

Pediatric Annex for Burn Surge

In follow-up discussion with Burn Surge Facilities (BSFs) as well as medical and emergency preparedness professionals around the state, it was determined that there may be insufficient pediatric expertise and resources at the BSFs or medical centers to optimally care for a large number of pediatric burn patients. It was determined that it would be important to rapidly deploy pediatric medical expertise and supplies to any medical facility experiencing the influx of a large number of pediatric burn patients.

Such assistance will be provided in the form of Burn Surge Strike Teams equipped with a cache of airway and vascular access supplies suitable for pediatric patients. Five select flight services around Michigan have agreed to transport these Burn Surge Strike Teams to the scene, the local medical facility or the nearest BSF in support of the triage, treatment and transport of patients. Activation and dispatch of these Burn Surge Strike Teams will be done at the direction of the SBCC medical director in consultation with the Community Health Coordination Center (CHECC). The strike teams will assist with initial stabilization, advanced airway management and IV/IO access for the pediatric patient. The configuration of the team will be dependent on the incident: it will include the Pilot/Driver and a Flight nurse as well as one or more of the following:

- Additional flight nurse
- Senior burn nurse
- Pediatric Critical Nurse
- Physician;
 - Pediatric Emergency Medicine Fellow
 - Senior ER Resident
 - Senior Level Pediatric Surgical Resident

The purpose of this annex is to provide guidance for the care of the pediatric patients injured in a Burn Mass Casualty Incident (BMCI). The goals of this plan are to:

- Provide highest level of care for a large number of pediatric burn patients
- Expand ability to provide burn care
- Prioritize use of limited resources
- Support Michigan healthcare facilities caring for a surge of pediatric burn patients.

This document outlines the plan and resources that have been developed to provide care for pediatric patients involved in a BMCI including:

- Initial resuscitation
- Fluid management
- Airway control
- Mechanical ventilation
- Pain control
- Wound assessment and management

The pediatric patient is more vulnerable to weather conditions and to toxic exposures because they are shorter and therefore closer to the ground. Their motor skills and cognitive reasoning may put them in harm's way because they cannot fully comprehend the dangers and the need to escape from a situation. They may even gravitate towards the danger out of curiosity. They may become frightened of the first responders because of their PPE gear as well as the fact that they are strangers. They may become separated from other family and will need assistance and supervision. They are also more vulnerable from a physiologic status:

Pediatric Characteristic	Special risk during disaster
Respiratory	Higher minute volume increases risk from exposure to inhaled agents.
Gastrointestinal	Higher risk for dehydration from vomiting and diarrhea after exposure to contamination
Skin	Higher body surface area increases risk for skin exposure. Skin is thinner and more susceptible to injury from burns, chemicals and absorbable toxins. Evaporation loss is higher when skin is wet or cold, so hypothermia is more likely.
Endocrine	Increased risk for thyroid cancer from radiation exposure.
Thermoregulation	Less able to cope with temperature problems, with higher risk for hypothermia
Developmental	Lower ability to escape environmental dangers or anticipate hazards
Psychological	Prolonged stress from critical events. Susceptible to separation anxiety

Basic Treatment Considerations

Children have a greater surface area per unit of body mass than adults and require relatively greater amounts of resuscitation fluid. Children have a higher percentage of Body Surface Area (BSA) devoted to the head relative to the lower extremities.

- The ratio of BSA: Mass is highest at birth and diminishes as the child grows
- The large head also contributes to larger heat loss.
- Pediatric skin is thinner and more permeable; toxins, if present will be absorbed faster and exert greater systemic effects.
- Smaller children have limited glycogen stores which can be rapidly depleted under stress; they should receive a maintenance fluid of D5LR, in addition to resuscitation fluids. (Refer to Appendix A page 10 of *The State of Michigan Multi-Casualty Incident Burn Plan*)

Vital Signs at Various Ages

Age	Heart Rate (beats/min)	Blood Pressure (mm Hg)	Respiratory Rate (breaths/min)
Premature	120-170	55-75/35-45	40-70
0-3 mo.	100-150	65-85/45-55	35-55
3-6 mo.	90-120	70-90/50-65	30-45
6-12 mo.	80-120	80-100/55-65	25-40
1-3 yr.	70-110	90-105/55-70	20-30
3-6 yr.	65-110	95-110/60-75	20-25
6-12 yr.	60-95	100-120/60/75	14/22

***** It is important to keep the patient NPO until assessment has been completed. *****

Special considerations for the Pediatric Patient

AIRWAY

Anatomical differences to be aware of:

- The tongue is relatively large compared with the oropharynx, which may create an obstruction
- The larynx is higher and more anterior in the neck, the vocal cords are at a more antero-caudal angle

- The epiglottis is omega shaped and soft
- The narrowest portion of the airway is the cricoid ring, not the vocal cords
- Significant burns to the nasal passage of infants < 6 months can cause airway compromise due to obligate nose breathing.

Intubation

Emergently intubate:

- Burns to mouth and/or nose
- Stridor, wheezing, respiratory distress, hypoxia
- Altered mental status with inability to protect airway

Urgent evaluation of airway:

- Carbonaceous sputum
- Facial burns
- Cough without distress, stridor or hypoxia
- Prolonged closed space heat exposures
- Large burns >20%

Early intubation, if airway control is needed, is vital to prevent a future difficult intubation scenario.

- Keep Patient NPO
- Administer 100% Oxygen
- Elevate HOB
- Appropriate size Endo-Tracheal Tube (ETT)
- Appropriate securing device
 - Commercial device
 - Tape/Twill tape/Trach ties
- Naso-Gastric Tube (NGT)/Oral Gastric Tube (OGT) inserted

The following tables can be used for reference and to assist with the induction and intubation.

**Cuffed endotracheal tubes should be used if available.

RAPID SEQUENCE INTUBATION AGENTS

Agent	Dosage	Duration of Action	Comment
Induction			
Etomidate	0.2 – 0.4 mg/kg	10-15 minutes	Rapid onset 30-60 sec, peaks in 1 minute
Versed	0.1 -0.2 mg/kg	30-60 minutes	
Fentanyl	1 – 5 mcg/kg	1-2 hours	
Paralytics			
Rocuronium	1mg/kg	30 – 60 minutes	Rapid onset
Succinylcholine	1 – 2 mg/kg	3 - 5 minutes	If < 24 hours since injury
Vecuronium	0.1 mg/kg	30-90 minutes	

Equipment Sizes: Up to 20Kg

Weight	3 kg	5 kg	10 kg	15 kg	20 kg
ETT	3-3.5	3.5-4.0	4-4.5	4.5-5.0	5.0-5.5
L Blade	Miller 0-1	Miller 0-1	Miller 0-1	Miller 1-2	Miller 2
Suction	6-8 Fr	8-10 Fr	10 Fr	10 Fr	10 Fr
NG Tube	5-8 Fr	5-8 Fr	8-10 Fr	10-12 Fr	12-14 Fr
Foley	6-8 Fr	6-8 Fr	8-10 Fr	10-12 Fr	10-12 Fr
Chest Tube	10-12 Fr	12-16 Fr	16-20 Fr	20-24 Fr	24-32 Fr
LMA (cuff)	1 (4 mL)	1.5 (7 mL)	2 (10 mL)	2 (10 mL)	2-2.5 (14 mL)

Equipment Sizes: greater than 20kg

Weight	20 -25 kg	30 kg	40 kg	> 50 kg
ETT	5.5-6.0 cuff	6.0-6.5 cuff	7.0-7.5 cuff	7.5-8.0 cuff
L Blade	Mil/Mac 2	Mil/Mac 2-3	Mil/Mac 3	Mil/Mac 3
Suction	10 Fr	10 Fr	12 Fr	12-14 Fr
NG Tube	12-14 Fr	14-26 Fr	14-16 Fr	16-18 Fr
Foley	12 Fr	12 Fr	12-14 Fr	12-14 Fr
Chest Tube	28-32 Fr	28-32 Fr	32-40 Fr	32-40 Fr
LMA (cuff)	2.5 (17 mL)	3 (20 mL)	3 (20 mL)	4-6 (30-50 mL)

Ventilator Management

Pediatric patients have smaller and more delicate lungs that are susceptible to barotrauma. Children have a unique respiratory physiology; they have higher minute ventilation per kg than adults. Because they have a higher respiratory rate than adults they are exposed to greater dosages of toxins that may be present during an MCI and will suffer the effects of these agents much more rapidly than adults. They also will potentially absorb more of the substance before it is cleared or diffused from the respiratory tissues. Many chemical agents have a high vapor density and are heavier than air, which means that they “settle” close to the ground, in the air space used by children.

Initial Ventilator Settings

	<10 kg	10-40 kg	>40 kg
Mode	Pressure Control	Pressure Control	Pressure Control
Rate	40	28	16
PIP	15-20 cm H₂O	15-20	20
PEEP	5-8 cm H₂O	5-8	5-8
FiO₂	100%	100%	100%
Inspiratory time	0.3 seconds	0.7 seconds	1 second

Inspiratory pressure may be increased **slowly** to get good chest rise and equal breath sounds. Too much pressure could cause a pneumothorax, which is why pressures are increased slowly for equal chest rise.

- Effective ventilator changes for
 - Poor Oxygenation: increase FiO₂, increase PIP
 - High CO₂: increase rate, increase PEEP
- Burn patients undergoing fluid resuscitation typically require higher ventilator pressures.
- For patients with circumferential burns of the torso/abdomen escalating ventilator pressures may indicate the need for escharotomies.

*****If considering escharotomy contact the SBCC*****

Sedation:

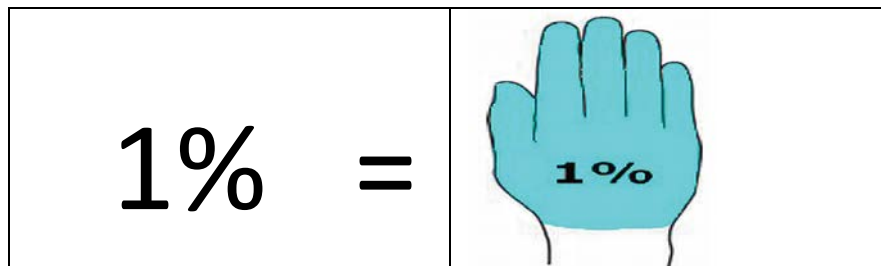
Ongoing sedation for care while waiting for and during transport should be considered. Does the patient need to be restrained? Consider the use of arm immobilizer as well as soft restraints, whichever method is presently used by the transport teams.

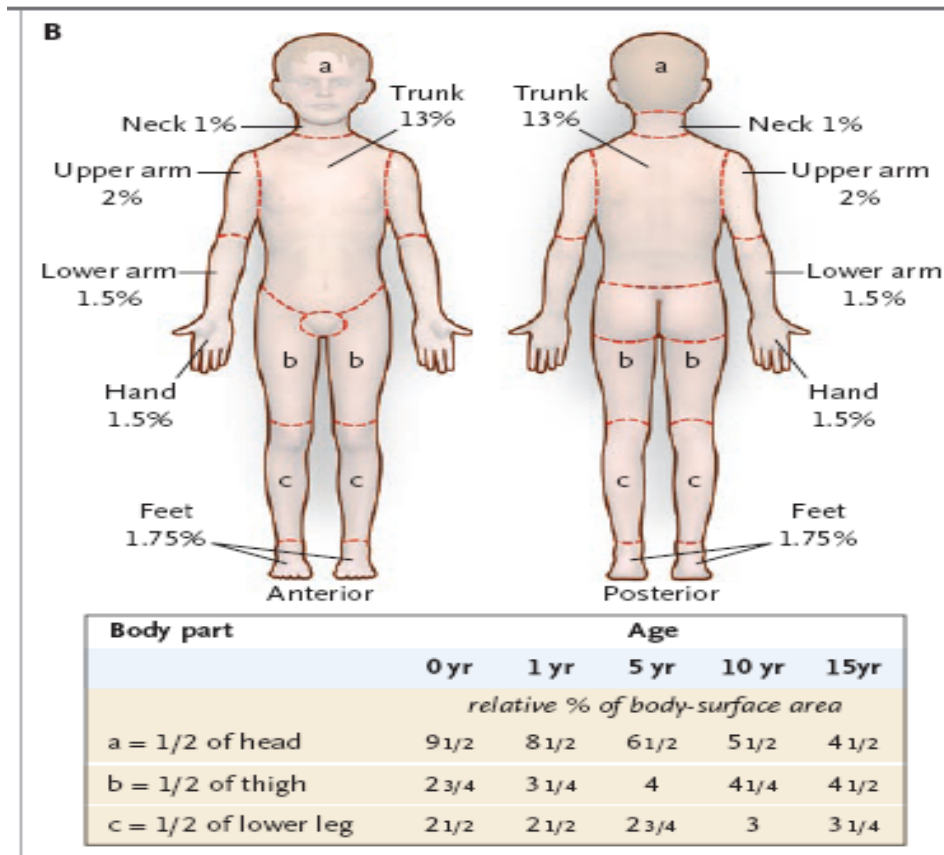
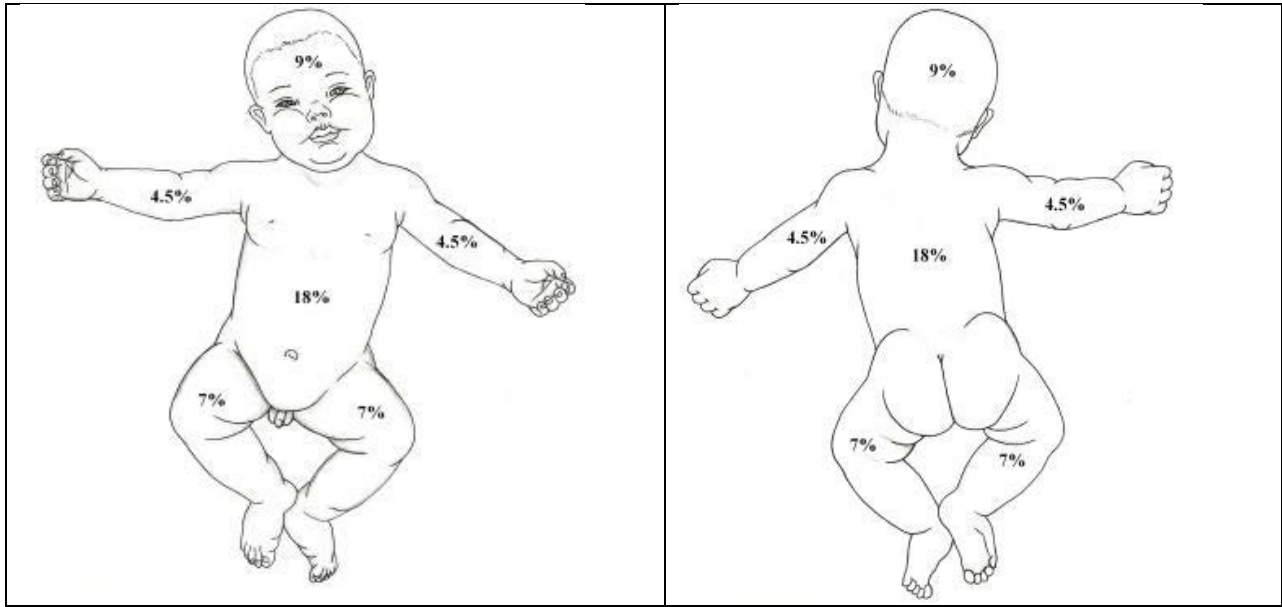
Agent	Age	Dosage	Max Doses
Versed	GA \leq 32 weeks	0.03 mg/kg/hr.	0.06mg/kg/hour
	> 32 weeks	0.06 mg/kg/hr.	0.12mg/kg/hour
Loading dose	1 month – 18 yrs.	0.05 – 0.2 mg/kg	Given slow IV over 2-3 minutes
Continuous IV		0.06 – 0.12 mg/kg/hr.	0.36 mg/kg/hour; titrate to effect
Morphine	< 50kg	0.01 mg/kg/hr.	0.04 mg/kg/hr.
	\geq 50 kg	1.5 mg/hr.	
Fentanyl	< 50 kg	Load: 1 – 10 mcg/kg <5 mcg/kg 3-5 minutes >5mcg/kg 5-10 minutes	1 - 10 mcg/kg hr.

BURN ASSESSMENT

Assessing the patient’s burns and estimating the area involved is important for the resuscitation phase of care. This can be done in several ways, the two that are easiest and quickest to use in and out of the field are the “Palm Method” and the “Rule of Nines”. It is important to note that only partial and full thickness burns are to be included in the Total Body Surface Area (TBSA) estimation.

Rule of Nines: The body is divided into multiples of 9% for different regions. While this works well for adult bodies, adjustments are necessary for the pediatric population. The child’s head is relatively larger and the legs smaller. The head and neck represent 18% TBSA (double that of an adult 9%). As the child ages each year and a half on the average, subtract 1% from the head and add half to each leg. The Palm method is extremely easy and is very helpful when the burns are scattered over the body. With this method and using the PATIENT’S hand as a guide, the palmar surface is equal to 1% of the patient’s body.





Fluid Resuscitation

Pediatric patients can compensate and maintain their heart rate during the early phases of hypovolemic shock, which can mislead the practitioner into under-resuscitating the patient. Then the patient will crash without warning. Vital signs, including heart rate, respiratory rate and blood pressure vary with age. Temperature regulation is harder for the child related to the thinner skin, body surface area to mass ration and the usual lack of subcutaneous tissue. This is why it is so important to keep the child warm, especially during the resuscitation phase.

1. If IV access cannot be obtained, intraosseous (IO) access should be used.
2. Initial starting points for fluid resuscitation for pediatric patients (Rate to be adjusted once TBSA is calculated)
 - a. ≤ 5 years: 125 ml LR per hour
 - b. 6-13 years old: 250 ml LR per hour
 - c. ≥ 14 years: 500 ml LR per hour
3. **Pediatric patients with burns $\geq 10\%$ TBSA require resuscitative fluids in addition to maintenance fluids.** (see Table for exemplar Calculations)
 - a. 3ml **Lactated Ringers** x Kg x TBSA (only partial and full thickness burns) is the estimated resuscitation fluid requirement for the first 24 hours.
 - b. Use D5LR for patients <10 kg.
 - c. Divide total by 2 and administer this amount in the first 8 hours from the time of injury. The remaining half to be given over the next 16 hours
4. Pediatric patients require maintenance fluid, IN ADDITION TO RESUSCITATION FLUID, until taking adequate PO. Maintenance fluid should be D5LR. Pediatric calculation for maintenance fluid formula:
 - a. 4ml/kg/hr. for the first 10 kg body weight
 - b. 2ml/kg/hr. for the second 10 kg body weight
 - c. 1ml/kg/hr. for the remaining kg of body weight
 - d. For patients < 10kg use D5LR
5. Urine Output target is 1-2 ml/kg/hr. (Adjusting rate of resuscitation fluid in response)
 - a. If the urine output is < 1ml/kg/hr.; Increase the infusion of LR by 33 % of the hourly calculated fluid requirement.
 - b. If the urine output is > 2ml/kg/hr.; Decrease the infusion of LR by 33% of the hourly calculated rate
 - c. Do not decrease the total IVF rate below 1.5 x calculated maintenance rate in ml/hr.
 - d. Dip urine to exclude glycosuria

Exemplar Burn Resuscitation Fluid Calculations				
Patient Weight	TBSA burn	Calculation	Estimated 24h Resuscitation Total (NOT including maintenance fluids)	Fluid type (dependent on patient weight)
8 kg	20%	3 x 8 x 20	480 ml	D5 LR
8 kg	40%	3 x 8 x 40	960 ml	D5 LR
8 kg	60%	3 x 8 x 60	1,440 ml	D5 LR
8 kg	80%	3 x 8 x 80	1,920 ml	D5 LR
10 kg	20%	3 x 10 x 20	600 ml	LR
10 kg	40%	3 x 10 x 40	1,200 ml	LR
10 kg	60%	3 x 10 x 60	1,800 ml	LR
10 kg	80%	3 x 10 x 80	2,400 ml	LR
20 kg	20%	3 x 20 x 20	1,200 ml	LR
20 kg	40%	3 x 20 x 40	2,400 ml	LR
20 kg	60%	3 x 20 x 60	3,600 ml	LR
20 kg	80%	3 x 20 x 80	4,800 ml	LR
30 kg	20%	3 x 30 x 20	1,800 ml	LR
30 kg	40%	3 x 30 x 40	3,600 ml	LR
30 kg	60%	3 x 30 x 60	5,400 ml	LR
30 kg	80%	3 x 30 x 80	7,200 ml	LR
40 kg	20%	3 x 40 x 20	2,400 ml	LR
40 kg	40%	3 x 40 x 40	4,800 ml	LR
40 kg	60%	3 x 40 x 60	7,200 ml	LR
40 kg	80%	3 x 40 x 80	9,600 ml	LR
50 kg	20%	3 x 50 x 20	3,000 ml	LR
50 kg	40%	3 x 50 x 40	6,000 ml	LR
50 kg	60%	3 x 50 x 60	9,000 ml	LR
50 kg	80%	3 x 50 x 80	12,000 ml	LR

***** Give HALF(1/2) of the estimated 24 hour resuscitation fluid total OVER THE FIRST 8 HOURS post-injury, in addition to maintenance fluids*****

Clinical Features of Dehydration

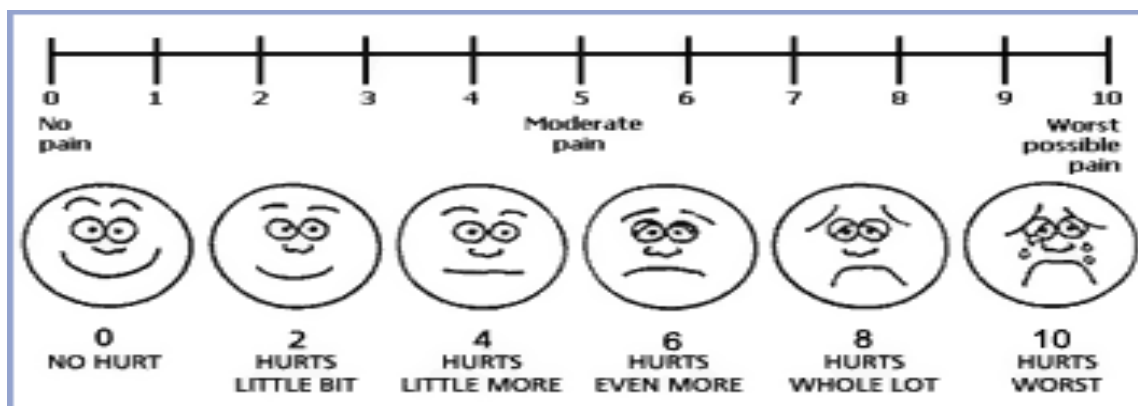
Feature	Mild (<5%)	Moderate (5% to 10%)	Severe (>10%)
Heart rate	Normal	Slightly increased	Rapid, weak
Systolic BP	Normal	Normal to orthostatic, >10 mmHg change	Hypotension
Urine output	Decreased	Moderately decreased	Marked decrease, anuria
Mucous membranes	Slightly dry	Very dry	Parched
Anterior fontanel	Normal	Normal to sunken	Sunken
Tears	Present	Decreased, eyes sunken	Absent, eyes sunken
Skin	Normal turgor	Decreased turgor	Tenting
Skin perfusion	Normal capillary refill (<2 seconds)	Capillary refill slowed (2-4 seconds); skin cool to touch	Capillary refill markedly delayed (>4 seconds); skin cool, mottled, gray

PAIN MANAGEMENT

The patient should only be given medication through IV access or IO access when available. (Oral or IM route can have a variable absorption rate).

- Fentanyl 0.5 - 1 mcg/kg/dose Every 5 minutes with a Max of 2 mcg/kg/hour OR
- Morphine 0.05 – 0.1 mg/kg dose. May repeat to 0.2 mg/kg/hr. max dose
- Oral pain medication should be reserved either for patients with very minor burns or patients with no other options for pain control.

Verbal Assessment Tool for Pediatric Pain.



Non-Verbal Pain Assessment Tool

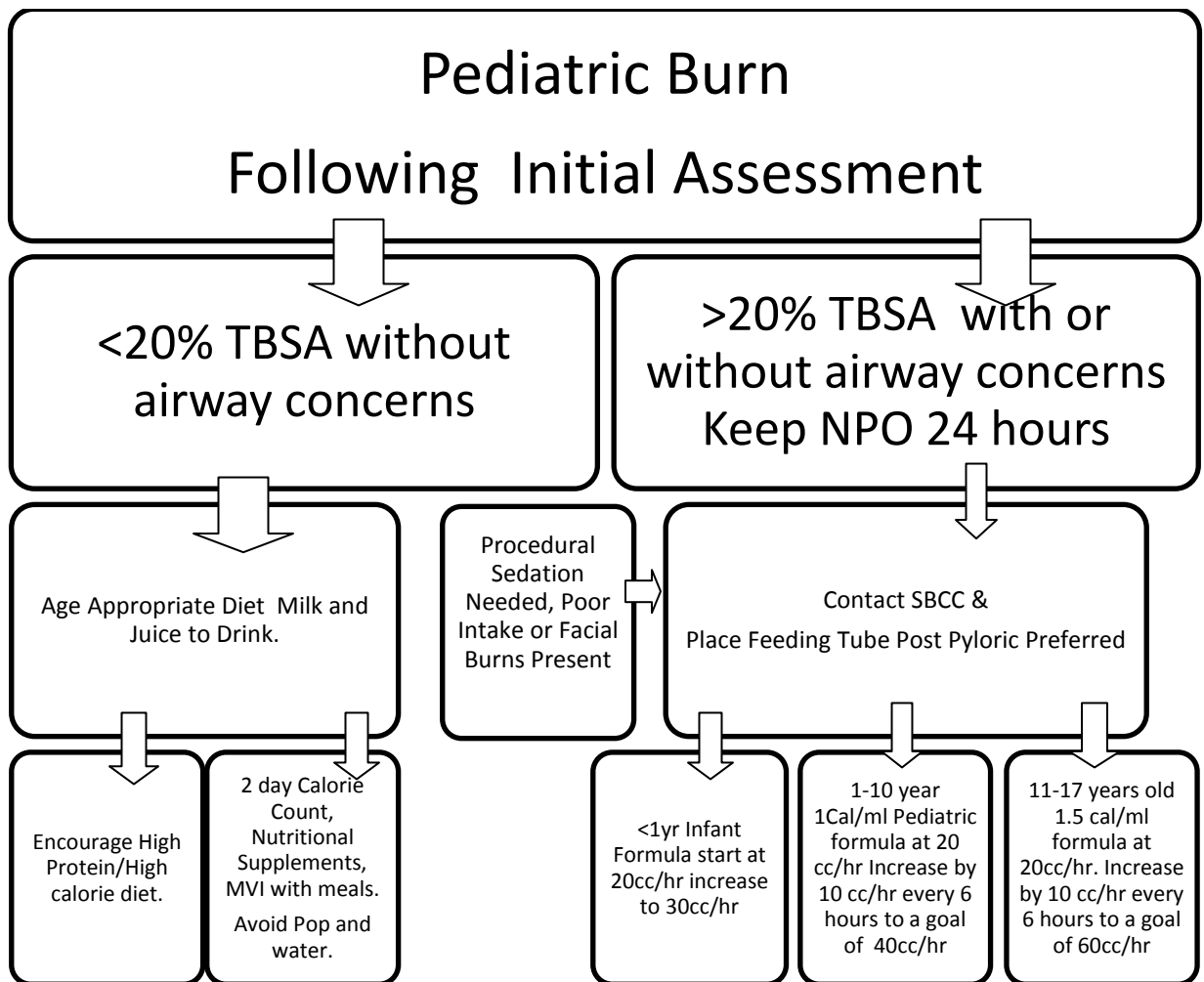
**This is a behavioral pain assessment scale for use in non-verbal patients unable to provide reports of pain. Instructions: Rate patient in each category, add together document total pain score.

FLACC SCALE			
(FACE, LEGS, ACTIVITY, CRY, CONSOLABILITY)			
	0	1	2
FACE	No particular expression or smile	Occasional grimace or frown, withdrawn, disinterested	Frequent to constant frown, clenched jaw, quivering chin
LEGS	Normal position OR Relaxed	Uneasy, Restless, Tense	Kicking Or Legs drawn up
ACTIVITY	Lying quietly Normal position Moves easily	Squirming, Shifting back and forth, Tense	Arched, Rigid or Jerking
CRY	No cry (Awake or Asleep)	Moans or Whimpers Occasional complaint	Crying Steadily, Screams or Sobs, Frequent complaints
CONSOLABILITY	Content Relaxed	Reassured by occasional touching, hugging or talking, Distractible	Difficult to console or comfort

***** It is important to keep the patient NPO until assessment has been completed*****

NUTRITION

Nutrition in a pediatric patient should be considered early in the treatment phase. Place enteral feeding tube as early as possible in all patients with burns $\geq 20\%$ TBSA. If none are available or if the patient is awake and alert and able to drink and eat encourage patient to do so.



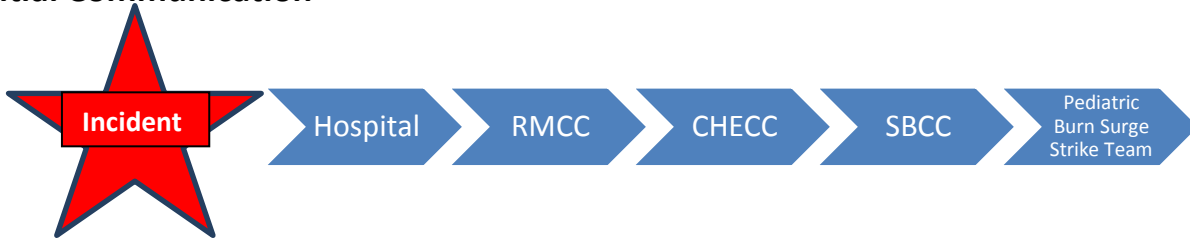
- If patient has an NG/OG, check residuals Q 4 hr. If residuals are more than 3 times the hourly rate stop the tube feedings and notify MD.
- Consult dietician for appropriate formula.

Nutritional Guidelines for Birth to 1 yr. old

Age	
Birth - 1 month	2-3 ounces (6-90 mL) per feeding breast or bottle every 2-3 hours
2-4 months	3-4 ounces (90-120 mL) per feeding every 3-4 hours
4-6 months	4-5 ounces (120-150 mL) per feeding, four or more time daily Begins baby food, usually rice cereal
6-8 months	6-8 ounces (180-240 mL) per feeding, four times daily Eats baby food such as rice cereal, fruits and vegetables
8-10 months	6 ounces (180 mL) per feeding, four times a day Soft finger foods
10-12 months	6-8 ounces (180-240mL) per feeding, four times a day Soft table foods, uses spoon and cup with lid
Formulas	Milk Based: Enfamil, Enfacare & Similac Soy Based: Prosobee & Isomil

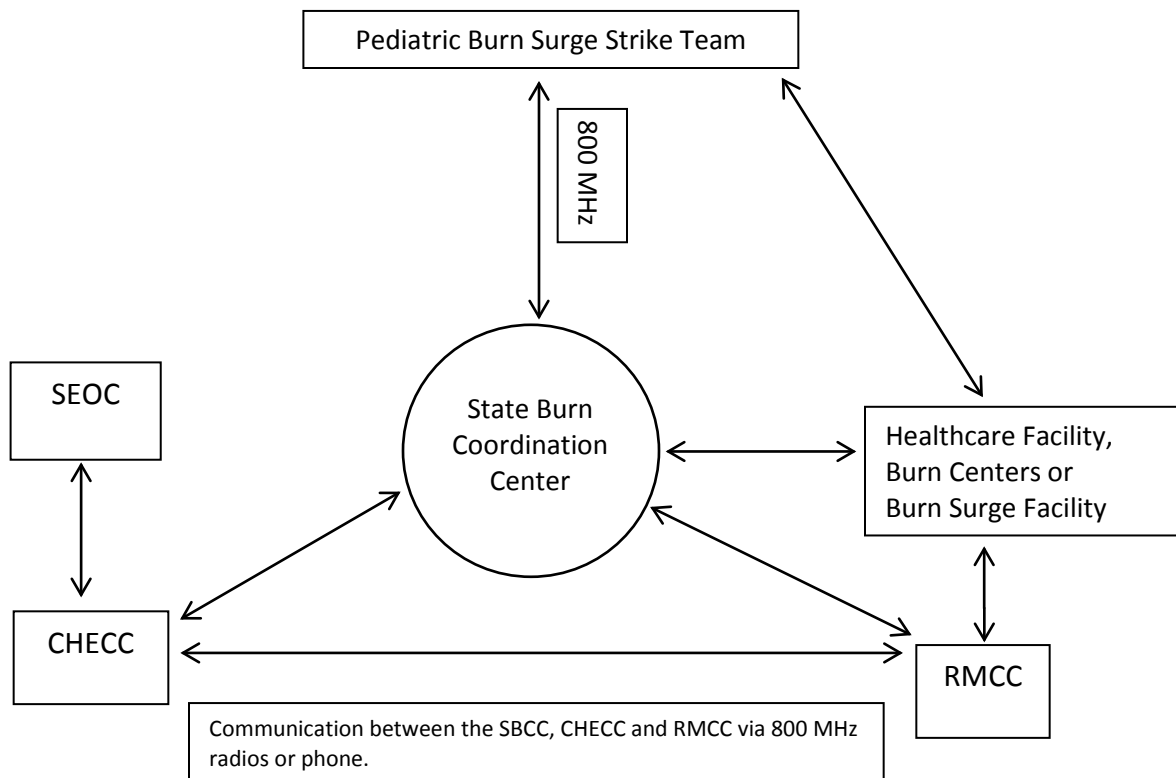
Communication Activation Model

Initial Communication



Gathering incident specific information is critical to communication both vertically and horizontally with the agencies involved. For communication with the Pediatric Burn Surge Strike Team deployed to assist with pediatric patients, the SBCC will ask the Healthcare/Burn Surge Facility for Elements of Essential Information (EEI) (Appendix B – *The Michigan State Multi-Casualty Incident Burn Plan*). This will provide the Pediatric Burn Surge Strike Team with basic information regarding patient quantity and injuries. All air ambulance services have 800 MHz radios and OPHP 1 is the fallback frequency. Direct phone communications will also occur.

On-going Communication Incident



Special Event frequencies for the 800 MHz radios will be determined and provided by the CHECC. All air ambulance services have Special Event frequencies.

APPENDIX PEDIATRIC GO BAG SUPPLIES

Item	Each
Broselow tape	1
RESUSCITATION	
Foleys	
6 fr	4
8 fr	4
10 fr	4
OG/NGT Tubes	
6 fr	4
8 fr	4
10 fr	4
IV catheters	
24 g	20
22 g	20
1 in silk tape	4
Tegaderm 2 3/8 x 2 3/4 in	20
Intra-Osseous EZ-IO	
Sets: 15 g x 15mm	10
15 g x 25mm	15
15 g x 45 mm	5
Driver for EZ-IO	1
AIRWAY	
2.5 uncuffed ETT	4
3.0 uncuffed ETT	4
3.5 cuffed ETT	4
4.0 cuffed ETT	4
4.5 cuffed ETT	4
5.0 cuffed ETT	4
5.5 cuffed ETT	4
6.0 cuffed ETT	4
6.5 cuffed ETT	4
7.0 cuffed ETT	4
7.5 cuffed ETT	2
8.0 cuffed ETT	2
6 Fr. Stylet	7
10 Fr. Stylet	5
Capnometers: < 15kg	12
>15kg	12
Peep Valves	12
Pop-off valves	8

Adult Ambu bag	1
Pediatric ambu bag	3
Peds cric tray (3.5)	1
Neo trach 3.5 uncuffed	2
Peds cric tray (4)	1
Ped trach 4 uncuffed	2
Introducer, perc trach	1
Resuscitation masks	
size 1 - neonatal	6
size 2 - infant	6
size 3 - toddler	6
size 4 - child	6
size 5 - small adult	6
Non-Rebreather Pediatric	10
Twill tape/tie	1
Nasal Cannula	
Infant	10
Pediatric	10
Suction Catheters	
6 Fr	10
8 Fr.	10
LARYNGYSCOPES	
Laryngoscope handle Medium	1
0 Miller blade	4
1 Miller blade	4
2 Miller blade	4
3 Miller blade	4
4 Miller blade	4
1 Macintosh blade	4
2 Macintosh blade	4
3 Macintosh blade	4
4 Macintosh blade	4
GlideScope Ranger:Batons 3-4	1
Includes 10 each 3 & 4 blades	
GlideScope Ranger:Batons 1-2	
Includes 10 each 1 & 2 blades	1

References

Pediatric Disaster CBRNE Incidents - Quick Medical Reference Guide. Developed by Region 2 South Healthcare Coalition in conjunction with the Michigan Department of Community Health (MDCH) Office of Public Health Preparedness (OPHP) utilizing the Department of Health and Human Services (HHS), Office of the Assistant Secretary for Preparedness and Response (ASPR) Hospital Preparedness Program Cooperative Agreement Number U3REPO90218-01-00 funding.

Centers for Bioterrorism Preparedness Planning (CBPP) Pediatric Task Force & New York City Department of Health and Mental Hygiene Pediatric Disaster Advisory Group. *Pediatric Disaster Toolkit: Hospital Guidelines for Pediatrics during Disasters*. 3rd Edition, 2008. Available at: <http://www.nyc.gov/html/doh/downloads/pdf/bhpp/hepp-peds-childrenindisasters-010709.pdf>

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<http://ummcpharmweb.med.umich.edu/i/GuidelinesForms/MedicationUseGuidelines/tabid/220/Default.aspx>

University of Michigan – Department of Pharmacy Services; PICU IV Guidelines
http://ummcpharmweb/i/portals/0/documentlibrary/DI/Medication%20Use%20Guidelines/pediatric%20iv%20drip%20charts/PICU_IV_InfusionChart.pdf

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