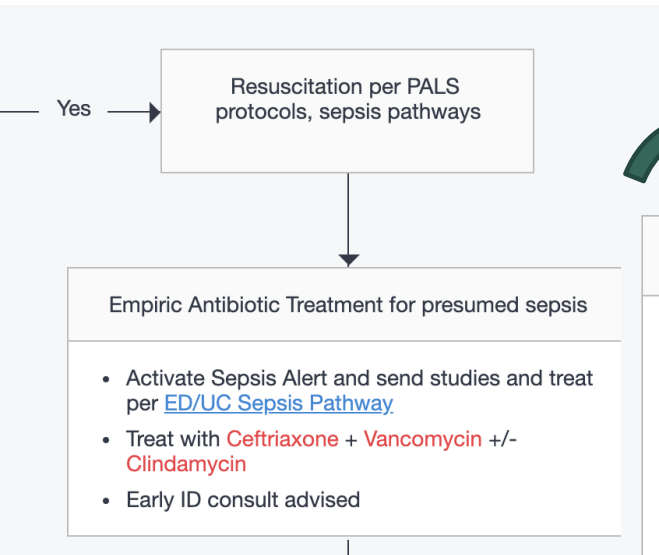
NOT SICK:

- Labs for MIS-C and other parts of the differential diagnosis (including sepsis)
- If labs are concerning for MIS-C, involve ID, cardiology
- ED treatment is generally supportive and involves early treatment for presumed sepsis

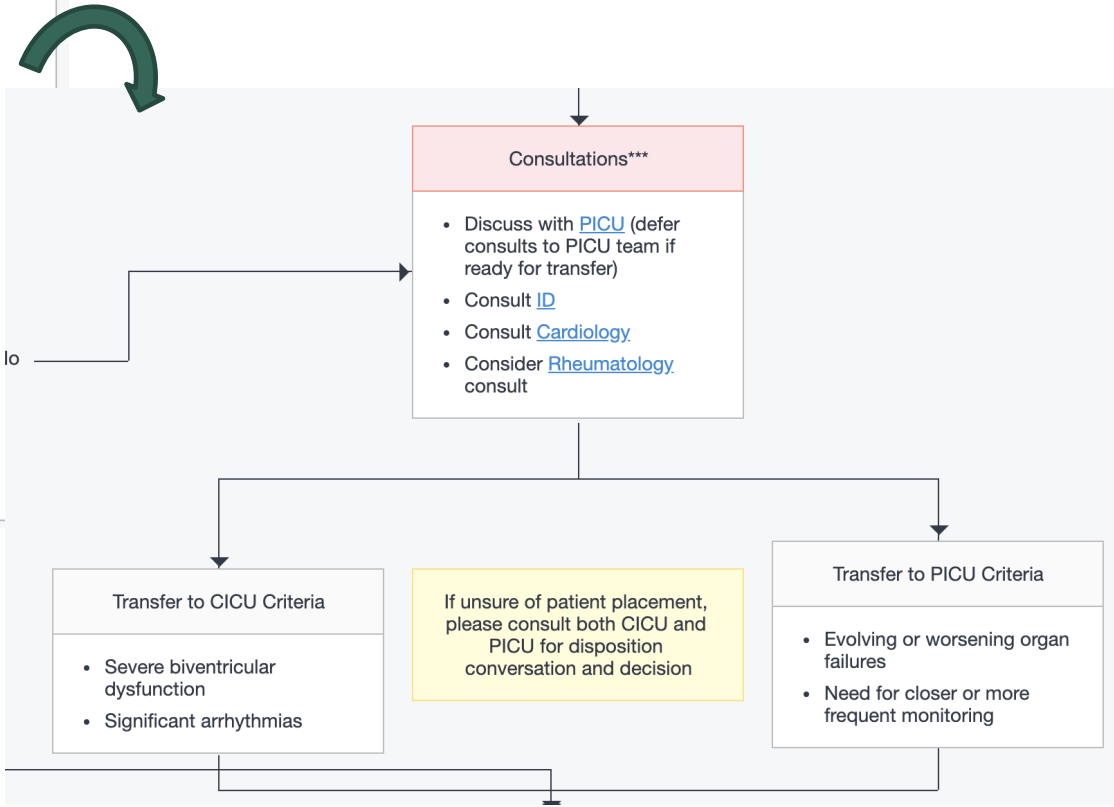
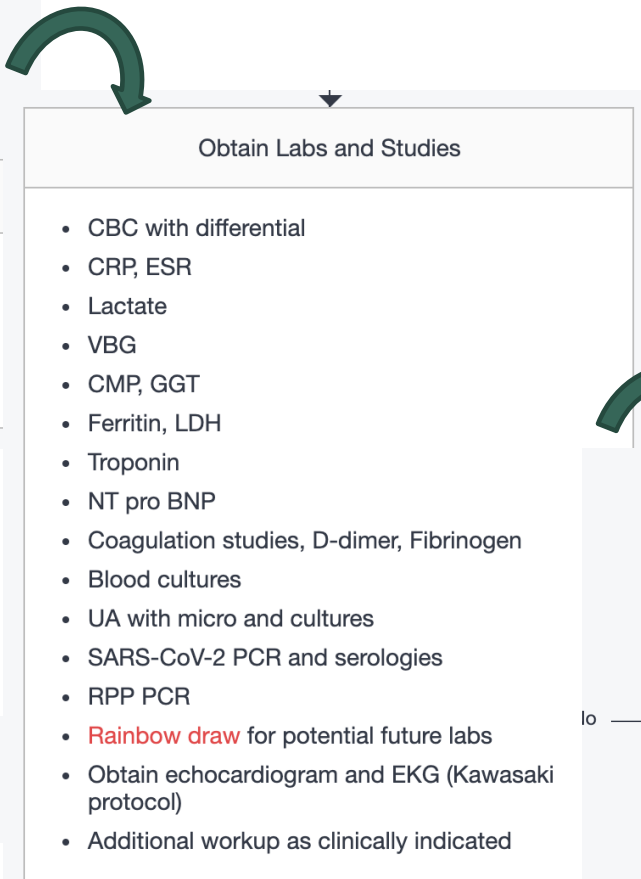
MIS-C TREATMENT AT CHCO:

- Broad spectrum antibiotics (ceftriaxone, vancomycin, +/- clindamycin)
- Supportive cares
- IVIG, aspirin
- Infliximab, Anakinra
- Consider remdesivir or methylprednisolone (not routinely recommended)

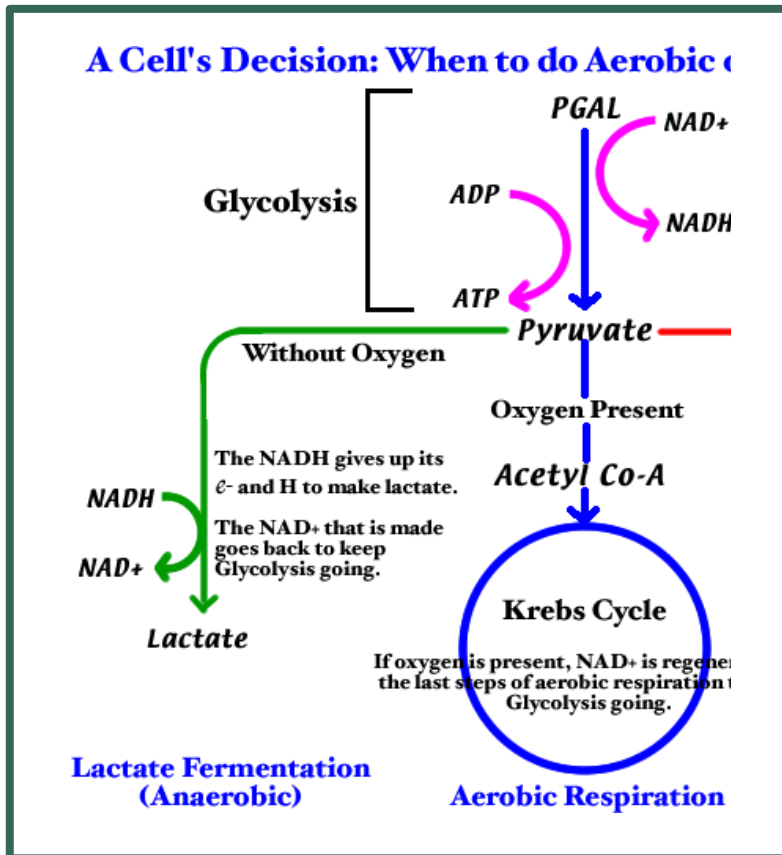
SICK?
YES



Get early echo and EKG where/when it is possible



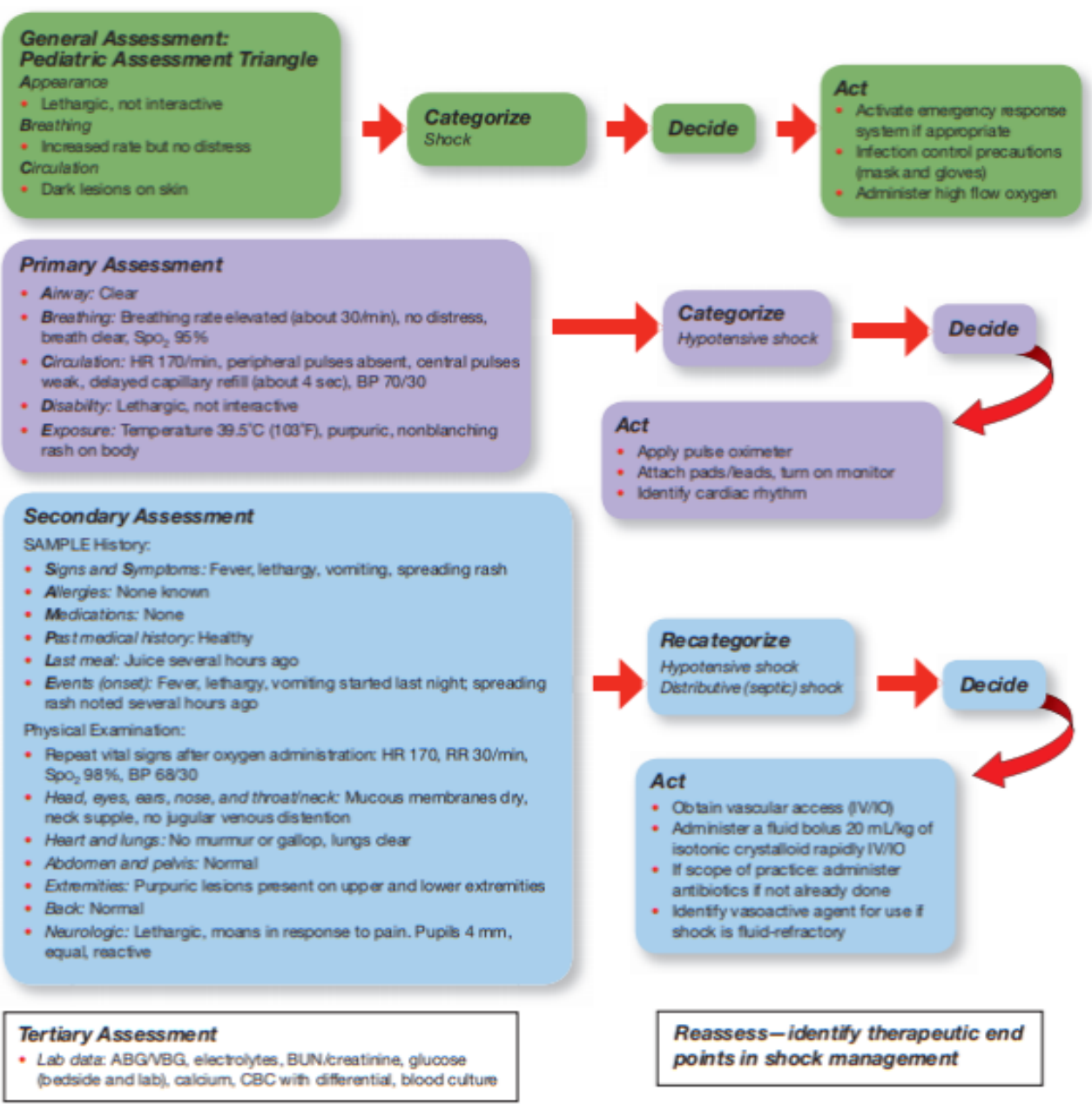
WHAT IS SHOCK?



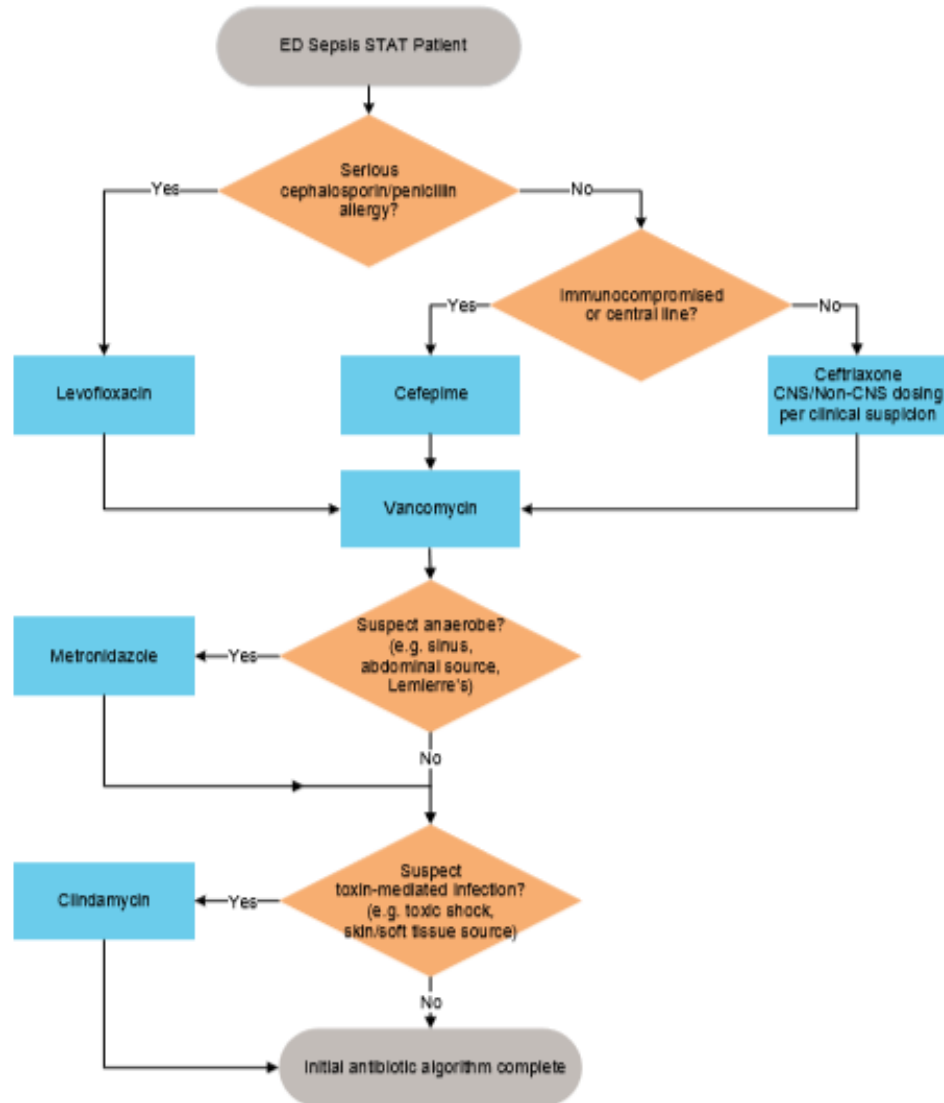
- Inadequate delivery of oxygen and nutrients to meet the metabolic demands of the tissues → cellular damage and organ failure
- Types of Shock:
 - Distributive (vasodilatory) – sepsis, anaphylaxis
 - **Hypovolemic** – dehydration, hemorrhage
 - Obstructive – tamponade, PE
 - Neurogenic
 - Cardiogenic – MIS-C
- Compensated vs un-compensated shock
- Warm vs cold shock

SEPTIC SHOCK

- Distributive, or vasodilatory shock
- Vasodilation → decreased blood flow to the brain, heart and kidneys
- Capillary leak



ED Antibigram for Suspected Sepsis in Patients > 60 Days



CHCO SEPSIS PATHWAY

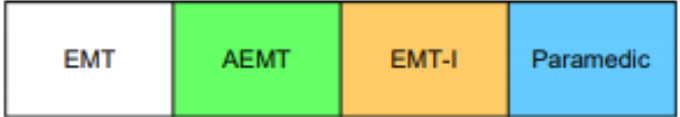
Hypotension for age and/or signs of poor perfusion

- ABCs
- Complete set of vital signs
- Full monitoring
- O₂ via NRB facemask @ 15L/min
- IV/IO access

Consider etiology of shock state

Treat dysrhythmia per appropriate protocol

Administer IV/IO fluids 20 mL/kg up to 1 L; reassess and repeat if needed



Hypotension for Age	
Age	Blood Pressure
<1 year	<70 mmHg
1-10 years	<70 + (2 x age in years)
>10 years	<90 mmHg

Tachycardia for Age	
Age	Heart Rate
<1 year	>160 bpm
1-2 years	>150 bpm
2-5 years	>140 bpm
5-12 years	>120 bpm
>12 years	>100 bpm

- Etiologies of Shock**
- Dysrhythmia, myocardial ischemia
 - Sepsis
 - Hemorrhage
 - [Anaphylaxis](#)
 - [Overdose](#)
 - Cyanide or carbon monoxide poisoning
 - Other: PE, MI, tension pneumothorax

For ongoing hypotension, poor perfusion or pulmonary edema, consider [Vasopressor Infusion](#)

If patient at risk for adrenal insufficiency, see [Adrenal Insufficiency](#) protocol

Pediatric Fluid Administration

- For children <40 kg or not longer than length based tape, hand pull/push fluid with a 60 mL syringe utilizing a 3 way stop cock.
- The treatment of compensated shock requires aggressive fluid replacement of 20 mL/kg up to 3 boluses.
- Goal of therapy is normalization of vital signs within the first hour.
- Hypotension is a late sign in pediatric shock patients.

Pediatric Shock

Signs of Compensated Shock

- Normal mental status
- Normal systolic blood pressure
- Tachycardia
- Prolonged (>2 seconds) capillary refill
- Tachypnea
- Cool and pale distal extremities
- Weak peripheral pulse

Signs of Decompensated Shock

- Decrease mental status
- Weak central pulses
- Poor color
- Hypotension for age

CARDIOGENIC SHOCK - ETIOLOGIES

- **Inadequate tissue perfusion caused by poor myocardial function** – myocarditis, cardiomyopathy, congenital heart disease >> arrhythmias, direct myocardial injury
- Your history and exam matters – poor feeding, poor growth, clammy/sweaty, tachycardia, respiratory distress, crackles, gallop, hepatomegaly, peripheral edema, JVD, femoral pulses
- Neonates (</= 30 days) – assume ductal dependent congenital heart disease
 - Dysrhythmias, dilated cardiomyopathies (metabolic disease)
- Infants and toddlers – might be ductal dependent (but unlikely to open the ductus with PGE infusion), dysrhythmias, myocarditis, cardiomyopathy (metabolic disease), structural disease (ALCAPA)
- Children – cardiomyopathy, myocarditis, Kawasaki, rhythm
- Teenagers – myocarditis, cardiomyopathy, rhythm, toxin/ingestions

CARDIOGENIC SHOCK – PRINCIPLES OF MANAGEMENT

- If hypotensive – don't withhold fluids or fear volume overload in the setting of congestive heart failure
- If hypoxemic/desaturated – don't withhold oxygen for fear of pulmonary over-circulation
- If a neonate and in shock – start PGE!
- If requiring a vasoactive – consider milrinone, epinephrine/nor-epinephrine, dopamine
- RSI and cardiogenic shock – if you don't have to intubate, don't
 - If you have to – cardiac anesthesia, code meds ready, access sites obtained, consider low-dose Epi, consider etomidate or fentanyl; avoid propofol, midazolam (potent vasodilators)

The Ethics of PPE and EMS in the COVID-19 Era

By Brian J Maguire, Dr.PH, MSA, EMT-P, Kirsty Shearer, John McKeown, MA, Scot Phelps, JD, MPH, Daniel R. Gerard, MS, RN, Kathleen A. Handal, MD, Paul Maniscalco, PhD(c), MPA, MS, EMT/P, LP and Barbara J. O'Neill, PhD, RN | 4.10.20

EMS PPE FOR COVID-19

- PPE recommended for all persons of interest (patients under investigation)
 - N-95, respirator, contact precautions
- Ethical dilemmas associated with PPE for EMS during the COVID-19 Pandemic
 - What is my ethical duty to care for patients during the pandemic (esp. in the absence of having proper PPE)?
 - If I am in a high-risk group due to my age or medical history, should I continue to care for patients (esp. in the absence of proper PPE)?
 - If I live with family members who are in a high-risk group due to age or medical history, should I continue to care for patients (esp. in the absence of proper PPE)?
 - If I believe that I might be spreading the virus to patients, patient family members, colleagues, and/or community members, should I continue to care for patients?

KEY POINTS TO REMEMBER

- COVID-19 infection is less common in the pediatric population with an overall mild clinical picture
- Multisystem inflammatory syndrome in children (MIS-C) related to COVID-19 is an evolving entity, characterized by prolonged fever, rash, GI symptoms, +/- cracked/red lips, lymphadenopathy, or other KD-like symptoms
- MIS-C patients are more likely to present with shock or cardiac involvement (aneurysms, failure)
- Maintain a broad differential diagnosis – think about KD, MIS-C, and TSS (and many viruses)
- Initiate broad spectrum antibiotics early for presumed sepsis
- Ensure appropriate PPE to prevent further spread and PROTECT YOURSELF in the process!



QUESTIONS?



REFERENCES

- Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the Chinese Center for Disease Control and Prevention. *JAMA*. 2020;323(13):1239-1242. doi:[10.1001/jama.2020.2648](https://doi.org/10.1001/jama.2020.2648)
- Lu X, Zhang L, Du H, et al; Chinese Pediatric Novel Coronavirus Study Team. SARS-CoV-2 infection in children. *N Engl J Med*. 2020;382(17):1663-1665.
- CDC COVID-19 Response Team. Coronavirus disease 2019 in children—United States, February 12–April 2, 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69(14):422-426. doi:[10.15585/mmwr.mm6914e4](https://doi.org/10.15585/mmwr.mm6914e4)
- Royal College of Paediatrics and Child Health Guidance: Paediatric multisystem inflammatory syndrome temporally associated with COVID-19, [https://www.rcpch.ac.uk/sites/default/files/2020-05/COVID-19- Paediatric-multisystem-%20inflammatory%20syndrome-20200501.pdf](https://www.rcpch.ac.uk/sites/default/files/2020-05/COVID-19-Paediatric-multisystem-%20inflammatory%20syndrome-20200501.pdf).
- Riphagen S, Gomez X, Gonzales-Martinez C, Wilkinson N, Theocharis P. Hyperinflammatory shock in children during COVID-19 pandemic. *Lancet*. 2020. Advance online publication, doi: [10.1016/S0140-6736\(20\)31094-1](https://doi.org/10.1016/S0140-6736(20)31094-1) [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(20\)31094-1/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)31094-1/fulltext)
- Verdoni L, Mazza A, Gervasoni A, Martelli L, Ruggeri M, Ciuffreda M, Bonanomi E, D'Anitga L. An outbreak of severe Kawasaki-like disease at the Italian epicentre of the SARS-CoV-2 epidemic: an observational cohort study. *Lancet*. 2020. Advance online publication, doi: [10.1016/S0140-6736\(20\)31129-6](https://doi.org/10.1016/S0140-6736(20)31129-6) [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(20\)31103-X/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)31103-X/fulltext)
- <https://www.cdc.gov/kawasaki/about.html>
- <https://www.dicardiology.com/article/kawasaki-inflammatory-disease-affects-children-covid-19%C2%A0>
- Helms J, Tacquard C, Severac F, et al. High risk of thrombosis in patients with severe SARS-CoV-2 infection: a multicenter prospective cohort study. *Intensive care medicine*. 2020
- Tang N, Li D, Wang X, Sun Z. Abnormal coagulation parameters are associated with poor prognosis in patients with novel coronavirus pneumonia. *J Thromb Haemost* 2020;18(4):844–7.
- Zhang L, Yan X, Fan Q, et al. D-dimer levels on admission to predict in-hospital mortality in patients with Covid-19. *J Thromb Haemost* 2020;:jth.14859–18.
- Shi, et al. The potential of low molecular weight heparin to mitigate cytokine storm in severe COVID-19 patients: a retrospective clinical study. *Pre-print*. April 2020
- <https://covid19treatmentguidelines.nih.gov/antithrombotic-therapy>
- Belhadjer Z, Meot M, Bajolle F, et al. Acute heart failure in multisystem inflammatory syndrome in children (MIS-C) in the context of global SARS-CoV-2 pandemic. *Circulation* 17 May 2020 <https://doi.org/10.1161/CIRCULATIONAHA.120.048360>
- <https://services.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/children-and-covid-19-state-level-data-report/>

Child Abuse for EMS Providers

POPPC LECTURE

JUNE 12, 2020

Objectives

1. Review historical perspectives and the epidemiology of abuse
2. Understand keys to detecting child abuse
 - Sentinel injuries, suspicious history, physical exam findings
3. Discuss child abuse and the role of the EMS provider
 - Barriers and reporting of child abuse

Epidemiology of Abuse and Historical Perspectives

Historical Perspective: Child Abuse in the US

1874: Society for the Prevention of Cruelty to Children (SPCC) was created in New York City

1946: Caffey first described an association between long bone fractures and chronic subdural hematomas in infants



1972: Caffey developed a theory on injuries sustained when shaking infants

*1974: Child Abuse Prevention and Treatment Act was passed mandating that all cases of abuse be reported

*100 years after SPCC developed



What is Child Abuse?

Definition: “physical or mental injury, sexual abuse, negligent treatment, or maltreatment of a child under the age of 18 by a person who is responsible for the child’s welfare...”

Four main types of child maltreatment:

1. Neglect (52% of reported cases)
2. Physical abuse (24%)
3. Sexual abuse (12%)
4. Emotional abuse (6%)

Colorado Statistics

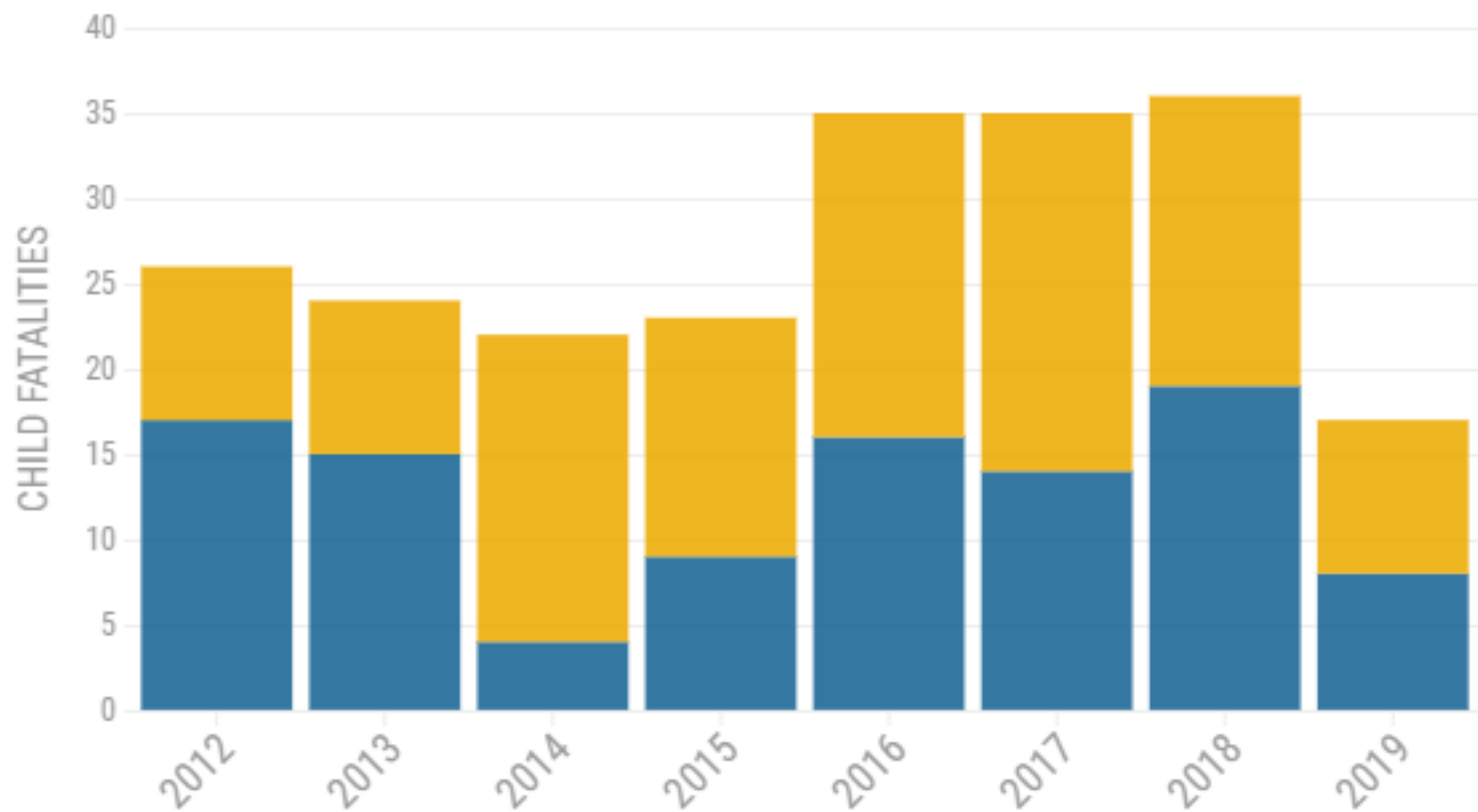
Hospital Reporting

- CHCO completes approximately 1,400 suspected child abuse and neglect reports annually
- Denver Health Medical Center performs ~720 evaluations each year

Statewide Reporting

- >57,000 children assessed for abuse and neglect by the Colorado DHS in 2018
- >13,000 children experienced abuse or neglect

Not Reported Previously Reported



Source: [Child Fatality Review Team, CDHS](#)

Why do we care?

> [Am J Prev Med. 1998 May;14\(4\):245-58. doi: 10.1016/s0749-3797\(98\)00017-8.](#)

Relationship of Childhood Abuse and Household Dysfunction to Many of the Leading Causes of Death in Adults. The Adverse Childhood Experiences (ACE) Study

[V J Felitti](#)¹, [R F Anda](#), [D Nordenberg](#), [D F Williamson](#), [A M Spitz](#), [V Edwards](#), [M P Koss](#), [J S Marks](#)

SURVEY OF >13,000 ADULTS

~9,500 (70.5%) responded

7 CATEGORIES OF ACEs: Psychological, physical, or sexual abuse; violence against mother; living with household members who were substance abusers, mentally ill or suicidal, or even imprisoned.

Results of the ACE Study

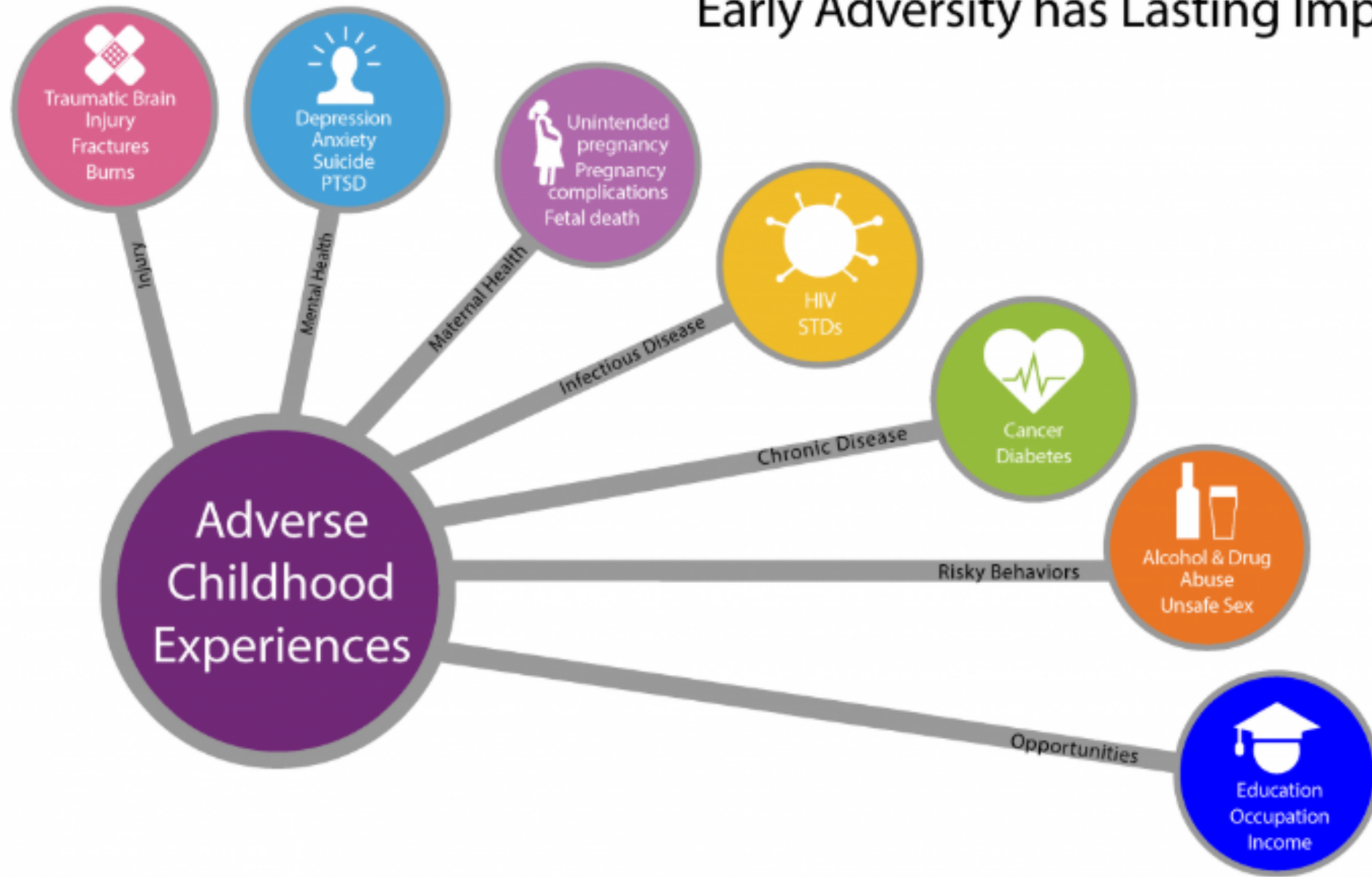
Adult Health Risk Behaviors

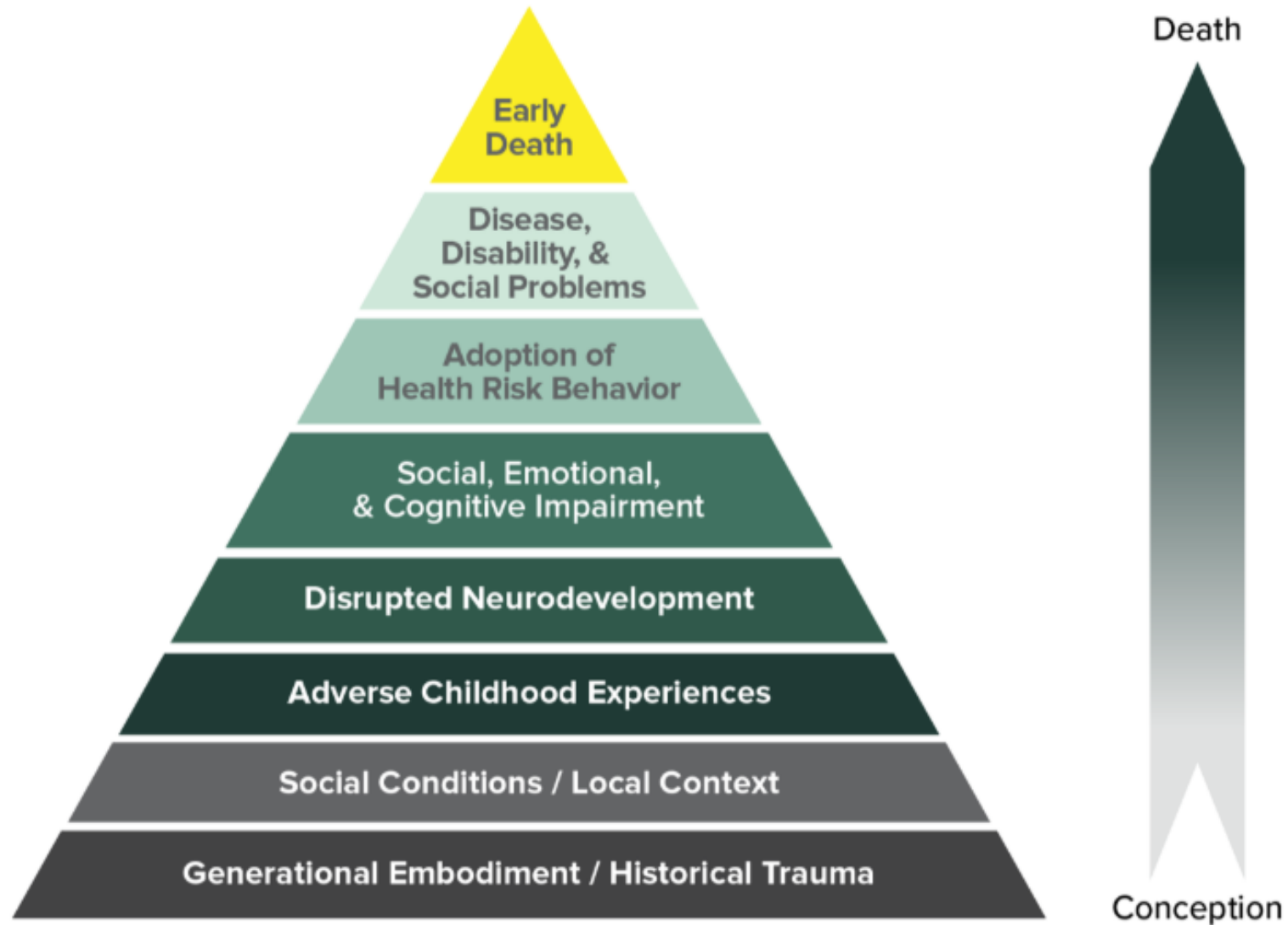
- ≥ 4 ACEs=
 - **4-12 fold** increased risk of alcoholism, drug abuse, depression, suicide attempt
 - **2-4 fold** increase in smoking, poor self-rated health, >50 sexual partners, STI
 - **1.4-1.6 fold** increase in low physical activity and severe obesity

Disease

- Heart disease
- Cancer
- chronic lung disease
- Skeletal fractures
- liver disease

Early Adversity has Lasting Impacts



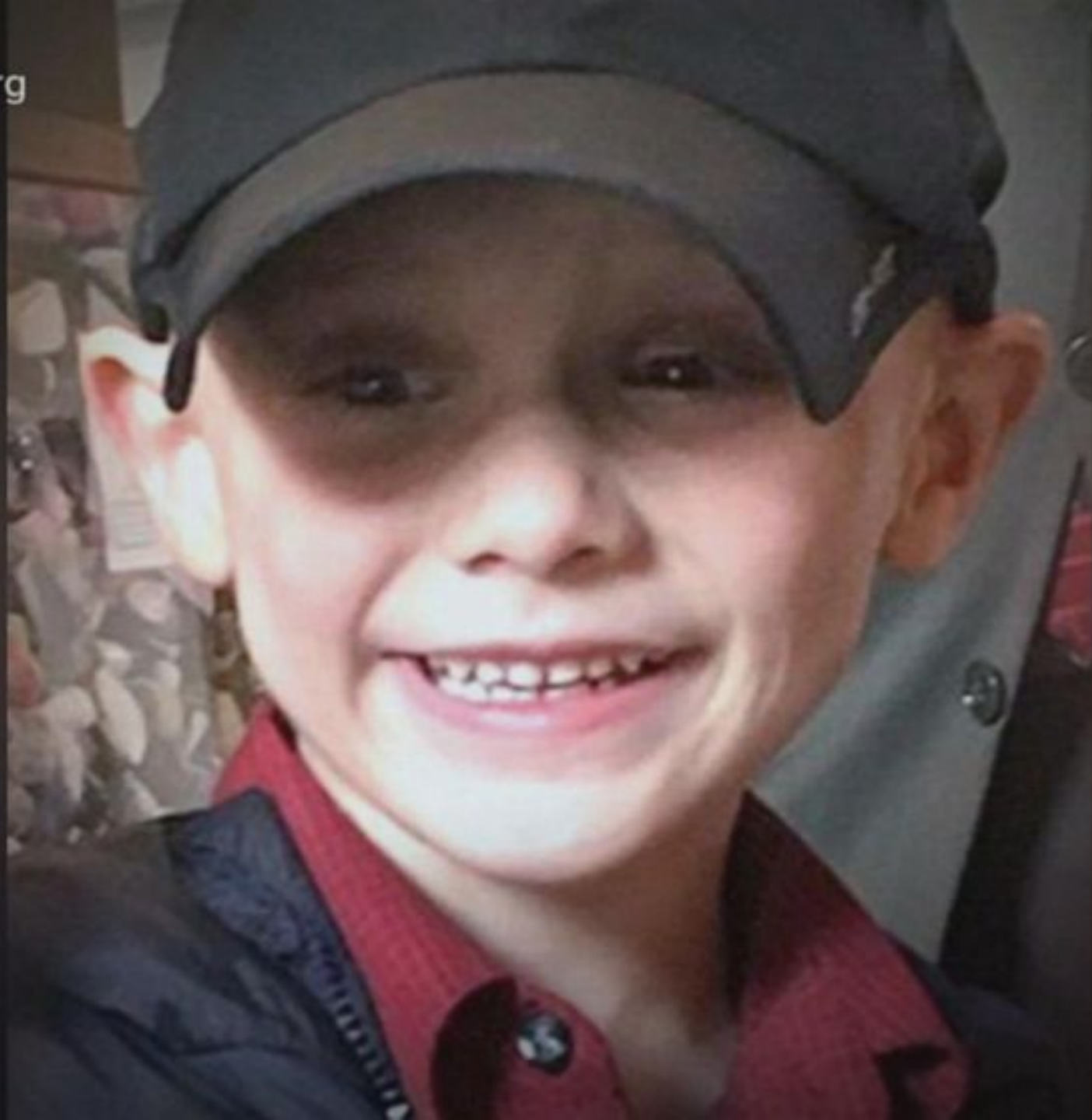


Mechanism by which Adverse Childhood Experiences Influence Health and Well-being Throughout the Lifespan

Detecting Child Abuse

Sentinel Injuries

MissingKids.org



Sentinel Events: Early Recognition

- Most children who are abused and/or neglected have prior medical encounters before the abuse is detected (C. Jenny, et al 1999; E. Guenther 2009)
- Sentinel injuries – multiple “minor” injuries or situational neglect injuries → SBI or death

› [Pediatrics](#). 2013 Apr;131(4):701-7. doi: 10.1542/peds.2012-2780. Epub 2013 Mar 11.

Sentinel Injuries in Infants Evaluated for Child Physical Abuse

Lynn K Sheets ¹, Matthew E Leach, Ian J Koszewski, Ashley M Lessmeier, Melodee Nugent, Pippa Simpson

- 200 abused children and 100 non-abused children
- 30% of abused children had a sentinel injury
 - 80% - BRUISING
- Medical providers MISSED the sentinel injury 60% of the time!

Detecting Child Abuse

Suspicious History

History: A Suspicious Story

1. Child fell from low height
2. Child fell onto furniture, floor, object
3. Unexpectedly found dead
4. Child choked, shaken to dislodge the object
5. Child turned blue, shaken to revive
6. Sudden seizure activity or stopped breathing
7. Resuscitation efforts caused injury
8. Traumatic event day or more prior
9. Tripped or slipped carrying the child
10. Child left alone for a short time
11. Child fell down the stairs
12. Sibling did it

History: Is it plausible?



4-6
months



6-8
months



9-12
months



2-3
years

CASE:

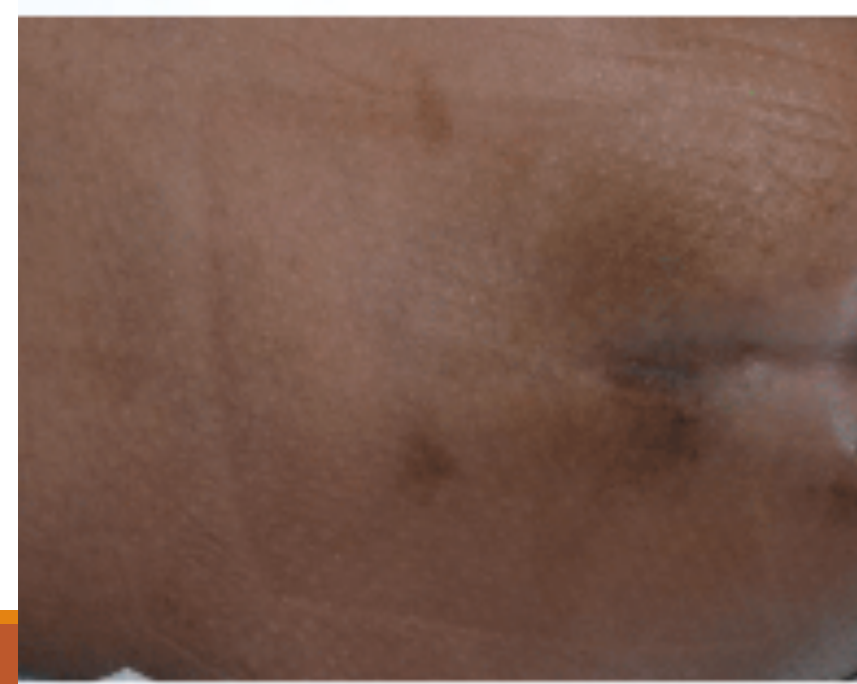
- Ex-35 week premature infant with complex medical history (short gut and gastroschisis) presents after 911 call
- EMS arrives and notes that infant is gray/dusky in appearance with mottled, cool extremities
- IVF started due to concern for sepsis
- Infant had an episode of apnea and bradycardia (HR 190>90) en route, which self-resolved

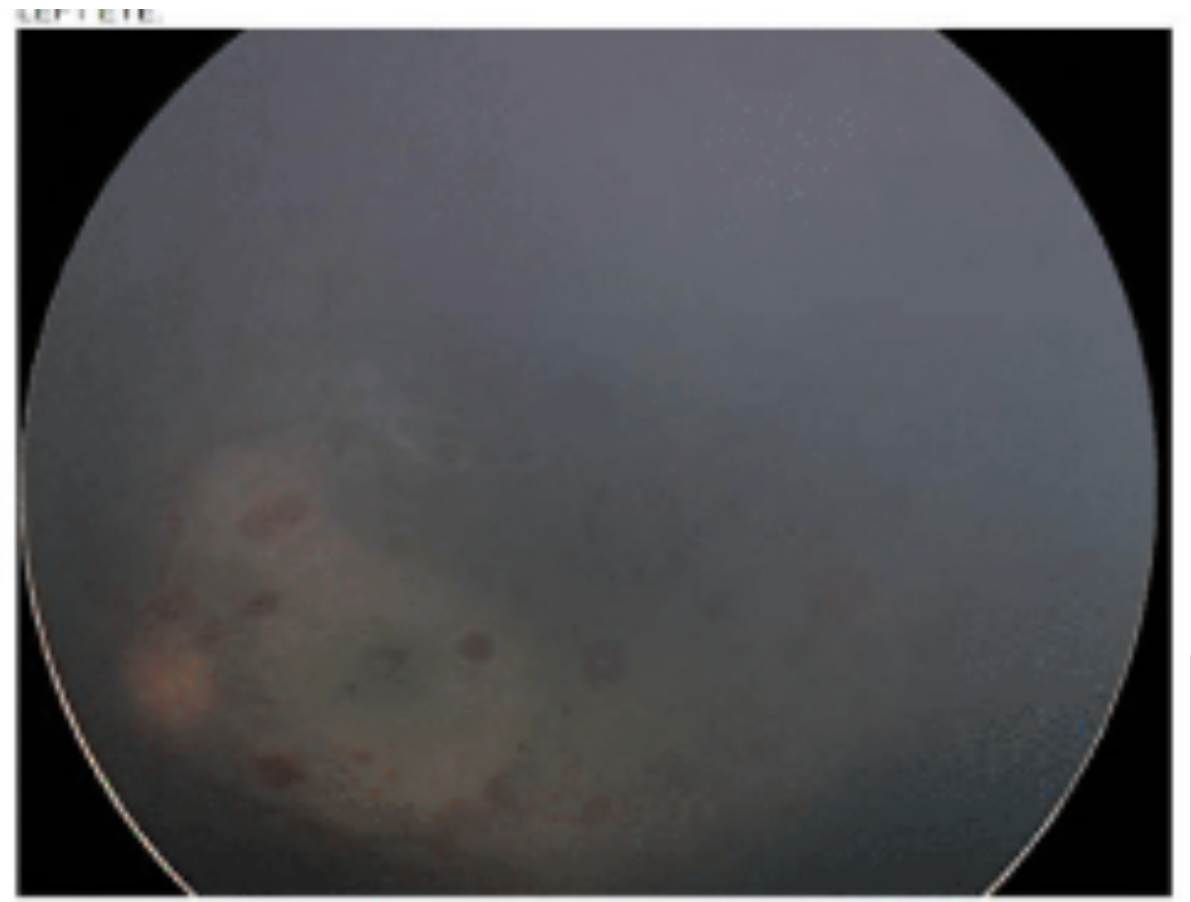
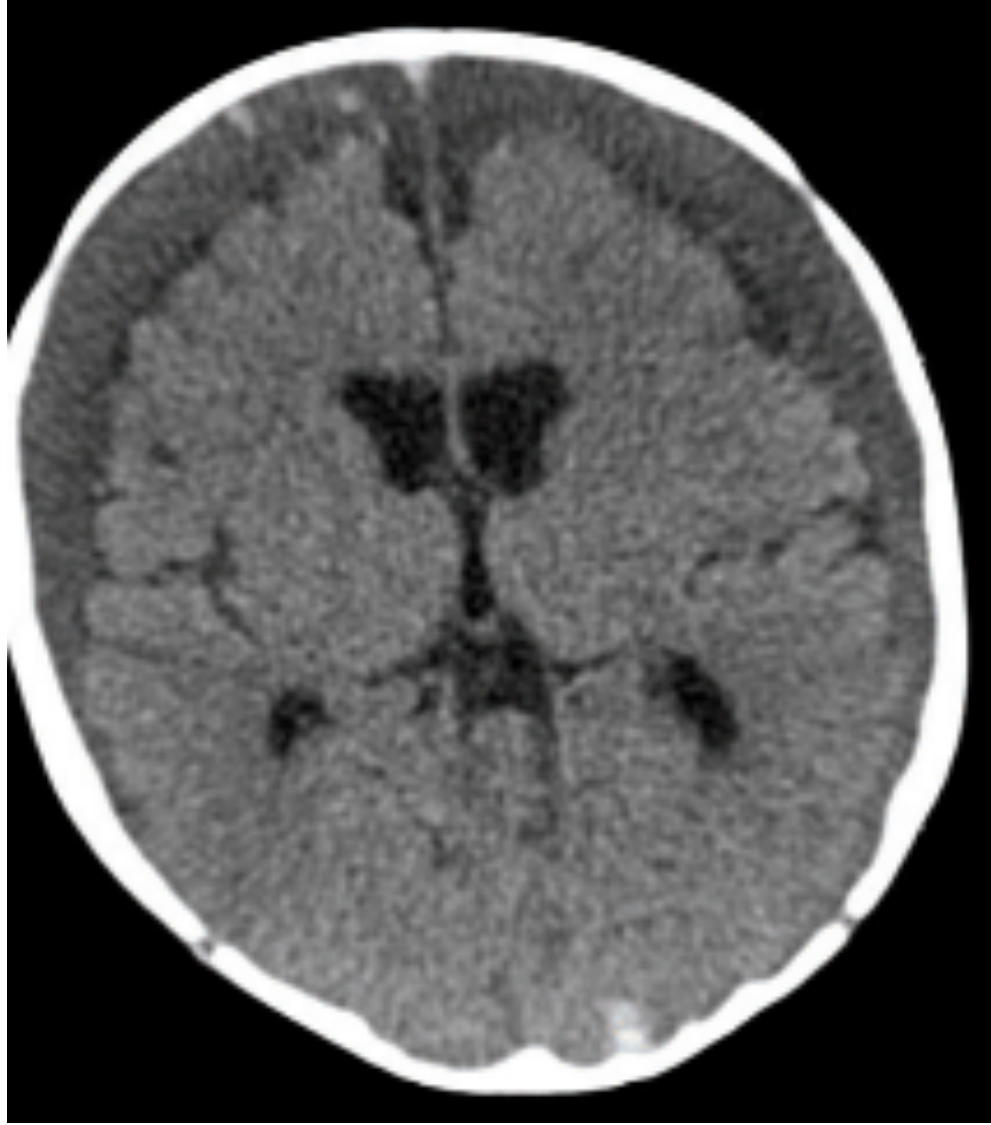
CASE:

- Arrives at CHCO and a 2nd IVF bolus is given for persistent tachycardia
- **Noted to have bilateral facial bruising**
- Parents report that infant was sitting on the floor when his brother kicked a ball that hit the wall and knocked the child onto a toy sitting on the ground nearby him. Patient cried immediately without LOC.
- Was seen by PCP last week who asked about the bruising but did not seem worried about it.

CASE: Physical Exam

- BP 96/74, HR 175, RR 30, SpO2 100% (RA), 99F, Wt 6.4kg
- General: **lethargic, minimally responsive**
- Child begins seizing during initial exam with legs crossed over to center, twitching, and symmetric movements of arms and legs
- **Linear bruising noted to left cheek. Round contusion noted to right cheek. Forehead with well-healing abrasion. Right lateral thigh with contusion present. Posterior torso noted to have purple appearing mark to sacral area which appears TTP. Also with rash – raw areas of broken-down skin**





Injuries in Unusual Locations & Patterned Injuries

PHYSICAL EXAM

TEN4 FACES-P:

- TEN: Torso, Ear, Neck
- 4: Any bruising <4-6 months of age
 - *“Those who don’t cruise rarely bruise”*
- FACES: Frenulum, Angle of the Jaw or Auricular, Cheek, Eyelid, Scleral hemorrhage
- P: Patterned (and Petechiae)

TEN4 FACES-P:



Bruising Characteristics Discriminating Physical Child Abuse From Accidental Trauma

AUTHORS: Mary Clyde Pierce, MD,^a Kim Kaczor, MS,^a Sara Aldridge, MSN, ARNP,^a Justine O'Flynn, RN,^b and Douglas J. Lorenz, MA, MSPH^c

^aDepartment of Pediatrics, School of Medicine, and ^cDepartment of Bioinformatics and Biostatistics, School of Public Health and Information Sciences, University of Louisville, Louisville, Kentucky; and ^bJust for Kids Critical Care Center, Kosair Children's Hospital, Louisville, Kentucky

KEY WORDS

bruising, decision rule, nonaccidental trauma, predictors, screening tools



WHAT'S KNOWN ON THIS SUBJECT: Bruising occurs with both physical child abuse and accidental trauma, and bruising characteristics discriminate between the 2 groups.



WHAT THIS STUDY ADDS: This study develops a clinically sensible model in the form of a bruising clinical decision rule to identify children and infants with bruising who are at high risk for physical abuse and require further evaluation.

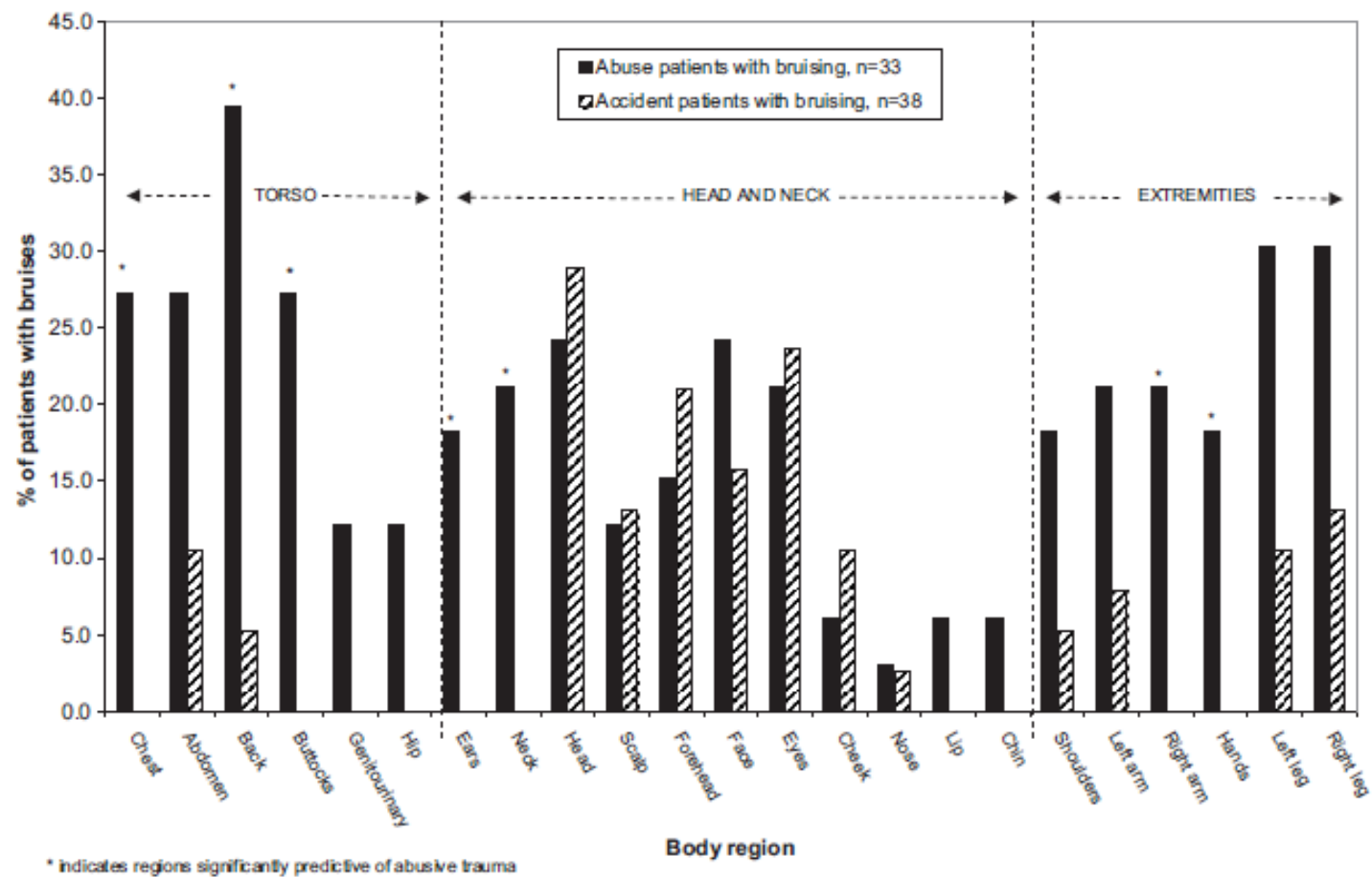


FIGURE 2
Bruise distribution for patients with abusive and accidental trauma.

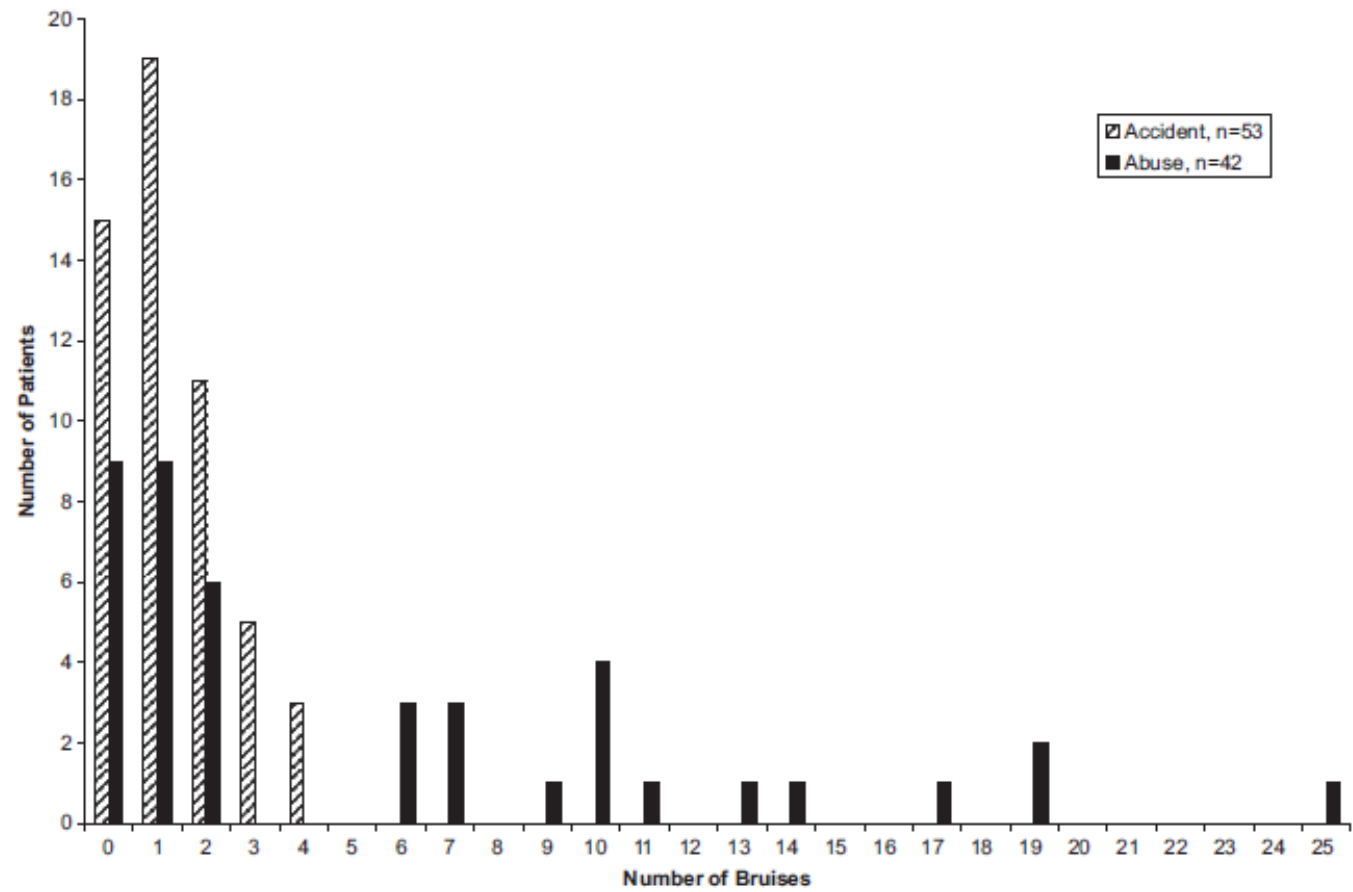


FIGURE 1
Comparison of cumulative numbers of bruises for patients with abusive versus accidental trauma.

Patterned Injuries:

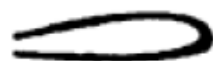
belt buckle



belt



looped cord



stick/whip



fly swatter



coat hanger



board or spatula



hand/knuckles



bite



sauce pan



paddles



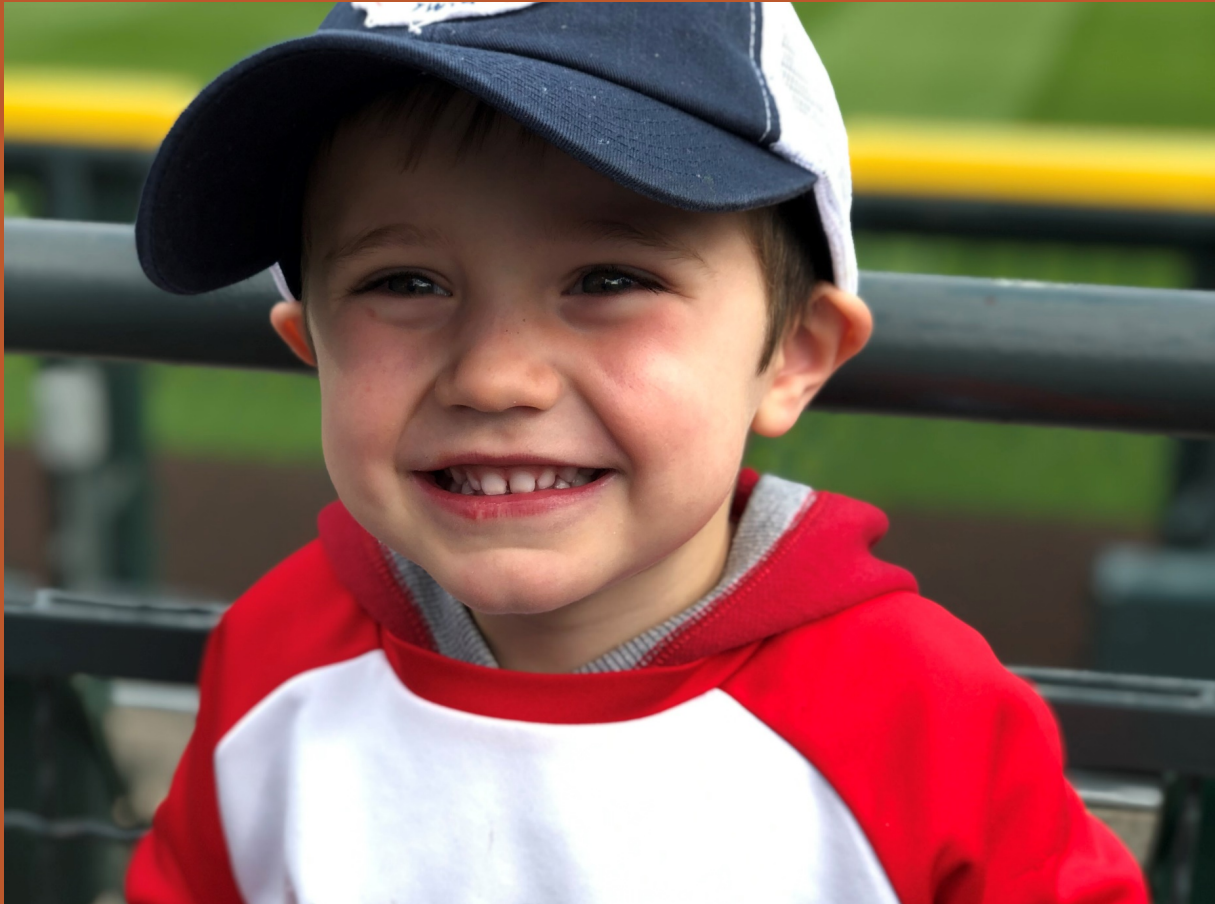
hair brush



spoon

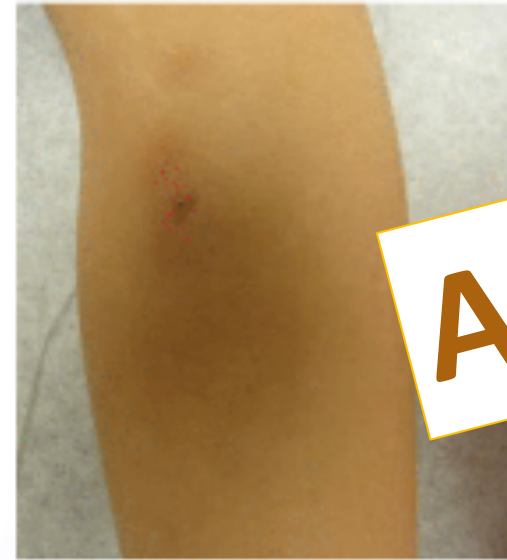
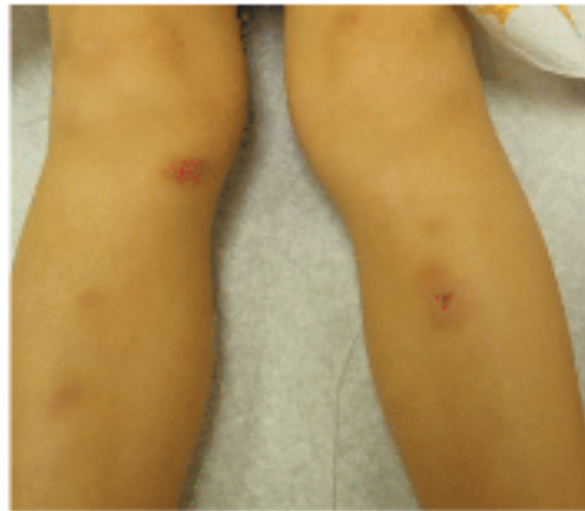


Petechiae



Abuse or Accidental?

5 yo female with injuries on her legs. The mother reports that she does not know what happened, but her daughter always seems “bruised.” Mom is worried there may be something wrong. Child is otherwise healthy. No bruising seen elsewhere on exam.



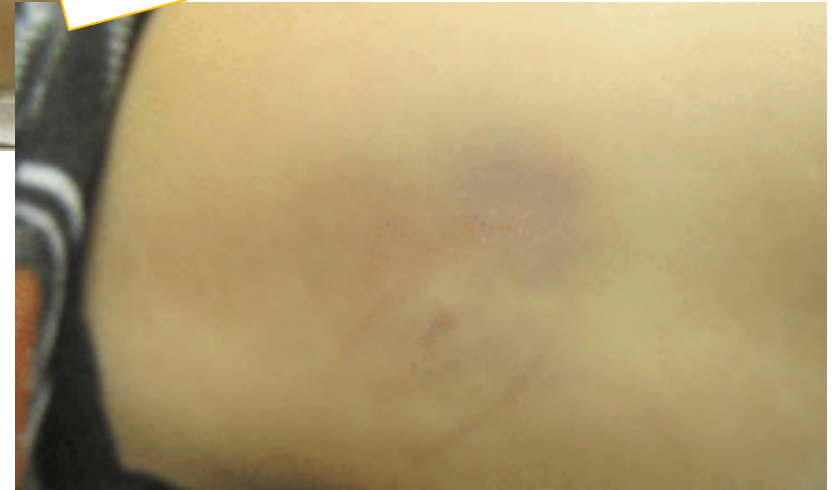
ACCIDENT

Abuse or Accidental?

A 5 yo male presents to clinic for vaccinations. When the nurse lifts his pants to give the injections, she sees this. The father states that he was rough-housing with the family dog who tried to bite him in the leg yesterday.



ABUSIVE



BURN INJURIES

PHYSICAL EXAM

Burn Injuries

- Up to 25% of childhood burns are due to abuse
- **ACCIDENT**
 - Splash marks
 - Buttocks and extremity location
 - Mechanism fits the injury pattern
 - Seek care immediately
- **ABUSE**
 - Sharp lines of demarcation
 - Immersion or scald injury
 - Burns on the mouth/face, hands/feet
 - Patterned – cigarette burns
 - Delay in seeking care



Abuse or Accidental?

2 yo male brought in by family after hot soup exploded from a pressure cooker when mother took the lid off.

ACCIDENT



Abuse or Accidental?

12 mo male brought in by mother for burns after the child pulled a bowl of hot soup off a low table.



ABUSIVE

Child Abuse and the EMS Provider

BARRIERS AND REPORTING

CASE: History

- 13yo boy with out of control behaviors – “restrained” at home
- EMS initiated by family and child brought to ED for evaluation
- En route, child reports that his older brother hurts him and his father “slammed his head to the ground during the restraint.”
- EMS notes bruising and scratches to his neck and back

CASE: Physical Exam

- Vitals: T 97F, HR 121, RR 18, BP 132/79, SpO2 99% (RA)
- General: alert, active, no acute distress, sad affect
- **Bruising noted to right anterolateral neck, posterior neck, ear, and left posterior torso**



Discussion

- Thoughts about the injuries?
- Next steps?

EMS Calls and Risk of Abuse

- EMS calls to the home may involve concern for potential abuse
 - ALTE
 - Psychiatric evaluations
 - Domestic violence
 - Substance abuse in the home

EMS Documentation

- Use direct quotes when appropriate (RED FLAG history)
- Identify risk factors: inconsistent story, changes in stated history
- Document scene evaluation: caregiver relationship to patient and appropriate behavior, other adults and children on the scene, safety of the scene
- Any prior injuries or history of injuries?
- Document physical findings – EXPOSE the patient
 - Airway, Breathing, Circulation, Neurologic, Exposure

Nonaccidental Injury in Pediatric Patients: Detection, Evaluation, and Treatment

Gunjan Tiyyagura¹, Meghan Beucher², Kirsten Bechtel³

Prehospital providers report:

- Discomfort with pediatric patients
- Uncertainty related to child abuse and neglect
- Difficulty distinguishing between accidental and intentional injuries
- Fear of being wrong and fear of caregiver reactions
- A need to focus on the chief complaint
- Limited opportunity for evaluation and fast-paced setting

Laws on Mandated Reporting

- Mandated reporting laws exist in all 50 states – CO Children’s Code 19-3-304
- Any suspected or known incident of child abuse **MUST** be reported
- Protecting patient confidentiality does not legally justify a failure to report
- Immunity for reporters “acting in good faith”
- Call **1-844-CO-4-KIDS** if you suspect child abuse or neglect

Mandated Reporters

- Certain professionals are required by law to report physical abuse, sexual abuse, caretaker neglect, and exploitation
- Physicians and Advanced Practice Providers
- Psychologists, Counselors, and Social Workers
- Law enforcement officers
- Teachers and school personnel at schools serving preschool-12th
- Clergy
- **EMS**

Summary

- Abuse is common, has been around for a long time, and children are vulnerable
- Be suspicious of an inconsistent history, a non-plausible story based on the child's development, a changing account of the injury, or delay in seeking medical care
- Bruising: Consider TEN4-FACES distribution and patterned injuries
- Burns: scald, submersion, and well-demarcated burn injuries are concerning for abuse
- There are many barriers to reporting, but it is our job (and the law) to report...and Colorado children are depending on you!

Questions?