

TRAUMA

Clinical Care and Pathophysiology

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Trauma: Clinical Care and Pathophysiology

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Preface

The management of trauma victims has achieved increasing respectability in the past two decades. Because of the periodic involvement of our country in armed external conflicts and the increased recognition of the terrible cost of civilian trauma, a growing cadre of physicians around the country are devoting their entire professional careers to the study and practice of trauma care. With these efforts to better understand how to treat various forms of injury has come a rededication to the study of basic science problems applicable to the care of the injured. Although the surface has barely been scratched in the basic science of trauma management, much has been learned about the pathophysiology of burns, the biochemistry of wound healing, the pathogenesis of adult respiratory distress syndrome, and the biomechanics of bone remodeling, to name only a few. One of the dual purposes of this book is to describe in detail methods of treating various injuries encountered in clinical practice. The second purpose of this book is to provide sound insights into the basic pathophysiology that is operative in a variety of injured states.

Our approach to the section on clinical care is to share some of what we have learned over the years about the care of the trauma patient at the University of Louisville teaching hospitals. We would not suggest that our methods are the only way, or even necessarily the best way, to manage various problems, but our experience has been considerable and this University's Department of Surgery has had a long and abiding interest in the injured patient.

1987 marks the 150th anniversary of the founding of the University of Louisville School of Medicine. Throughout most of its recent history, the University's primary teaching facility has been the major source of

trauma care for both the city of Louisville and, indeed, much of Kentucky and Southern Indiana.

Publications on trauma care from our predecessors in this unit have been numerous throughout this century. In 1913 Dr. J. Garland Sherrill reported on the management of stab wounds of the heart from the Louisville City Hospital, later to become the Louisville General Hospital. Thus, while other institutions have scrambled to designate a now-fashionable accident unit, the University of Louisville has recently celebrated the 50th anniversary of its trauma service!

Through the years, the front line management of trauma patients has been provided by a long procession of surgical residents who have consistently and tirelessly dedicated themselves to this often thankless task. At the faculty level, there has always been a succession of men in Louisville committed to the care of the injured: Arnold Griswold, James Drye, Rudolf Noer, Truman Mays, and numerous others have staffed this service until the present generation of surgeons, whose ideas are featured in this book.

The production of this book would not have been possible without the editorial assistance of Shirley A. Cook. The efforts of Harriett Langdon, Darlene Newlin, Lynne McKnight, and the division secretaries, in preparing manuscripts, and Susan Brown, in providing technical support, cannot be overemphasized. Likewise, the assistance of medical illustrator Tamara Bell Rentschler is gratefully acknowledged. Finally, the cooperation and patience of our Sponsoring Editor, Daniel J. Doody, and Frances M. Perveiler, Manager of Copyediting Services at Year Book Medical Publishers, have been invaluable in bringing our project to successful completion.

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Contents

<i>Preface</i>	ix
1 / Introduction <i>by J. David Richardson, Hiram C. Polk, Jr., and Lewis M. Flint.</i>	1
2 / Organization for Trauma Care <i>by Lewis M. Flint and J. David Richardson</i>	5
3 / Shock: Cardiovascular Pathophysiology and Treatment <i>by Donald D. Trunkey, Richard H. Carmona and Bartholomew Tortella</i>	13
4 / Host Defense and Organ System Failure Part A: Host Defense in the Trauma Patient <i>by Donald E. Fry and Hiram C. Polk, Jr.</i>	41
Part B. Stress Gastritis in the Trauma Patient <i>by Gerald M. Larson</i>	76
5 / The Metabolic Consequences of Injury <i>by J. David Richardson and Jorge L. Rodriguez</i>	87
6 / Principles of Hemostasis and Transfusion in Injured Patients <i>by Charles E. Lucas, Celestine Harrigan, and Anna M. Ledgerwood</i>	103
7 / Pathophysiology of Burn Injury <i>by Robert H. Demling</i>	121
8 / Respiratory Pathophysiology <i>by Richard J. Mullins and Richard N. Garrison</i>	167
9 / Wound Repair and Bone Healing Part A: Wound Repair: Biologic Foundations and Clinical Considerations <i>by Gordon R. Tobin</i>	213
Part B: Bone Healing <i>by J.A. von Fraunhofer</i>	262
10 / Skeletal Trauma of the Face <i>by Brian Alpert and Serge A. Martinez</i>	271
11 / Management of Thoracic Injuries <i>by J. David Richardson and Constantine Mavroudis</i>	291
12 / Abdominal Injuries <i>by Lewis M. Flint and Mark A. Malangoni</i>	353
13 / Urologic Trauma Part A: Upper Urinary Tract Trauma <i>by Mohammad Amin</i>	397
Part B: Lower Genitourinary Trauma <i>by James I. Harty</i>	406
14 / Pelvic Trauma <i>by Roger W. Seibel, John R. Border, and Lewis M. Flint</i>	421

15 / Cervical Injuries <i>by Michael B. Nolph and J. David Richardson</i>	433
16 / The Upper Extremity <i>by Graham D. Lister, Luiz C. Toledo, Danny L. Bennett, and Harold E. Kleinert</i>	451
17 / Pathophysiology and Management of Injuries to the Central Nervous System <i>by Christopher B. Shields and E. Joy Arpin</i>	479
18 / Management of Traumatic Injury to Soft Tissue <i>by Joseph C. Banis, Jr., and Bruce Silverberg</i>	501
19 / Special Aspects of the Care of Injured Children <i>by Diller B. Groff</i>	523
20 / Management of Extremity Trauma <i>by Susan E. Briggs and David Seligson</i>	535
21 / The Ethical, Moral, and Legal Issues of Trauma Care	
Part A: Ethical and Moral Issues	
<i>by Richard L. Barber and Virginia T. Keeney</i>	563
Part B: Legal Issues <i>by Steven R. Smith, J.D.</i>	569
<i>Index</i>	581

CHAPTER 1

Introduction

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It is entirely fitting that one ask, "Why another major trauma book?" Indeed, the contributions of currently available and recently produced books and monographs on trauma have done much to familiarize the surgical reader with many of the principles involved. Although we have sought the contributions of leaders from a broad base of world surgery in problems related to trauma, the theme of this book is unique in that it is effectively a statement of the practice in our university trauma unit, based on a 40-year experience within a single institution with a major commitment to the trauma patient, his illness, and his ongoing care. The data and conclusions drawn therefrom are the results of systematic out-

come studies conducted over the 12-year period beginning in 1973.

The continuing documentation that death and disability due to injuries is a major public health problem, as expressed numerically in Figures 1-1 and 1-2 and in Table 1-1, has proved the need for a multilevel, interdisciplinary, community-wide response to the trauma patient.^{1, 2} A recent survey recounted the appalling statistics: 140,000 deaths occur annually from trauma in the United States.² Allowing for two to three disabled patients for every patient's death, the cost to society is staggering. Data to document the efficiency of the medical system at saving life through an integrated medical response to trauma are

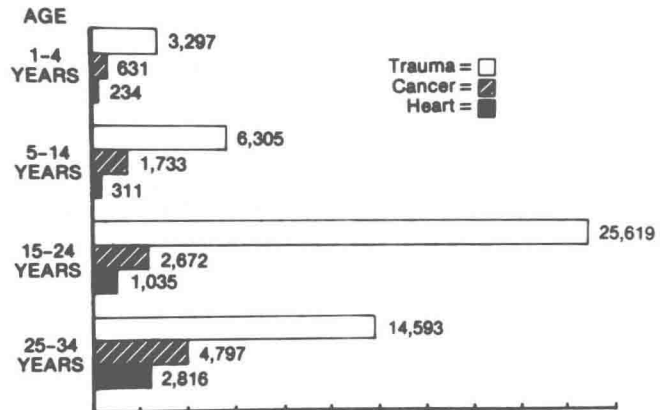
TABLE 1-1.

Percentages of Deaths From Injury and Other Causes in the United States in 1980, By Age

AGE, YR	INJURIES	CONGENITAL ANOMALIES	CANCER	PNEUMONIA/ INFLUENZA	HEART DISEASE	LIVER DISEASE	STROKE	OTHER
1-4	46	13	7	3	4	—	—	27
5-14	55	5	14	—	3	—	—	23
15-24	79	—	5	—	3	—	—	13
25-34	62	—	10	—	6	3	—	19
35-44	31	—	21	—	20	6	4	18
45-64	7	—	32	—	36	4	5	16
65+	2	—	19	3	48	—	10	18

Modified from Baker SP, O'Neill B, Karpf R: *The Injury Fact Book*. Lexington, Mass, Lexington Books, 1984. Used with permission.

FIG 1-1.
Comparison of deaths due to trauma, cancer, and heart disease in the United States in 1977. (Data from the National Center for Health Statistics. Personal communication, 1981. Used with permission from Trunkey DD: On the nature of things that go bang in the night. *Surgery* 1982; 92:123.)



plentiful, but proof that the medical trauma system facilitates the return of functional citizens to a productive life is unavailable. Rehabilitation of trauma victims is a specialty in its infancy in North America. Unfortunately, there are many deterrents to the successful

rehabilitation of trauma victims. Many communities and many medical centers are without the full-time services of specialists in rehabilitation. We have observed that our legal system and the method of compensation for injury often leads to cumbersome delays in the rehabilitation process and eventually lessens the likelihood that the trauma victim can ever be returned to a productive role in society.

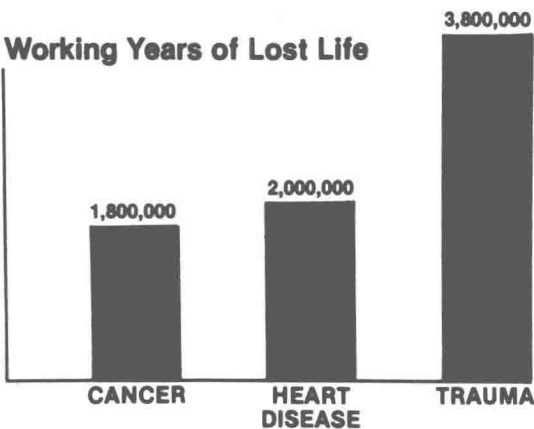


FIG 1-2.
Approximate annual loss in working years of life attributable to premature deaths due to injuries, diseases of the heart, and malignant neoplasms in the United States in 1970. For each 5-year age group (0-64 years) the number of people who died was multiplied by the number of years between ages 18 and 64 years that would have remained had they not died. (Data from Haddon W, Baker SP: Injury control, in Clark DW, MacMahon B (eds): *Preventive Medicine*, ed 2. Boston, Little, Brown & Co, 1978. Used with permission from Trunkey DD: On the nature of things that go bang in the night. *Surgery* 1982; 92:123.)

A further manifestation of trauma as a national public health priority is the widening recognition that the best and most productive form of medical care is that which is never required, i.e., the prevention of either personal violence or accidents in all aspects of daily life. The issue of personal violence is closely related to issues of freedom, and one cannot fail to recognize the impact of acute or chronic alcohol abuse as a major contributor to the process. Similarly, the right to own and carry firearms is a uniquely American claim and certainly promotes violence in some circumstances. It may well be that these are insolvable problems. On the other hand, the remarkable accomplishments of organizations such as Mothers Against Drunk Driving (MADD) are noteworthy. In fact, the steady decline in the per capita alcohol consumption in the United States has been associated with an overt decision of many of the major distillers to diversify their investments into other parts of American industry.

Another example of productive initiative in the area of prevention is a defined automobile passenger restraint law. Data from the United Kingdom suggest the efficacy of restraint devices.³ Similarly, anecdotal evidence supports the effect of lower speed limits as a preventive measure.

Beginning in the 1960s, a major effort by surgeons, scientists, government agencies, and professional and charitable organizations has sought to define the need for a trauma network of highly skilled hospital centers manned by specialists knowledgeable in trauma care. Studies begun by Frey et al.⁴ and continued by West et al.^{5,6} and Baxt and Moody⁷ in California have documented the improved patient outcome associated with a systems approach to trauma care using the basic facilities categorization design promulgated by the American College of Surgeons through its Committee on Trauma.⁸

The nationwide development of the Emergency Medical System (EMS) and increased awareness of the importance of trauma care fostered by the Committee on Trauma of the American College of Surgeons and The American Trauma Society has resulted in efforts to improve both prehospital care and the care the trauma victim receives within the first hour after admission to the emergency department. While the evolution of specialized trauma units is still in its infancy nationwide, there is an emerging awareness among physicians and hospital administrators that it is no longer plausible or ethical for every hospital in America to have a full-service Emergency Room. **Increased medical, societal, and legal pressures have demanded that those institutions that purport to deliver emergency care in fact are staffed and equipped to do so.**

Some special aspects of this book will contribute to the easy adaptation of the techniques described to other units providing tertiary care to trauma victims. This book emphasizes the concept that the general surgeon should function as the primary physician for the injured patient. By no means is he the person most capable of dealing comprehensively

sively with every one of the trauma patient's problems, but in every case he is the physician most broadly aware of the total aspects of the patient's well-being.

At the same time, by virtue of his obligatory training in the surgical specialties, the general surgeon is at least conversant with important priorities for each of the more narrowly focused disciplines. There is a strong concurrence among those of us who have worked within our system for more than a decade that a method stressing early involvement of a multispecialty team, led by the general surgeon, allows the appropriate consideration of special skills and, most crucially, avoids the occasionally too narrow view by the specialist surgeon toward the multiple trauma victim. Visitors to our unit have repeatedly recognized this practice as a key to the operational excellence of the University of Louisville "trauma service." For example, even a patient with an isolated head injury is briefly admitted to the trauma service and seen in consultation by specialists in neurologic surgery. When it is ascertained that the head injury is the patient's sole concern, he is transferred to the neurosurgical service, and the neurosurgeon becomes the primary physician, with the general trauma surgeon frequently serving as consultant.

In other situations, where multiple injuries complicate a head injury and multiple specialty skills are required over time, the patient may remain on the general surgery trauma services for weeks while the respective specialists carry out the bulk of the operative care. This is often a nongratifying kind of undertaking for a procedure-oriented general surgeon. On the other hand, some of our finest examples of overall patient care and the most mature exemplars of quality surgical judgment arise in this setting, and **there is no more demanding task than the persistent, sensitive judgment required of the general surgeon who oversees the continuing care of such a patient.**

This book is organized along both conceptual and specific anatomical lines. There is ob-

viously overlap among these considerations but this is, we think, readily perceived by the reader. We also wish to point out that working relationships with specialists in emergency medicine have generally been productive, enhancing the care of our trauma patients. Inevitably, there are unproductive and petty turf wars. Both emergency medicine and surgical specialty teams periodically err in their judgment as to the relative values of their contributions to a given patient in a given set of circumstances. On the other hand, in broad measure the mature emer-

gency medical specialist is capable of providing effective resuscitation and triage. It is our firm opinion that the emergency medical specialist who wishes to perform surgical procedures should become fully trained in surgery.

This book finally is a description of how the trauma patient may be treated to achieve predictable success. It is also a clear expression of the methods by which our unit has contributed a sequence of leadership observations to the trauma literature in a wide variety of settings, as reflected in the accompanying references.

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CHAPTER 2

Organization for Trauma Care

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An effective, integrated response to the injured patient requires participation of many individuals and commitment on the part of diverse agencies. The surgeon's role in the organization of the trauma care system is crucial. By virtue of his training in multisystem disease, the general surgeon is a fitting choice for a key role in this activity. Although his main area of activity is within the hospital, the surgeon is an important catalyst for change, a facilitator of communication, and a spokesman for health professionals with an interest in trauma.

Since the recognition of the problems in trauma care, which began in the United States with the landmark National Academy of Sciences document in 1966, much information has been generated concerning the anatomy and function of an effective trauma care system. The views expressed in this chapter reflect the experience at the University of Louisville Trauma Center as well as an analysis of experience elsewhere. The components of the system include:

1. *Alert*: a method for reporting a trauma event.
2. *Agency Response and Scene Control*: dispatch of personnel and vehicles to the scene, with acquisition and maintenance of order.
3. *Rescue*: the process of controlling life-

threatening scene conditions with subsequent protective packaging and preparation of the patient(s) for evacuation.

4. *Evacuation*: choice and use of appropriate transport to the definitive care center under effective medical control.

5. *Facilities' Location and Availability*: arrangement of health care facilities for the most efficient provision of cost-effective care.

6. *Hospital Organization*: medical team identification and support.

7. *The Protocol Approach to Trauma Care*: development and use of prescribed treatment programs for consistency and ease of evaluation and change as necessary.

8. *Evaluation of Results*: probably the most important aspect of the system after rescue.

9. *Community Service and Attitude Development Fostered by the Trauma System*: this keeps the community informed and secure in the knowledge that an effective response is available and, in addition, aids in mobilizing community resources and political support. Each component will be discussed individually below.

THE ALERT SYSTEM

A system is necessary for reporting a trauma event and summoning help. Although

the "911" telephone system is being utilized increasingly as a universal alert system, many communities have not adopted such a plan. A satisfactory system should include a method of access that can be understood and easily used by anyone from elementary school children to the invalid elderly, and education programs to document this knowledge are required. We have undertaken an educational program in our community that deals with appropriate alert responses to accidents or injuries. A trained respondent is required to evaluate the nature of the emergency, activate agency response, and give advice to the caller. The respondent should operate under strict orders, with a back-up respondent and a program of medical control and evaluation. The respondent will usually activate the community disaster alert system in multicasualty events.

AGENCY RESPONSE AND SCENE CONTROL

Coordination of several community protection agencies is required in order that appropriate ambulances, fire and police personnel, and equipment are available to the accident scene. By agreement, the agencies should determine in advance the responsibility for scene control. Dependable communication and interagency cooperation is essential, since the complexity and intensity of this activity rapidly escalates with increasing numbers of casualties, bad weather, and dangerous scene situations, such as criminal and terrorist activity.

RESCUE

Personnel trained and equipment designed to extricate victims from deformed vehicles or other structures are essential. This activity must occur in the context of maximum protection for the victim. At this juncture, communication with trauma system medical control is essential so that the receiving hospital may be forewarned and two-way radio discussion of the victim's condition and his medical needs may occur.

EVACUATION

The victim is protected from further injury by a system of splinting and immobilization designed to afford maximum protection against cervical spinal cord injury and unwanted mobility of fracture sites. These efforts at the scene of the accident provide for patient safety and the prevention of further injury. The measures to be taken at the scene by ambulance personnel are arrived at through communication with medical control. Effective medical control requires that the decisions concerning the level and intensity of prehospital care for the injured patient are understood and agreed on by all concerned. The time spent preparing the rescued victim for transport is determined by medical control. Because several types of paramedical personnel are available in many communities and because the levels of training and abilities vary, the modalities of prehospital intervention are tailored by medical control to fit the situation. The types of rescue and prehospital care personnel with the training requirements for each level are shown in Figure 2-1. The definition of effective medical control has recently been promulgated by the American College of Surgeons through its Committee on Trauma.

Optimum prehospital care for the trauma patient emphasizes the minimum evacuation time consistent with patient safety. Evacuation, or response time, is defined for purposes of comparing trauma systems and evaluating results as the time lapse between rescue and arrival in the operating room for definitive operative care.

Data are available which support the use of intravenous (IV) fluids, drugs, and cardiac monitoring for the prehospital care of the emergency cardiac patient but not for the trauma patient. Gervin and Fischer¹ documented an adverse effect on survival of injured patients when prehospital care interventions prolonged evacuation time. Obviously, **the sense of urgency that dictates rapid evacuation of trauma patients to the**