Begin fluid resuscitation at ____mL/hr Lactated Ringers
Following 1 hour of fluid administration:
If vitals signs unstable, Start Hypotension Guidelines, and Notify Burn Attending
At 12 hours post burn injury evaluate if fluids at current rate exceeds 6 mL/kg/hr. If so Notify Physician to consider Difficult to Resuscitate Protocol (Albumin).
At 24 hours post injury, goal is to decrease resuscitation fluid rate to 1/2 of the previous 16 hour rate. Urine output goals remain the same. Consider Difficult to Resuscitate Protocol if still needing high fluid rates.
Urine Output <30 ml/hr
Increase IV rate by 33% and Notify Physician
If Urine Output < 30 ml/hr for two consecutive hours, despite an increase in fluid OR Patient develops complications related to edema CALL PHYSICIAN and communicate assessment of urinary catheter, breath sounds, vital signs, and bladder pressure.
Consider moving Fluid rates up to 3-4 cc/kg Resuscitation or Begin Burn Center Difficult to Resuscitate Protocol (Albumin)
Urine Output > 50 ml/hr
Decrease IV rate by 33% and Notify Physician
Urine Output 30 – 50 ml/hr Leave IV at current rate
Fluid resuscitation is COMPLETE If maintaining urine output with stable fluid rate for > 2 hours and at least 24 hours post-injury Continue maintenance IVF rate
Urinary Output <30 ml/hr
Increase IV rate by 33% and Notify Physician
Total pre-hospital fluids ______ml
First 8 hr = 50% of calculated volume = ______ml Rate/hr = ______ml
First 8 hr = 50% of calculated volume = ______ml Rate/hr = ______ml
Total volume per Protocol =________ml

ABA Adjusted Fluid Rate: 2 mL LR x wt (kg) x TBSA% = Total volume for 24hrs.
(Consider 3-4 cc/kg if large percentage of 3rd degree burns or significant Inhalation injury)
Pre-admit weight ______kg
Total volume =________ml

Clinical Standardization

Burn Center Fluid Resuscitation, Inpatient

Updated: January 2023

Clinical algorithms:

1. Burn Center Fluid Resuscitation Algorithm: Adults and Peds > 14 yo (>30 kg)

For TBSA greater than 20% or TBSA 15% with Inhalation Injury
ABA Adjusted Fluid Rate: 2 mL LR x wt (kg) x TBSA% = Total volume for 24hrs.
(Consider 3-4 cc/kg if large percentage of 3rd degree burns or significant Inhalation injury)
Pre-admit weight ______kg
Total volume per Protocol =________ml
First 8 hour volume starts from time of injury.
Must subtract all pre-hospital volume given from First 8 hr total.
Total pre-hospital fluids ______ml
First 8 hr = 50% of calculated volume = ______ml Rate/hr = ______ml
Last 16 hrs = 50% of calculated volume = ______ml Rate/hr = ______ml
2. Adult Burn Center Difficult to Resuscitate (Albumin Algorithm)

Patients Admit Wt: ____ KG

Start 5% Albumin at current Resuscitation IVF rate, Discontinue LR
(MUST Order from BURN MAJOR Order set - Ask Pharmacy for 500 mL Bottles)
Following 1 hour of fluid administration:

If vital signs stable, measure patient's urine output over the last hour:

Urine Output < 30 mL/hr
Increase Albumin IV rate by 30%
Notify MD

Urine Output 30-50mL/hr
Leave IV at current rate

Urine Output > 50mL/hr
Decrease Albumin IV rate by 20% (Min 150 cc/hr)

Urine Output > 100mL/hr
Decrease Albumin rate by 30%
Be sure to assess patient's BP, and HR before decreasing IV Rate.
CALL PHYSICIAN.

Measure Urine output and adjust fluid rate based on urine output hourly as above until #1 or #2 below are achieved:

1: Urine output < 30mL/hr for two hours, despite an increase in fluids
OR
Patient requires increasing fluids for more than two consecutive hours
OR
Patient requires more than twice the initial fluid rate for more than two hours
OR
Patient develops complications related to edema (i.e. loss of peripheral pulses, decreased SaO₂)

CALL PHYSICIAN and communicate assessment of urinary catheter, breath sounds, vital signs, and bladder pressure.

2: Current rate IVF is maintained or decreased for four hours with stable urine output.
If >24 hours post-burn, resuscitation is COMPLETE. Titrate slowly to Maintenance fluid rate.
Consider Continuing Albumin for 48 hours post-burn at Maintenance in place of LR
NOTIFY PHYSICIAN.

If end points of resuscitation (Ex: SV, SCVO₂, PoCUS) are at goal, then do not increase IVF rate any further (even if UOP<30mL/hr.) The patient should be considered hemodynamically optimized and the oliguria is likely a result of established renal insult. Some degree of renal failure is expected and should be tolerated. Continued increases in fluid administration despite optimal hemodynamic parameters will only result in "resuscitation morbidity," that is oftentimes more detrimental than renal failure.

SICU and BURN Attendings to discuss Resuscitation Plan.
3. Pediatric Burn Center Fluid Resuscitation Algorithm: Age < 14 or <30kg

For TBSA greater than 15%, pts admit weight ______kg
Parkland Protocol: 3 mL LR x wt (kg) x TBSA% = Total volume for 24hrs.
First 8 hour volume starts from time of injury.
Must subtract all pre-hospital volume given from First 8 hr total.
Total pre-hospital fluids ______ml
First 8 hr = 50% of calculated volume = ______ml Rate/hr = ______ml
Last 16 hrs = 50% of calculated volume = ______ml Rate/hr = ______ml

If vitals signs unstable, Start Hypotension Guidelines, and Notify Burn Attending
Begin fluid resuscitation at ____mL/hr Lactated Ringers (plus Maintenance for < 30 kg)
Following 1 hour of fluid administration:

Urine Output < 1ml/kg/hr
Increase LR IV rate by 33% and Notify Physician
(Do Not Change Maintenance IVF)

Urine Output 1 ml/kg/hr
Leave IV at current rate

Urine Output > 2 ml/kg/hr
Decrease LR IV rate by 33% and Notify Physician
(Do Not Change Maintenance IVF)

If Urine Output < 1ml/kg/hr for two consecutive hours, despite an increase in fluid
Patient develops complications related to edema
CALL PHYSICIAN and communicate assessment of urinary catheter, breath sounds, vital signs, and bladder pressure.
Begin Burn Center Pediatric Difficult to Resuscitate Protocol (Albumin)

At 12 hours post burn injury evaluate if fluids at current rate exceeds 6 mL/kg/hr. If so Notify Physician to consider Pediatric Difficult to Resuscitate Protocol (Albumin).

At 24 hours post injury, goal is to decrease resuscitation fluid rate to 1/2 of the previous 16 hour rate. Urine output goals remain the same. Consider Pediatric Difficult to Resuscitate Protocol if still needing high fluid rates.

Fluid resuscitation is COMPLETE
If maintaining urine output with stable fluid rate for > 2 hours and at least 24 hours post-injury
Continue maintenance IVF rate

Example Fluid Calculation:
Child is 20 kg with 30% TBSA thermal burns.
3 mL LR x 20 x 30 = 1800 mL LR
1800/2 = 900 in 1st 8 hrs and 900 in remaining 16 hrs.

If < 30 kg:
In addition to resuscitation fluids, infuse D5LR maintenance fluids at:
1. 4 mL/hr for first 10 kg of body weight
2. 2 mL/hr for next 10 kg of body weight
3. 1 mL/hr for remaining kg of body weight

Do NOT titrate maintenance fluids

Total volume per Parkland Protocol = ______ml

First 8 hours = 113 mL LR/hr
Final 16 hours = 56 mL LR/hr

*subtract pre-hospital fluids from first 8 hour total
Clinical pathway summary

CLINICAL PATHWAY NAME: Burn Center Fluid Resuscitation

PATIENT POPULATION AND DIAGNOSIS: Adult and Pediatric Burn Patients

APPLICABLE TO: Butterworth and Helen DeVos Children’s Hospital

BRIEF DESCRIPTION: This guideline presents a standardized approach of best practice for fluid resuscitation in an acutely burned patient. Fluid resuscitation is foundational to early management of the burn injured patient.

LAST REVISED: January 2023

Clinical pathways clinical approach

TREATMENT AND MANAGEMENT:

1. Definitions
   Burn Shock: defined as hypovolemic shock and cellular shock with hemodynamic challenges characterized by decreased cardiac output, increased extracellular fluid, decreased plasma volume, and oliguria. Burn shock that is not managed adequately may lead to further complications of ARDS, renal failure and abdominal compartment syndrome.

2. Guideline Contents
   The primary goal of resuscitation in the inflammatory phase of a burn is to restore and preserve adequate tissue perfusion and maximize organ function with the least amount of physiologic complications. The patient experiences changes in microvasculature caused by a profound inflammatory response to the burn injury. This is often referred to as capillary permeability and is characterized by a disruption in the balance of fluid between the intravascular space and the interstitial compartment. There are multiple methods to accomplish adequate perfusion and they must be approached systematically.
   Primarily a crystalloid solution, specifically Lactated Ringers, is administered intravenously to replace fluid that is lost from the intravascular space. See Algorithm 1: Adult Burn Center Fluid Resuscitation.
   The secondary approach, determined by failure of the primary approach to achieve adequate resuscitation, includes a colloid solution in addition to the crystalloid. See Algorithm 2: Adult Burn Center Difficult to Resuscitate.
   Finally, there may be times during the process of resuscitation where the attempted methods do not sustain vitals and there will be a need to review hypotension guidelines for guidance. See Hypotension Guidelines below.
3. Parkland Protocol

**Parkland Protocol** = 2(mL) x wt(kg) x TBSA% = Total volume for 24hrs.
“First 8 hour volume” starts from time of injury
Must subtract all pre-hospital volume given from “First 8 hour” total

Pts admit weight: _____ kg
Total pre-hospital fluids: _____ mL

Total volume per Parkland Protocol = ________ mL
First 8 hr = 50% of calculated volume = ________ mL  Rate/hr = _____ mL/hr
Last 16 hr = 50% of calculated volume = ________ mL  Rate/hr= _____ mL/hr

4. Hypotension Guidelines for Fluid Resuscitation

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

1. Contact SICU Attending
2. Start with Vasopressin 0.04 units/min IV (do not titrate)
3. Monitor CVP (goal 8-10) or SVV (<13) or ScvO₂ (60-65%)
4. If the CVP/SVV/ScvO₂ is not at goal, increase fluid rate by 33%
5. If the CVP/SVV/ScvO₂ is at goal, then add norepinephrine IV 0.01 mcg/kg/min and titrate to effect. (Maximum dose 0.2 mcg/kg/min)
6. If additional vaspressors are needed, consider the placement of a PA catheter to guide resuscitation with specific PCWP and ScvO₂ goals (goal PCWP 10-12, ScvO₂ 60-65%). These patients may be volume depleted but a missed injury should be suspected.
   a. If PCWP/ ScvO₂ is not at goal, increase IVF rate by 33%
   b. If PCWP/ ScvO₂ is at goal, consider dobutamine 5mcg/kg/min and titrate until ScvO₂ reaches goal. (Max dose of dobutamine: 20mcg/kg/min)
   c. If hypotension persists, assess for missed injury.
   d. Consider adding epinephrine or neosynephrine as a last resort.
7. If the patient is exhibiting catecholamine-resistant shock, consider the following diagnoses:
   a. Missed injury and ongoing blood loss.
   b. Acidemia. If pH is less than 7.2, then adjust ventilator settings to optimize ventilation (target PCO₂ 30-35). If, despite optimal ventilation, patient still has a pH less than 7.2, consider bicarbonate administration.
c. **Adrenal insufficiency.** Check a random cortisol level and start hydrocortisone 100mg every 8 hours.

d. **Hypocalcemia.** Maintain ionized calcium greater than 1.1

Note: Hypotension Guidelines are contraindicated in patients with a history of MI in the past 6 months, acute MI or active ischemic changes

**Pathway information**

**OWNERS(S):** Amy Spencer (Physician, Acs), Tracy Hosford (Clinical Nurse Specialist)

**CONTRIBUTOR(S):** Emily Krebsbach (Burn Center Program Coordinator), Chad Galdys (Clinical Nurse Specialist), Jennifer Wheaton (Nurse Mgr), Mary Dougherty (Dir, Oncology & Med Surg), Wendy Thomas (Clinical Pharmacist API)

**EXPERT IMPROVEMENT TEAM (EIT):** Burn Quality

**CLINICAL PRACTICE COUNCIL (CPC):** Acute Health

**CPC APPROVAL DATE:** February 7, 2023

**OTHER TEAM(S) IMPACTED:** Cardiology, Critical Care, Emergency Services, Medical Specialties

**References**

Cochran, A., Morris, SE., Edelman, LS., Saffle JR. Burn patient characteristics and outcomes following resuscitation with albumin. Burns 2007; 33:25-30

Gibran, N. American Burn Association Consensus Statements: Burn Resuscitation (p.368) DOI: 10.1097/BCR.0b013e31828cb249