Challenging Pediatric Cases … without Pediatric Backup!

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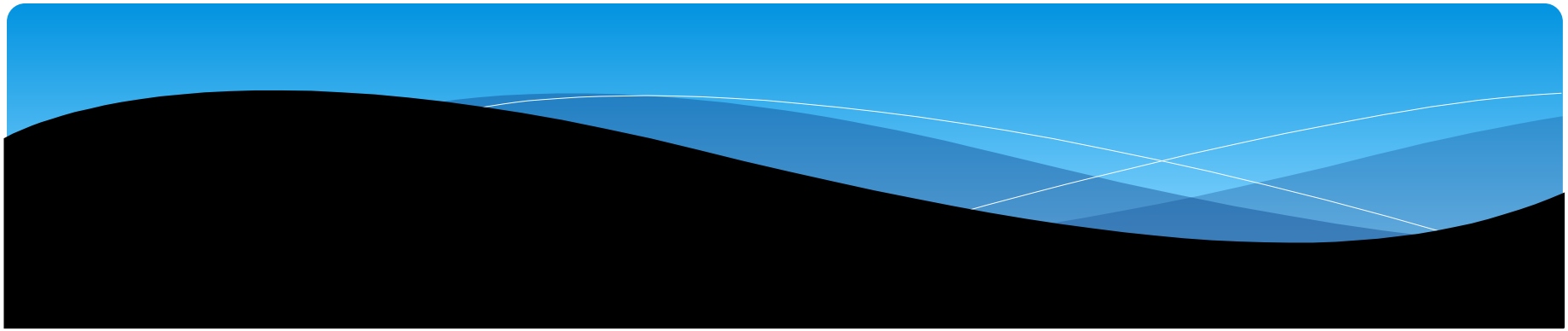


EPICdemic

Decisions, Decisions

Achy Breaky Heart

9 day old…

Sweet Child of Mine

Round up!

The End of the Road

March 2020

Case: 17 mo female

Pulse: (not recorded) Heart Rate (Monitored): (!) 179 (03/22/20 2243)	Resp: (!) 48 **SpO2: 90 %**	Temp: (!) 39.7 °C (103.4 °F)

Pulmonary:

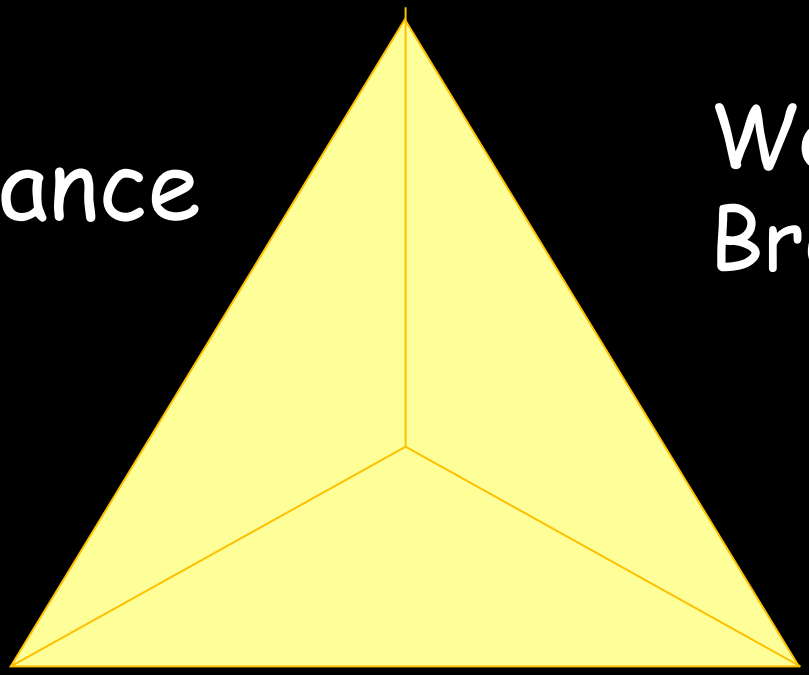
Effort: Tachypnea, respiratory distress and retractions present. No nasal flaring.

Breath sounds: Normal breath sounds. Stridor present. No decreased air movement. No wheezing, rhonchi or rales.

Comments: **Crying and tachypneic with deep substernal retractions with inspiration, audible stridor, wet non-barky cough, no wheezes, no expiratory phase prolongation**

Appearance

Work of Breathing



Circulation to skin

* 23:30 racemic, then vomited, re-dosed
  ibuprofen and dexamethasone
* 00:20 sleeping but recurrent audible stridor, mild with recurrent substernal retractions. RR 24. Second racemic epi
* 01:30 no stridor, RR 20, 98% RA, P 138.
* 02:40 mild stridor while asleep with no retractions
  3rd racemic and admit

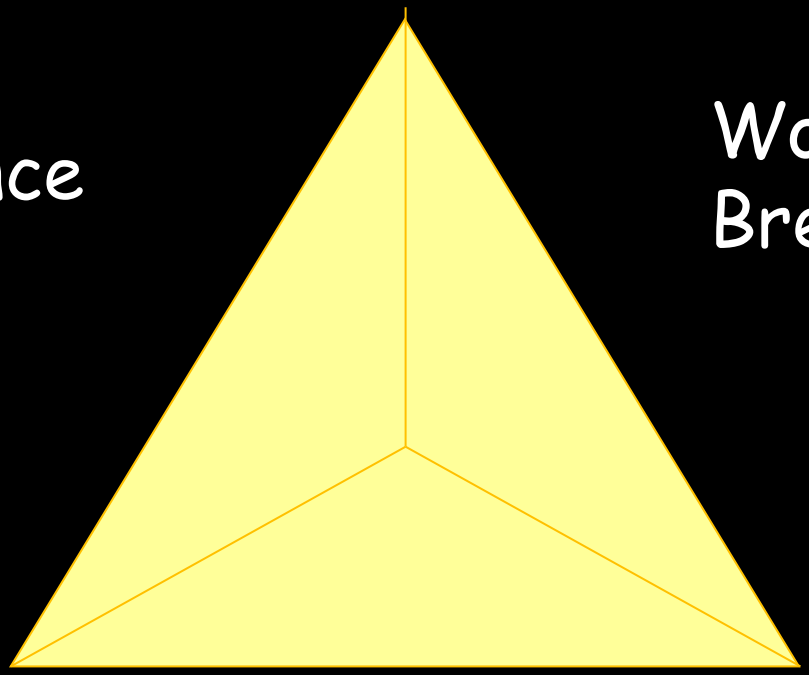
BioFire: human metapneumovirus and rhinovirus/enterovirus

Bounceback!

* 39.1°C (102.3°F), 192, 54, 89%, 12.5 kg
* Listless
* Tachycardia
* Resp distress: tachypnea, grunting with coarse rhonchi at bases, retractions
* Abd distended but nontender
* Fine erythematous rash left cheek

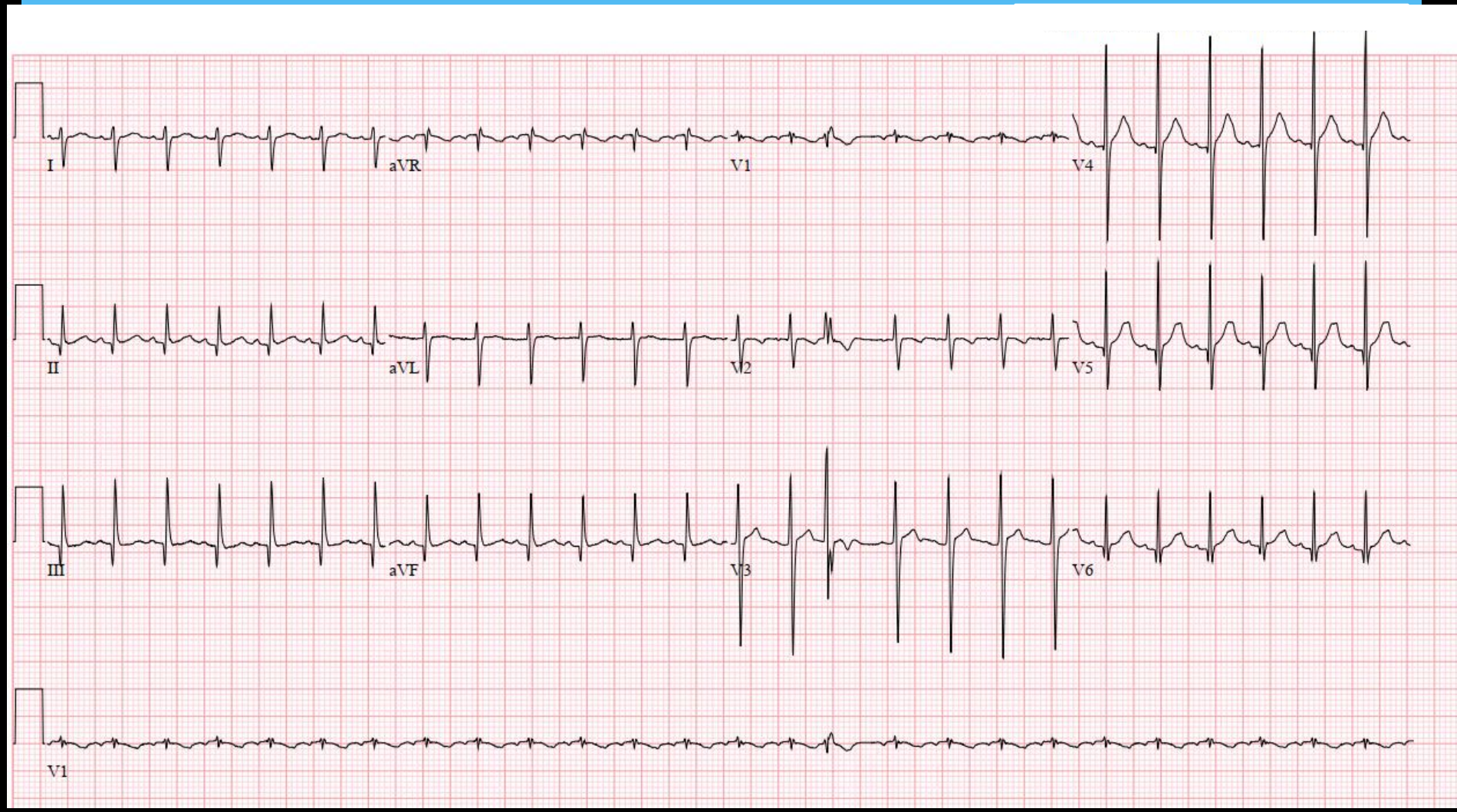
Appearance

Work of Breathing



Circulation to skin

EKG



Labs

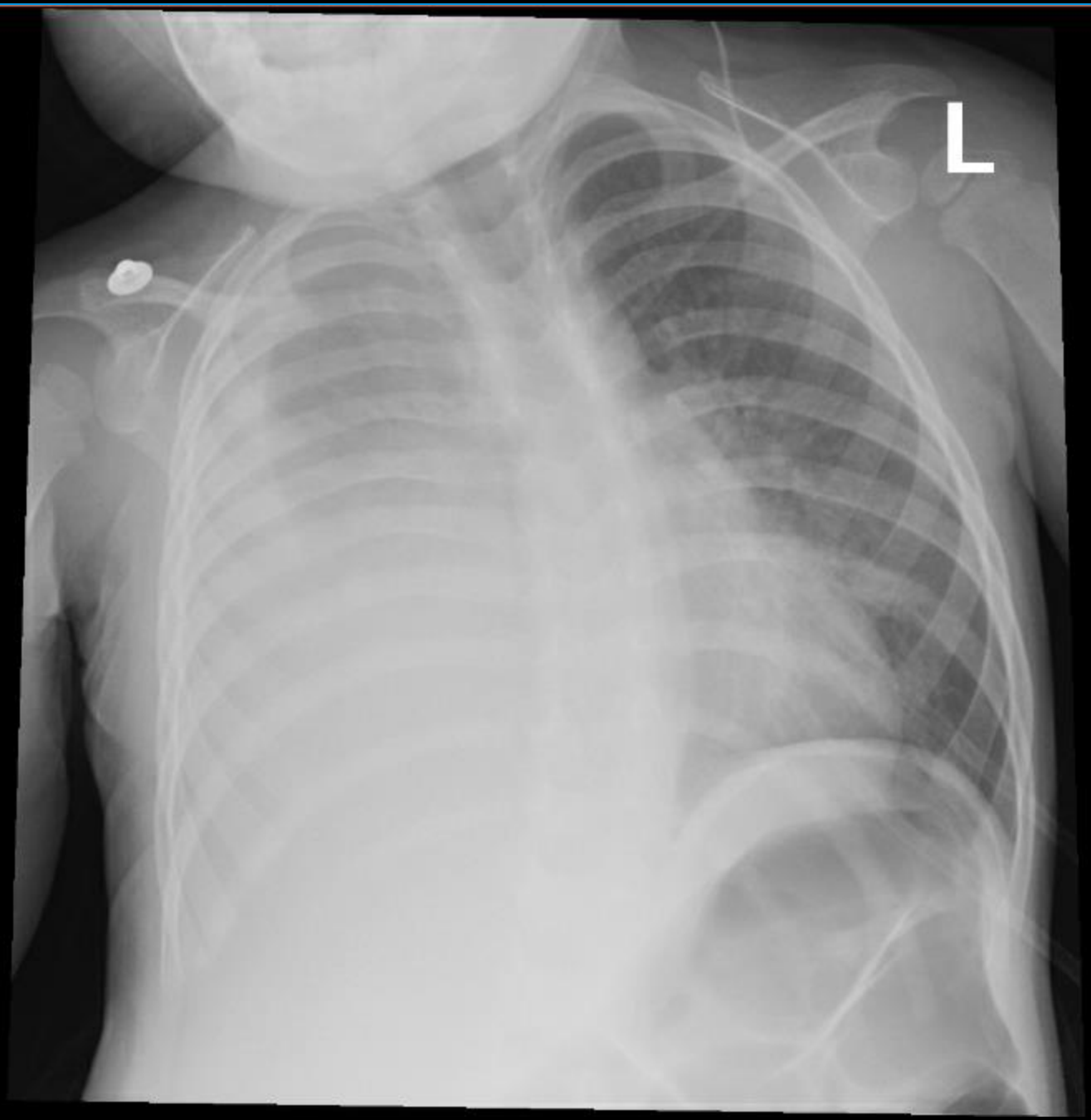
VBG: 7.46/ 30/ O2 52/ -1.5

132	98	15	179
**	26	0.19	

	11.8	
7.36		238
	35.7	

Lactate 2.2
CRP 8.9


L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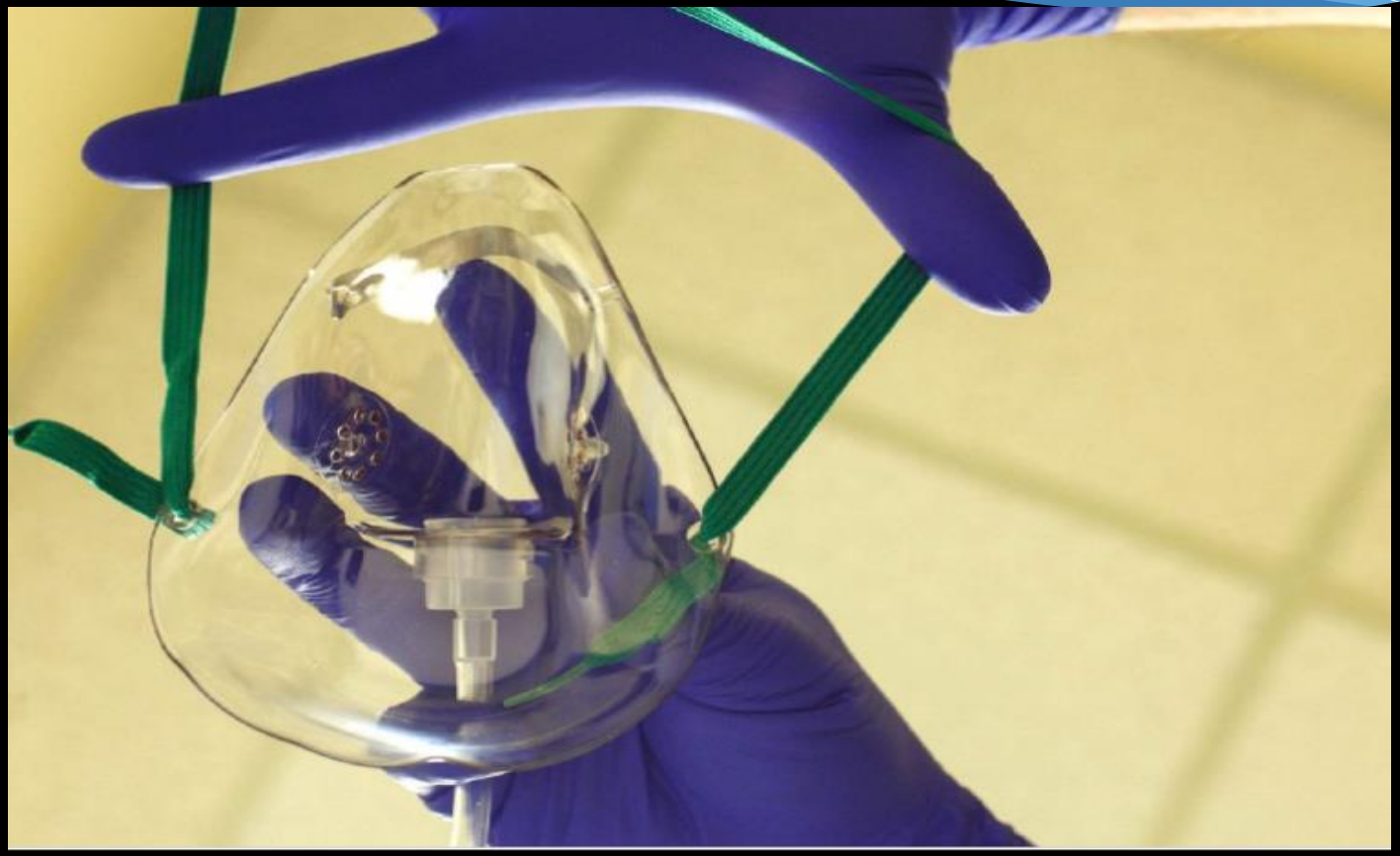
Assessment / Plan?



RN note

* Ketamine 25.5mg @ 1813
* Rocuronium 12.5mg @ 1814
* Pt. Intubated @ 1816.
* SpO2 in 60's.
* HR 40’s……

And then….

Circulation

Part 4: Pediatric Basic and Advanced Life Support

2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Topjian AA et al. Circulation 2020;142 (supple 2):S469-S523)

American Heart Association
Learn and Live

Back to the case…

RN note

* Tube pulled by MD and second attempt made.
* Spo2 to 88-89%.
* 10fr NG tube placed in left nare. Placement confirmed with auscultation. Approx. 20cc brown fluid aspirated with syringe.
* Post intubation films obtained, tube adjusted, sats to 95%.

Diagnosis

* Septic shock in setting of GAS bacteremia
* Right empyema

* Admit 3/26
* DC 4/9

Home

Case

10 yo diabetic ♂ with abdominal pain

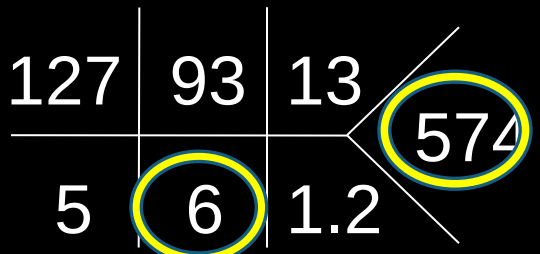
- nausea, no vomiting, no diarrhea, no fevers

PMHx: Diabetes
Meds: Novolog, Lantus

PEx:
T 37.5°C, P 128, RR 35, BP 109/71, 100% RA
pale, +tender LUQ and LLQ

Case

10 yo diabetic ♂ with abdominal pain

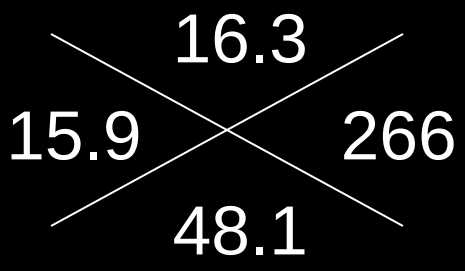


Lipase: 335 (23-300)

UA: 3+ ketones

AG = 28

VBG: 7.098/ 28/ -21



Case

45 yo diabetic ♂ with abdominal pain

- hyperglycemia, ketosis, acidosis

Dx: DKA

Rx: IVF

IVF

IVF

Insulin (bolus?)

Pearl

Umpierrez et al, ADA Consensus Report, *Diabetes Care,* 2024

Case #1

10 yo diabetic ♂ with abdominal pain
- hyperglycemia, ketosis, acidosis

Dx: DKA
Rx: IVF
~~IVF~~
~~IVF~~
Insulin ~~(bolus?)~~

Cerebral edema

pitfall

Edge, *Diabetologia*, 2006
Wolfsdorf, *Pediatr Diabetes* ,2009

Similarities: DKA

Adults

* Fluid resuscitation
* Correct electrolytes
* Insulin therapy
* Find the source
* No bicarbonate!

Pediatrics

* Fluid resuscitation
* Correct electrolytes
* Insulin therapy
* Find the source
* No bicarbonate!

Differences: DKA

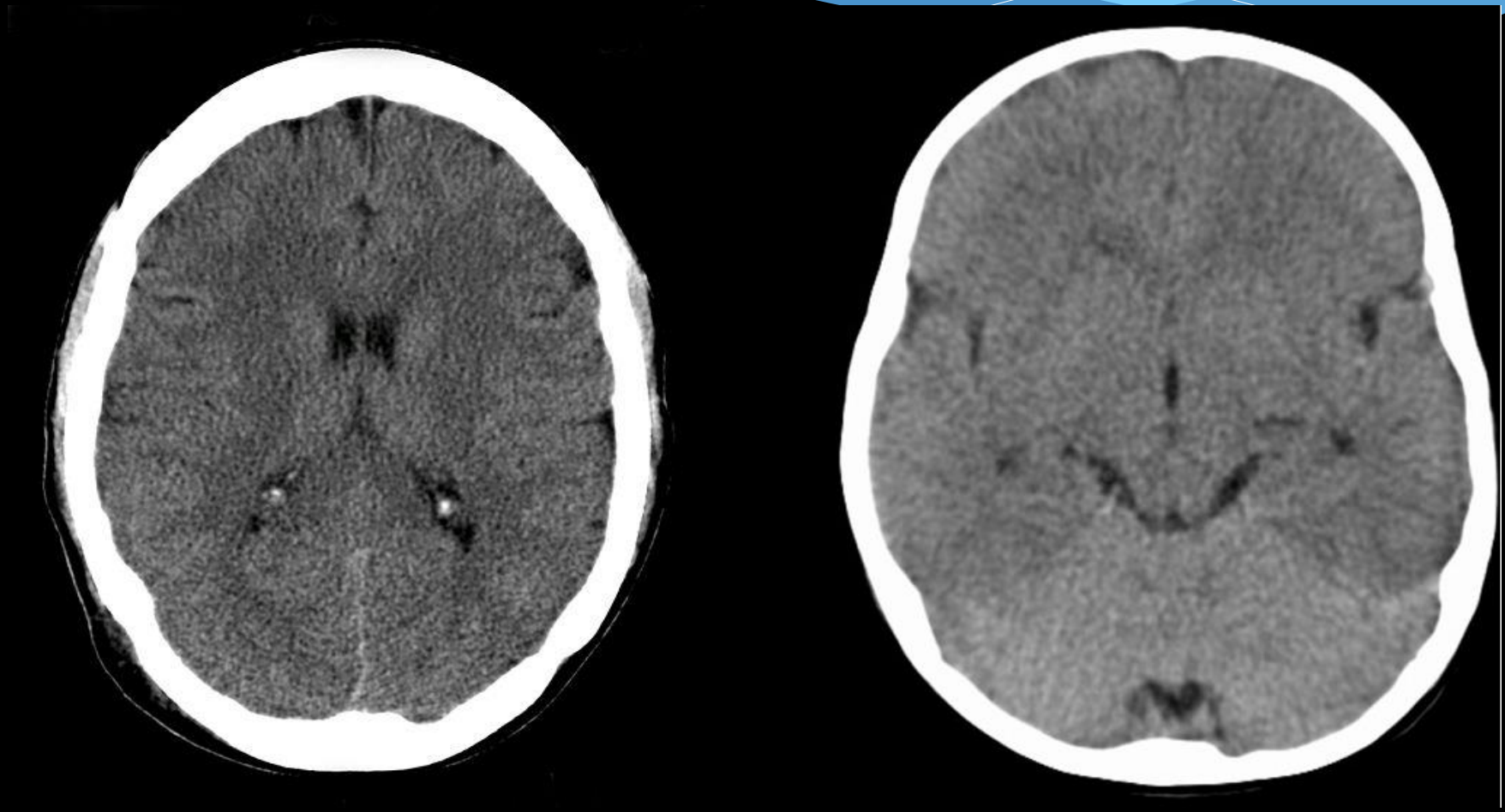
Adults

* Liberal use of IVF
* Insulin bolus vs infusion
  * 0.1 vs 0.14 units/kg/hr

Pediatrics

* (More) conservative IVF
  * 20 ml/kg over 1 hr
* No insulin bolus
  * 0.05-0.1 units/kg/hr
* Two bag system
* Cerebral edema

Cerebral edema



Cerebral edema

"There is no convincing evidence of an association between the rate of fluid or sodium administration used in the treatment of DKA and the development of cerebral edema"

Wolfsdorf J, *Pediatric Diabetes,* 2009

Cerebral Edema: Related to treatment?

Rosenbloom et al, 1990

Glaser et al, 2001

Hsia et al, 2014

Mel & Werther, 1995

Lawrence et al, 2005

Duck, Wyatt, 1988

Marcin et al, 2002

Bello & Sotos et al, 1990

Bakes et al, 2016

Cerebral edema management

Unclear

* Immediate treatment *before* imaging
* Decrease fluid rates*
* Mannitol (0.5-1 g/kg within 5-10 min)
* Hypertonic saline (5-10 ml/kg)
* Avoid mechanical hyperventilation
* Meds at bedside

DeCourcey DD et al, Ped Crit Care, 2013
Rameshkumar R et al, Pediatr Crit Care Med 2020
Albialy A et al, Arch Dis Child, 2021

Fluids

Treatment: fluids

* Initial fluid choice:
  * 20 ml/kg over 1-2 hour
  * Max: 40-50 mL/kg over 4 hours

Peds DKA rarely presents in hypovolemic shock….
find another source!

Treatment: fluids

* Replace deficit over next 48 hours
  * Approximately 2x maintenance
    * 4 ml/kg/hr for first 10 kg
    * 2 ml/kg/hr for next 10 kg
    * 1 ml/kg/hr for remaining kg

* Example:
  * 35 kg patient = 75 ml/hr
  * Approx 150 ml/hr


STOP


DEBATE

Clinical Trial of Fluid Infusion Rates for Pediatric Diabetic Ketoacidosis

Nathan Kuppermann, M.D., M.P.H., Simona Ghetti, Ph.D., Jeff E. Schunk, M.D., Michael J. Stoner, M.D., Arleta Rewers, M.D., Ph.D., Julie K. McManemy, M.D., M.P.H., Sage R. Myers, M.D., M.S.C.E., Lise E. Nigrovic, M.D., M.P.H., Aris Garro, M.D., M.P.H., Kathleen M. Brown, M.D., Kimberly S. Quayle, M.D., Jennifer L. Trainor, M.D., et al., for the PECARN DKA FLUID Study Group*

* Randomized controlled trial
* 0.9% vs 0.45% NaCl, rapid vs slow
* GCS <14: 48/1389 (3.5%)
* Clinically apparent brain injury: 12/1389 (0.9%)

Conclusion:

* Neither the rate of administration nor the sodium chloride content of intravenous fluids significantly influenced neurologic outcomes in children with diabetic ketoacidosis.

NEJM, 2018

Now what???

ISPAD CLINICAL PRACTICE CONSENSUS GUIDELINES

ISPAD Clinical Practice Consensus Guidelines 2018: Diabetic ketoacidosis and the hyperglycemic hyperosmolar state

Joseph I. Wolfsdorf[1] | Nicole Glaser[2] | Michael Agus[1,3] | Maria Fritsch[4] | Ragnar Hanas[5] | Arleta Rewers[6] | Mark A. Sperling[7] | Ethel Codner[8]

Pediatric Diabetes, 2019

REVIEWS AND COMMENTARIES

Fluid treatment for children with diabetic ketoacidosis: How do the results of the pediatric emergency care applied research network Fluid Therapies Under Investigation in Diabetic Ketoacidosis (FLUID) Trial change our perspective?

Nicole Glaser[1] | Nathan Kuppermann[1,2]

Pediatric Diabetes, 2018

Type of fluid?

* Retrospective study
* NS vs LR
* Outcomes: cost, LOS, rates of CE

Conclusion:

* Resuscitation with LR compared with NS was associated with lower total cost and rates of CE.

Bergmann KR, *Pediatr Emerg Care,* 2021

Insulin

Treatment: insulin

* Continuous infusion (0.05-0.1 units/kg/hr)
* Prime IV tubing
* Start 1-2 hours after initial fluid bolus
* **No bolus** in peds
* Continue until resolution of acidosis
* Maintain glucose> 250-300 mg/dL

Treatment

BAG A

NS + KCl +KPhos

BAG B

D_{10}NS + KCL + KPhos

Insulin

0.05-0.1 units/

No bolus

Total rate (mL/hr)

ISPAD Clinical Practice Consensus Guideline: Diabetic ketoacidosis in the time of COVID-19 and resource-limited settings-role of subcutaneous insulin

* SC rapid-acting insulin analog (lispro or aspart)
* 0.15 U/kg, 1 hour after IVF replacement.
* SC doses 0.1 U/kg every 2 hours

OR

* SC short-acting regular insulin every 4 hours (alternative to IV insulin infusion in children with DKA and pH ≥7.1)
* 0.13 to 0.17 U/kg/dose every 4 hours (0.8 to 1 U/kg/day)
* increased or decreased 10% to 20%
(Level C)

Priyambada L et al, *Pediatr Diabetes*. 2020

Subcutaneous Insulin Versus Traditional Intravenous Insulin Infusion in Treatment of Mild to Moderate Diabetic Ketoacidosis

Ku'ulei Stuhr, PHARMD,* Regan LeeMaster, PHARMD,† Abby W. Hickman, PHARMD,* Breyanna Reachi, PHARMD,* Wilson Pace, PHARMD,† and Curtis Meek‡

J Emerg Med, 2023

The SQuID protocol (subcutaneous insulin in diabetic ketoacidosis): Impacts on ED operational metrics

Richard T. Griffey MD, MPH[1] | Ryan M. Schneider MSN, ACNP-BC, CPPS[1] | Margo Girardi MD[2] | Julianne Yeary Pharm D, BCCCP[3] | Craig McCammon Pharm D, BCCCP[3] | Laura Frawley RN[3] | Rachel Ancona MS, PhD[1] | Paulina Cruz-Bravo MD[2]

Acad Emerg Med, 2023

Academic peds center vs community ED?

* Retrospective, 487 children
* Characterize variations from guidelines on initial presentation to tertiary PED vs community ED and compare clinical outcomes for pediatric DKA
* variations: IVF, insulin delivery and sodium bicarbonate

Freeman JN et al, *Pediatr Emer Care* , 2024

OSH more likely acidotic, larger AG, larger fluid bolus, **sodium bicarbonate** and insulin bolus.

Less likely started on mIVF or have glucose or potassium

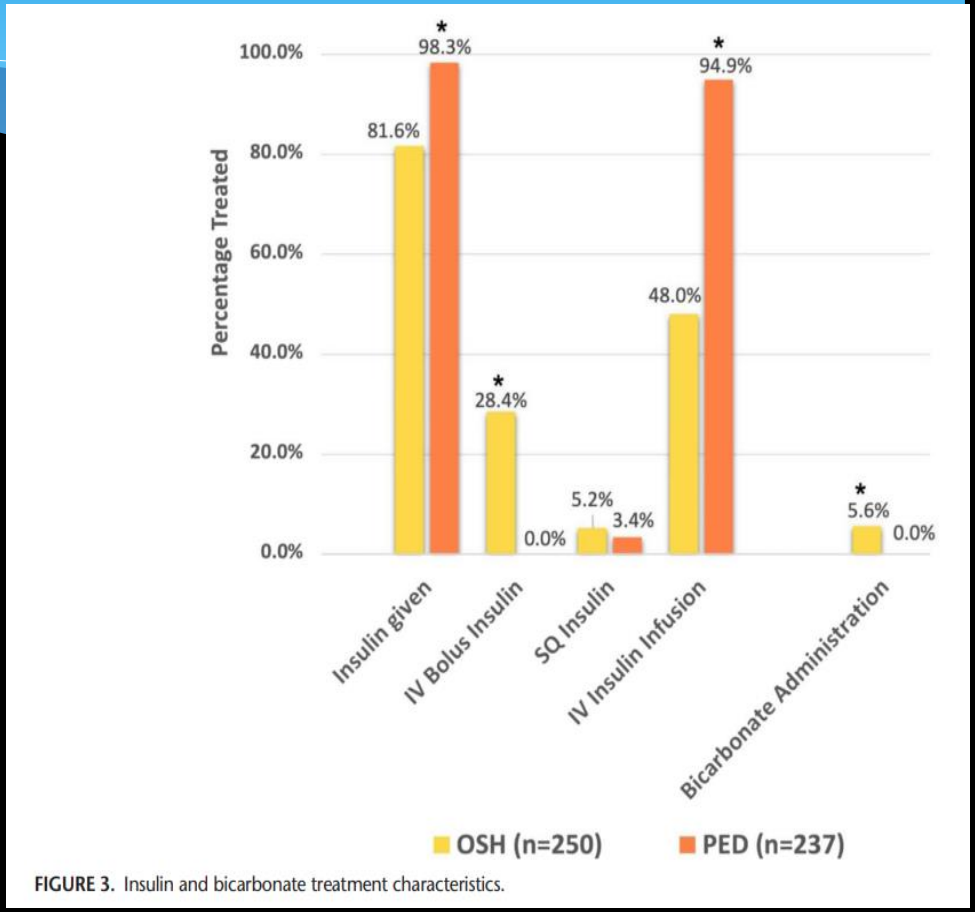


FIGURE 3. Insulin and bicarbonate treatment characteristics.

Freeman JN et al, *Pediatr Emer Care* , 2024

Academic peds center vs community ED?

* Outcome:
  * longer time for AG correction, insulin infusion, hospital discharge; intubation
  * Similar hypokalemia, hypoglycemia, rapid serum glucose decline, cerebral edema
* No difference in morbidity or mortality

Freeman JN et al, *Pediatr Emer Care* , 2024

Bottom line

* (More) conservative use of IV fluids
  * 20 ml/kg over 1-2 hours
* No bicarbonate
* No insulin bolus in peds
* Treat *before* imaging for cerebral edema

Home

15 yo chest pain

* 97.8
* 102
* 20
* 120/84
* 97%

ID:M800703090 01-MAR-2018 05:34:55

05-SEP-2002 (15 yr)
Male Caucasian

Room:
Loc:1

Vent. rate	98	BPM
PR interval	122	ms
QRS duration	72	ms
QT/QTc	314/400	ms
P-R-T axes	25 80	43

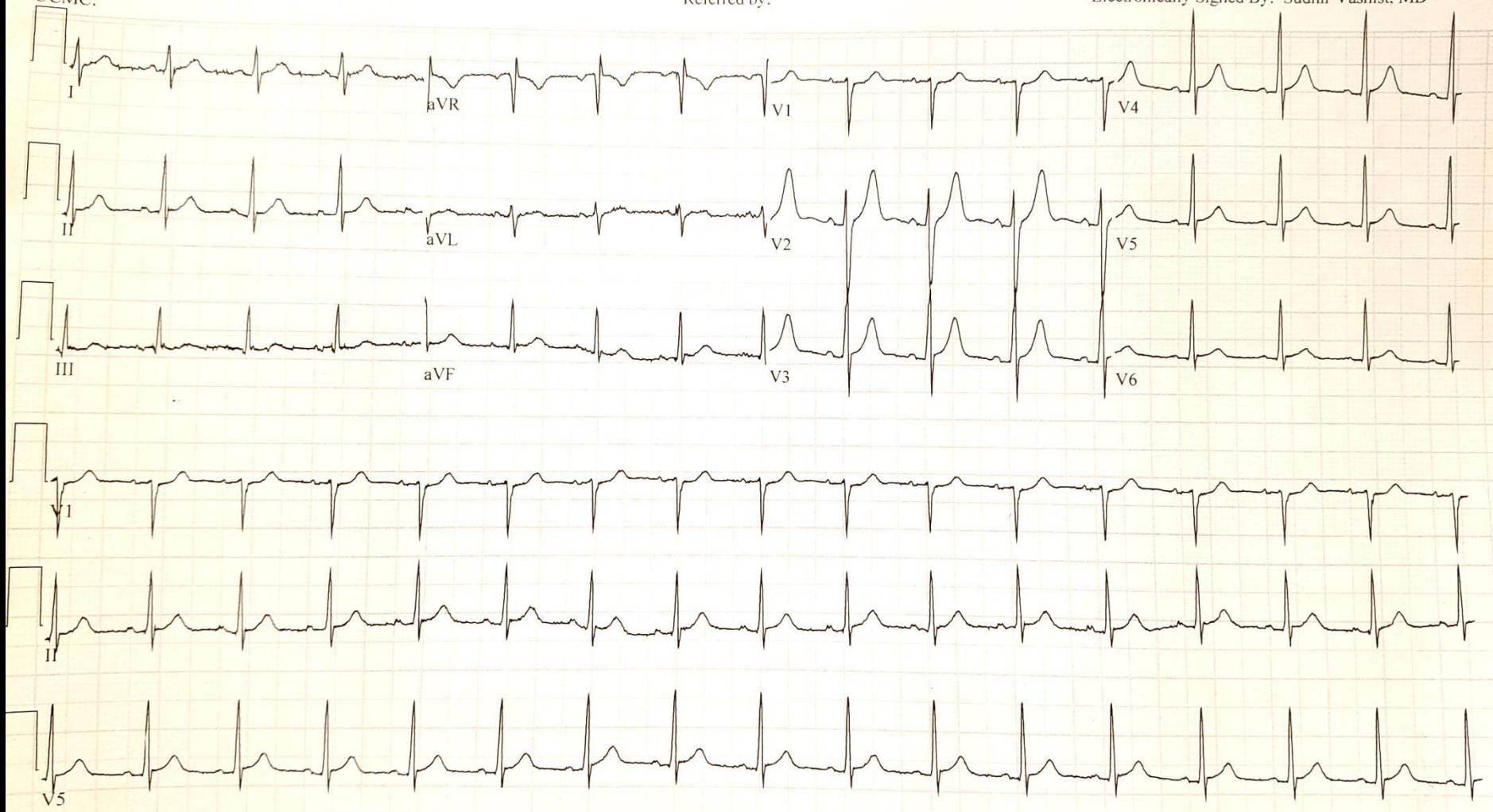
** * Pediatric ECG analysis * **
Normal sinus rhythm
Normal ECG

Technician: AF
Test ind:Chest Pain (CP) R07.9

UCMC:

Referred by:

Electronically Signed By: Sudhir Vashist, MD



25mm/s 10mm/mV 150Hz 8.0.1 12SL 241 HD CID: 11

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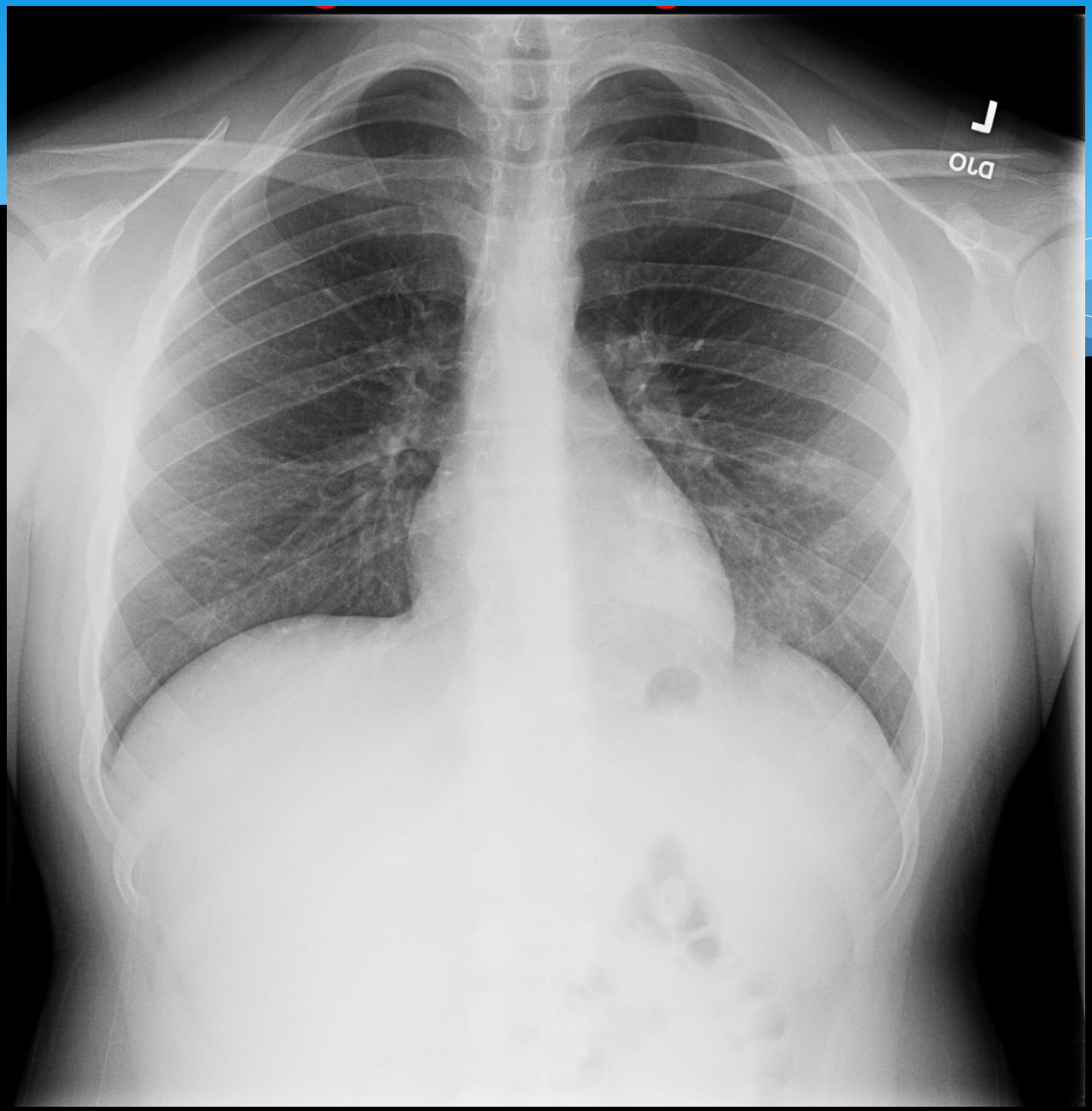

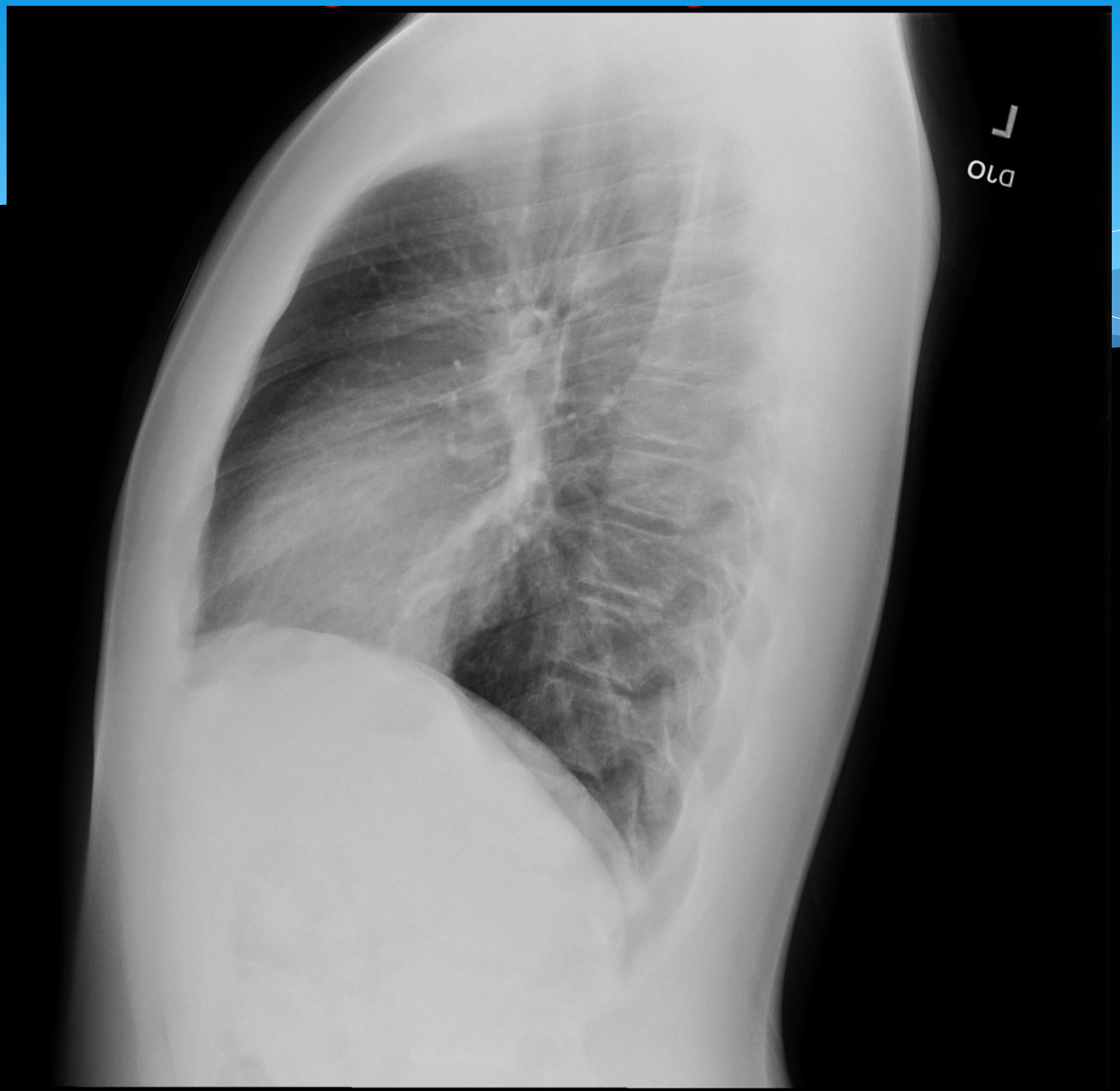
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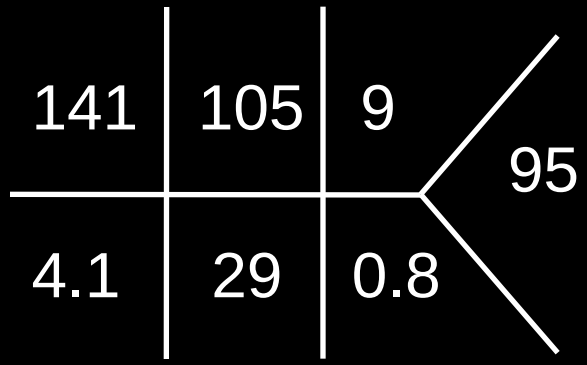
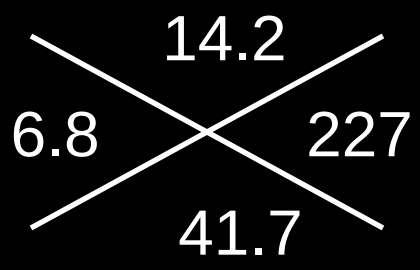
D10

Labs



Ca: 9

LFT: wnl
AST: 28



ESR: 14
CRP: 40.4

CPK: 228
Trop: 4.8

Case

* 3 yo healthy female
* CC: vomiting

* HPI:
  * Fever to 101.5
  * Vomiting x 2 days, no diarrhea
  * No URI
  * Tylenol in triage

Case

* Physical exam
  * 38.4°C, 185, 105/60, 32, 98%
  * Gen: sitting quietly on dad's lap
  * HEENT: dry MM
  * CV: no murmurs, CR 4"
  * Resp: no wheezes/ rales/ retractions
  * Abd: soft, nontender, no HSM
  * Skin: no rash

Case

* ED course
  * Ondansetron
  * PO hydration
  * Reassessment: 39°C, 175, 32, 100/60, 96%
  * Playing on bed

  * Ibuprofen
  * Reassessment: 37.4°C, 165, 34, 100/65, 95%
  * Playing on the bed, +retractions & flaring

Case

* ED course
  * CXR ordered
  * Signed out to next team

Case

Case

* ED course
  * CXR negative
  * Reassessment: 37, 160, 45, 90/50, 95%
  * Fatigued, lying on bed, CR 4”

Case

* ED course
  * IVF bolus, antibiotics, labs (presumed sepsis)
  * Reassessment: 37, 160, 45, 95/50, 92%
  * Listless
  * Transferred to PICU

Case

* PICU course:
  * IVF, vasopressors
  * > 12 hr after presentation, Troponin = 10
  * Transfer for transplant
    * epinephrine gtt
    * patient died < 24hrs after presentation

Dx: Myocarditis

Pause if:

- Persistent unexplained tachycardia
- Antecedent illness
- New murmur
- Not quite right…

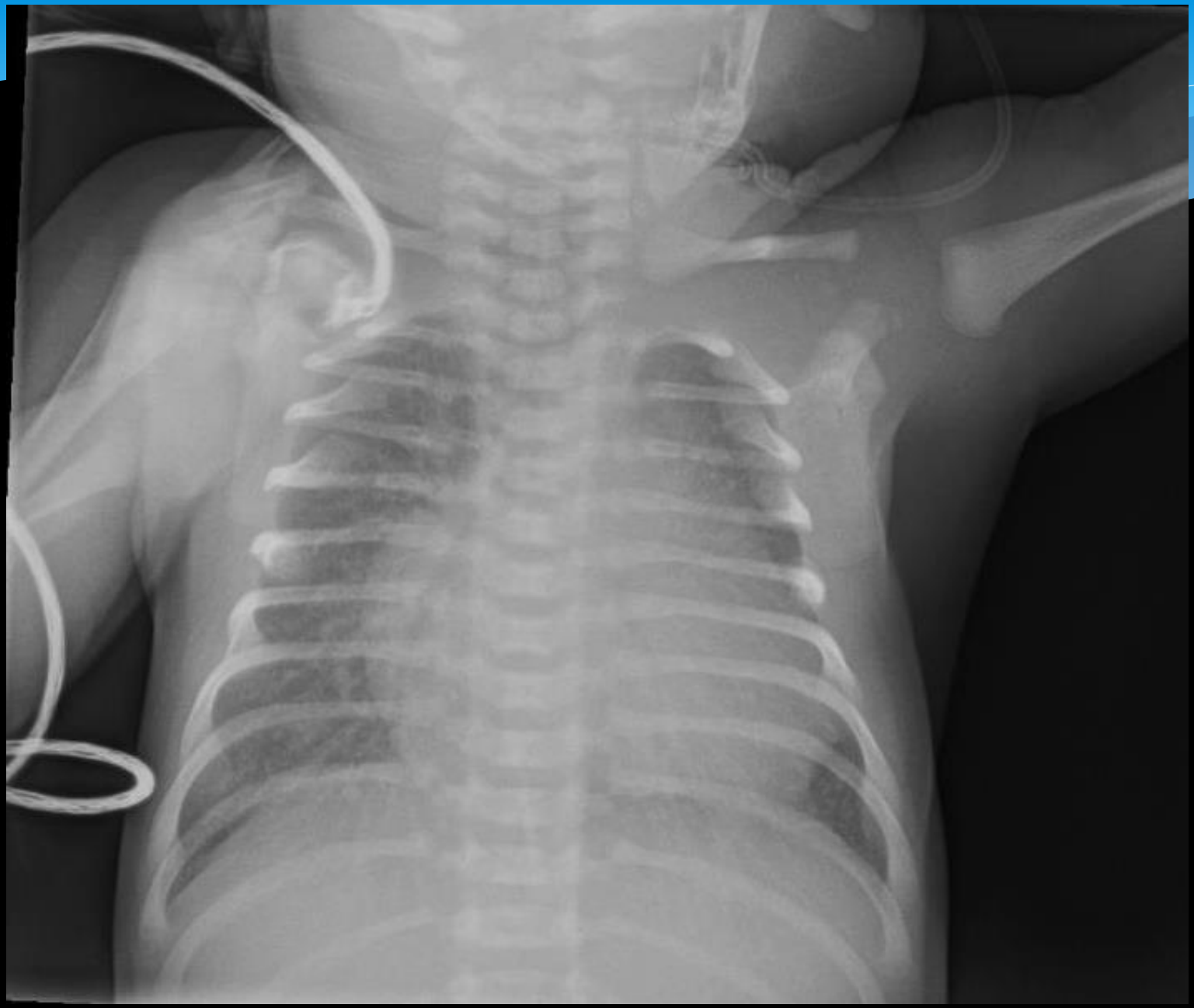
Home

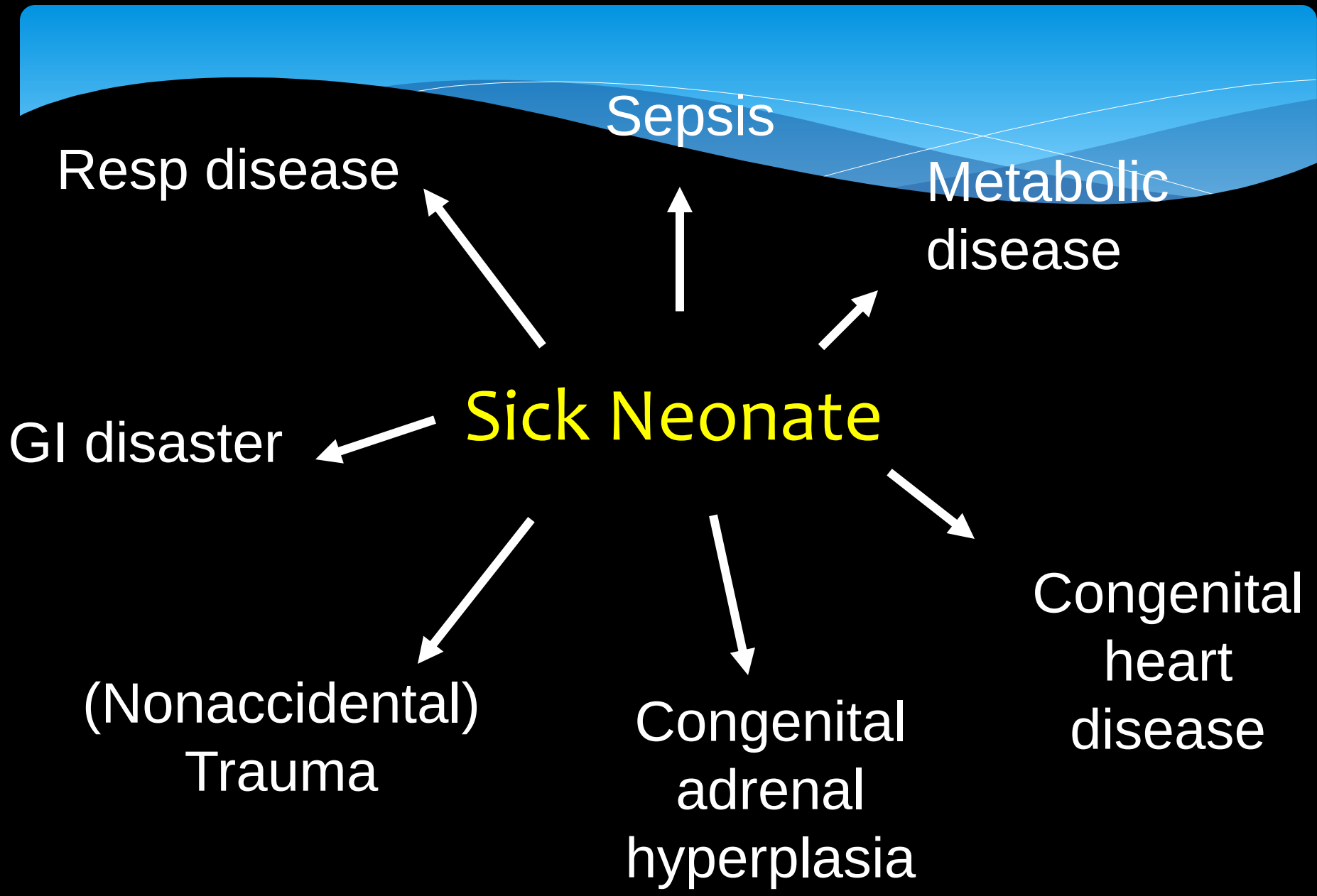
9 day male

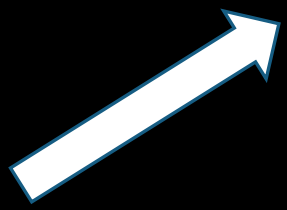
* FT male, meconium fluid, no aspiration
* BF x 10 but kept falling asleep
* p/w poor feeding and increased WOB
* Went to PCP and sent to ED

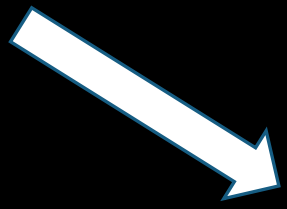
Physical Exam

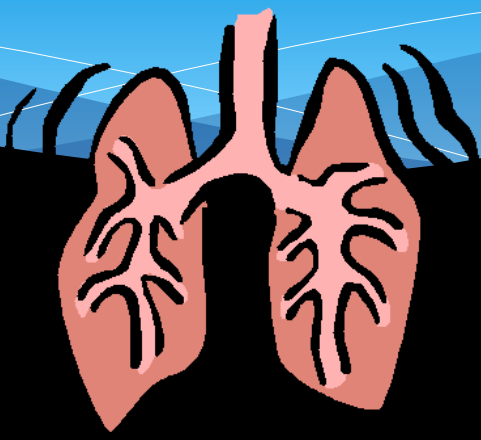
* 36.7 C, P 188, RR 96, 88% RA
* Retractions, tachypneic, grunting
  * no wheezing, no rhonchi
* Tachycardic, no murmur
* Palpable brachial pulses, weak femoral, faint radial, no dorsalis pedis, CR 4-5 sec
* Liver 2 cm below CM, no edema

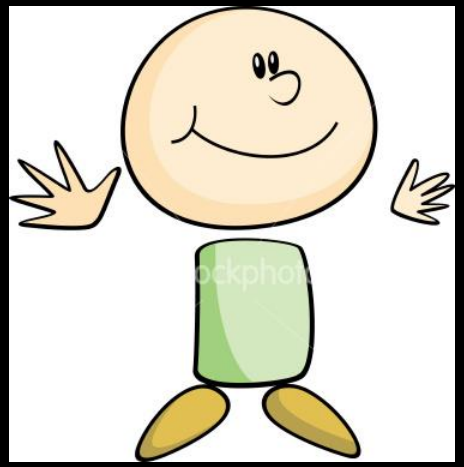



Sepsis
Resp disease
Metabolic disease
Sick Neonate
GI disaster
(Nonaccidental) Trauma
Congenital adrenal hyperplasia
Congenital heart disease

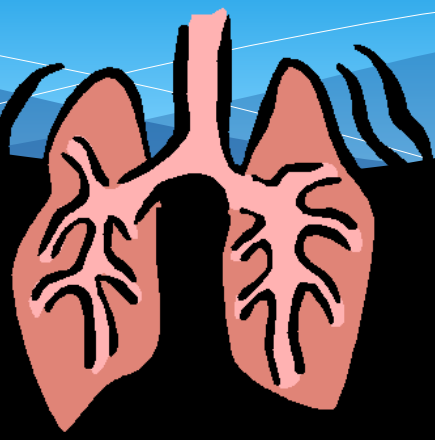


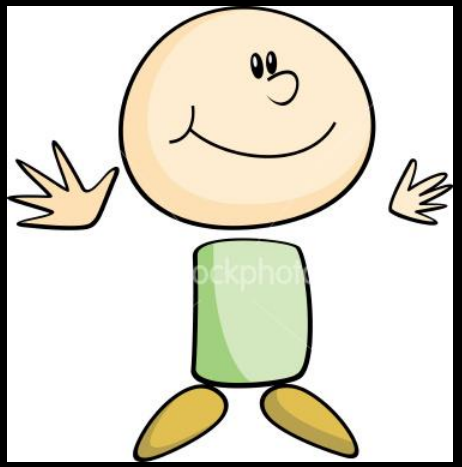


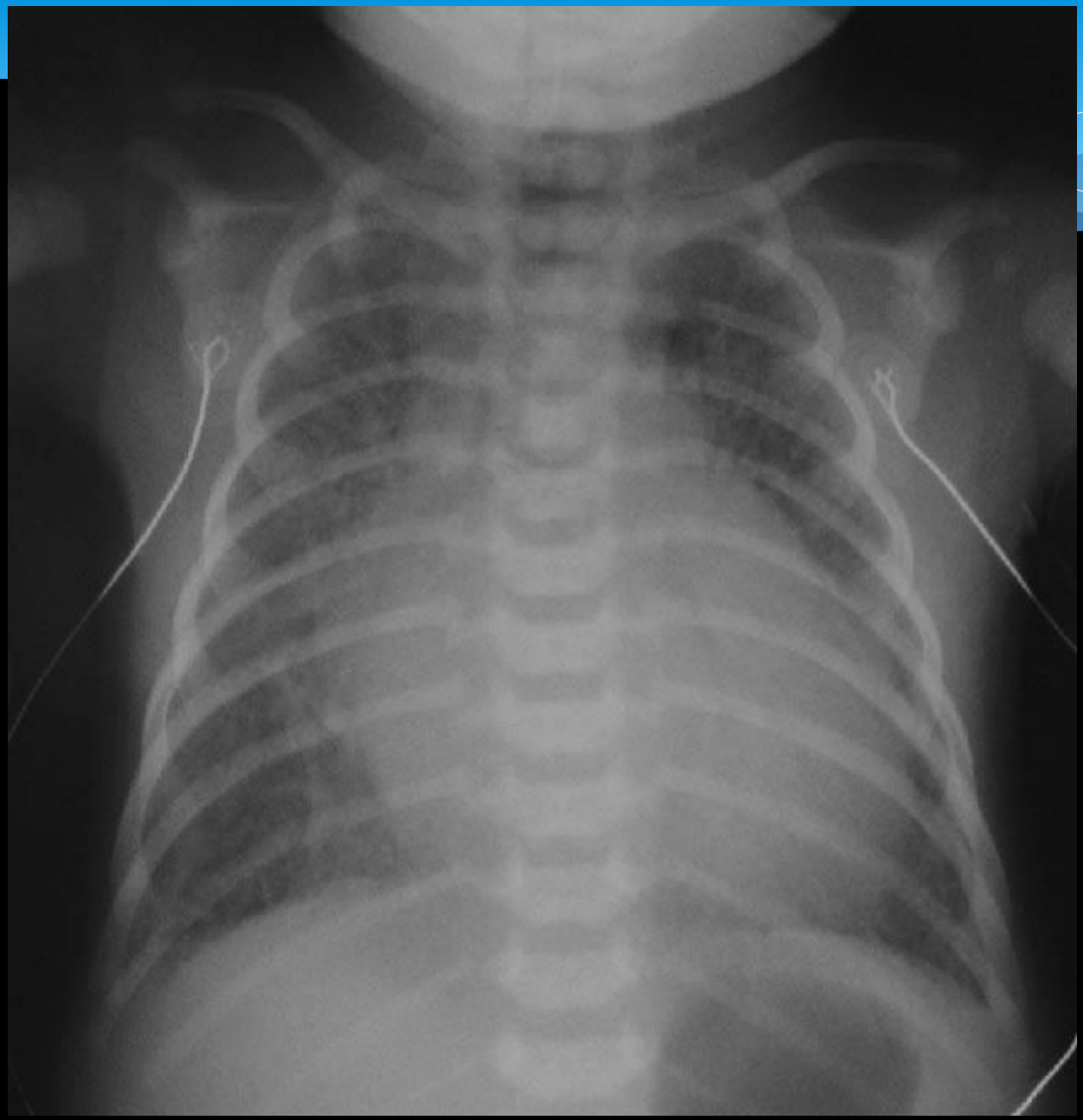




O_2

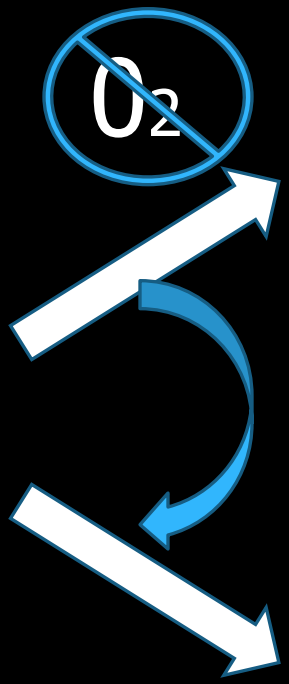


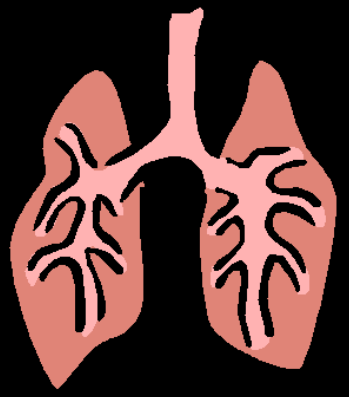


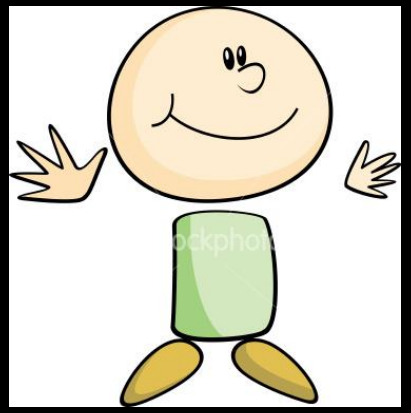


Prostaglandin (PGE_1)

- Apnea
- Hypotension
- Fever
- Flushing

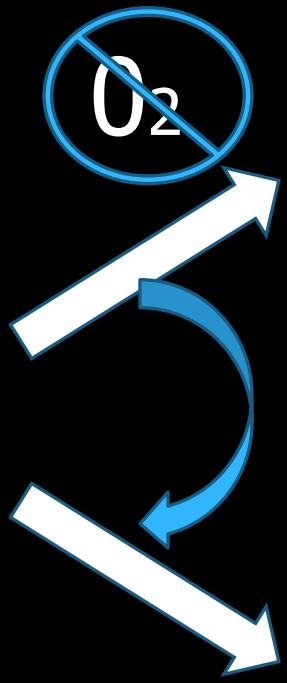


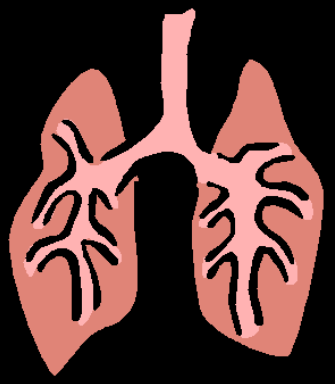


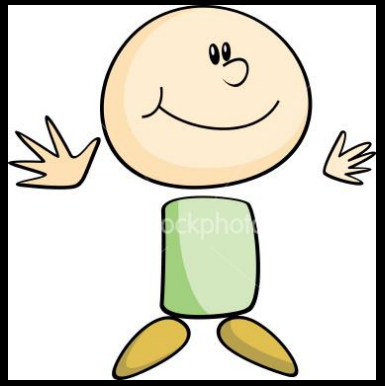


Shunt blood away from lungs

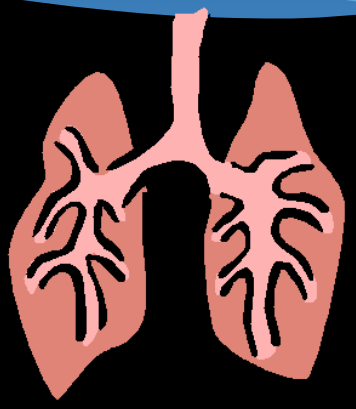
Prostaglandin (PGE_1)
Hypoventilation
Carbon dioxide

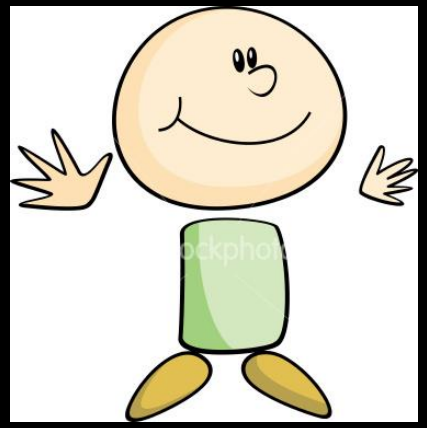






O_2





Shunt blood to lungs

Oxygen (hyperoxia test)

Hyperventilation

Nitric oxide

Inotropes

Back to the case…

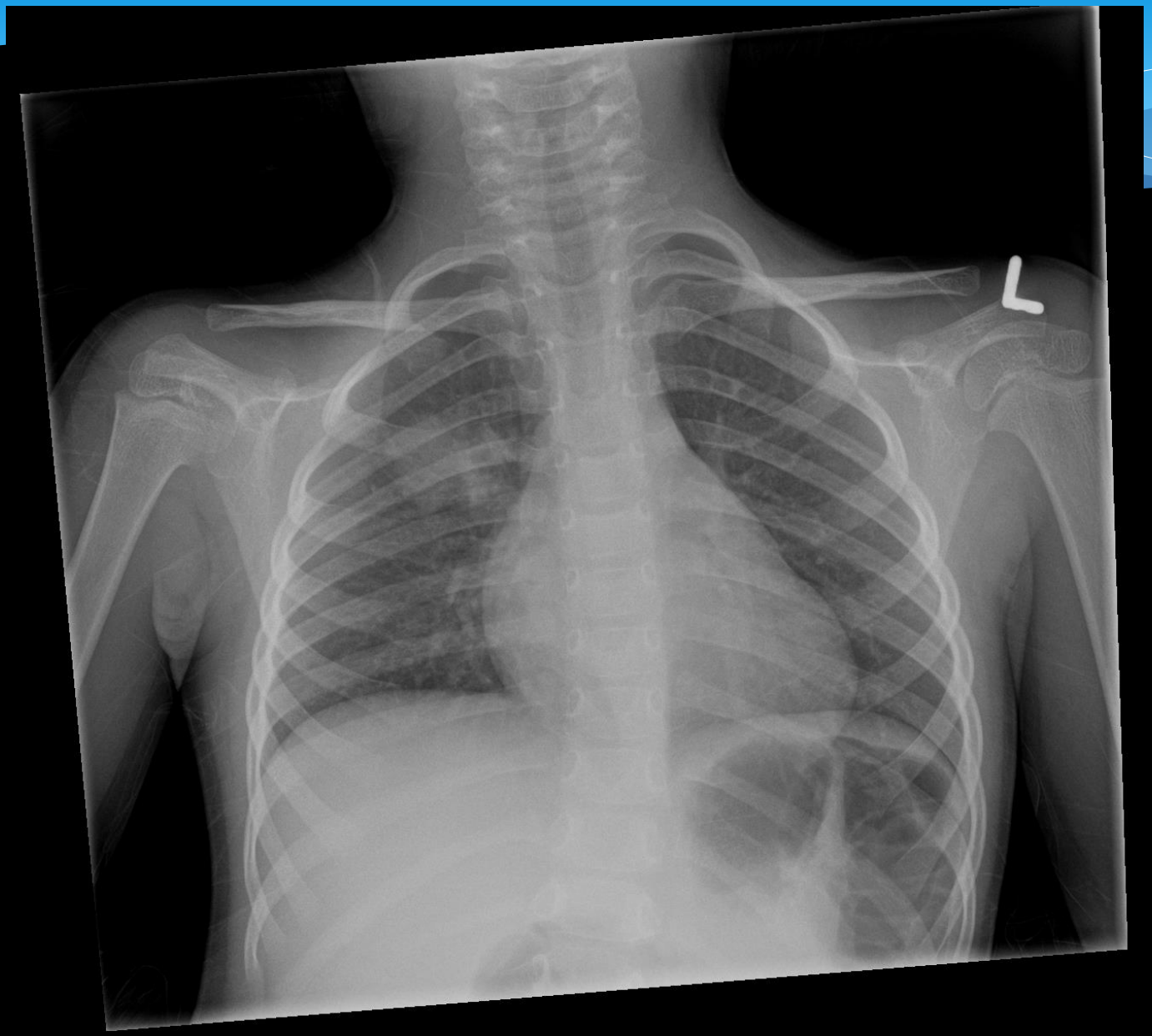
* 4 point BP: RUE 93/69, RLE 44/36, LLE 28/20
* Multiple unsuccessful attempts at IV
  * Intraosseus
* Bedside ECHO
* Started prostaglandin
  * Prepare for intubation

Back to the case…

* Transfer team arrived → called for flight team
* Diagnosis: aortic arch hypoplasia

Home

4 yo with vomiting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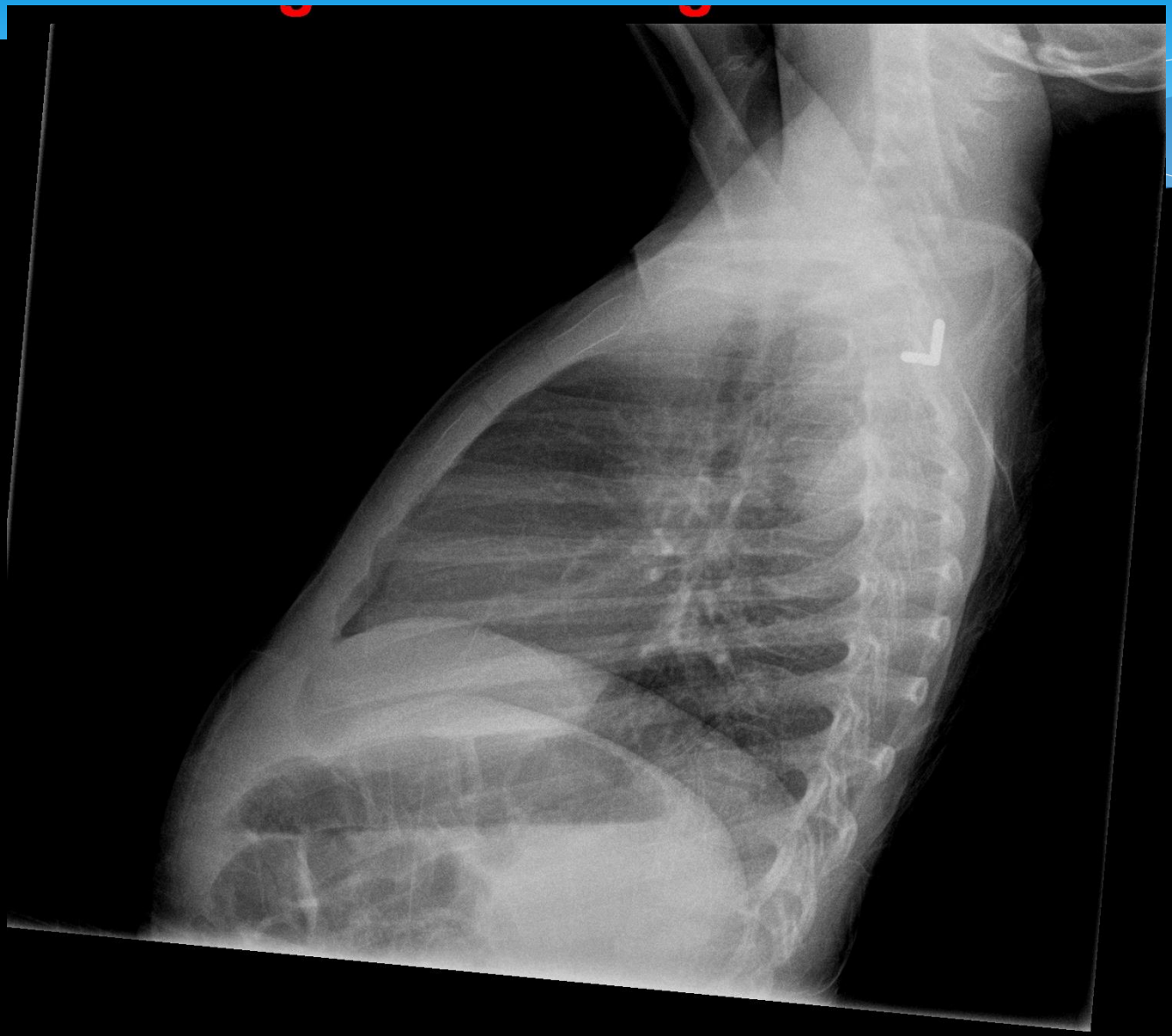
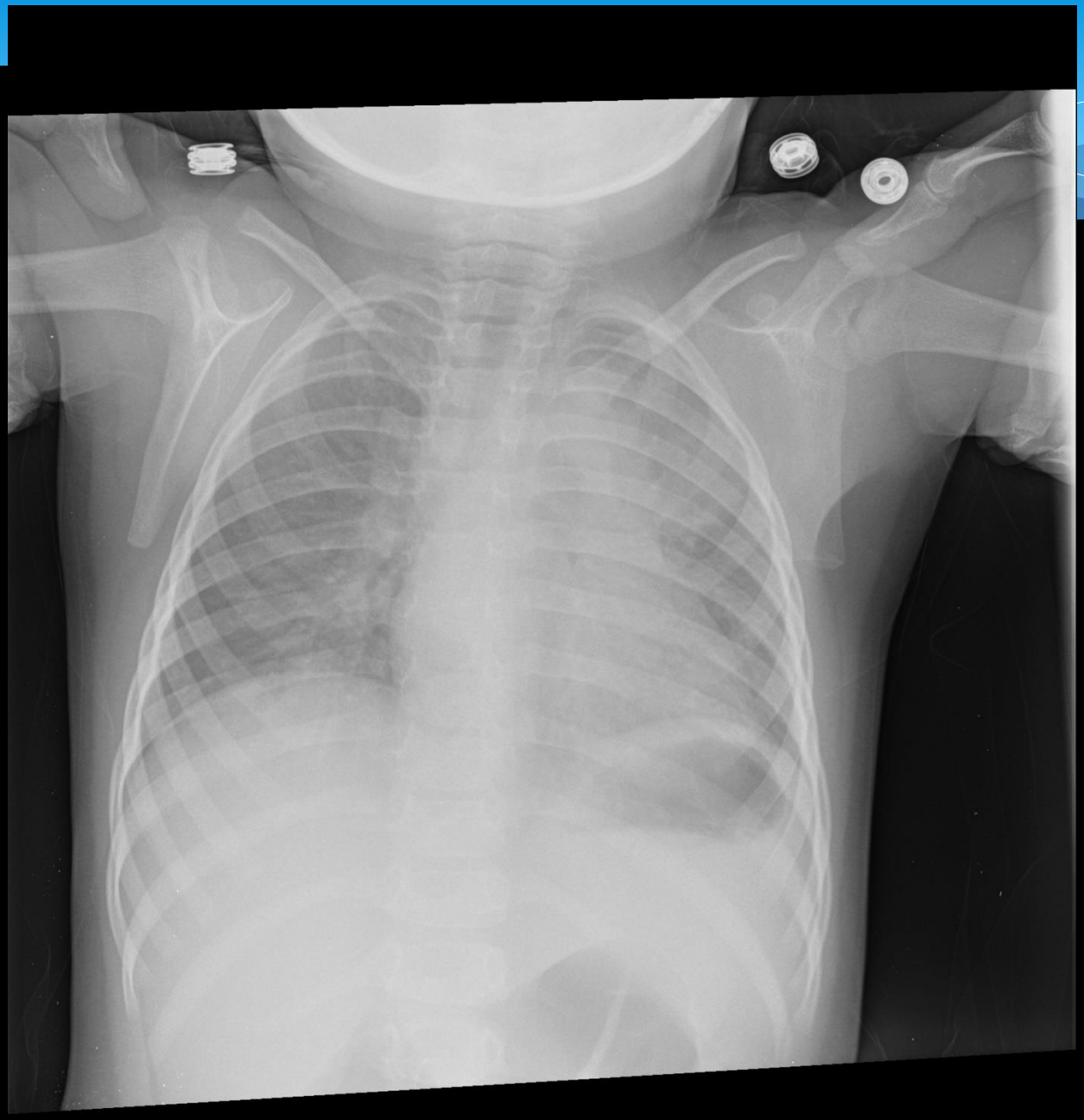
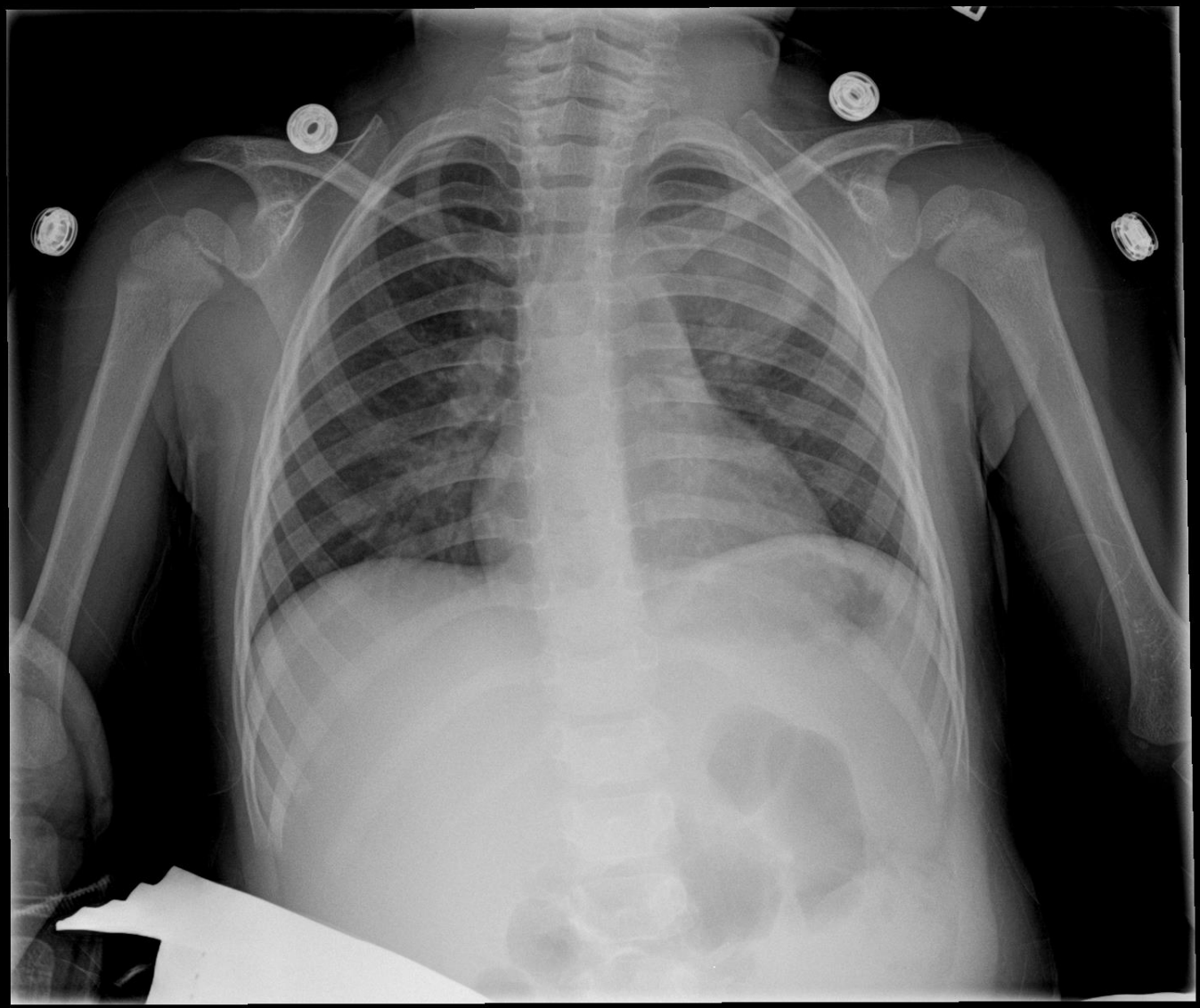
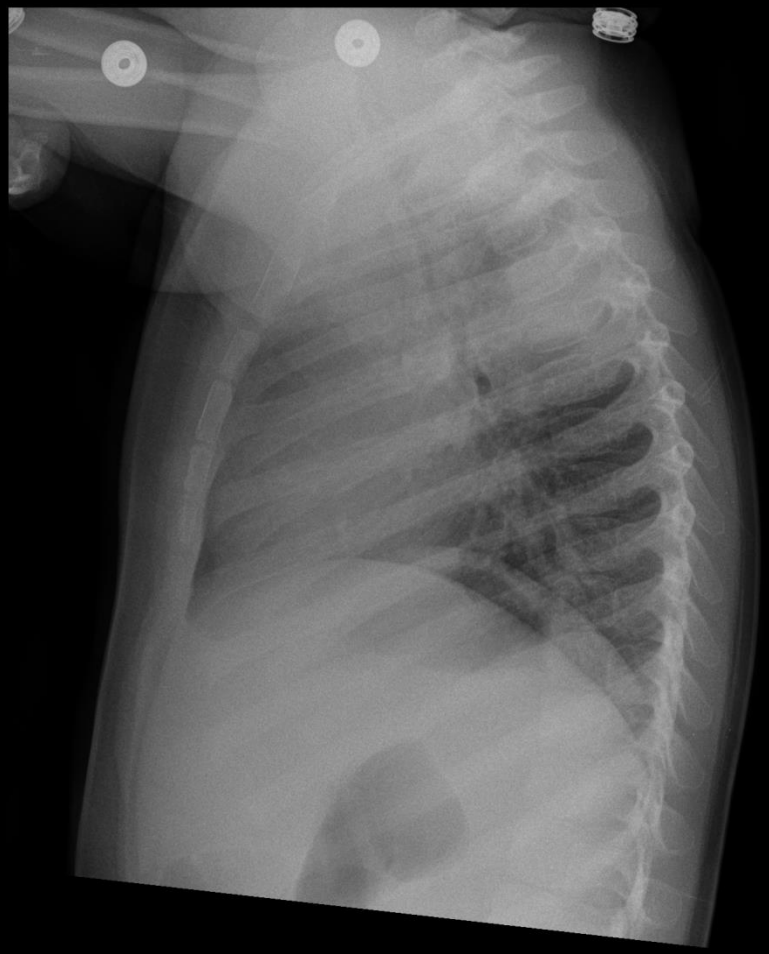


2.5 yo with fever x 4 days







“Round” Pneumonia/ Strep Pneumonia

High Dose Amoxicillin?

* Poor Penetration
  * Ears, Sinuses
* Pneumococcal resistance*
  * Ears, sinuses, lungs (pneumonia)

Standard therapy: Group A strep pharyngitis, dental problems, skin infections and urinary infections for susceptible pathogens

Take Home Point

More Clavulanate = More diarrhea

For HIGH dose amoxicillin dosing
(90 mg/kg/day)

Use Augmentin ES-600

Home

Case 1: Child with Asthma

Case 1

* 10 yo female h/o asthma sent from Urgent Care with wheezing x 2 days. Received 1+1 nebs.

* PMHx: Asthma, 2 ICU, 1 intubation
* Meds: Albuterol, Flovent, Singulair

VS: T 37.8°C, P 134, RR 40, BP 90/40, 93% neb
Wt: 30 kg

Case 2: Vomiting Infant

Case 2

* 3 week FT male sent from PMD for progressive vomiting. Formula fed. Recent change to Similac. BM 2 days ago. Last wet diaper 2300 last PM.

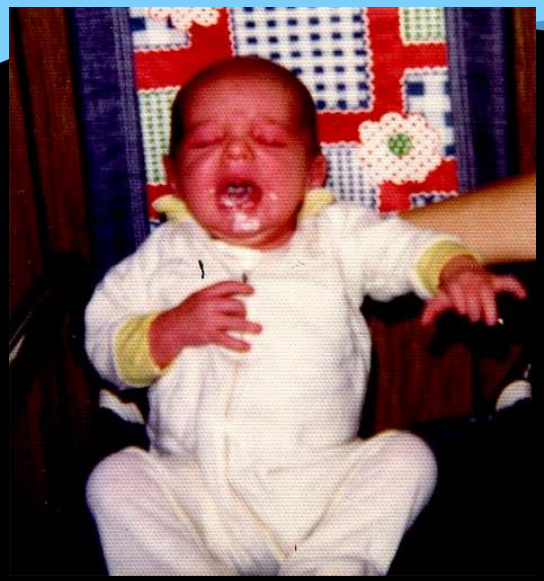
* VS: T 37°C, P 160, RR 50, 98% RA
* Wt: 5 kg

Back to Case 1: Asthma

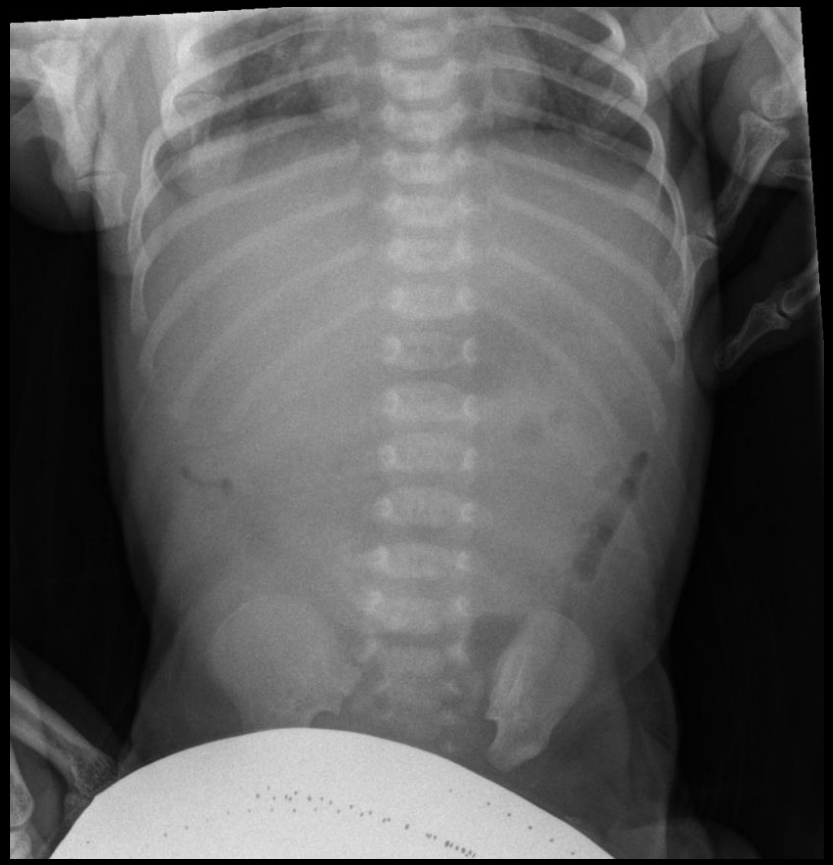
Triage VS: T 37.8°C, P 134, RR 40, BP 90/40, 93% neb
Wt: 30 kg

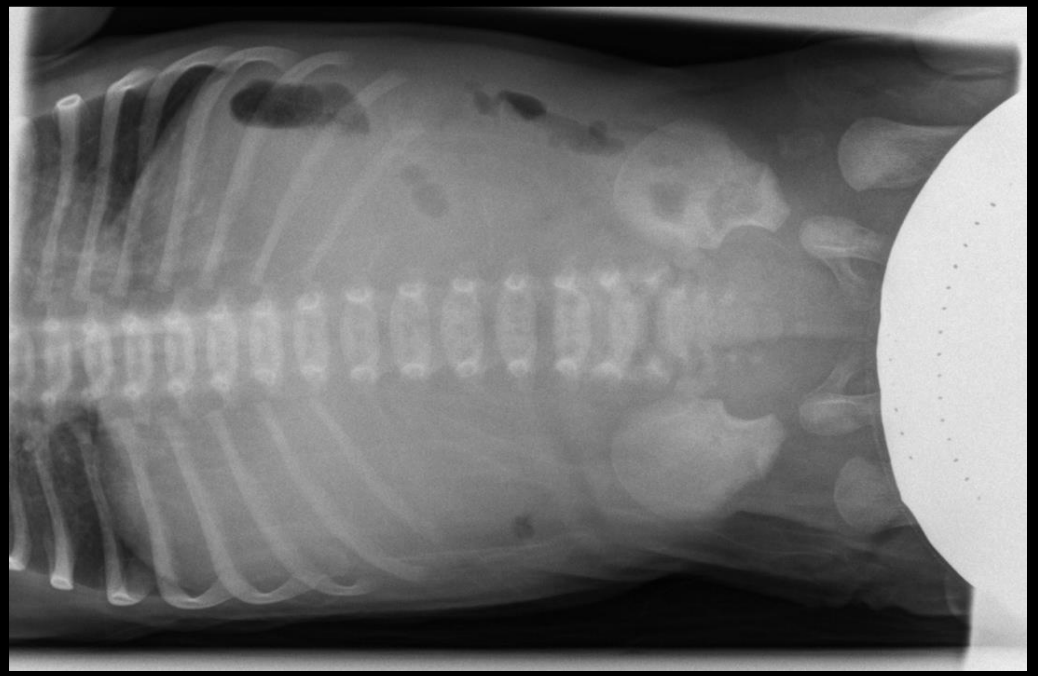
Repeat VS: T 38.1°C, P 144, RR 32, BP 95/42, 92% neb

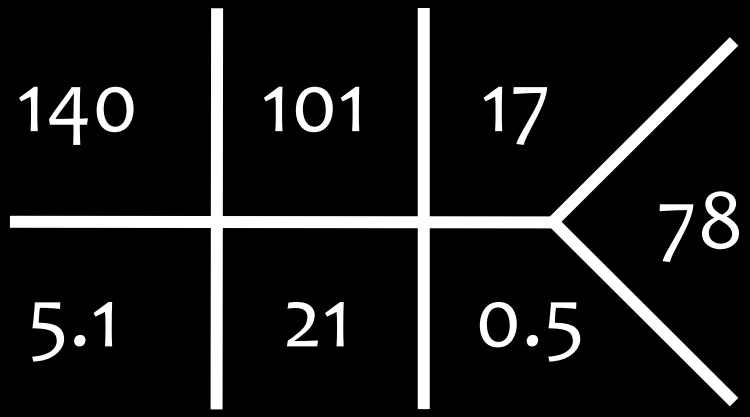
Back to Case 2: vomiting infant



Case 2





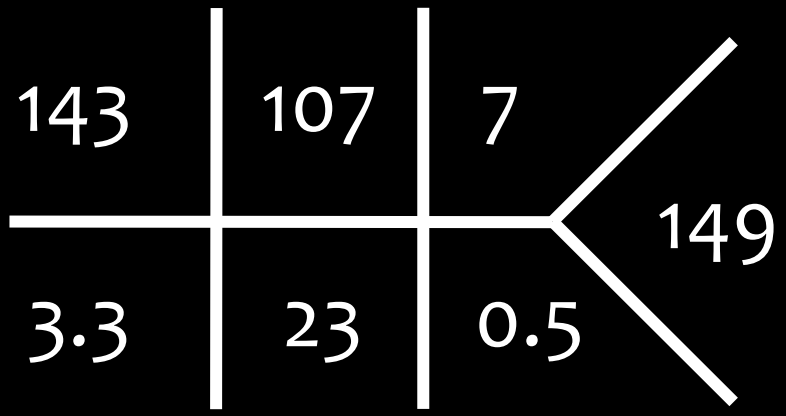


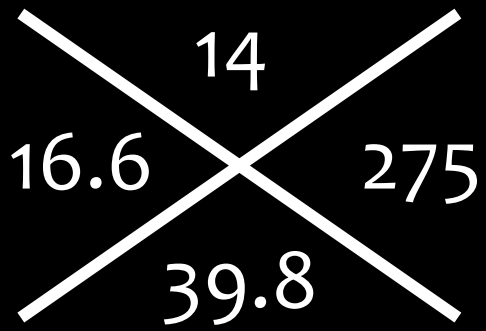
Ca 11.2

Ultrasound: normal pylorus

Back to Case 1: Asthma

Case 1





$N^{86}L^{6}$

Ca 8.6
Ph 3.9
Mg 1.9

ABG: 7.20/ 55/ 69
BE: -4

Case 2: vomiting infant

Malrotation with midgut volvulus

Abdominal Xray

Upper GI

Differential for vomiting infant

Bilious

* Malrotation with volvulus
* Intestinal atresia
* Meconium ileus

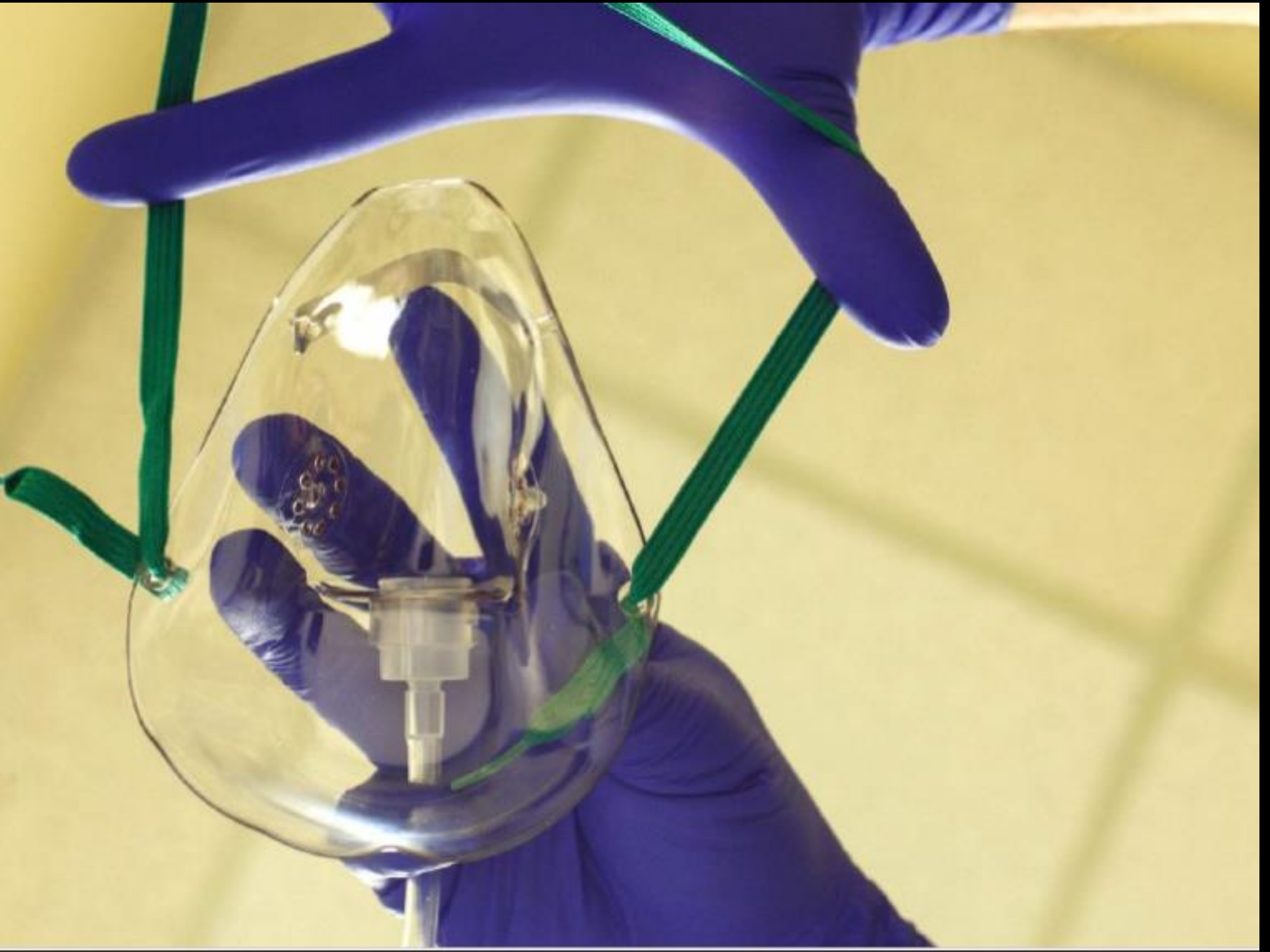
Bilious or non-bilious

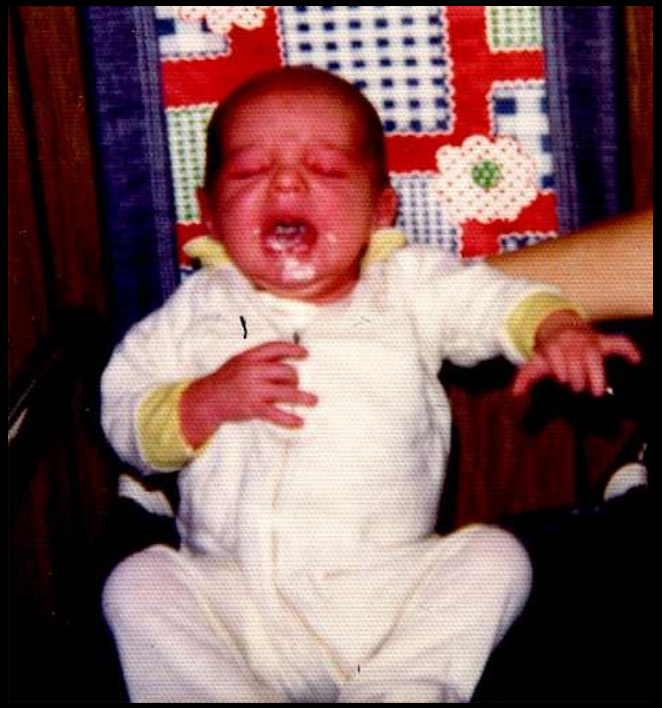
* Necrotizing enterocolitis
* Pyloric stenosis
* Hirschprung's
* Inborn errors of metabolism
* Infection
  * UTI, pneumonia, meningitis
* GERD
* Intussusception

Infant with bilious emesis

* NEVER normal
* Surgical emergency until proven otherwise
* Potential for rapid decompensation
* Critical actions:
  * Sepsis if ischemic bowel
  * Treat metabolic derangements
  * IVF resuscitation
  * Antibiotics
  * Upper GI
  * Transfer to higher level of care

Back to Case 1: Asthma





Home

Poll

Thanks!

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