GLOBAL EDITION

International Trauma Life Support
for Emergency Care Providers

NINTH EDITION

Roy L. Alson, PhD, MD, FACEP, FAEMS
Kyee H. Han, MBBS, FRCS, FRCEM
John E. Campbell, MD, FACEP

Ninth Edition
Global Edition

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Cover Photos: lem/Shutterstock
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Printing and Binding: Vivar, Malaysia

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Authorized adaptation from the United States edition, entitled *International Trauma Life Support for Emergency Care Providers*, 9th Edition, ISBN 978-0-13-537931-8 by Roy L. Alson, Kyee H. Han, and John E. Campbell, published by Pearson Education © 2020.

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ISBN 10: 1-292-35767-3

ISBN 13: 978-1-292-35767-6

uPDF ISBN 13: 978-1-292-35768-3

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

1 21

Typeset in Palatino LT Pro 10/12 by SPi Global

Notice on Care Procedures

It is the intent of the authors and publisher that this textbook be used as part of an education program taught by qualified instructors and supervised by a licensed physician, in compliance with rules and regulations of the jurisdiction where the course is being offered. The procedures described in this textbook are based upon consultation with emergency care providers including EMTs, paramedics, nurses, and physicians, who are actively involved in prehospital care. As a field, prehospital medicine is constantly evolving. The authors and publisher have taken care to make certain that these procedures reflect currently accepted clinical practice; however, the procedures cannot be considered absolute recommendations, nor do they supersede applicable local laws or rules and the medical supervision of the prehospital provider.

The material in this textbook contains the most current information available at the time of publication. However, international, national, federal, state, provincial, and local guidelines concerning clinical practices, including, without limitation, those governing infection control and universal precautions, change rapidly. The reader should note, therefore, that new regulations may require changes in some procedures.

The references to products in this text do not represent an official endorsement by ITLS. Efforts have been made to include multiple types of devices, for illustrative purposes, when possible. It is impossible to include in this text an example of every type of device. As in other areas of medicine, there is ongoing development of equipment for use in the care of the prehospital trauma patient, which the authors and editors believe is good. It remains the responsibility of the ITLS provider in conjunction with local medical direction to determine which specific devices are applicable in their specific practice setting.

It is the responsibility of the reader to familiarize himself or herself with the policies and procedures set by federal, state, provincial, and local agencies as well as the institution or agency where the reader is employed. The authors and the publisher of this textbook and the supplements written to accompany it disclaim any liability, loss, or risk resulting directly or indirectly from the suggested procedures and theory, from any undetected errors, or from the reader's misunderstanding of the text. It is the reader's responsibility to stay informed of any new changes or recommendations made by any national, federal, state, provincial, and local agency as well as by his or her employing institution or agency.

Notice on Gender Usage

The English language has historically given preference to the male gender. Among many words, the pronouns, he and his are commonly used to describe both genders. Society evolves faster than language, and the male pronouns still predominate our speech. The authors have made great effort to treat the two genders equally, recognizing that a significant percentage of EMS providers are female. However, in some instances, male pronouns may be used to describe both males and females solely for the purpose of brevity. This is not intended to offend any readers of the female gender.

Notice on Prehospital Personnel Designation

Around the world, the credentialing and training of personnel who provide prehospital care vary greatly. In some jurisdictions, physicians and nurses respond as part of the EMS crew, whereas in other areas, those responding may only be trained to a basic life support (BLS) level. As the principles of care of the multiple trauma patient are the same regardless of the level of training of the persons providing care, the authors and publisher have attempted to describe those care providers in generic terms throughout the book. Common terms in English such as *medic* or *emergency medical responder* are, in some jurisdictions, actual certification levels of personnel. The term *emergency care provider* is used in this text to describe all levels of personnel who provide care in the prehospital setting. When other common terms are used to refer to persons providing care, it is intended to represent all persons who provide prehospital care and not to exclude or offend any care provider.

Dedication

Dr. John Campbell
1943–2018
Founder, President and Patriarch, Philanthropist and Altruist,
Teacher and Mentor, Friend

Known worldwide for his ground-breaking work in developing prehospital trauma education, Dr. Campbell founded the Basic Trauma Life Support (BTLS) program in 1982. It was the first course and curriculum dedicated to prehospital trauma assessment and trauma care worldwide. Dr. Campbell conducted the first BTLS course at Southeast Alabama EMS System on August 23, 1982. The goal of the first BTLS course was to provide the student the knowledge and experience to recognize, assess, and care for critical trauma patients and ensure timely transport to the emergency department. Students were taught to identify conditions requiring "load and go." From its beginning, patient assessment has been the core of the BTLS/ITLS curriculum.

ITLS had humble beginnings in Alabama as a local course developed by Dr. Campbell for paramedics to learn the principles of Advanced Trauma Life Support (ATLS) to improve the care provided to trauma patients. ITLS is now a worldwide organization offering 15 types of trauma courses and teaching more than 30,000 students annually in more than 40 countries across the globe. Dr. Campbell's work has touched more than 800,000 trauma care providers worldwide since the program began and the millions of patients they care for.

From its very beginning, Dr. Campbell's program was based on current research while maintaining a conservative and noncontroversial approach. He wanted the course to be simple, practical, and short enough to be taught in 2 days. Dr. Campbell also recognized the importance of allowing the course to be adapted for regional differences among local EMS systems.

"I'm speechless to think of this and I can't believe that this little course has come this far," Dr. Campbell once said about the growth of ITLS worldwide. "It's just an idea whose time had come, and I just happened to be, by accident, the one who was there when it started. It's still as important now as it was then."

Dr. Campbell leaves behind a legacy of unfailing dedication and excellence in trauma care. He will be missed by the thousands of students, instructors, colleagues, and friends whose lives he touched, personally and professionally, through the reach of ITLS training and education.

International Trauma Life Support will continue to advance Dr. Campbell's mission of improving trauma care worldwide by continuing to develop innovative curricula, programs, and services that are evidence based, flexible, and assessment focused for trauma care providers and the patients they serve. The ITLS Board of Directors and Editorial Board will continue under the leadership of Board Chair Jonathan L. Epstein, MEMS, NRP, of Massachusetts, and Editor-in-Chief Roy L. Alson, PhD, MD, FACEP, FAEMS, of North Carolina.

International Trauma Life Support (ITLS) announced the passing of our Founder and President, John Emory Campbell, MD, FACEP of Alabama, in August 2018. Dr. Campbell passed away in his home after a long illness. He was 75 years old.

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About the Editors

Roy L. Alson, *PhD, MD, FACEP, FAEMS*

Dr. Roy L. Alson is a Professor Emeritus of Emergency Medicine at Wake Forest University School of Medicine and the former Director of the Office of Prehospital and Disaster Medicine, also at Wake Forest. He is also an Associate Professor at the Childress Institute for Pediatric Trauma at Wake Forest University and an Adjunct Associate Professor in the Department of Military Medicine at Rocky Vista University College of Osteopathic Medicine, in Parker, Colorado. Dr. Alson received his bachelor's degree from the University of Virginia in 1974 and both his PhD and MD from the Bowman Gray School of Medicine of Wake Forest University (1982, 1985). He completed his residency in emergency medicine at Allegheny General Hospital in Pittsburgh, Pennsylvania, and is board certified in both emergency medicine and emergency medical services by the American Board of Emergency Medicine.

Dr. Alson's EMS career began in the early 1970s as an EMT in New York City. As a graduate student, he became a member of the Winston-Salem Rescue Squad and began working for the Forsyth County EMS as an EMT. Upon completion of his residency, Dr. Alson returned to Wake Forest University and the Forsyth County EMS system, serving as Assistant Medical Director for 14 years and Medical Director from 2003 to 2019. He remains actively involved in the education of EMS personnel.

Dr. Alson's involvement with ITLS dates to the 1980s. He served as the North Carolina Chapter Medical Director for 15 years. Since the early 1990s, Dr. Alson has been a member of the editorial board for ITLS as well as a contributing author. He was the co-Editor-in-Chief for the eighth edition of this textbook.

Along with EMS, disaster medicine is an area of interest. Dr. Alson served as the Medical Director for the North Carolina State Medical Response System (NC SMAT) program. He has served as the Chairman of the Disaster Preparedness and Response Committee for the American College of Emergency Physicians from 2011 until 2016, a member of the EMS Committee for ACEP, and as a member of the EMS Committee for the American Academy of Emergency Physicians. Dr. Alson was the Chairman for the NAEMSP Disaster Preparedness Committee in 2014–2016.

Dr. Alson served with the National Disaster Medical System (NDMS) for 28 years, most recently as a member of the International Medical Surgical Response Team East (IMSURT-E). He previously served as the Commander and Deputy Commander for the North Carolina Disaster Medical Assistance Team (NC-DMAT-1) and Deputy Commander of the NMRT-E

Dr. Alson has responded to numerous nationally declared disasters. He continues to teach about the delivery of care in austere and surge-type conditions and has lectured nationally and internationally on prehospital trauma care and disaster medicine.

He and his wife, Rebecca, reside in Winston-Salem, North Carolina.

Kyee H. Han, *MBBS, FRCS, FRCEM*

Dr. Kyee H. Han is a Consultant in Trauma and Emergency Medicine at the James Cook University Hospital, in Middlesbrough, which is a Regional Major Trauma Centre in the North East of England. He is also Honorary Medical Director to the North East Ambulance Service NHS Foundation Trust. Dr. Han completed his undergraduate medical training at the Institute of Medicine in Rangoon, Burma, in 1976. Following his internship and Senior House Officer surgical rotational training in Birmingham, UK, he worked as a Surgical Registrar and was awarded the FRCS in 1981. After gaining cardiothoracic surgical experience in Leicester, Dr. Han decided to pursue a career in an up-and-coming specialty then known as Accident and Emergency Medicine (A&E) in the UK. He entered the Northern Deanery residency/specialist training program at the Royal Victoria Infirmary (RVI) in Newcastle upon Tyne and Middlesbrough General

Hospital (MGH). On receiving his Certificate of Completion in Specialist Training (CCST), Dr. Han was appointed as Consultant at MGH in 1990. Over his working life as an emergency physician, he has taken on many management, training, and advisory roles including the positions of Clinical Director in A&E, Honorary Senior Lecturer at Newcastle University, Chairman of the Specialist Training Committee for the Northern Deanery, and College Examiner and Regional Chair for the Royal College of Emergency Medicine Board. Dr. Han also served on the Board for the North Tyneside Clinical Commissioning Group as Secondary Care Specialist Doctor.

Management of the acutely injured has been Dr. Han's interest and passion. Realizing very early in his career how prehospital care can influence patient outcome, he has always dedicated considerable time in prehospital training of the EMS (ambulance, fire, police) and voluntary agencies like the St. John Ambulance. For his years of service as County Surgeon and County Medical Officer, he was awarded the status of Officer (Brother) in the Order of St. John in 2004. Regionally, Dr. Han is a trustee on the board of Great North Air Ambulance Service (GNAAS), which is a publicly funded organization serving the North of England with the Helicopter Emergency Medical Service (HEMS). It deploys a physician and paramedic team to provide enhanced medical care on scene.

Dr. Han's involvement with ITLS dates to 1995. He served as the Chapter Medical Director for Tees East and North Yorkshire and the Cleveland Fire and Rescue Service Training Centre and currently as the Chapter Medical Director for North East England. Since 2011, he has been an Editorial Board member as well as a contributing author. He leads the research work group and the research forum, which is an integral part of the annual international trauma conference.

Throughout his career, Dr. Han has always actively welcomed, promoted, and collaborated with any prehospital emergency service capable of enhancing the outcome of patients. Internationally, he led a UK team of ITLS instructors to train the trainers in Lilongwe, Malawi, twice. This training has since been cascaded to trauma care providers in all parts of Malawi, where incidence of trauma and mortality are high. More recently, the ITLS Board of Directors envisioned piloting a Regional ITLS Forum in Europe and Dr. Han co-chairs the group, successfully bringing the European ITLS family closer. With this edition, he joins Professor Alson as Associate Editor.

He and his wife, Sally, reside in Norton, Stockton on Tees, United Kingdom.

John E. Campbell, MD, FACEP

Dr. Campbell received his BS degree in pharmacy from Auburn University in 1966 and his medical degree from the University of Alabama at Birmingham in 1970. He was in the practice of emergency medicine for 40 years, practicing in Alabama, Georgia, New Mexico, and Texas. Dr. Campbell became interested in prehospital care in 1972 when he was asked to teach a basic EMT course to members of the Clay County Rescue Squad where he was still an honorary member at the time of his death. Dr. Campbell also served as medical director of many EMT and paramedic training programs. He was also the Medical Director for EMS and Trauma for the State of Alabama.

From the original basic trauma life support course, an international organization of teachers of trauma care developed called "International Trauma Life Support, Inc.," or ITLS. Dr. Campbell was its president since the inception of the organization.

Dr. Campbell was the author of the first edition of the *Basic Trauma Life Support* textbook and continued to be the editor through to the eighth edition, now entitled *International Trauma Life Support for Emergency Care Providers*. He also coauthored *Homeland Security and Emergency Medical Response* and *Tactical Emergency Medical Essentials*.

Dr. Campbell was a member of the first faculty of Emergency Medicine at the School of Medicine at the University of Alabama at Birmingham. In 1991 he was the first recipient of the American College of Emergency Medicine's EMS Award for outstanding achievement of national significance in the area of EMS. In 2001 Dr. Campbell received the Ronald D. Stewart Lifetime Achievement Award from the National Association of EMS Physicians. He died in August 2018.

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Organization of This Book

The ninth edition of *International Trauma Life Support for Emergency Care Providers* has been reorganized to reflect a more functional approach to the assessment and management of the trauma patient in the prehospital environment. The book is divided into four sections.

Section I, "Essential Information," includes Chapters 1–7. These topics are core to the care of the trauma patient and include mechanism of injury, assessment of the trauma patient, hemorrhage control, and shock and airway management. Following each didactic chapter on a clinical topic is a chapter that reviews the essential skills needed to manage the clinical situation.

Section II, "Foundational Knowledge," includes Chapters 8–16. Topics include assessment and management of injuries to specific body areas: chest trauma, abdominal trauma, spinal injuries and spinal motion restriction, extremity trauma, and traumatic cardiac arrest. Chapters covering specific skills follow the didactic material.

The chapters in Section III, "Special Populations," include burn patients, older adults, pediatric and pregnant patients, and patients under the influence of intoxicating substances.

The final section, available online or in text, covers other important areas: standard precautions, pain control, multicasualty triage, trauma scoring, air medical, drowning, heat and cold injuries, advanced skills, and overview of tactical medical care.

What's New in This Edition

The ninth edition of *International Trauma Life Support for Emergency Care Providers* has been updated to provide the emergency care provider with information on the latest and most effective approaches in the care of the trauma patient. The science of trauma is constantly evolving, and the authors, in collaboration with the research working group at ITLS, have updated the text with the latest information that is pertinent to the initial care of the trauma patient.

This is the first edition without the presence of Dr. John Campbell, FACEP, the founder of ITLS and the first Editor in Chief. Dr. Campbell passed away in 2018 after a long and valiant battle with cancer. This text strives to continue his focus on providing the emergency care provider with the knowledge and skills to render to trauma patients the best possible care.

Also new to this edition is the editorial assistance of Dr. Kyee Han, Consultant in Accident and Emergency Medicine, who has joined Dr. Alson as the Associate Editor of the text. Dr. Han has extensive experience in EMS care and education and has been a contributor to the ITLS text and course for over 20 years.

The text again conforms to the American Heart Association/International Liaison Committee of Resuscitation (AHA/ILCOR) guidelines, as well as those put forth by the Committee on Trauma of the American College of Surgeons, as well as position statements from the National Association of EMS Physicians, the Committee for Tactical Emergency Casualty Care, the American College of Emergency Physicians, and other international advisory groups.

Some of the chapter-by-chapter key components and changes are:

- The *Introduction* explains the concept of the "Golden Period" and why it remains important to what we do as emergency care providers.
- *Chapter 1* continues to emphasize scene safety and the concept that trauma care as a team effort involving many disciplines as central components. The chapter now includes a discussion of the changes in response put forth by the Hartford Consensus.
- *Chapter 2* includes minor changes in the assessment sequence based on feedback from ITLS instructors and providers. It also reinforces the importance of identifying and controlling hemorrhage at the start of the assessment. As the leader performs the assessment, he or she will delegate responses to abnormalities found in the initial assessment. This is to reinforce the rule that the leader must not interrupt the assessment to deal with problems but must delegate the needed actions to team members. This emphasizes the team concept and keeps on-scene time at a minimum. The order of presentation of the three assessments (ITLS–Primary Survey, ITLS Reassessment Exam, and ITLS Secondary Survey) has been changed. The ITLS Reassessment Exam is performed before the ITLS Secondary Survey, a more common situation, and may replace it. The chapter also mentions the use of fingerstick serum lactate levels and prehospital abdominal ultrasound exams as ways to better identify patients who may be in early shock.
- The assessment skills in *Chapter 3* reflect the changes in Chapter 2.

- *Chapter 4* includes an updated discussion of hemorrhagic shock to once again reflect the latest experience of the military during recent conflicts. A discussion of the role of tranexamic acid (TXA) in the management of hemorrhage has been added as well as the need to limit crystalloid infusion to prevent hemodilution of clotting factors. Emphasis on fluid resuscitation in the field is to restore perfusion, not normalize vital signs.
- *Chapter 5* covers the skills associated with hemorrhage control including wound packing, use of hemostatic agents, and early application of tourniquets. It also reviews intraosseous access.
- *Chapter 6* again stresses capnography as the standard for confirming and monitoring the position of the endotracheal tube as well as the best way to assess for hyperventilation or hypoventilation. The volume of air delivered with each ventilation now emphasizes the response of the patient (rise and fall of the chest), rather than a fixed volume amount.
- *Chapter 7* discusses the importance of properly positioning the patient to improve successful airway management and reinforces the key role of supraglottic airways (SGAs) in basic airway management. The chapter also includes a discussion of video intubation as a tool for difficult airways and reviews drug-assisted intubation.
- *Chapter 8* reviews the indications for needle decompression of tension pneumothorax and pericardiocentesis when such procedures are in the emergency care provider's scope of practice. It also discusses the use of ultrasound to identify such injuries and also to identify a pneumothorax.
- *Chapter 9* covers needle decompression of the chest for a tension pneumothorax, reflecting challenges faced by tactical EMS providers, as well as the use of chest seals. Three-sided taping of field-expedient chest seals is replaced with four-sided taping and use of needle decompression.
- *Chapters 11 and 12* now reflect current science and evolution of when to apply spinal motion restriction based on published guidelines. Emphasis is on the use of the backboard as a transfer device and the transport of a patient on a backboard is now discouraged. These chapters also include how to remove the patient from the backboard once placed on a transport stretcher.
- *Chapter 13* now includes pelvic fractures, reflecting the association of these injuries with concurrent abdominal injuries. The chapter also discusses application of pelvic binders and reviews the use of fingerstick serum lactate levels and the use of prehospital abdominal ultrasound exams.
- *Chapter 14* reviews the management of bleeding from extremity injuries, including a discussion of hemostatic agents.
- *Chapter 15* reviews procedures for use of a tourniquet and use of hemostatic agents and includes a discussion of pelvic binders for pelvic fractures.
- *Chapter 16* now includes an algorithm for management of traumatic cardiac arrest. Again, the chapter also reviews indications for termination of resuscitation for the trauma patient in the prehospital setting.
- *Chapter 19* now includes a discussion of the ways in which advancing age increases mortality and identifies it as an independent risk factor for needing trauma center care.
- Appendices: Online at Student Resources Page (www.pearsonglobaleditions.com) and/or in-text
  - —Added a section on pain control in the prehospital setting
  - —Updated section on drowning and hypothermia (online)
  - —Bloodborne pathogens has been moved to online
  - —Tactical EMS has been revised to reflect current thinking within the Hartford Consensus (online)
  - —Additional skills includes surgical cricothyrotomy (online)
  - —Videos (online) demonstrating
    - Cricothyrotomy: needle and surgical
    - Wound packing
    - Tourniquet application
    - Chest seal application
    - IO insertion—electric and manual
    - Needle decompression of tension pneumothorax
    - Supraglottic airway insertion
    - Log roll
    - Scoop stretcher

Note on Skills and Terminology

Prehospital personnel around the world vary in their permitted scope of practice, based on local regulations. This textbook may at times describe procedures that are outside the permitted scope of practice. Completion of an ITLS course should not be construed as permission for an emergency care provider to exceed their permitted scope of practice. Ultimately, the final arbiter of what the emergency care provider is permitted to do is determined by the physician medical director (advisor) for the EMS system.

The text has attempted to be gender neutral in describing personnel. In places where it is not, it should not be construed as diminishing the ability of any one person to perform the skills needed to provide emergency care.

Throughout the world, there are many terms used to describe those who provide emergency care to the victims of injury and illness. In this text, we use emergency care provider to describe such individuals. When used, the terms "first responder" and "emergency medical technician (EMT)" refer to personnel trained at a basic life support level, while "paramedic" refers to personnel trained at an advanced life support level.

As has been said before, EMS constantly undergoes changes. Things that were only ideas a couple of years ago are now in common use. This change in technology and resources will only continue to grow. As this book goes to press, we note the markedly increasing use of point-of-care ultrasound to help identify life threatening injuries and help with determination of destination for trauma patients. EMS agencies and helicopter emergency medical services are beginning to carry blood for transfusion when dealing with a patient in shock due to blood loss. Retrograde endovascular balloon occlusion of the aorta (REBOA), which acts like cross clamping of the aorta during a thoracotomy, is showing promise as an intervention for patients with massive internal hemorrhage. At this point however, civilian field use is limited to those systems where there is an EMS physician on scene who is trained in use of the device. At this time, ITLS has not included discussion of REBOA in the text due to the limited availability of this device to EMS personnel.

Acknowledgments

The creation of a text and course is a major undertaking and could not be done without the effort of many. For many of those involved, this is a true labor of love. We want to give special thanks to the following friends of ITLS who provided invaluable assistance with ideas, reviews, and corrections of the text. This was such a big job, and there were so many people who contributed that we are sure we have left someone out. Please accept our apologies in advance.

We wish to thank the following EMS professionals who reviewed material especially for this ninth edition of *International Trauma Life Support for Emergency Care Providers*. Their assistance is appreciated.

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We wish to thank Jill Rembetski, our development editor, for her patience and for "herding the cats."

Another special thanks goes to the following photographers who donated their work to help illustrate the text:

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Sabina Braithwaite, MD, FACEP
James Broselow, MD
Brant Burden, EMT-P
Anthony Cellitti, NRP
Alexandra Charpentier, EM-P
Leon Charpentier, EMT-P
Stanley Cooper, EMT-P
Delphi Medical
Pamela Drexel, Brain Trauma Foundation
Ferno Washington, Inc.
Peter Gianas, MD
Peter Goth, MD
KING Airway Systems
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Introduction to the ITLS Course

Trauma, the medical term for *injury*, has become the most expensive health problem in the United States and most other countries. In the United States, trauma is the fourth leading cause of death for all ages and the leading cause of death for children and adults under the age of 45. Trauma causes 73% of all deaths in the 15- to 24-year-old age group. For every fatality, there are 10 more patients admitted to hospitals and hundreds more treated in emergency departments. The price of trauma, in both physical and fiscal resources, mandates that all emergency medical services (EMS) personnel learn more about this disease to treat its effects and decrease its incidence.

Because the survival of trauma patients is often determined by how quickly they get definitive care in the operating room, it is crucial that you know how to assess and manage the critical trauma patient in the most efficient way. The purpose of the ITLS course is to teach you the most rapid and practical method to assess and manage critical trauma patients. The course is a combination of written chapters to give you the "why" and the "how" and practical exercises to practice your knowledge and skills on simulated patients so that at the end of the course you feel confident in your ability to provide rapid lifesaving trauma care.

Philosophy of Assessment and Management of the Trauma Patient

Severe trauma, along with acute coronary syndrome and stroke, is a time-dependent disease. The direct relationship between the timing of definitive (surgical) treatment and the survival of trauma patients was first described by Dr. R. Adams Cowley of the famous Shock-Trauma Center in Baltimore, Maryland. He discovered that when patients with serious multiple injuries were able to gain access to the operating room within an hour of the time of injury, the highest survival rate was achieved. He referred to this as the "Golden Hour." Over the years we have found that some patients (such as penetrating trauma to trunk) do not have a golden hour but rather a shorter period of minutes, whereas many patients with blunt trauma may have a golden period longer than an hour. It has been suggested that we now call the prehospital period the "Golden Period" because it may be longer or shorter than an hour.

The Golden Period begins at the moment the patient is injured, not at the time you arrive at the scene. Much of this period has already passed when you begin your assessment, so you must be well organized in what you do. In the prehospital setting it is better to think of the Golden Period for on-scene care as being 10 minutes. In those 10 minutes, you must identify live patients, make treatment decisions, and begin to move patients to the appropriate medical facility. This means that every action must have a lifesaving purpose. Any action that increases scene time but is not potentially lifesaving must be omitted. Not only must you reduce evaluation and resuscitation to the most efficient and critical steps, but you also must develop the habit of assessing and treating every trauma patient in a planned logical and sequential manner so you do not forget critical actions.

When performing patient assessment, it is best to proceed in a "head-to-toe" manner so that nothing is missed. If you jump around during your assessment, you will inevitably forget to evaluate something crucial. Working as a team with your partner is also important because many actions must be done at the same time.

It has been said that medicine is a profession that was created for obsessive–compulsive people. Nowhere is this truer than in the care of the trauma patient. Often the patient's life depends on how well you manage the details. It is very important to remember that many of the details necessary to save the patient occur before you even arrive at the scene of the injury.

You or a member of your team must:

- Know how to maintain your ambulance or rescue vehicle so that it is serviced and ready to respond when needed.
- Know the quickest way to the scene of an injury. Use of global positioning satellite (GPS) navigation has been shown to decrease not only the time to respond but also the time of transport.
- Know how to size up a scene to recognize dangers and identify mechanisms of injury.
- Know which scenes are safe and, if not safe, what to do about them.
- Know when you can handle a situation and when to call for help.
- Work effectively as a team so the care provided is appropriate and effective.

- Know when to approach the patient and when to leave with the patient.
- Know your equipment, and maintain it in working order.
- Know the most appropriate hospital and the fastest way to get there. (Organized trauma systems and transfer/bypass guidelines can shorten the time it takes to get a trauma patient to definitive care.)

As if all that were not enough, you also have to:

- Know where to put your hands, which questions to ask, what interventions to perform, when to perform them, and how to perform critical procedures quickly and correctly.

If you think the details are not important, then leave the profession now. Our job is saving lives, a most ancient and honorable profession. If we have a bad day, someone will pay for our mistakes with suffering or even death. Since the early beginnings of emergency medical services, patients and even rescuers have lost their lives because attention was not paid to the details listed here. Many of us can recall patients that we might have saved if we had been a little smarter, a little faster, or a little better organized. Make no mistake, there is no "high" like saving a life, but we carry the scars of our failures all our lives.

Your mindset and attitude are very important. You must be concerned but not emotional, alert but not excited, quick but not hasty. Above all, you must continuously strive for what is best for your patient. When your training has not prepared you for a situation, always fall back on the question, *What is best for my patient?* When you no longer care, burnout has set in and your effectiveness is severely limited. When this happens, seek help. (Yes, all of us need help when the stress overcomes us.) Or seek an alternative profession.

Since 1982, the International Trauma Life Support (ITLS, formerly BTLS) organization has been identifying the best methods to get the most out of those few minutes that prehospital EMS providers have to save the patient's life. Not all patients can be saved, but our goal is never to lose a life that could have been saved. The knowledge in this book can help you make a difference. Learn it well.

About ITLS

International Trauma Life Support is a global not-for-profit organization dedicated to preventing death and disability from trauma through education and emergency trauma care.

The Smart Choice for Trauma Training

Train with the best. Train with ITLS. Together, we are improving trauma care worldwide. International Trauma Life Support—a not-for-profit organization dedicated to excellence in trauma education and response—coordinates ITLS education and training worldwide. Founded in 1985 as Basic Trauma Life Support, ITLS adopted a new name in 2005 to better reflect its global role and impact. Today, ITLS has more than 80 chapters and training centers around the world. Through ITLS, hundreds of thousands of trauma care professionals have learned proven techniques endorsed by the American College of Emergency Physicians.

ITLS is the smart choice for your trauma training because it is:

- *Practical.* ITLS trains you in a realistic, hands-on approach proven to work in the field—from scene to surgery.
- *Dynamic.* ITLS content is current, relevant, and responsive to the latest thinking in trauma management.
- *Flexible.* ITLS courses are taught through a strong network of chapters and training centers that customize content to reflect local needs and priorities.
- *Team centered.* ITLS emphasizes a cohesive team approach that works in the real world and recognizes the importance of your role.
- *Grounded in emergency medicine.* Practicing emergency physicians—medicine's frontline responders—lead ITLS efforts to deliver stimulating content based on solid emergency medicine.
- *Challenging.* ITLS course content raises the bar on performance in the field by integrating classroom knowledge with practical application of skills.

Focused Content That Delivers

ITLS empowers you with the knowledge and skill to provide optimal care in the prehospital setting. It offers a variety of training options for all levels and backgrounds of emergency personnel around the world. ITLS courses combine classroom learning, hands-on skills stations, and assessment stations that put your learning to work in simulated trauma situations. Not only are courses taught as a continuing education option, but they are also used as essential curricula in many paramedic, EMT, and first responder training programs.

International Trauma Life Support Courses

ITLS Basic

ITLS Basic is designed for the Emergency Medical Technician (EMT-Basic) and the emergency care responder. This hands-on training course offers basic EMS providers complete training in the skills necessary for rapid assessment, resuscitation, stabilization, and transportation of the trauma patient. The course provides education in the initial evaluation and stabilization of the trauma patient.

ITLS Advanced

ITLS Advanced is a comprehensive course covering the skills necessary for rapid assessment, resuscitation, stabilization, and transportation of the trauma patient for advanced EMTs, paramedics, and trauma nurses. The course teaches the correct sequence of evaluation and the techniques of critical intervention, resuscitation, and packaging of a patient.

ITLS Combined

Many ITLS courses choose to train both Advanced- and Basic-level providers. In the ITLS Combined courses, the Basic-level providers partake of all didactic sessions and observe the advanced skill stations.

ITLS Military

The ITLS Military Provider course combines the fundamentals of ITLS trauma assessment and treatment with recent military innovations utilized in the world's current war zones. The course adapts proven techniques taught in the civilian ITLS course to the military environment, where limited resources are the rule, not the exception.

eTrauma

ITLS eTrauma covers the 8 hours of ITLS Provider classroom instruction providing online training on the core principles of rapid assessment, resuscitation, stabilization, and transportation of trauma patients. ITLS eTrauma is offered at both the Basic and Advanced levels. At the completion of eTrauma, the learner receives 8 hours of CEUs from CECBEMS and is qualified to take the ITLS Completer course that will lead to ITLS certification.

Completer Course

The ITLS Completer course is for the learner who has successfully completed eTrauma and wishes to become ITLS certified. The Completer course covers 8 hours of skills learning and assessment as well as the ITLS written post course exam.

Provider Recertification

This course provides continuing education in ITLS for the experienced provider who has already completed the Basic or Advanced course. Sample course agendas are available in the eighth edition ITLS Coordinator and Instructor Guide or from the International Office.

ITLS Instructor Bridge Course

The ITLS Instructor Bridge Course is designed for the instructor who has successfully completed an Advanced Trauma Life Support (ATLS) or Pre-hospital Trauma Life Support (PHTLS) instructor course and wishes to transition to the ITLS program. The course typically runs 8 hours, and a sample course agenda is available in the eighth edition ITLS Coordinator and Instructor Guide or from the International Office. Following completion of an ITLS Bridge course, a candidate must be monitored teaching an ITLS provider course to complete the steps to become an ITLS instructor.

ITLS Provider Bridge Course

The ITLS Provider Bridge Course is designed for the provider who has successfully completed a PHTLS, ATT, or TNCC course and wishes to transition to the ITLS program. The course typically runs 8 hours. A sample course agenda is available in the eighth edition ITLS Coordinator and Instructor Guide or from the International Office.

ITLS Access

This ITLS Access course provides EMS crews and first responders with training to utilize the tools commonly carried on an ambulance or first responder unit to reach entrapped patients and begin stabilization and extrication.

ITLS Pediatric

ITLS Pediatric concentrates on the care of injured children. The course is designed to train EMS and nursing personnel in the proper assessment, stabilization, and packaging of a pediatric trauma patient. The course also covers communication techniques with pediatric patients and parents.

ITLS Instructor Courses

ITLS Instructor courses are offered for both ITLS Advanced and ITLS Basic courses. Other methods of achieving instructor status are used for ITLS Pediatric and ITLS Access courses. To become an instructor, students must have successfully completed the provider-level course with specific requirements on both the written and practical exams and be monitored teaching the lecture, skills, and testing portions of the Provider course.

Enrolling in an ITLS Course

ITLS provides its courses through chapters and training centers. The ITLS Course Management System makes it easy to find a course in your area. Log on to *cms.itrauma.org* to search for courses and contact the course administrator to register.

If you need information about your local chapter or training center, check our list at *itrauma.org* or call ITLS headquarters at 888-495-ITLS or +1-630-495-6442 (for international callers). We will put you in touch with your local organization—or help you start a program in your area.

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Introduction to Traumatic Disease

(Jack Dagley Photography/Shutterstock)

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Einführung in die Traumatologie
Introducción al Trauma como Enfermedad
Introducción a la Enfermedad Traumática
Uvod u traumatsku bolest
Introdução ao Trauma
Pengantar Pada Penyakit Traumatis
Введение Оценка места происшествия
Introduction aux lésions d'origines traumatiques
Εισαγωγή στο Τραύμα
Bevezetés a sérült ellátásba
外傷性疾患の概要
創傷疾病介紹
Poškodbe

Key Terms

blast injury, *p. 35*
blunt trauma, *p. 27*
committee for tactical emergency casualty care (C-TECC), *p. 26*
disease, *p. 27*
essential equipment, *p. 26*
focused exam, *p. 23*
high-energy event, *p. 28*
index of suspicion, *p. 28*
ITLS Primary Survey, *p. 23*
kinetic energy (KE), *p. 27*
mass casualty incident, *p. 23*
mechanism of injury (MOI), *p. 27*
occupant restraint systems, *p. 30*

Objectives

Upon successful completion of this chapter, you should be able to:

1. Identify the most common causes of death due to traumatic injury.
2. Summarize the components of scene size-up.
3. Describe the role of scene size-up in provider safety and anticipation of patient injuries.
4. Explain the relationship between kinetic injury and injury severity.
5. Identify the three collisions associated with a motor vehicle collision, and relate potential patient injuries to the deformity of the vehicle, interior structures, and body structures.
6. Describe how vehicle safety mechanisms affect anticipated injury patterns.
7. List the factors that predict the type and severity of injury due to fall.

Key Terms (continued)

OPIM, *p. 24*
penetrating trauma, *p. 33*
personal protective equipment (PPE), *p. 24*
preventable death, *p. 36*
rapid trauma survey, *p. 23*
scene size-up, *p. 23*
secondary collision, *p. 30*
secondary insult, *p. 36*
standard precautions, *p. 22*
tactical combat casualty care (TCCC), *p. 36*
temporary cavity, *p. 34*
wound ballistics, *p. 33*
wound track, *p. 34*

Objectives (continued)

8. Describe how bullets cause tissue injury and explain the relationship between bullet characteristics and injury severity.
9. Relate the five injury mechanisms involved in blast injuries to scene size-up and patient assessment.
10. Describe the priorities of prehospital trauma care and relate them to preventable causes of death.
11. Discuss the role of preventative efforts in reducing injury and death due to trauma.

Chapter Overview

Traumatic injury remains a leading cause of death internationally. More than 5 million people die every year secondary to injury, accounting for 9% of the world's deaths (World Health Organization [WHO] 2014). The most common cause of death by injury is road traffic injury, followed by intentional injury, suicide, and falls (WHO 2014). As a result of preventative efforts and changing demographics, the epidemiology of trauma is changing. For example, in developed countries, preventive efforts have reduced death due to traffic injuries by crash avoidance, car safety, and improved medical care (Sise et al. 2014; WHO 2014). Meanwhile, deaths due to falls continue to rise, in part due to aging of the population (Alberdi et al. 2014; Sise et al. 2014).

Death is only one consequence of trauma. Injury leads to substantial health care costs and survivors may have significant physical, psychological, or economic morbidity. This is particularly true for traumatic injury, as it disproportionately impacts young people who have many potential life-years left (WHO 2014). Injuries account for 6% of all years lived with disability (WHO 2014). Therefore, while the ideal intervention is injury prevention, measures to improve trauma care postinjury can minimize death and disability from those events that do occur.

Situational Awareness

At the scene of an injury, there are certain important steps to perform *before* you begin care of the patient. Failure to perform a scene size-up will subject you and your patient to danger and may cause you to fail to anticipate serious injuries your patient may have sustained. Take **standard precautions** and assess the scene for

standard precautions: steps each health care worker takes to protect themselves and their patient from exposure to infectious agents; includes treating each patient and him- or herself as if infectious. At a minimum this entails wearing gloves, frequently requires a face shield, and occasionally requires a protective gown.

Table 1-1: ITLS Patient Assessment

ITLS Primary Survey	Perform a scene size-up Perform initial assessment Perform a **rapid trauma survey** or **focused exam** Make critical interventions and transport decision Contact medical direction
ITLS Secondary Survey	Repeat initial assessment Repeat vital signs and consider monitors Perform a neurological exam Perform a detailed (head-to-toe) exam
ITLS Reassessment Exam	Repeat initial assessment Repeat vital signs and check monitors Reassess the abdomen Check injuries and interventions

dangers first. Determine the total number of patients. Look for stickers or other markers that may indicate a special needs patient. Determine the need for additional emergency care providers or special equipment. If there are more patients than you can manage with available resources, report to dispatch and initiate **mass casualty incident** protocols.

Scene size-up is the first step in the **ITLS Primary Survey** (Table 1-1). It is a critical part of trauma assessment. It begins before you approach the patient, and should even start before arrival on scene by using dispatch information. Failure to perform

rapid trauma survey: a brief exam from head to toe performed to identify life-threatening injuries.

focused exam: an exam used when there is a focused (localized) mechanism of injury or an isolated injury. The exam is limited to the area of injury.

mass casualty incident (MCI): also referred to as a multiple casualty, is an event that produces more casualties than the responding agency has resources to manage.

scene size-up: observations made and actions taken at a trauma scene before actually approaching the patient. It is the initial step in the ITLS Primary Survey.

ITLS Primary Survey: a brief exam to find immediately life-threatening conditions. It is made up of the scene size-up, initial assessment, and either the rapid trauma survey or the focused exam.

Case Presentation

Your ambulance is dispatched along with the fire service to the scene of a road traffic accident. Dispatch advises responding personnel that bystanders report fluid leaking from the vehicle. Upon arrival, the fire department establishes command and orders the ambulance to stage approximately one-half mile (800 meters) upwind of the incident. Two minutes later, the senior fire officer advises medical personnel that the minor petroleum spill is controlled and reports that more than one patient exists: a pedestrian and the driver of the vehicle, who is out walking around. The fire service officer tells you to proceed to the site.

As you arrive with the ambulance, you smell diesel fuel. You see a four-door sedan damaged in the front and left fender with a starred front windshield. Some 30 feet (9 meters) behind it, you see a man on the ground in the roadway, not moving. What are the first steps and decisions you need to make?

Before proceeding, consider these questions:

- Is the scene safe?
- Are responders and/or victims in potential danger?
- What protective clothing is required?
- Other than the spill, are there other potential hazards?
- How many patients do you have?
- What additional equipment may be required?

Keep these questions in mind as you read through the chapter. Then, at the end of the chapter, find out how the emergency care providers managed this emergency.

Table 1-2: Steps of the Scene Size-up

1. Standard precautions (personal protective equipment)
2. Scene safety
3. Initial triage (total number of patients)
4. Need for more help or equipment
5. Mechanism of injury

the preliminary steps of scene size-up may jeopardize your life as well as the life of your patient. Scene size-up includes taking standard precautions to prevent exposure to blood and other potentially infectious material, evaluating the scene for dangers, determining the total number of patients, determining essential equipment needed for the particular scene, and identifying the mechanisms of injury (Table 1-2).

Scene Size-up

Scene size-up begins at dispatch, when you anticipate what you will find at the scene. Based on the nature of the event—such as a hazardous material (hazmat) incident or a scene involving an active shooter—where you stage before you enter the scene can vary. Agencies and jurisdictions will have protocols to help guide your decision as to whether to stage, what location to stage, or whether to enter the scene. At that time, you should think about what equipment you may need and whether other resources (e.g., more units, special extrication equipment, mass casualty incident [MCI] protocols) may be needed. Although information from dispatch is useful to begin to think about a plan, do not overrely on this information. Information given to the dispatcher may not be accurate. Be prepared to change your plan according to your own size-up of the scene.

Standard Precautions

Emergency care providers are at significant risk of exposure to blood or other potentially infectious material (**OPIM**) when caring for trauma patients. Not only are trauma patients often bloody, but they may also require active airway management under adverse conditions. **Personal protective equipment (PPE)** is necessary at trauma scenes. Protective gloves are always needed, and many situations will also require eye and face protection. It is wise for the emergency care provider in charge of airway management to don a face shield or eye protection and mask. In highly contaminated situations, impervious gowns with mask or face shield may be needed as well. In a toxic environment, chemical suits and gas masks may be needed. Remember to protect your patients from body fluid contamination by changing your gloves between patients.

OPIM: short for *other potentially infectious material* to which an emergency care provider may be exposed (other than blood).

personal protective equipment (PPE): equipment that an emergency care provider dons for protection from various dangers that may be present at a trauma scene. At a minimum that entails wearing protective gloves. At a maximum it is a chemical suit and self-contained breathing apparatus.

Scene Safety

Begin sizing up the scene for hazards as you approach in your vehicle. Your first decision is to determine the nearest safe place to park the ambulance or rescue vehicle. You would like the vehicle as close to the scene as possible, and yet it must be far enough away for you to be safe while you are performing the scene size-up. In some situations, you should not enter the scene until it has been cleared by fire personnel, law enforcement, or hazmat technicians. Try to park facing away from the scene, so if dangers arise, you can load the patient and leave quickly. Next, determine if it is safe to approach the patient. Perform a "windshield survey" before leaving your response vehicle. Consider the following:

- *Crash/rescue scenes.* Is there danger from fire or toxic substances? Is there danger of electrocution? Are unstable surfaces or structures present such as ice, water, a slope, or buildings in danger of collapse? Areas with potential for low oxygen levels or toxic chemical levels (e.g., sewers, ship holds, silos, etc.) should never be entered until you have the proper protective equipment and breathing apparatus. You should never enter such areas without proper training, safety equipment, and appropriate backup support.

- *Hazmat incidents.* Presence of hazardous materials is often indicated by placards on the outside of the vehicle (see Figure 1-1). These will vary depending on the country in which you work. If you observe such indicators, do not approach without proper protective equipment and training. Request specialist resources to assist with the rescue, containment, and possible decontamination.
- *Farms.* Silos are confined spaces and should not be entered without proper equipment and training. Livestock can also pose hazards to emergency care providers. Be aware of the machinery present as well as manure pits or ponds.
- *Crime scenes.* Danger may exist even after a crime has been committed. Be alert for persons fleeing the scene, for persons attempting to conceal themselves, and for persons who are armed or who make threatening statements or gestures. Do not approach a known crime scene if law enforcement personnel are not present. Wait for law enforcement, not only for your own safety and the safety of victims, but also to help preserve evidence. Do not approach the scene if you have not been cleared to enter it by law enforcement.
- *Bystanders.* You and the victims may be in danger from bystanders. Are bystanders talking in loud, angry voices? Are people fighting? Are weapons present? Is there evidence of the use of alcohol or illegal drugs? Is this a domestic-violence scene? Are dangerous animals present? Request law enforcement personnel at any sign of danger from violence.
- *Blast scene.* Explosions are usually associated with industrial accidents, but because the threat of terrorist activity is both common and worldwide, it should be considered when approaching the scene of an explosion. Terrorists often place a second device designed to kill or injure responders. In addition, in some countries

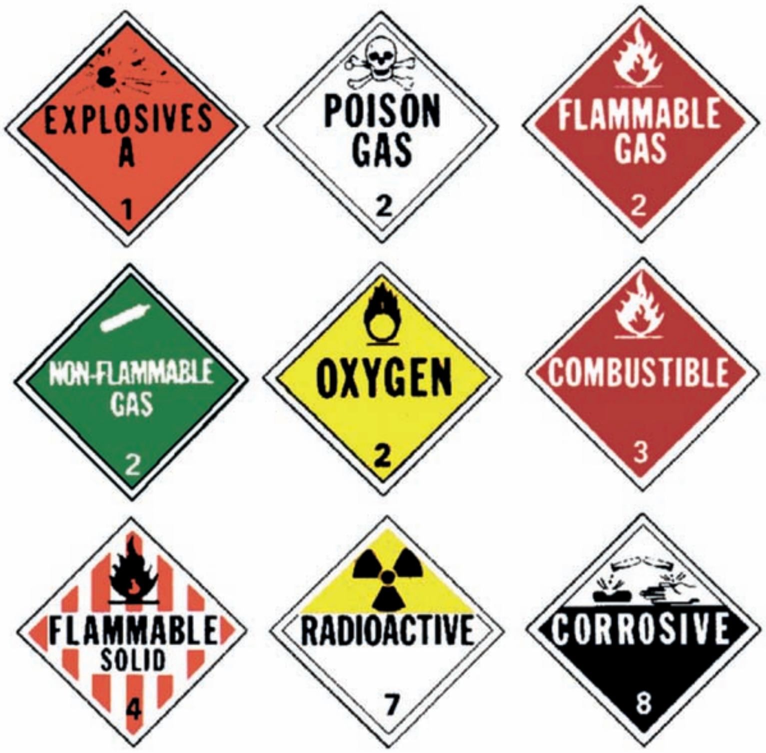


Figure 1-1 Warning placards indicating presence of hazardous material.

the proliferation of illegal methamphetamine labs has been associated with an increased incidence of chemical explosions.

Whatever the cause of an explosion, if possible, law enforcement personnel, along with appropriate specially trained personnel (hazmat technician, bomb technician), should first evaluate the blast scene to make sure it is safe to enter and that no active chemical, biological, or radiological hazards exist. If possible, park your vehicle outside the blast zone (the area where glass is broken). If you are not sure of scene safety, call for ambulatory victims to leave the scene by following a designated emergency responder to a safe area for triage and decontamination.

- *Mass shooting/active shooter events.* An active shooter is an individual who is actively engaged in killing or attempting to kill people in a confined or populated area. Unfortunately, the number of active shooter incidents leading to mass casualty events has increased in recent years, particularly in the United States. Traditionally, emergency care providers have not entered the scene until it was secured by law enforcement, potentially causing significant delays during which victims may die of massive hemorrhage. A number of initiatives have recommended revising these traditional roles and more fully integrating emergency medical services (EMS) into the response to an active shooter in an effort to save as many lives as possible. Rather than staging and waiting for casualties to be brought to the secure part of the scene, EMS responders enter the scene with law enforcement protection to provide care in areas where there is no immediate threat. The goal is to provide only emergent interventions such as control of life-threatening hemorrhage, then rapidly evacuate victims to a more secure area for further assessment and treatment (Jacobs et al. 2013; Joint Committee 2013). This model of rapid assessment medical support, as outlined in the Hartford Consensus, requires cross-disciplinary training between law enforcement and EMS in which law enforcement receives education in hemorrhage control and EMS providers acquire additional operational knowledge of active shooter events and **committee for tactical emergency casualty care (C-TECC)** (CTECC 2015; Joint Committee 2013; Mechem, Bossert, and Baldini 2014).

committee for tactical emergency casualty care (C-TECC): evidenced-based and best-practice trauma care guidelines for civilian high-threat prehospital environments.

essential equipment: equipment that is worn or carried when the team approaches the trauma patient. It includes personal protective equipment, long backboard and strapping, rigid cervical extrication collar, oxygen and airway equipment, and trauma box.

PEARLS

MCI Initial Response

ETHANE

- **Exact** location of the incident
- **Type**: The nature of the incident, includes numbers of vehicles and types, buildings, aircraft, etc. that are involved
- **Hazards**: Identified and possible hazards such as fuel spills, weather, floods
- **Access**: How arriving units should approach and enter the scene
- **Numbers**: Number of casualties including dead on scene; triage categories, if known
- **Emergency services**: Which services are already on scene and which others are required, including special resources such as hazmat, Search and Rescue, etc.

Total Number of Patients

Next, determine the total number of patients. If there are more patients than your team can effectively handle, call for additional resources. Based on dispatch information and additional information received en route, you may need to do this while still responding to the incident. On arrival, medical command must be established. Use the acronym ETHANE to help guide you through the initial steps after arrival.

Remember that you usually need one ambulance for each patient who is seriously injured. If there are many patients, establish medical command and initiate mass casualty incident (MCI) protocols.

When determining the total number of patients, consider this question: Are all patients accounted for? If a patient is unconscious, and there are no witnesses to the incident, look for clues that other patients might be present (e.g., schoolbooks or diaper bag, passenger list in a commercial vehicle). Carefully evaluate the scene for patients. As you do so, not only look toward the vehicle or the center of the scene, but also look outward to see if there are victims behind you. This is especially important at night or if there is poor visibility.

Essential Equipment and Additional Resources

If possible, carry all **essential equipment** to the scene. This prevents loss of time returning to the vehicle. The following equipment are often needed for trauma patients.

- Personal protection equipment: minimum of gloves and goggles
- Patient extrication and transport devices (stretcher, long spine board, vacuum mattress, scoop stretcher, etc.) with effective strapping and head motion-restriction device

- Rigid cervical extrication collar of an appropriate size
- Oxygen and airway equipment, which should include suction equipment and a bag-valve mask (BVM)
- Trauma box (bandage material, hemostatic agent, tourniquet, blood pressure cuff, stethoscope)

Remember to change gloves between patients.

If special extrication equipment, more ambulances, or additional personnel are needed, call as soon as you recognize the need. Be sure to tell additional responders exactly where to respond or stage and of any dangers present on the scene. In larger events, a staging area for ambulances and other responding units may be established. Use of designated radio channels for a specific incident, if available, helps in effective communications.

PEARLS
Equipment
It is wise to invest in a high-intensity tactical flashlight. It is small enough to carry in your shirt pocket but it is many times brighter than regular flashlights.

Mechanism of Injury

A **disease** is an illness that is characterized by specific signs and symptoms. While the term is traditionally applied to afflictions such as infection, cancer, and chronic illness, trauma can be considered a disease as well. Much like a virus has a predictable effect on the body, with signs and symptoms that often present with characteristic patterns, the effect of trauma on the body follows reproducible patterns that can often be predicted by **mechanism of injury (MOI)**.

disease: A dysfunction in the body usually due to an identifiable cause, producing specific signs and symptoms.

mechanism of injury (MOI): the means by which the patient was injured, such as a fall, motor vehicle collision, or explosion.

The absorption of **kinetic energy (KE)** is the major component producing tissue damage in traumatic injury. The law of conservation of energy states that energy is neither created nor destroyed, but is only changed in form. Thus, kinetic energy, whether in the form of a bullet or moving vehicle, must be absorbed. Kinetic energy is proportional to the mass of an object and to the square of the velocity. Therefore, the speed at which a vehicle collision occurs or the speed of a bullet has greater impact on the severity of traumatic injury than the size of the object.

kinetic energy (KE): the energy that an object has as a result of being in motion.

Broadly speaking, the two major types of traumatic injury due to motion are blunt and penetrating, though patients can have both at the same time.

Blunt Trauma

Part of the initial assessment of a trauma scene is identification of clues that signal a high-energy mechanism, as it may help you predict severe injury. To explain the forces involved, consider Sir Isaac Newton's first law of motion: *A body in motion remains in motion in a straight line unless acted on by an outside force*. Motion is created by force (energy exchange), and therefore force will stop motion. If this energy exchange occurs within the body, tissue damage occurs. You should keep in mind that injuries from **blunt trauma** occur as separate events: machine collision, body collision, and organ collision, which are described in the next section (Figure 1-2).

blunt trauma: injury produced by application of force to the body.

Motor Vehicle Collisions

With respect to motor vehicle collisions (MVCs), research has demonstrated that certain features are highly associated with increased injury severity. Some collision features that are associated with increased risk of death include rollover crashes, passenger compartment intrusion, death of another occupant in the vehicle, significant extrication time, ejection from the vehicle, and pedestrian struck (Champion, Lombardo, and Shair 2009; Evans et al. 2009; Haider et al. 2009; Lerner et al. 2011). Understanding the association between mechanism of injury and potentially life-threatening injury is important not just for anticipating the need for prehospital interventions, but also in assisting in determining patient transport destination in systems that have designated trauma centers (Sasser et al. 2012).

The patterns of injuries from collisions with automobiles, motorcycles, all-terrain vehicles (ATVs), personal watercraft, and farm or construction vehicles are varied (Table 1-3).

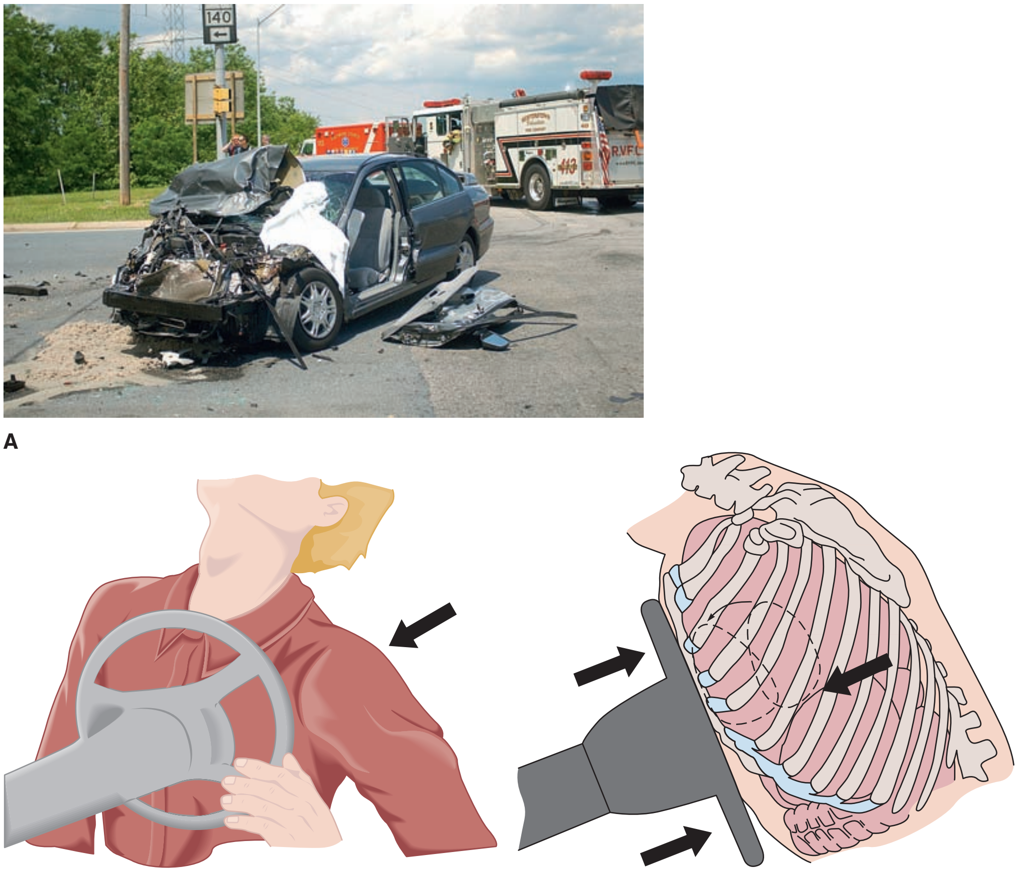


Figure 1-2 The three collisions of a motor vehicle crash. A. Vehicle collision. B. Body collision. C. Organ collision. *(Photo copyright Mark C. Ide)*

Newton's law is well exemplified in the automobile crash. The kinetic energy of the vehicle's forward motion is absorbed as each part of the vehicle is brought to a sudden halt by the impact. Remember that the body of the occupant is also traveling at the same speed as the vehicle until impacted by some structure within the car when it stops as a result of a collision.

For example, consider approaching an MVC in which an automobile has hit a tree head-on at 40 miles (64 kilometers) per hour. The tree brings the automobile to an immediate stop by transferring the energy into damage to the tree and the automobile (*vehicle collision*). The person inside the vehicle is still traveling at 40 miles per hour until he or she strikes something that stops him or her (such as seat belts, steering wheel, windshield, or dashboard) (*body collision*). At that point, energy transfers into damage to the person and to the surface struck. The organs inside the person are also traveling at 40 miles per hour until they are stopped by striking a stationary object (such as inside of skull, sternum, steering wheel, dashboard) or by their ligamentous attachments (such as the aorta by ligamentum arteriosum) (*organ collision*). In this auto-versus-tree example, appreciation of the rapid forward decelerating mechanism (**high-energy event**) coupled with a high **index of suspicion** should make you concerned that the victim may have life-threatening multisystem trauma.

high-energy event: a mechanism of injury in which it is likely that there was a large release of uncontrolled kinetic energy transmitted to the patient, thus increasing the chance for serious injury.

index of suspicion: the medical provider's estimate of a disease or injury being present in a patient. A high index of suspicion means there is a high probability the injury is present. A low index of suspicion means there is a low risk of the injury.

Utilizing the three-collision concept described previously, check for the presence of the following:

- *Machine collision.* Look for damage to the vehicle at the site of impact, but also in other areas that may indicate rollover or spinning of the vehicle as a result of impact.

Table 1-3: Mechanisms of Motion Injury and Potential Injury Patterns

Mechanism of Injury	Potential Injury Patterns
Frontal impact	• Traumatic brain injury • Cervical spine fracture • Facial injuries • Myocardial contusion • Pneumothorax/hemothorax • Aortic disruption • Spleen or liver laceration • Posterior hip dislocation
Lateral impact (T-bone)	• Contralateral neck sprain • Cervical spine fracture • Pneumothorax • Lung contusion • Laceration of spleen, liver, kidney • Pelvic fracture • Extremity injuries on the side of impact
Rear impact	• Cervical spine injury
Pedestrian versus car	• Head injury • Abdominal visceral injuries • Fracture of the lower extremities and pelvis
Tractor accidents	• Crush injury • Thermal burns
Small-vehicle crashes (motorcycle, all-terrain vehicle, personal watercraft, snowmobile)	• Traumatic brain injury • Facial fractures • Pneumothorax/hemothorax • Extremity and pelvic fractures • Spinal fractures • Degloving injuries • Clothesline injuries with airway compromise • Rectal and vaginal trauma

- *Body collision.* Check the steering wheel for ring fracture and deformity and the steering column for any displacement (thoracic injuries in driver, abdominal injury in passenger); look for broken glass and windshield starring (head/facial injury), dashboard damage (extremity injury, particularly the knees), and airbag deployment (chest, face, arm injury) (Newgard, Lewis, and Kraus 2005).
- *Organ collision.* While outward signs of trauma may be readily visible such as traumatic tattoos of the chest wall and bruising of the abdomen, deeper structures and organs may have occult injuries due to shearing forces, compression forces, and transfer of kinetic energy. Injury to the chest wall itself can cause sternal fractures and rib fractures that can be associated with cardiac contusions and dysrhythmias as well as pneumothorax or simply significant pain with respiration leading to hypoventilation. Organs that are susceptible to shearing injuries due to their ligamentous attachments are the aortic arch, liver, spleen, kidneys, and bowel. With the exception of small-bowel tears, those injuries are sources for major occult bleeds and hemorrhagic shock. Compression injuries are common for the lungs, heart, diaphragm, and urinary bladder. In short, the steering wheel is a lethal weapon capable of producing devastating injuries, many of which are occult. Restraints (seat belts) greatly reduce this type of injury, though do not completely eliminate it and therefore serious thoracic injury should always be suspected when a steering wheel deformity is noted and evidence of steering wheel deformity should be actively sought (Chen and Gabler 2014) (Figure 1-3).

Figure 1-3 Lift the collapsed air bag to note whether or not there is a deformity of the steering wheel. *(Olivier Le Queinec/Shutterstock)*

Additional collisions other than the three already mentioned may occur. Objects inside the automobile (e.g., books, bags, luggage, other persons) will become missiles traveling at the original speed of the automobile and may strike persons in front of them. These are called **secondary collisions**. For example, an unrestrained monitor in a moving ambulance may strike the EMS provider or patient during an ambulance collision and cause fatal injury.

secondary collision: when an unsecured object continues to move after the vehicle collides with something (primary collision), and the object strikes an occupant (or unsecured occupant strikes vehicle interior).

In cases where the severity of clinical presentation seems out of proportion to the mechanism of injury (e.g., an unresponsive patient following a low-speed MVC), the possibility of a medical etiology (e.g., hypoglycemia, arrhythmia, seizure, stroke, overdose) should also be considered.

Vehicle safety mechanisms have greatly improved survival from motor vehicle collisions. Restrained occupants are more likely to survive a collision because they are protected by **occupant restraint systems** from much of the impact inside the vehicle and are much less likely to be ejected. Passive restraints such as passenger seat belts and airbags are the two occupant restraint systems that are most significant in limiting injury from the body collision component of the MVC. Restrained occupants are still at risk for specific injuries related to the restraints. A lap belt is intended to go across the pelvis (iliac crests), not the abdomen, and is intended to work together with the shoulder belt. If only the lap belt is in place and the victim is subjected to a frontal deceleration crash, the body tends to fold together like a clasp knife (Figure 1-4). The head may still impact the steering wheel or dashboard. Facial, head, or neck injuries are common if the occupant is restrained only with a lap belt or is unrestrained. Abdominal injuries can also occur if the lap belt is positioned improperly. The compression forces that are produced when a body is suddenly folded at the waist may injure the abdomen or the lumbar spine. The three-point restraint or lap and shoulder belt combination (Figure 1-5) secures the body much better than a lap belt alone. The chest and pelvis are restrained, so life-threatening injuries due to contact with the vehicle are much less common. The head is not restrained, and therefore the neck is still subjected to forces that may cause fractures, dislocations, or spinal cord injuries. Clavicle fractures (at the point where the chest strap crosses) are common, as are chest wall injuries. Even in restrained individuals, internal organ damage may still occur due to organ collisions.

occupant restraint systems: systems built into a vehicle to prevent the driver and passengers from being thrown about the interior of the vehicle or from being ejected from the vehicle in the event of a collision, such as seat belts and airbags.

Figure 1-4 Clasp-knife effect.

Air bag and three-point restraint prevents collisions 2 and 3.

Figure 1-5 Airbag and three-point restraint.

Like belt restraints, airbags will reduce injuries in victims of MVCs in most but not all situations. Airbags are designed to inflate from the center of the steering wheel and the dashboard to protect the front-seat occupants in case of a frontal deceleration crash, but are specifically designed to work together with seat belts. If functioning properly, the seat belts hold the individual in place long enough for the airbag to fully inflate. The airbags can then cushion the head and chest at the instant of impact, thus effectively decreasing (but not eliminating) injury to the face, neck, and chest. Airbags deflate immediately, so they protect against only one impact. The driver whose car hits more than one object loses airbag protection after the initial collision. Airbags also do not prevent "down-and-under" movement, so drivers who are extended (tall drivers and drivers of small, low-slung automobiles) may still impact the dash with their legs and suffer leg, pelvis, or abdominal injuries. Many newer vehicles have airbag systems designed to prevent this type of injury. Side airbags may also be built into the body, seat, or headrest. Just like frontal airbags, they only protect the driver during the initial collision. All vehicles with such systems have warning labels throughout the vehicle.

Airbags are associated with specific injuries. Small drivers who bring the seat up close to the steering wheel may sustain serious injuries when the bag inflates because it does not have adequate space or time to inflate before the body impacts it. Infants in car seats placed in the front seat, especially front-facing car seats, may be seriously injured by deployment of the air bag. The smoke seen with airbag deployment is really powder (talc or cornstarch) that is used to "lubricate" the nylon bag so it slides smoothly during inflation. Abrasions from the nylon bag, corneal abrasions, and superficial burns on exposed skin near the airbag vents have been reported. Emergency care providers should be aware that many new vehicles are equipped with side airbags and air curtains (Figure 1-6).

Figure 1-6 Side airbags and air curtains can pose a hazard to responders if the devices did not activate in the collision. *Note:* See the *Access: First on Scene—Rapid Vehicle Entry Provider Manual* from ITLS for more information about rendering nondeployed airbags safe. *(testing/Shutterstock)*

Remember that airbags may pose a hazard to responders if the safety devices did not activate in the collision. Disconnecting the battery may deactivate some airbag systems. However, some airbags may still be able to deploy after the battery has been disconnected. A good safety rule to follow when working around undeployed airbags is the 5-10-20 rule:

- Stay 5 inches (13 cm) away from side curtain airbags
- Stay 10 inches (25 cm) away from steering wheel airbags
- Stay 20 inches (50 cm) away from passenger side airbags.

Falls

Falls are the second leading cause of unintentional injury deaths worldwide, particularly in children and older adults (WHO 2014). Older people are at risk for falling in part because of age-related changes in mobility, balance, and vision, compounded by medication use. They are simultaneously at risk for more serious injury from lower-energy falls due to bony changes and frequency of anticoagulant use (Ang et al. 2017; Sterling, O'Connor, and Bonadies 2001). In contrast, children are at risk for falls at varying ages because of evolving developmental changes and risk-taking behaviors (Figure 1-7).

The mechanism of injury for falls is vertical deceleration. The type and severity of injuries sustained depend on the following four factors: distance of fall, anatomic area impacted, surface struck, and patient age (Lapostolle et al. 2005). Typical injuries include:

- Head trauma
- Axial loading or hyperextension/hyperflexion injury to the spine
- Extremity fractures
- Hip and/or pelvic injuries
- Vertical deceleration forces to the organs

The greater the height, the greater the potential for injury. With falls greater than 10 feet (3 meters), approximately 1 in 4 patients will have a spinal or intracranial injury, and 1 in 20 will have a serious intra-abdominal injury (Demetriades et al. 2005;

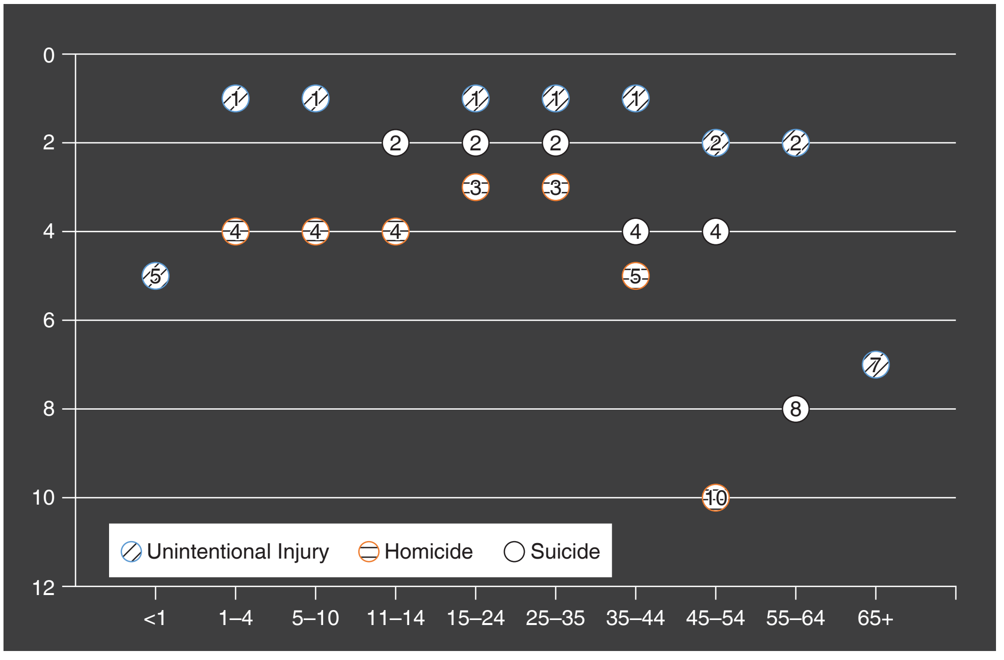


Figure 1-7 Ranked cause of death by trauma as a function of age. *(Data from CDC 2016)*

Velmahos et al. 2006). However, serious injury can occur with a short-distance fall. Ground-level falls in older adults can lead to injuries associated with significant mortality and morbidity, such as intracranial hemorrhage and hip fracture (Spaniolas et al. 2010). The severity of traumatic injury is frequently underestimated in older adults, and a high index of suspicion for serious or life-threatening injury must be maintained when evaluating these patients, especially in those who take oral anticoagulants (Ang 2017; Sterling 2001).

Finally, while a large proportion of falls are mechanical in nature, people often fall as a result of a concurrent medical problem, such as cardiac arrhythmia, hypotension from infection, or stroke. Thus, evaluation of the patient who has undergone a fall includes consideration of *why* the fall occurred so that concurrent acute medical pathology can be addressed. To help assess the cause of a fall, you can use the mnemonic *SPLAT*:

- Symptoms before the fall
- Previous falls
- Location of the fall (home, work, outdoors)
- Activity at time of the fall
- Time of day of the fall

Penetrating Trauma

MVCs remain the largest cause of death for young adults and children. Homicides in the United States are rising, and this has become the leading cause of traumatic death in young males in urban areas. **Penetrating trauma** is often associated with acts of violence. Emergency care providers should exercise caution in such situations. Scene safety is always paramount and, whenever possible, law enforcement should be part of the response. If the scene becomes unsafe, then providers may have to evacuate the scene for a safe area before fully assessing the patient.

Many objects can produce penetrating injuries. Examples include an industrial saw blade that breaks off at a high rate of speed, a foreign body thrown by a lawn mower, as well as common knife and gun wounds. Most high-velocity objects can penetrate the thorax or abdomen.

The severity of a knife wound depends on the anatomic area penetrated, length of the blade, and angle of penetration (Figure 1-8). Knife wounds are low-energy injuries, and tissue damage is confined to the direct path of the blade. Remember, an upper-abdominal stab wound may cause intrathoracic organ injury, and stab wounds below the fourth intercostal space may have penetrated the abdomen.

PEARLS

Basic Ballistics

Know the information offered here, but remember: *Treat the patient, not the weapon*.

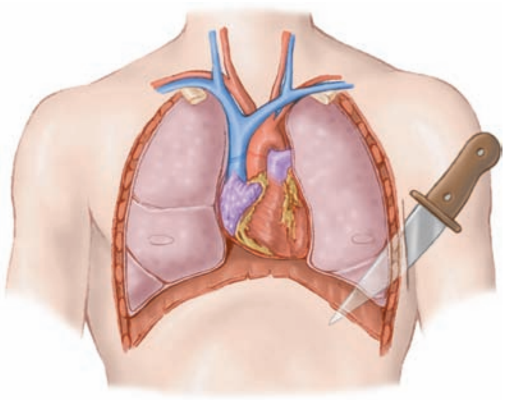
penetrating trauma: an injury produced when an object penetrates the skin, creating an open wound, and possibly damaging deeper structures.

wound ballistics: the study of the behavior of the projectile when it strikes the target and transfers energy to the target.

Wound Ballistics

Most penetrating wounds inflicted by firearms are due to handguns, rifles, and shotguns. In combat situations or terrorist events, penetrating wounds can also result from shrapnel. In terms of firearms, the bullet is the projectile fired from the gun. Bullets vary in size (caliber) and design, which determines whether they fragment on impact and cause massive damage or remain together and travel through the body.

As noted earlier in the chapter, injury to tissue results from the transfer of kinetic energy to the tissue. **Wound ballistics** studies the effect of the kinetic energy from the bullet leading to the crushing, lacerating, stretching, and shearing of tissues (Breeze et al. 2017). Because the kinetic energy produced by a projectile is proportional to the square of the velocity, bullets shot from high-velocity weapons (e.g., military rifle) can be more destructive than those from low-velocity weapons (e.g., some handguns). However, only the energy deposited in the tissue (kinetic energy of the bullet entering minus the kinetic energy on leaving the tissue) causes tissue disruption. Thus, factors that increase the drag on the bullet and stop the bullet in the tissues



Stab wounds at nipple level or below frequently penetrate the abdomen.

Figure 1-8 Stab wounds.

result in complete energy transfer from bullet to tissue. Modifications of bullets such as hollow-point rounds deform in the tissue and create larger wounds. Military rounds are full-metal jacketed, which limits expansion on hitting the target. However, many of them are designed to tumble or break apart on contact with the target, increasing the wounding potential of the round (Breeze et al. 2017; Ragsdale and Sohn 1988).

Bullets cause tissue injury by three mechanisms:

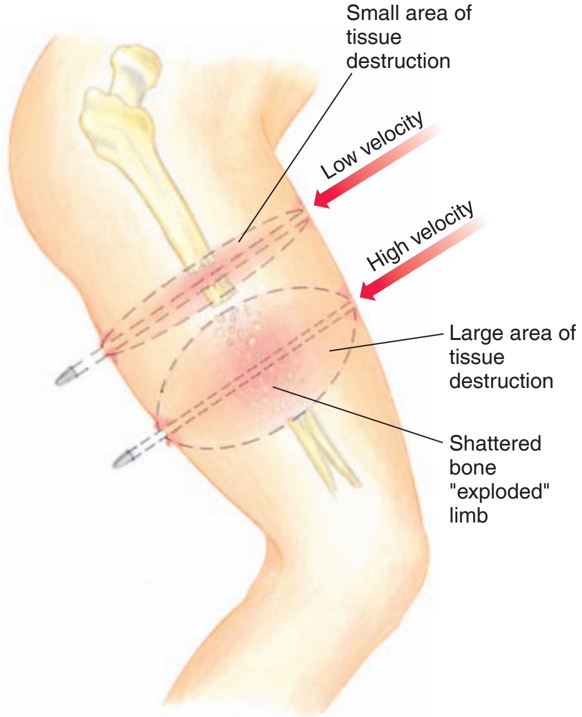
- *Shockwave*: blast effect caused by escape of propellant gases into the tissue
- ***Temporary cavity***: tissue is driven outward away from the path of the bullet, causing stretching and shearing of tissues. This leads to a larger area of damage than may be suggested by the external appearance of the bullet track and results in a vacuum that pulls debris into the wound and increases risk of infection. This mechanism is most important in when dealing with bullets traveling at a high velocity (Figure 1-9A).
- *Permanent **wound track***: Direct tissue crush injury inflicted by the bullet as it traverses the tissue, leading to irreversible damage.

temporary cavity: the maximum temporary displacement of tissue due to the hydrostatic shock from a bullet's passage.

wound track: the path through the tissue made by a projectile.

Because the drag force on a bullet is increased with increasing tissue density, tissue damage is proportional to tissue density (Figure 1-9B). Highly dense organs such as bone, muscle, and the liver sustain more damage than less dense organs such as the lungs. Bone damaged by a gunshot can fragment and damage surrounding tissues.

With regard to lethality, the single most important factor is not the bullet design or velocity, but what part of the body is hit by the projectile. It is not the bullet itself that is toxic, but the path that the bullet takes. Effort should be taken to identify the total number of wounds and their location. While medical providers are not forensic experts and should not label whether a bullet wound is entrance or exit, certain features suggest that a wound is an entrance wound, such as abrasion collars, soot, and tattooing. The size of the wound does not always indicate entrance versus exit wounds. The entrance wound can be larger than an exit wound and vice versa. A key factor to remember is that once a bullet enters the body, its trajectory will not always be in a straight line.



A

B

Figure 1-9 A. High-velocity versus low-velocity injury. B. Example of a high-velocity wound of the leg. *(Courtesy Roy Alson, PhD, MD, FACEP, FAEMS)*

Blast Injuries

There are five mechanisms of injury due to blast or explosion (Figure 1-10):

- *Primary.* Caused by the initial air blast, a primary **blast injury** is caused by the direct effect of blast overpressure on tissue. Air is easily compressible, unlike water. As a result, the primary blast injury almost always affects air-filled structures such as the lungs, ears, and gastrointestinal tract. Primary blast injury is less common in the civilian setting than in combat. Injuries due to the primary air blast are almost exclusive to the air-containing organs. The auditory system often involves ruptured tympanic membranes, which renders victims unable to hear. Once thought of as a marker of exposure to blasts sufficient to cause primary injury, recent data suggests that this is not a good triage tool. Lung injuries resulting from primary blast injury can include pneumothorax, parenchymal hemorrhage, and especially alveolar rupture. Alveolar rupture may cause air embolus that may be manifested by strokelike symptoms such as dysarthria, paralysis, or visual disturbances. Gastrointestinal tract injuries may vary from mild intestinal and stomach contusions to frank rupture. Always suspect lung injuries in a blast victim.
- *Secondary.* The secondary blast injury is the result of the patient being struck by material (shrapnel) propelled by the blast force. Injuries caused by secondary factors may be penetrating or blunt. Fragments of shrapnel from an explosion may attain velocities of 14,000 feet (4,270 meters) per second. This is over four times the

blast injuries: injuries commonly produced by the different mechanisms associated with an explosion (air blast, shrapnel, burns, etc.).

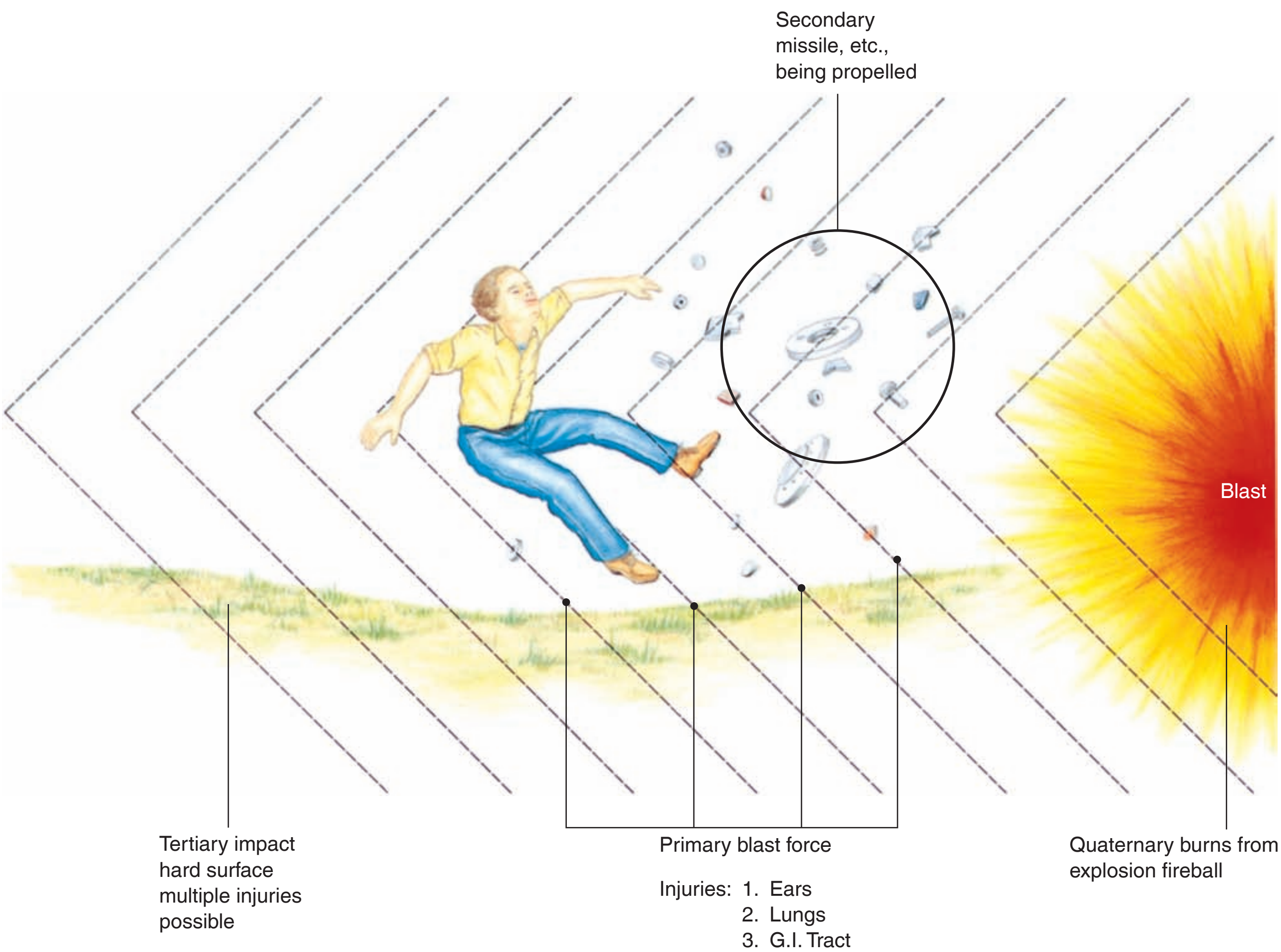


Figure 1-10 Explosions can cause injury with the initial blast, when the victim is struck by debris, or by the victim being thrown against the ground or fixed objects by the blast.

velocity of the most powerful high-velocity rifle bullets. A piece of shrapnel traveling at this velocity would impart more than 16 times the energy of a similarly sized high-velocity rifle bullet.

- *Tertiary.* A tertiary injury is due to the body being thrown, resulting in an impact with the ground or an object. Tertiary injuries are much the same as when a person is ejected from an automobile or has fallen from a height. The blast wave may propel the person at a high velocity for a varying distance. The injuries will depend on what the person impacts (e.g., solid object versus water or soft ground).
- *Quaternary.* As a result of the explosion fireball, the body can sustain thermal burns or an inhalation injury due to toxic dust or fumes. Quaternary injuries are seen when there is a large fireball associated with the explosion or when toxic fumes or dust are produced by the explosion. They are more common when the victim is in an enclosed space or has a previous lung disease such as asthma or emphysema.
- *Quinary.* This injury is the hyperinflammatory state that results from exposure to contaminants in the blast, such as chemical, biological, or radiological material dispersed by the explosion (dirty bomb). This is a delayed type of injury. Quinary injuries are relatively new and reflect a terrorist's attempts to make bombs more deadly by using the explosion to disperse toxic chemicals, biological agents, or radiological agents. Such bombs are called "dirty bombs" for that reason.

Priorities of Trauma Care

The goal of prehospital trauma care is to minimize injury and reduce preventable death. To accomplish these goals, the prehospital care provider must focus on treating the preventable causes of death on scene, minimizing secondary insults, and rapidly transporting to a facility capable of definitively addressing the patient's injuries. The organized evaluation of the trauma patient and treatment of the associated signs and symptoms in a time-sensitive manner can be potentially lifesaving.

Military medicine has played a critical role in identifying best practices in trauma care. Most recently, military operations in Afghanistan and Iraq led to the development of significant advances in trauma care aimed at treating **preventable deaths**. Preventable causes of death on scene are those conditions that will result in patient death prior to arrival at definitive care if they are not addressed. Military studies identified three major preventable causes of death prehospital: (1) exsanguination from massive extremity hemorrhage, (2) airway obstruction, and (3) tension pneumothorax. During United States military operations in Iraq from 2003 until 2006, significantly more patients died of extremity hemorrhage than of airway obstruction (Kelly et al. 2008). **Secondary insults** are those factors that worsen patient outcomes from traumatic injury. Examples include hypoxia, hypotension, and hyperventilation, which worsen neurologic outcomes in patients with traumatic brain injury (refer to Chapter 12), and hypothermia, which worsens traumatic coagulopathy. These priorities of care are emphasized in algorithms borrowed from military **tactical combat casualty care (TCCC)** (MARCHE) and tactical medicine (XABC), as shown in Table 1-4 (also see Appendix G) (Butler, Hagmann, and Butler 1996; Butler and Blackbourne 2012; Eastridge et al. 2012; Holcomb et al. 2007). Extrapolating from military experience, training and focus on management of preventable causes can greatly reduce deaths from traumatic injury (Kotwal et al. 2011).

preventable death: those conditions that will result in patient death prior to arrival at definitive care if they are not addressed.

secondary insult: damage that is not the direct result of the trauma but due to trauma-induced changes in body systems; for example, hypoxia worsening traumatic brain injury.

tactical combat casualty care: Also called TCCC; guidelines for the care of combat casualties developed by the Committee on Tactical Combat Casualty Care (CoTCCC).

Hemorrhage and brain injury account for the majority of deaths from traumatic injury. Definitive treatment of life-threatening hemorrhage and/or brain injury requires resources and personnel that are not typically available in the out-of-hospital environment. Thus, after management of preventable causes of death, the next management priority is expeditious transport to a facility capable of treating the patient's injuries. Most importantly, rapid transport should supersede other interventions that are often performed on scene but that, depending on clinical circumstance, may not

Table 1-4: Priorities of Care

XABC	Explanation/Adaptation to Civilian EMS	MARCHE (TCCC)
EXsanguinating hemorrhage	• Identify and treat hemorrhage; treatments including tourniquets, pressure dressings.	**M**assive hemorrhage control
Airway	• Open the airway and ensure adequate ventilation and oxygenation; importantly, this does not necessarily mean invasive airway management and BLS airway maneuvers such as jaw thrust, airway adjuncts (OPA/NPA), and/or BVM are often sufficient.	**A**irway control
Breathing	• Treat tension pneumothorax with needle decompression. • Beware of overventilation, which can decrease cardiac venous return and be harmful in traumatic brain injury.	**R**espiratory support
Circulation	• Assess and treat shock, manifested by hypotension, tachycardia, and/or low capnography. • With the exception of traumatic brain injury, hypotensive resuscitation is favored to reduce further hemorrhage and minimize crystalloid infusion. • Consider TXA and blood product transfusion, if available.	**C**irculation and shock management
	• Minimize hypothermia in order to prevent coagulopathy and increased hemorrhage. • Maintain CNS perfusion and oxygenation.	**H**ypothermia **H**ead injury
	• Environment (hyperthermia, hypothermia) • Eye Injury • Preparation for transport • Pain Control • Antibiotics if indicated	**E**verything else

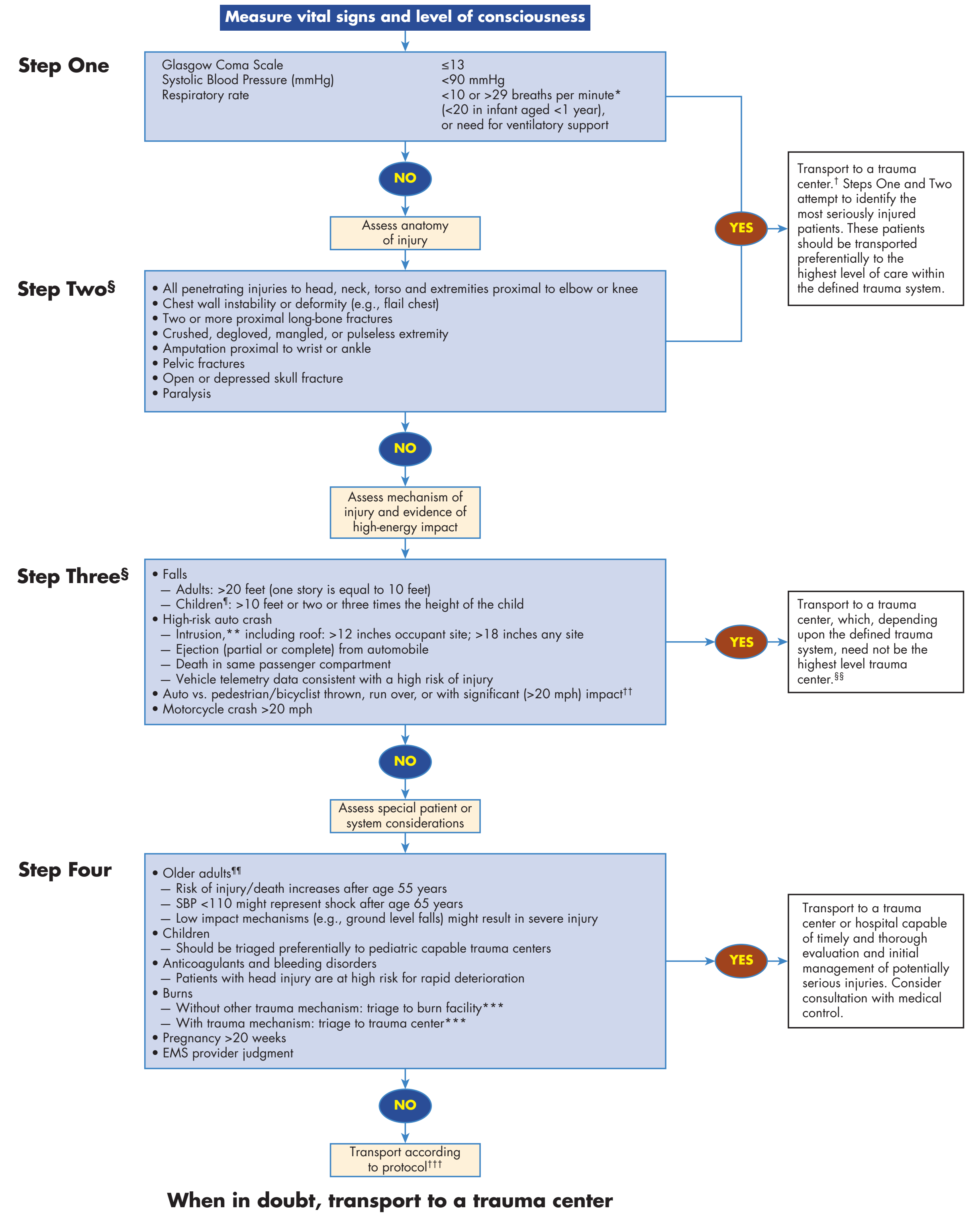
be necessary to patient survival, such as intravenous access or endotracheal intubation (Stiell 2008). Interventions that are not lifesaving, such as intravenous access and pain control, should be performed en route.

Trauma Triage Decisions

Organized trauma systems are associated with improved survival (Gabbe et al. 2012). The challenge for emergency care providers is to determine who needs to be treated at a trauma center and who can be managed at a community-level hospital. Taking all trauma patients to a trauma center (overtriage) will overload the system and impair the ability to provide care for those who need it. Undertriage (not sending patients who require specialized trauma care to a trauma center) results in worse outcome for the patients. Numerous guidelines have been developed over the years to assist in the triage process. Presented here is one developed by the Centers for Disease Control and Prevention, in cooperation with the American College of Surgeons Committee on Trauma and other professional organizations. The chart shown in Figure 1-11 is a stepwise approach using specific factors that can be identified on scene.

Prevention and Public Education

Traditionally, the traumatic injuries described in this text have been thought to be separate entities. In recent years, thinking has shifted to describe trauma itself as a disease, with specific causes, methods of prevention or mitigation, and methods of treatment. While the primary focus of this text is management of traumatic injury once it has occurred, prevention of injury is actually preferred and has a much greater potential for decreasing injury and death. A good example of this has been the campaign to encourage seat-belt use in many countries, which has been associated with a decrease in MVC deaths.



* The upper limit of respiratory rate in infants is >29 breaths per minute to maintain a higher level of overtriage for infants.

† Trauma centers are designated Level I-IV. A Level I center has the greatest amount of resources and personnel for care of the injured patient and provides regional leadership in education, research, and prevention programs. A Level II facility offers similar resources to a Level I facility, possibly differing only in continuous availability of certain subspecialties or sufficient prevention, education, and research activities for Level I designation; Level II facilities are not required to be resident or fellow education centers. A Level III center is capable of assessment, resuscitation, and emergency surgery, with severely injured patients being transferred to a Level I or II facility. A Level IV trauma center is capable of providing 24-hour physician coverage, resuscitation, and stabilization to injured patients before transfer to a facility that provides a higher level of trauma care.

§ Any injury noted in Step Two or mechanism identified in Step Three triggers a "yes" response.

¶ Age <15 years.

** Intrusion refers to interior compartment intrusion, as opposed to deformation which refers to exterior damage.

†† Includes pedestrians or bicyclists thrown or run over by a motor vehicle or those with estimated impact >20 mph with a motor vehicle.

§§ Local or regional protocols should be used to determine the most appropriate level of trauma center within the defined trauma system; need not be the highest-level trauma center.

¶¶ Age >55 years.

*** Patients with both burns and concomitant trauma for whom the burn injury poses the greatest risk for morbidity and mortality should be transferred to a burn center. If the nonburn trauma presents a greater immediate risk, the patient may be stabilized in a trauma center and then transferred to a burn center.

††† Patients who do not meet any of the triage criteria in Steps One through Four should be transported to the most appropriate medical facility as outlined in local EMS protocols.

Figure 1-11 Guidelines for the Field Triage of Injured Patients—U.S. CDC 2011. *(Source: Centers for Disease Control and Prevention)*

The WHO has focused its prevention efforts in several areas, including violence, road safety, drowning, and child injury. For example, road traffic injuries are the leading cause of death worldwide for 15- to 29-year-olds and are projected to result in injury to 20–50 million people and 1.9 million deaths worldwide annually by 2020. To help decrease these injuries, the WHO initiative "Decade of Action for Road Safety (2011–2020)" (*decadeofaction.org*) advocates for specific road and vehicle safety initiatives and improving emergency services. Even small changes can significantly decrease injury and death from trauma within a community. From an EMS standpoint, the WHO recommends integration of prevention and EMS within the health care system and use of universal emergency numbers to access responders, such as 911 (U.S.), 192 (Brazil), 999 (UK), 119 (Japan/Korea), and 112 (GSM Cell phone worldwide).

With the increasing frequency of terrorist and mass injury events in civilian settings, training not only EMS but also lay bystanders to engage when such events occur can promote rapid action to save lives. Techniques such as hemorrhage control and tourniquet use can limit loss of lives in the critical minutes following injury. For example, in its first year, the "Stop the Bleed" public awareness campaign educated over 150,000 U.S. civilians in immediate massive hemorrhage control.

Case Presentation *(continued)*

As you pull up, your scene survey reveals a possible multiple-patient scene with hazards. The senior fire officer assures you that the spill is under control and that other than a slight fuel odor, there is no fire danger or other hazmat threat. He also says that the driver seems uninjured and that "at least the guy from the bike is breathing."

Having donned gloves, you head toward the car. The driver assures you he does not need emergency medical attention, that his neck is "just a little stiff," and that he swerved in order to avoid the pedestrian who ran into the roadway.

The driver is alert, talking normally, and complaining of neck discomfort with tingling in the right arm. "He just swerved into me," he says, "just flew over the hood right into the windshield in front of me. Ripped my side mirror off as he fell past me!"

You request an additional ambulance from the senior fire officer and proceed with the trauma kit to the pedestrian. Your assessment of the pedestrian reveals an unresponsive patient with an airway compromise. Because the nearest trauma center is a considerable distance from the scene, the emergency care provider considers requesting air medical transport (a helicopter).

Summary

- Trauma is a serious disease affecting all ages worldwide. An organized approach to the trauma patient is essential to improve outcomes.
- At the scene of an injury, there are important steps to perform before you begin care of the patient. Failure to perform a scene size-up will subject you and your patient to danger and may cause you to fail to anticipate serious injuries your patient may have sustained. Take standard precautions and assess the scene for dangers first. Then determine the total number of patients and the need for additional emergency

care providers or special equipment. If there are more patients than your team can manage, report to dispatch and initiate multiple-casualty incident protocols.

- Identify the mechanism of injury and consider it as part of the overall management of the trauma patient. Ask yourself: What happened? What type of energy was applied? How much energy was transmitted? What part of the body was affected?
- Information about the high-energy event (e.g., a fall, a vehicle collision) is also important to the emergency physician. Be sure not only to record your findings but also to give a verbal report to the emergency department physician or trauma surgeon when you arrive. With this knowledge and a high index of suspicion, you can give your patient the greatest chance of survival.
- Thorough scene assessment with an understanding of the mechanism of injury is critical to both provider safety and fully assessing the patient's risk of life-threatening injury. As trauma is a disease of time and energy—time to definitive care and the amount of external energy applied to the body—out-of-hospital trauma care should focus on those interventions that limit preventable death and disability.

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World Health Organization. n.d. "Falls." Accessed July 27, 2018. http://www.who.int/newsroom/fact-sheets/detail/falls

Injury Prevention Resources

Trauma System Agenda for the Future: https://one.nhtsa.gov/people/injury/ems/emstraumasystem03/introduction.htm, https://one.nhtsa.gov/people/injury/ems/emstraumasystem03/appendices-a.htm

CDC Traumatic Injury Prevention: https://www.cdc.gov/niosh/programs/ti/default.html

WHO Violence and Injury Prevention http://www.who.int/violence_injury_prevention/en/, https://www.dhs.gov/stopthebleed, https://stopthebleed.usuhs.edu, https://www.bleedingcontrol.org

(Courtesy Roy Alson, PhD, MD, FACEP, FAEMS)

2

Trauma Assessment and Management

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Untersuchung und initiale Maßnahmen bei Traumapatienten
Evaluación y Manejo del Paciente
Pregled i zbrinjavanje ozlijeđene osobe
Abordagem e Gestão da Vítima de Trauma
Pengkajian dan Penatalaksanaan Trauma
Оценка состояния потерпевшего после травмы
Evaluation et gestion des traumatismes
Εκτίμηση και Διαχείριση Τραυματία
Sérültvizsgálat és a kezdő beavatkozások
外傷傷病者の観察と治療
創傷評估與處置
Ocena in obravnava poškodb

Key Terms

AVPU, *p. 49*
DCAP-BLS, *p. 57*
focused exam, *p. 46*
general impression, *p. 49*
ITLS Patient Assessment, *p. 44*
ITLS Primary Survey, *p. 44*
ITLS Reassessment Exam, *p. 44*
ITLS Secondary Survey, *p. 46*
initial assessment, *p. 46*
load-and-go situation, *p. 54*
MIST Report, *p. 59*
rapid trauma survey, *p. 46*
SAMPLE history, *p. 53*
PMS, *p. 55*
TIC, *p. 57*

Objectives

Upon successful completion of this chapter, you should be able to:

1. Outline the steps of the ITLS Trauma Assessment.
2. Describe the ITLS Primary Survey.
3. Explain the initial assessment and how it relates to the rapid trauma survey and the focused exam.
4. Describe when the initial assessment can be interrupted.
5. Identity which patients have critical conditions and how they should be managed.
6. List the 10 critical interventions made during the primary survey and when to make them.
7. List 10 life-threatening injuries that should be identified during the ITLS Primary Survey.
8. Describe the ITLS Reassessment Exam.
9. Describe the ITLS Secondary Survey.