



# TRACIE

HEALTHCARE EMERGENCY PREPAREDNESS  
INFORMATION GATEWAY

Burns  
Topic Collection  
7/26/2016

## Topic Collection: Burns

Many types of critical incidents (in addition to house and other structure fires) can lead to burn injuries, and not every healthcare facility is able to provide adequate care to burn patients. The resources in this Topic Collection will help healthcare facility staff plan for burn casualties as a result of structural fires, blast emergencies, or chemical burns caused by terrorist attacks or hazardous materials incidents. Select articles provide a review of emergency burn care (including care of patients that may have to remain at non-burn centers while awaiting transfer), but this collection is not a comprehensive review of burn care.

Each resource in this Topic Collection is placed into one or more of the following categories (click on the category name to be taken directly to that set of resources). Resources marked with an asterisk (\*) appear in more than one category.

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### Must Reads

ABA Board of Trustees and the Committee on Organization and Delivery of Burn Care. (2005). [Disaster Management and the ABA Plan](#). (First page only.) *Journal of Burn Care and Research*. 26(2).

This article provides an in-depth overview of the plan developed by the Committee on Organization and Delivery of Burn Care and the Board of Trustees to manage mass burn casualties. It includes key background facts about burn injuries and burn centers, definitions and policy statements, tiered response plan language, and other pertinent information.

American Burn Association. (n.d.). [Advanced Burn Life Support Now](#). (Accessed 7/3/2015.)

This online training course (fee required) prepares clinicians to assess burn injuries and make treatment decisions for the first 24 hours following a disaster. This does not provide full ABLS certification which requires attendance at hands-on training offered by burn centers.

ASPR TRACIE. (2016). [Mass Burn Event Overview](#). U.S. Department of Health and Human Services, Office of the Assistant Secretary for Preparedness and Response.

This document provides guidance for healthcare coalitions, burn centers, state public health preparedness professionals, healthcare entities, and other stakeholders planning for a burn mass casualty incident.

Dacey, M. (2003.) [Tragedy and Response—The Rhode Island Nightclub Fire. New England Journal of Medicine.](#) (First 100 words only.) 349:1990-1992.

This article provides a graphic account with excellent learning points from the vantage of an emergency department physician caring for multiple victims in the aftermath of the Station Nightclub fire in Rhode Island.

Endorf, F.W., and Dries, D.J. (2011). [Burn Resuscitation.](#) Scandinavian Journal of Trauma, Resuscitation, and Emergency Medicine. 11;19:69.

The authors discuss how under resuscitation has become rare with the use of weight- and injury-based formulas, and that over resuscitation is now a concern to prevent organ death and poor outcomes in adult and pediatric patients. They provide practice-based recommendations that use the 2008 American Burn Association consensus statement as a starting point, with noted modifications based on their clinical experience.

Herndon, D. et al. (2012). Total Burn Care. (E-book only for 4th edition. Print version of 3rd edition may also be purchased.)

This book provides a comprehensive discussion on the management of burn patients from initial presentation to rehabilitation, with an emphasis on an integrated team approach to meet the clinical, social, and physical needs of burn patients.

Horner, C.W., Crighton, E., and Dziewulski, P. (2012). [30 Years of Burn Disasters within the UK: Guidance for UK Emergency Preparedness.](#) (Abstract only.) Burns. 38(4):578-84.

This articles reviews 37 disasters from 1980-2009 that occurred in the UK; only 3 disasters included had more than 5 patients with greater than 10% body surface burned. Findings may be used for surge staff and bed planning and pre-hospital care, as well as to inform exercise planning.

Jeschke, M.G., et al. (2012). Handbook of Burns Volume 1: Acute Burn Care. (Book available for purchase.)

This book discusses the initial presentation of a burn patient, and describes in detail all aspects of acute burn care.

Kraft, R., Herndon, D.N., Al-Mousawi, A.M., et al. (2012). [Burn Size and Survival Probability in Pediatric Patients in Modern Burn Care: A Prospective Observational Cohort Study.](#) Lancet. 379(9820):1013-21.

This article describes a single center, observational cohort study of 952 pediatric burn patients with burns covering at least 30% of their bodies to identify burn size(s) associated with morbidity and mortality. The authors recommend that pediatric patients with burns over more than 60% of their bodies should be transferred immediately to a burn center for care.

Rowan, M., Cancio, L., Elster, E., et al. (2015). [Burn Wound Healing and Treatment: Review and Advancements](#). Critical Care. 19(1): 243.

This review article discusses advances in the care of burn patients. It focuses on burn wound pathophysiology and treatment, and discusses inflammation; infection; nutrition; resuscitation; wound coverage and grafting; and keratinocytes and stem cells in the role of wound healing.

University of Michigan Burn Coordinating Center. (2012). [Emergency Burn Triage and Management](#).

This website offers a breadth of burn care information as well as free just-in-time training modules for hospital staff on the management of burn patients.

U.S. Army Medical Department, Medical Research and Materiel Command, U.S. Army Institute of Surgical Research. (2013) [Burn Care](#).

This Clinical Practice Guideline created by the US Army provides detailed guidelines for the assessment and care of burn patients both in treatment facilities, and in the field, including information and issues regarding casualties that cannot be referred to a specialty center.

## **Burn Care Considerations and Research**

Avni, T., Levcovich, A., Ad-El, D.D., et al. (2010). [Prophylactic Antibiotics for Burns Patients: Systematic Review and Meta-Analysis](#). British Medical Journal. 340:c241.

The authors performed a review and meta-analysis of studies that looked at the use of systemic antibiotics in burn patients. They found a benefit to prophylactic antibiotics in all-cause mortality at 100 days, but note the poor quality of the research to that point in time, so only recommend perioperative use of antibiotics.

Azzopardi, E.A., Azzopardi, E., Camilleri, L., et al. (2014). [Gram Negative Wound Infection in Hospitalised Adult Burn Patients--Systematic Review and Metanalysis](#). PLoS One. 21;9(4):e95042.

The authors found that Gram-negative infections are the most common in burn wounds, and that bacterial species do not differ across institutions, as has been assumed in the past.

Conversano, C., Lensi, .E, Testi, C., Gremigni, P. (2010). [The Burn Patient: Factors Associated with Post-Traumatic Stress Disorder and Directions for Intervention](#). (Abstract only.) *Rivista di Psichiatria*. 45(4):221-33.

The authors performed a review of studies on post-traumatic stress disorder (PTSD) in burn patients to identify variables that contributed to the development of PTSD in this population. They recommend assessing burn patients for psychological trauma as part of their overall care.

Davydow, D.S., Katon, W.J., Zatzick, D.F. (2009). [Psychiatric Morbidity and Functional Impairments in Survivors of Burns, Traumatic Injuries, and ICU Stays for Other Critical Illnesses: A Review of the Literature](#). *International Review of Psychiatry*. 21(6):531-8.

The authors discuss the prevalence of post-traumatic stress disorder, depression, and functional impairments in patients suffering burns, severe trauma, and ICU stays for critical illnesses. They also discuss risk factors for these conditions; interventions to improve outcomes; and future research directions.

Endorf, F.W., and Dries, D.J. (2011). [Burn Resuscitation](#). *Scandinavian Journal of Trauma, Resuscitation, and Emergency Medicine*. 11:19:69.

The authors discuss how under resuscitation has become rare with the use of weight- and injury-based formulas, and that over resuscitation is now a concern to prevent organ death and poor outcomes in adult and pediatric patients. They provide practice-based recommendations that use the 2008 American Burn Association consensus statement as a starting point, with noted modifications based on their clinical experience.

García de Lorenzo y Mateos, A., Ortiz Leyba, C., Sánchez, S.M. (2011). [Guidelines for Specialized Nutritional and Metabolic Support in the Critically-ill Patient: Update. Consensus SEMICYUC-SENPE: Critically-ill Burnt Patient](#). *Metabolism and Nutrition Working Group of the Spanish Society of Intensive Care Medicine and Coronary units. Nutrición Hospitalaria*. Suppl 2:59-62.

The authors provide nutritional-metabolic support guidelines for critically-ill burn patients that take into account the hypermetabolism and hypercatabolism experienced by burn patients. They advocate for early initiation of feeding by the enteral route, with complementary support by the parenteral route, and note that anabolic drugs are also indicated.

Herndon, D. et al. (2012). *Total Burn Care*. (E-book only for 4th edition. Print version of 3rd edition may also be purchased.)

This book provides a comprehensive discussion on the management of burn patients from initial presentation to rehabilitation, with an emphasis on an integrated team approach to meet the clinical, social, and physical needs of burn patients.

Hettiaratchy, S. and Dziewulski, P. (2004.) [ABC of Burns: Introduction](#). BMJ. 328(7452):1366-8.

This is an introduction to a series of articles on burn care.

Hettiaratchy, S., and Papini, R. (2004.) [ABC of Burns: Initial Management of a Major Burn: I—Overview](#). BMJ. 328(7455):1555-7.

The authors review how to take a history; conduct primary and secondary surveys of the injury; how to dress the wound; and when to refer patients to a burn center. They emphasize that initial management is similar to that of any trauma patient, and that assessment of the airway and breathing takes precedence over the burn injury.

Hettiaratchy, S., and Papini, R. (2004.) [ABC of Burns: Initial Management of a Major Burn: II--Assessment and Resuscitation](#). BMJ. 329(7457):101-3.

The authors review assessment of the burn area; resuscitation regimens; how and when to perform escharotomies; and how to classify and estimate burn depth.

Hoffman H.G., Chambers G.T., Meyer W.J. 3rd, et al. (2011). [Virtual Reality as an Adjunctive Non-Pharmacologic Analgesic for Acute Burn Pain during Medical Procedures](#). Annals of Behavioral Medicine. 41(2):183-91.

This article reviews clinical and laboratory studies on the use of virtual reality for pain management in burn patients.

Jeng, J, Gibran, N, and Peck, M. (2014). [Burn Care in Disaster and other Austere Settings](#). Surgical Clinics of North America. 94(4):893-907.

This article appears in a special issue dedicated to burns and discusses considerations for managing burn patients in conditions with limited resources, such as using oral hydration for resuscitation. The authors maintain that all plans should include procedures for resuscitation, airway management, wound care, and pain management, and should be tested to their limits on a regular basis.

Jeschke, M.G. (2013). [Clinical Review: Glucose Control in Severely Burned Patients - Current Best Practice](#). Critical Care. 17(4):232.

This article reviews studies focused on glucose control in burn patients. The author concludes that a glucose level between 130-150 mg/dL improves morbidity and mortality without inducing hypoglycemic episodes.

Jeschke, M.G., et al. (2012). Handbook of Burns Volume 1: Acute Burn Care. (Book available for purchase.)

This book discusses the initial presentation of a burn patient, and describes in detail all aspects of acute burn care.

Jeschke, M.G., Finnerty, C.C., Shahrokhi, S., et al. (ABA Organization and Delivery of Burn Care Committee.) (2013). [Wound Coverage Technologies in Burn Care: Novel Techniques](#). Journal of Burn Care Research. 34(6):612-20.

The authors review investigational techniques showing promise in improving wound repair and call for additional research to create clinically applicable products. Included is a discussion of gene therapy and growth factors; spray-on skin; tissue engineering with stem cells; fibrin sealant for grafting; and facial transplantation.

Kamolz, L.P., Pieber, T., Smolle-Jüttner, F.M., and Lumenta, D.B. (2013). [Optimal Blood Glucose Control in Severely Burned Patients: A Long Way to Go, but One Step Closer](#). Critical Care. 17(5):1005.

This article discusses the need for techniques, such as the closed loop technique, for achieving insulin control in burn patients to counteract the dangers of hyperglycemia, yet not trigger hypoglycemic episodes, which can also increase mortality. The authors suggest maintaining a glucose level of between 90 to 140 mg/dl in burn patients.

Klein, M.B., Goverman, J., Hayden, D.L., et al. (2014). [Benchmarking Outcomes in the Critically Injured Burn Patient](#). Annals of Surgery. 259(5):833-41.

The authors followed 300 adults and 241 children from 6 burn centers with TBSA  $\geq$ 20% through hospitalization using a single, uniform protocol, and collected data to compare to existing benchmarks. The authors contend that the results form the basis for new outcome benchmarks.

Macedo, J.L., and Santos, J.B. (2007). [Predictive Factors of Mortality in Burn Patients](#). Revista do Instituto de Medicina Tropical de São Paulo.49(6):365-70.

The authors incorporated microbiological and laboratorial test results into their predictions of burn mortality, which had not generally been done with other models to this point in time. They found that advanced age; limited availability of donor sites; and presence of multi-drug resistant bacteria and fungi in wounds were the strongest predictors of mortality.

Mert Sevgi, M., Toklu, A., and Vecchio, D. (2013). [Topical Antimicrobials for Burn Infections – An Update](#). Recent Patents on Anti-Infective Drug Discovery. 8(3): 161–197.

This article provides an overview of the patented antimicrobials for burn infections and describes how they work, as well as their individual spectrums of activity.

Milner, S.M., Greenough, W.B. 3rd, Asuku, M.E., et al. (2011). [From Cholera to Burns: A Role for Oral Rehydration Therapy](#). Journal of Health, Population, and Nutrition. 29(6):648-51.

This article describes a very small study that demonstrated the utility of oral hydration to replace fluids normally provided by IV therapy. The authors advocate for additional studies to determine if protocols used for cholera need to be modified to provide oral resuscitation to burn patients, as may be needed during a mass casualty incident where resources may be limited.

Mitchell, K.B., Khalil, E., Brennan, A., et al. (2013). [New Management Strategy for Fluid Resuscitation: Quantifying Volume in the First 48 Hours after Burn Injury](#). Journal of Burn Care Research. 34(1):196-202.

The authors prospectively collected data on 40 patients with burns  $\geq 15\%$  from 2009-2011 to evaluate a 24-hour resuscitation protocol; establish a formula to quantify resuscitation volume for the second 24 hours (provided in the article); describe the relationship between the first and second 24 hours; and, identify which patients required high volumes. They found that intubation, higher age, and use of narcotics increased fluid needs and that there is a correlation between the first and second 24 hours.

Namdar, T., Stollwerck, P.L., Stang, F.H., et al. (2011). [Progressive Fluid Removal Can Avoid Electrolyte Disorders in Severely Burned Patients](#). German Medical Science.9:Doc13.

The authors retrospectively analyzed data on daily infusion-diuresis ratio from 40 patients with burns over 12-40% of their bodies; half with prolonged hypernatremia and half without. They concluded that the volume and rate by which fluid is removed following resuscitation and subsequent patient stabilization causes electrolyte disorders and that serum sodium levels may be used to determine fluid removal strategies.

Orban, C., and Tomescu, D. (2013). [The Importance of Early Diagnosis of Sepsis in Severe Burned Patients: Outcomes of 100 Patients](#). Chirurgia. 108(3):385-8.

The authors examined causes of sepsis in 100 burn patients and found that the most common causes were from multi-drug resistant Gram-positive (58%) and Gram-negative (26%) organisms; this confirmed earlier study findings. The article discusses effective antibiotics to combat these organisms, and highlights the variability in pharmacokinetics in burn patients, and the corresponding need for dose adjustments of these antibiotics.

\*Phua, Y., Miller, J., and Wong, S. (2010). [Total Care Requirements of Burn Patients: Implications for a Disaster Management Plan](#). (Abstract only.) Journal of Burn Care and Research. 31(6): 935-41.

The authors reviewed patient data from 2006-2009 to better understand their operative and ward-based needs. They found that they could use a formula based on burn surface area, mean depth, and burn type to predict total operating theater time, and that operative

time required was greatest during the first week (nursing and related health hours remained relatively constant).

Rex, S. (2012). [Burn Injuries](#). (Abstract only.) *Current Opinion in Critical Care*. 18(6):671-6.

The author provides a review of considerations for burn resuscitation; common causes of death in burn patients following initial shock; the management of sepsis; and burn care organization and cost.

\*Rodriguez, N.A., Jeschke, M.G., Williams, F.N., et al. (2011). [Nutrition in Burns: Galveston Contributions](#). *Journal of Parenteral and Enteral Nutrition*. 35(6):704-14.

The authors provide recommendations for aggressive nutritional support based on a review of available data and their own clinical experiences. They maintain that such support is required for proper wound care; attenuates hypermetabolism and catabolism; and improves outcomes.

Rojas, Y., Finnerty, C.C., Radhakrishnan, R.S., and Herndon, D.N. (2012). [Burns: An Update on Current Pharmacotherapy](#). *Expert Opinion on Pharmacotherapy*. 13(17):2485-94.

The authors review available therapies for treating post-burn sequelae triggered by hypermetabolic response.

Rosanova, M.T., Stambouljian, D., and Lede, R. (2012). [Systematic Review: Which Topical Agent is More Efficacious in the Prevention of Infections in Burn Patients?](#) *Archivos Argentinos de Pediatría*. 110(4):298-303.

The authors reviewed 11 studies that met their research criteria and determined that there are no differences in efficacy of topical antimicrobials for preventing infections in burns.

Rowan, M., Cancio, L., Elster, E., et al. (2015). [Burn Wound Healing and Treatment: Review and Advancements](#). *Critical Care*. 19(1): 243.

This review article discusses advances in the care of burn patients. It focuses on burn wound pathophysiology and treatment, and discusses inflammation; infection; nutrition; resuscitation; wound coverage and grafting; and keratinocytes and stem cells in the role of wound healing.

Shahrokhi, S., Arno, A., Jeschke, M.G. (2014). [The Use of Dermal Substitutes in Burn Surgery: Acute Phase](#). *Wound Repair and Regeneration*. 22(1):14-22.

This article discusses dermal substitutes and their use as scaffolds that promote tissue regeneration and wound healing. Currently available products are reviewed in detail.

Summer, G.J., Puntillo, K.A., Miaskowski, C., et al. (2007). [Burn Injury Pain: The Continuing Challenge](#). The Journal of Pain. 8(7):533-48.

This article discusses the different types of pain associated with the different phases of burn recovery, and how opioids, the most frequently utilized medications for pain, are often incorrectly dosed due to the shifting nature of burn pain. The authors also summarize pain management strategies and medications used in the various stages of burn care.

\*U.S. Army Medical Department, Medical Research and Materiel Command, U.S. Army Institute of Surgical Research. (2013) [Burn Care](#).

This Clinical Practice Guideline created by the US Army provides detailed guidelines for the assessment and care of burn patients both in treatment facilities, and in the field, including information and issues regarding casualties that cannot be referred to a specialty center.

U.S. Army Medical Department Center and School Health Readiness Center of Excellence. (2014.) [Emergency War Surgery: Burns](#).

This online book chapter provides an overview of the initial management of burns, including escharotomy.

\*U.S. Department of Health and Human Services, Radiation Emergency Medical Management. (2014). [Burn Triage and Treatment: Thermal Injuries](#).

This website provides information on caring for patients with thermal injuries resulting from a radiation event/nuclear detonation, including treatment of burns under mass casualty conditions. It also provides information on national burn bed capacity, and includes algorithms and tools, such as a dose estimator and “scarce resources triage tool.”

Various authors. (2014). [Cochrane and Evidence Aid: Resources for Burns](#). Cochrane Library.

This special collection from the Cochrane Library contains systematic, evidence-based reviews in the areas of topical care for burns; systemic care for burns; nutrition and supplementation for people with burns; and treatment of scars.

Various Authors. (2014). [Management of Burns](#). Surgical Clinics of North America. 94(4).

This issue of the journal focuses on burn care and includes articles on initial assessment and resuscitation; management of burns; acute care of burns; special problems in burns; and dermal substitutes in burns.

\*Williams, F.N., Branski, L.K., Jeschke, M.G., and Herndon, D.N. (2011). [What, How, and How Much Should Patients with Burns be Fed?](#) Surgical Clinics of North America. 91(3):609-29.

This review focuses on nutritional support to decrease post-burn hyper-metabolism and insulin resistance. The authors recommend enteral delivery of high-protein, high carbohydrate feedings and drugs to promote anabolism, in addition to thermoregulation and early excision and grafting of wounds.

Xiao, S.C., Zhu, S.H., Xia, Z.F., et al. (2008). [Prevention and Treatment of Gastrointestinal Dysfunction Following Severe Burns: A Summary of Recent 30-Year Clinical Experience](#). World Journal of Gastroenterology. 14(20):3231-5.

The authors reviewed data on gastrointestinal (GI) dysfunction in 219 burn patients from 1980-2007 categorized in 1 of 3 cohorts based on treatment protocols at the time. In looking at how protocols changed over time, they found that mortality and GI dysfunction were decreased by fluid resuscitation; early excision of necrotic tissue; staged food ingestion; and administration of specific nutrients.

\*Yale New Haven Health System Center for Emergency Preparedness and Disaster Response. (2013). [Trauma/Burn Clinical Guidelines](#).

This guide serves as a quick reference for trauma/burn emergencies. Steps based on the word "DISASTER" can help staff quickly assess and respond to an incident (Detection, ICS, Safety/Security, Assessment, Support, Triage and Treatment, Evacuate, Recovery).

## Education and Training

American Burn Association. (n.d.). [Advanced Burn Life Support Now](#). (Accessed 7/3/2015.)

This online training course (fee required) prepares clinicians to assess burn injuries and make treatment decisions for the first 24 hours following a disaster. This does not provide full ABLS certification which requires attendance at hands-on training offered by burn centers.

Cross, J., Kazzi, Z., Lee, C. (2010). [Burn Evaluation and Care for Emergency Responders](#). South Central Preparedness and Emergency Response Learning Center.

This course focuses on initial evaluation, triage, and management of burn injuries. It is targeted to first responders and first receivers (e.g., paramedics, emergency room nurses and physicians).

Cross, J. and Kazzi, Z. (2009). [Responding to Victims with Burn Injuries in Disaster Events](#). Alabama Department of Public Health Learning Management System.

This 90-minute webcast provides participants with information to enhance their expertise in burn care.

\*Helminiak, C., Lord, G., Barillo, D., et al. (2012). [Proceedings of the National Burn Surge Strategy Meeting, Atlanta, Georgia, March, 2012](#). (First page only.) Journal of Burn Care Research. 35(1):e54-65.

This article describes the National Burn Surge Framework, which was initiated by meeting participants.

\*Kearns, R.D., Myers, B., Cairns, C.B., et al. (2014). [Hospital Bioterrorism Planning and Burn Surge](#). Biosecurity and Bioterrorism. 12(1):20-8.

This article discusses how using an all-hazards approach to bioterrorism response planning helped to prepare hospitals in the Raleigh/Durham, NC area to care for casualties from a plant explosion in June 2009. The rescue, response, and resuscitation of survivors by first responders and first receivers, as well as efforts to develop burn surge, are described.

\*Los Angeles County Emergency Medical Services Agency (EMS). (2010). [Burn Resource Manual](#).

Based on the plan developed for Los Angeles County hospitals, this manual may serve as a model for other locales when developing burn bed surge plans; an accompanying training curriculum also provides clinicians with information on triage, and early care and management of burn injuries. Guidelines and recommendations included are drawn from the American Burn Association Practice Guidelines for Burn Care.

University of Michigan Burn Coordinating Center. (2012). [Emergency Burn Triage and Management](#).

This website offers a breadth of burn care information as well as free just-in-time training modules for hospital staff on the management of burn patients.

### **Event-Specific Lessons Learned**

Cairns, B.A., Stiffler, A., Price, F. et al. (2005.) [Managing a Combined Burn Trauma Disaster in the Post-9/11 World: Lessons Learned From the 2003 West Pharmaceutical Plant Explosion](#). The Journal of Burn Care and Research. 26(2):144-50. (Abstract only.)

The authors share lessons learned from a January 2003 chemical plant fire and describe the challenges associated with managing patients with combined burn and trauma injuries. Recommendations for future disaster responses are included.

\*Chan, C., Green, L., Lu, Y., et al. (2012). [Prioritizing Burn-Injured Patients during a Disaster](#). Manufacturing and Service Operations Management. 15(2).

The authors examine data from previous burn catastrophes and develop a new system for prioritizing patients for transfer to burn beds as they become available.

Chim, H, Yew, W.S., and Song, C. (2007). [Managing Burn Victims of Suicide Bombing Attacks: Outcomes, Lessons Learnt, and Changes Made from Three Attacks in Indonesia](#). *Critical Care*.11(1):R15.

The authors reviewed medical charts of victims of three separate terrorist bombings to identify lessons learned and develop a burn disaster response plan for future events. Considerations for simultaneous blast injuries in the management of bombing casualties are included.

Dacey, M. (2003.) [Tragedy and Response—The Rhode Island Nightclub Fire](#). *New England Journal of Medicine*. (First 100 words only.) 349:1990-1992.

This article provides a graphic account with excellent learning points from the vantage of an emergency department physician caring for multiple victims in the aftermath of the Station Nightclub fire in Rhode Island.

Fadeyibi, I.O., Omosebi, D.T., Jewo, P.I., Ademiluyi, S.A. (2009). [Mass Burns Disaster in Abule-egba, Lagos, Nigeria from a Petroleum Pipeline Explosion Fire](#). *Annals of Burns and Fire Disasters*. 30;22(2):97-103.

The authors describe their experience following the 2006 oil pipeline explosion in Nigeria in a facility with limited resources. They discuss the triage system used, and advocate for the transfer of what they call “salvageable” patients to a burn center.

Horner, C.W., Crighton, E., and Dziewulski, P. (2012). [30 Years of Burn Disasters within the UK: Guidance for UK Emergency Preparedness](#). (Abstract only.) *Burns*. 38(4):578-84.

This articles reviews 37 disasters from 1980-2009 that occurred in the UK; only 3 disasters included had more than 5 patients with greater than 10% body surface burned. Findings may be used for surge staff and bed planning and pre-hospital care, as well as to inform exercise planning.

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This article discusses how using an all-hazards approach to bioterrorism response planning helped to prepare hospitals in the Raleigh/Durham, NC area to care for casualties from a plant explosion in June 2009. The rescue, response, and resuscitation of survivors by first responders and first receivers, as well as efforts to develop burn surge, are described.

Kennedy, P.J., Haertsch, P.A., and Maitz, P.K. (2005). [The Bali Burn Disaster: Implications and Lessons Learned](#). *Journal of Burn Care Rehabilitation*. 26(2):125-31.

This article details the experience of an Australian hospital managing 12 patients from the Bali bomb blast in 2002 that were received 54-69 hours after receiving initial care in Indonesia. Burns ranged from 15% to 85% of each patient's body and were generally full-thickness burns; all patients survived.

Kumar, P. (2013). [Fire Disaster Following LPG Tanker Explosion at Chala in Kannur \(Kerala, India\): August 27, 2012.](#) Burns. 39(7):1479-87.

This article describes a tanker fire in India in 2012 and the resulting casualties observed. Injuries sustained, including burn patterns observed, are discussed.

Little, M., Cooper, J., Gope, M., et al. (2012). ['Lessons Learned': A Comparative Case Study Analysis of an Emergency Department Response to Two Burns Disasters.](#) Emergency Medicine Australasia. 24(4):420-9.

This comparative case study examined how lessons learned in the management of patients from the 2002 Bali bombing translated into improved outcomes in the management of patients from a 2009 boat explosion in a single hospital.

O'Neill, T.B., Rawlins, J., Rea, S., and Wood, F. (2012). [Complex Chemical Burns Following a Mass Casualty Chemical Plant Incident: How Optimal Planning and Organisation Can Make a Difference.](#) Burns. 38(5):713-8.

The authors reviewed patient case notes and surgery logs to identify lessons learned in the management of four severely burned patients injured in a sulphuric acid pipeline rupture.

Seifman, M., Ek, E.W., Menezes, H., et al. (2011). [Bushfire Disaster Burn Casualty Management: The Australian "Black Saturday" Bushfire Experience.](#) (Abstract only.) Annals of Plastic Surgery. 67(5):460-3.

This article describes the Australian Mass Casualty Burn Disaster Plan (AUSBURNPLAN) and details the experience of managing burn casualties from the country's largest natural disaster.

Sheridan, R., Schulz, J., Ryan, C. and McGinnis, P. (2004.) [Case 6-2004—A 35-Year-Old Woman with Extensive, Deep Burns from a Nightclub Fire.](#) (First page only.) New England Journal of Medicine. 350:810-821.

The authors provide this case report of a burn patient from the Rhode Island nightclub fire as an overview of the challenges and complications faced in caring for patients with extensive, deep burns.

Various authors. [Journal of Burn Care and Research.](#) Volume 26(2). (Entire issue dedicated to post-disaster burn care. Subscription or purchase of individual articles necessary.)

This issue of the journal focuses on post-disaster burn care and includes articles on 9/11, the Station Nightclub (RI) fire, burns sustained in combat, and burn disasters and mass casualty incidents.

Weissman, O., Israeli, H., Rosengard, H., et al. (2013). [Examining Disaster Planning Models for Large Scale Burn Incidents--A Theoretical Plane Crash into a High Rise Building](#). *Burns*. 39(8):1571-6.

This article uses outcome data from the El-Al cargo Aircraft crash near the Amsterdam Schiphol Airport in 1992; the World Trade Center attacks in New York; and the attack against the Pentagon in Washington, DC on 9/11/01 to develop recommendations for burn mass casualty incidents.

### **Pediatric Considerations**

Branski, L.K., Norbury, W.B., Herndon, D.N., et al. (2010). [Measurement of Body Composition in Burned Children: Is there a Gold Standard?](#) *Journal of Parenteral and Enteral Nutrition*. 34(1):55-63.

This prospective study of 279 pediatric patients with burns covering 40% of total body surface area compared 2 measurement methods for body composition: whole body potassium counting (K count); and dual x-ray absorptiometry (DEXA). The authors concluded that DEXA scans be used (with a correction factor, as needed) because they are less stressful for the patient, in addition to being more affordable than K counts.

Finnerty, C., Ali, A., McClean, J., et al. (2014). [Impact of Stress-Induced Diabetes on Outcomes in Severely Burned Children](#). *Journal of the American College of Surgeons*. 218(4): 783–795.

This article describes a randomized study of pediatric patients with burns covering  $\geq 30\%$  of their body who either received insulin on a sliding scale, or did not receive insulin at all. Results were mixed; notably there were no deaths in the group that did not receive insulin, but there were deaths in the group that did receive insulin.

Hoffman, H.G., Meyer, W.J. 3rd, Ramirez, M., et al. (2014). [Feasibility of Articulated Arm Mounted Oculus Rift Virtual Reality Goggles for Adjunctive Pain Control during Occupational Therapy in Pediatric Burn Patients](#). *Cyberpsychology, Behavior, and Social Networking*. 17(6):397-401.

This article describes a case study that demonstrates the successful use of Oculus Rift Virtual Reality goggles to decrease pain intensity and unpleasantness of a pediatric patient during daily occupational therapy involving skin stretching exercises. The availability of this new technology that is priced at approximately 1/1000<sup>th</sup> of existing equipment most commonly used could significantly expand the use of virtual reality for pain management.

Jeschke, M.G., Kulp, G.A., Kraft, R., et al. (2010). [Intensive Insulin Therapy in Severely Burned Pediatric Patients: A Prospective Randomized Trial](#). American Journal of Respiratory and Critical Care Medicine. 182(3):351-9.

This prospective randomized study of 239 severely burned pediatric patients with burns over greater than 30% of their bodies showed that intensive insulin therapy decreased mortality in the treatment group vs. the control group. Insulin was shown to improve organ function, and to decrease catabolism, insulin resistance, sepsis, and infection.

Jeschke, M.G., Gauglitz, G.G., Kulp, G.A., et al. (2012). [Long-Term Persistence of the Pathophysiologic Response to Severe Burn Injury](#). PLoS One.6(7):e21245.

This cohort study was conducted from 1998-2008, and enrolled 997 pediatric burn patients and a matched control group to measure hypermetabolic and inflammatory changes for 36 months post-burn. The authors found that alterations persisted for far longer than originally thought, and that severely burned pediatric patients require treatment for a longer period of time.

Kraft, R., Herndon, D.N., Al-Mousawi, A.M., et al. (2012). [Burn Size and Survival Probability in Pediatric Patients in Modern Burn Care: A Prospective Observational Cohort Study](#). Lancet. 379(9820):1013-21.

This article describes a single center, observational cohort study of 952 pediatric burn patients with burns covering at least 30% of their bodies to identify burn size(s) associated with morbidity and mortality. The authors recommend that pediatric patients with burns over more than 60% of their bodies should be transferred immediately to a burn center for care.

Kraft, R., Herndon, D.N., Branski, L.K., et al. [Optimized Fluid Management Improves Outcomes of Pediatric Burn Patients](#). Journal of Surgical Research. 181(1):121-8.

The authors compared results of fluid resuscitation using a transcardiopulmonary thermodilution monitoring device (PiCCO) vs. fluid resuscitation using body weight, burn size, and urinary output in pediatric patients with burns over greater than 30% of their bodies. There were 76 patients in each group. Patients were followed for 20 days post-burn and there was less incidence of cardiac and renal failure in the PiCCO group.

Kraft, R., Herndon, D.N., Finnerty, C.C., et al. (2014). [Occurrence of Multiorgan Dysfunction in Pediatric Burn Patients: Incidence and Clinical Outcome](#). Annals of Surgery. 259(2):381-7.

This prospective study of 821 pediatric burn patients with burns over greater than 30% of their bodies at a single burn center categorized patients as having single- organ failure, multi-organ failure, and no organ failure, and related impact on clinical outcomes. The authors found that patients with liver and renal failure had the worst outcomes, while

those with cardiac and pulmonary organ failures had good prognoses. Patients with three or more organ failures were generally fatal cases.

Landolt, M.A., Buehlmann, C., Maag, T., Schiestl, C. (2009). [Brief Report: Quality of Life is Impaired in Pediatric Burn Survivors with Posttraumatic Stress Disorder](#). *Journal of Pediatric Psychology*. 34(1):14-21.

The authors interviewed 43 pediatric burn patients at an average of 4.4 years post-burn and found that 8 of them had post-traumatic stress disorder (PTSD); PTSD was also negatively correlated with patients' health-related quality of life.

Lee, J.O., Gauglitz, G.G., Herndon, D.N., et al. (2011). [Association Between Dietary Fat Content and Outcomes in Pediatric Burn Patients](#). *Journal of Surgical Research*. 166(1):e83-90.

This retrospective analysis looked at 994 children with burns covering more than 40% of their total body surface area that were divided into two groups: patients receiving a low-fat/high-carbohydrate diet (n=518); and patients receiving milk (high-fat diet; n=426). Patients receiving the low fat/high carbohydrate diet had better outcomes.

Rivero, H.G., Lee, J.O., Herndon, D.N., et al. (2010). [The Role of Acute Pancreatitis in Pediatric Burn Patients](#). *Burns*. 37(1):82-5.

The authors looked at autopsy reports of 78 burned children for reported evidence of pancreatic inflammation, and fat/parenchymal necrosis. The incidence of pancreatitis was found to be low, but its negative effects on mortality were found to be high. The authors advocate for increased monitoring and management of pancreatitis in burned children.

\*Rodriguez, N.A., Jeschke, M.G., Williams, F.N., et al. (2011). [Nutrition in Burns: Galveston Contributions](#). *Journal of Parenteral and Enteral Nutrition*. 35(6):704-14.

The authors provide recommendations for aggressive nutritional support based on a review of available data and their own clinical experiences. They maintain that such support is required for proper wound care; attenuates hypermetabolism and catabolism; and improves outcomes.

Rosanova, M.T., Stambouljian, D., and Lede, R. (2014). [Risk Factors for Mortality in Burn Children](#). *Brazilian Journal of Infectious Disease*. (2):144-9.

The authors reviewed clinical data for 100 pediatric patients ranging from 31.5 months to 204 months old to determine risk factors for mortality; burn sizes and depths were variable among the study population. They identified age less than or equal to 4 years; Garces index score 4; colistin use in documented multiresistant infections; mechanical ventilation; and graft requirement as independent variables related with mortality.

Ryan, C.M., Antoon, A., Fagan, S.P., et al. (2011). [Considerations for Preparedness for a Pediatric Burn Disaster](#). *Journal of Burn Care Research*. 32(5):e165-6.

This “Letter to the Editor” outlines considerations that must be included in the development of pediatric burn plans, such as addressing mental health and family reunification needs; specialized equipment/size of equipment; and modifications of triage and care protocols to suit pediatric patients.

Tompkins, R.G. (2012). [Survival of Children with Burn Injuries](#). *Lancet*. 379(9820):983-4.

This article discusses improvements in survival from burn injuries and briefly summarizes key advances that have led to decreased mortality from burns for both children and adults.

\*Williams, F.N., Branski, L.K., Jeschke, M.G., and Herndon, D.N. (2011). [What, How, and How Much Should Patients with Burns be Fed?](#) *Surgical Clinics of North America*. 91(3):609-29.

This review focuses on nutritional support to decrease post-burn hypermetabolism and insulin resistance. The authors recommend enteral delivery of high-protein, high carbohydrate feedings and drugs to promote anabolism, in addition to thermoregulation and early excision and grafting of wounds.

Williams, F.N., Herndon, D.N., Hawkins, H.K., et al. (2009). [The Leading Causes of Death after Burn Injury in a Single Pediatric Burn Center](#). *Critical Care*. 13(6):R183.

The authors reviewed autopsy reports for 144 pediatric burn patients admitted to their burn center from 1989-2009. The leading cause of death over the 20-year period was sepsis (47% overall; 54% for 1999-2009), followed by respiratory failure (29%), anoxic brain injury (16%), and shock (8%). Multi-drug resistant bacteria are believed to account for the increase in sepsis over time.

## **Plans, Tools, and Templates**

ABA Board of Trustees and the Committee on Organization and Delivery of Burn Care. (2005). [Disaster Management and the ABA Plan](#). *Journal of Burn Care and Research*. 26(2).

This article provides an in-depth overview of the plan developed by the Committee on Organization and Delivery of Burn Care and the Board of Trustees to manage mass burn casualties. It includes key background facts about burn injuries and burn centers, definitions and policy statement, tiered response plan language, and other pertinent information.

Abir, M., Davis, M.M., Sankar, P., et al. (2013). [Design of a Model to Predict Surge Capacity Bottlenecks for Burn Mass Casualties at a Large Academic Medical Center.](#) Prehospital Disaster Medicine. 28(1):23-32.

The authors designed a model using data from the University Hospital of the University of Michigan Health System to predict time to bottlenecks and waiting time for a bed using ProModel software. They looked at how long it would take for bottlenecks to occur for beds, supplies, and staff. They found that bottlenecks were due to ventilators; topical epinephrine; staplers; foams; antimicrobial non-adherent dressing/Telfa; types A, B, or O blood; and nurse, respiratory therapist, and physician staffing did not induce bottlenecks in this particular model.

ASPR TRACIE. (2016). [Mass Burn Event Overview.](#) U.S. Department of Health and Human Services, Office of the Assistant Secretary for Preparedness and Response.

This document provides guidance for healthcare coalitions, burn centers, state public health preparedness professionals, healthcare entities, and other stakeholders planning for a burn mass casualty incident.

Atiyeh, B., Gunn, S.W., and Dibo, S. (2013). [Primary Triage of Mass Burn Casualties with Associated Severe Traumatic Injuries.](#) Annals of Burns and Fire Disasters. 26(1):48-52.

This article reviews existing pre-hospital triage systems to try to correctly categorize burn patients who simultaneously have trauma injuries. The authors contend that additional research is necessary to develop a standardized, evidence-based triage system for these patients.

\*Chan, C., Green, L., Lu, Y., et al. (2012). [Prioritizing Burn-Injured Patients during a Disaster.](#) Manufacturing and Service Operations Management. 15(2).

The authors examine data from previous burn catastrophes and develop a new system for prioritizing patients for transfer to burn beds as they become available.

Conlon, K.M., Ruhren, C., Johansen, S., et al. (2014). [Developing and Implementing a Plan for Large-Scale Burn Disaster Response in New Jersey.](#) (Abstract only.) Journal of Burn Care Research. 35(1):e14-20.

The authors discuss considerations for expanding burn surge capacity (both beds and staffing) and plan development with only one designated burn center in the state of New Jersey.

\*Helminiak, C., Lord, G., Barillo, D., et al. (2012). [Proceedings of the National Burn Surge Strategy Meeting, Atlanta, Georgia, March, 2012.](#) (First page only.) Journal of Burn Care Research. 35(1):e54-65.

This article describes the National Burn Surge Framework, which was initiated by meeting participants.

Joho, B.S., Lozano, D., Pagella, P., et al. (2014). [Burn Disaster-Management Planning: A Preparedness Tool Kit](#). *Journal of Burn Care Research*. 35(4):e205-16.

This article describes a four-module toolkit designed to help burn center emergency providers prepare for disasters. It covers equipment needs, regional burn center practice policies, the latest burn care techniques, and resources for conducting drills.

Kearns, R.D., Cairns, B.A., Hickerson, W.L., and Holmes, J.H. 4th. (2014). [ABA Southern Region Burn Disaster Plan: The Process of Creating and Experience with the ABA Southern Region Burn Disaster Plan](#). (Abstract only.) *Journal of Burn Care Research*. 35(1):e43-8.

This article discusses the creation of the ABA Southern Region Burn disaster plan developed in 2006 in response to a regional disaster and has been refined through exercises, modeling, and actual events. The authors emphasize the need to build relationships and collaborations in the pre-event setting to ensure the success of any emergency plan, and include information on elements that should be included all burn plans.

Kearns, R.D., Conlon, K.M., Valenta, A.L., et al. (2014). [Disaster Planning: The Basics of Creating a Burn Mass Casualty Disaster Plan for a Burn Center](#). (Abstract only.) *Journal of Burn Care Research*. 35(1):e1-e13.

This article discusses the place of burn centers within the overall local and state disaster response plans, and provides a framework and priorities for a burn surge plan, which are: coordination, communication, triage, plan activation (trigger point), surge, and regional capacity. The authors advocate for regular plan exercising and emphasize the need for coordination with governmental authorities and other burn centers in the area.

Kearns, R.D., Holmes, J.H. 4th, Alson, R.L., Cairns, B.A. (2014). [Disaster Planning: The Past, Present, and Future Concepts and Principles of Managing a Surge of Burn Injured Patients for those Involved in Hospital Facility Planning and Preparedness](#). (Abstract only.) *Journal of Burn Care Research*. 35(1):e33-42.

The authors reviewed published plans, academic works, findings from actual disasters, and reports on disaster modeling to develop surge plan recommendations and a checklist for non-burn center hospitals to use before they are able to transfer burn patients. They focus on staff, supplies, and space.

Kearns, R.D., Hubble, M.W., Holmes, J.H. 4th, and Cairns, B.A. (2014). [Disaster Planning: Transportation Resources and Considerations for Managing a Burn Disaster](#). (Abstract only.) *Journal of Burn Care Research*. 35(1):e21-32.

The authors review resources for transporting patients, ranging from public to private ambulances and military and governmental vehicles. The authors also emphasize the need for emergency medical planners to know availability, capability, and how to access all potential resources for transporting patients in a mass casualty incident.

Kearns, R.D., Hubble, M.W., Lord, G.C., et al. (2015). [Disaster Planning: Financing a Burn Disaster, Where Do You Turn and What Are Your Options When Your Hospital Has Been Impacted by a Burn Disaster in the United States?](#) (Abstract only.) Journal of Burn Care Research.

This article discusses the significant care costs for burn patients and provides guidance to hospitals for identifying sources to support care for a large number of burn casualties at their facility.

Leahy, N.E., Yurt, R.W., Lazar, E.J., et al. (2012). [Burn Disaster Response Planning in New York City: Updated Recommendations for Best Practices](#). Journal of Burn Care Research. 33(5):587-594.

This article describes the New York City Burn Response Plan. Highlights include recommendations for: a triage system that considers comorbidities; provider indemnification; staff resources; data flow; a centralized patient and resource tracking database; and educational modules for pre-hospital providers and non-burn specialist nurses and physicians.

\*Los Angeles County Emergency Medical Services Agency (EMS). (2010). [Burn Resource Manual](#).

Based on the plan developed for Los Angeles County hospitals, this manual may serve as a model for other locales when developing burn bed surge plans; an accompanying training curriculum also provides clinicians with information on triage, and early care and management of burn injuries. Guidelines and recommendations included are drawn from the American Burn Association Practice Guidelines for Burn Care.

Matherly, A., Wallace, B., Sperry, R., et al. (2013). [Utah Burn Disaster Crisis Standards of Care](#). University of Utah Health Care, Burn Center.

Emergency medical planners can tailor and use this plan for mass burn casualty disasters, particularly where local resources are overwhelmed and the possibility of transferring patients is relatively low. Medical professionals can also use this as a reference when they are not able to transfer, or are waiting to transfer, a burn patient. The guide includes flow sheets, guidelines, a decision table, and other helpful resources. Note that the website is titled crisis standards of care but most of the materials refer to normal burn care techniques.

Michigan Department of Community Health. (2014). [Michigan State Burn Plan](#).

This plan was developed to help local jurisdictions and healthcare coalitions plan for and provide coordinated healthcare services to a mass casualty burn incident.

North Carolina Burn Surge Program. (2012). [North Carolina Hospital Burn Surge Plan \(BSP\) Checklist](#).

This checklist developed by the North Carolina Burn Surge Program contains the elements the authors recommend be included in a burn surge plan.

\*Phua, Y., Miller, J., and Wong, S. (2010). [Total Care Requirements of Burn Patients: Implications for a Disaster Management Plan](#). (Abstract only.) *Journal of Burn Care and Research*. 31(6): 935-41.

The authors reviewed patient data from 2006-2009 to better understand their operative and ward-based needs. They found that they could use a formula based on burn surface area, mean depth, and burn type to predict total operating theater time, and that operative time required was greatest during the first week (nursing and related health hours remained relatively constant).

Taylor, S., Jeng, J., Saffle, J., et al. (2014). [Redefining the Outcomes to Resources Ratio for Burn Patient Triage in a Mass Casualty](#). *Journal of Burn Care and Research*. 35(1): 41–45.

The authors used data from the National Burn Repository to develop a burn resource disaster triage table. They found that burn care has changed in the past decade and that inhalation injury significantly changes triage in a burn disaster.

\*U.S. Army Medical Department, Medical Research and Materiel Command, U.S. Army Institute of Surgical Research (USAISR). (2013) [Burn Care](#).

This Clinical Practice Guideline created by the US Army provides detailed guidelines for the assessment and care of burn patients both in treatment facilities, and in the field, including information and issues regarding casualties that cannot be referred to a specialty center.

\*U.S. Department of Health and Human Services, Radiation Emergency Medical Management. (2014). [Burn Triage and Treatment: Thermal Injuries](#).

This website provides information on caring for patients with thermal injuries resulting from a radiation event/nuclear detonation, including treatment of burns under mass casualty conditions. It also provides information on national burn bed capacity, and includes algorithms and tools, such as a dose estimator and “scarce resources triage tool.”

\*Yale New Haven Health System Center for Emergency Preparedness and Disaster Response. (2013). [Trauma/Burn Clinical Guidelines](#).

This guide serves as a quick reference for trauma/burn emergencies. Steps based on the word "DISASTER" can help staff quickly assess and respond to an incident (Detection, ICS, Safety/Security, Assessment, Support, Triage and Treatment, Evacuate, Recovery).

## Agencies and Organizations

**Note:** The agencies and organizations listed in this section have a page, program, or specific research dedicated to this topic area.

[American Burn Association](#). (A listing of verified burn centers is available from this site.)

[Michigan State Burn Coordinating Center](#).

[University of Utah Burn Center](#).

[U.S. Department of Health & Human Services: Burn Triage and Treatment - Thermal Injuries](#).

*This ASPR TRACIE Topic Collection was comprehensively reviewed in July and August 2015 by the following subject matter experts (listed in alphabetical order): **Richard Besserman, M.D.**, MD, Operations Executive, Center for Emergency Management and Homeland Security, and Arizona State University; **John Hick, MD**, HHS ASPR and Hennepin County Medical Center; **Mark P. Jarrett, MD, MBA, MS**, Sr. Vice President & Chief Quality Officer, Associate Chief Medical Officer, North Shore-LIJ Health System, and Professor of Medicine, Hofstra – North Shore LIJ School of Medicine; and **James C. Jeng, MD, FACS**, Associate Professor of Surgery, Mount Sinai Medical System (New York, NY), Chairman, American Burn Association Ad Hoc Disaster Committee, and Chairman, International Society for Burn Injuries Committee on Disaster Preparedness.*