

BURN: HEMODYNAMIC EFFECTS AND RESUSCITATION

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Question

A 5-year-old 20 kg girl presents to the emergency department following burns to her anterior trunk. According to the Parkland Formula, what volume of crystalloid should be infused over the next 8 hours in addition to maintenance fluids?

- A. 390 mL
- B. 520 mL
- C. 650 mL
- D. 1040 mL

Key Points

- Initial hemodynamic changes following a burn include systemic inflammatory response, myocardial depression, and significant hypovolemia.
- The Parkland formula guides fluid resuscitation in the 24 hours following a burn.
- Clinicians should target clinical endpoints for adequate fluid resuscitation.
- Age-specific estimations of total body surface area should be utilized.

Hemodynamic Effects

Initial effects – systemic inflammatory response

- Release of vasoactive mediators, catecholamines, and inflammatory markers leads to myocardial depression and systemic capillary leak.¹
- Thermal disruption of the skin barrier leads to significant evaporative fluid losses and predisposes the patient to infections.²

Later effects (after 3-5 days) – hypermetabolic state

- Cardiac output may increase by up to 2-3 times compared to baseline.
- Increased circulating catecholamines and activation of the renin-aldosterone-angiotensin system (RAAS) can cause persistent hypertension and refractory tachycardia.^{2,3}
- Closure of the burn wound will reduce demand and abate the hypermetabolic state.²

Fluid Resuscitation Strategies

| Table 1: Common Burn Resuscitation Formulas | | |
|---|---------------------------------------|---------------------------------------|
| Formula | Crystalloid (mL) | Colloid (mL) |
| Parkland | 4 mL/kg/TBSA x % TBSA x weight (kg) | None |
| Brooke | 1.5 mL/kg/TBSA x % TBSA x weight (kg) | 0.5 mL/kg/TBSA x % TBSA x weight (kg) |
| Give ½ of the calculated amount over the first 8 hours and ½ over the next 16 hours. This volume should be given in addition to calculated maintenance fluids. | | |

- **The Parkland formula is the most widely utilized formula for calculating the total volume of fluid to be administered in the 24 hours following a burn.**
- Patients weighing less than 10 kilograms are at risk for under-resuscitation.⁴

- Clinical endpoints for adequate fluid resuscitation include capillary refill, hemodynamic stability, urine output, mental status, lactic acid level, and base deficit.²
- Colloid solutions are often incorporated after the first 24 hours and may reduce overall fluid requirements.⁵
- Fluid resuscitation in burn patients is complicated by capillary leak, predisposing patients to acute respiratory distress syndrome (ARDS), compartment syndrome, and cerebral edema.³

Burn Area Estimation

- The extent of hemodynamic effects and fluid losses after a burn will correlate with the percentage of total body surface area (TBSA) affected.³
- Infants and children have disproportionately larger relative body surface area of the head and neck, and smaller relative body surface area of the lower extremities compared to adults.⁶
- The Lund-Browder diagram provides age-appropriate estimations of body surface area.
- The rule-of-9s is commonly used to estimate adult TBSA. It is easy to remember (9% for the head, chest and abdomen, and each arm; 18% for the back and each leg; 1% for the perineum), but it is not as accurate as the Lund-Browder diagram.

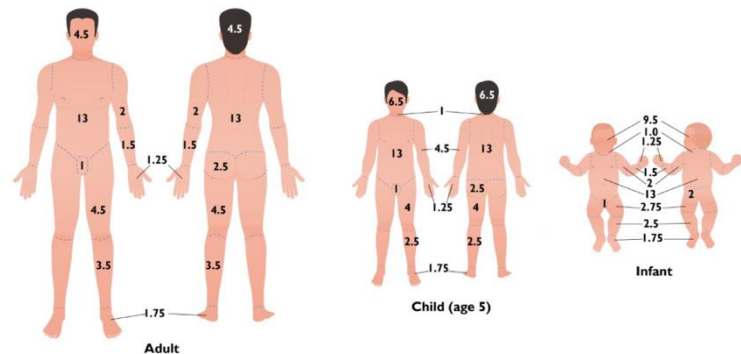


Figure: Lund and Browder chart for calculating the percentage of total body surface area burns. Used with permission from Ding J, Perlman R. Burn injuries: Initial evaluation and management. OpenAnesthesia. 2023.

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Answer: B. This 5-year-old patient has burns to her anterior trunk, so TBSA involved is 13%. According to the Parkland formula, $4 \times 13 \times 20 = 1040$ mL of crystalloid, which should be infused in the first 24 hours (answer D). Half of that (520mL) should be given in the first 8 hours (answer B). Using the Brooke formula, the 24-hour crystalloid requirement is 390mL (answer A).