

Guidelines for Pediatric Burn Resuscitation

PURPOSE

To provide standardized orders and a protocol for the U of M Burn Service regarding pediatric burn patient resuscitation in the intensive care unit. Recommendations are also included for difficult fluid resuscitation and hypotension.

DEFINITION

This protocol applies to all pediatric cutaneous burn patients. Prior to initiating the protocol an assessment of the patient's TBSA burn must be performed including only partial and full-thickness burn injury using the Rule-of-Nines diagram. Obtain the patients weight or close estimate in kg.

RESUSCITATION GUIDELINES

1. First 24 hours post-burn.

A. TBSA < 20%

1. Maintenance IV fluid until patient taking adequate oral intake.

B. TBSA ≥ 20% and Weight ≥ 30 kg

1. Calculate estimated intravenous fluid needs:
 - a. 2-4 mL of LR x kg body weight x %TBSA burn
 - b. Administer half of calculated volume over the first 8 hours post burn. $IVF_{8} \text{ rate} = ([2-4 \text{ mL of LR x kg body weight x \%TBSA burn}] / 2 - IVF \text{ already given in mL}) / (8\text{hr} - \text{time since injury in hrs})$
 - c. Administer remaining half of calculated volume over the subsequent 16 hours. $IVF_{16} \text{ rate} = ([2-4 \text{ mL of LR x kg body weight x \%TBSA burn}] / 2) / 16 \text{ hours}$
 - d. At the 9 hour mark take the IVF rate at 8 hrs and divide by 2 (IVF_{8} rate). Use the greater of the two calculated rates (IVF_{16} rate or IVF_{8} rate) as the hour 9 IVF rate.
2. If the patients urine output is less than 0.5 mL/kg/hr (usually 30 mL/hour) then increase the infusion of LR by 33% of the hourly calculated fluid requirement.
3. If the patients urine output is > 70 mL/hour:

- a. Dip urine to exclude glycosuria.
- b. Decrease the infusion of LR by 33% of the hourly calculated fluid requirement.
- c. Do not decrease IVF rate below 125 mL/hr.

C. TBSA \geq 20% and Weight < 30 kg

1. Calculate estimated intravenous fluid needs:
 - a. 3-4 mL of LR x kg body weight x %TBSA burn
 - b. Administer half of calculated volume over the first 8 hours post burn. $IVF_{rate} = ([3-4 \text{ mL of LR} \times \text{kg body weight} \times \%TBSA \text{ burn}] / 2 - IVF \text{ already given in mL}) / (8 \text{ hr} - \text{time since injury in hrs})$
 - c. Administer remaining half of calculated volume over the subsequent 16 hours. $IVF_{16 \text{ hr}} \text{ rate} = ([3-4 \text{ mL of LR} \times \text{kg body weight} \times \%TBSA \text{ burn}] / 2) / 16 \text{ hours}$
 - d. At the 9 hour mark take the IVF rate at 8 hrs and divide by 2 (IVF_8 rate). Use the greater of the two calculated rates ($IVF_{16 \text{ hr}}$ rate or IVF_8 rate) as the hour 9 IVF rate.
 - e. In addition to burn fluid requirements, also infuse maintenance IVF at:
 - 4 mL/hr for the first 10 kg body weight
 - 2 mL/hr for the second 10 kg body weight
 - 1 mL/hr x remaining kg body weight
2. If the patient's urine output is less than 1 mL/kg/hr then increase the infusion of LR by 33% of the hourly calculated fluid requirement.
3. If the patient's urine output is $>> 1 \text{ mL/kg/hr}$:
 - a. Dip urine to exclude glycosuria.
 - b. Decrease the infusion of LR by 33% of the hourly calculated fluid requirement.
 - c. Do not decrease the total IVF rate below the calculated maintenance rate in mL/hr.
4. In patients < 2 years of age use D5LR to avoid hypoglycemia.

D. Place enteral feeding tube as early as possible in all patients with burns \geq 20% TBSA.

F. At 12 hours after burn injury, assess IVF administered and calculate the projected 24 hour total IVF if fluid rates are kept constant. If the projected 24

hour IVF requirement exceeds 6mL/kg/%TBSA burn then switch to the difficult fluid resuscitation guideline.

2. 24 hours post-burn.

- A.** Check serum Na⁺ and K⁺ every 6 hours on the second burn day.
- B.** Adjust type of fluid by the serum Na⁺ level.
- C.** If after 24 hours the IVF rate remains high consider switching to 5% albumin.
- D.** Goal is to decrease IVF rate to half of rate infused over the previous 16 hours. Will have to estimate based on patient size, % burn, response to resuscitation and estimated losses (Attending input recommended).
 - 1. If the patient is > 30 kg, the urine output goal is 0.5 mL/kg/hr (usually 30 cc/hour with a maximum of 70 mL/hour).
 - 2. If the patient is ≤ 30 kg, the urine output goal is 1 mL/kg/hr (maximum 2/mL/kg/hr).

3. Treatment of low urine output

- A.** If urine output falls below lower limit for one hour, increase current IVF infusion rate by 33% of the calculated hourly requirement.
- B.** If urine output falls below lower limit for second consecutive hour, increase current IVF infusion rate by another 33% of the calculated hourly requirement.
- C.** If urine output remains below target for third consecutive hour notify H.O.
- D.** If urine output exceeds upper limit for one hour and dipstick of urine shows no glucose present, decrease current IVF infusion rate by 33% of the calculated hourly requirement.

4. For patients with burns > 20% TBSA start Oxandrolone 10 mg po BID.

5. For patients with burns > 20% TBSA start beta-blockade with po metoprolol.

DIFFICULT FLUID RESUSCITATION GUIDELINES

1. Switch intravenous fluid to 5% albumin (isotonic premixed 5% albumin or 200 mL of 25% albumin in 800 mL 0.9% NS, [See Appendix]) at the previous crystalloid IVF rate.
2. Check bladder pressures every 4 hours.
3. If urine output (UOP) < 30 mL/hr in a > 30 kg patient or < 1mL/kg/hr in a ≤ 30 kg patient, strongly consider monitoring central venous pressures (CVP) from a subclavian or IJ line along with central venous (ScvO₂) saturations (Goal CVP 8-10 mmHg, ScvO₂ 60-65%).
 - a. If CVP not at goal then increase fluid rate by 33%.
 - b. If CVP at goal then consider dobutamine 5 µg/kg/min (titrate until ScvO₂ at goal). Max dose of dobutamine is 20 µg/kg/min.
 - c. If both CVP and ScvO₂ at goal, then stop increasing fluids (even if UOP < target). The patient should be considered hemodynamically optimized and the oliguria is likely a result of established renal insult. Some degree of renal failure should be tolerated and expected. Continued increases in fluid administration despite optimal hemodynamic parameters will only result in “resuscitation morbidity,” that is oftentimes more detrimental than renal failure.
4. If the patient becomes hypotensive along with oliguria (UOP < target), then follow the hypotension guidelines.
5. Every attempt should be made to minimize fluid administration while maintaining organ perfusion. If UOP >70 mL/hr and patient > 30 kg, then decrease the fluid rate by 33%. If UOP >2 mL/kg/hr and patient is ≤ 30 kg, then decrease the fluid rate by 33%. Do not decrease below the maintenance IVF rate based on the patients weight.
6. After 24 hours, infusion of Lactated Ringer’s should be titrated down to maintenance levels and 5% albumin continued until the 48-hour mark.

HYPOTENSION GUIDELINES

The optimal minimum blood pressure for burn patients must be individualized. Some patients will maintain adequate organ perfusion (and thus have adequate UOP) at MAP's lower than 70 mmHg. True hypotension must be correlated with UOP. If a MAP (generally <55 mmHg) is not adequate to maintain the UOP goal of 30 ml/hr, then the following steps are recommended:

1. Start with vasopressin 0.003 Units/kg/min drip (do not titrate).
2. Monitor CVP (goal 8-10 mmHg).
3. If CVP not at goal, then increase IV fluid rate by 20-33%.
4. If CVP at goal, then add Levophed (norepinephrine) start at 0.02 mcg/kg/min. With addition of a second vasoactive agent would consider stress dose hydrocortisone at 2 mg/kg/dose q8h (max 100 mg/dose) for 48 hours and then reassess (see catecholamine resistant shock).
5. If additional pressors are needed, consider guiding resuscitation with specific ScvO₂ goals (ScvO₂ 60-65%). These patients may be volume depleted but a missed injury should be suspected.
 - a. If CVP not at goal, then increase IV fluid rate 20-33%.
 - b. If CVP at goal, then consider epinephrine starting at 0.02 mcg/kg/min and titrate to effect.
 - c. If hypotension persists, look for missed injury and initiate stress dose hydrocortisone.
 - d. Consider adding neosynephrine as a last resort.
6. If the patient is exhibiting catecholamine-resistant shock, consider the following diagnoses:
 - a. Missed injury and ongoing blood loss.
 - b. Acidemia. If pH<7.20, then adjust ventilator settings to optimize ventilation (target pCO₂ 30-35). If, despite optimal ventilation, patient still has a pH<7.2, consider bicarbonate administration.
 - c. Adrenal insufficiency. Start hydrocortisone 2mg/kg mg IV every 8 hours (maximum dose of 100 mg/dose).
 - d. Hypocalcemia. Maintain ionized calcium > 1.1.

APPENDIX

1. Flexbumin 25% contains 12.5g albumin and 145 ± 15 mEq/L of Na in 50 mL.
2. Lactated Ringers contains 130 mEq/L Na.
3. 0.9% Normal Saline contains 154 mEq/L.
4. To make a 5% albumin solution you remove 200 mL of 0.9% NS from a 1 L bag and add 4 bags (200 mL) of Flexbumin 25%.

$$154 \text{ mEq/L} \times 200 \text{ mL} \times 1 \text{ L}/1000 \text{ mL} = 30.8 \text{ mEq Na removed}$$

$145 \text{ mEq/L} \times 50 \text{ mL/bag} \times 4 \text{ bags} \times 1 \text{ L}/1000 \text{ mL} = 29 \text{ mEq Na added}$, therefore the concentration of Na in this 5% albumin mixture is 152 mEq/L. The Cl conc. will be approximately 123 mEq/L.

$$((12.5 \text{ g} \times 4 \text{ bags}) / 1 \text{ L}) \times 1 \text{ L}/1000 \text{ mL} \times 100 \text{ mL/dL} = 5 \text{ g/dL or 5\% albumin}$$