American Burn Association

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Advanced Burn Life Support Course

PROVIDER MANUAL
2018 UPDATE

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2017–2018

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continue until organ and tissue perfusion has been adequately restored. Infusion of adequate amounts of resuscitation fluid restores cardiac output and tissue blood flow thereby helping prevent organ failure.

III. RESUSCITATION

A. Vascular Access and Choice of Fluid

Reliable peripheral veins should be used to establish intravenous access. Use vessels underlying burned skin if necessary. If it is not possible to establish peripheral intravenous access, a central line will be necessary. The intraosseous route may be considered if intravenous access is not immediately available and cannot be established.

In the presence of increased capillary permeability, colloid content of the resuscitation fluid exerts little influence on intravascular retention during the initial hours post-burn. Consequently, crystalloid fluid is the cornerstone of resuscitation for burn patients. Lactated Ringer's (LR) is the fluid of choice for burn resuscitation because it is widely available and approximates intravascular solute content.

Hyperchloremic solutions such as normal saline should be avoided. (Refer to Chapter 10, *Burn Disaster Management* for possible exceptions to this caveat.)

B. Goal of Resuscitation

The goal of resuscitation is to maintain adequate tissue perfusion and organ function while avoiding the complications of over or under resuscitation. Burn fluid resuscitation must be guided by basic critical care principles and managed on a near-continuous basis to promote optimal outcomes.

1. Complications of Over-resuscitation

Edema that forms in dead and injured tissue reaches its maximum in the second 24 hours post-burn. Administration of excessive volumes of resuscitation fluid exaggerates edema formation, leading to various types of resuscitation-related morbidity. These include extremity, orbital, and abdominal compartment syndromes, as well as pulmonary edema, and cerebral edema.

2. Complications of Under-resuscitation

Shock and organ failure, most commonly acute kidney injury, may occur as a consequence of hypovolemia in a patient with an extensive burn who is untreated or receives inadequate fluid. The increase in capillary permeability caused by the burn is greatest in the immediate post-burn period and diminution in effective blood volume is most rapid at that time. Prompt administration of adequate amounts of resuscitation fluid is essential to prevent decompensated burn shock and organ failure. A delay in initiating resuscitation will often lead to higher subsequent fluid requirements, thus it is imperative that fluid resuscitation commence as close to the time of injury as feasible.

C. Traditional Fluid Resuscitation Formulas

With the inception of modern burn care, a number of burn fluid resuscitation formulas have been devised to estimate resuscitation fluid needs in the first 24-hours post-burn. Fluid resuscitation after burn injury is a cornerstone of burn care and fittingly, these formulas collectively are among the greatest advances in modern burn care. Appropriately, all burn formulas account for the surface area of burn and body weight. A patient's weight in kilograms is obtained or estimated and only second and third degree total burn surface are calculated, using the Rule of Nines or any of several commonly available burn diagrams. First-degree burns should not be included in the fluid resuscitation calculations as it is unnecessary and increases the likelihood of over-resuscitation.

By consensus, the American Burn Association published a statement in 2008 establishing the upper and lower limits from which the 24-hour post-burn fluid estimates could be calculated. These limits were derived from the two most commonly applied resuscitation formulas: the Parkland Formula (4 ml/kg/%TBSA/24 hours) and the Modified Brooke Formula (2 ml/kg/%TBSA/24 hours).

For any traditional formula, it was estimated that one-half of the calculated total 24-hour volume would be administered within the first 8 hours post-burn, calculated from the time of injury. The traditional formulas further estimated that the remaining half of the calculated total 24-hour resuscitation volume would be administered over the subsequent 16 hours of the first post-burn day.

It is important to emphasize that the volume of fluid actually infused in practice is adjusted according to the individual patient's urinary output and clinical response. Although being able to estimate and predict how the 24-hour burn resuscitation might unfold is highly valuable, the actual 24-hour total resuscitative volumes patients receive are highly variable due to patient variability in the response to injury.

D. The Initial Fluid Rate and Adjusted Fluid Rate

In the pre-hospital and early hospital settings, prior to calculating the percent Total Body Surface Area (TBSA) burned, the following guidelines based on the patient's age are recommended as the INITIAL FLUID RATE as a STARTING POINT:

- 5 years old and younger: 125 ml LR per hour
- 6 – 13 years old: 250 ml LR per hour
- 14 years and older: 500 ml LR per hour

Once the patient's weight in kg is obtained and the percent second and third degree burn is determined in the secondary survey, the ABLS Fluid Resuscitation Calculations are used to calculate the ADJUSTED FLUID RATE.

1. Adult Thermal and Chemical Burns:

2 ml LR x patient's body weight in kg x % second and third degree burns, with half of the 24-hour total (in mls) infused over the first 8 hours.

Research indicates that resuscitation based upon using 4 ml LR per kg per %TBSA burn commonly results in excessive edema formation and over-resuscitation.

EXAMPLE:

An adult patient with a 50% TBSA second and third degree burn who weighs 70 kg:

2 ml LR x 70 (kg) x 50 (% TBSA burn) = 7,000 ml LR in the first 24 hours. 3,500 ml (half) is infused over the first 8 hours from the time of injury. A minimum of 437 ml LR / hour should be infused over the first 8 hours.

If initial resuscitation is delayed, the first half of the volume is given over the number of hours remaining in the first 8 hours post-burn.

For example, if the resuscitation is delayed for two hours, the first half is given over 6 hours (3500 ml / 6 hours). A minimum of 583 ml LR per hour should be infused over the remaining 6 hours.

In the scenario where fluid resuscitation is delayed beyond six hours post-burn, the burn center should be consulted for the most appropriate 'catch-up' approach. Administration of crystalloids via bolus infusion should be avoided except when the patient is hemodynamically unstable.

2. Pediatric Patients (13 years and under):

3 ml LR x child's weight in kg x % TBSA second and third degree burns, with half of the 24-hour total (in mls) infused over the first 8 hours as per the adult calculation.

Children have a greater surface area per unit body mass than adults and require relatively greater amounts of resuscitation fluid. The surface area/body mass relationship of the child also defines a smaller intravascular volume per unit surface area burned, which makes the burned child more susceptible to fluid overload and hemodilution.

In addition to the resuscitation fluid noted above, infants and young children should also receive LR with 5% Dextrose at a maintenance rate. In this course, we define young children and infants as individuals weighing ≤30 kg. Hypoglycemia may occur as limited glycogen stores for a child can become rapidly exhausted. Therefore, it is important to monitor blood glucose levels and, if hypoglycemia develops, to continue resuscitation using glucose containing electrolyte solutions.

Consulting the burn center is advised when resuscitating infants and young children.

Additional information relating to pediatric fluid resuscitation will be addressed in Chapter 8, *Pediatric Burn Injuries*.

3. Adult Patients with High Voltage Electrical Injuries with evidence of myoglobinuria (dark red-tinged urine):

4 ml LR x patient's weigh t in kg x % T BSA second and third degree burns, with half of the 24 hour total (in mls) inf used over the first 8 hours.

The special fluid resuscitation requirements associated with high voltage electrical injuries are discussed in Chapter 6, *Electrical Injury*.

4. Pediatric Patients with High Voltage Injuries with evidence of myoglobinuria (dark red-tinged urine):

Consult a burn center immediately for guidance.

Once the ADJUSTED FLUID RATE based on the weight and burn size is infusing, the MOST CRITICAL consideration is the careful titration of the hourly fluid rate based on the patient's urinary output and physiological response. The next section provides guidance on how fluids should be titrated.

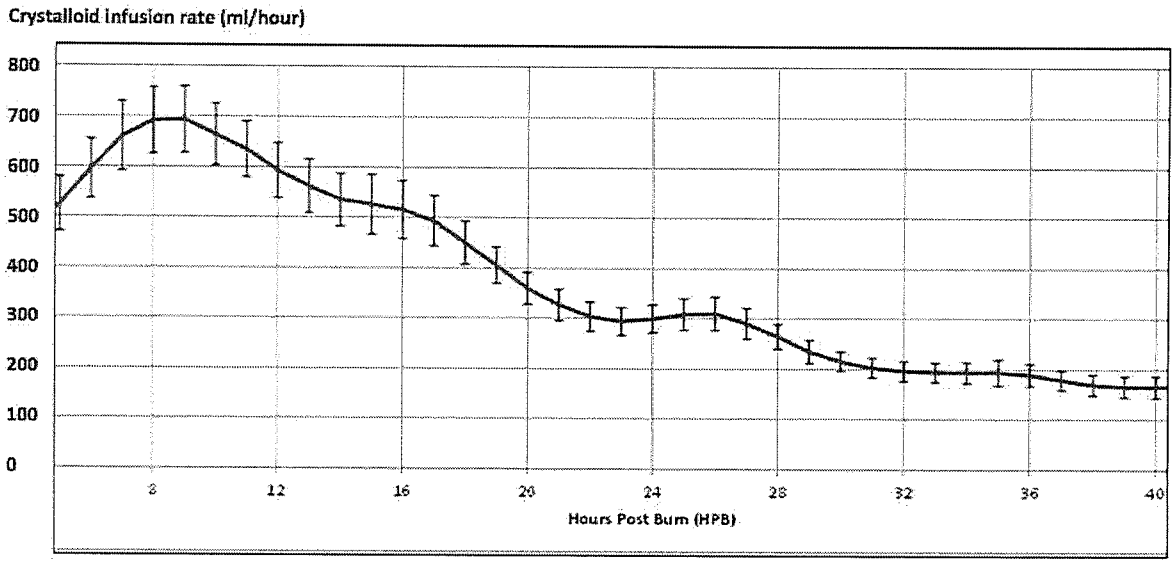
E. Titration of Fluids and Monitoring

Current resuscitation practice is a very dynamic process that requires hourly re-evaluation of the patient's progress through the first 24 hours. It is important to put the traditional formulas in the context of this current practice. Each patient reacts differently to burn injury and resuscitation. The actual volume of fluid infused will vary from the calculated volume as indicated by physiologic monitoring of the patient's response. It is easier during resuscitation to infuse additional fluid as needed than to remove excess fluid. A resuscitation regimen that minimizes both volume and salt loading, prevents acute kidney injury, and is associated with a low incidence of pulmonary and cerebral edema is optimal.

The overall goal is a gradual de-escalation of IV fluid rate over the first 24 hours. However, as the following graph summarizing average real life resuscitation volumes over the first 24 hours indicates, fluids often need to be titrated upward in major burns until the patient reaches target urine output in subsequent hours. Aggressive titration during this early phase is critical to minimize the chance of acute kidney injury. Once target urine output is reached, a gradual reduction in IV fluid rate is advisable to prevent over-resuscitation. It is not necessary to wait for 8 hours to start reducing fluids. It is also dangerous to suddenly reduce fluid rate by ½ at 8 hours.

Conceptually, the IV fluid rate for the next 16 hours, as derived by traditional formulas, is simply a target IV fluid rate to achieve.

Figure. Representative graph of dynamic hourly fluid rate (y-axis) over the first 40 hours (x-axis) in severely burned patients. (Image obtained with per mission from the United States Army Institute of Surgical Research)



With appropriate fluid resuscitation, cardiac output, which is initially depressed, returns to predicted normal levels between the 12th and 18th hours post-burn, during a time of modest progressive decrease in blood volume. Although uncommon in young and healthy individuals, cardiac dysfunction should be considered in many older adults with burns. Invasive monitoring may be required and treatment targets may need to be modified.

Reassess the patient frequently, including their mental status. Anxiety and restlessness are early signs of hypovolemia and hypoxemia. Fluid and ventilatory support should be adjusted as needed. In intubated patients, excessive doses of opioids and/or sedatives should be avoided. Their liberal use often exacerbates peripheral vasodilation and may cause hypotension, which then leads to administration of more fluids. Other medications that can cause hemodynamic compromise include propofol and dexmedetomidine and should be used with caution. Whether they are intubated or not, the goal is for every burn patient to remain alert and cooperative with acceptable pain control.

1. Urinary Output

The hourly urinary output obtained by use of an indwelling bladder catheter is the most readily available and generally reliable guide to resuscitation adequacy in patients with normal renal function.

- Adults: 0.5 ml/kg/hour (or 30-50 ml/hour)

- Young Children (weighing ≤ 30kg): 1 ml/kg/hour

- Pediatric (Weighing > 30 kg,up to age 17): 0.5 ml/kg/hour

- Adult patients with high voltage electrical injuries with evidence of myoglobinuria: 75 – 100 ml/hour until urine clears.

The fluid infusion rate should be increased or decreased based on urine output. The expected output should be based on ideal body weight, not actual pre-burn weight (i.e., the patient who weighs 200 kg does not need to have a urinary output of 100 ml per hour).

Once an adequate starting point has been determined, fluid infusion rate should be increased or decreased by up to one-third, if the urinary output falls below or exceeds the desired level by more than one-third every hour.

a. Management of Oliguria

Oliguria can be caused by mechanical obstruction, such as intermittent urinary catheter kinking or dislodgment from the bladder. This situation may present as intermittent adequate urine output with periods of anuria. Verifying that the catheter is functioning well is imperative in this situation.

Oliguria, in association with an elevation of systemic vascular resistance and reduction in cardiac output, is most frequently the result of insufficient fluid administration. In such a setting, diuretics are contraindicated, and the rate of resuscitation fluid infusion should be increased to achieve target urine output. Once a diuretic has been administered, urinary output is no longer an accurate tool to monitor fluid resuscitation.

Older patients with chronic hypertension may become oligouric if blood pressure falls significantly below their usual range. As such, a systolic blood pressure of 90-100 mm Hg may constitute relative hypotension in older patients.

b. Management of Myoglobinuria and Dark, Red-tinged Urine

Patients with high voltage electrical injury, patients with associated soft tissue injury due to mechanical trauma and very deep burns may have significant amounts of myoglobin and hemoglobin in their urine. The administration of fluids at a rate sufficient to maintain a urinary output of 1.0-1.5 ml per kg per hour in the adult (approximately 75-100 ml/hour) will often produce clearing of the heme pigments with sufficient rapidity to eliminate the need for a diuretic. When an adequate urinary output has been established and the pigment density decreases, the fluid rate can be titrated down.

Persistence of dark red-tinged urine may indicate compartment syndrome.

Administration of a diuretic or the osmotic effect of glycosuria precludes the subsequent use of hourly urinary output as a guide to fluid therapy; other indices of volume replacement adequacy must be relied upon.

2. Blood Pressure

In the first few hours post-burn, the patient should have a relatively normal blood pressure. Early hypovolemia and hypotension can be a manifestation of associated hemorrhage due to trauma. It is important recognize and treat hemorrhage in cases of combined burn/trauma injuries.

Blood pressure cuff measurement can be misleading in the burned limb where progressive edema is present. Even intra-arterial monitoring of blood pressure may be unreliable in patients with massive burns because of peripheral vasoconstriction and hemoconcentration. In such instances, it is important to place more emphasis on markers of organ perfusion such as urine output.

3. Heart Rate

Heart rate is also of limited usefulness in monitoring fluid therapy. A rate of 110 to 120 beats per minute is common in adult patients who, on the basis of other physiologic indices of blood volume, appear to be adequately resuscitated. On the other hand, a persistent severe tachycardia (>140 beats per minute) is often a sign of under treated pain, agitation, severe hypovolemia or a combination of all. The levels of tachycardia in pediatric patients should be assessed on the basis of the irage-related normal heart rate.

4. Hematocrit and Hemoglobin

As fluid resuscitation is initiated, in the early post-burn period, it is very common to see some degree of hemoconcentration. In massive burns, hemoglobin and hematocrit levels may rise as high as 20 g/dL and 60% respectively during resuscitation. This typically corrects, as intravascular volume is restored over time. When these values do not correct, it suggests that the patient remains under-resuscitated.

Whole blood or packed red cells should not be used for resuscitation unless the patient is anemic due to pre-existing disease or blood loss from associated mechanical trauma at the time of injury. In that case, transfusion of blood products should be individualized.

5. Serum Chemistries

Baseline serum chemistries should be obtained in patients with serious burns. Subsequent measurements should be obtained as needed based on the clinical scenario. To ensure continuity of care and patient safety during transfer, the treatment of hyperkalemia and other electrolyte abnormalities should be coordinated with the burn center physicians.

F. The Difficult Resuscitation

Estimates of resuscitation fluid needs are precisely that — estimates. Individual patient response to resuscitation should be used as the guide to add or withhold fluid. The following groups are likely to be challenging and may require close burn center consultation:

- Patients with associated traumatic injuries
- Patients with electrical injury
- Patients with inhalation injury
- Patients in whom resuscitation is delayed
- Patients with prior dehydration
- Patients with alcohol and/or drug dependencies (chronic or acute)
- Patients with very deep burns
- Patients burned after methamphetamine fire or explosion
- Patients with severe comorbidities (such as heart failure, or end-stage renal disease)

In patients requiring excessive fluids, resuscitative adjuncts should be considered to prevent major complications such as pulmonary edema and compartment syndromes. Typical scenarios are: the provider is unable to achieve sufficient urine output at any point, or the patient develops oliguria when crystalloid infusion is reduced. Colloids in the form of albumin (and less commonly plasma) can be utilized as a rescue therapy. Synthetic colloids in the form of starches should be avoided due to their increased risk of harm. Close consultation with the nearest burn center is advised when initiation of colloid is being considered.

IV. SUMMARY

In burns greater than 20% TBSA, fluid resuscitation should be initiated using estimates based on body size and surface area burned. The goal of resuscitation is to maintain tissue perfusion and organ function while avoiding the complications of inadequate or excessive therapy. Excessive volumes of resuscitation fluid can exaggerate edema formation, thereby compromising the local blood supply. Inadequate fluid resuscitation may lead to shock and organ failure.

Promptly initiated, adequate resuscitation permits a modest decrease in blood and plasma volume during the first 24 hours post-burn and restores plasma volume to predicted normal levels by the end of the second post-

burn day. In the event that the patient transfer must be delayed beyond the first 24-hours, close consultation with nearest burn center is recommended regarding ongoing fluid requirements.

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AMERICAN BURN ASSOCIATION – BURN CENTER VERIFICATION REVIEW PROGRAM

Verification Criteria Updated as of 08/01/2019

Pre-Review Questions (PRQ) Updated as of 01/01/2020*

(See PRQ implementation timeline for guidance on which PRQ version to use during the 2020-2021 transition year)

Section 1: Burn Center Administration			
#	**Criteria**	**Criterion Level (1 or 2)**	**PRQs**
1.1. (1)	The burn center hospital is currently accredited by the Joint Commission or equivalent.	1	1.1.a. What is the regulatory accrediting body of your hospital? 1.1.b. Are you currently accredited? 1.1.c. What is the date of the last accreditation? 1.1.e. If the burn program has any special recognition, list recognition and year attained.
1.2. (2)	The burn center has an identifiable medical and administrative commitment to the care of the patient with burns.	1	*Attach administrative support letter*
1.3. (3)	The burn center hospital maintains a specialized unit dedicated to acute burn care.	1	1.3.a. Do you have a specialized unit dedicated to acute burn care? 1.3.b. If patients followed by the burn service are housed outside the burn center, describe how those patients are managed, specifically regarding how continuity of care is handled across disciplines. 1.3.c. Do other services in the hospital admit patients to the burn service? YES:

Section 4: Burn Surgeons			
#	**Criteria**	**Criterion Level (1 or 2)**	**PRQs**
4.1 (41.)	Burn surgeons are licensed surgeons with board certification by American Board of Surgery, American Board of Plastic Surgery or equivalent based on review by Verification Committee.	1	4.1.a. Attach a current CV for all burn surgeons, including the burn center director (PDF). *Data from Certification and Training table*
4.2 (42.)	Burn surgeons have demonstrated expertise in burn treatment, by two or more years of mentored experience in the management of patients with acute burn injuries.	1	4.2.a. Have burn surgeons demonstrated expertise in burn treatment as evidenced by completion of a one-year fellowship in burn treatment or by two or more years of mentored experience in the management of patients with acute burn injuries? *Data from Certification and Training table*
4.3 (45.)	Each burn surgeon has participated, including primary decision-making, in the care of sufficient acutely burned patients annually.	1	4.3.a. Has each burn surgeon participated annually, including primary decision-making, in the care of a sufficient number of acutely burned patients? 4.3.b. When more than one surgeon is involved in clinical care, explain how they share patients, admissions, call responsibility and maintain continuity of care. *Data from Cases table*
4.4 (43.)	Each burn surgeon must participate in continuing medical education in burn treatment.	1	4.4.a. Has each burn surgeon participated in continuing medical education in burn treatment? *Education, Meetings and Publications table*
4.5 (44.)	Burn surgeons have had ABLS (or equivalent) training.	2	4.5.a. Do all burn surgeons have ABLS (or equivalent) training? *ABLS data from Certification and Training table*
4.6 (49.)	Assigned burn center medical staff are promptly available on a 24-hour basis.	1	4.6.a. Attach a call schedule for burn surgeon/resident daytime and nighttime coverage. 4.6.b. Explain who is in house who would provide care, who is out of house and what is the average distance/time.

Section 7: Therapy			
#	**Criteria**	**Criterion Level (1 or 2)**	**PRQs**
7.1 (60.)	A comprehensive rehabilitation program is designed for burned patients within 24 hours of admission.	1	7.1.a. Describe the process and timing for initiating occupational and/or physical therapy evaluation for inpatients. 7.1.b. Describe the mechanism to track timeliness of initial therapy evaluation for acute burns. 7.1.c. When the rehabilitation plan is not established within 24 hours, explain why.
7.2 (61.)	Physical and occupational therapists in the burn center are appropriately licensed in their respective disciplines and demonstrate ongoing continuing education in burn rehabilitation.	1	7.2.a. Are physical and occupational therapists in the burn center appropriately licensed in their respective disciplines? 7.2.b. Have physical and occupational therapists who are designated to the burn service received burn-specific continuing education in the last three years? *Therapist table* *Education, Meetings and Publications table* 7.2.b. Describe the process for burn rehabilitation orientation and training for therapists designated to the burn center and those providing coverage, including the topic areas covered.
7.3 (62.)	Therapy staffing is based upon burn center inpatient and therapy specific outpatient activity with at least one designated full-time equivalent burn physical therapist and one occupational therapist, but more depending on center volume.	1	7.3.a. How many total FTEs are designated to the burn service for occupational therapy (OT)? 7.3.b. How many total FTEs are designated to the burn service for physical therapy (PT)? *Therapist table* 7.3.c. Describe how therapy staffing is determined for burn inpatients.
7.4 (63.)	Inpatients with an active rehabilitation plan must have care delivered as prescribed in the evaluation which should determine duration and frequency	1	7.4.a. How is the frequency and duration of therapy services determined for the burn patient? 7.4.b. Do any of the therapists assigned to the burn program have patient care responsibilities with other patients in the hospital?

	based on acuity, include goals, outcome and plan for follow up.		YES: 7.4.b.1. Describe the method of prioritization and staffing for the burn patients relative to the other patients. 7.4.b.2. How often is the rehabilitation plan, goals and outcome reviewed? 7.4.b.3. What rehabilitation outcome measures are used regularly?
7.5 (64.)	Burn therapy services are provided 7 days per week for care of burn inpatients.	1	7.5.a. List the availability of therapy services for burn patients for each day of the week and indicate how the services are provided for during holidays and weekends. List adults and pediatric separately. 7.5.b. How are therapy services provided for inpatients located outside the burn center including who is responsible for their therapy?
7.6 (65.)	Burn therapists participate in multidisciplinary rounds and quality improvement.	1	7.6.a. Is there therapist representation within burn center quality improvement process? 7.7b. How is therapy represented at multidisciplinary rounds? *Onsite: Provide an example of a project in which a therapist was involved.* *Quality Improvement table*
7.7 (66.)	Therapists assigned to the burn center must show evidence of ongoing burn specific competency training.	1	7.7.a. Describe your competency-based training program for: 1) Regularly assigned therapists to the burn program 2) Staff that covers for holidays and weekends *Onsite: Have competency documents available upon request* 7.7.b. Describe how competency is assessed (method of assessment, person assessing, frequency, etc.).
7.8 (67.)	Therapists must participate in burn-related CEU activity on a regular basis.	1	7.8.a. Do therapists participate in burn-related continuing education activity on a regular basis? *Education, Meetings and Publications table*
7.9**P**	Therapy staff participates in pediatric specific continuing education.	2	*Education, Meetings and Publications table (peds column)*
7.10**P**	Therapy department has pediatric age-appropriate therapeutic equipment.	2	7.10.a. Describe the pediatric specific equipment used for therapy with burn children.

	as needed basis.		8.7.b. How and when are burn patients typically referred to mental health services? 8.7.c. How do the mental health care professionals integrate the plan of care with the burn team could include daily rounds, weekly multidisciplinary meetings, or other)? *Education, Meetings and Publications table*
8.8**P** (72.)	A child life/recreational therapist is available for children cared for in the program.	2	8.8.a. Describe the role and responsibilities of the child life/recreational therapist in the burn center. 8.8.b. Describe the availability of child life or recreational therapy consultation to the burn team. 8.8.c. What FTE percentage is available for child life or recreational therapy services to the burn center? 8.8.d. How does the child life professional or recreational therapist integrate the plan of care with the burn team (could include daily rounds, weekly multidisciplinary meetings, or other)? *Education, Meetings and Publications table*
8.9 (106)	Burn team members are provided with a minimum of one regional, national or international burn-related continuing education opportunity annually OR demonstrate annual participation in internal educational process specific to burn care.	1	8.9.a. Generally describe burn team participation in local, regional, national conferences and the resources available to support these activities. (Specifics should be provided in the education table) *Education, Meetings and Publications table* 8.9.b. Considering limited resources, describe how it is decided who attends these meetings. 8.9.c. Describe any internal burn educational opportunities provided to members of the burn team.
8.10 (107)	A burn center orientation and ongoing continuing education program documents staff competencies specific to age appropriate care and treatment of burn patients, including critical care, wound care, and rehabilitation.	1	8.10.a. Describe the process for the burn orientation program for the burn team including the topics covered (exclude residents, APPs, nurses and therapists as this is covered separately). 8.10.b. How often are the orientation and continuing education plan reviewed and who is responsible for this review? 8.10.c. Describe how ongoing continuing education is provided to members of the burn team (exclude residents, APPs, nurses & therapists as this is covered separately).