They are Not Just Little Adults:
Pediatric Crisis Management in the Ambulatory Surgery Center

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Disclosures

Lead Site Reviewer

Boston Children's Hospital at Waltham

- Free standing children's satellite hospital
- 12 miles from main quaternary hospital
- No emergency services on site

Case

- Healthy, athletic 13 y/o scheduled for outpatient ACL reconstruction with hamstring graft
- After induction of anesthesia, LMA placement and administration of antibiotics, dexamethasone, opioids → BP = 58/17
- Phenylephrine x 2 then epinephrine – multiple boluses
- Intubation, IV fluids, Tryptase obtained

Case - continued

- Profound vascoconstriction – difficult IV placement
- Central venous access → Epinephrine drip
- Stabilization and transfer to Main Hospital ICU via Critical Care Transport
- Extubated that afternoon
- Discharged from hospital the next day
- Tryptase “positive”

“Stat” Calls

Vlassakova BG, et al. Anesth Analg 2018;127:126–33.

Table 2. STAT Calls Grouped by Underlying Causes and Reasons for Calls Within Each Grouping

Underlying Cause of STAT Calls					
Cardiac	**26**	**Respiratory**	**144**	**Other**	**26**
Subtypes for call categories					
Arrhythmia	13	Desaturation	54	Emesis	4
CPR for “Code”	13	Laryngospasm	54	Patient movement	4
		Bronchospasm	1[illegible]	Anaphylaxis	3
		Accidental extubation	13	Emergence issues	3
		Airway obstruction	6	Need of additional staff or medical care	3
		Breath holding	2	Coughing/gagging	2
		Inability to ventilate	1	Nonresponsive	2
				Air embolism	1
				Intravascular injection of local anesthetic	1
				Major bleeding	1
				Seizures	1
				Unknown	1

Abbreviations: CPR, cardiopulmonary resuscitation; STAT calls, “calls for help.”

75% Respiratory
13% Cardiac
12% Other

“Stat” Calls

Vlassakova BG, et al. Anesth Analg 2018;127:126–33.

Table 4. Multivariable Analysis of the Association of Underlying Causes for STAT Call and Perioperative Phase of the Call

Perioperative Phase	Respiratory (%)	Cardiac and Other (%)	OR (95% CI)	*P* Value
Induction	69	31	1.2 (0.5–2.7)	.62
Intraoperative[a]	65	35	-	-
Emergence	85	15	3.1 (1.1–8.3)	.024[c]
PACU	85	15	2.9 (1.02–8.5)	.044[c]
Perioperative Phase	**Cardiac (%)**	**Respiratory and Other (%)**	**OR 95% CI**	***P* Value**
Induction	12	88	0.5 (0.16–1.5)	.198
Intraoperative[a]	21	79	-	-
Emergence	7	93	0.3 (0.08–1.07)	.065
PACU	3	97	0.1 (0.01–0.92)	.042[c]

Abbreviations: 95% CI, 95% confidence interval; OR, odds ratio; PACU, postanesthesia care unit; STAT call, “call for help.”
[a]Reference category. Statistics (OR, CI, and *P* value) are presented as differences within each characteristic relative to this category.
[b]$P < .001$.
[c]$P < .05$.

Many respiratory events occur in the PACU

Satellite Rapid Response Team

Major Events	Ambulatory (N = 131)	Perioperative (N = 74)
Respiratory depression	34 (26%)	21 (28%)
Cardiac	9 (7%)	[illegible]
Anaphylaxis	14 (11%)	4 (5%)
Seizure	12 (9%)	0 (0%)
Bleeding	0 (0%)	19 (26%)
Uncontrolled pain	1(0.7%)	9 (12%)
Syncope	6 (5%)	0 (0%)
Aspiration	0 (0%)	2 (3%)
Diabetic ketoacidosis	3 (2%)	0 (0%)
Sepsis	1 (0.7%)	2 (3%)
Uncontrolled HTN	2 (1.5%)	1 (1%)
Other (Uncategorized)	49 (37%)	8 (11%)

Rapid Response Team created to care for children throughout the facility. Team members include: CCM hospitalist, nurse manager, social work and nurses from inpatient unit, PACU, Infusion Unit, Radiology and Specialty Clinic

Critical Elements for Satellite Emergency Response

Emergency Response System

Point of Care Testing

i-STAT® Blood Gas

CG8+ Cartridges - Blood Gases
Product Code: AB-3P8825

Blood gas panel plus electrolytes, glucose, ionized calcium.

The CG8+ Cartridge, used with the i-STAT® blood, utilizes biosensor technology and advanced microfluidics to provide *in vitro* quantitative determinations of the following analytes:

pH	Na
PCO2	K
PO2	iCa
TCO2*	Glu
HCO3*	
BE*	sO2*

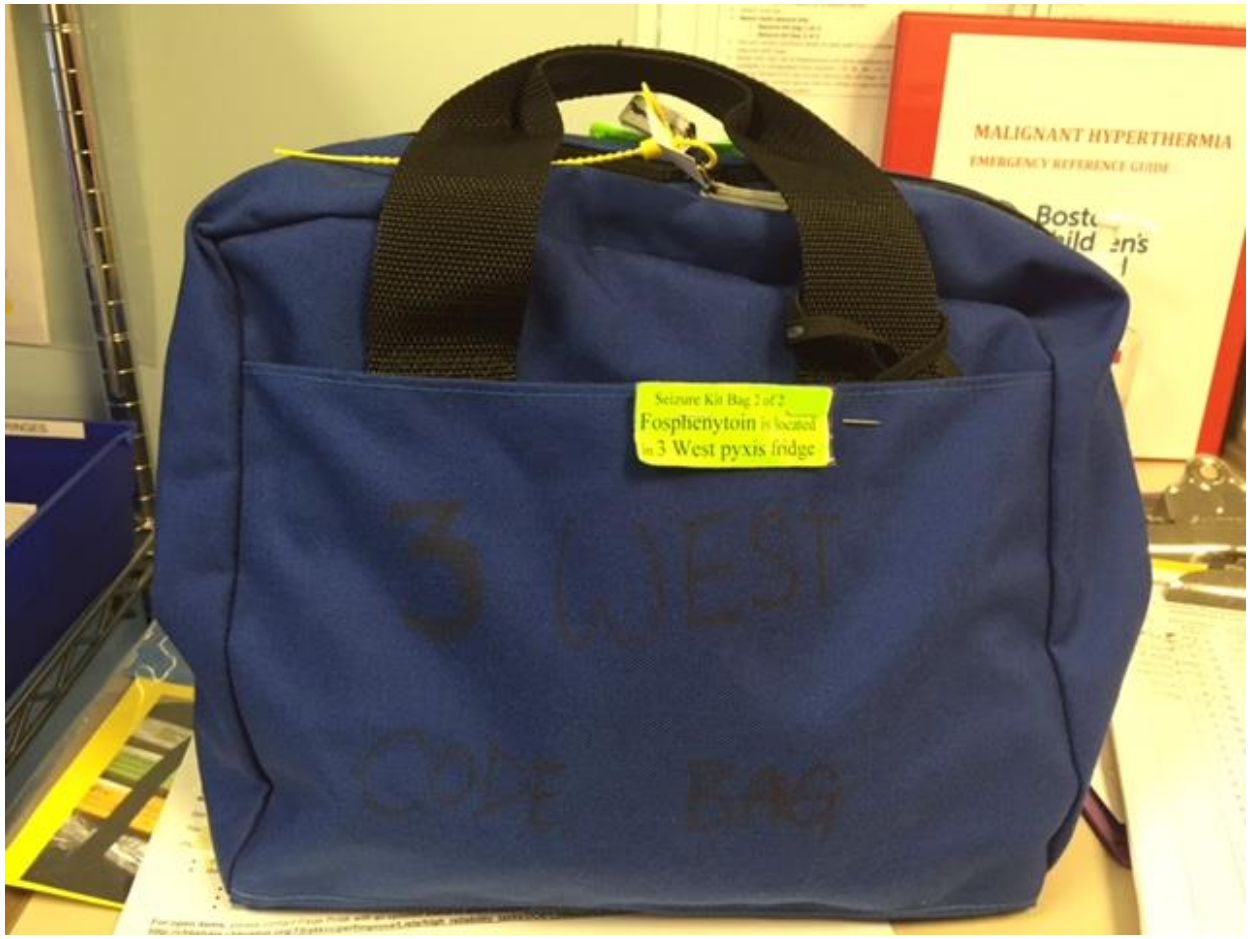
*Calculated value

HemoCue®

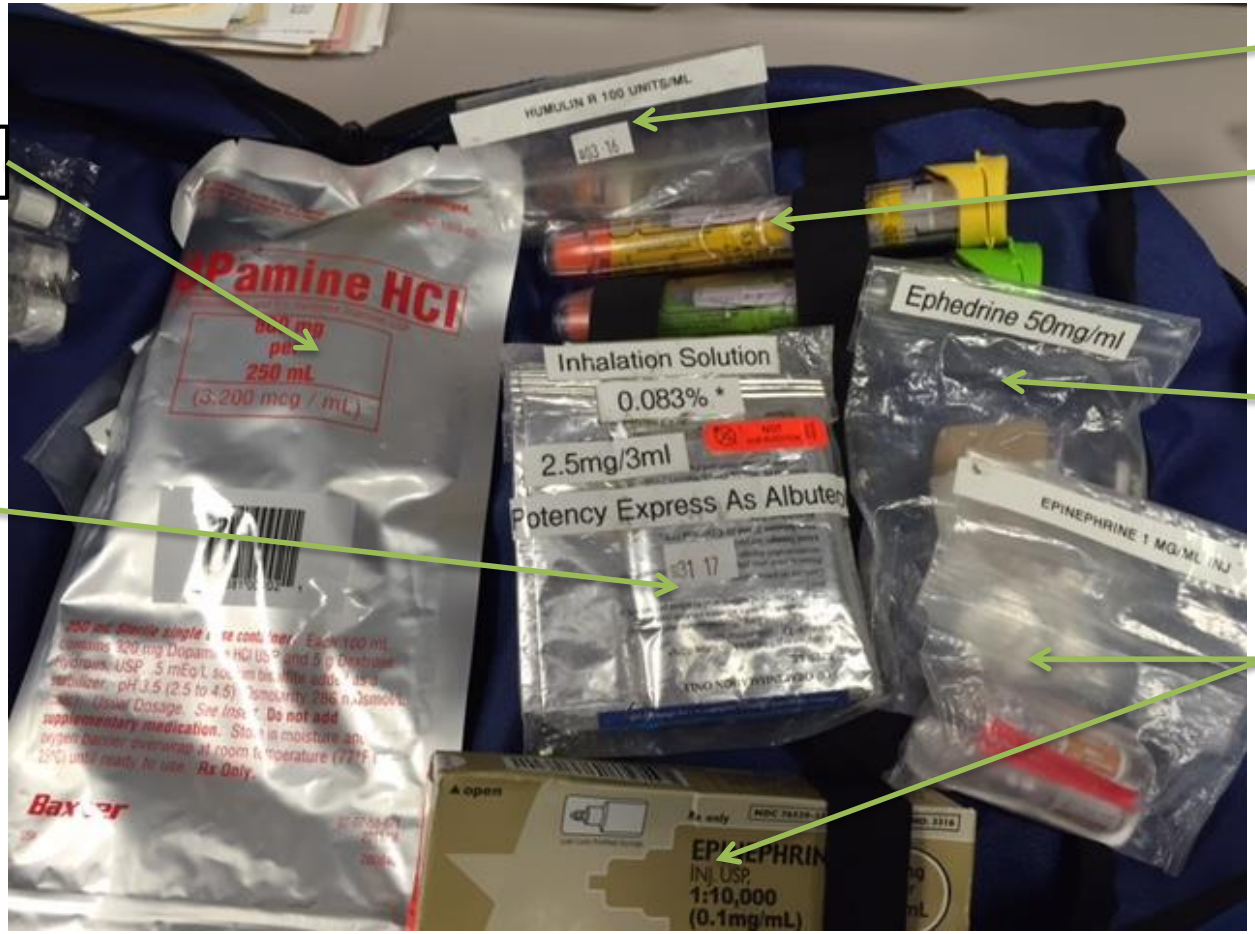
- HemoCue® measures hemoglobin by **photometry** and requires only 10 µL of blood
- Results are available within 60 seconds
- Hematocrit is calculated by multiplying the hemoglobin measurement by 3

EKG - Wireless Transmission

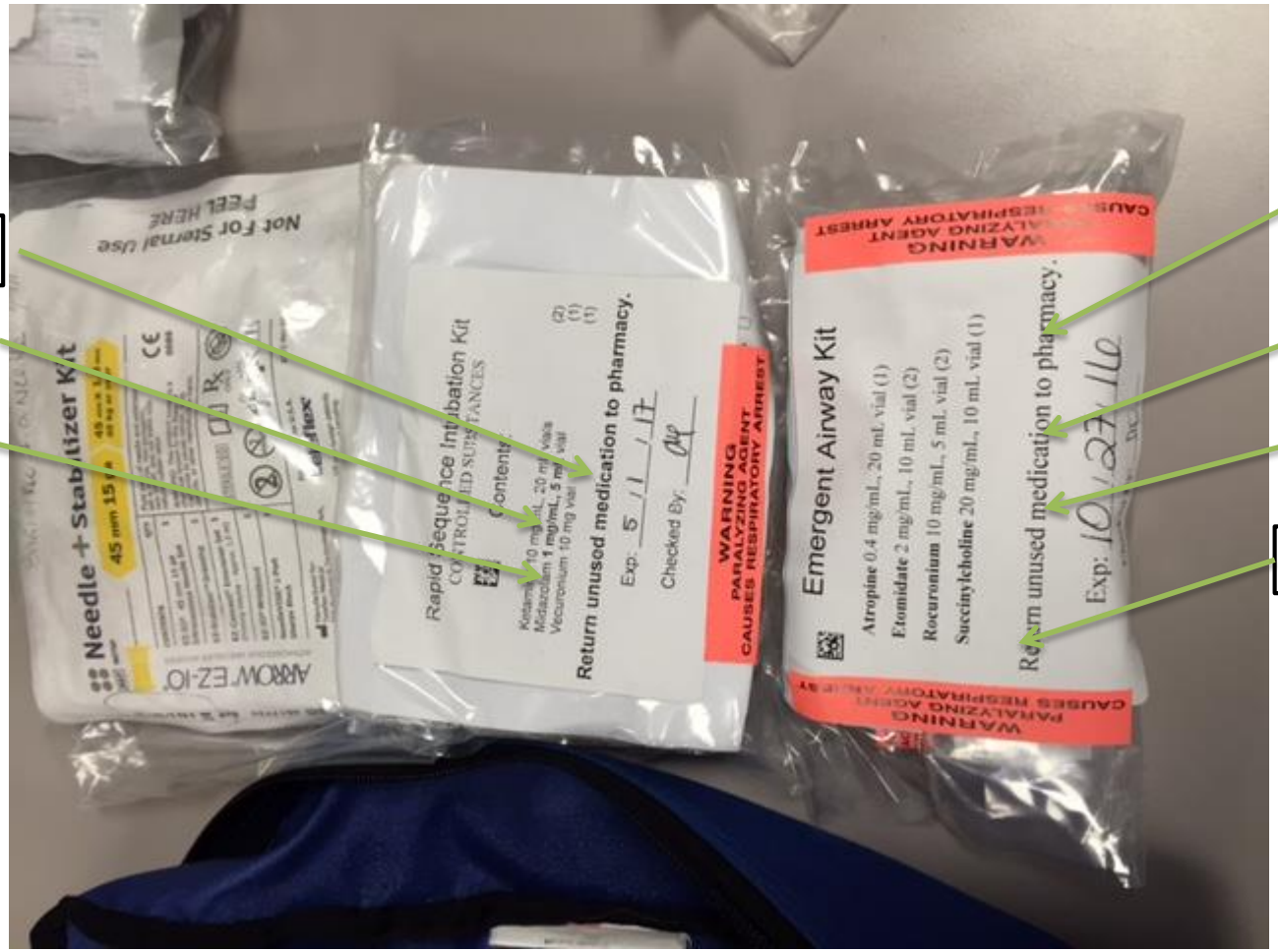
Waltham Code Blue Bag



Resuscitation Medications



Emergency Airway & Rapid Sequence Induction Medications



Cognitive Aids

Anaphylaxis Checklist

Anaphylaxis

Rash, bronchospasm, hypotension

- Increase O_2 to 100%
- Remove suspected trigger(s)
  - If latex is suspected, thoroughly wash area
- Ensure adequate ventilation/oxygenation
- If HYPOtensive, turn off anesthetic agents

Common causative agents:
- Neuromuscular blockers
- Latex
- Chlorhexidine
- IV colloids
- Antibiotics

Purpose	Treatments	Dosage and Administration
To restore intravascular volume NS or LR		10-30 mL/kg IV/IO, **rapidly**
To restore BP and ↓ mediator release	EPInephrine	• 1-10 mcg/kg IV/IO as needed, may need infusion 0.05-1 mcg/kg/min • Additionally may give IM for depo effect: EPInephrine 0.01 mg/kg IM < 10 kg EpiPen JR. (0.15 mg) IM 10-29 kg EpiPen (0.3 mg) IM ≥ 30 kg
To ↓ bronchoconstriction	Albuterol (Beta-agonists)	4-10 puffs as needed
To↓ mediator release	MethylPREDNISolone	2 mg/kg IV/IO (MAX 125 mg)
To↓ histamine-mediated effects	Diphenhydramine	1 mg/kg IV/IO (MAX 50 mg)
To↓ effects of histamine	Ranitidine Famotidine	1 mg/kg IV/IO (MAX 60 mg) 0.25 mg/kg IV/IO (MAX 20 mg)

- If anaphylactic reaction suspected - send mast cell tryptase levels between 15 minutes and 3 hours after event (Mature and Total Trypase)

**** Please refer to BCH Emergency Medication Dosage Guide for dose per kg**

Rev. March 2017

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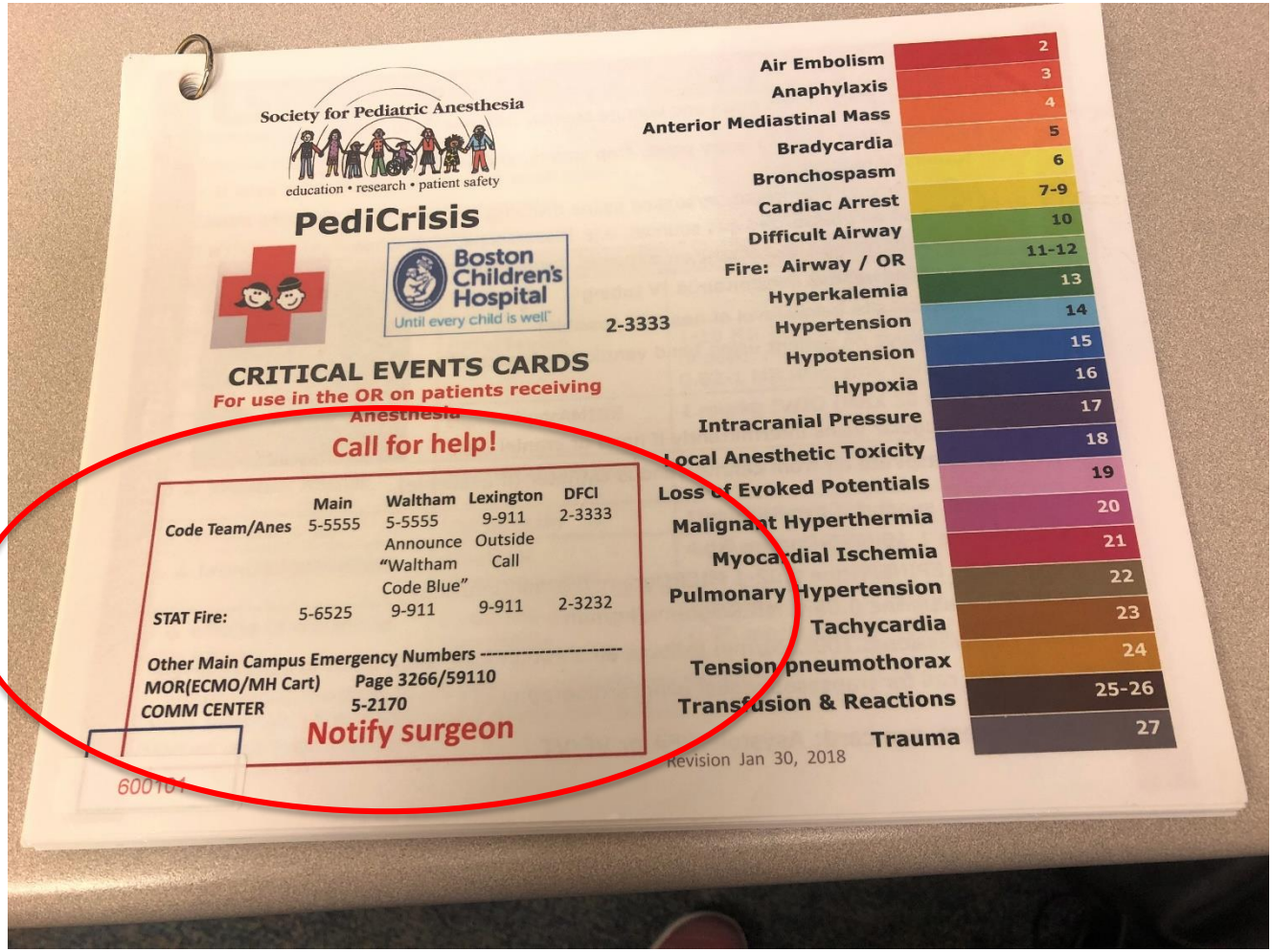
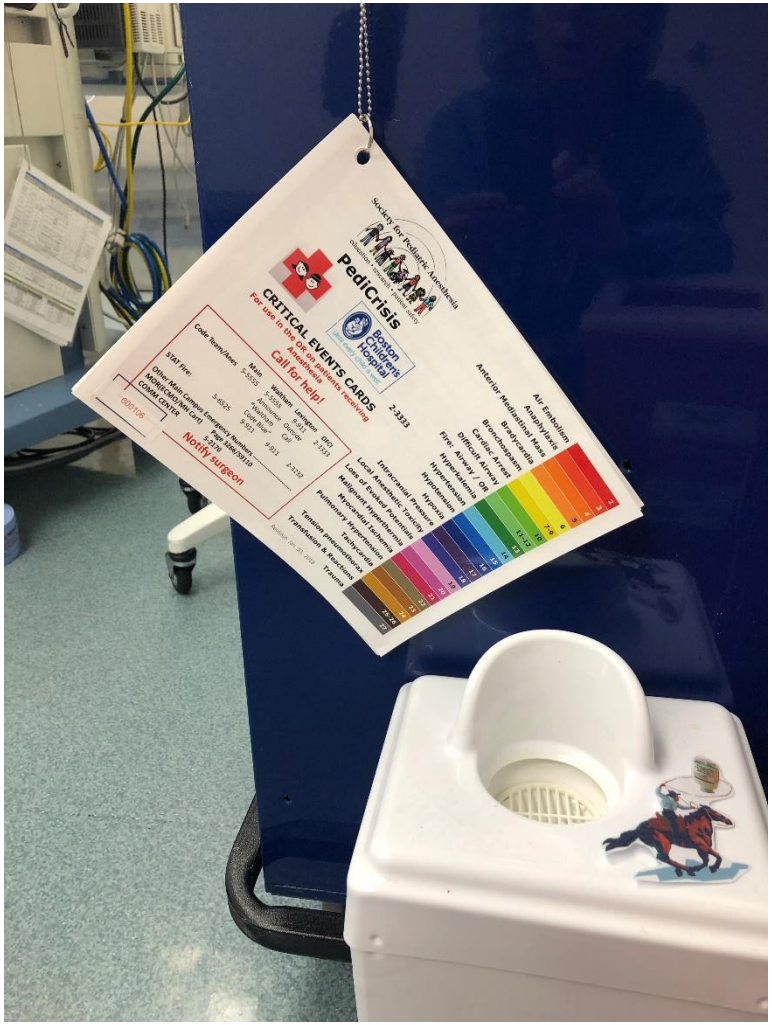
Anaphylaxis

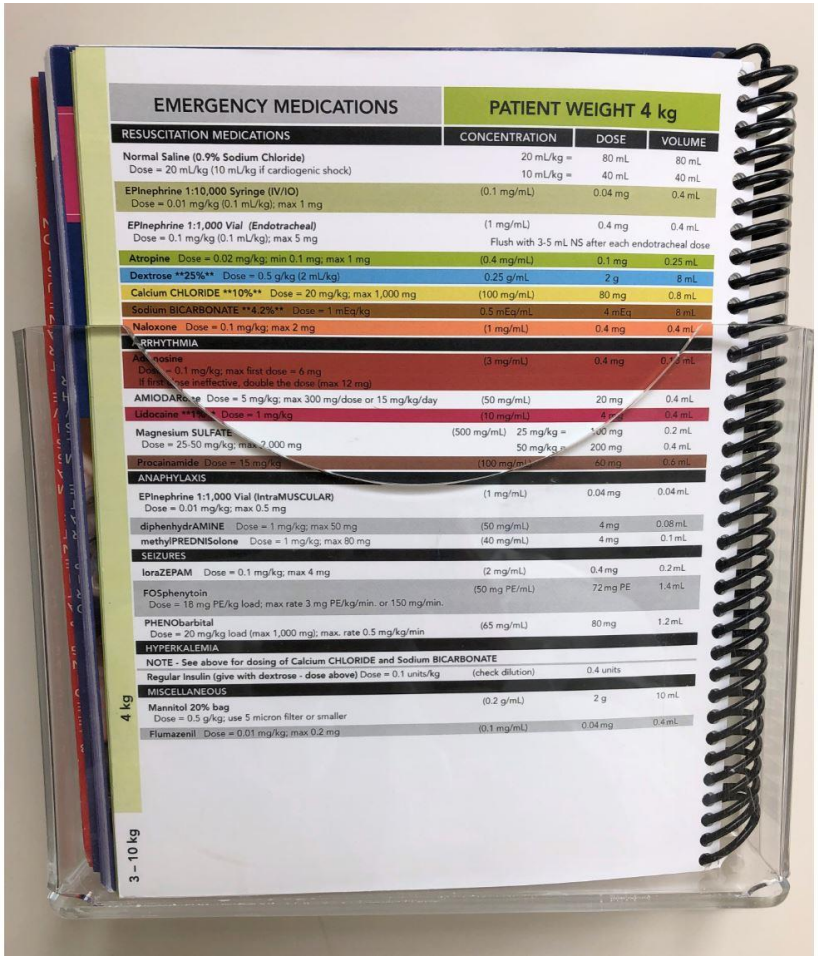
Hospital-specific Anesthesia Critical Event Checklist



OR Carts + Cognitive Aids



Emergency Drug Guide



EMERGENCY MEDICATIONS	PATIENT WEIGHT 4 kg		
RESUSCITATION MEDICATIONS	CONCENTRATION	DOSE	VOLUME
Normal Saline (0.9% Sodium Chloride) Dose = 20 mL/kg (10 mL/kg if cardiogenic shock)		20 mL/kg = 10 mL/kg =	80 mL 40 mL
EPInephrine 1:10,000 Syringe (IV/IO) Dose = 0.01 mg/kg (0.1 mL/kg); max 1 mg	(0.1 mg/mL)	0.04 mg	0.4 mL
EPInephrine 1:1,000 Vial (Endotracheal) Dose = 0.1 mg/kg (0.1 mL/kg); max 5 mg	(1 mg/mL)	0.4 mg	0.4 mL
	Flush with 3-5 mL NS after each endotracheal dose		
Atropine Dose = 0.02 mg/kg; min 0.1 mg; max 1 mg	(0.4 mg/mL)	0.1 mg	0.25 mL
Dextrose **25%** Dose = 0.5 g/kg (2 mL/kg)	0.25 g/mL	2 g	8 mL
Calcium CHLORIDE **10%** Dose = 20 mg/kg; max 1,000 mg	(100 mg/mL)	80 mg	0.8 mL
Sodium BICARBONATE **4.2%** Dose = 1 mEq/kg	0.5 mEq/mL	4 mEq	8 mL
Naloxone Dose = 0.1 mg/kg; max 2 mg	(1 mg/mL)	0.4 mg	0.4 mL
ARRHYTHMIA			
Adenosine Dose = 0.1 mg/kg; max first dose = 6 mg If first dose ineffective, double the dose (max 12 mg)	(3 mg/mL)	0.4 mg	0.1 mL
AMIODARone Dose = 5 mg/kg; max 300 mg/dose or 15 mg/kg/day	(50 mg/mL)	20 mg	0.4 mL
Lidocaine **1%** Dose = 1 mg/kg	(10 mg/mL)	4 mg	0.4 mL
Magnesium SULFATE Dose = 25-50 mg/kg; max 2,000 mg	(500 mg/mL)	25 mg/kg = 50 mg/kg =	100 mg 0.2 mL 200 mg 0.4 mL
Procainamide Dose = 15 mg/kg	(100 mg/mL)	60 mg	0.6 mL
ANAPHYLAXIS			
EPInephrine 1:1,000 Vial (IntraMUSCULAR) Dose = 0.01 mg/kg; max 0.5 mg	(1 mg/mL)	0.04 mg	0.04 mL
diphenhydrAMINE Dose = 1 mg/kg; max 50 mg	(50 mg/mL)	4 mg	0.08 mL
methylPREDNISolone Dose = 1 mg/kg; max 80 mg	(40 mg/mL)	4 mg	0.1 mL
SEIZURES			
loraZEPAM Dose = 0.1 mg/kg; max 4 mg	(2 mg/mL)	0.4 mg	0.2 mL
FOSphenytoin Dose = 18 mg PE/kg load; max rate 3 mg PE/kg/min. or 150 mg/min.	(50 mg PE/mL)	72 mg PE	1.4 mL
PHENObarbital Dose = 20 mg/kg load (max 1,000 mg); max. rate 0.5 mg/kg/min	(65 mg/mL)	80 mg	1.2 mL
HYPERKALEMIA			
NOTE - See above for dosing of Calcium CHLORIDE and Sodium BICARBONATE			
Regular Insulin (give with dextrose - dose above) Dose = 0.1 units/kg	(check dilution)	0.4 units	
MISCELLANEOUS			
Mannitol 20% bag Dose = 0.5 g/kg; use 5 micron filter or smaller	(0.2 g/mL)	2 g	10 mL
Flumazenil Dose = 0.01 mg/kg; max 0.2 mg	(0.1 mg/mL)	0.04 mg	0.4 mL

4 kg

3 – 10 kg

Pedi Crisis 2.0 App

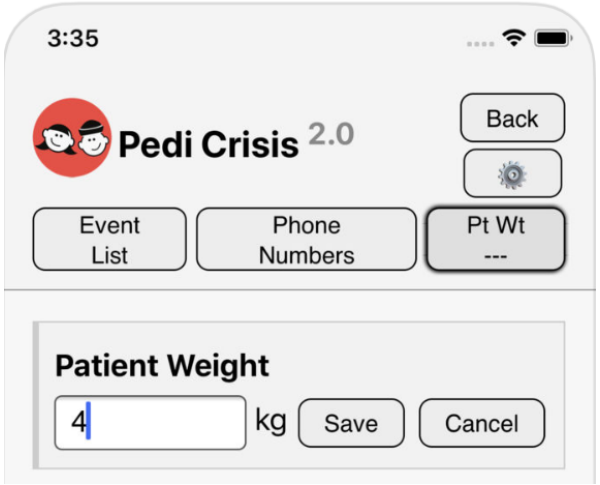
Pedi Crisis 2.0 17+

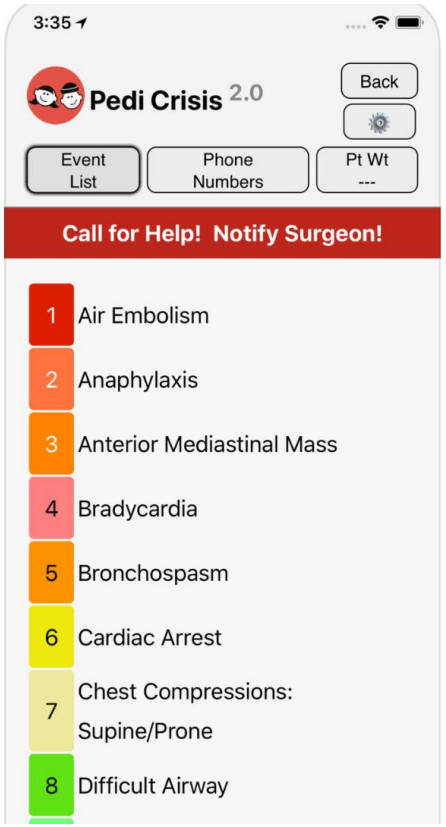
SPA Pediatric Crisis Checklist

Society for Pediatric Anesthesia

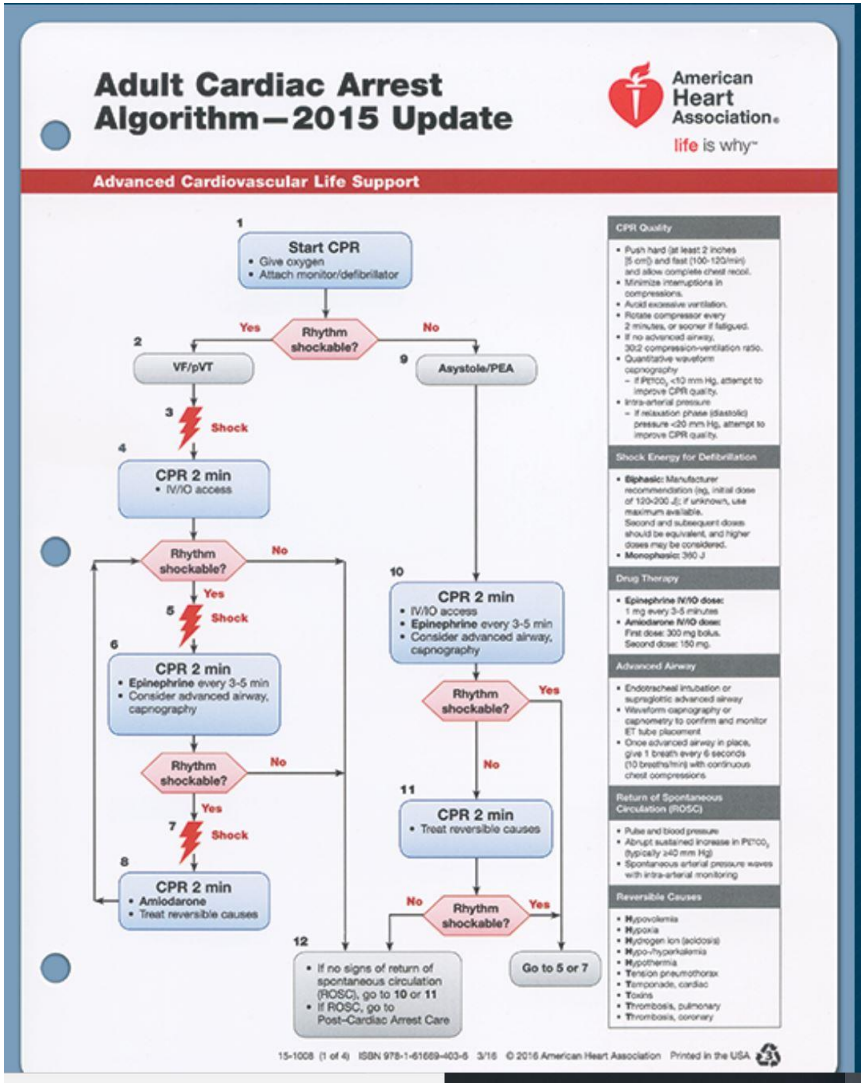
★★★★★ 4.8, 9 Ratings

Free

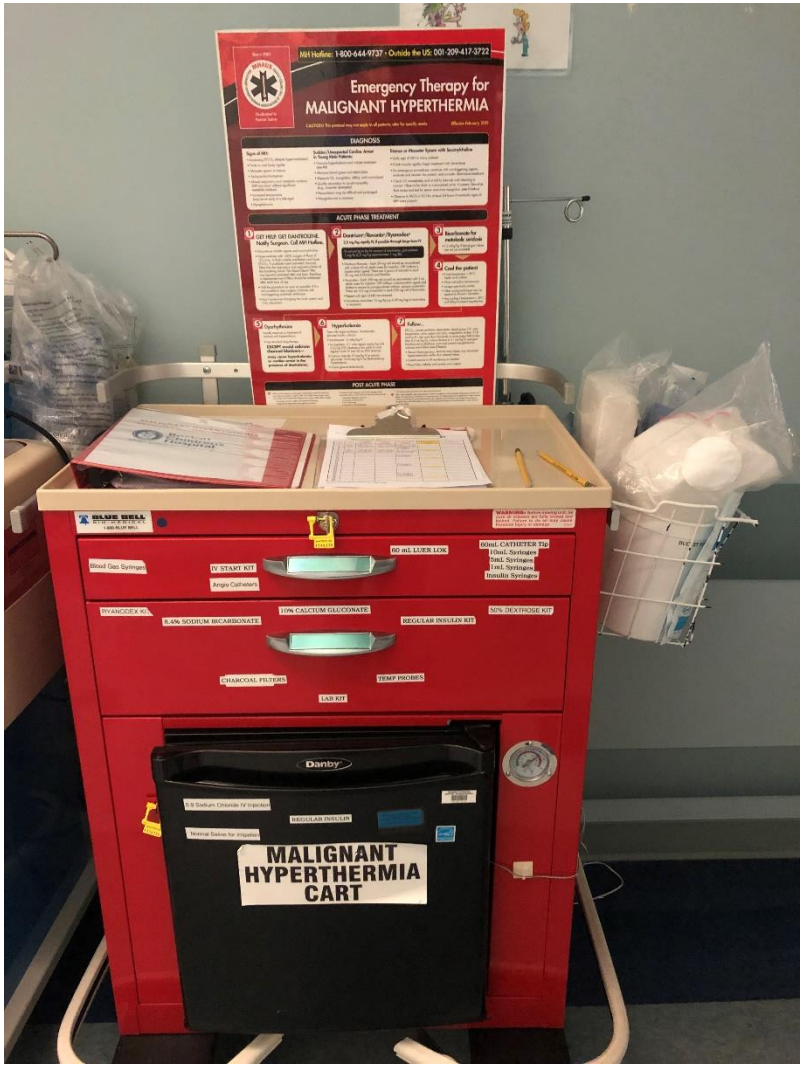




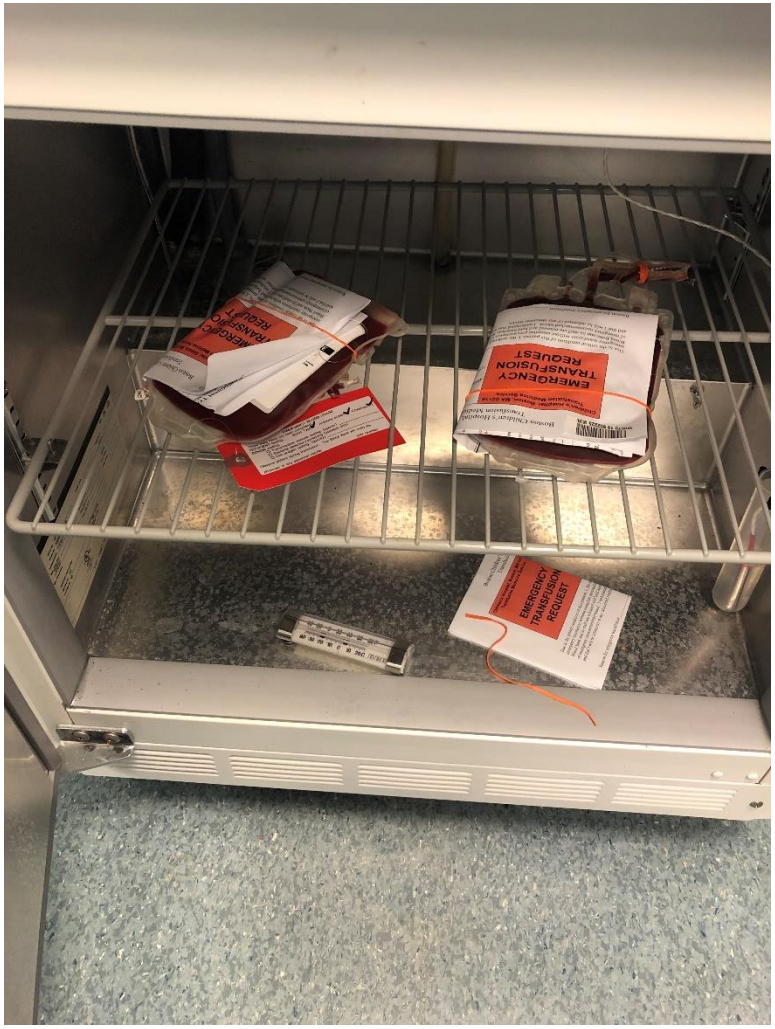
ACLS Crash Cart Cards



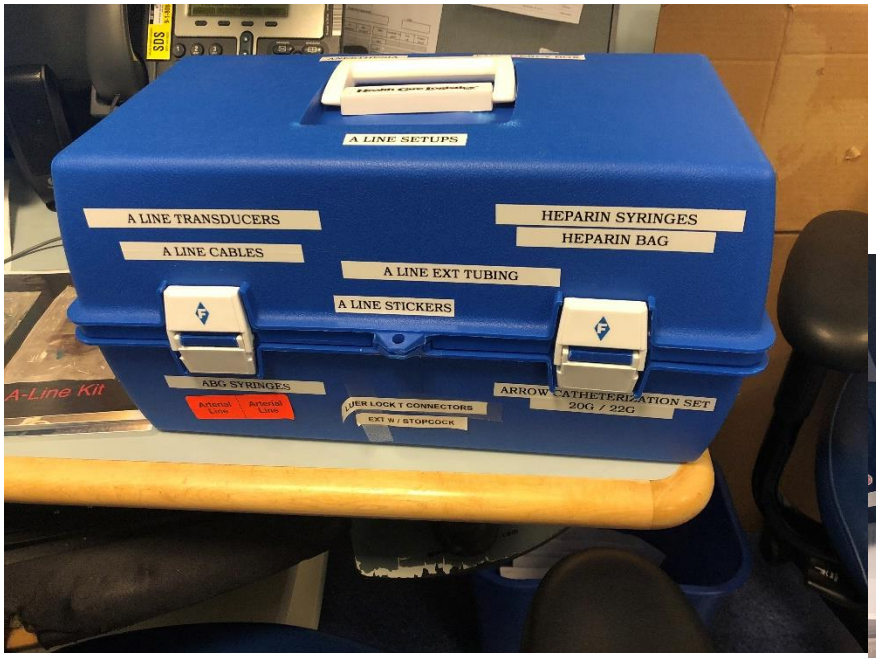
Malignant Hyperthermia Cart



Emergency Blood

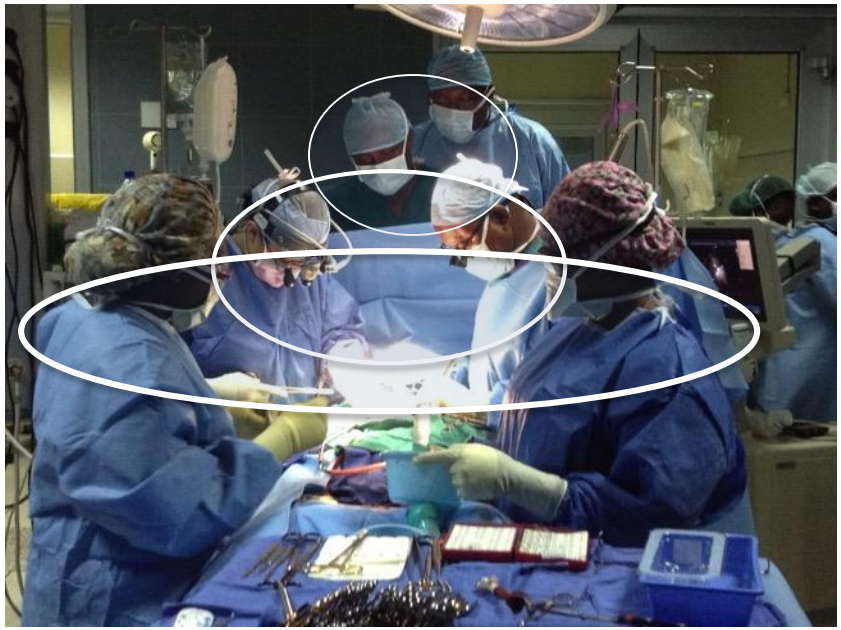


Emergency A-line Kits



Medical/Surgical teams have performance "micro-climates"

Much thinking, acting *and not acting/communicating* happens because of sub-team dynamics.

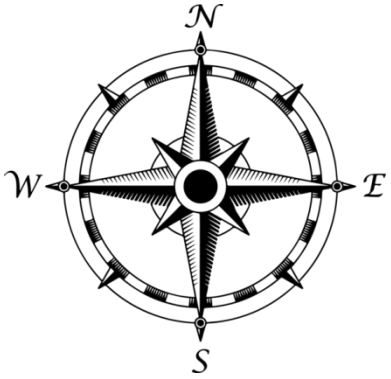


Within micro-climates can exist distinct norms and understandings of the team and the situation.

The Compelling Need for Simulation

Promoting uniformity of preparedness in the care of acutely ill children

- Harmonizing large networks
- Cascading know-how
- Risk mitigation throughout geographic expansion
- Mechanism to share policies and best practices
- Community building
- Continual needs assessment and gap analysis
- Quality Assurance in care of children



On-site Simulation

Crisis Resource Management Principles

1. **Role Clarity**
   - Establish event manager
   - Organize the room
2. **Communication**
   - Closed loop, feedback, tone
3. **Personnel Support**
   - Call for backup *(How? When? Who?)*
4. **Resources**
   - Awareness of skillsets
   - Awareness of equipment
5. **Global Assessment/ Situational Awareness**
   - Avoid fixation
   - Enable collaborative problem-solving
   - Plan for contingencies

Observation/Evaluation

Activation	Communication	Equipment	Medication	Transport
Activating STAT system	Articulation of problem to team	Applying monitors	Code med administration	Initiating transfer
Waltham Code Blue Call	Identifying unmet needs	Defibrillator practice	Code Bag resources	Communication with EMS
Mobilization of Local Resources	Offering clinical suggestions	Airway support	EpiPen administration	Determining Transport Modes
Directing Code Team to Event	Algorithms & Checklists	Intravenous fluid setup	Seizure med administration	Monitoring prior to transfer

12 High-Fidelity Courses over 2 years identifying

- Team-level knowledge deficits
- Safety threats
- System level issues

Performance Checklist

Table 1 Example performance checklist – Laryngospasm

Action	Not done	Done poorly	Done well
Communicate diagnosis to team	0	1	2
Apply CPAP (attempts at IPPV is *not* optimal management here)	0	1	2
Ensure 100% oxygen as carrier gas	0	1	2
Simple or specialized airway maneuvers[a]	0	1	2
Assessment of ventilation using chest movement and/or bag movement	0	1	2
Eliminate stimulus (instruct surgeon)	0	1	2
Deepen anesthesia (volatile or propofol)	0	1	2
Succinylcholine at dose appropriate for chosen route (e.g. 3–4 $mg \cdot kg^{-1}$ IM)	0	1	2
Atropine 20 $\mu g \cdot kg^{-1}$ IM	0	1	2
Manually ventilate	0	1	2

[a]Specialized maneuvers: (i) Pressure in the laryngospasm notch and (ii) Pull of mandible.

From: Everett TC, et al. Pediatric Anesthesia 2017;27:984–99

Society for Pediatric Anesthesia Simulation Scenarios

CHECKLISTS SIMULATION SCENARIOS

Air Embolism

Anaphylaxis

Bradycardia

Malignant Hyperthermia

Mediastinal Mass

Tension Pneumothorax

Conclusions

- Major perioperative events can occur even in healthy children
- Ability to respond quickly and efficiently is the key
- Pediatric-specific critical event checklists and dosing guidelines are crucial
- Mock codes and simulation drills maintain staff competency for rare events