Objectives

- Understand post-burn hemodynamic changes
- Identify post-burn fluid requirements
- Describe physiologic monitoring of resuscitation
- List common complications of burn injury and resuscitation therapy
- Identify patients requiring special fluid management
Proper fluid management is critical to survival

Resuscitation must be aimed at

- Maintaining tissue perfusion and organ function
- Avoiding complications of inadequate or excessive fluid therapy
Systemic Effects of Burn Injury

↑ PVR with ↓ CO

- Unrelated to hypovolemia
- Due to neurogenic & humoral effects
- B/P Δ’s reflect
  - Edema formation in burn
  - ↓ Blood volume
  - ↓ Cardiac output
  - Resultant compensatory vascular response

Peripheral Vascular Resistance

Cardiac Output
Systemic Effects of Burn Injury

- Response proportional to extent of body surface injury
- Results in diminution and redistribution of tissue blood flow
- Adequate resuscitation ameliorates burn shock.
Goal of Resuscitation

Maintain tissue perfusion and organ function while avoiding the complications of inadequate or excessive fluid therapy.
Edema maximum in 2nd 24 hrs post burn

- Excessive fluid administration
  - Exaggerates edema formation
  - Compromises local blood supply
Patients particularly sensitive to excess fluids

- Children
- The elderly
- Patients with pre-existing cardiac disease
Shock and acute renal failure as a consequence of hypovolemia

Multiple organ dysfunction

Delay in resuscitation increases capillary leak

Prompt resuscitation essential to ameliorate shock and organ failure
Related to Extent of Burn & Body Size

- Influenced by patient age since children have greater surface area / unit body mass
- Estimated using patient weight & % TBSA burn
Establish Large Bore Peripheral IV

- Use vessels underlying burned skin if needed
- CVP line (preferred through non-burned skin)

- Intraosseous route OK for pediatric patients < 8 years of age
Resuscitation Fluid

- Isotonic crystalloid early
- Colloid of little use in presence of increased capillary permeability
Initiate Resuscitation Using the Following Calculations of Fluid Needs

**Adults & Older Children**

LR (Ringer’s Lactate) \(2-4 \text{ ml} \times \text{Kg wt} \times \% \text{TBSA burn}\)

**Infants & Younger Children**

LR \(3-4 \text{ ml} \times \text{Kg wt} \times \% \text{TBSA burn}\)

Plus D5LR at maintenance rate

Adjustments to fluid rates will be dependent upon patient response in subsequent hours
Resuscitation Fluid

- Infuse ½ of estimated volume in 1st 8 hrs post burn

- Infuse ½ of estimated volume over next 16 hrs post burn

- Adjust actual volume of infused fluid according to patient response
Promptly initiated and adequate resuscitation permits

- Modest decrease in blood & plasma volume
- Restores plasma volume in second 24 hours post burn

If patient transfer is delayed beyond first 24 hrs, consult with burn center staff regarding ongoing fluid resuscitation
Children have greater surface area / unit body mass compared to adults

- Require relatively greater amounts of resuscitation fluid
- Have lesser intravascular volume/unit surface area burned
- Are more susceptible to fluid overload and hemodilution
Children have limited glycogen stores

- They are rapidly exhausted by early post-burn elevation of endogenous steroids and catecholamines
- Blood glucose levels must be monitored
- Glucose containing electrolyte solutions may need to be continued
Fluid calculation is an ESTIMATE
Individual patient response dictates therapy
fluid needs common in patients with
- Associated injuries
- Electric injury
- Inhalation injury
- Resuscitation delay
- Prior dehydration
- ETOH &/or drug abuse
- Very deep burn injury
- Small children with small burns
Shock & Fluid Resuscitation

- Actual fluid volume depends on patient response
- Easier to infuse more fluid than remove excess fluid

- Optimally, try to minimize volume & salt loading
  - Prevents acute renal failure
  - Low incidence pulmonary & cerebral edema
Cardiac output is commonly “normal” in latter half of 1st post-burn day, but if not

- Consider myocardial infarction or insufficiency
- Invasive monitoring may be required

- General patient condition reflects resuscitation adequacy
- Assess mental status frequently
- Anxiety & restlessness are early signs of hypovolemia and hypoxemia
Maintain adequate urine output

**Adult**

0.5 ml / kg / hr (30 – 50 cc/hr)

**Children weighing <30 kg**

1 ml / kg / hour

Indwelling urinary catheter most available & reliable resuscitation guide

Incrementally ↑ or ↓ IV rate in response to UOP
Management of Oliguria

- Most often result of inadequate resuscitation
- Associated with $\uparrow$ SVR & $\downarrow$ CO
- Requires more rapid fluid administration
- Diuretics contraindicated
Myoglobinuria & Hemoglobinuria (Red Pigmented Urine)

- High voltage electric injury or soft tissue injury due to mechanical trauma
- Administer fluids to maintain UOP 1.0-1.5 ml / kg / hr in adults
- Often clears urinary heme pigments & eliminates need for diuretic
Myoglobinuria & Hemoglobinuria (Red Pigmented Urine)

- The addition of Mannitol to IV fluid is rarely needed
- If used, a diuretic precludes use of UOP as guide to fluid therapy
- May add Na+ bicarbonate to IV fluid to maintain a slightly alkaline urine
Blood Pressure

- May be misleading in burned limb
- Auditory signal ↓ as edema forms
- If used to titrate IV infusion rate, edema formation may be exaggerated
Heart Rate

Of Limited Use

- Tachycardia common in adequately resuscitated adults
- May be related to pain as well as hypovolemia
- Levels of tachycardia in children dependent on normal HR
Laboratory Studies

Hemoglobin & Hematocrit

- Not a reliable guide to resuscitation
- Whole blood or packed RBC not indicated unless
  - Pre-existing anemic disease
  - Acute blood loss from associated trauma
- Maintain Hct 30 – 35%

Chemistries

- Obtain baseline data for serious burns and inhalation injury
- Repeat based upon patient response
Summary

 rê Maintain tissue perfusion & organ function

 rê Avoid complications of inadequate / excessive therapy

 • Excessive IV fluid: exaggerates edema formation, compromising local blood supply

 • Inadequate IV fluid: leads to shock and organ failure
Adults and Older Children

2-4 cc LR x Kg wt x % TBSA burn

Infants and younger children

3-4 cc LR x Kg wt x % TBSA burn
Plus D_5 LR at maintenance rate

Incrementally ↑ or ↓ IV rate in response to UOP

Actual volume of infused fluid is dictated by patient response