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HEALTHCARE EMERGENCY PREPAREDNESS INFORMATION GATEWAY

On-Scene Mass Casualty Triage and Trauma Care Topic Collection

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Topic Collection: On-Scene Mass Casualty Triage and Trauma Care

Performing triage and trauma care during a mass casualty incident (MCI) requires efficiency and coordination among multiple response entities. Efforts may need to be directed toward doing the greatest good for the greatest amount of people, which is counter to day-to-day trauma triage. Simple actions to control bleeding and manage breathing issues can, and do, save lives, and should be part of on-scene care, as appropriate.

The majority of emergency management services (EMS) MCI plans are very detailed, and often unlikely to be referenced by responding ambulance personnel. Simple job aids should be provided that can be easily referenced and limited to one page to allow crew members to rapidly review their roles and responsibilities. More detailed plans can be used to support training and policy.

Research indicates that the most effective triage is performed by experienced providers using their clinical skill. Tools and protocols such as START or SALT are valuable to personnel that do not routinely triage trauma patients, but trauma criteria applied on an everyday basis to categorize patients as critical should also be applied during mass casualty situations whenever relevant as this generates practice and familiarity.

On-scene triage and trauma care should only be conducted if it safe to do so. The safety of first responders and pre-hospital providers is always paramount, and when adequate transportation resources are available triage activities should not delay rapid transport to a trauma hospital. This Topic Collection can help hospital emergency planners, EMS personnel, and emergency medicine clinicians understand the basics of field triage and immediate stabilization of MCI victims. Lessons learned from recent incidents are included. For incident-specific information, access our Topic Collections on Burns, Explosives and Mass Shooting, and Radiological and Nuclear Events.

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.

Must Reads

American College of Emergency Physicians. (2013). Joint Committee to Create a National Policy to Enhance Survivability from Mass Casualty Shooting Events: The Hartford Consensus II.

The Hartford Consensus committee recommends strategies and tactics for ensuring seamless, integrated hemorrhage control interventions to improve survival of victims of active shooter and intentional mass casualty incidents. For those with suspected internal hemorrhage, the committee emphasizes the importance of rapid transportation and access to a trauma center, and prompt access to the operating room.

American College of Physicians. (2016). Bombings: Injury Patterns and Care.

This webpage contains resources to assist clinicians with treating victims of bombings and other explosive events. Included are fact sheets; training materials; and a link to a mobile application to assist in the response and clinical management of blast injuries.

Army Medical Department Center and School. (n.d.). Mass Casualty and Triage. (Accessed 8/3/2017).

This chapter in *Emergency War Surgery* discusses considerations, goals, and protocols for mass casualty triage, from the perspective of the Army.

Baker, M. (2007). Creating Order from Chaos: Part I: Triage, Initial Care, and Tactical Considerations in Mass Casualty and Disaster Response. AMSUS Military Medicine. 172(3): 232-236.

This article discusses considerations for mass casualty response, from on-scene triage and field care, to transfer to definitive medical care at a healthcare facility.

Biddinger, P., Baggish, A., Harrington, L., et al. (2014). Be Prepared — The Boston Marathon and Mass-Casualty Events. New England Journal of Medicine. 368:1958-1960.

The authors describe how planning and training for mass-casualty events helped the Boston medical community successfully respond to the marathon bombing. The authors highlight the presence of medical tents, the mobilization of communications and additional resources, and the activation of hospital emergency plans as helpful contributing factors.

Bulger, E., Snyder, D., Schoelles, K., et al. (2014). An Evidence-Based Prehospital Guideline for External Hemorrhage Control: American College of Surgeons Committee on Trauma. Prehospital Emergency Care. 18(2):163-173.

This guideline is a culmination of an extensive literature review on the use of tourniquets and hemostatic agents for managing life-threatening extremity and junctional hemorrhage. An expert panel examined the results of the literature review, then provided recommendations for emergency medical services care.

Cannon, W. and Heightman, A.J. (2015). A Scientific Look at START and Our Ability to Do It. Journal of Emergency Medical Services. May 4.

The authors analyzed START triage application in several MCIs to determine how efficient, effective and consistently it was performed. In the article they also discuss when it may be appropriate for Emergency Medical Services (EMS) personnel to use other parameters (such as resources available and hospital capabilities) to perform triage and patient distribution in an optimal manner.

*County of San Luis Obispo Health Authority, Public Health Department. (2017). MCI Plan-Key Points for First Responders.

This Emergency Medical Service (EMS) bulletin provides direction for the triage and transport of MCI victims. The protocol designates the START/JumpSTART algorithms for primary triage, and instructs EMS providers to use more detailed Trauma Triage Criteria during secondary triage on-scene.

*Critical Illness and Trauma Foundation. (2001). START Triage-Flowchart.

This resource provides a graphic of the START triage system. Detailed and simplified flowcharts are included.

Duckworth, R. (2017). How to Use SALT to Triage MCI Patients. EMS1.

The author discusses the implementation of SALT (Sort, Assess, Lifesaving interventions, Treatment and/or Transport) during a mass casualty incident, and the importance of utilizing the triage system to keep patients moving away from the hazard and toward a casualty collection point for further triage.

Federal Interagency Committee on Emergency Medical Services. (2014). National Implementation of the Model Uniform Core Criteria for Mass Casualty Incident Triage: A Report of the FICEMS.

The Model Uniform Core Criteria (MUCC) for Mass Casualty Triage is a science and consensus-based national guideline that recommends 24 core criteria for all mass casualty triage systems. These criteria were developed to support interoperability among multiple existing triage tools across the country.

Gutierrez de Ceballos, J., Turégano-Fuentes, F., Perez-Diaz, D., et al. (2005). 11 March 2004: The Terrorist Bomb Explosions in Madrid, Spain– An Analysis of the Logistics, Injuries Sustained and Clinical Management of Casualties Treated at the Closest Hospital. Critical Care. 9(1):104-111.

In 2004, 10 bombs exploded in four commuter trains in Madrid, Spain. The authors provide an in-depth overview of the 250 patients with severe injuries and found the following injuries in patients: soft tissue and musculoskeletal injuries (85%), ear blast injury (67%), blast lung injury (63%), and head trauma (52%).

Hirsch, M., Carli, P., Nizard, R., et al. (2015). The Medical Response to the Multisite Terrorist Attacks in Paris. The Lancet. 386(10012): 2535–2538.

The authors describe the medical response to the attacks from the perspectives of three medical professionals: emergency physician, anesthesiologist, and trauma surgeon.

Hsieh, A. (2014). 5 Triage Lessons Learned from the Boston Marathon Bombing. EMS1.

This article discusses lessons learned from the scene of the Boston Marathon bombing.

InterAgency Board for Equipment Standardization and Interoperability. (2017). Training Trigger: Tourniquet Use Under Medical Protocols.

This fact sheet discusses indications for and proper use of tourniquets for bleeding control in field management of casualties.

Jacobs, L.M. and Joint Committee to Create a National Policy to Enhance Survivability from Intentional Mass Casualty and Active Shooter Events. (2016). The Hartford Consensus IV: A Call for Increased National Resilience. (Abstract only.) Connecticut Medicine. 80(4):239-44.

This resource discusses the call for greater involvement of volunteer responders at the scene of a mass casualty incident to ensure that victims don't die from uncontrolled bleeding. It reviews the THREAT acronym: Threat suppression. Hemorrhage control. Rapid Extrication to safety. Assessment by medical providers. Transport to definitive care.

Lerner, E.B., Schwartz, R.B., Coule, P.L., et al. (2010). Use of SALT Triage in a Simulated Mass-Casualty Incident. Pre-hospital Emergency Care. 14(1): 21-25.

This study evaluated the accuracy of SALT (sort–assess–lifesaving interventions–treatment/transport) triage during a simulated mass-casualty incident; the average time it took to make triage designations; and providers' opinions of SALT triage. The authors concluded that the accuracy rate was higher than those published for other triage systems, and of similar speed.

Los Angeles County Emergency Medical Services Agency (EMS). (2012). Pediatric Surge Quick Reference Guide.

This document contains summaries of critical information for managing the care of children during emergencies or disasters, including vital signs; risks during disasters; signs of respiratory distress; equipment sizes; and fluid resuscitation.

National Center for Disaster Preparedness and Public Health, Uniformed Services University. (n.d.). SALT Mass Casualty Triage Algorithm (Sort, Assess, Lifesaving Interventions, Treatment/Transport). (Accessed 8/3/2017.)

This resource is a graphic of the SALT algorithm.

*Santa Barbara County (CA). (2013). Multi-Casualty Incident (MCI) Response Plan.

This plan describes policies and procedures for managing mass casualty incidents, including those related to on-scene coordination, triage, and treatment.

Wild, J., Maher, J., Frazee, R.C., et al. (2012). The Fort Hood Massacre: Lessons Learned From a High Profile Mass Casualty. (Abstract only). Journal of Trauma and Acute Care Surgery. 72(6):1709-13.

The authors discuss lessons learned from the mass shooting at Fort Hood in 2009. They note that triage was compromised because the scene was not secure for responders, and this led to under triage of several patients.

Education and Training

*Badiali, S., Giugni, A., and Marcis, L. (2017). Testing the START Triage Protocol: Can It Improve the Ability of Nonmedical Personnel to Better Triage Patients During Disasters and Mass Casualties Incidents? (Abstract only.) Disaster Medicine and Public Health Preparedness. 11(3):305-309.

The authors evaluated whether "last-minute" START training of nonmedical ambulance personnel in Italy during a disaster or MCI (using data from a train system victim database as proxy) would result in more effective triage of patients. There was significant improvement in accuracy, and less over- and under-triage for evaluations performed by the group that received just-in-time training on the START protocol. (Note that validation was against the tool itself, making it unclear whether it improved victim triage.)

Beam, B. (2011). START (Simple Triage and Rapid Treatment) Triage Basics. University of Nebraska Medical Center (UNMC).

This seven-and-a-half-minute video demonstrates the Simple Triage and Rapid Treatment (START) Triage system for use during mass casualty incidents.

* Blessing Health System (Quincy, IL.). (2013). Mass Casualty, START Triage and the SMART Tag System.

This presentation includes information on START triage and the SMART patient tagging system. It includes Illinois-approved triage tags and assessment forms, and a link to an online test anyone can take after reviewing the presentation.

Center for Domestic Preparedness. (n.d.). Emergency Medical Operations for CBRNE Incidents. Federal Emergency Management Agency. (Accessed 9/8/2017.)

This four-day course (usually offered in Anniston, AL) provides emergency medical personnel with hands-on training in the pre-hospital management of Chemical, Biological, Radiological, Nuclear, Explosives and mass casualty incidents, as well as on-scene triage, and field treatment of victims exposed to chemical hazards, biological agents, radiological hazards and explosions. The course concludes with a multi-task, pre-hospital exercise.

Children's National Health System, Emergency Medical Services for Children National Resource Center (EMSC). (2012). Pediatric Disaster Triage: Doing the Most Good for the Most Patients in the Least Time.

This course consists of several modules that discuss how to recognize a disaster; the rationale for pediatric disaster triage; and common triage strategies applicable to disaster response. Four common triage strategies (JumpSTART, Smart, SALT and Clinical Decision-Making) are reviewed, and case studies and quizzes are included throughout to illustrate concepts.

*Cone, D., Serra, J., and Kurland, L. (2011). Comparison of the SALT and SMART Triage Systems Using a Virtual Reality Simulator with Paramedic Students. European Journal of Emergency Medicine. 18(6): 314-321.

Paramedic students (N=22) were trained on SALT and then applied it to triage a bus crash scene; this was repeated 3 months later with SMART. The authors concluded that virtual reality seems to be a viable research tool for examining mass casualty triage, and participants triaged simulated patients faster and with greater accuracy with SMART triage vs. SALT triage.

*Cuttance, G., Dansie, K., and Rayner, T. (2017). Paramedic Application of a Triage Sieve: A Paper-Based Exercise. (Abstract only.) Prehospital and Disaster Medicine. 32(1):3-13.

The authors split 292 paramedics into 4 groups to assess how accurately they applied the triage sieve/algorithm: no training or job aid provided; just-in-time (JIT) training only provided; job aid only provided, and JIT training plus a job aid provided. They found that both JIT training and use of a job aid significantly improved triage accuracy and recommend that paramedics be provided with job aids for field triage because JIT

training is impractical when a mass casualty incident occurs. This study also provides some guidance on triage sieve accuracy rate measures.

Glow, S.D., Colucci, V.J., Allington, D.R., et al. (2013). Managing Multiple-Casualty Incidents: A Rural Medical Preparedness Training Assessment. Prehospital and Disaster Medicine. 28(4):334-41.

The authors evaluated the effectiveness of a training model for using mass-casualty incident (MCI) scenarios that trained hospital and prehospital staff together during a one-day training comprised of 2 one-hour functional exercises; 4 distinct, one-hour didactic instructional periods (communications, National Incident Management Systems/Incident Command Systems (NIMS/ICS) and professional roles and responsibilities in NIMS and triage); and 2 MCI functional exercises. Improvements in post-test scores were noted for participants from all disciplines and in all didactic areas. Based on these results, the authors advocate for multidisciplinary MCI training that utilizes real data about a community's response resources.

Hansen, S. (n.d.).Mass Casualty Incident Triage. South Central Preparedness and Emergency Response Learning Center. (Accessed 7/31/2017).

This course was designed for emergency responders caring for a large number patients after natural or human-caused incidents. It covers how to use the Simple Triage and Rapid Treatment (START) system, along with the "All Hazards" or "All Risk" Triage Tag, as well as the Incident Management System (IMS) for mass casualty response.

Hopper, K., Hrdina, C., and Case, C. (2016). Patient Movement Following a Mass Casualty Radiological Event. National Alliance for Radiation Readiness (NARR).

The speakers in this webinar discuss the effects of an improvised nuclear detonation on infrastructure, human beings, and medical resources. They then explain field evacuation of three groups (those with combined injuries, radiation exposure, and limited injuries) to four types of healthcare facilities (medical centers, assembly centers, evacuation centers, and centers set up for "national care" purposes). The Radiation Injury Treatment Network is discussed at the end of the webinar.

Illinois Emergency Medical Services for Children (IL EMSC) and Illinois Department of Public Health. (2016). Pediatric Disaster Triage Training Scenarios: Utilizing the JumpSTART© Method. Stritch School of Medicine.

This handbook includes full descriptions of the START and JumpSTART triage methods, and provides detailed scenarios for use in training and exercises.

Ingrassia, P., Ragazzoni, L., Carenzo, L., et al. (2015). Virtual Reality and Live Simulation: A Comparison Between Two Simulation Tools for Assessing Mass Casualty Triage Skills. European Journal of Emergency Medicine. 22(2): 121-127.

The authors compared accuracy and efficiency of triage by fourth-year medical students using the START method with virtual reality or live simulation of a mass casualty incident. They found no difference in accuracy or speed of triage between the two tools.

Lampi, M., Junker, J., Berggren, P., et al. (2017). Pre-hospital Triage Performance After Standardized Trauma Courses. Scandinavian Journal of Trauma, Resuscitation, and Emergency Medicine. 25(1):53.

The authors compared triage skills (decision-making; prioritization of 15 hypothetical casualties involved in a bus crash; and prioritization for evacuation) among Swedish Advanced Trauma Life Support and Pre-Hospital Trauma Life Support course participants before and after their respective trainings. The only improvement in triage skills observed through the post-test was for Pre-Hospital Trauma Life Support participants who had previously participated in real mass casualty incidents (MCIs), or MCI exercises, suggesting the need for changes to these standardized courses.

National Association of Emergency Medical Technicians. (2015). NAEMT Education.

This webpage provides links to educational opportunities in various categories (e.g., bleeding control, Tactical Combat Casualty Care, and trauma first response) offered by the National Association of Emergency Medical Technicians.

National Association of Emergency Medical Technicians. (n.d.) Pre-hospital Trauma Life Support Courses. (Accessed 9/8/2017.)

This series of courses was developed in cooperation with the American College of Surgeons' Committee on Trauma and promote “critical thinking as the foundation for providing quality care.” There are courses for pre-hospital providers, instructors, and first responders.

National Disaster Life Support Foundation. (n.d.). The Basic Disaster Life Support Course. (Accessed 9/7/2017.)

This in-person course can prepare healthcare professionals and first responders for mass casualty events. The basic course is 7.5 hours long and builds upon the Core Disaster Life Support course. It includes information on the use of a standardized step-wise approach and uniform triage categories for mass casualty field triage, as well as the clinical assessment and management of injuries sustained during a disaster.

National Disaster Life Support Foundation. (n.d.). The Advanced Disaster Life Support Course. (Accessed 9/7/2017).

This 15-hour in-person course is geared towards physicians, nurses, physician assistants, emergency medical technicians, and others in similar fields. Simulated all-hazards scenarios are included and allow participants to practice mass casualty triage, and the application of clinical skills for the management of mass casualty victims.

National Disaster Life Support Foundation. (2015). SALT Mass Casualty Triage On-Line Training.

The National Disaster Life Support Foundation developed this SALT (sort, assess, life-saving interventions, treatment and/or transport) training program for first responders working on a mass casualty incident. This on-line training program consists of a 22-minute video, links to articles on SALT Mass Casualty Triage, and a downloadable PowerPoint set for teaching SALT Triage to others. The program concludes with a short (five question) quiz that participants can take and receive a certificate once complete.

Pauze, D. (2015). Pediatric Triage. University at Albany, State University of New York, School of Public Health and Health Professions, Center for Public Health Preparedness.

This archived webcast from a full-day training included identifying the basic steps involved in pediatric disaster triage and describing the fundamental difference between adult and pediatric disaster triage as objectives. Topics covered include: principles of pediatric triage; triage tools & algorithms (START vs. SALT); and PEARLs/pitfalls of pediatric triage.

Pelaccia, T., Delplancq, H., Triby, E., et al. (2009). Can Teaching Methods Based on Pattern Recognition Skill Development Optimise Triage in Mass-Casualty Incidents? (Abstract only.) Emergency Medicine Journal. 26(12):899-902.

Teaching methods based on pattern recognition skill development were used to train a group of medical and nursing students to perform triage. A similar group of medical and nursing students was trained using a standardized curriculum. The group taught pattern recognition skills development performed triage more accurately, with a lower overtriage rate than the other group.

Risavi, B., Terrell, M., Lee, W. and Holsten, D. (2013). Prehospital Mass-Casualty Triage Training—Written Versus Moulage Scenarios: How Much Do EMS Providers Retain? Prehospital and Disaster Medicine. 28(3): 251-256.

The authors found that there was no difference in skill retention for written vs. moulage scenarios immediately after participants received training in START triage. However, they did find a significant decline in skill retention when participants were evaluated 6 months after training.

University of Nebraska Medical Center (UNMC). (2014). Million Dollar Challenge: START (Simple Triage and Rapid Treatment) Triage I.

This interactive game takes participants through a series of 15 scenarios in which they must select the correct triage category based on the information presented.

Emergent Trauma Care

Alarhayem, A.Q., Myers, J.G., Dent, D., et al. (2016). Time is the Enemy: Mortality in Trauma Patients with Hemorrhage from Torso Injury Occurs Long Before the "Golden Hour". (Abstract only.) American Journal of Surgery. 212(6):1101-1105.

The authors reviewed data from 42,135 records with Abbreviated Injury Scale (AIS) for body regions 4 (Thorax) and 5 (Abdomen) from the National Trauma Database to examine the impact of prehospital time and torso injury severity on survival. They found a "precipitous rise" in patient mortality for patients with non-compressible torso hemorrhage (AIS $\geq$ 4) and prehospital times >30 min. Rapid transport to trauma centers should be a priority whenever severe torso injury is recognized or suspected.

American College of Emergency Physicians. (2013). Joint Committee to Create a National Policy to Enhance Survivability from Mass Casualty Shooting Events: The Hartford Consensus II.

The Hartford Consensus committee recommends strategies and tactics for ensuring seamless, integrated hemorrhage control interventions to improve survival of victims of active shooter and intentional mass casualty incidents. For those with suspected internal hemorrhage, the committee emphasizes the importance of rapid transportation and access to a trauma center, and prompt access to the operating room.

American College of Physicians. (2016). Bombings: Injury Patterns and Care.

This webpage contains resources to assist clinicians with treating victims of bombings and other explosive events. Included are fact sheets; training materials; and a link to a mobile application to assist in the response and clinical management of blast injuries.

American College of Surgeons, The Committee on Trauma. (2017). Stop the Bleed: Resources for Saving a Life.

This webpage provides information and links to resources related to the "Stop the Bleed" initiative. This initiative seeks to prepare trauma professionals, professional first responders, and immediate responders (i.e., citizens) who can respond and stop bleeding of victims of mass casualty incidents.

Autrey, A., Hick, J., Bramer, K., et al. (2014). 3 Echo: Concept of Operations for Early Care and Evacuation of Victims of Mass Violence. (Abstract only.) Prehospital Disaster Medicine. 29(4):421-8.

The authors describe a three-phase approach used by responders to a mass shooting event that happened in Minneapolis (MN) in 2012: Enter, Evaluate, and Evacuate (or 3 Echo). 3 Echo stresses early, multi-disciplinary coordination and teaches participants about unified command, swift victim evacuation, how to establish corridors of safety, and other critical skills.

Bulger, E., Snyder, D., Schoelles, K., et al. (2014). An Evidence-Based Prehospital Guideline for External Hemorrhage Control: American College of Surgeons Committee on Trauma. Prehospital Emergency Care. 18(2):163-173.

This guideline is a culmination of an extensive literature review on the use of tourniquets and hemostatic agents for managing life-threatening extremity and junctional hemorrhage. An expert panel examined the results of the literature review, then provided recommendations for emergency medical services care.

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 Rehabilitation. 26(2):144-50.

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.

*Ciottone, G.R., Biddinger, P.D., Darling, R.G., et al. (2015). Ciottone's Disaster Medicine, 2nd Edition. (Book available for purchase.) Elsevier.

The preparation, assessment, and management of both natural and man-made disasters, domestic and international, are discussed in this book. Part 1 covers “every aspect of disaster medicine and management,” and Part 2 includes “an exhaustive compilation of every conceivable disaster event, organized to facilitate quick reference in a real-time setting.”

* Committee for Tactical Emergency Casualty Car (C-TECC). (2017). Tactical Emergency Casualty Care (TECC) Guidelines for BLS/ALS Medical Providers.

Combat Casualty Care guidelines were adapted to create these civilian-specific medical guidelines for high-threat operations. The guidelines are organized by 3 phases of care: Direct Threat Care; Indirect Threat Care; and Evacuation Care.

*Committee for Tactical Emergency Casualty Care (C-TECC). (2015). Pediatric Tactical Emergency Casualty Care.

This resource provides guidelines for the immediate on-scene stabilization of victims, depending on whether or not there is an ongoing threat to safety.

Deatley, C., Allan, S., William, H., et al. (2003). Jane's Mass Casualty Handbooks - Pre Hospital: Emergency Preparedness and Response. (Book available for purchase.) Janes Information Group.

This book "provides detailed planning, response and recovery information for paramedics and other on-scene emergency responders." Critical planning issues and important response considerations are included.

*Einav, S., Limor Aharonson-Daniel, L., Weissman, C., et al. (2006). In-Hospital Resource Utilization during Multiple Casualty Incidents. Annals of Surgery. 243(4): 533–540.

Data from patients admitted to six Level 1 Trauma Centers in Israel just after a mass casualty incident allowed the authors to develop related guidelines for hospitals to activate in the event of similar events.

*Flynn, F. and Goans, R. (2006). Nuclear Terrorism: Triage and Medical Management of Radiation and Combined-Injury Casualties. Surgical Clinics of North America. 86:601–636.

The authors discuss triage and medical management of patients with burns, trauma, and/or radiation sickness resulting from a nuclear detonation.

Friese, G. (2010). 9 Strategies for Deploying a Mass Casualty Trailer. EMS1.

This article discusses considerations for stocking and staging a mass casualty supply trailer to support Emergency Medical Services (EMS) operations.

*Gutierrez de Ceballos, J., Turégano-Fuentes, F., Perez-Diaz, D., et al. (2005). 11 March 2004: The Terrorist Bomb Explosions in Madrid, Spain– An Analysis of the Logistics, Injuries Sustained and Clinical Management of Casualties Treated at the Closest Hospital. Critical Care. 9(1):104-111.

In 2004, 10 bombs exploded in four commuter trains in Madrid, Spain. The authors provide an in-depth overview of the 250 patients with severe injuries and found the following injuries in patients: soft tissue and musculoskeletal injuries (85%), ear blast injury (67%), blast lung injury (63%), and head trauma (52%).

Klein, K., Pepe, P., Burkle, F., et al. (2008). Evolving Need for Alternative Triage Management in Public Health Emergencies: A Hurricane Katrina Case Study. (Abstract only.) Disaster Medicine and Public Health Preparedness. 2(Suppl 1):S40-4.

The authors explain how post-Katrina "life-and-death triage scenarios" contribute to the need for the "establishment of disaster-specific, consensus-based, public health emergency-related triage protocols-developed with ethical and legal expertise and a renewed focus on multidimensional, multifactorial matrix decision-making processes."

Koenig, K.L. and Schultz, C.H. (2016). Koenig and Schultz's Disaster Medicine: Comprehensive Principles and Practices, 2nd edition. (Book available for purchase.) Cambridge University Press.

This book is written for emergency physicians and nurses and Chapter 12 (pp. 174-184) provides a review of triage and covers basic methods. Discussion of the evaluation and treatment of victims suffering from blast injuries, or exposure to chemical, biological, and radiological agents is included in the book with some information about triage in these situations as well.

Harmsen, A.M., Giannakopoulos, G.F., Moerbeek, P.R., et al. (2015). The Influence of Prehospital Time on Trauma Patients Outcome: A Systematic Review. (Abstract only.) Injury. 46(4):602-9.

The authors conducted a literature search to try to determine the correlation between prehospital time intervals and the outcome of trauma patients. They concluded that patients suffering neurotrauma and hypotensive unstable penetratingly injured patients should be transported to definitive care as quickly as possible. For hemodynamically stable undifferentiated trauma patients, increased on-scene-time and total prehospital time does not increase odds of mortality.

Hick, J., Hanfling, D., Evans, B. et al. (2016). Health and Medical Response to Active Shooter and Bombing Events.

This discussion paper examines some of the issues and potential best practices during responses to terrorist incidents, including mass shootings and bombings. Response coordination and planning considerations are also discussed which could optimize patient outcomes.

InterAgency Board for Equipment Standardization and Interoperability (IAB). (2017). Training Trigger: Tourniquet Use Under Medical Protocols.

This fact sheet discusses indications for and proper use of tourniquets for bleeding control in field management of casualties.

Jacobs, L.M.; Joint Committee to Create a National Policy to Enhance Survivability from Intentional Mass Casualty and Active Shooter Events. (2016). The Hartford Consensus IV: A Call for Increased National Resilience. (Abstract only.) Connecticut Medicine. 80(4):239-44.

This resource discusses the call for greater involvement of volunteer responders at the scene of a mass casualty incident to ensure that victims don't die from uncontrolled bleeding. It reviews the THREAT acronym: Threat suppression. Hemorrhage control. Rapid Extrication to safety. Assessment by medical providers. Transport to definitive care.

Kragh, J.F., O Neill, M.L., Beebe, D.F., et al. (2011). Survey of the Indications for Use of Emergency Tourniquets. Journal of Special Operations Medicine. 11(1):30-8.

The authors analyzed data on emergency tourniquet use from a large clinical study to define emergency tourniquet use indications to stop limb bleeding. They concluded that tourniquets should be used on any compressible limb wounds having possibly lethal hemorrhages. They call for additional research to address the gaps in knowledge that exist regarding tourniquet use.

Lesperance, R.N. and Nunez, T.C. (2015). Blast Injury: Impact on Brain and Internal Organs. (Abstract only.) Critical Care Nursing Clinics of North America. 27(2):277-87.

Based on a literature review, the authors discuss some key points for the immediate care of blast injury victims. Specifically, they note that these patients should be treated as having multisystem trauma and managed according to Advanced Trauma Life Support guidelines, and damage control resuscitation should be practiced until definitive hemorrhage control has been achieved.

Meenach, D. (2015). Military Use of Chest Seals and Tourniquets: Lessons for EMS. EMS1.

This article discusses the proper use of tourniquets to stop hemorrhaging in the field, and how a chest seal should be used to close an open pneumothorax.

National Academies of Sciences, Engineering, and Medicine. (2016). A National Trauma Care System: Integrating Military and Civilian Trauma Systems to Achieve Zero Preventable Deaths After Injury. Washington, DC: The National Academies Press.

Due to advances in trauma care, the case fatality rate for U.S. service members injured in Afghanistan decreased by almost half. The authors discuss applying these advances to trauma care in defense and civilian settings in response to mass casualty events.

The National Association of Emergency Medical Technicians. (2013). Improving Survival from Active Shooter Events: The Hartford Consensus.

The Hartford Consensus suggests that an integrated response by law enforcement, fire/rescue, and EMS to an active shooter scene will improve patient outcomes. First responders are recommended to apply the actions in the acronym THREAT: 1) Threat suppression, 2) Hemorrhage control, 3) Rapid Extrication to safety, 4) Assessment by medical providers, and 5) Transport to definitive care.

*Oregon State Area Trauma Advisory Board # 6 and Washington State Southwest Regional EMS. (2012). Mass Casualty Incident Plan Initial Response Guide.

This plan was prepared to ensure successful coordination between more than one pre-hospital agency and more than one hospital in the state trauma region. Triage and immediate care for victims of a mass casualty incident are discussed.

Schauer, S.G., April, M.D., Simon, E., et al. (2017). Prehospital Interventions During Mass-Casualty Events in Afghanistan: A Case Analysis. (Abstract only.) Prehospital and Disaster Medicine. 32(4):465-468.

The authors reviewed data on 50 mass casualties from explosions obtained from the Department of Defense Trauma Registry and the Pre-hospital Trauma Registry. They note that the most common pre-hospital interventions were tourniquet and pressure dressing hemorrhage control, and pain medication administration.

*Schwartz, R.B., McManus Jr., J.G., and Swienton, R.E. (2008). Tactical Emergency Medicine. (Book available for purchase.) Lippincott, Williams, & Wilkins.

This book covers the practice of emergency medicine in the field during disasters, police or military conflicts, mass events, and community incidents. Topics covered include: medical support; planning and triage; medical evaluation in the incident zone; medical control of incident site; and decontamination, among others.

Smith, R. (2013). ACFD Rescue Task Force. National Fire Protection Association.

This presentation describes the Rescue Task Force concept, and how the Arlington County, Virginia Fire Department has implemented it to “provide stabilizing medical care in areas that are clear but not secure.”

Stiver, S.I., and Manley, G.T. (2008). Prehospital Management of Traumatic Brain Injury. Neurosurgical Focus. 25(4):E5.

The authors conducted a literature review of the current protocols of prehospital practice and their impact on outcome in the management of traumatic brain injury (TBI) for the period 1980-2008. The article includes discussion of the management of brain oxygenation, blood pressure, cerebral perfusion pressure, and raised intracranial pressure in the field, as well as considerations for managing TBI during mass casualty incidents.

Tan, D. (2015). Rescue Task Force is Best Medical Response to An Active Shooter Incident. EMS1.

The author discusses the differences between Tactical Emergency Medical Support (TEMS) and Rescue Task Force (RTF) personnel. RTF providers work with law enforcement to deliver immediate medical intervention (e.g., control severe bleeding; address airway compromise) in the "warm zone" of an active shooter incident to stabilize victims for evacuation to definitive care.

*Texas Trauma Service Area (TSA) B. (2016). Trauma Service Area - B (BRAC): Regional Pediatric Plan.

This plan provides prehospital and hospital providers with regional standardized procedures for the treatment of pediatric patients. It addresses various issues to include: prehospital triage, helicopter activation, inter-hospital transfers, pediatric trauma triage/ transfer decision scheme, among others topics.

Williamson, K., Ramesh, R. and Grabinsky, A. (2011). Advances in Prehospital Trauma Care. International Journal of Critical Illness and Injury Science. 1(1):44-50.

The authors review advances in prehospital trauma care that improve patient outcomes. They note that training of pre-hospital providers is inconsistent, that the level of care varies, and that standardization of skills that incorporate lessons learned from the most current advances in the field among prehospital providers is warranted to improve patient outcomes.

*Wipfler III, E.J., Campbell, J.E., Heiskell, L.E., and Smith, J.M. (2012). Tactical Medicine Essentials, 1st edition. (Book available for purchase.) American College of Emergency Physicians.

This book covers the "essential curriculum of tactical medicine" for Emergency Medical Services (EMS) and medical professionals of all levels, to prepare them to "safely accompany a SWAT unit into the tactical environment."

Incident Coordination

Biddinger, P., Baggish, A., Harrington, L., et al. (2014). Be Prepared — The Boston Marathon and Mass-Casualty Events. New England Journal of Medicine. 368:1958-1960.

The authors describe how planning and training for mass-casualty events helped the Boston medical community successfully respond to the marathon bombing. The authors highlight the presence of medical tents, the mobilization of communications and additional resources, and the activation of hospital emergency plans as helpful contributing factors.

*County of Santa Clara Emergency Medical Services. (2015). Field Treatment Site Operations Guide.

This plan is an annex to the county's *Multiple Patient Management Plan* and describes the setup, management, and utilization of a Field Treatment Site (FTS) during a multiple patient event. The FTS will be used to provide treatment to appropriate (i.e., those not needing immediate transfer to a trauma center) victims after they have been triaged using the START algorithm at a Casualty Collection Point when demand exceeds available transportation resources.

Hirsch, M., Carli, P., Nizard, R., et al. (2015). The Medical Response to the Multisite Terrorist Attacks in Paris. The Lancet. 386(10012): 2535–2538.

The authors describe the medical response to the attacks from the perspectives of three medical professionals: emergency physician, anesthesiologist, and trauma surgeon.

Raiter, Y., Farfel, A., Lehavi, O., et al. (2008). Mass Casualty Incident Management, Triage, Injury Distribution of Casualties and Rate of Arrival of Casualties at the Hospitals: Lessons From a Suicide Bomber Attack in Downtown Tel Aviv. (Abstract only.) Emergency Medicine Journal. 25(4):225-9.

The authors discuss lessons learned for incident management from a bombing at the central bus station in Tel Aviv in 2006, and describe injury patterns of casualties. They note that quickly responding Emergency Medicine Services (EMS) vehicles, effective primary triage between urgent and non-urgent casualties, and primary distribution between five hospitals contributed to rapid and efficient response.

Soffer, D. and Klausner, J.M. (2012). Trauma System Configurations in Other Countries: The Israeli Model. (Abstract only.) Surgical Clinics of North America. 92(4):1025-40, x.

The authors review mass casualty management in the pre-hospital and hospital settings, and the experience gained from multiple mass casualty incidents experienced in Israel.

Spencer, C. (2011). Managing Mass Casualty Events is Just the Application of Normal Activity on a Grander Scale for the Emergency Health Services. Or is it? Australasian Journal of Paramedicine, 9(1).

The author explains that managing mass casualty events is not "business as usual" for the following reasons: it requires emergency medical services to go above and beyond traditional services, these incidents extend day-to-day triage, and large incidents require a medical surge response.

Mass Triage

Aylwin, C.J., König, T.C., Brennan, N.W., et al. (2006). Reduction in Critical Mortality in Urban Mass Casualty Incidents: Analysis of Triage, Surge, and Resource Use After the London Bombings on July 7, 2005. The Lancet. 368(9554):2219-25.

The authors retrospectively analyzed the pre-hospital and hospital response to the 2005 London bombings. They found that over-triage rates were reduced where advanced prehospital teams did initial scene triage, and that critical mortality did not seem to be related to over-triage.

Arcos González, P., Castro Delgado, R., Cuartas Alvarez, T., et al. (2016). The Development and Features of the Spanish Prehospital Advanced Triage Method (META) for Mass Casualty Incidents. Scandinavian Journal of Trauma, Resuscitation, and Emergency Medicine. 29;24:63.

This article describes the process of development of the Spanish Prehospital Advanced Triage Method (META), which was designed for use by pre-hospital providers with expert knowledge of Advanced Trauma Life Support (ATLS) during mass casualty incidents. META is based in ATLS protocols, and includes evaluation of each patient's anatomical injuries and mechanism of injury.

Arshad, F.H., Williams, A., Asaeda, G., et al. (2015). A Modified Simple Triage and Rapid Treatment Algorithm from the New York City (USA) Fire Department. (Abstract only.) Prehospital and Disaster Medicine. 30(2):199-204.

The authors used a computer simulation of 28 cases in a 2-train collision to determine if modification of the Simple Triage and Rapid Treatment (START) system by the addition of an Orange category, intermediate between the most critically injured (Red) and the non-critical, non-ambulatory injured (Yellow), would reduce over- and under-triage rates in a simulated mass-casualty incident (MCI) exercise. Triage for the five orange cases (chest pain or dyspnea without obvious trauma) was performed correctly 86.3% of the time using the modified START algorithm vs. 81.5% of the time using unmodified START.

Army Medical Department Center and School. (n.d.) Mass Casualty and Triage. (Accessed 8/3/2017).

This chapter in *Emergency War Surgery* discusses considerations, goals, and protocols for mass casualty triage, from the perspective of the Army.

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.

*Badiali, S., Giugni, A., and Marcis, L. (2017). Testing the START Triage Protocol: Can It Improve the Ability of Nonmedical Personnel to Better Triage Patients During Disasters and Mass Casualties Incidents? (Abstract only.) Disaster Medicine and Public Health Preparedness. 11(3):305-309.

The authors evaluated whether "last-minute" START training of nonmedical ambulance personnel in Italy during a disaster or MCI (using data from a train system victim database as proxy) would result in more effective triage of patients. There was significant improvement in accuracy, and less over- and under-triage for evaluations performed by the group that received just-in-time training on the START protocol.

Baker, M. (2007). Creating Order from Chaos: Part I: Triage, Initial Care, and Tactical Considerations in Mass Casualty and Disaster Response. AMSUS Military Medicine. 172(3): 232-236.

This article discusses considerations for mass casualty response, from on-scene triage and field care, to transfer to definitive medical care at a healthcare facility.

Barnett, A., Wang, N., Sahni, R., et al. (2013). Variation in Prehospital Use and Uptake of the National Field Triage Decision Scheme. Official Journal of the National Association of EMS Physicians and the National Association of State EMS Directors. 17(2):135148.

The objective of this study was to compare the use of field triage criteria by emergency medical services personnel in six regions. The researchers ultimately found a large variation between the frequency and type of field triage criteria used and suggested opportunities for incorporating updated guidelines.

Bhalla, M.C., Frey, J., Rider, C., et al. (2015). Simple Triage Algorithm and Rapid Treatment and Sort, Assess, Lifesaving, Interventions, Treatment, and Transportation Mass Casualty Triage Methods for Sensitivity, Specificity, and Predictive Values. (Abstract only.) The American Journal of Emergency Medicine. 33(11):1687-91.

The authors performed a retrospective chart review of 100 trauma patients seen in their emergency department (ED). They concluded that, overall, neither SALT nor START was sensitive or specific for predicting clinical outcome.

*Blessing Health System (Quincy, IL.). (2013). Mass Casualty, START Triage and the SMART Tag System.

This presentation includes information on START triage and the SMART patient tagging system. It includes Illinois-approved triage tags and assessment forms, and a link to an online test anyone can take after reviewing the presentation.

Bultman L.L. and Hick, J.L. (2005). Does START Triage Correspond to Emergency Department Acuity? (Abstract only on p. 167.) Academic Emergency Medicine. 12:S167.

The authors applied START triage to 228 patients arriving to their stabilization room at a Level 1 trauma center and found 26% of "yellow" patients needed lifesaving interventions within the first few minutes of care and patients categorized "red" by absent radial pulse had 70% mortality. The authors found that START may result in significant under-triage within the yellow category.

Cannon, W. and Heightman, A.J. (2015). A Scientific Look at START and Our Ability to Do It. Journal of Emergency Medical Services. May 4.

The authors analyzed START triage application in several MCIs to determine how efficient, effective and consistently it was performed. In the article they also discuss when it may be appropriate for Emergency Medical Services (EMS) personnel to use other parameters (such as resources available and hospital capabilities) to perform triage and patient distribution in an optimal manner.

Chou, R., Totten, A.M., Pappas, M., et al. (2017). Glasgow Coma Scale for Field Triage of Trauma: A Systematic Review—Executive Summary. Agency for Healthcare Quality and Research.

This review was prepared by the Pacific Northwest Evidence-based Practice Center to assess the predictive utility, reliability, and ease of use of the total Glasgow Coma Scale (tGCS) versus the motor component of the Glasgow Coma Scale (mGCS) for field triage of trauma. The comparative effects on clinical decision-making and outcomes are also discussed.

Christian, M., Toltzis, P., Kanter, R., et al. (2011). Treatment and Triage Recommendations for Pediatric Emergency Mass Critical Care. Pediatric Critical Care Medicine. 12(6 Suppl):S109-19.

The authors discuss issues related to developing triage algorithms and protocols, and the allocation of scarce resources, during pediatric emergency mass critical care.

*Ciottone, G.R., Biddinger, P.D., Darling, R.G., et al. (2015). Ciottone's Disaster Medicine, 2nd Edition. (Book available for purchase.) Elsevier.

The preparation, assessment, and management of both natural and man-made disasters, domestic and international, are discussed in this book. Part 1 covers "every aspect of disaster medicine and management," and Part 2 includes "an exhaustive compilation of every conceivable disaster event, organized to facilitate quick reference in a real-time setting."

City of Santa Monica. (2013). Casualty Collection Point (CCP)/Field Treatment Site.

This guideline describes the purpose and use of a Casualty Collection Point (CCP)/Field Treatment Site (FTS) for managing mass casualty incidents. The CCP/FTS is used for the assembly, triage (sorting), medical stabilization and subsequent evacuation of casualties when demand exceeds transport capacity.

Claudius, I., Kaji, A.H., Santillanes, G., et al. (2015). Accuracy, Efficiency, and Inappropriate Actions Using JumpSTART Triage in MCI Simulations. (Abstract only.) Prehospital Disaster Medicine. 30(5):457-60.

Medical students applied JumpSTART triage to evaluate simulated mass casualty patients (moulaged actors and computer-simulated cases) and the authors assessed overall accuracy and time required for triage, and if the performance of unnecessary steps, or failure to perform required steps, in the algorithm was associated with inaccuracy of triage designation or increased time to reach a triage decision. Increasing triage level, performance of inappropriate actions, and omission of recommended actions were all associated with increasing time to perform triage.

*Cone, D., Serra, J., Kurland, L. (2011). Comparison of the SALT and SMART Triage Systems Using a Virtual Reality Simulator with Paramedic Students. 18(6): 314-321.

Paramedic students (N=22) were trained on SALT and then applied it to triage a bus crash scene; this was repeated 3 months later with SMART. The authors concluded that virtual reality seems to be a viable research tool for examining mass casualty triage, and participants triaged simulated patients faster and with greater accuracy with SMART triage vs. SALT triage.

Cone, D.C., Serra, J., Burns, K., et al. (2009). Pilot Test of the SALT Mass Casualty Triage System. Prehospital Emergency Care. (Abstract only.)13:53640.

The authors examined how quickly and accurately trained paramedics could triage using the SALT (sort-assess-lifesaving interventions-treat/transport) method. Results indicated that SALT can be applied quickly and safely in the field, though the authors indicate the need for more research to address the significant over-triage observed during the pilot test.

Cone, D.C., MacMillan, D.S., Parwani, V. and Van Gelder, C. (2008). Pilot Test of a Proposed Chemical/Biological/Radiation/Nuclear-Capable Mass Casualty Triage System. (Abstract only.) Prehospital Emergency Care. 12(2):236-40.

Speed and accuracy of a system that can triage injured patients who are or may be contaminated by chemical, biological, radiation, or nuclear (CBRN) material was pilot-tested paramedics at an airport disaster drill on 56 patient scenarios, some involving signs and symptoms of organophosphate toxicity in addition to physical trauma. The study authors concluded that the chemical algorithm of the proposed CBRN-capable mass casualty triage system can be applied rapidly by trained paramedics, but a significant under-triage rate (10.7%) was observed in this pilot test. They call for further refinement and testing of the algorithm.

Cross, K.P., Petry, M.J., and Cicero, M.X. (2015). A Better START for Low-Acuity Victims: Data-driven Refinement of Mass Casualty Triage. (Abstract only.) Prehospital Emergency Care. 19(2):272-8.

The authors used data from 322,162 subjects in the National Trauma Database (NTDB) to assess gaps of the START algorithm when it is used to triage low-acuity patients. They identified factors for mistriage of "Green/Minor" level patients who died in the hospital (N=2,046), and then developed and tested evidenced-based improvements to START using an iterative process. They concluded that START accuracy was significantly improved when elderly, but otherwise minimally injured patients were triaged as "Yellow" instead of "Green."

Cross, K.P. and Cicero, M.X. (2012). Independent Application of the Sacco Disaster Triage Method to Pediatric Trauma Patients. (Abstract only.) Prehospital and Disaster Medicine. 27(4):306-11.

The authors applied the Sacco Triage Method to 90,037 records of children ≤ 18 years of age with complete initial scene data from the National Trauma Database for the period 2007-2009. They concluded that this method is a highly accurate predictor of mortality in pediatric trauma patients in this registry database.

*Cuttance, G., Dansie, K., and Rayner, T. (2017). Paramedic Application of a Triage Sieve: A Paper-Based Exercise. (Abstract only.) Prehospital and Disaster Medicine. 32(1):3-13.

The authors split 292 paramedics into 4 groups to assess how accurately they applied the triage sieve/algorithm: no training or job aid provided; just-in-time (JIT) training only provided; job aid only provided, and JIT training plus a job aid provided. They found that both JIT training and use of a job aid significantly improved triage accuracy and recommend that paramedics be provided with job aids for field triage because JIT training is impractical when a mass casualty incident occurs. This study also provides some guidance on triage sieve accuracy rate measures.

Desi, N. and Benin-Goren, O. (2017). Triage During a MCI: A Collaborative Process. World Association for Disaster and Emergency Medicine.

The authors discuss the importance of collaboration among disciplines for conducting triage, from field/on-scene triage, through to the Emergency Department, and beyond. Triage algorithms and considerations are presented.

Duckworth, R. (2017). How to Use SALT to Triage MCI Patients. EMS1.

The author discusses the implementation of SALT (Sort, Assess, Lifesaving interventions, Treatment and/or Transport) during a mass casualty incident, and the importance of utilizing the triage system to keep patients moving away from the hazard and toward a casualty collection point for further triage.

*Federal Interagency Committee on Emergency Medical Services. (2014). National Implementation of the Model Uniform Core Criteria for Mass Casualty Incident Triage: A Report of the FICEMS.

The Model Uniform Core Criteria (MUCC) for Mass Casualty Triage is a science and consensus-based national guideline that recommends 24 core criteria for all mass casualty triage systems. These criteria were developed to support interoperability among multiple existing triage tools across the country.

*Flynn, F. and Goans, R. (2006). Nuclear Terrorism: Triage and Medical Management of Radiation and Combined-Injury Casualties. Surgical Clinics of North America. 86:601–636.

The authors discuss triage and medical management of patients with burns, trauma, and/or radiation sickness resulting from a nuclear detonation.

Frykberg, E. (2005). Triage: Principles and Practice. Scandinavian Journal of Surgery. 94: 272-278.

The author discusses the foundations of triage, lists challenges associated with triaging after a mass casualty incident, shared data on under- and over-triage, and lists factors that should be taken into account when making triage decisions.

*Gutierrez de Ceballos, J., Turégano-Fuentes, F., Perez-Diaz, D., et al. (2005). 11 March 2004: The Terrorist Bomb Explosions in Madrid, Spain– An Analysis of the Logistics, Injuries Sustained and Clinical Management of Casualties Treated at the Closest Hospital. Critical Care. 9(1):104-111.

In 2004, 10 bombs exploded in four commuter trains in Madrid, Spain. The authors provide an in-depth overview of the 250 patients with severe injuries and found the following injuries in patients: soft tissue and musculoskeletal injuries (85%), ear blast injury (67%), blast lung injury (63%), and head trauma (52%).

Horne, S. and Nutbeam, T. (2016). You Can't Make a Silk Purse Out of a Sow's Ear: Time to Start Again with MCI Triage. Prehospital Disaster Medicine. 31(4):459-60.

This is a commentary on a study that examined the use of JumpSTART triage by medical students, wherein they either performed unnecessary steps (55.0% of the time) or omitted them (57.0%), even with notes to help them follow the algorithm. The authors contend that, regardless of how the information is taught to the medical community, the algorithm does not work, and so should not be accepted in the first place. They cite other studies that have demonstrated that "application of JumpSTART is more likely to triage patients incorrectly than any other decision-making tool, including a coin toss." They call for more research to create new triage paradigms.

Hsieh, A. (2014). 5 Triage Lessons Learned from the Boston Marathon Bombing. EMS1.

This article discusses lessons learned from the scene of the Boston Marathon bombing.

Hu, H., He, Y., Zhang, S., and Cao, Y. (2014). Streamlined Focused Assessment with Sonography for Mass Casualty Prehospital Triage of Blunt Torso Trauma Patients. (First page only.) American Journal of Emergency Medicine. 32(7):803-6.

The authors used a streamlined version of Focused Assessment with Sonography for Trauma (sFAST) to perform field triage of injured patients for the first 24 hours after a large earthquake. They compared their results to those obtained using the START algorithm, and determined that ultrasound yielded significantly more predictive information in a similar period of time.

Iserson K., and Moskop, J. (2007). Triage in Medicine, Part I: Concept, History, and Types.Annals of Emergency Medicine. 49(3):275-81.

This article provides information on the history and evolution of the practice of triage. It includes a chart detailing the "continuum of triage" from "most resources, most social order, to fewest resources, chaos." (See also the Part II article by Moskop and Iserson.)

Jones, N., White, M.L., Tofil, N., et al. (2014). Randomized Trial Comparing Two Mass Casualty Triage Systems (JumpSTART versus SALT) in a Pediatric Simulated Mass Casualty Event. Prehospital Emergency Care. 18(3):417-23.

Paramedics received a 15-minute training in either JumpSTART or SALT and then were asked to assign triage categories to 10 pediatric patients in a simulated building collapse (4 moulaged actors; 6 high-fidelity simulators) using whichever method they were trained in. Study authors concluded that SALT is at least as good as JumpSTART in overall triage accuracy (~66% for each), overtriage (~23% for each), or undertriage (~11% for each) rates in a simulated pediatric mass casualty incident. Both were considered easy to use, and JumpSTART was 8 seconds faster per patient to assign triage designations.

Kahn, C.A., Schultz, C.H., Miller, K.T. and Anderson, C.L. (2009). Does START Triage Work? An Outcomes Assessment After a Disaster. Annals of Emergency Medicine. 54(3):424-30, 430.e1.

The authors reviewed 148 patient records from 14 hospitals after a train crash to determine how well triage levels assigned in the field using START corresponded with outcomes-based triage levels assigned at the hospital. Seventy-nine patients were overtriaged; 3 were undertriaged; and 66 patients' outcomes matched their triage level.

Kilner, T.M., Brace, S.J., Cooke, M.W., et al. (2011). In 'Big Bang' Major Incidents Do Triage Tools Accurately Predict Clinical Priority?: A Systematic Review of the Literature. (Abstract only.) Injury. 42(5):460-8.

The authors reviewed 11 papers as part of a literature review conducted to identify existing triage tools and to determine the extent to which their reliability and validity have been assessed. They concluded that there is limited evidence for the validity of existing triage tools in 'big bang' major incidents, and what evidence there is focuses on sensitivity and specificity in relation to prediction of trauma death or severity of injury based on data from single or small number patient incidents.

Kupas, D.F., Melnychuk, E.M., and Young, A.J. (2016). Glasgow Coma Scale Motor Component ("Patient Does Not Follow Commands") Performs Similarly to Total Glasgow Coma Scale in Predicting Severe Injury in Trauma Patients. Annals of Emergency Medicine. 68(6):744-750.e3.

The authors conducted a retrospective analysis of a statewide trauma registry including records from 393,877 patients from 1999 to 2013 to compare the predictive ability of a total Glasgow Coma Scale (GCS) ≤13 vs. a Glasgow Coma Scale motor component (GCS-m) <6 for 6 trauma outcomes: Injury Severity Score (ISS) greater than 15; ISS greater than 24; death; ICU admission; need for surgery; or need for craniotomy. They concluded that the GCS-m predicts serious outcomes as well as the total GCS, and its use would simplify triage in the field.

Lampi, M., Vikström, T., and Jonson, C.O. (2013). Triage Performance of Swedish Physicians Using the ATLS Algorithm in a Simulated Mass Casualty Incident: A Prospective Cross-sectional Survey. Scandinavian Journal of Trauma, Resuscitation, and Emergency Medicine. 20;21:90.

Participants in the Advanced Trauma Life Support (ATLS) provider course (N=142) completed pre- and post-tests to determine whether the mnemonic ABCDE as instructed in the ATLS provider course, affects the ability of Swedish physicians to correctly triage patients in a simulated mass casualty incident. Post-test results did not show improvement in the ability of physicians to perform triage using the ABCDE algorithm.

Lee, C.W., McLeod, S.L., and Peddle, M.B. (2015). First Responder Accuracy Using SALT After Brief Initial Training. (Abstract only.) Prehospital and Disaster Medicine. 30(5):447-51.

First-year primary care paramedic (PCP), fire, and police trainees attended a 30-minute didactic training on SALT and completed a paper-based test to assess their ability to understand and apply SALT immediately thereafter, and again 3 months later. PCPs were able to apply the SALT triage tool with the most accuracy, followed by fire, then police. Over-triage was the most frequent error, and critical errors were rare.

Lee, C.W., McLeod, S.L., Van Aarsen, K., et al. (2016). First Responder Accuracy Using SALT During Mass-casualty Incident Simulation. (Abstract only.) Prehospital Disaster Medicine. 31(2):150-4.

The authors compared triage accuracy, error patterns, and time to triage completion using SALT during a mock mass casualty incident using 8 moulaged actors following a 30-minute didactic training of second year fire service and paramedic students. They found that accuracy was slightly higher among paramedic students (79.9% vs. 72.0% for fire students), and suggest that fire service personnel may be used to support triage during MCIs when medical resources are limited.

Lerner E.B., Drendel A.L., Cushman, J.T., et al. (2017). Ability of the Physiologic Criteria of the Field Triage Guidelines to Identify Children Who Need the Resources of a Trauma Center. Prehospital Emergency Care. 21(2):180-184.

The authors conducted a structured medical record review of children ≤15 years old that were transported to trauma centers in 3 midsize cities to determine the accuracy of the Physiologic Criteria (Step 1) of the Field Triage Guidelines in identifying injured children who need the resources of a trauma center. They concluded that the Physiologic Criteria are a moderate predictor of trauma center need, and their predictive value may have been limited by inaccurate or missing vital signs.

Lerner, E.B., Cushman, J.T., Drendel, A.L. et al. (2017). Effect of the 2011 Revisions to the Field Triage Guidelines on Under- and Over-Triage Rates for Pediatric Trauma Patients. Pre-hospital Emergency Care. 21(4):456-460.

The authors describe results from a retrospective study that compared rates of over- and under-triage of pediatric patients using the 1999, 2006, and 2011 Field Triage Guidelines. They concluded that there is significant under-triage of pediatric patients using existing guidelines, and more research is needed to modify them for use in triage of this population.

Lerner, E., Schwartz, R., Coule, P., et al. (2008). Mass Casualty Triage: An Evaluation of the Data and Development of a Proposed National Guideline. (Abstract only.) Prehospital and Disaster Medicine. 2(S1): S25-S34.

The authors discuss the development of the SALT (sort, assess, life-saving interventions, treatment and/or transport) triage guidelines, based on the best available science and consensus opinion. SALT was developed as "a single overarching guide for unifying the mass casualty triage process across the United States."

Lerner, E.B., Schwartz, R.B., Coule, P.L. et al. (2010). Use of SALT Triage in a Simulated Mass-Casualty Incident. Pre-hospital Emergency Care. 14(1): 21-25.

This study evaluated the accuracy of SALT (sort–assess–lifesaving interventions–treatment/transport) triage during a simulated mass-casualty incident; the average time it took to make triage designations; and providers' opinions of SALT triage. The authors concluded that the accuracy rate was higher than those published for other triage systems, and of similar speed.

Lidal, I.B., Holte, H.H. and Vist, G.E. (2013). Triage Systems for Pre-hospital Emergency Medical Services - A Systematic Review. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine. 21:28.

The authors conducted an extensive literature review to answer the questions: 1) are pre-hospital triage systems effective, 2) is one triage system more effective than others, and 3) is it effective to use the same triage system in two or more settings of the EMS-chain? They found a gap in the literature and were unable to draw any conclusions.

Mack, D. (2010). The Importance of a Triage Tag. Journal of Emergency Medical Services.

The pros and cons of using triage tags and the importance of incorporating tags into exercises are discussed in this brief article.

Mills, A., Argon, N., and Ziya, S. (2013). Resource-Based Patient Prioritization in Mass-Casualty Incidents. Manufacturing and Service Operations Management. 15(3): 361-377.

The authors created a "fluid model" of patient triage in a mass-casualty incident that incorporates resource limitations and the changes in survival probabilities with respect to time. They tested it using a simulation model and data from emergency medicine literature, and conclude that the policy developed outperforms START in all scenarios considered.

Moskop, J. and Iserson, K. (2007). Triage in Medicine, Part II: Underlying Values and Principles. Annals of Emergency Medicine. 49(3):282-7.

In this article on the foundations of triage decision making, the authors discuss the "moral significance" of triage and summarize three principles of distributive justice that can guide triage decisions.

Powers, R., Daily, E., and The World Association of Disaster and Emergency Medicine. (2010). International Disaster Nursing. (E-book.) Cambridge University Press.

This book covers “the essential components of practice” during disasters, including disaster triage. Organizational aspects of preparedness and response, as well as individual and team roles and responsibilities, are discussed.

Price, C.L., Brace-McDonnell, S.J., Stallard, N., et al. (2016). Performance Characteristics of Five Triage Tools for Major Incidents Involving Traumatic Injuries to Children. Injury. 47(5):988-92.

The authors conducted a retrospective observational cohort study using data from 31,292 patients in the UK Trauma Audit and Research Network (TARN) database aged less than 16 years who sustained a traumatic injury. They assessed sensitivity, specificity and level of agreement between five triage tools (JumpSTART, START, CareFlight, Paediatric Triage Tape/Sieve and Triage Sort) to identify patients at high risk of death or severe injury. They concluded that “no single tool performed consistently well across all evaluated scenarios.”

Rådestad, M., Lennquist Montán, K., Rüter, A., et al. (2016). Attitudes Towards and Experience of the Use of Triage Tags in Major Incidents: A Mixed Method Study. (Abstract only.) Prehospital Disaster Medicine. 31(4):376-85.

The authors studied ambulance personnel attitude towards, and experiences of, practicing triage tagging during day-to-day management of trauma patients, as well as in major incidents (MIs), using questionnaires and focus groups. They found that, although ambulance personnel accept the value of using triage tags, they will likely not use them during MIs because they don’t have much experience with them during day-to-day operations or through exercises.

Rubenson Wahlin, R., Ponzer, S. Lövbrand, H., et al. (2016). Do Male and Female Trauma Patients Receive the Same Prehospital Care?: An Observational Follow-up Study. BMC Emergency Medicine. 16(6).

The authors retrospectively analyzed data from 383 records obtained from local trauma registries and hospital and ambulance records in Stockholm County, Sweden. They found that males were more likely to be transported directly to a trauma center than females, and hypothesize that this may be due to gender differences in symptom presentation that

physiologic criteria for triage do not account for. There were no differences in total on-scene time or on-scene interventions provided between genders.

Sasser, S., Hunt, R., Faul, M., et al. (2012). Guidelines for Field Triage of Injured Patients: Recommendations of the National Expert Panel on Field Triage, 2011. Centers for Disease Control and Prevention, Morbidity and Mortality Weekly Report, Recommendations and Reports, 61(1).

This guidance can help emergency medical services providers recognize when patients would benefit from specialized trauma care resources. The report includes a list of tools that can be used to assess vital signs; anatomy of injury; mechanism of injury and evidence of high-energy impact; and special considerations (e.g., age, bleeding disorders, burns, pregnancy).

*Schwartz, R.B., McManus Jr., J.G., and Swienton, R.E. (2008). Tactical Emergency Medicine. (Book available for purchase.) Lippincott, Williams, & Wilkins.

This book covers the practice of emergency medicine in the field during disasters, police or military conflicts, mass events, and community incidents. Topics covered include: medical support; planning and triage; medical evaluation in the incident zone; medical control of incident site; and decontamination, among others.

Stevenson, J., Andrews, L., and Moore, F. (2015). Developing and Introducing a New Triage Sieve for UK Civilian Practice. Trauma. 17(2) 140–141.

This article describes the revised National Ambulance Service Medical Directions (NASMeD) triage sieve introduced in the UK in 2013. The algorithm is included.

West, B., Cusser, A., Etengoff, S. et al. (2014). The Use of FAST Scan by Paramedics in Mass-Casualty Incidents: A Simulation Study. (Abstract only.) Prehospital and Disaster Medicine. 29(6):576-9.

Ten paramedics with field experience were trained in the use of Focused Abdominal Sonography in Trauma (FAST) scan, which is used to detect free fluid in the peritoneal cavity, or pericardium, to identify injuries needing immediate surgical intervention. After 2 weeks, they used FAST to attempt to correctly identify patients with such fluid conditions. Mean accuracy was found to be low (60%; range 40-80%), and false positives (59%) were significantly greater than false negatives detected (41%).

Wild, J., Maher, J., Frazee, R.C., et al. (2012). The Fort Hood Massacre: Lessons Learned From a High Profile Mass Casualty. (Abstract only). Journal of Trauma and Acute Care Surgery. 72(6):1709-13.

The authors discuss lessons learned from the mass shooting at Fort Hood in 2009. They note that triage was compromised because the scene was not secure for responders, and this led to under triage of several patients.

Wydo, S.M., Seamon, M.J., Melanson, S.W., et al. (2016). Portable Ultrasound in Disaster Triage: A Focused Review. (Abstract only.) European Journal of Trauma and Emergency Surgery. 42(2):151-9.

The authors present their literature review regarding the application of sonography in mass casualty incidents (MCI) and disaster scenarios, focusing on the most promising and practical ultrasound-based paradigms applicable in these settings.

Plans, Tools, and Templates

*Committee for Tactical Emergency Casualty Care (C-TECC). (2015). Pediatric Tactical Emergency Casualty Care.

This resource provides guidelines for the immediate on-scene stabilization of victims, depending on whether or not there is an ongoing threat to safety.

* Committee for Tactical Emergency Casualty Care (C-TECC). (2017). Tactical Emergency Casualty Care (TECC) Guidelines for BLS/ALS Medical Providers.

Combat Casualty Care guidelines were adapted to create these civilian-specific medical guidelines for high-threat operations. The guidelines are organized by 3 phases of care: Direct Threat Care; Indirect Threat Care; and Evacuation Care.

*County of San Luis Obispo Health Authority, Public Health Department. (2017). MCI Plan-Key Points for First Responders.

This Emergency Medical Service (EMS) bulletin provides direction for the triage and transport of MCI victims. The protocol designates the START/JumpSTART algorithms for primary triage, and instructs EMS providers to use more detailed Trauma Triage Criteria during secondary triage on-scene.

*County of Santa Clara Emergency Medical Services. (2015). Field Treatment Site Operations Guide.

This plan is an annex to the county's Multiple Patient Management Plan and describes the setup, management, and utilization of a Field Treatment Site (FTS) during a multiple patient event. The FTS will be used to provide treatment to appropriate (i.e., those not needing immediate transfer to a trauma center) victims after they have been triaged using the START algorithm at a Casualty Collection Point when demand exceeds available transportation resources.

Critical Illness and Trauma Foundation. (2001). The Triage Tag.

Responders can duplicate these free triage tags and use them to categorize patients (by color and status) in a mass casualty incident.

*Critical Illness and Trauma Foundation. (2001). START Triage-Flowchart.

This resource provides a graphic of the START triage system. Detailed and simplified flowcharts are included.

Los Angeles County Emergency Medical Services Agency (EMS). (2012). Pediatric Surge Quick Reference Guide.

This document contains summaries of critical information for managing the care of children during emergencies or disasters, including vital signs; risks during disasters; signs of respiratory distress; equipment sizes; and fluid resuscitation.

Metropolitan EMS Board – Minnesota. (2012). Incident Response Plan.

This brief job action sheet has been adopted by the 24 agencies in the Minneapolis / St. Paul area for rapid reference by arriving ambulances to a mass casualty incident scene. It emphasizes initial tasks, staging, and rapid transport.

National Center for Disaster Preparedness and Public Health, Uniformed Services University. (n.d.) SALT Mass Casualty Triage Algorithm (Sort, Assess, Lifesaving Interventions, Treatment/Transport). (Accessed 8/3/2017).

This resource is a graphic of the SALT algorithm.

National Center for Injury Prevention and Control. (2011). Decision Scheme: 2011 Guidelines for Field Triage of Injured Patients.

This poster can help emergency medical services providers determine when patients may need to be transported to trauma centers with specific capabilities.

*Oregon State Area Trauma Advisory Board # 6 and Washington State Southwest Regional EMS. (2012). Mass Casualty Incident Plan Initial Response Guide.

This plan was prepared to ensure successful coordination between more than one pre-hospital agency and more than one hospital in the state trauma region. Triage and immediate care for victims of a mass casualty incident are discussed.

*Santa Barbara County (CA). (2013). Multi-Casualty Incident (MCI) Response Plan.

This plan describes policies and procedures for managing mass casualty incidents, including those related to on-scene coordination, triage, and treatment.

*Texas Trauma Service Area (TSA) B. (2016). Trauma Service Area - B (BRAC): Regional Pediatric Plan.

This plan provides prehospital and hospital providers with regional standardized procedures for the treatment of pediatric patients. It addresses various issues to include: prehospital triage, helicopter activation, inter-hospital transfers, pediatric trauma triage/ transfer decision scheme, among others topics.

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 College of Emergency Physicians. Mass Casualty Incidents Fact Sheet.

American College of Surgeons, The Committee on Trauma. Stop the Bleed: Resources for Saving a Life.

American Trauma Society. Trauma Information Exchange Program.

Committee for Tactical Emergency Casualty Care.

National Association of Emergency Medical Technicians. NAEMT Education.

National Disaster Life Support Foundation. Advanced Disaster Life Support.

National Disaster Life Support Foundation. Basic Disaster Life Support.

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