BODY TRAUMA

A Writer's Guide To Wounds and Injuries

By

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FOREWORD

Conflict is the core of all fiction. Without conflict there is no story. When obstacles prevent a character from attaining his or her goals, there is conflict. It is also necessary that the consequences of not attaining the goal be profoundly significant for the character. The threat of death or severe bodily injury is among the most serious and dreadful obstacles a character must face, and therefore creates conflict and tension.

Death is an important part of most fiction. This includes all genres, not just murder mysteries (which are always one of the top-selling genres). But it is not always necessary to kill a character to have conflict. A character sustaining a severe injury can often be more compelling than a dead person when the injury is used wisely and with accurate details. Whereas my book *Cause of Death* in the Howdunit Series discusses death and dying, this book provides vital information on nonfatal wounds and trauma.

If a hunter accidentally shoots himself, can he walk out of the woods to safety, or does he crawl, slowly bleeding to death? How long can he survive, and how much pain and anguish does he experience? Survivors of a plane wreck; a child hit by a car; an old lady attacked by dogs; a ranger struck by lightning; a farmer crushed beneath his tractor: All of these could create great tension and conflict in a story.

In this book, Dr. David Page expertly guides you through such scenarios, shows you how to use proper medical terminology, gives surgical "tips" along the way and discusses emergency care, all presented in a manner geared specifically for you, the writer. Adding accurate details to such scenes makes the story come to life and draws

the reader into the world you have created.

In addition to being an accomplished writer, David Page is also a surgeon and an expert on trauma. Dave is a good friend of mine, and what he won't tell you is that in addition to being a surgeon with a busy practice, he also teaches medical students and surgical residents and has won several Citations for Excellence in Teaching from Tufts University School of Medicine.

This reference book is a must for all writers. Keep it at your desk. You'll use it over and over.

Keith Wilson, M.D.

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INTRODUCTION

In literature, as in life, sooner or later everyone becomes injured—accidentally or as a consequence of malice—somewhere in the story. The writer must force characters to face conflict. And that includes creating injuries. Every writer needs to understand how to create authentic traumatic injuries as well as how to deal with their consequences.

The focus of this book is on violent injuries that do not result in death.

Every writer confronted with the dilemma of how severely to hurt a character must understand the consequences of the physical havoc created. Injuries should be realistic, reflect the character of the person inflicting the insult and be tailored to the needs of the plot. More sophisticated than in the past, today's readers have become avid, critical consumers of media violence. Hence, your story's accidents and injuries and the convalescence they cause must ring true.

As you write what is referred to in this book as an "injury scenario", you must hold the tuning fork of authenticity to your ear. You'll learn to review pertinent anatomy, assess the world of your story—what's there to serve as a weapon and who's present in the scene to use it—and decide what mayhem your tale needs. These are the elements of a trauma prescription.

Whether the genre is mystery-murder, horror, romance or any of the varieties of mainstream thrillers, or if your story is character-driven, the writer's art hinges on accurately depicting human suffering. Ernest Hemingway insisted it is what the writer leaves out that counts most. The late Gary Provost in a similar vein taught his writing students: Less is more. Richard Cohen, in *Writer's Mind*, instructs: Fiction

writing should imply there is a great deal more than what has been written.

If using less material is the goal of good writing, why learn so much about inflicting injuries?

In "The Snows of Kilimanjaro", Hemingway never describes the gangrenous leg that plays a central role in the story. He alludes to the offensive smell and the progression of gangrene and even reflects on how it began with an element of neglect on Harry's part. At no point is there an explicit description of the rotting leg.

In Ian Hamilton's biography entitled *In Search of J.D. Salinger*, he describes the author of *The Catcher in the Rye* as he becomes progressively urbane, increasingly accomplished at his craft. Following the publication of Salinger's "A Perfect Day for Bananafish", Hamilton states, "Thanks to *The New Yorker* he was beginning to learn the pleasures of reader manipulation, of having a sophisticated readership that had been trained in the enjoyment of inconsequential sorrow. He was learning how to leave things out, to flatter and deceive."

Herein lies the paradox of fiction writing: You must understand what to include and what to leave out. In order to leave something out of a scene, you need to understand all of the elements that could (but shouldn't) be included.

Authenticity emerges from personal experience, struggle and then understanding. Certainly, Hemingway had seen his share of war wounds. But most writers have little experience with traumatic injuries. This book describes in detail what you must learn about body impact and the spectrum of potential injuries in order to select what details to include in your scene. Once you understand what's there and how it gets maimed, you'll feel the pain and know what aspects of the

injury to describe. The reader's visual imagery is enhanced by the inclusion of the right details. By learning a lot about a particular injury, you may select the most visual elements and write a sparse, fast-paced action scene.

Rather than being anecdotal, this book describes the process of how to create a dramatic injury scene. Included are suggestions on how to incorporate the more complicated material into your story.

No writer can describe, allude to, or choose to ignore something that she doesn't understand. And you can bet the treasury that before the chubby cherub chortles, someone in *your* story is going to get hurt. If it's *your* traumatic scene, you'd better know exactly how it happens.

***Body Trauma* provides an organized menu of injuries and a suggested method of approach to guide you through the process of creating authentic misery. Using the various examples presented in conjunction with *master injury lists* (a menu of specific injuries) for each body system, you may construct innovative insults and terrible wounds to fit the specific demands of your plot. Not just a mere laundry list of clinical mutilations, this book describes how to create novel impacts, bodily disruptions and agonizing tissue trauma. By identifying where the impact occurs and what it does to the body, you can properly weave the length of the disability into the drama. This is called the *time line* of the injury.**

If imaginable, any injury is possible. By using the ideas presented in this book, you'll learn how to finesse the details.

***Body Trauma* is divided into three distinct parts in order to organize and highlight for easy use what is at times complex material.**

Part I provides an overview of trauma as well as some basic concepts about the body. Principles are explained regarding tissue impacts, mechanisms of injury and how the trauma victim is handled in different locations both in and out of the hospital.

Part II is an intense discussion of major trauma, organized by body area. It includes detailed information about head and neck, chest, abdominal and limb trauma. This section represents virtually all types of major injury seen in a busy emergency room by trauma surgeons.

Part III includes unique injuries according to their cause rather than by body region. Some of these forms of damage are quite horrible. Examples from classic and contemporary literature are included in Parts II and III to demonstrate how accomplished authors handled body insults.

At the end of the book, there is a discussion of what occurs when an injured person dies and the issue of organ donation arises. Sitting on the cutting edge of high-tech medical care, organ transplantation programs struggle with a national shortage of organs suitable for donation. All seriously injured victims should be considered as potential organ donors. And although not our primary concern in this book, a discussion of the process of making this cherished gift closes our discussion about broken bodies. It's an important topic for fiction writers.

So often in contemporary fiction, as in the movies, our suspension of disbelief is stretched to near rupture by violent body insults sequenced with an implausibly swift recovery. On the other hand, it seems many writers have an intuitive sense of what is biologically correct, and this book is intended to augment that instinct. Not

only will you learn how to write your injury scenarios by using this book, but by the end of the book, you should have become a sophisticated first responder to the injured.

Just as fiction is part of real life, trauma is a glaring real-life epidemic awaiting its place in your fiction. The dilemma for the writer lies in *what* injury to fit into the world of the story.

Most of medicine is common sense. Have fun with the material, and don't panic at the med-speak.

Writing your trauma scene may be the only time *you* can be the doctor. Early in my surgical career, I performed my share of trauma surgery and many of my personal experiences have insinuated themselves into these pages. My professional life includes a busy surgical practice as well as teaching surgical residents and medical students. As part of my teaching preparation over the years, I have used multiple editions of the American College of Surgeons Committee on Trauma's *Advanced Trauma Life Support For Doctors (ATLS) Student Course Manual*. I wish to give special thanks to the ACS Committee on Trauma and the Seventh Edition of the Manual; I have used this precious resource for portions of this book.

PART I

AN OVERVIEW OF TRAUMA

CHAPTER ONE

CONCEPTS AND TERMINOLOGY IN TRAUMA CARE

Injuries occur for a reason.

Before entering the world of trauma, you need to know a few basic terms. If you understand simple mechanisms of injury causation, this part of modern medicine and its funny-sounding verbiage will be easier to grasp. For your story to sound authentic, you need to know what you're talking about.

***Trauma* refers to the physical wounds and innumerable body insults that result from direct or indirect contact with something in the environment. In the chaotic history of medicine, surgeons became the specialists who assumed the task of managing traumatic wounds, treating terrible numbers of war casualties from the numerous conflicts that seeded every century. With time, weaponry became more sophisticated, more destructive. Nonetheless, even the rock hatchets, spears, darts and arrows of primitive humans were deadly, and the injuries horrible.**

Warriors wear scars with pride, and one wonders if physical conflict is our species' norm. In humankind's history, it seems quite possible that intentional wounding has been more frequent than the occurrence of unanticipated trauma. A

cursory examination of man's warring history reveals repeated, massive conflicts in which large numbers of warriors became wounded. Many died. But many survived their injuries to fight again. Scientists refer to an animal's (including man's) response to confrontation as the "fight or flight" reaction, the choice presumably determined by a recognition of the odds. Man has a poor track record of avoiding the odds of sustaining traumatic injuries.

Traumatic events can thus be *accidental* or *intentional*. Some injuries are more repugnant precisely because the assault is premeditated, an attack designed to hurt another person. But even so-called accidents may be more a matter of inattention and risk taking than of pure chance.

For the writer, the introduction of any form of body damage into a sordid tale increases suspense and introduces an element of uncertainty. Plot possibilities emerge from the doubt born of disaster and from the character's back story, for example, the compulsion to practice risky behavior. On the other hand, some folks are so preoccupied with problems of daily living they become distracted and are therefore *accident-prone*. In this book, we look at accidents as well as injuries that result from being in a hostile environment.

Why Do Accidents Occur?

For a moment, let's consider real *accidents*. This term implies a traumatic episode occurred that could not have been anticipated and therefore is not the consequence of an expected series of events. The accident produced an unexpected outcome because it occurred suddenly, created alarm and resulted in injury.

A true accident can't be avoided. Why do accidents occur? Two reasons why accidental events occur are sudden, unexpected changes in:

1. A person

2.The environment

Consider the elements of a typical automobile accident. Available data indicates that most accidents occur on the weekend and at night. Young people who consume alcohol are involved in the majority of car crashes. The *person components* that result in so-called "accidental" automobile mishaps include:

- **Inebriation or drug abuse**
- **Distraction by others in the car**
- **Excessive speed**
- **Risky maneuvers, such as passing or bumper hugging**
- **Falling asleep at the wheel**
- **Anger, rage, depression, anxiety that cause preoccupation and failure to pay attention to driving chores**
- **Inadequate driver training**
- **Visual or motor skill impairment, as in some elderly drivers**

***Environmental factors* also contribute to car crashes and may include one or a combination of the following:**

- **Poor road construction**
- **Poor road conditions, e.g., rain, snow, ice or fog**
- **Excessive traffic**
- **Lack of familiarity with road**

- **Abusive drivers, e.g., risky passing behavior or startling another driver with high beams**

These factors may be compounded by defective car parts, such as brakes, windshield wipers or engine components. Also, an impact may involve a poorly designed car. Failure to wear a seat belt and failure or absence of an air bag make the impact all the more dangerous.

Therefore, an accident may be viewed in general terms as an unexpected event that occurs because of the linkage of a series of related factors:

- **Distraction (inattention to the task at hand)**
- **Lack of training with specific equipment**
- **Lack of motor skills (inferior innate talent)**
- **Cavalier attitude toward dangerous equipment**
- **Ignorance about potential dangers with specific equipment**
- **Poorly maintained equipment**
- **Effect of aging or disease on person's mobility, reasoning ability and perception**

The terms described next are used in the assessment and care of the trauma patient.

***Assault* includes both physical and verbal attacks on another person. A character's interpersonal relationships and background will contribute to which element is most often employed in relationships. Verbal abuse may be more subtle, frightening and chronic than outright fisticuffs.**

***Domestic violence*, including *elder abuse*, *child abuse*, *spouse abuse* and *rape*, involves the most violent of crimes and produces many of the most despicable injuries. These will be covered in detail in Part III.**

***Self-mutilation* is a fascinating topic that implies a purposeful alteration in self-image. We'll merely nudge this topic in our discussion. What happens to self-image? Why tattoos? Scars?**

***Mortality* refers to death. The mortality rate in a given circumstance means how many people died. It's the death rate for a specific medical procedure or life event.**

***Morbidity*, on the other hand, refers to injury. It's the meat of this book. The accidental event itself has a morbidity rate, as does the surgery performed to fix the broken body. Each event has a potentially poor outcome—things that can go wrong because of uncontrolled trauma or despite controlled surgery.**

Some things just happen.

Emergency Management

The events that surround the management of major accidents are divided into the sequential events that are part of trauma care.

Extrication: This is the removal of the victim from the scene. It may involve using the "jaws of life" to get someone out of a car wreck, removing a victim from a mountaintop or a deep ravine or bringing a child up from a well shaft.

Transportation of the patient: Three methods of transportation are available for trauma victims and are dependent upon the distance from site of injury to the nearest available appropriate acute care facility.

1.Ambulance—up to about 50 miles

2.Helicopter—about 50 to 100 miles

3.Fixed wing aircraft—about 100 to 300+ miles

Helicopters and fixed wing aircraft provide rapid transport for victims who are only marginally stable and who must reach expert trauma care for specialty surgical care.

Resuscitation equipment is available in all transport vehicles. The most important principle in patient transport is to deliver the victim quickly and safely to the nearest appropriate hospital. A contingency plan for foul weather is needed.

Dead victims don't enter the Emergency Medical System (EMS) but must be taken to the proper facility as directed by the coroner or medical examiner.

Transfer of Patients

This refers to the transfer of a patient from one trauma center to another of a more sophisticated level (see "Levels of Trauma Care" on page ____). Criteria for considering early transport of the injured victim are summarized in Figure 1 (page ___). An example of a transfer sheet is included in Figure 2 (page ____).

The trauma victim's *illness severity* is calculated from vital signs, specific lab tests and other variables. Each patient is assigned what is called the *revised trauma score*. It gives an estimate of survival potential and consists of:

- **Respiratory status**
- **Cardiac status (blood pressure, pulse, etc.)**
- **Glasgow Coma Score (see Chapter Five)**

Not only does this derived number permit the trauma surgeon to predict outcome, it also gives an estimate of the patient's potential for developing major complications.

A paramedic, doctor, or layperson caring for a trauma victim must recognize where in the following sequence they have entered the continuum of trauma management:

- **Assess the extent and type of injuries**
- **Stabilize the victim/patient**
- **Prepare for definitive treatment or transfer to another hospital**

In the paramedic's case, the initial transportation is to the closest local hospital or to a regional trauma center depending on the circumstances. If a smaller hospital doesn't have surgeons who are able to care for these patients either through close monitoring in the intensive care unit or by operating on them, then the patient must be transferred. Making a decision to transfer a patient occurs as the doctor quickly assesses the patient in the ER trauma room. It's not just a matter of the surgeon's time it's also a question of the local capabilities and limitations. Will the care of one complicated patient consume most of a limited ICU staff's time?

If the decision is made to transfer a patient, no further work-up (tests such as a CT scan, ultrasound, etc.) should be performed. The goal is to get the patient into the hands of surgeons who can immediately institute the proper care. Delay results in increased mortality. If your doctor character hesitates, fumbles the ball, acts out of his own ego needs, the victim may die. Or incur serious disabilities. Your doctor must decide whether an operation should be performed at the smaller hospital prior to

transfer to a trauma center to assure the patient's safety. You may be surprised to learn that some rather serious blunt and penetrating traumatic injuries are managed without surgery. Here's the catch. Let's say your fictional doctor is watching a trauma patient, (instead of transferring the patient to a medical center) monitoring their vital signs, re-checking their clinical examination to determine if the patient is stable or deteriorating. If she's going to do this, she must have the surgical skills and an available operating room - not to mention a full capability blood bank, ICU and other ancillary support personnel - at her disposal if the patient "crashes" (plunges into shock). Your fictional surgeon can't admit, assess and watch her patient in hopes of a good outcome unless she's ready to perform emergency surgery if "observation" doesn't work.

If someone else died in the accident, the mechanism of injury was probably such that your patient harbors obvious or occult life-threatening injuries as well. Alcohol and drugs may alter a victim's level of consciousness. But, the surgeon must assume until proven otherwise that the patient has a significant head injury. A head CT scan must be performed to rule out intracranial bleeding if certain "lateralizing" signs (neurological findings on examination that result from a so-called space occupying lesion, blood clot, for example, in the brain) are present.

The severity of the injury is assessed in the field by a paramedic before the trauma surgeon becomes involved. Field assessment of the degree of injury is determined by the following four factors:

1. **Abnormal body functions such as low blood pressure and fast pulse that**

describe shock or abnormal respirations and neurologic findings that suggest a severe head injury

2. Obvious disruption of the victim's anatomy, e.g., traumatic amputation, impalement, gaping chest or belly wound

3. The mechanism of injury—blunt or penetrating, the caliber of the gun, speed of the motorcycle, length of the knife, distance of the fall, etc.

4. Associated illnesses, such as diabetes, hypertension, heart failure, chronic lung disease or kidney failure

Once the paramedic identifies major life-threatening injuries, he institutes emergency care before moving the victim. The pattern of identifying and treating trauma emergencies is ritualized to avoid mistakes.

***Prehospital protocols* refer to specific instructions given to paramedics and EMTs as part of their training to assure reproducible and safe care for all trauma victims. These kinds of treatment plans are also available for a variety of medical conditions seen "in the field". The goals of all emergency care protocols are:**

- **To provide lifesaving care in the field**
- **To provide comfort to victim**
- **To transport victim to the appropriate hospital in a timely fashion**

The elements of prehospital "cookbook" emergency care plans are taught in a defined order to be followed by every emergency responder in exactly the same way. The concept is to eliminate freelancing and creative thinking in the management of life-threatening emergencies. Anyone who has been responsible for another human who was in the act of dying knows the intense fear that surrounds providing acute

care. It's easy to forget what to do for the victim.

Thus, the basic resuscitation scheme used by all EMTs, paramedics, nurses and physicians is *ABCDE*. This translates into looking for and solving the following acute problems, which, if not reversed, may result in a life-ending tragedy.

- ***A* is for *airway*. Assure nothing is blocking free flow of air in the mouth and trachea.**
- ***B* is for *breathing*. Make certain air exchange is actually occurring.**
- ***C* is for *circulation*. The heart is beating, pulses are present and bleeding is stopped.**
- ***D* is for *disability*. Check the nervous system. Is the victim verbally responding? Are eyes open? Arms moving? Legs?**
- ***E* is for *exposure*. Take off the victim's clothes, if necessary, and check for other hidden life-threatening injuries.**

***Triage* refers to the sorting out of trauma victims according to the severity of their injuries. This process occurs in the field, in the trauma room and in the setting of mass casualties. It's crucial to know that half of all trauma victims who will eventually die, never reach a hospital. Two-thirds of those who die in spite of acute medical care will expire within the first four hours.**

Your "first responder" character should know whom to let die at the scene—unless you are purposely creating conflict by having him make the wrong decision or involving him in a dispute with someone else at the scene about triage priorities.

Why do trauma victims die after reaching the hospital? The reasons include:

- **Delayed transportation to a trauma care facility**

- **Improper triage in the field with missed vital injuries**
- **Inadequate or delayed resuscitation**

The paramedic must consider four situations when performing triage in the field:

1. Whom to ignore because they are going to make it without attention (minor lacerations, abrasions, etc.)

2. Whom to let die at the scene because no amount of care will reverse their overwhelming injuries (massive head injuries, profound shock from blood loss, etc.)

3. Who has life-threatening injuries that must be reversed immediately at the accident scene (obstructed airway; major ongoing bleeding requiring pressure dressings; head or neck injuries, requiring stabilization, urgent evacuation and hospital treatment; etc.)

4. Who needs care for major injuries that are not life threatening (broken bones, bleeding, uncertain internal injuries, etc.)

Sadly, the sickest victim isn't always the one you pay most attention to when sorting injuries. It's a numbers game and it's tough.

Finally, before a trauma patient is transferred to another facility, it is the original doctor's responsibility to communicate doctor-to-doctor to the receiving surgeon at the Level One medical center. There is no place in a well-executed transfer for relying on ER notes or asking a nurse to call the other hospital. The receiving surgeon will want to know specifics about the patient's status in order to consider what will be needed in terms of interventions when the patient arrives, as well as if there has been a change in the patient's status during transport. The doctor who had the original

contact must provide this information.

Levels of Trauma Care

Now we'll discuss in detail the different levels of trauma care available throughout the U.S. and the way various hospitals mesh together to form a regional trauma care system. There are four recognized levels of trauma care expertise—all of which are vital for a smoothly run national system of trauma care delivery.

***Level I trauma centers* are major urban medical centers, with all surgical specialties available, including a neurosurgeon, plastic surgeon, urologist, cardiac surgeon, orthopedic surgeon, ophthalmologist, ENT surgeon, pediatric surgeon and hand surgeon. A trauma surgeon is on call in-house (surgical resident) at all times, intensivists work in multi-specialty critical care units (ICU). There exists an excellent blood bank, laboratory facility and support systems, such as rehabilitation, social services and religious support.**

***Level II trauma centers* are urban community hospitals with most surgical specialties represented. They handle ninety-five percent of all traumas. Level II centers have board-certified general surgeons with trauma experience and many, but not all, support services. More complex cases are referred to Level I centers.**

***Level III trauma centers* are usually rural hospitals. Surgeons aren't on call twenty-four hours a day specifically for trauma, but they are readily available. Most other surgical specialties are available as well. Less complicated cases, for example, patients with single system trauma, may be handled at these facilities.**

***Level IV trauma centers* are rural hospitals or clinics with minimal resources, but**

they are the only care available for some trauma patients. There may not be a doctor present, so paramedical personnel play a vital role in resuscitating and transporting trauma victims.

The transport of the victim to a big-city Level I super-specialty medical center characterizes a continuum of expertise and opportunity. Every link in the national trauma system is vital for the effective running of the program. But some victims only suffer from one injury.

***Single system trauma* involves only one organ system in the impact event. For example, head trauma by itself causes a majority of traumatic deaths and many long-term disabilities. A fractured leg is also single system trauma but carries little potential for prolonged disability and rehabilitation.**

***Multiple system trauma* is seen in auto accidents, falls and other extreme accidental impacts where deceleration affects any organ that is poorly anchored and not well protected. That is, the aortic arch, spleen, kidney or intestine may continue to move after the body halts abruptly with collision or contact with the ground. In addition to multiple fractures, internal organs are often torn or ruptured, creating a variety of clinical problems for the surgeon. And because so many impacts occur as different force vectors are applied, it isn't surprising that, at times, injuries go undetected.**

Missed injuries just happen. Think about the trauma center setting and the chaotic way victims of serious trauma come into the hospital. It's difficult to know exactly how the accident occurred. At first, there's little information about the event. A number of factors contribute to the failure to diagnose certain conditions:

- **Fatigue—late at night, the surgeon has already put in a full day and another awaits and there are no residents to help.**
- **Poor history—occasionally what happened at the accident scene isn't transmitted to the treating doctors. Also, the history is often given by a belligerent patient who may be further confused by substance abuse, shock, concussion, etc.**
- **Severe, life-threatening injuries—these injuries may preoccupy the surgeon's initial interaction with the victim.**
- **Ventilator intubation—patient can't indicate the site of pain.**
- **Paralysis—patient can't localize pain.**
- **Examining doctor's inexperience—a physical finding may be missed or misinterpreted, or an x-ray may be misread.**
- **Breakdown in usual evaluation routine—doctor becomes distracted and omits parts of the physical exam or does not perform an essential x-ray.**

While surgeons in the past have been reluctant to acknowledge that injuries were periodically missed, most trauma surgeons in the last few years have elected to "look the issue straight in the eye" rather than attribute omitted diagnoses to the inexperience of new surgeons. All surgeons miss something at some point in their careers.

In one study of trauma victims who underwent autopsy, the incidence of missed diagnosis was thirty-four percent! It is felt that available data suggests only about five percent of missed diagnoses caused death while an additional twenty-three percent of concealed injuries contributed to death. Half of all missed x-ray diagnoses

in a Cook County (Chicago) study involved trauma patients. A lot of these patients were victims of inner city war.

Perhaps that sad fact is fitting as, historically, advancements in trauma care have been concentrated in times of conflict. War has educated doctors through the centuries and continued in the modern era to dictate how trauma surgeons care for civilian patients. A brief overview of developments that accompanied modern wars:

- **American Civil War—use of antiseptics, amputation and horse ambulances in the field**
- **World War I—improved wound care, delayed closure of infected wounds to avoid abscess formation; blood loss related to shock, with sea water used to replace lost volume; field ambulances with motors**
- **World War II—blood transfusions used, rapid evacuation (about two hours), surgical units placed closer to the front lines, colostomy used for traumatic colon injuries.**
- **Korean War—vascular surgery developed for repair of arteries, use of helicopters (evacuation time less than an hour), MASH units developed, kidney failure understood and dialysis developed.**
- **Vietnam War—rapid helicopter evacuation (twenty to thirty minutes from field to hospital); massive IV fluid replacement for shock; realization that respiratory failure is secondary to shock and understanding of resuscitation, leading to new treatment strategies for what became modern critical care medicine**

War wounds became better understood through these epic struggles as scientists began to study injury models as well as the affect of various ballistics on tissue. The

U.S. Army had special teams in the field evaluating traumatic wounds during the Vietnam era and had research programs involving the study of projectile injuries in animal subjects. Surgical care improved as tissue insults became better understood.

Destructive Impacts

Different types of forces act on human flesh to cause damage and may act simultaneously or concurrently in the same victim. There are four forces that produce destructive impacts in a specific manner.

Impact-Producing Forces

High-velocity versus low-velocity projectiles: Rather than mass, it is the speed (and "tumbling") of a projectile that determines the extent of the damage.

Crush injuries: Soft tissue is squeezed between deep bony structures and whatever is pressing against the skin. The Oklahoma City federal building collapse witnessed many crush injuries. First, damage caused by the direct injury to crushed tissues occurs, followed by the release of toxic inflammatory substances from the area of the crush. "Washed out" into the blood stream when the victim is resuscitated, these toxins may cause lung and kidney failure.

Shear forces: One type of tissue shears against the tissue next to it, often because the first tissue decelerates or stops suddenly and another adjacent tissue keeps in motion. If solid, the organ rips and bleeds, and if hollow, for example, the bowel, the organ tears and perforates, releasing irritating body fluid.

Cavitation: This may be instantaneous and temporary, or permanent. A

temporary cavity forms when tissue is compressed by an external force, creating a hole or tear in the tissue that then re-closes when the force stops. As will be discussed in a moment, the best example is a gunshot wound that leaves a bullet track.

Automobile Accidents

Now, we'll examine the forces that may cause injuries to a person inside an automobile during impact. Serious injury occurs when a part of the body is struck by an object or another body. The fascinating part is the variable end results. Why variable? Because the differences in the force applied and the individual's anatomy are just enough to create an unpredictable and, at times, bizarre array of injuries.

Automobile accidents are so common that the mechanisms of injury deserve special mention. In addition to any torque or spinning motions created by the collision of one car with another or with a roadside object, there are three types of impact: frontal, rear and side.

A *frontal* or *rear impact* stops the car, but the occupants continue to move forward. The driver strikes the steering wheel; the passenger strikes the dash or windshield. Rear impacts snap the neck. Both traumatic events are more severe if the occupants aren't wearing seat belts or if the car doesn't have air bags or neck protection. These devices are designed to blunt the effects of moving inertia, to "cushion" the kinetic energy of the people in the car. Injuries may include:

- **Flexion-extension injury to the neck**
- **Blunt chest trauma**

- **Compression of intra-abdominal organs with possible rupture**
- **Blunt facial trauma with fractured facial bones and lacerations, and scalp lacerations**
- **Skull fracture, brain contusion, laceration, intracranial hemorrhage**

***Lateral*, or side, impact may cause any of the above injuries as well as spinal fractures caused by rotation and compression of the torso or pelvis upon direct contact. Arm and leg fractures may also occur from lateral force. If the car rolls over, anything can happen.**

Injury may be related to the restraining device, particularly the seat belt. Let it be said loud and clear that restraints prevent a vastly larger number of injuries than they cause. Three-point seat belts must be used with air bags as the latter are useless in lateral and rear impacts. Besides, when the air bag deflates, which is immediately after impact, any secondary hits will only be reduced by the seat belt.

Lap seat belts used alone may result in trapped bowel and intestinal rupture as well as flexion spinal cord injury. The use of diagonal belts only may cause neck and chest trauma. Thus, both are needed to protect the automobile occupant from serious harm during impact.

For a moment, consider the basic principles of physics that determine what happens during impact. Newton's first law of motion states that an object will remain in motion in a straight line until acted upon by some external agent or force. The passenger of a car experiences impact when the car stops because his body is in motion as well. Not until the seat belt, air bag or dashboard intervenes does the driver's forward momentum cease. Which restraint or auto part is impacted partially

determines the type and degree of injury.

The idea of *acceleration* is that of changing velocity. A body may be induced to move faster or slower or change direction. It accelerates or decelerates. To do so the body must acquire kinetic energy or energy on the run, moving energy, and when that body stops suddenly, all of that kinetic energy must be transferred to something else. If that something else is your character's body, he gets seriously hurt.

Other Destructive Impacts

Falls can be disastrous because of the *acceleration of gravity*, the increase in velocity of a falling body because it is pulled by Earth's gravitational forces. Each second during a free fall, the velocity of the falling body increases by thirty-two feet per second. What your character strikes also partially defines the traumatic injury. The results of a fall are determined by:

- **The distance of the fall—a fall from a standing position to a tumble into the Grand Canyon.**
- **The body part first struck when contact with the ground is made—neck, head, arm, etc.**
- **The nature of the impact point—water, gravel, concrete, grass, shrubs, etc.**

Any of the minor or major injuries described in Part II may be the consequence of a fall, and there can be surprises in the degree of trauma resulting from different tumbles. A slip on the ice may result in a ruptured spleen, as I discovered recently in a young patient. And a fall from a cliff may cause only scratches and bruises.

Gunshot wounds are just as unpredictable. In a companion book in this series

entitled *Armed and Dangerous: A Writer's Guide to Weapons*, Michael Newton covers basic ballistics. The following discussion focuses more on what happens to human flesh because of the peculiarities of ballistics and body structure.

As you can see in Figure 3 (page ____), bullets don't leave simple wounds. It is the velocity of the bullet that primarily determines the nature and extent of the wound, although this isn't the only factor, as a .45 caliber slug traveling at 850 feet per second will cause more damage than a .22 caliber bullet at 1000 feet per second. Part of the damage is due to the soft lead projectile, which disintegrates and disperses all of its kinetic energy in the flesh. A faster copper jacket bullet may pass through a body structure without causing much harm because a lot of its energy is still in motion after the exit wound. Add a few bone fragments to a disintegrating bullet and now you've got secondary missiles, which cause more damage.

Shock waves are transmitted to the surrounding tissues and cause damage far away from the missile track. Also, the bullet path is not initially narrow but rather *cavitation* occurs. This sudden expansion and then collapse of the tissues may suck clothing and other debris into the wound. The entry wound may appear to be small because the skin's normal elasticity partially closes it. These wounds often require extensive surgical debridement, or cleaning, to clear the track of dirt and dead tissue.

Shotgun wounds are quite different from gunshot impacts. Multiple pellets cause a literal chewing up of a specific area, with less body penetration than a single bullet. Massive damage to skin, soft tissue and vital structures close to the surface occurs. This is particularly true of the heavier duck and goose loads (numbers 2 and 4, BBs).

Wounds in a Trauma Victim

Any tissue in a trauma victim may be injured, and a host of terms are used to describe these injuries. First, we'll describe those injuries that do not involve bone.

Soft Tissue Wounds

Not only do these include special structures, such as the ears, nose, eyes and genitalia, soft tissue wounds may also include any or all of the following structures:

- **Skin**
- **Fat**
- **Muscle**
- **Tendons**
- **Ligaments**
- **Nerves**
- **Arteries and veins**

These common types of soft tissue injuries vary in degree of severity:

Abrasion: **A superficial "scabbing" injury, like skinning a knee, caused by contact with a flat, rough surface. Sometimes called a "strawberry", it results in a partial-thickness loss of skin with some bleeding and "crust" formation, which is old blood and serum.**

Contusion: **A bruise or deeper injury caused by a direct strike. Skin, subcutaneous fat and muscle, tendons or ligaments are trapped between the surface and the bone and become crushed. Swelling, pain and loss of function are common.**

Hematoma: A pocket, or collection, of blood anywhere in the body. Caused by the rupture of small or large arteries or veins. The collection may be within a specific organ or in soft tissue, such as muscle or fat.

Avulsion: The tearing away of tissue from its attachments. This may be partial or complete and includes muscle tears, fingernail avulsions or the ripping away of skin from underlying tissue, a so-called "degloving" injury—skin torn away like removing a pair of gloves.

Why does one person suffer major tissue avulsion from direct trauma while another individual develops only an irritating abrasion? Why do some tissues lacerate while others resist trauma? A couple of factors determine how seriously a trauma victim may be injured:

- **The elasticity of the impacted tissue—can it stretch or deform and resume its original configuration?**
- **The speed at which the tissue is loaded—is the arm smacked with a baseball bat at sixty miles per hour or a .44 magnum bullet at 900 feet per second? The tissue can't "escape" the bullet, and therefore disrupts, whereas with the bat, it is compressed and then assumes its original shape. Load a joint suddenly and the ligaments and tendons tear (ruptured ligaments or torn cartilage) instead of stretch (strain).**

Fractures and Dislocations

The force causing a broken bone or a disrupted joint may be _direct_ or _indirect_. An example of the latter is a fall on an outstretched hand causing dislocation or fracture

of the shoulder. Direct force from a fall causes a variety of fractures and dislocations.

A *fracture* is a break in a bone. It may be partial or complete. Different patterns are seen and include:

- **Compound fracture—bone fragment projects through the skin causing an open wound.**
- **Comminuted fracture—several small fragments of broken bone in wound rather than one "clean" break.**
- **Greenstick fracture—seen in children, a "buckle", or partial break of the cortex of an immature bone.**
- **Oblique, spiral, transverse fractures—result from different forces exerted on the bone.**

A special case occurs with *skull fractures*, which may be *depressed* when the bony table of the skull is pushed below the plane of the normal surrounding bone. Treatment involves elevating the fragment(s) surgically. An *undisplaced* skull fracture may be left alone.Similarly, fractures of the long bones of the arms and legs in good alignment may be splinted or pinned without manipulation or realignment.

***Pelvic fractures* may be innocent or life threatening. The "rings of bone", or rami, may break in one place, may become disrupted on both sides or may fracture in two or more locations on the same side. The larger bones of the pelvic bowl may also break with enough impact, and often serious visceral (organ) injuries accompany these pelvic fracture(s). These include ruptured bladder, rectum or major blood vessels. The most serious problem associated with pelvic fractures is massive, uncontrolled hemorrhage. Torn pelvic veins traveling through bone are controlled by**

pushing sterile thumbtacks into the sacral bone to compress the bleeding vessels.

Dislocations **are seen most often in joints with the most freedom of motion. These include the shoulder, elbow, fingers, knee and ankle. The hip joint may dislocate, but it requires a major impact. By definition, a dislocation occurs when all or a portion of a joint surface moves out of alignment and is no longer in contact with its "mating" surface. Specific maneuvers are needed to reduce a dislocation. After a period of time, muscle spasm around the joint will prevent easy reduction.**

Spinal fractures are discussed in Chapter Six.

The Control of Hemorrhage

First responders are required to staunch the flow of blood as part of resuscitating an injured trauma victim. Several techniques are useful and may be employed according to the body area that is bleeding. In order of decreasing effectiveness, they are:

- **Direct pressure over the bleeding tissue**
- **A pressure wrapping of an extremity, especially if a large surface area is involved**
- **Packing a bleeding cavity**
- **Applying a tourniquet above the bleeding point on an extremity**

If a pressure bandage becomes soaked with blood, it is often advisable to leave it in place as beneath the gauze the body is depositing clotting factors in an attempt to stop the bleeding. People with clotting disorders, such as hemophilia, will hemorrhage from minor abrasions and lacerations as well as from major trauma.

Also, patients on blood thinners, or anticoagulants, such as warfarin or Coumadin, will bleed more from minor trauma. These patients would include people with prosthetic heart valves, those who have had a stroke, those with blood clots in the legs and those recovering from certain operations that carry high risk of phlebitis.

Finally, a *medical disaster* is defined as an unexpected event resulting in multiple simple and complex injuries to a large number of people with destruction of property and disruption of the daily routines of society.

Thus, a *traumatic impact* is the result of an energy transfer from an object or body to another body. Either a moving object (a missile of some sort) strikes the body or the moving body hits something.

Either way tissue suffers.

Shock States

Shock is defined as a clinical condition in which there is inadequate blood supply to vital tissues. This state of under-perfusion results in the body's cells receiving inadequate amounts of oxygen and nutrients. We're excluding the use of the term "shock" to describe psychological stress. Shock involving the cardiovascular system may occur for several reasons. The classification of shock that will be described later shows you how complicated patients may be, particularly when they may have the same signs and symptoms for different shock states.

First, how do you recognize that someone is in shock? Let's take each measurable component of shock and review it separately. Obviously, these findings are

combined in a shock patient. The sicker the patient, the more abnormal the components will be:

1. ***Tachycardia* - this means a rapid heart beat; it may be absent in some shock patients; the pulse rate may drop to an abnormally slow rate in severe (advanced) shock called *bradycardia***
2. ***Tachypnea* - a rapid respiratory rate driven by the accumulation of lactic acid**
3. ***Poor skin perfusion* - as skin arteries constrict the skin becomes "pale, cold, and clammy" as the "fight or flight" reaction kicks in; of course it may be seen in hypothermia without shock**
4. ***Mental changes* - confusion to loss of consciousness may occur as the brain receives less and less blood as the shock state advances**
5. ***Reduced urine output* - as the kidneys receive less blood, they conserve body fluid volume by excreting less urine; this is a very sensitive sign of shock regardless of the cause**
6. ***Chest pain* - either from a heart attack as the prime cause of the shock state, or secondarily from poor heart muscle perfusion of the coronaries because of a different shock state**
7. ***Heart rhythm changes* - too fast , to slow, and arrhythmias characterized by abnormal EKG complexes; some of these rhythm changes may lead to ventricular tachycardia which results in a "machinegun" fast heart rate that is inefficient in pumping blood.**
8. ***Systolic blood pressure drop* - less than 110 mm hg in an adult, less than 100 mm hg in a school child, and less than 80-90 mm hg in an infant or preschooler**

respectively

There are a number of ways to classify shock. The easiest is based on the most important defect in the cardiovascular system. By that term, I mean the pump (heart), the hydraulic fluid (blood, plasma, body compartment salt and water component), and the vessels themselves (arteries, veins and capillaries). That's the system. The fourth category is based on compression of some part of the system (obstructive shock).

Hypovolemic ("hydraulic fluid") Shock

The causes of low blood volume and the reduction of other body fluids are numerous and frequently seen by surgeons. This is the most common form of "surgical" shock. *Hemorrhagic shock* is one form. The specific causes include:

1. **Trauma (blunt and penetrating) causing disruption of major blood vessels such as the thoracic (chest) aorta, liver, spleen, and intestinal blood supply**
2. **Bleeding after surgery (missed or re-bleeding points)**
3. **Massive body fluid losses after a major burn (>30% second degree or >10% third degree burn)**
4. **Inadequate replacement of IV fluids during surgery**
5. **Severe dehydration from vomiting, diarrhea, etc.**

Cardiogenic ("pump failure") Shock

This form of shock may be associated with chest pain, dizziness and heart failure. When the pump fails you must think of a number of possible causes:

1. **Heart attack (myocardial infarction) with coronary artery "plugging" with clot on top of arteriosclerotic narrowing and loss of heart muscle (ischemia)**
2. **Malfunctioning valves from bacterial growths for example, endocarditis**
3. **Inflammation of the heart sac (pericarditis)**
4. **Heart arrhythmias or disrupted rhythms that make the heart "spin its wheels"**
5. **Pulmonary embolus or blood clot blocking the outflow veins of the heart, usually from a clot breaking off from the leg or thigh veins**

Neurogenic ("distributive") Shock

In this kind of shock, the volume is preserved for the most part and there's little wrong with the heart. But, the arteries and/or veins dilate, become larger because of alterations in the nervous system input controlling the blood vessels. Thus, the vascular system is "too big for its britches". There's relatively too little blood to fill the now expanded arteries or veins and the blood pressure plunges. Causes include:

1. **A high spinal cord injury**
2. **Spinal anesthesia**
3. **An anaphylactic reaction or allergic response causing "anaphylactic shock"**

Obstructive ("heart compression") Shock

The neck veins may become distended in obstructive shock. Other specific findings such as one-sided chest pain, shortness of breath, and muffled heart sounds (cardiac tamponade) may help make the diagnosis. A history of chest trauma will also

lead you to this diagnosis. Therefore, the two most common causes of this type of shock are:

1. **Tension pneumothorax (lung collapse under pressure)**
2. **Cardiac tamponade (heart sac fluid or blood compressing the heart)**

Septic ("infected\inflammation") Shock

Infections such as acute perforated appendicitis, colitis, perforated ulcers, acute inflammation of the pancreas with or without infection, are examples of clinical conditions that may result in septic shock. What's unique about septic shock is that it shares many if not all of the components of the other shock states. Septic shock causes "leaky membranes" and fluid loss, the heart may not contract as forcefully (myocardial depression), and the vessels relax and dilate and contribute to the mismatch between container size (blood vessels) and volume. Treatment is directed toward surgical drainage of abscesses and intravenous antibiotics.

Invasive monitoring of the shock patient **is beyond the scope of this book. However, you should be aware of the three most commonly used advanced techniques for tracking the course of a patient in shock. These involve placing catheters (plastic tubes) into veins, arteries, and the heart.**

1. **Central venous pressure (CVP) - placed either under the collarbone or in the neck to access the subclavian and internal jugular veins respectively; with normal heart function the CVP line allows monitoring of right heart pressures and serves as a guide to IV fluid replacement: high pressures mean the tank is full, low pressures mean give fluids; if the heart is failing the CVP will rise**

regardless of the fluids status.

2. Arterial line - usually placed in the radial artery at the wrist (with the palm facing up), the "A-line" permits direct blood pressure readings on a continuous basis as well as a visual of the wave form on the monitor next to the bed.

3. Swan-Ganz catheter - a balloon-tipped special long catheter that doctors "float" into the pulmonary artery; it proves both direct numbers of how much blood the heart is ejecting and the heart pressures, as well as derived fancy numbers the computer spits out; these numbers allow the ICU staff (where most of these special lines are placed - CVPs are inserted on floor patients regularly, too) to sort out the type of shock and how to treat it.

The Treatment of Shock

Regardless of the type of shock the following steps are taken:

1. Establish an airway and make certain the patient is breathing well - monitor oxygen saturations with "finger" monitor; give facemask oxygen.

2. If the patient isn't breathing adequately - intubate and ventilate.

3. Start two large bore IVs and administrate normal saline or Lactated Ringers IV fluid; if bleeding is involved, cross match and type and give blood (check blood count).

4. Insert a Foley catheter into the bladder to monitor urine output.

5. Check blood pressure, pulse, temp and respiratory rate.

6. For complicated patients arterial blood gases, a serum lactate level, cultures of any fluid thought to be infected (including x-ray guided drainage or sampling

of internal "collections" (abscesses).

Specific treatments **aim at the major deficit. But, there's a lot of overlap. These treatments include blood for the hemorrhaging patient; cardiac drugs IV for the patient in cardiogenic shock, vasoconstricting drugs for patients in neurogenic shock, chest tube decompression of a tension pneumothorax and blood thinners (anticoagulation) for a pulmonary embolus. A really sick ICU patient may require all of these at the same time. Of these treatments intravenous fluid replacement is the most important and the first and most commonly employed.**

Important Facts About a Bullet and the Wound It Causes

- **Weight and diameter (caliber) of projectile**
- **Muzzle velocity**
- **Design of bullet jacket**
- **Point of impact (skull, leg, buttocks, etc.)**
- **Pathway through body (specific tissues encountered)**
- **Secondary bone fragment missiles**

CHAPTER TWO

CARE OF THE TRAUMA VICTIM IN THE FIELD

In the field, there are no formal white sheets, no forgiving first bandages, no comforting EKG beeps. In the field, there are no IV poles laden with bags of lactated Ringer's, no authoritative antiseptic odor, no crisp uniform, and no barking intercoms. In the field, no knowledgeable people stand with you to confirm the correctness of your decisions. Not a single x-ray box winks approvingly, not one overhead page announces another professional is nearby to help.

In the field, there is only terror.

Take the viewpoint of a *first responder*. By that, I mean the first person to arrive on the accident scene following a traumatic event. The interval between the accident and the arrival of the first responder may be minutes or hours. Blood and body parts may lie strewn about the accident scene while the more insidious effects of the impact on vital functions (e.g., shock) worsen before your eyes. Deterioration of the victim's condition may continue despite your best efforts. Or the situation may become stable. That's the hell of it. You never know.

In 1994, on a flight from Hong Kong, a woman suffered a collapsed lung

(pneumothorax) from a motorbike accident that occurred on her way to the airport. Professor Angus Wallace of Nottingham, England, operated in the back of the plane using a urinary catheter mounted on a piece of coat hanger dipped in brandy, a bottle of Evian water and a few first aid odds and ends. He placed a makeshift chest tube, and the lung expanded. Undoubtedly, so did the professor's free air miles with British Airways. The woman survived. She received the ultimate in field treatment. Now you see that the field can be anywhere.

This is an example of what can be done if you understand the principles of the problem. It's a grand example of how a writer may take the elements of the story's world and create novel injuries and treatments. Wasn't Stallone the first actor, as John Rambo, to suture himself on screen?

Sometimes it doesn't matter if the first responder is an EMT—an Emergency Medical Technician with basic or advanced training—or a paramedic, police officer, physician's assistant, nurse or physician. Yes, physician. With medical training so specialty-oriented of late, not all doctors are properly trained in acute care. Most effective in this setting is the skilled person who knows how to assess injury priorities, sort out victims (triage) and start treatment.

The starkness of the accident scene and the immediacy of broken bodies provokes fear in everyone. Experienced doctors often react with trepidation at the accident scene. In that one instant, the first responder must master her emotions *and* deal with the disaster in front of her.

In Chapter One, you learned about the ABCs of resuscitation. The simplicity of this recall system seemed obvious, so casual that perhaps you skimmed over it. You

may have assumed that of all the material tossed at you so far, certainly the ABCs of acute care are the easiest to remember.

How could anyone forget the alphabet?

With an incontinent trauma victim lying in a ditch gasping for air, blood dripping from his smashed face, his life ebbing before you, you forget to *breathe*. Your world spins into a blur of doubt.

Of course, not every medical emergency is a life-and-death deal. But some startling impacts can scare the hell out of you. In this chapter, we'll discuss a unified approach to common injuries. We'll learn what happens to folks with the unique problems discussed in Parts II and III *before* they arrive in the emergency room.

Many trauma victims would not live long enough to be treated in the hospital without competent initial care in the field by expert paramedical personnel. Let's assume a paramedic's viewpoint. The victim is best served in the field by an individual like a paramedic because of her level of acute care experience.

The beginning of the alphabet serves all first responders well by reminding us of lifesaving priorities in urgent care. Saving a life isn't an act of genius. Not much in medicine requires the sort of intellect required to design and direct manned space flight. Clinical care requires the application of basic principles that work—over and over again. That's what emergency care in the field's all about.

Stick to the basics. Or, if you choose, have your character miss the critical diagnosis. Because, while the doctor in your tale may look like a hero when he diagnoses bacteria-laden growths on someone's heart valves by merely examining the patient's fingernails, it's important for your paramedics to go through the proper

steps in assisting a victim in the field to make the thing ring true. If it's important to the plot to have an injury missed, go ahead.

You'll recall from Chapter One that missed injuries are an unfortunate but real part of trauma care. The likelihood of not documenting every traumatic injury in the wilderness is quite possible. Stuff happens.

Again, you need to know how to get it right before you can accurately toy with making it "wrong" to complement your story. Acute care resuscitation in the field begins with this "alphabet" mnemonic:

- ***A* is for *airway*.**
- ***B* is for *breathing*.**
- ***C* is for *circulation*.**
- ***D* is for *disability* (interruptions of neurologic function).**
- ***E* is for *exposure*.**

Managing the Airway in the Field

In the field, where resources are limited, the problem of asphyxia can quickly become dire. Two dilemmas confront the first responder:

1. **Can I establish an adequate airway with the resources on hand?**
2. **Does this victim have a broken neck?**

To begin with, ask yourself: Is this victim breathing adequately? This means (1) is there an open airway? And (2) is the victim actually breathing and exchanging air? If the airway is blocked, there are two easy ways to open it:

1. ***Chin lift*—place your fingers under the front of the jaw, and with your thumb**

behind the lower teeth, lift up gently without moving the neck. This is the best way to open the airway, particularly in someone who may have a broken neck.

2. *Jaw thrust*—place your fingers under the angle of the jaw and pull forward. Because the tongue is often what's blocking air exchange ("swallowed tongue") and is attached to the jaw, this move and the chin lift work to clear the passage.

What causes upper airway obstruction? Look to the story environment for the answer. Location and activity determine why blockage to the character's breathing may become a real possibility. Usually it's from:

- **The tongue "falling back" in the throat in a victim who is drunk, drugged, diabetic, debilitated or otherwise suffering from decreased awareness**
- **Grass, sticks, stones, shells, frog, etc., from a river, pond, reservoir, lake or ocean in a case of near drowning**
- **Chunks of food in a restaurant, the so-called "café coronary"**
- **Swelling of tissues around the airway from an allergic or anaphylactic reaction to medication, seafood, bee sting, etc.**
- **Swelling from attempted strangulation**
- **Swelling from attempted suicide by hanging**

What do victims with blocked airways look like? They're not all the same. It depends on the cause. Here are a few visual clues:

- **Victim is awake and anxious with noisy breathing (called stridor, it's a "crowing" sound), but the chest is moving. It's *partial* obstruction.**
- **Victim is becoming cyanotic—turning blue—with little chest movement and may be "bucking" to breathe but can't exchange air. It's a *completely* blocked**

airway.

- **Victim is frantic, can't talk, is becoming panicky and flushed, then blue, with complete blockage from foreign matter or broken larynx (voice box).**
- **Victim is unconscious when you arrive.**
- **Victim is wheezing ("musical" high-pitched noisy breathing), typically in asthmatics with partial closure of lower airways (called bronchospasm).**

Let's assume for the moment your character arrives on the scene and doesn't have a rescue kit; there's no tube available to place in the victim's throat. Later, in the hospital, the victim may be intubated and placed on a ventilator. But not usually in the field. Your character may carry one of those curved plastic airways in his pack. It's called an *oropharyngeal airway*.

To use it, the tongue is depressed with a spoon, hunting knife or branch and the airway is slipped past the tongue to keep the throat open. Care should be taken to not push the tongue farther back, making the obstruction worse. Another way to insert the plastic airway is to point the tip at the roof of the mouth, inserting it upside down. Then, when it's far enough back in the throat, rotate it 180 degrees. The victim breathes around it.

If the victim's airway seems all right when the initial assessment is performed, it's time to decide if the victim needs help breathing. Adequate ventilation may be confirmed in the field if the victim is exchanging good tidal volumes of air heard with a stethoscope. If the victim is not experiencing "air hunger", you should see the chest moving with each breath, and the victim shouldn't be gasping. But if adequate ventilation is in question, a number of helpful maneuvers may be followed next:

- **Provide an oxygen source—mask or nasal tongs**
- **Mouth-to-mouth respiration**
- **Ambu bag ventilation**

Whatever you do, keep in mind the possibility of a fractured neck. Both the chin lift and jaw thrust must be done without yanking the neck back (hyperextension). Both techniques carry the potential risk of converting a victim with a broken neck without spinal cord damage into a cord disrupted, incontinent quadriplegic. At all times: Do no harm.

It's not always as simple as lifting the jaw. Airway obstruction may result from a major facial smash, and whether it's from a fall off of Mount Sheercliff or from an unrestrained windshield/face impact, the problems are the same. First, if the head is smashed, the neck may be broken. Second, how do you find the throat if the nose is mush and the mouth is missing? Bruises, blood clots and disrupted tissue may conceal the nose and mouth orifices.

No openings in the face? No air bubbles?

The neck!

Sure, your character must cut open the windpipe in the neck. Not a tracheotomy, the procedure is a little easier (but not much!) and still requires a cut into the upper airway. A character with courage, a sharp knife and a tube of some sort can relieve life-threatening airway obstruction when the mouth and nose are compromised.

You have your hero feel the upper notch of the larynx (Adam's apple) and slide the finger down the cartilage until the second notch, a depression actually, is felt. That's where your character cuts horizontally across the neck skin and muscles, right

through a tough membrane into the windpipe. The procedure is called a *cricothyrotomy*. A blast of air spews bloody froth all over your character when the trachea is entered, unless of course your wimpy character reaches the deep membrane with a Swiss Army knife and hesitates, fearful of slicing a jugular, unable to complete the job.

A Breath of Life

If the victim's chest isn't moving when the airway is cleared, or if he's unconscious, you've got to breathe for him. *B* is for breathing. What's needed is a portable respirator with a good tidal volume (the amount of air exchanged in the lungs with each breath), a ventilator that's immediately available, reliable and with an extended energy source. It means your character must perform mouth-to-mouth or mouth-to-tube respiration. A lot of issues arise in this era of infectious diseases, especially hepatitis and AIDS. Of course, we've still got the old favorites such as tuberculosis. The argument about a person's duty to risk self-harm in the emergent setting becomes distressingly philosophical if the victim is seriously injured and you're the only life-preserving agent in sight.

Conflict? You bet.

Most hotels, recreational facilities and other public places have first aid kits, and some have more advanced equipment including an Ambu bag and facemask. If available, this setup can be used to ventilate the victim. One person can hold the mask over the face *and* pump the bag, but it's quite difficult. Two helpers can share the task with more efficiency. Oxygen, if available, may be attached to the bag

system.

Maintain Circulation

Circulation is best preserved by stopping blood loss as well as by giving the victim fluids by mouth. Most folks don't carry IV equipment with them. Force-feeding liquids may not be as dramatic as IV resuscitation, but in the field, it's all you've got. You may also elevate the victim's legs. This serves to auto-transfuse the person's own blood from the periphery of the body to the central heart-lung core where it's needed. This works for mild to moderate bleeding.

The best way to stop bleeding is by applying direct pressure to the hemorrhaging point. With an understanding of the distribution of arteries and veins in the body, you can apply pressure effectively in a number of settings. Bleeding can occur in the following ways:

- **From the head—face and scalp**
- **From the neck—anterior wounds (where the jugulars and carotids live) are more dangerous than posterior**
- **From the chest wall or into the chest (hidden cause of shock)**
- **From the abdominal wall or hidden in the belly—again, shock?**
- **From the flank or back**
- **Deep inside the pelvis**
- **From the arms and legs**

Hemorrhage from flat surfaces such as the chest wall, flank, belly, back or scalp responds to direct pressure held for several minutes. If small arteries or veins are

responsible, the bleeding will stop with pressure alone. Of course, the wounds will eventually require further treatment. Big arteries can be controlled with direct pressure in an emergency, but definitive surgical care is needed to identify and ligate (tie with a suture) the offending "pumpers" or active arterial bleeders. At times, the really big arteries must be reconstructed.

Bleeding from the extremities, scalp and some neck wounds can be controlled with pressure dressings—a lump of gauze pads placed over the bleeding point and wrapped tightly with gauze strips. If there's a cavity with tissue loss and bleeding from the defect, sterile gauzes can be stuffed into the hole and wrapped up or pressure may be applied manually.

Tourniquets are seldom used. But, if needed, a tourniquet is placed just above the bleeding point. Anything such as a rope, length of cloth, belt, etc., may be used to apply enough circumferential squeeze pressure to stop the hemorrhage. The problem with a tourniquet is the risk of leaving it on for an excessively long time. How long? The question begs how long tissue below the tourniquet can tolerate having virtually no blood supply. If it's a matter of stopping a life-threatening hemorrhage or creating potential damage, the person in the field must decide what to do. A tourniquet can be released periodically. But usually direct pressure is the best policy.

In the next chapter, we'll discuss hemorrhage in more detail, but for the moment, anyone looking at a pool of blood out there in no-man's land must have a sense of what volume of blood has been lost. A quick assessment of the victim will give you a general idea about the seriousness of the bleed. A useful guideline goes like this:

- **If there's no change in the level of consciousness, breathing or pulse, and if**

the victim is just a little thirsty, the hemorrhage volume is about a unit of blood or less. Have the victim drink liquids and go on with life.

- **If the victim is lethargic or comatose, cold or clammy, with a racing or difficult-to-find pulse and gasping for breath, the victim has probably bled over 40 percent of her total blood volume. This is a life-threatening picture, and IV fluid replacement and transfusions are essential. In this scenario, two to three quarts of blood have been lost; it doesn't matter how or where. Field treatment alone isn't going to do it for this poor soul. Transport to medical case ASAP.**
- **Between there two extremes are lesser degrees of hemorrhage—losses of two to four pints of blood. These victims present with a rapid pulse, rapid breathing and a look of anxiety. Although serious, they do well after transfer to a hospital where transfusions are administered.**

Control of bleeding is relatively easy because the source is usually obvious, and pressure suffices for emergency treatment. Follow-up depends on how much blood is lost. Major hemorrhage requires hospitalization, intravenous fluid administration and, often, transfusion.

Disability: Can the Victim Talk and Move?

The basis for a quick evaluation of the victim's brain and spinal cord function is observation of the best verbal and eye movement responses to questions and the presence of limb movement. Detailed in Chapter Five as the Glasgow Coma Scale, this assessment involves determining whether the victim can answer questions or is in a coma, whether the victim can open his eyes and look at the examiner, and

whether the victim can move his arms and legs.

Not only is this information important as the first assessment, it must be recorded in case the examination data change. For example, if an alert trauma victim slips into a coma, the change in level of consciousness may signal a major intracranial bleed (subdural or epidural hematoma). Similarly, a person with a neck or back injury who is able to move the arms and legs may, with time, become paralyzed. In both scenarios, if your character is out in the wilderness, there's trouble in the wind. Brain and spinal cord injuries can progress. Prognosis may depend on whether the victim is stuck in the field or is immediately transported to medical care.

Make certain your description of the victim's initial condition is clear and that the course of any deterioration is vivid and concise. Tension mounts because of the uncertainty that characterizes the interplay between improvement and deterioration in neurological trauma.

Expose the Victim

Imagine multiple victims of a drive-by attack lying on the pavement in shock, several with obvious gunshot wounds from an assault weapon. One woman lies in shock with no visible injuries—unless you take off her glove and examine her hand.

Why?

Figure 4 demonstrates the random nature of some impacts. Other serious trauma such as impalement may be quirky and occult. Such trauma may only become evident after thorough examination of the victim. More than once, a gaggle of young doctors have stared at a trauma victim lying on a stretcher with no obvious reason to

be near death. Only when they flip the victim over do they discover the tiny stiletto wound between the patient's ribs.

***ABCDE*. It's the beginning of acute care in the field. If done improperly, the victim may die or suffer unnecessary disability.**

Once life-threatening problems are cared for, the next step is to address specific impacts and evaluate them with respect transport to a hospital.

Special Problems in the Field

Extraction with Head and Neck Trauma

In-line traction on the head and neck is mandatory during any movement of the victim from the accident scene, onto a backboard or stretcher or out of a building, vehicle or wilderness cranny. But get the victim away from a dangerous situation as quickly as possible while controlling the neck and the airway. Scalp wounds bleed profusely and look worse than they are. Compress head and neck bleeding with sterile bandages, and transport the victim to a trauma center. Always remember a skull fracture or brain damage may be associated with a scalp laceration.

Chest and Abdomen Trauma

Care of abdominal wounds in the field is easy: Cover any wound, even if there are exposed intestines, with a wet, sterile gauze (if possible), bandage and transport. Chest wounds must also be covered in a similar fashion, and if there is a hole in the thoracic wall, a so-called "sucking chest wound", cover it with something to seal it off. Choices include cellophane or plastic with a rim of any ointment you may be

carrying on your person. Wrap the chest and transport. Oxygen should be provided to any seriously injured trauma victim, especially one with chest trauma, when respiration is compromised.

Arm and Leg Trauma

Bleeding is easily controlled with direct pressure, and wounds may be cleaned gently and bandaged with sterile gauze. Dislocations of the hip need little intervention before transport to the hospital, while a knee dislocation should be aligned if possible by gentle traction to remove any compression of the artery to the lower leg. Fractures should be splintered, and the pulses below the fracture or dislocation site evaluated and documented, if possible. At least determine if the foot is warm or cool.

Bites

Cover and seek medical care. But before you do, obtain as much information about the biting agent as possible. If it's a dog attack, is it a known dog? Have it quarantined for possible rabies. Rabies is also possible with raccoon, fox, bat and other small mammal bites. Snakebites must be treated according to the degree of envenomation and the poisonous status of the disgruntled reptile. Speed is vital in seeking medical care as swelling, tissue death and infection at the fang penetration site may swiftly ensure.

Impalement

If the object impaled in the body is small, it should be left untouched as the victim is transported to a trauma center. If fixed, as with a picket or wrought iron fence, the fencing material must be cut within a foot or so of the body and transported without movement to the hospital. If some part of the body is impaled on a small sharp fixture, e.g., a bolt protruding from a concrete slab, the body must be lifted from the impaling object. In all of these scenarios, two potential problems exist: Will the removal or movement of the impaled object cause massive hemorrhage or further internal organ damage?

Traumatic Amputation

The stress of dealing with a traumatic amputation is similar to discovering someone impaled, in pain and in danger. The first responder has several specific duties:

- **Stop bleeding from amputation stump. Apply wet, sterile (if possible) gauze. Wrap.**
- **Find the amputated part.**
- **Clean amputated part gently if dirty. Wrap in wet gauze or cloth, and place in a bag of ice—but *not* in contact with the ice.**
- **Transport victim and part to trauma center immediately. Minimal passage of time before an attempt at replantation is crucial.**

Burns and Frostbite

Local care is adequate for small areas of skin involvement. This includes topical

over-the-counter antibiotic ointment and frequent dressing changes. Larger burns or severe frostbite require hospital care. For affected areas covering more than ten percent of the body, frostbite or burns that involve the hands, feet, face or genitalia or local deep injury with obvious full thickness tissue death, care must be provided by the appropriate surgical specialist. Other issues such as body fluid loss, infection and surgical cleaning of ongoing tissue loss justify hospitalization.

Diving Accidents and Altitude Sickness

Anticipation and prevention are the hallmarks of the style of serious climbers and divers. Where is the closest decompression chamber? Are there helicopter facilities to get an injured or sick climber off the mountain? Do you have oxygen? What special medications do you need to take at high altitudes? Do you have rope and extra tanks to execute a decompression dive? Do you have waterproof U.S. Navy Decompression Tables with you? Do you know the waters you're diving in? Do you need a guide for your proposed climb? Is everyone in the party in good physical condition?

Certain questions must be answered before any short or prolonged expedition is attempted. It's a matter of planning a fallback position if something goes wrong.

Assaulted Elders, Battered Women and Injured Kids

Underestimated over the years, domestic violence may be subtle or flagrant, occasional or agonizingly repetitive. No age group is spared. The resultant injuries may be trivial or quite serious. At times, battered elders and children are

misdiagnosed by their doctors, especially if their caregivers or parents purposely scheme to keep the trauma concealed.

Clues to hidden injuries as well as to constant abuse from domestic violence abound, and the wise writer sprinkles them about her story like a delicate spice. One very productive source of conflict for writers in the arena of battered people is the dilemma of distinguishing accidental injury from malicious violence. Also, a history of battering—for the abuser and for the recipient—serves as a powerful ingredient of your character's back story.

Sexual Assault

The victim of sexual assault usually brings herself to the hospital, although not all sexual assaults are reported. Many women feel embarrassed, frightened and, at times, responsible for the assault. If a victim is found injured, helpless and possibly in shock, the first responder's task is to provide first aid, comfort and transportation to a hospital. But it is also the helper's duty to contact local law enforcement personnel. The first responder is in a crime scene, and certain procedures must be followed in order to preserve sensitive information for subsequent prosecution of the criminal.

Mass Casualty Management

Multiple injuries occurring in large numbers of citizens creates a nightmare all hospitals fear. Larger medical centers and Level One trauma centers (usually the same) are required to have in place a mass casualty disaster plan.

Disasters may be natural or man-made. Post 9/11, everyone fears further terrorist attacks. The definition of a mass casualty event is one in which the number of injured and dying victims far exceeds the capacity of the (closest) hospital to provide proper care. The process of mass injury management involves triage at the scene by paramedical personnel, further triage to floors, ICU and the operating rooms at the receiving hospital, as well as the possibility of triaging the overflow to nearby hospitals. Other hospitals are usually needed because of the sheer number of patients as well as the complexity and number of multi-system injured patients.

At any of these sites, chaos and confusion will prevail at first. And unless trained personnel are present to streamline the process, the havoc will go on endlessly. Too often the most vocal victims, those moaning and crying out in pain, will be considered for early transport, while the more seriously injured (but salvageable victims) may lie quietly dying. How does one learn how to handle this level of emotional distress?

The approach addressed in this book, namely the Advanced Trauma Life Support (ATLS) concept works well in the mass casualty setting. Trained personnel follow the guidelines established by ATLS in triaging victims according to degree of injury and expectation of a survival outcome. An expert will identify airway needs and shock states. The coordinator will provide or direct others in the use of simple methods of quickly establishing an airway and stopping bleeding. This directed triage and resuscitation will stabilize the largest number of victims.

Later issues of splinting fractures and dislocations, when salvageable patients have been sent to the hospital, are appropriately addressed. Terribly injured victims

of the disaster may have to be left to die while care was being provided to more potentially treatable cases. This is where triage gets difficult. Someone left to die (considered too badly injured to make it) may still be alive at the end of the scramble to transport victims to definitive care. Your "expert" character - it may be a doctor, a paramedic, a nurse - will decide who lives and who dies. Post-traumatic stress disorders may arise from such problematic decisions, especially if the expected death doesn't happen immediately and raises the question: ***Would this victim have survived if I had designated her to be transported immediately?***

Code Blue refers to victims who are dead or are expected to die because of the severity of their injuries. The dead are moved to an outpatient area and the dying are kept in the ER. Code Red covers victims with severe injuries thought to be treatable and survivable. They receive immediate treatment and are admitted to a ward or to the ICU. Code Yellow refers to victims who have sustained lacerations, non-critical head injuries or blunt injuries not associated with shock. A doctor treats these patients as one became available. Code Green patients have minor injuries and are assessed and treated by nurses in the outpatient area and discharged.

Physicians treating mass casualty survivors must address them with the same focus as any other patient - despite the chaos around them. As traumatic injuries are sutured, splinted and bandaged, the emotional scars must also be acknowledged. If the event is still evolving patients may not know if they have lost family members, close colleagues, or dear friends. This uncertainty must be spoken to and support for those who wait for word of the disaster's extent must be provided.

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CHAPTER THREE

THE TRAUMA CENTER

More physicians than you might imagine dread the responsibility of caring for trauma patients. Even seasoned doctors hesitate before the broken body, held back by a twinge of doubt and a passing uncertainty about how they will behave in the presence of the torn-up body.

Like you, doctors dislike injury-associated gore. And that, in itself, may serve as a source of story conflict. The hospital course of a trauma victim is uncertain and the length of follow-up isn't well defined—nothing as predictable as elective surgery. The day after laparoscopic gallbladder surgery, you pack up your toothbrush and go home. A single follow-up office visit completes your care. Sadly, for the victim of uncontrolled injury, rehabilitation may go on for months, possibly years.

A heavy artillery of interventional diagnostics and treatment booms loudly in the modern high-tech hospital. A lot happens quickly. Within most specialties, controversy rages about which tests are most reliable, so you need to grasp a few key points in order to negotiate the trauma center when you write your hospital scene. This includes an appreciation of the interactions of the different players on the

trauma team.

The Dynamics of Trauma Care

Despite the media's splashy, intermittent interest in acute hospital care, this part of the physician's world has not been delved into much by writers. It's an expansive vista of opportunity. And everyday, it changes.

Lots of conflict can arise when you mix stressed doctors with sick patients. Mounting survival stakes flush adrenaline through your physician character's circulation and sweat drenches his clothes as he stands in the trauma room with a fresh broken body. What to do first? What's really wrong with this one? Are there others? Should he be operating on this patient?

In addition to learning how a trauma center functions, you'll become aware of a load of medical dirty laundry. Not an attempt to smear the profession, this information provides you with more ideas about how to create conflict when you write your hospital scene. Ugly turf battles, fear and indifference, all insinuate their unwashed hands into trauma care at all levels.

Why? Because doctors are human.

And while fifty million people are injured in the U.S. each year and are managed by trauma specialists as well as other doctors, there exists in this complex care system an underlying current of greed, ego and recrimination. Why does a young vascular surgeon in a small community hospital treat a child's severely compromised arm herself rather than refer the case to the nearby Level I trauma center? For the fee? For glory?

Why not?

You can take advantage of your own discomfort as you think about these issues, as well as the bothersome subjects of traumatic amputation, impalement and mutilation, and create a realistic tone in your injury scenes.

Of course, not all injury victims go to a Level I trauma center. Most are transported from the field to the local community hospital where they are treated effectively by a variety of physicians. The national trauma care system certainly isn't a seamless whole and many parts of the country still aren't set up to provide adequate care to everyone. It's constantly improving, and overall the system works well. Still, there are flaws in the organization and provision of care to the injured. These areas of concern that have arisen over the years include:

- **Appropriate levels of physician training**
- **Which victims to transport to Level I trauma centers**
- **How to prepare victims for transfer**
- **Who is responsible for the transfer**

Which story elements from these issues might you write about? Where is the conflict? Here are a few suggestions:

- **The surgeon on call is not immediately available when called by the hospital with a trauma patient. Does the ER doctor transfer the patient himself? Does he call the administrator on call? Does he report the delinquent surgeon for disciplinary measures?**
- **A specialist, say a neurosurgeon, isn't available to care for a head injury. Does the local doctor attempt to place burr holes in the victim's skull to evacuate the**

life-threatening blood clot? Or does she send the patient to the closest trauma center knowing he may not survive the trip?

- **The local surgeon feels he can handle the injury himself despite the presence of injuries to three or more major organ systems. Is there anyone around to fight his ego-driven, ill-advised care plan?**
- **The local surgeon doesn't want to be bothered by what she expects to be time-consuming patient with no insurance. Does she dump the victim on the other hospital in town? Or is the ER doctor who works for the hospital trying to dump this "self-payer"—a euphemism you might hear in the ER back room for what are called street bums, slime balls, dirtballs—on the nearest trauma center? Who blows the whistle on the hospital?**
- **The local HMO says not to transfer the patient—it doesn't have a contract with the trauma center and wants its own surgeon to handle the case. Does the HMO administrator pressure the doctor into agreeing the injuries aren't really severe enough to warrant transfer? Do life-threatening injuries go undetected by the under-trained HMO physician?**
- **The local aging surgeon dislikes the young stud trauma surgeon at the local trauma center. Does he refuse to transfer the patient or do it in a sloppy manner with inadequate information sent with the patient?**

There's no end to clinical chaos.

When a trauma victim reaches the local hospital, a lot of decisions must be made in a hurry. The ER doctor, unlike his pre-1980 predecessor, is trained to provide immediate trauma care. But not complete trauma care. That's where the trauma team

comes in. This is one of the hottest areas of debate in trauma care. When a big crunch comes into the emergency room it is manned by ER residents and surgical residents. Who takes care of the patient? Well, the ER resident, physically in the ER when the patient comes in, can perform an initial assessment. Should he put in the various tubes? The surgical resident is better at it and can open the chest if necessary. The surgical resident has the good hands. So what happens?

Conflict.

All the way from the trauma room's bloody floor to the executive offices of the chairpersons of the departments of surgery and ER medicine, there is conflict about who should do what and to whom. Somehow it gets worked out, at least for the moment.

Thus, the trauma team or the emergency room doctor involved in the initial assessment of the trauma victim must:

- **Rapidly assess the victim's condition, including vital signs—blood pressure, pulse rate, respiratory rate and temperature**
- **Stabilize and resuscitate the victim and treat life-threatening injuries immediately**
- **Decide if local (hospital) management is appropriate**
- **Arrange for transfer and transportation to higher level trauma center if local care is not adequate**
- **Be responsible for the transfer**

The Level I Trauma Center

In Chapter One, we discussed the requirements for each level of care designated in the national trauma care system. Each level depends upon the local availability of doctors and technology. Linked by the needs of the trauma victim, these hospitals refer to each other when patients are triaged according to the severity of their injuries. In the field, the paramedic or EMT assess the victim, calls the hospital and describes the injuries. As well as giving the hospital lead time to prepare for the victim's arrival, this communication also launches the triage process itself if several injured people are involved.

Lesser injuries may be sent to the local hospital where such things as chest tubes may be placed, fractures set and uncomplicated abdominal and head injuries observed. Victims of multiple organ trauma are usually taken directly to the nearest Level I facility unless resuscitation in a smaller hospital is warranted first.

The different levels of trauma care described in chapter one are being integrated nationally into a regionalized plan of trauma care. The American College of Surgeons over many years has worked diligently to improve the plight of the trauma victim in America. Hardly complete, the aim of all states is to create a network of hospitals that function as parts of a universal care plan. In some geographical areas, trauma care is fine-tuned. In others, it is all but absent.

Next we will look at what is available at a top-notch Level I trauma center.

The Trauma Room

Readily accessible in all Level I trauma centers is a specially equipped room kept open for major injury cases. It isn't used to suture lacerations or to bandage abrasions

or to reduce and cast fractures. This huge room (Figure 5) has two or three operating room tables and is filled with resuscitation equipment, including an oxygen source, ventilators, suction apparatus, emergency surgical instruments and emergency cardiac medication and other equipment stored in wheeled carts. The walls are lined with drawers laden with suture material, sponges and surgical instruments as well as equipment used in the diagnosis and treatment of rapidly evolving, life-ending problems. Oral airways and endotracheal tubes are on standby ventilators and suction equipment is available for swift resuscitation. IV poles prepared with bags of lactated Ringer's and tubing are ready to be connected to large-bore catheters the surgeons will immediately place in the victim's arm veins on arrival in the trauma room. IV fluid resuscitation represents an essential part of the surgeon's first line of treatment.

Nurses specially trained in the immediate care of the trauma victim wheel the patient into the room from the ambulance or helicopter with the help of the paramedics who transported the patient from the field. There is no record taking, no search for identification, no asking for a history—the traditional steps in diagnosis. These critically ill patients are rushed into the trauma room, and, after assuring the cervical spine (neck) is protected with a rigid collar (it was probably applied in the field) an airway is established, ventilation started with an Ambu bag by hand or with the ventilator and IV lines placed and fluid rushed into the victim. As members of the team accomplish these initial tasks, the trauma surgeon, surgical resident or ER doctor goes through the first of the four steps in trauma care, which I'll describe in a moment. To avoid missing a life-threatening condition, these four procedures are

always followed in the same sequence regardless of the patient's condition.

In Part II, you will come familiar with twelve nasty chest injuries that can kill the victim immediately or within hours of injury. It is the doctor's responsibility to make certain that the trauma patient doesn't have any of the "dirty dozen"—or, if present, that they are treated swiftly to reverse their lethal potential.

When these victims arrive in the emergency room, they represent the second wave of traumatic disasters. The first wave of killer injuries occurred in the field right after impact, terrible wounds that snuffed out life before anyone could respond. When death occurs within minutes or seconds of impact, the traumatic wounds sustained are usually:

- **Severe laceration of the brain stem resulting in immediate cessation of breathing**
- **Severe laceration or contusion of the brain associated with massive increased intracranial pressure (on the brain) and compression of vital centers**
- **Transection or smashing of the spinal cord high in the neck with damage to the nerves to the diaphragm—death results from complete inability to breathe**
- **Laceration of the heart of aorta (off of the heart) or any other major blood vessel, causing immediate loss of blood volume, shock and death by exsanguinations**

The Four First Steps in Trauma Care

Out in the field, your hero should use these same steps in assessing the victim of a traumatic injury. Whatever the setting, the sequence of steps is always the same—

unless you want an injury to be missed.

Step One: The Primary Survey

In the ER, the doctor who first evaluates the victim follows these steps. The trauma surgeon, for example, arrives at the side of the stretcher and begins this quick drill. As the doctor makes his initial assessment, nurses start IV lines and remove clothing to permit careful examination. It all happens at once.

The trauma surgeon's initial brief examination is performed to identify life-threatening injuries. The elements of the examination are to:

- **Establish an airway**
- **Make certain victim is breathing**
- **Check pulses and stop any major hemorrhage**
- **Look for head and spinal cord damage, surface wounds, chest injuries, abdominal tenderness or any other findings that suggest hidden injuries**

Step Two: Resuscitation

- **Place two large-bore (caliber) IVs in the arms—usually forearm veins—or legs if needed. If neither is available, use neck veins (this is called a *central line*). Last choice is a "cutdown" on an ankle vein.**
- **Administer lactated Ringer's IV solution as fast as possible, anywhere from two to ten liters in the first hour. Place IV bag inside pressure cuff for faster infusion of fluid in cases of severe shock.**
- **Draw *labs* (blood tests) to cross and type for blood transfusion and to determine specific organ function, body chemistries and blood count.**
- **Place a nasogastric tube to decompress stomach, a Foley catheter in the**

bladder to measure urine output (and thus judge how much fluid and blood to administer) and, in the ICU, special lines to measure blood pressure (arterial line) and heart function (Swan-Ganz catheter).

- **Emergency surgery, either in the ER or in the OR, may be part of the act of resuscitation; nothing short of operative intervention will save the victim's life. In the ER, the surgeon may open the chest (cut between the ribs on the left) and suture a bullet or stab wound to the heart (twenty-five percent of these warriors will live to fight another day). In the OR, any surgery designed to halt massive hemorrhage may be needed to catch up on blood volume.**

Step Three: The Secondary Survey

With lines in place and life-threatening injuries treated for the moment, the trauma surgeon now goes back and starts to examine the victim all over again. A meticulous head-to-toe evaluation is carried out to check for broken bones, dislocations and deep soft tissue injuries. Appropriate x-rays will now be performed with extra films taken of areas of concern based on this second exam. Also, if no injury mandates a rushed trip to the operating room, CT scans and other special x-rays may now be done.

Regardless of the types or pattern of the injuries, in all multiple-injury victims the following x-rays are performed routinely:

1. **Chest x-ray—Any evidence of the "dirty dozen"?**
2. **Cervical spine x-rays—Fractures or dislocation of neck vertebrae?**
3. **Pelvis x-rays—Fractures? How many?**

If the original abdominal examination reveals significant tenderness, or if the

tenderness seems to be increasing on subsequent examinations, the trauma surgeon will perform a test called a *peritoneal lavage*. This involves placing a plastic tube into the abdominal cavity through a tiny incision near the belly button and infusing saline solution. The peritoneal lavage test is positive and leads to emergency abdominal surgery if:

- **Frank blood comes out of the tube when first placed in the belly—something is bleeding massively.**
- **Feces come out of the tube mixed in the saline—it means the colon (large intestine) is ruptured.**
- **Food—ruptured stomach.**
- **Urine—ruptured bladder.**
- **Bile comes out in the fluid—gallbladder, liver, bile ducts or duodenum (first part of small intestine) are ruptured (perforated).**
- **Many red or white blood cells are present in a sample of the saline when examined under the microscope.**

Note: If the abdomen is swelling up before the surgeon's eyes in the ER, no test is required as the assumption is that massive bleeding is occurring in the belly. An urgent operation is mandatory, so a peritoneal lavage isn't needed. The FAST test (Focused Assessment Sonography in Trauma) is an ultrasound examination of the abdomen. The ultrasound scanning test looks for blood.

Step Four: Management of All Major Injuries

After a detailed secondary survey of the victim, the trauma surgeon knows what's wrong or has a high index of suspicion for certain injuries. Specific operative or non-

operative treatment may be started or further tests may be ordered to chase additional diagnostic possibilities. Injury severity and the need for specific organ support determine what happens next. Basically, the patient goes to the OR or the ICU. With lesser injuries, some trauma patients may go directly to a surgical floor for careful monitoring. Which floor depends on the injury: "neuro" floor for a head injury, orthopedic floor for a fractured femur or a general surgical floor for lesser degrees of both. For patients who do not require a surgical intervention, observation becomes the name of the game.

It is, at this point, when conflict may arise among members of the surgical team. Does the trauma surgeon repair the torn bladder or should an urologist be called in? Should the trauma surgeon fix the fractured femur or ask for assistance from an orthopedic colleague? Is the chest injury severe enough to warrant the services of a thoracic surgeon or can the trauma surgeon handle it herself? Who repairs the child's torn bladder—a pediatric urologist or an adult trauma surgeon? Or an adult urologist or a general pediatric surgeon?

Turf battles rage all over the country. Somehow it gets worked out and excellent care is provided in a timely fashion. Despite the conflicts, trauma care in the U.S. is becoming consistent and more universally available.

CHAPTER FOUR

CARE OF THE TRAUMA PATIENT IN THE OPERATING ROOM

Trauma surgery is almost never elective, not unless the patient is well down the road to recovery from the original night of horror. Follow-up operations are usually undertaken to fix broken bones, remove screws and pins, debride (clean away) dead tissue from open wounds or place skin grafts on beds of burned flesh. This sort of follow-up surgery may be performed more leisurely than the chaotic emergency procedures. Nonetheless, the mood in the operating room during surgery for the first big crunch and subsequent surgery is never casual.

Before writing an authentic operating room scene, you need to know who works in this hallowed and horrid corner of the hospital. Who are they? What do they say? What *is* the mood in surgery? Does it change when things get tense? Who's in charge? Also, you need to have a handle on the equipment.

First, who is the trauma surgeon?

All surgeons, other than those whose specialties you recognize—orthopedics, neurosurgery, plastics, urology, vascular—are *general surgeons*, not general practitioners, not primary care docs. A general surgeon is the board-certified surgeon

most people refer to when they say "surgeon". A general surgeon does everything except the more complex and specific procedures done by specialists. In some circumstances, and in many small communities, the general surgeon performs all of the basic duties of the specialist, referring the complex cases to a larger medical center.

A *trauma surgeon* is a general surgeon with five years of residency and extra training or a fellowship in trauma surgery. Able to perform a variety of lifesaving operations as well as the usual general surgical procedures, the trauma surgeon sees all major injuries admitted to the hospital through the emergency room. Of these creatively smashed-up souls, only about fifteen percent require a major operation.

Other than the lifesaving kinds of things done in the trauma room that you've already learned about, the remainder of the trauma victim's surgical care is rendered in the OR, the surgical ICU and on the surgical floors. Unlike elective cases where a specific procedure is prepared for and a defined area of the body shaved and prepped with specific instruments picked and sterilized, in trauma cases the victim's status is unknown. The surgeon expects and often finds bizarre injuries.

The trauma surgeon expects to operate in all body cavities. All tissues are potential areas of injury. Nothing's a given.

The Operating Room

The operating room (Figure 6) is a familiar place to most readers. Movies and television productions portray realistic, well-researched hospital scenes. Your readers know intuitively that there's a lot going on in that clean, well-lighted place. When

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you write about the operating room, it's the drama that counts, not a detailed description of the hardware. Sprinkle a few details onto your reader's visual screen. She'll fill in the rest.

You may choose a splash of authenticity from any of the following items on this OR list.

Anesthesia machine: **Bulky and on wheels with a screen that displays the patient's blood pressure, pulse, temperature, oxygen saturation; dials that control the "inhalation" gases to keep the patient asleep; plastic tubes going to the patient; other hoses connected to a wall oxygen source; large corrugated hose from machine to patient; suction apparatus.**

Anesthesia cart: **On wheels, with drawers containing everything from vials of drugs, syringes, plastic tubing, instruments and gauze pads to anesthesia journals, the most recent stock market report and a copy of *your* last novel.**

OR table: **Narrow with thin plastic mattress, restraining belt, foot pedals to adjust height and tilt, small pillow.**

Back table (or two): **Stainless steel tables draped with sterile sheets, laden with all of the instruments to be used during surgery; manned by the *scrub tech*, the person who hands the surgeon instruments and whatever else is needed.**

Suction apparatus: **Usually one for the surgeon and one for anesthesia; consists of tubes coming out of the ceiling or walls, going to huge disposable plastic containers that seal for the disposal of body fluid.**

Cautery machine: **The electrocautery has several settings for cutting or cauterizing tissue; the current varies and different levels of intensity may be used**

from a setting of twenty to what the residents call "stun" at fifty or more.

Laser machine: **Used much less often than the cautery, the laser is an excellent source of energy for delicate surgery such as fixing a detached retina; not much use in trauma.**

Small prep table: **Covered with a sterile towel, holds two or three stainless steel cups or bowls to hold antiseptic solution; scrub tech puts a sponge stick (a clamp to hold sponges when the surgeon cleans the skin) on the prep table from his bundle of instruments.**

TV cameras and associated technology: **For laparoscopic surgery: one or two screens and multiple cables and hoses.**

The OR Personnel

What's the maximum number of people who might be involved in a trauma case? For a Level I trauma center, the number of personnel is considerable, and within the ranks seen in the OR are many young doctors and medical students. In smaller community hospitals, the team to be described may shrink considerably.

Most or all of the following medical personnel will participate in the care of the trauma victim in the OR:

Trauma surgeon: **The leader, a general surgeon whose life is devoted to the care of the injured.**

Surgical residents: **One or more; often do the procedure under the supervision of the trauma surgeon; may be at any level of training. The big secret: these unsung heroes do all the grunt work, are in the ER when the trauma victim comes in and save**

the lives that are nearly shattered at the scene; they have never been given credit by the public who so desperately and unwittingly rely on them.

Third and fourth year medical students: **One or more observe, scrubbed and crowded about the OR table or in the way somewhere else. They see life from the "other side" often for the first time on the trauma service.**

Anesthesiologists: **One or more monitor vital signs, give anesthesia, support volume with blood and IV fluid; may leave the room periodically to let the anesthesia resident sweat the case.**

Anesthesia residents: **They are actually doing a lot of things under the supervision of the anesthesiologist; they try to give an alternate explanation to the surgeon for the patient's blood pressure dropping when the surgeon knows it's because of the hole in the bloody spleen in his hand.**

Circulating nurse: **One or two RNs. Gets supplies; coordinates the room internally and with the front desk regarding the progress of the case, anticipated ending time, when the next case starts, etc.; gets "stuff" for the annoyed surgeon; keeps the equipment in the room functioning properly; gets more "stuff" for the anesthesiologist; answers the resident's beeper, calls central supply for the one instrument the surgeon doesn't have but needs *now*.**

Scrub tech: **Stands within elbow distance of the surgeon and, unlike in American football, is not permitted to wear protective equipment. Hands instruments to the surgeon, including sutures, in a swift cadence.**

OR assistants: **Sometimes called orderlies. They help move patients onto the OR table before the case starts and off of the table at the conclusion of surgery; clean**

rooms (mop floors, stuff laundry, move the table, etc.) between cases and keep supplies available; go to preadmission for elective patients and return the gurneys to the surgical floors; know a lot about sophisticated OR equipment and how to keep it running.

Front desk personnel: **Nurses or secretaries. They coordinate elective and emergency cases as well as all of the calls coming into the OR, some of which must be passed on to specific rooms. When the place heats up, there is no more stressful place in the world—for air traffic controllers, a plane *might* get into difficulty if something isn't done immediately; in the OR, trauma patients are wheeled down from the ER who are *already in the act of dying*; while this is going on, five other surgeons can't understand why they've been delayed; oh, and a patient in radiology having his coronaries reamed out just "crashed" —which means the chest boys will soon dance on the front desk person's head and will drown out the rest of the noise.**

How Cases Are Listed: The "Bumping" Scenario

Most of the multiple trauma cases come in a night. Booze, drugs and barrel-bottom human behavior kick in when the sun sets. It is then that the world turns more slowly and groans on its axis.

It is at night when the blood flows.

Last night, as I prepared my notes to write this section, I discovered yet another human had died in our trauma room of savagely inflicted stab wounds to the chest. Lest you believe this to be purely theoretical, I remind you there is a head injury sustained somewhere in the U.S. every seven seconds, a stab wound inflicted every

fifteen minutes, a woman raped every six minutes. Operating room time is needed for the "knife and gun club", as doctors call them, as they unpredictably slash and maim each other. Within hours, a schedule of elective surgery booked for the next day must be completed. Someone has to make time. Also, other non-traumatic emergencies, such as perforated ulcers, burst appendixes, fractured hips, dog bites, etc., must be squeezed into the schedule, night and day.

Where do the trauma crunches go?

At least one operating room is kept open for dire emergencies. When the trauma surgeon calls from the ER and says, "We're coming down with a gunshot to the chest, in shock . . . oh, we may need bypass," he doesn't ask for the next available room. That's a different kettle of physical insult. The next available room is for a lesser type of distress, the perforated intestine cases that can stand a little "buffing up", a few hours of IV fluids and antibiotics.

Big trauma goes to the operating room immediately.

Stat.

Sometimes, the victim isn't *in extremis*. There's nothing to wait for because in this circumstance, surgery is part of the process of resuscitation. If the hole in the heart isn't patched, it doesn't matter how much IV fluid you administer to the patient. On the other hand, a stab wound to the belly, like the busted intestine, may need stabilization and fluid resuscitation, then an operation.

And sometimes a room just isn't available.

That's when *bumping* comes into play.

Often the surgeon, who books an emergency, doesn't know exactly what the

problem is with his patient. Alas, the diagnostic rub! Although the surgeon knows something bad is going on in, say, the patient's belly, he *never* knows for certain the nature of the problem. Honesty is imperative to make bumping work.

Bumping refers to the selecting of one case over another to go directly to surgery because of the perceived acuteness of the emergency. The second case, although also urgent, is considered to be less so. That patient is taken to the next available operating room and everyone gets the care that's needed.

It's another wonderful source of conflict for a story.

Doctors milk the system for their own advantage. Often, bumping becomes an issue because everyone wants to get home. If the patient is stable, the wait for OR time is usually no more than an hour or two—a little time for a stable patient, an eternity for an impatient surgeon.

The following is a representative system of rating cases in order to determine what order emergency cases will be performed:

Designation of case: 1-4

1. A case designated a "one" must be done within two hours - highest priority, e.g. a patient with a perforated intestine and peritonitis

2. A case designated a "two" must be done within three to six hours - e.g. a patient with acute (uncomplicated) appendicitis

3. A case designated a "three" must be done within six to twelve hours - e.g. re-look after damage control surgery, a skin graft, or cleaning up a traumatic wound

4. A case designated a "four" must be done within twelve to twenty-four hours - e.g. a patient admitted with an infected gallbladder on antibiotics who needs a

cholecystectomy before discharge

There's a final chapter in the bumping story.

The OR personnel—the anesthesiologists and nurses—talk to the surgeons involved about their patients and set up the order in which the cases will be done. If the surgeon who must wait disagrees, she must discuss it with the surgeon listed to go first. Listen to the conversation: The pediatric surgeon asks the neurosurgeon if it were *his* (the neurosurgeon's) child with the perforated appendix, would he want the pediatric surgeon to be bumped? The neurosurgeon counters with a demand that the pediatric surgeon tell him what he would want the neurosurgeon to do if this were *his* (the pediatric surgeon's) mother with the clot in her brain.

You take if from there.

Easy Cases

Most trauma victims never go to the operating room. Only fifteen percent need surgical treatment. For example, the drunk kid who bumps his head in a car crash and has a negative CT scan will be observed in the ICU and eventually discharged when stable. He may need a chest tube to treat a pneumothorax (collapsed lung, more on this in Part II), or his fractured fibula may require a cast before he goes to the ICU or special neurology unit for observation. But no major operation is needed.

***Single organ trauma* is the buzzword for uncomplicated cases. A broken thighbone represents a major injury with lots of rehabilitation in the wings. For the orthopedic surgeon, it's a matter of placing a rod into the bone (marrow cavity) to stabilize the fracture and encourage early ambulation.**

A smashed spleen may be preserved by follow-up serial abdominal CT scans to make certain there is no further bleeding. Or the trauma surgeon may find blood in the abdomen when he performs an abdominal "tap" in the ER, which leads to exploratory surgery. There the issue becomes saving the ruptured spleen (less complicated than saving the whales) for its immune function. If terribly lacerated, the trauma surgeon may be obligated to remove the spleen.

But single organ trauma can also be horrible.

Take the case of a lacerated liver. Although most liver lacerations are small and the bleeding stops spontaneously, some livers are shattered and massive blood loss may spell eventual death, even though only one organ is damaged. So it depends which one. Woe to the poor soul with a major isolated head injury who slips into the persistent vegetative state.

Complicated Cases

***Multiple organ system failure* is the end point in trauma care gone wrong. The vital organs that ultimately fail—heart, lungs and kidneys, as well as the immune system, brain and intestines—may not be the organs injured. Thus, *multi-system trauma* refers to badly hurt people with some combination of broken bones, chest injury, brain trauma, ruptured abdominal organs and shock on admission to the ER trauma room. Not all systems on this list must be injured for the victim to be in serious difficulty.**

Let's see what happens with a complicated case in the operating room. Two or three teams of surgeons swell the OR ranks and everyone is screaming "priority".

Who actually operates first? If you've got an OR scene in your story, you need to know who gets to fix his or her system first.

Here's a guide:

- **Any serious bleeding must be handled first. If the surgeon is in a small hospital, she will do most of this work alone (with an assistant). In a level I center, the specialist, in whose anatomic territory the bleeding occurs, will stop the hemorrhage, unless the trauma surgeon decides to handle it (remember the turf battle issue?).**
- **Any acute head injury with brain compression from a blood clot or a depressed skull fracture must be handled next.**
- **Any chest injury that wasn't handled in the trauma room must now be fixed, and the thoracic or trauma surgeon will work simultaneously with the neurosurgeon on the multiple injury victim.**
- **The abdominal part, if not approached earlier for exsanguinating hemorrhage, is next.**
- **Lastly, the orthopedic surgeon does what's needed for extremity damage—except when there's a vascular injury and the orthopedic surgeon operates first to fix broken bones (stabilize with rods, pins or screws) or reduce and stabilize dislocated limbs before the vascular surgeon attempts to suture delicate disrupted blood vessels.**
- **Somewhere in the course of the trauma victim's multiple, simultaneous operations, the plastic surgeon may become involved, as might an ENT surgeon, for maxillofacial smashes. The urologist works with the abdominal surgeon if the**

kidneys, bladder or other parts of the victim's plumbing are disrupted.

Multiple trauma is a team endeavor.

Major trauma occurs most often because someone took a calculated risk and lost. Enter the trauma team, the dedicated group of specialized doctors, nurses and other technicians—the "expensive care" team. A hospital with high-tech facilities and a dedicated staff of surgeons, nurses, OR personnel, ICU staff and regular floor nurses greet and care for the trauma victim.

When Things Go Wrong in the OR

Not all surgery ends happily.

Not all victims of trauma, treated at a dedicated facility, get better. Some don't make it out of the hospital alive. Not all injuries are treated successfully. Disabilities often linger long after all efforts have been exhausted to return the victim to a state of sound health.

Sometimes excreta strikes the flabellum.

Your stalwart surgeon hero may feel the nibbling pangs of fear when up from the depths of the opened abdomen, blood appears in huge clots and dribbles over the drapes. "Oh my God!" he cries, before catching himself. "Quick! Suction . . .". The controlled atmosphere of the OR abruptly disappears, replaced by panic and uncertainty.

Experienced surgeons get rattled?

It happens.

A sudden, unexplained fall in blood pressure, a cardiac arrest, a heart rhythm

change, an unexplained rise in airway pressures suggesting a blocked windpipe, massive bleeding from the depths of a body cavity—all of these cause rapid acceleration of emotions among members of the operating team. Not all surgeons react with emotion. Most move through their planned emergency drill, step by calculated step. But the atmosphere is never the same again in that OR on that day.

At time, frustration creeps up on the surgeon. It's more of an insidious unraveling of the doctor's expectations. He can't locate the bullet in the belly. He can't actually find the blood vessel in the torn lung that's hemorrhaging. He can't get adequate exposure behind the liver where fresh blood keeps puddling.

OR Atmosphere

You've just had a taste of a panic scene—something that doesn't occur very often in the OR. At times, things heat up for other reasons. Surgeon and anesthesiologist may disagree about what constitutes adequate abdominal or chest wall muscle relaxation (permitting easy access to organs), how much fluid to give, which antibiotics to administer, where the patient should go after surgery (ICU versus the floor) and on and on.

Maybe the front desk calls into the room to see how much longer the surgeon thinks he'll be before closing. "Why are you asking?" fumes the surgeon. Is he late for the trauma clinic? Did his boss refuse to consider a raise? Is his wife out shopping as they speak? Did his favorite stock drop twenty-six points? Or was it because the resident doing the case is a klutz and the surgeon gets chest pain watching? It's anyone's guess why the surgeon loses his temper.

Often in the easier cases, music plays and everyone in the room begins to talk once the tough part of the operation is over. The scrub tech asks the circulating nurse for a recipe for chicken François or the name of her boyfriend's brother who fixes mufflers. The surgeon hits on the intern who asked if she could try to close the skin. Use your imagination. Most of the time it's just solid professionals doing their jobs.

Worked into these various levels of communication is the ever-present question asking ("pimping", as the residents call it). Anything in the surgical field or facts related to the case is fair game if a medical student is scrubbed. These obtuse questions are asked in the name of education.

Many exchanges, both with instruments and verbally, occur during a case. In the OR there's a doe's-eyelash distance between harassment in all forms and accepted behavior. Sometimes it's just harassment. In this case of on-the-job education, excreta obeys the laws of gravity. It flows from the trauma surgeon downhill to the intern. It's a wonder they're not all on antibiotics.

PACU: The Recovery Area

The severity of the injury determines where the trauma patient goes after surgery. Most post-op injured go to the *post-anesthesia care unit* (PACU) to recover from the affects of anesthetic drugs, the shock state caused by the trauma and the impact of major surgery. Monitors are used to watch heart and lung function (EKG, blood pressure, pulse, respiratory rate) as well as record urine production and keep track of bandages and drain output. When extubated (breathing tube removed from the windpipe), awake and stable, the patient is taken to the surgical floor.

Sometimes the trauma victim will go directly to the ICU from the operating room. In the more severely injured, there is no need to stop in PACU as the ICU serves the same purpose and the patient cannot be extubated anyway. Intense monitoring and care is begun in the surgical ICU beginning in the immediate postoperative period.

The Intensive Care Unit

Special medical services and personnel are available to ICU patients. Also available on the surgical floors, these services and treatments are given priority in the intensive care unit.

Special medical services available in the ICU include:

- **The intensivist—a doctor specially trained in critical care medicine**
- **Specially trained ICU nurses**
- **Multiple high-tech machines to support ventilation, blood pressure, kidney function, nutrition, etc.**
- **Residents (in teaching hospitals) who work around the clock at the bedside, making minute-to-minute adjustments in sophisticated treatments**
- **Doctors and nurses with special training**

There are also special critical care units in the hospital that function like the main ICU in providing specialized care. These include cardiac surgery ICU, coronary care unit, pediatric ICU and dialysis unit.

The Surgical Floor

Depending on the body system most injured, the trauma victim may be transferred from the PACU or ICU to a regular surgical floor. Some go to a specialty floor. For example, the hospital may have a neurological care floor to manage all head trauma, stroke victims and postneurosurgical patients. The orthopedic floor handles all of the bone and joint cases. If one of these is the predominantly traumatized system, the patient then goes to that floor.

Other trauma patients recover from their injuries on a floor designated as a specific unit for certain surgeons. Most are cared for on a general surgical floor, which manages a variety of cases. This includes elective operations.

Trauma patients go through a series of steps in their recovery. As each phase of recovery is completed, a number of possible complications are treated or the likelihood of getting a particular complication passes. Eventually, the patient "turns the corner". What does this mean?

Here is a list of *general phases of recovery* that every trauma victim passes through on her path to renewed health.

The acute injury phase: **Stress hormones make the body retain fluid to fight shock and to use energy efficiently; much IV support is needed. The patient is ill in this phase for days.**

The turning point: **When the body decides the threat to survival is over, the patient feels better and begins to get rid of excess body fluid via increased urine production, temperature returns to normal, appetite improves, walks become longer, stairs seem less treacherous.**

The anabolic phase: **A natural buildup or anabolic replacement of lost body**

protein associated with major gains in strength, resumption of activities of daily living, and a return of interest in hobbies and work; even sex drive returns now (assuming it didn't reestablish itself moments after leaving the operating room).

The fat gain phase: **Convalescence melds imperceptibly into normalcy, the metabolic piper has been paid, structural damage is repaired, extra calories become fat and life goes on.**

Rehabilitation and Going Home

Some trauma victims don't go home.

Fifty percent of all head-injured patients die, and almost half of the survivors have a neurologic deficit. Often, these poor souls must be cared for in long-term or chronic care facilities. Unable to perform activities of daily living, the brain-injured patient must rely on constant nursing care. There are institutions around the country that specialize in caring for head-injured and spinal cord-damaged patients.

If your story includes a victim of trauma to the nervous system, here are a number of chronic problems you may wish to visit upon your character:

Quadriplegia: **Results in inability to use one's arms or legs due to paralysis. Patient may have slight finer or upper arm movement; some are on ventilators, no control over bowels and bladder.**

Paraplegia: **Paralysis of the lower extremities; control problems of bowels and bladder; patient can get around in a wheelchair.**

Pelvic or genital trauma: **May result in permanent colostomy if bowel-controlling anal sphincter muscle is seriously damaged.**

Disfigurement: **Affecting face, hands or other parts. May include exaggerated scarring, amputations, tissue loss with skin grafting, burns, fused joints and a useless arm or leg.**

Loss of voice: **Neck trauma with permanent tracheotomy or paralysis of vocal cords.**

Other rehabilitation issues include management of chronic bladder catheterization, treatment for urinary tract infections, cleaning and bandaging chronic open wounds, managing feeding tubes (through the abdominal wall into the stomach), bathing of patients with muscle weakness, physical therapy, occupational therapy and psychiatric evaluation and support. Most of these begin in the hospital and must be continued at home. Home care has replaced longer hospital stays in order to complete the rehabilitation process.

At home, the trauma patient begins to see the course of his illness. Lost time, perhaps lost job security and difficulties he has pressed on the family with such a complicated clinical course may cause depression. Anger at the random nature of the accident and at the doctors and nurses who performed so many unpleasant tests and treatments may push the recovering patient to despair. Of course, many find solace and a genuine sense of gratitude that they are survivors.

Lastly, the trauma victim is evaluated in the surgical clinic several times following discharge from the hospital. In addition, the patient may need to see an orthopedic or neurosurgeon for more specific follow-up. At times, the patient must be readmitted for additional surgery. These procedures include skin grafts; removal of pins, screws and other orthopedic hardware; or plastic surgery to revise scars and

repair poorly healing wounds.

The areas of the trauma center of most concern to the victim of major body injury are the operating room, the intensive care unit, the rehabilitation unit and the hospital's surgical clinic. Each of these settings provides you with an opportunity to weave another thread of uncertainty about recovery into the fabric of your story.