

Western Trauma Association critical decisions in trauma: Preferred triage and initial management of the burned patient

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ABSTRACT: This is a recommended management algorithm from the Western Trauma Association addressing the management of victims of burn injury. Because there is a paucity of published prospective randomized clinical trials that have generated Class I data, these recommendations are based primarily on published retrospective studies, clinical guidelines, and the expert opinion of members of the Western Trauma Association in conjunction with partner members of the American Burn Association. The algorithm and accompanying comments represent one safe and sensible approach that can be followed at most trauma centers. We recognize that there may be patient or institutional factors that warrant deviation from the published algorithm. We would encourage institutions to use this document as a starting point toward a dialog with local burn centers to collaboratively create a patient-centered care experience for the victims of minor burn injuries arriving at local trauma centers. (*J Trauma Acute Care Surg.* 2019;87: 1239–1243. Copyright © 2019 Wolters Kluwer Health, Inc. All rights reserved.)

KEY WORDS: Algorithm; burn; resuscitation; triage.

Burn injuries are extremely common events seen at trauma centers across the United States on a daily basis. Approximately 486,000 patients require treatment for burns, and 40,000 require hospitalization within the United States each year.¹ Nationally, 70% of patients who are burned receive burns that compromise less than 10% total body surface area (%TBSA), and 88% of all patients receive a less than 20% TBSA burn. By deduction, only 12% of all burns occurring in the United States are considered major burns by American Burn Association (ABA) criteria. Despite this data, the vast majority of patients with burn injuries, regardless of size or severity, are transported at great expense, sometimes for long distances for basic wound care. The reasons for almost universal transport of all burns to burn centers are multiple but include a reluctance of local referring institutions to assess and treat

even minor burn wounds, because of inexperience with burn injuries, lack of training, and an impression that all patients require specialist opinion for medicolegal reasons.²

Throughout the United States, there is great opportunity for basic, safe burn care to be rendered without immediate and costly transfer to a burn center. If successful triage can be accomplished, a great opportunity for health care system savings can be achieved while still rendering safe and effective burn care to our patients.^{3–5} In the past several years, advances in video-based consultation using smartphone technology have allowed for accurate initial consultation and mentoring, which can be used to facilitate appropriate triage decisions and initial care to the majority of patients seen at trauma centers for acute burn injury.^{6–13}

While this algorithm differs in small ways from the Burn Center Referral Criteria published by the American Burn Association (<https://ameriburn.org>), it was developed as a tool to be used in conjunction with the ABA criteria. The algorithm described within this article is not designed to determine who requires care by a burn center. Rather, it was fashioned to determine which cohort of patients would be safe to receive initial treatment by on-call, in-house, attending surgeons at most regional trauma centers within the United States by using modern telephonic and video consultation in a cooperative relationship with burn surgeons at regional burn centers. This consultation would include not only advice on the triage of these patients but also jointly determined decisions on the direction of initial management. Furthermore, we posit that discussions regarding near- and long-term follow-up at regional burn centers would be initiated (for patients not requiring immediate transfer) during this initial discussion. In this way, patients would receive optimal initial care, including burn center transfer when appropriate, while avoiding unnecessary emergency transfer to a burn center when initial care can be rendered by an acute care surgeon (with

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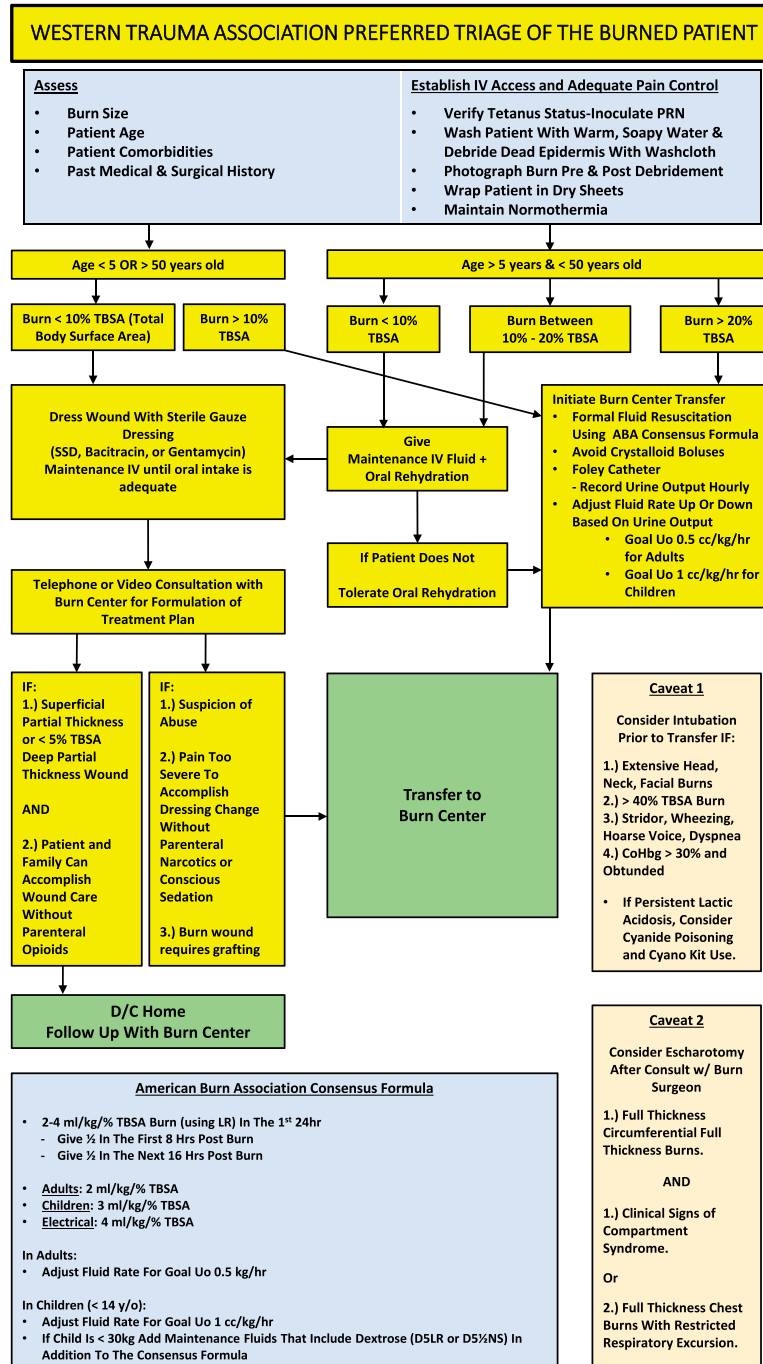
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Algorithm 1.

burn center follow-up) so as to save the patient and the entire health care system a significant amount of money in duplicated service fees and unnecessary emergency transport costs while rendering safe and effective burn care to those suffering minor burn injury.^{12,14}

SAFE INITIAL CARE FOR ALL PATIENTS

As is current practice when any patient comes to the trauma center after suffering a burn, we advocate for basic

assessment and care. Patients should be assessed for burn size (using the rule of nine's, see Figure 1) and severity (Fig. 2), basic demographic information should be gathered, and medical and surgical history should be obtained. In addition, intravenous (IV) access should be obtained. In the case of a major burn, preferences for intravenous access are as follows: the first is two large bore-peripheral IVs through nonburned skin if possible; then through burned skin; next, central access; temporary intraosseous access; and, finally, a surgical cut down. Tetanus status should be verified, and patients should receive a booster when

necessary. This initial care mirrors the care rendered to any other patient who is received by the trauma center. Once the initial data have been collected, the patient should be washed with warm soap and water, the burn should be debrided gently with a clean washcloth or gauze, and adequate pain control should be delivered as needed. This may include conscious (procedural) sedation as required. Before and especially after debridement, photographs should be taken of all burn wounds to help facilitate accurate communication with consulting burn surgeons. The patient should then be covered with clean dry sheets and a blanket, and the room and fluids should be warmed as necessary to maintain normothermia.¹⁵

BURN CARE SEGREGATED BY AGE AND PERCENT TOTAL BODY SURFACE AREA BURNED

The American Burn Association has segregated care into the care of at risk and less at risk populations. This is defined by age and size of burn. The following is logical triage for these groups.

For those who are relatively young or old as defined by less than 5 years old or more than 50 years old, who has a relatively small burn, as defined by a burn encompassing less than 10% TBSA, after initial debridement, the wound should be

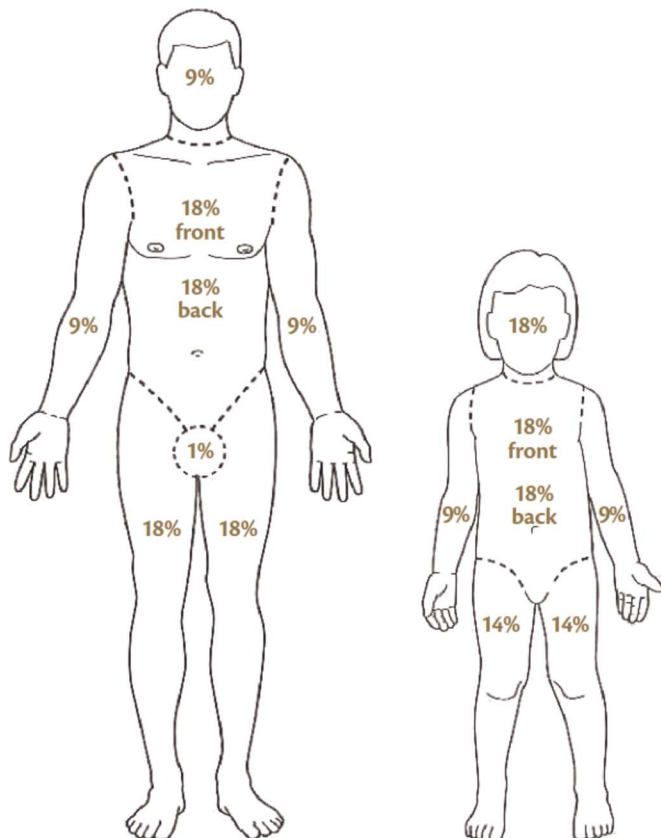


Figure 1. The rule of nine's. Portions of the body are segmented into multiples of nine for easy approximation of burn TBSA. It must be remembered that children have relatively large heads and small legs as compared with adults, accounting for differences in the rule of nine's between young and old.



Figure 2. The top photo shows a deep (third degree) alkali burn from cleaning products. Note the leathery, dead appearance of the dermis and visible thrombosed vessels (which are not always this obvious). The bottom right picture is of a mixed deep partial thickness (second degree) and full thickness (third degree) burn suffered after a TASER was used to subdue the patient. Note the leathery white central portion of this (full thickness) burn and the pink yet dry appearance (deep partial thickness burn) of the surrounding dermis. The bottom left picture is of a superficial, partial thickness (second degree) burn suffered when hot water was spilled on this persons' hand. Note the wet appearance of the wound and the pink dermis, which is alive. This wound should heal without grafting in 7 to 10 days. Because of the fact that these burns involved the hands and feet, and cross joints, both the foot and hand burns technically meet the criteria for referral to a burn center. In the case of the hand burn, video consultation with the burn surgeon on call resulted in this patient being instructed in wound care and follow-up with the burn center a few days later.

covered with an antibiotic containing cream or ointment (Silver Sulfadiazine [SSD], bacitracin, gentamicin) and dressed with sterile gauze. Maintenance IV fluid should supplement oral intake until adequately achieved. The same care should be rendered to those who are considered less at risk for significant systemic complications of burn injury (between the ages of 5 and 50 years old) with somewhat larger burns (up to 20% TBSA).

Once the patients have been debrided and their wounds dressed, as well as maintenance IV fluids initiated, either telephonic or video (preferred) consultation with a burn center is recommended. If after consultation with a burn surgeon there is suspicion of abuse as the cause of the burn, the decision has been made that the patient's pain is too severe to undergo dressing changes without parenteral narcotics or conscious (procedural) sedation, or the wound is likely to require formal tangential debridement and skin grafting, arrangements should be made to

transfer the patient to the regional burn center. If, however, after burn center consultation, it is determined that the patient has a superficial partial thickness burn or a mixed burn with a relatively small (<5% TBSA) deep partial thickness component, and the patient and family have demonstrated adequately the ability to accomplish wound care without parenteral narcotics, then we would recommend that the patient be discharged home with initial and continuing burn center follow-up within the next several days.^{12,16}

Many small burns may meet the ABA referral criteria for care by a burn center because of location alone (i.e., foot, hand, or perineal burns, or burns that cross joints). In this instance, if the burn is a simple partial thickness burn, is within the size parameters for discharge and follow-up with a burn center, and is simply being transferred because of location, we would recommend a collaborative decision be made regarding the necessity of immediate transfer. It may be reasonable to perform and instruct the patient on basic wound care, as well as basic stretches and the importance of maintaining flexibility, with burn clinic follow-up within a few days. This will help to avoid emergent transport of the patient, where he/she is likely to get similar care at the burn center and be discharged after consultation with routine burn clinic follow-up.

Regardless of age, the 12% of burn patients arriving at trauma centers with major burns as defined by greater than 10% TBSA in those less than 5 or more than 50 years old, or greater than 20% TBSA in those between 5 and 50 years old, should be triaged to formal fluid resuscitation and transferred to a burn center. While initiating transfer to a burn center, if it is determined that transport will be delayed, these patients should be debrided with soap, water, and a washcloth or gauze and dressed with antibiotic salve and gauze (including parenteral narcotics or procedural sedation as required) as any other burn patient. As this is being accomplished, formal fluid resuscitation should be started using the American Burn Association Consensus Formula (Fig. 3), which varies rate of fluid administration based on age, weight, and burn mechanism.¹⁷ A Foley catheter should be placed, and urine output should be monitored hourly. The goal for urine output in these patients should be 0.5 mL/kg per hour in adults and 1 mL/kg per hour in children. If urine output is greater than the stated goal, once excessive hyperglycemia

has been ruled out or treated appropriately, fluid rate should be adjusted down 20% per hour until urine output is in line with goals. If urine output is less than expected, fluid rates should be adjusted up by 20% per hour until urine output goals are met.¹⁸ Crystalloid boluses should be avoided, as these will only contribute to resuscitation morbidity and potentially lead to increased pulmonary edema, secondary extremity, or abdominal compartment syndromes because of the large capillary leak seen in these patients.^{19–22}

CAVEATS WHILE AWAITING TRANSFER

Before transfer, the airway of a significantly burned patient should always be evaluated. Loss of airway can be catastrophic and is preventable. There are three indications for intubation before transfer in a serious burn.²³

First, an airway can be compromised because of the direct effects of the burn. This is the most obvious indication for intubation before transfer. Signs and symptoms include pertinent history (burned in a closed space such as a car or mobile home or house fire) extensive head, neck, or facial burns; carbonaceous sputum and singed nasal or facial hair; and later on, the development of airway stridor. If even some of these signs or symptoms are present, it would be reasonable to intubate before transfer.²⁴ A second reason for intubation before transfer in a serious burn is obtundation caused by carbon monoxide poisoning. As a general rule, if the measured CO level is greater than 30% and transfer is imminent, intubate before transfer. If, however, transfer to the burn center is delayed for some reason and the patient is not obtunded, it may be reasonable to place the patient on 100% oxygen and monitor for improvement, as CO levels should be normalized within less than 90 minutes. A third reason for intubation of a serious burn before transfer is the size of the burn. If the patient has a large burn (>40% TBSA), it can be expected that the patient will become very edematous over the next few hours and will become relatively ill within 6 hours. It is also reasonable to assume that this patient will require relatively large doses of parenteral narcotics and benzodiazepines for pain control and sedation. It is prudent to intubate before transfer in this circumstance.

American Burn Association Consensus Formula	
•	2-4 ml/kg/% TBSA Burn (using LR) In The 1st 24hr
-	Give ½ In The First 8 Hrs Post Burn
-	Give ½ In The Next 16 Hrs Post Burn
•	Adults: 2 ml/kg/% TBSA
•	Children: 3 ml/kg/% TBSA
•	Electrical: 4 ml/kg/% TBSA
In Adults:	
•	Adjust Fluid Rate For Goal Uo 0.5 kg/hr
In Children (< 14 y/o):	
•	Adjust Fluid Rate For Goal Uo 1 cc/kg/hr
•	If Child Is < 30kg Add Maintenance Fluids That Include Dextrose (D5LR or D5½NS) In Addition To The Consensus Formula

Figure 3. The American Burn Association Consensus Formula—this is an algorithm for the safe resuscitation of large burns in children and adults. It segregates burns based on predicted fluid needs in an attempt to avoid overzealous crystalloid resuscitation and by adjusting fluid rate in accordance with hourly urine output.

Evaluation for escharotomy is another important step in the management of a burn that should be accomplished before transfer to a burn center. The vast majority of burn patients will not require escharotomy before transfer to a regional burn center, especially if transfer is to occur within the first few hours after the burn has occurred. We would recommend that an escharotomy be accomplished before transfer only in the following circumstances. The first circumstance in which an escharotomy may be reasonable would be the patient with a full thickness circumferential extremity burn and who develops a tight extremity because of evolving edema before transfer. In this circumstance, we feel that consultation with the accepting burn surgeon about the merits of an escharotomy is warranted before transfer. If the transfer is not imminent or the travel time to the accepting burn center prolonged, and the accepting burn surgeon has reviewed the case and agrees that escharotomy should be accomplished, it would seem reasonable to accomplish escharotomy before transfer to avoid the possibility of a compromised extremity. As the skin of the effected extremity is dead and the patient will undergo formal tangential debridement and skin grafting in the near future, there is little downside to the procedure.²⁵ Much as in the case of a significant circumferential extremity wound, after discussion with the accepting burn surgeon, escharotomy is warranted before transfer in the case of the patient with full thickness thoracoabdominal burns and restricted respiratory excursion.

CONCLUSIONS

Care of the patient with a large burn is multifaceted and requires burn center expertise for optimal resuscitation, intensive care unit management, wound care and skin grafting, nutritional support, psychological counseling, physical and occupational therapy, rehabilitation, and eventual reconstruction as needed. The American Burn Association has done an excellent job of establishing, verifying, and maintaining regional burn centers across North America. Within the population of patients that receive burn injuries, there is a subset that receives only minor burn injury. Currently, these patients are often triaged to burn centers far from their homes and families at great expense for evaluation and care. This algorithm was designed to create collaborative care with local trauma centers and regional burn centers using telephonic and video based consultation to triage those with minor burns, who do not need immediate burn center referral, to appropriate care rendered by acute care surgeons, with burn center input and follow-up for subsequent care. This algorithm, if adopted, would allow for safe, effective, patient-centered care without unnecessary and costly transfer to regional burn centers when this care is not immediately required.

AUTHORSHIP

G.A.V., H.B.A., M.J.M., K.B., E.E.M., C.V.B., and K.I. designed this algorithm. G.A.V., H.B.A., and M.J.M. searched the literature. All authors participated in article preparation and editing.

DISCLOSURE

The authors declare no conflicts of interest.

REFERENCES

1. Burn Incidence and Treatment in the U.S.: 2012 Fact Sheet (American Burn Association Web Site). Available at: <http://ameriburn.org/who-we-are/media/burn-incidence-fact-sheet/Internet>. Accessed February 6, 2018.

2. Al-Mousawi AM, Jeschke MG, Herndon DN. Invited commentary on "The demographics of modern burn care: should most burns be cared for by non-burn surgeons?". *Am J Surg*. 2011;201(1):97-99.
3. Vercruyse GA, Ingram WL, Feliciano DV. The demographics of modern burn care: should most burns be cared for by non-burn surgeons? *Am J Surg*. 2011;201(1):91-96.
4. Vercruyse GA, Ingram WL. Overutilization of regional burn centers for pediatric patients—a healthcare system problem that should be corrected. *Am J Surg*. 2011;202(6):802-808; discussion 808-9.
5. Vercruyse GA, Ingram WL, Feliciano DV. A rationale for significant cost savings in patients suffering home oxygen burns: despite many comorbid conditions, only modest care is necessary. *J Burn Care Res*. 2012; 33:e268-e274.
6. Lavrentyev V, Seay A, Rafiq A, Justis D, Merrell RC. A surgical telemedicine clinic in a correctional setting. *Telemed J E Health*. 2008;14(4):385-8.
7. Eadie LH, Seifalian AM, Davidson BR. Telemedicine in surgery. *Br J Surg*. 2003;90:647-658.
8. Groves RH Jr, Holcomb BW Jr, Smith ML. Intensive care telemedicine: evaluating a model for proactive remote monitoring and intervention in the critical care setting. *Stud Health Technol Inform*. 2008;131:131-146.
9. Breslow MJ, Rosenfeld BA, Doerfler M, Burke G, Yates G, Stone DJ, Tomaszewicz P, Hochman R, Plocher DW. Effect of a multiple-site intensive care unit telemedicine program on clinical and economic outcomes: an alternative paradigm for intensivist staffing. *Crit Care Med*. 2004;32(1):31-38.
10. Joseph B, Hadeed G, Sadoun M, Rhee PM, Weinstein RS. Video consultation for trauma and emergency surgical patients. *Crit Care Nurs Q*. 2012; 35(4):341-345.
11. Zangbar B, Pandit V, Rhee P, Aziz H, Hashmi A, Friese RS, Weinstein R, Joseph B. Smartphone surgery: how technology can transform practice. *Telemed J E Health*. 2014;20(6):590-592.
12. Jones SM, Milroy C, Pickford MA. Telemedicine in acute plastic surgical trauma and burns. *Ann R Coll Surg Engl*. 2004;86:239-242.
13. Challacombe B, Kavoussi L, Patriciu A, Stoianovici D, Dasgupta P. Technology insight: telementoring and telesurgery in urology. *Nat Clin Pract Urol*. 2006;3(11):611-617.
14. Saffle JR, Edelman L, Theurer L, Morris SE, Cochran A. Telemedicine evaluation of acute burns is accurate and cost-effective. *J Trauma*. 2009;67:358-365.
15. Pruitt BA Jr. Reflection: evolution of the field over seven decades. *Surg Clin North Am*. 2014;94(4):721-740.
16. Vercruyse GA, Ingram WL: Chapter 12. A surgeon's thought process in the management of burn patients. In: *Surgical Decisions, The Art and the Science*. 1st ed. Latifi R, Rhee PR, Gruessner RW. New York, NY: Springer Publishing; 2016.
17. Gibran NS, Wiechman S, Meyer W, et al. Summary of the 2012 ABA Burn Quality Consensus conference. *J Burn Care Res*. 2013;34(4):361-385.
18. Pham TN, Cancio LC, Gibran NS. American Burn Association practice guidelines: burn shock resuscitation. *J Burn Care Res*. 2008;29(1):257-266.
19. Pruitt BA Jr. Protection from excessive resuscitation: "pushing the pendulum back". *J Trauma*. 2000;49(3):567-568.
20. Saffle JR. The phenomenon of "fluid creep" in acute burn resuscitation. *J Burn Care Res*. 2007;28(3):382-395.
21. Balogh Z, McKinley BA, Cocanour CS, Kozar RA, Valdivia A, Sailors RM, Moore FA. Supranormal trauma resuscitation causes more cases of abdominal compartment syndrome. *Arch Surg*. 2003;138(6):637-642; discussion: 642-3.
22. Lawrence A, Faraklas I, Watkins H, Allen A, Cochran A, Morris S, Saffle J. Colloid administration normalizes resuscitation ratio and ameliorates "fluid creep". *J Burn Care Res*. 2010;31(1):40-47.
23. De Wing MD, Curry T, Stephenson E, Palmieri T, Greenhalgh DG. Cost-effective use of helicopters for the transportation of patients with burn injuries. *J Burn Care Rehabil*. 2000;21:535-540.
24. Herndon DN, Barrow RE, Linares HA, Rutan RL, Prien T, Traber LD, Traber DL. Inhalation injury in burned patients: effects and treatment. *Burns Incl Therm Inj*. 1988;14(5):349-356.
25. de Barros MEPM, Coltro PS, Hetem CMC, Vilalva KH, Farina JA Jr. Revisiting escharotomy in patients with burns in extremities. *J Burn Care Res*. 2017;38(4):e691-e698.