GLOBAL EDITION

International Trauma Life Support for Emergency Care Providers

EIGHTH EDITION

John E. Campbell, MD, FACEP
Roy L. Alson, PhD, MD, FACEP, FAAEM
and Alabama Chapter, American College of Emergency Physicians

Pearson

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Trauma Life Support
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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

The best way to find yourself is to lose yourself in the service of others.

– Mohandas K. Gandhi

This eighth edition of the ITLS textbook is dedicated to the men and women who each day answer the call for help. Every hour of every day they stand watch keeping our fellow citizens, our friends, and our families safe. When crises arise, they are there, providing care and comfort, often at great risk to themselves. And each year, all over the world, some of our colleagues make the ultimate sacrifice. We honor them and their families in our resolve to continue to "answer the call." We can think of no one who better epitomizes that dedication better than our friend and colleague Vickey G. Lewis, RN, BSN.

Vickey has been a first responder, ED RN, EMS and Nurse educator, and a fixture in ITLS for 30 years. She was certified in the first BTLS course taught in North Carolina in the early 1980s, served as the first chapter coordinator for North Carolina BTLS (now ITLS), establishing a training program that continues to grow. Furthermore, she has shared her knowledge and experience with others, all across the globe as they sought to bring the program to their communities. She taught hundreds of providers how to care for trauma patients as well as established educational programs for providers and citizens to deal with cardiac arrest. She has served as the speaker of the ITLS annual delegate meeting for over 10 years, "herding the cats" with both knowledge and humor. Over her long career, she consistently gives credit to others for what is accomplished. As an organization and as individual providers and educators, we have greatly benefited from her wisdom, experience, and dedication. For that we are truly grateful.

Vickey G. Lewis, RN, BSN

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About the Editors

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 has been in the practice of Emergency Medicine for 40 years, practicing in Alabama, Georgia, New Mexico, and Texas. He 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. He is still an honorary member of that outstanding group. Since then, he has served as medical director of many EMT and paramedic training programs. He recently retired as the Medical Director for EMS and Trauma for the State of Alabama.

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

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

He was a member of the first faculty of Emergency Medicine at the School of Medicine, 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 he received the Ronald D. Stewart Lifetime Achievement Award from the National Association of EMS Physicians. He is currently retired from clinical practice and resides in Montgomery, Alabama.

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

Dr. Roy L. Alson is an Associate Professor of Emergency Medicine at the Wake Forest University School of Medicine and Director of the Office of Prehospital and Disaster Medicine at Wake Forest. He is also an Associate Professor at the Childress Institute for Pediatric Trauma at Wake Forest University. He 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.

His EMS career began in the early 1970s as an EMT in New York City. As a graduate student, Dr. Alson 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 for the last 12 years. 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 1990s he has been a member of the editorial board for ITLS as well as a contributing author. With this edition, he joins Dr. Campbell as co-editor in chief.

Along with EMS, disaster medicine is an area of interest. Dr. Alson serves 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 American College of Emergency Physicians, as well as a member of the EMS Committee for the American Academy of Emergency Physicians. He is the Chairman

for the NAEMSP Disaster Preparedness Committee for 2014-16.

He has served with the National Disaster Medical System (NDMS) for 20 years and is currently 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).

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.

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What's New in This Edition

The eighth edition of the ITLS textbook, *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 to the care of the trauma patient. The science of trauma is constantly evolving, and the research working group at ITLS has worked to bring to the authors and the text information that is pertinent to the initial care of the trauma patient.

One of the biggest changes in this edition is that Dr. Roy Alson has joined Dr. John Campbell as co-editor in chief. Dr. Alson is a board-certified EM and EMS physician with extensive experience in EMS care and education and has been a contributor to the ITLS text and course for over 25 years.

The text again conforms to the latest AHA/ILCOR guidelines for artificial ventilation and CPR. The case presentations used in many of the chapters draw upon a single scenario as an effort to have the illustrative cases used reflect a more realistic situation. Although trauma can result in single-system injuries, major trauma victims often have multiple organ systems or body areas involved, and these must all be assessed and stabilized.

The text continues the presentation of Key Terms and updates of photos and drawings as needed. There is now also a new student and instructor resource Web site, which provides additional information beyond the core material of ITLS.

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

- In the Introduction it is explained what the concept of the "Golden Period" is and why it remains important to what we do.
- In Chapter 1, the emphasis on scene safety continues to be a central component, as is the concept that trauma care is a team effort involving many disciplines. There is a discussion of the changes in response put forth by the Hartford Consensus.
- In Chapter 2, minor changes have been made in the assessment sequence based on feedback from ITLS instructors and providers. The importance of identifying and controlling at the start of the assessment is reinforced. 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. That emphasizes the team concept and keeps on scene time at a minimum. The order of presentation of the three assessments (ITLS Primary Survey, ITLS Ongoing Exam, and ITLS Secondary Survey) has been changed. The ITLS Ongoing Exam is performed before the ITLS Secondary Survey, a more common situation, and may replace it. The use of finger-stick serum lactate levels and prehospital abdominal ultrasound exams are mentioned as areas of current study to better identify patients who may be in early shock.
- Chapter 3 reflects the changes in Chapter 2.
- In Chapter 4, capnography is stressed 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.
- In Chapter 5, fiberoptic and video intubation are discussed as evolving technologies. Drug-assisted intubation is now included in this chapter, rather than in the appendix, because it is more commonly used. The key role of blind insertion airway devices (BIADs) in basic airway management is reinforced.
- In Chapter 6, a discussion of the indications for decompressing pericardial tamponade has been added, when such a procedure is in the emergency care provider's scope of practice. Also discussed is the use of ultrasound to identify such injuries and also to identify a pneumothorax.
- In Chapter 7, there is a revised discussion of needle decompression of the chest for a tension pneumothorax reflecting challenges faced by tactical EMS providers.
- In Chapter 8, the discussion of hemorrhagic shock has again been updated to reflect the latest experience of the military during the recent conflicts. A discussion of the role of tranexamic acid (TXA) in the management of hemorrhage has been added.
- Chapters 11 and 12 now reflect current science and published guidelines. There has been a complete revision of when to apply spinal motion restriction. In addition, the transport of a patient on a backboard is now discouraged. Included also is how to remove the patient from the backboard once placed on a transport stretcher. The standing backboard procedure has been eliminated.

- In Chapter 13, the use of finger-stick serum lactate levels and the use of prehospital abdominal ultrasound exams are mentioned.
- In Chapter 14, the discussion of management of bleeding from extremity injuries has been expanded, including discussion of hemostatic agents.
- In Chapter 15, procedures for use of a tourniquet and use of hemostatic agents have been expanded as well as discussion of pelvic binders for pelvic fractures.
- In Chapter 16, the use of Ringer's lactate as a resuscitation fluid in major burns is emphasized.
- Chapter 21 discusses the indications for termination of resuscitation for the trauma patient in the prehospital setting.
- Chapter 22 has been updated with the latest recommendations for postexposure prophylaxis and an expanded section on emerging infections that pose challenges to emergency care providers.

What's New on Student Resource Page

Student Resources can be found at ***www.pearsonglobaleditions.com/itls***. Students can access additional skills and information for more practice and review.

- In "Additional Skills," the use of the new FastResponder™ sternal IO has been added.
- In "Role of the Medical Helicopter," the data has been updated.
- In "Trauma Scoring in the Prehospital Care Setting," the CDC Trauma Triage Scheme is included.
- In "Tactical EMS," the bibliography has been revised to reflect current thinking within the Hartford Consensus.

Acknowledgments

The creation of a text and course is a major undertaking and could not be done without a team effort. 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 EMS professionals who reviewed material especially for this 8th Edition of *International Trauma Life Support for Emergency Care Providers*. Their assistance is appreciated:

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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 years. 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 life-saving 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 life-saving purpose. Any action that increases scene time but is not potentially life saving 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 (EMS), 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 mind-set 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.

John E. Campbell, MD, FACEP
Editor

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 eight 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 eight hours of CEU 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 eight 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 8th 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 ATLS or PHTLS instructor course and wishes to transition to the ITLS program. The course typically runs eight hours, and a sample course agenda is available in the 8th 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 eight hours. A sample course agenda is available in the 8th 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

Pediatric ITLS 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 Pediatric ITLS 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 the program in your area.

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1

Scene Size-up

Photo courtesy of International Trauma Life Support

James H. Creel, Jr., MD, FACEP

Valoración de la Escena
Ocena miejsca zdarzenia
Procjena mjesta događaja
Ocena prizorišča
Valutazione della Scena
Taille-haute de scène
Beurteilung der Einsatzstelle
مسح الموقع
mesto nesreće
Helyszinfelmérés

Key Terms

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essential equipment, *p. 21*
focused exam, *p. 23*
high-energy event, *p. 22*
index of suspicion, *p. 23*
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scene size-up, *p. 18*
standard precautions, *p. 18*

Objectives

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

1. Discuss the steps of the scene size-up.
2. List the two basic mechanisms of motion injury.
3. Identify the three collisions associated with a motor-vehicle collision (MVC), and relate potential patient injuries to deformity of the vehicle, interior structures, and body structures.
4. Name the five common forms of MVCs.
5. Describe potential injuries associated with proper and improper use of seat restraints, headrests, and air bags in a head-on collision.
6. Describe potential injuries from rear-end collisions.
7. Describe the three assessment criteria for falls, and relate them to anticipated injuries.
8. Identify the two most common forms of penetrating injuries, and discuss associated mechanisms and extent of injuries.
9. Relate five injury mechanisms involved in blast injuries and how they relate to scene size-up and patient assessment.

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.

standard precautions: steps each health-care worker takes to protect themselves and their patient from exposure to infectious agents; includes treating each patient and himself as if they were infectious. This always entails wearing gloves, frequently requires a face shield, and occasionally requires a protective gown.

Chapter Overview

Scene size-up is the first step in the **ITLS Primary Survey** (Table 1-1). It is a critical part of trauma assessment and begins before you approach the patient. If you fail to perform the preliminary steps of scene size-up, you 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 infective 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 injuries (Table 1-2). Each step will be covered in detail in this chapter, with special emphasis on how to use your knowledge of the mechanisms of injury to predict occult injuries to the patient.

Motion (mechanical) injuries are by and large responsible for the majority of deaths from trauma in most countries. This chapter reviews the most common mechanisms of motion injuries and stresses the injuries that may be associated with those mechanisms.

Scene Size-up

Scene size-up begins at dispatch, when you anticipate what you will find at the scene. At that time, you should think about what equipment you may need and whether other resources (more units, special extrication equipment, multiple-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 is often exaggerated or even completely wrong. Be prepared to change your plan depending on your own scene size-up.

Courtesy of Roy Alson, PhD, MD, FACEP, FAAEM

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 involved. 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, a 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 1-1: 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 Ongoing Exam	Repeat initial assessment Repeat vital signs and check monitors Reassess the abdomen Check injuries and interventions

Standard Precautions

Trauma scenes are among the most likely to subject the emergency care provider to contamination by blood or other potentially infectious material (**OPIM**). The subject of OPIM will be covered in more detail in Chapter 22. Not only are trauma patients often bloody, but they also frequently require airway management under adverse conditions. **Personal protective equipment (PPE)** is necessary at trauma scenes. Protective gloves are always needed, and many situations will require eye 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 patient 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 it 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

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

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 (sewers, ship holds, silos, and so on) 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.
- *Farms.* Silos are confined spaces and should not be entered without proper equipment and training. Livestock also can 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 see that law enforcement personnel are in defensive positions or have their weapons drawn.
- *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? You may not be recognized as an emergency care provider, but as a symbol of authority and thus attacked. Are dangerous animals present? Request law enforcement personnel at any sign of danger from violence.
- *Mass-Shooting Events.* Unfortunately, mass-shooting events have become too common worldwide. Classic instructions for emergency care providers have been not to enter the scene until law enforcement has "secured" it, which could take a very long time. Based on the analysis of a number of events, the Hartford Consensus document recommends that EMS responders enter the scene with law enforcement protection, when an area with victims has been rendered "safe," meaning there are no immediate threats in the area in which EMS personnel are operating. Then control any life-threatening hemorrhage in victims found, and rapidly evacuate them to a safer area for further assessment and treatment.

Another type of hazardous scene is the *blast scene*. Explosions usually are 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. In addition, in some countries 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 a bomb technician and a hazmat technician, should first evaluate the blast scene to make sure it is safe to enter and that no 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.

If it is necessary to enter the blast zone to save lives, try to do so in protective clothing using respiratory protection (which may include a chemical suit and gas mask). Identify those who are still alive prior to entry if possible. Rapidly rescue patients who are too injured to walk using "load-and-go" tactics with expedient spinal motion-restriction techniques. If the scene could be dangerous, the best policy is not to provide treatment on scene but rather to immediately remove all living patients. Take the

patients directly to the casualty collection point, and begin patient assessment and treatment there or in the ambulance. If resources are available, those patients should be taken directly from the scene to the appropriate hospital. Leave the dead in place.

The proper management of blast scenes is beyond the scope of this course, which is focused mainly on assessment and management of the injured patient. Other courses are available for more in-depth knowledge of this subject.

Consider whether or not the scene poses a continued threat to the patient. If there is danger of fire, water, structure collapse, toxic exposure, and so on, the patient may have to be moved immediately. This does not mean that you should expose yourself or your partners to unnecessary danger. You may need to call for special equipment and proper backup from law enforcement, fire services, or the power company. If the scene is unsafe, you should make it safe or try to remove the patients from the scene without putting yourself in danger. Sometimes there is no clearly good way to do this. Use good judgment. You are there to save lives, not give up your own.

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. Remember that you usually need one ambulance for each seriously injured patient. If there are many patients, establish medical command and initiate multiple-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 (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. Remember to change gloves between patients. The following equipment is always needed for trauma patients.

- Personal protection equipment
- Patient transport device (stretcher, long spine board, and so on) 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)

If special extrication equipment, more ambulances, or additional personnel are needed, call now. You are less likely to call for help when involved in patient care. Be sure to tell additional responders exactly where to respond and of any dangers present. In larger events, a staging area for ambulances and other responding units may be established. Use of designated radio channels, if available, helps in effective communications.

Mechanism of Injury

Once you determine that it is safe to approach the patient, begin to assess for the **mechanism of injury (MOI)**. This may be apparent from the scene itself, but it may require questioning the patient or bystanders. Injuries are caused by the transfer of

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.

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.

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

energy. Kinetic energy is equal to the mass (M) of the object in motion multiplied by the square of the velocity (V) divided by two.

$$\text{Kinetic Energy} = \tfrac{1}{2} (M \times V^2)$$

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 chances for serious injury.

You are not expected to calculate how much energy was transferred in a traumatic event but rather to estimate whether the collision was a low-energy event (such as an auto that backed into another in a parking lot) or **high-energy event** (such as an auto that hit a tree at a speed of 40 miles [64 kilometers] per hour). The formula is shown only to stress that speed (velocity) has a much larger effect on energy than does mass. A small increase in speed causes a large increase in energy transferred. Energy transmission follows the laws of physics; therefore, injuries present in predictable patterns (Table 1-3). Knowledge and appreciation of the mechanism of injury is very helpful in your evaluation of the patient for occult injuries. By performing a careful patient assessment, guided in part by the MOI, you should be able to identify the majority of injuries the patient has sustained. Missed or overlooked injuries may be catastrophic, especially when they become known only after the compensatory mechanisms of the body are exhausted.

Remember that patients who are involved in a high-energy event are at risk for severe injury. Despite normal vital signs and no apparent anatomic injury upon the initial assessment, 5% to 15% of those patients will later exhibit severe injuries that

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

Mechanisms of Injury	Potential Injury Patterns
Frontal impact Deformed steering wheel Dashboard knee imprints Spider-web deformity of windscreen	• Cervical-spine fracture • Flail chest • Myocardial contusion • Pneumothorax • Aortic disruption • Spleen or liver laceration • Posterior hip dislocation • Knee dislocation
Lateral impact (T-bone)	• Contralateral neck sprain • Cervical-spine fracture • Lateral flail chest • Pneumothorax • Aortic disruption • Diaphragmatic rupture • Laceration of spleen, liver, kidney • Pelvic fracture
Rear impact	• Cervical-spine injury
Ejection	• Exposure to all mechanisms and mortality increased
Pedestrian vs. car	• Head injury • Aortic disruption • Abdominal visceral injuries • Fracture lower extremities and pelvis

are discovered on repeat examinations. Therefore, a high-energy event signifies a large release of uncontrolled energy. Consider the patient injured until you have proven otherwise.

It is important to be aware of whether the mechanism of injury is generalized or focused. Generalized mechanisms include motor-vehicle collisions, falls from a height, and so on. Focused mechanisms cause injuries to discrete areas of the body, such as a stab wound of the abdomen or an amputation of a foot. Generalized mechanisms require a **rapid trauma survey** of the whole body, whereas focused mechanisms may only require a **focused exam**, which is a limited exam of the affected areas or systems.

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.

Factors to be considered are direction and speed of impact, patient kinetics and physical size, and the signs of energy release (such as major vehicle damage). A strong correlation exists between injury severity and automobile velocity changes, as measured by the amount of vehicle damage. So, it is important that you consider these two questions: What happened? How was the patient injured?

The mechanism of injury is an important triage tool. It provides information you should report to the emergency physician or trauma surgeon. Severity of vehicle damage has been suggested as a nonphysiologic sign of injury. Taking a few brief photos with a digital camera of the vehicle's damage can be helpful for emergency department personnel to recognize the severity of forces involved. It is essential to develop an awareness of mechanisms of injury and thus have a high **index of suspicion** for occult injuries. Always consider the potential injury to be present until it is ruled out in a hospital setting.

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.

Mechanisms of Motion Injury

Motion injuries are by and large responsible for the majority of the mortality from trauma in the world. The most common are discussed in the sections that follow. The important concept to appreciate is that energy is neither created nor destroyed but is only changed in form (law of conservation of energy). Thus the kinetic energy of motion must be absorbed. It is this absorption of energy that is the major component in producing injury.

The two basic mechanisms of motion injury are blunt and penetrating (Table 1-4), although patients can have injuries from both at the same time. In the United States, penetrating injury is a major cause of young minority males needing trauma care. For the nonurban areas of the United States and for most of the world (outside of combat zones), blunt force trauma remains the major cause.

Motor-Vehicle Collisions

The patterns of injuries from collisions with automobiles, motorcycles, all-terrain vehicles (ATVs), personal watercraft, and tractors are varied. Therefore, you should keep in mind that all MVCs occur as three separate events (Figure 1-1):

- Machine collision
- Body collision
- Organ collision resulting in rupture, shearing, or bruising

Table 1-4: Basic Mechanisms of Motion Injury

Blunt Injuries	Penetrating Injuries
• Rapid forward deceleration (collisions) • Rapid vertical deceleration (falls) • Energy transfer from blunt instruments (baseball bat, blackjack)	• Projectiles • Knives • Falls on fixed objects

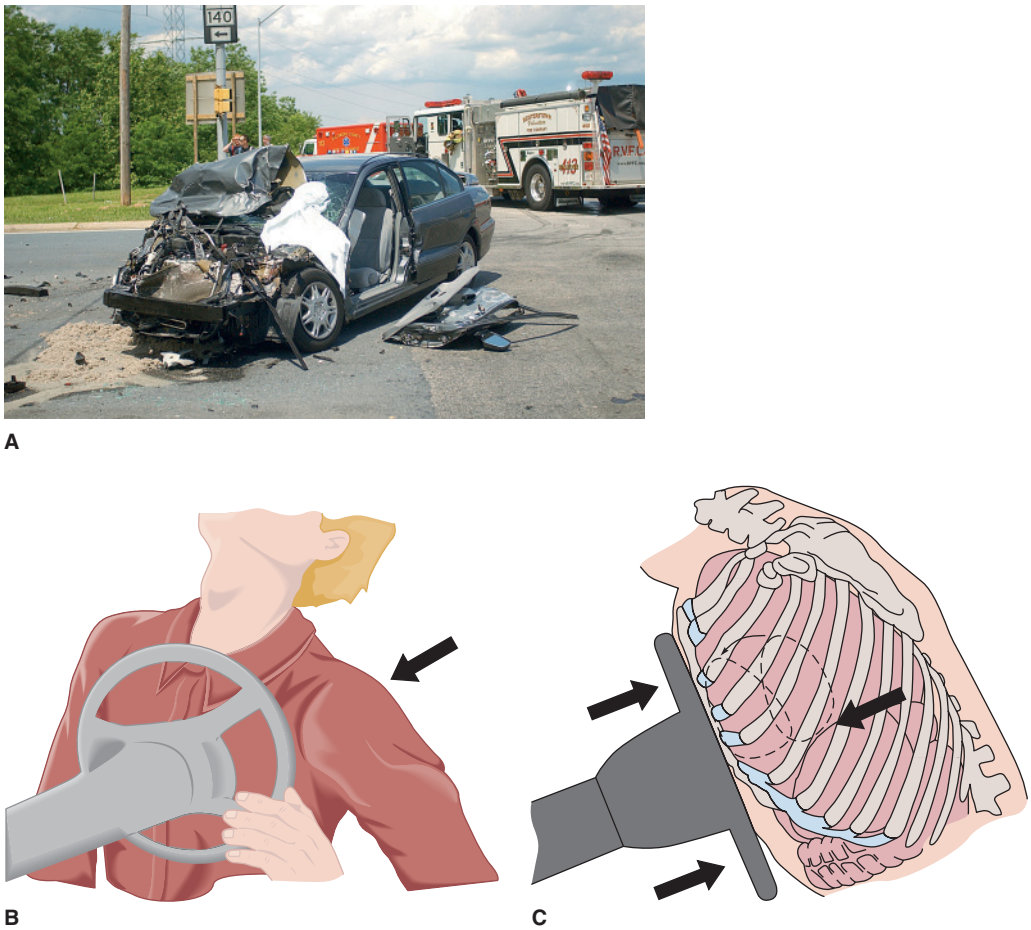

Figure 1-1 The three collisions of a motor-vehicle crash. (A) Vehicle collision. (B) Body collision. (C) Organ collision. *(Photo copyright Mark C. Ide)*

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 auto to an immediate stop by transferring the energy into damage to the tree and the automobile. The person inside the auto is still traveling at 40 miles (64 kilometers) per hour until he strikes something that stops him (such as seat belts, steering wheel, windshield, or dashboard). 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 (64 kilometers) 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). 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 possible head injury, cervical-spine injury, myocardial contusion, any of the "deadly dozen" chest injuries (described in Chapter 6), intra-abdominal injuries, and musculoskeletal injuries (especially fracture or dislocation of the hip).

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. This 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

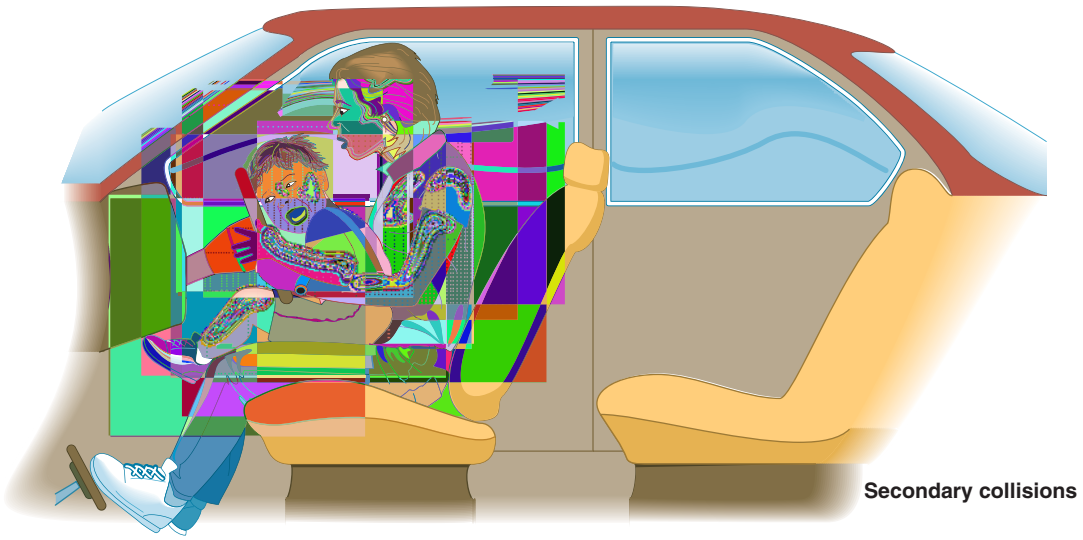

Figure 1-2 Secondary collisions in a deceleration motor-vehicle collision. In this case, a secondary collision is the unrestrained body of the mother crushing the child against the steering wheel.

the impact. Remember that the body of the occupant is also traveling at 40 miles (64 kilometers) per hour until impacted by some structure within the car. With awareness of this mechanism, one can see the multitude of injuries that could occur. Be aware of the following clues:

- Deformity of the vehicle (indication of forces involved—energy exchange)
- Deformity of interior structures (indication of where the patient impacted—energy exchange)
- Deformity or injury patterns of the patient (indication of what parts of the body may have been impacted)

Additional collisions other than the three already mentioned may occur. Objects inside the automobile (books, bags, luggage, and other persons) will become missiles traveling at the original speed of the auto and may strike persons in front of them. These are called *secondary collisions*. A good example occurs when an unrestrained parent is holding a child in her lap and crushes the child between her and the dashboard in a deceleration collision (Figure 1-2).

In rear-impact auto collisions, multiple impacts may occur if the auto strikes another auto in the rear and is then in turn struck from behind by another auto following. Also, vehicles frequently deflect from hitting one object and then collide with a second or even third vehicle or stationary object. They are similar to what occurs in a rollover collision: the persons inside the vehicle are subjected to energy transfer from multiple directions. It is often more difficult to predict injuries in these cases. You must quickly but carefully look for clues inside the vehicle. Remember that in multiple-impact collisions, the airbag only works for the first one.

MVCs occur in several forms, and each form is associated with certain patterns of injury. The five common forms of MVCs are the following:

- Frontal-impact or head-on collision
- Lateral-impact or T-bone collision
- Rear-impact collision
- Rollover collision
- Rotational collision

Figure 1-3 In a head-on collision, most injuries are inflicted by the windshield, steering wheel, and dashboard. *(Photo courtesy of Maria Dryfhout, Shutterstock)*

Frontal-Impact Collision (Head-on)

In an MVC involving a frontal-impact collision, an unrestrained body is brought to a sudden halt. The energy transfer is capable of producing multiple injuries.

Windshield injuries occur in the rapid forward-decelerating type of event, in which the unrestrained occupant impacts the windshield forcefully (Figure 1-3). The possibility for injuries is great under those conditions. Of utmost concern is the potential for serious airway and cervical-spine injury.

Remembering the three separate collision events, note the following:

- *Machine collision*—deformed front end
- *Body collision*—spider-web pattern of windshield
- *Organ collision*—coup/contracoup brain, soft-tissue injury (scalp, face, neck), hyperextension/flexion of the cervical spine

From the spider-web appearance of the windshield and an appreciation of the mechanism of injury, you should maintain a high index of suspicion for possible occult injuries of the cervical spine. The head usually strikes the windshield, resulting in direct trauma to the face and head. External signs of trauma include cuts, abrasions, and contusions. They may be quite dramatic in appearance. However, the key concern is airway maintenance with motion restriction of the cervical spine and evaluation of level of consciousness.

Steering-wheel injuries most often occur to an unrestrained driver of a vehicle in a head-on collision. The driver may subsequently impact with the windshield. The steering wheel is the vehicle's most lethal weapon for the unrestrained driver, and any degree of steering-wheel deformity (check under collapsed airbags) must be treated with a high index of suspicion for face, neck, thoracic, or abdominal injury. The two components of this weapon are the ring and column (Figure 1-4). The ring is a semirigid, plastic-covered metal circle attached to a fixed inflexible post, which essentially is a battering ram.

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

- *Machine collision:* Look for front-end deformity of the vehicle.
- *Body collision:* Check the steering wheel for ring fracture and deformity and the column for any displacement.
- *Organ collision:* Look for traumatic tattooing of patient's skin.

The head-on collision is entirely dependent on the area of the body that impacts with the steering wheel, dashboard, or other portion of the vehicle's interior. Signs may be readily visible, with direct trauma such as lacerations of mouth and chin, contusion/bruises of the anterior neck, traumatic tattoos of the chest wall, and bruising of the abdomen. These external signs may be subtle or dramatic in appearance, but more important, they may represent only the tip of the iceberg. Deeper structures and organs may harbor occult injuries due to shearing forces, compression forces, and displacement of kinetic energy.

Figure 1-4 Steering wheel injuries.

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 occult bleeds and hemorrhagic shock. Compression injuries are common for the lungs, heart, diaphragm, and urinary bladder. An important sign is respiratory distress, which may be due to pulmonary contusions, pneumothorax, diaphragmatic hernia (bowel sounds in chest), or flail chest. Consider a bruised chest wall as a myocardial contusion that requires monitoring of cardiac rhythm and, if available, a 12-lead ECG. In short, the steering wheel is a lethal weapon capable of producing devastating injuries,

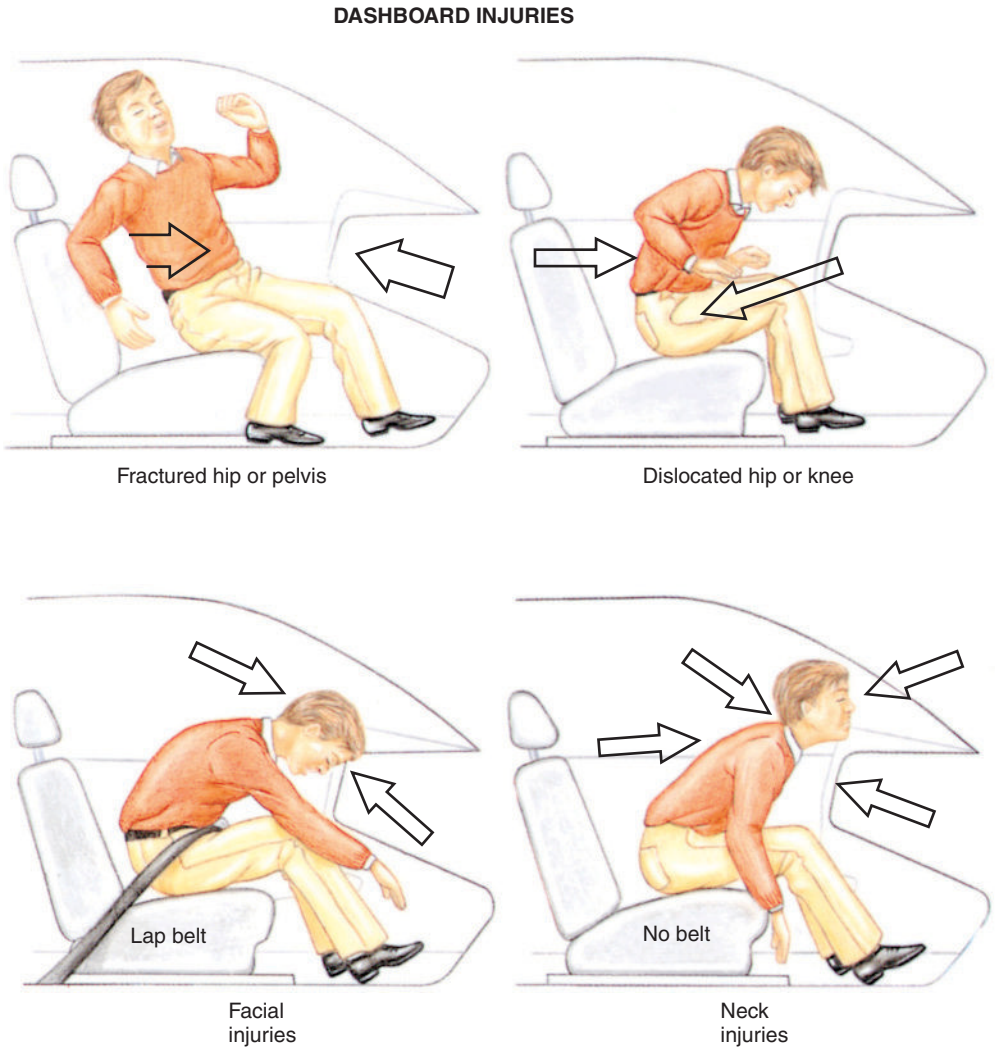

Figure 1-5 Dashboard injuries.

many of which are occult. Steering wheel deformity is a cause for alarm and must heighten your index of suspicion. You also must relay this information to the receiving physician.

Dashboard injuries occur most often to an unrestrained passenger. The dashboard has the capability of producing a variety of injuries, depending on the area of the body that strikes the dashboard. Most frequently, injuries involve the face and knees. However, many types of injuries have been described (Figure 1-5). Applying the three-event concept of collision, you will note the following:

- *Machine collision:* Look for deformity of the vehicle.
- *Body collision:* Check the dash for fracture and deformity.
- *Organ collision:* Look for facial trauma, coup/contracoup brain, hyperextension/flexion of the cervical spine, pelvis, hip, and knee trauma.

Facial, brain, and cervical-spine injuries have already been mentioned. These are more likely if the crash forces send the victim up over the dash into the windshield. Like chest contusion, knee trauma may represent only the tip of the iceberg. Knees commonly impact with the dashboard, especially if the patient is thrown down under it. Knee trauma may range from a simple contusion to a severe compound fracture of the patella. Frank dislocation of the knees also can occur, along with fractures of the

A

B

Figure 1-6 In a lateral-impact collision, most injuries are inflicted by intrusion of the door, armrest, side window, or door post. *(Photo courtesy of Anthony Cellitti, NREMT-P)*

proximal tibia (tibial plateau fracture). In addition, kinetic energy may be transmitted proximally and result in fracture of the femur or fractured/dislocated hip. On occasion, the pelvis can impact with the dash, resulting in acetabulum and pelvic fractures. Such pelvic injuries are often associated with hemorrhage that may lead to shock. Maintain a high index of suspicion, and always palpate the femurs, gently squeeze the pelvis, and palpate the symphysis pubis.

Deceleration collisions are most commonly associated with secondary collisions with people or loose objects in the vehicle, which can become missiles causing deadly injuries.

Lateral-Impact or T-Bone Collision

The mechanism of the lateral-impact collision is similar to that of the frontal-impact collision, with the addition of lateral energy displacement (Figure 1-6). Applying the three-collision concept to the lateral-impact collision, look for the presence of the following:

- *Machine collision:* Look for primary deformity of the vehicle, being sure to check the impact side (driver or passenger).
- *Body collision:* Determine the degree of door deformity (for example, armrest bent, outward or inward bowing of door).
- *Organ collision:* This cannot be predicted by external exam alone. Instead, consider organs beneath areas of external injury.

Look for the following common injuries:

- *Head.* Coup/contracoup is due to lateral displacement.
- *Neck.* Lateral displacement injuries range from cervical-muscle strain to fracture or subluxation with neurologic deficit.
- *Upper arm and shoulder.* Injuries appear on the side of the impact and are common, as are injuries to the lower extremities.
- *Thorax/abdomen.* Injury is due to direct force either from inward bowing of the door on the side of the impact or from an unrestrained passenger being propelled across the seat. Injuries vary from soft-tissue injuries to flail chest, lung contusion, pneumothorax, hemothorax, or possible traumatic aortic dissection. Abdominal injuries include those to solid and hollow organs.
- *Pelvis/legs.* Occupants on the side of the impact are likely to have pelvic, hip, or femur fractures. Pelvic injuries may also include dislocation, bladder rupture, and urethral injuries.

Emergency care providers do need to be aware that many new vehicles are equipped with side airbags and air curtains (Figure 1-7). They pose a hazard to responders, if those safety devices did not activate in the collision.

Figure 1-7 Side airbags and air curtains 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)*

Rear-Impact Collision

In the most common form of rear-impact collision, a stationary car is struck from the rear by a moving vehicle (Figure 1-8). Or a slower-moving car may be impacted

Figure 1-8 In a rear-impact collision, the potential exists for neck and back injury. *(Photo courtesy of Bonnie Meneely, EMT-P)*

from the rear by a faster-moving car. The sudden increase in acceleration produces posterior displacement of the occupants and possible hyperextension of the cervical spine if the headrest is not properly adjusted. If the seat back breaks and falls backward into the rear seat, there is greater chance of lumbar-spine injury. Rapid forward deceleration may also occur if the car suddenly strikes something in the front or if the driver applies the brakes suddenly. Note deformity of the auto anterior and posterior as well as interior deformity and headrest position. The potential for cervical-spine injuries is great (Figure 1-9). Be alert for associated deceleration injuries as well.

A Victim moves ahead while head remains stationary. Head rotates backward. Neck extends.

B Head snaps forward. Head rotates forward. Neck flexes.

Figure 1-9 Mechanism of cervical-spine injury in a rear-impact collision.