

# THE MANAGEMENT OF TRAUMA

*Edited by*

*Third Edition*

GEORGE D. ZUIDEMA, M.D.

ROBERT B. RUTHERFORD, M.D.

WALTER F. GALLINGER, II, M.D.

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# PREFACE

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The battleground, with its insistent pressure for immediate yet thoughtful and considered management of injury, has traditionally been a rich medium for development of surgical principles and procedures. The progressive decrease in the mortality rate of the wounded from World War I, World War II, the Korean War and the Vietnam conflict offers striking evidence of advantages, not only in the surgical management of trauma but also in general supportive care and rapid means of transportation to centers where definitive management is possible.

But just as disease patterns and epidemiology change with the passage of time, so has the spectrum of trauma altered in recent years. We can now speak of the epidemiology of trauma with at least as much assurance as of the epidemiology of hepatitis, and we can state with precision that since the turn of the century the contribution of motor vehicles to the annual accidental death rate has steadily risen to the point where it now exceeds 45 per cent. As a result, blunt trauma, frequently producing multiple injuries, has taken a dominant position in our accident wards, and therefore in the surgeon's training and experience.

While our methods of treatment have improved and continue to improve, our means of producing injury are also being perfected. Ever increasing horsepower, coupled with an unchanging degree of human error, has exceeded the rate of our willingness or ability to incorporate safety features into our automobiles. Furthermore, new weapons and changing methods of waging war continue to demand much of our resources. In our opinion, these factors provide clear evidence of the large and continuing need for investigation of the mechanism of injuries and for a methodology for their prevention and management.

Although impressive progress has been made recently in a number of areas, such as organ transplantation, mechanical cardiopulmonary assistance and prosthetic valves and vessels, we have not paid sufficient attention to another area—one that involves the death or disability of large numbers of our population every year. The following statistics bear sobering insight into the serious impact of trauma in this country. Accidents injure more than 50 million people and kill more than 100,000 in the United States each year. Trauma is exceeded only by cardiovascular disease and cancer as a cause of death in this country, and it is the leading cause of death among persons between the ages of 1 and 37. Thus, in terms of productive man-years lost, trauma can be considered our leading "killer." Moreover, for every person killed accidentally, approximately 100 suffer a temporarily disabling injury, and 10 to 15 require hospitalization. Accident patients occupy 12 per cent of the total

general hospital space, requiring more hospital bed days than all heart patients and four times more than all cancer patients.

The challenge continues to be great.

All the material in the previous two editions of *The Management of Trauma* has been reviewed, updated and, in many cases, completely rewritten, incorporating newer concepts of diagnosis and management. Particular attention has been paid to increasing coverage of cardiopulmonary resuscitation, anesthesia, acute renal failure and injuries of the neck. Furthermore, entirely new chapters have been added, emphasizing the importance of post-traumatic pulmonary insufficiency, organization of the emergency department, epidemiology and prevention of injuries, and the psychiatric management of the injured patient.

In order to confine the almost limitless scope of trauma from injury through rehabilitation, we have urged our associates to stress the principles and techniques of early management as opposed to those of late reconstructive care. We have asked them to pay special attention to interpretation of the constellation of physiologic disturbances that inevitably accompany serious injury, and to describe the ways they have found effective for restoring body functions quickly and gently to a normal pattern.

To each of the contributors the editors express their sincere appreciation.

Walter F. Ballinger  
Robert B. Rutherford  
George D. Zuidema

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## GENERAL PRINCIPLES

There is no task in surgery more difficult or more important than the initial evaluation of a trauma victim. When dealing with acute trauma it is often impossible to separate diagnostic and therapeutic measures; in fact, it is improper to attempt to dissociate them. The care of the acutely injured patient imposes certain important time restrictions upon the physician. He must not only carry out his usual diagnostic evaluation but must also attend to the urgent therapeutic needs of his patient. It is frequently impossible and impractical to obtain a detailed history. He is forced to rely heavily on physical findings for diagnosis, and the initial examination may well be performed with an agitated, uncooperative patient making the task even more difficult.

The initial priority in the evaluation of an injured patient is an immediate search for rapidly fatal but reversible conditions (Table 1-1). When these have been excluded or treated, a complete inventory of injuries that will require further diagnostic studies will help the physician to form an orderly plan of management. Then, based

on the known pattern of injury, the physician conducts an aggressive search for occult injuries. Finally, consideration is given to likely future complications and the available preventive measures to be instituted.

Following severe trauma there are only a few situations that are reversible but produce death within minutes if left unattended. The first of these is inadequate ventilation; the second is hypoxia resulting from circulatory insufficiency; and the third, which often accompanies the second, is rapid, continuing bleeding. Other types of reversible injury lead to slower deterioration of the patient's condition and therefore are not given the same priority for emergency management.

### Inadequate Ventilation

Inadequate ventilation leads immediately to hypoxemia and insufficient oxygen delivery to tissues. This state is tolerated poorly, and if complete asphyxia follows, the brain suffers irreversible anoxic damage within 5 minutes. If ventilation is to be re-established, it must be done quickly.

Inadequate ventilation can result from

**TABLE 1-1. Priorities in Evaluation and Resuscitation of the Injured Patient**

Rapidly fatal conditions	Inadequate ventilation Inadequate circulation Rapid bleeding
Injuries requiring prompt therapy or diagnostic studies	Closed head trauma Long bone fractures Arterial injury Urinary tract injury
Occult injuries	Blunt abdominal trauma Facial bone fractures Cervical spine injuries Aortic tears Myocardial contusion
Complications	Progressive pulmonary insufficiency Sepsis Withdrawal from drugs

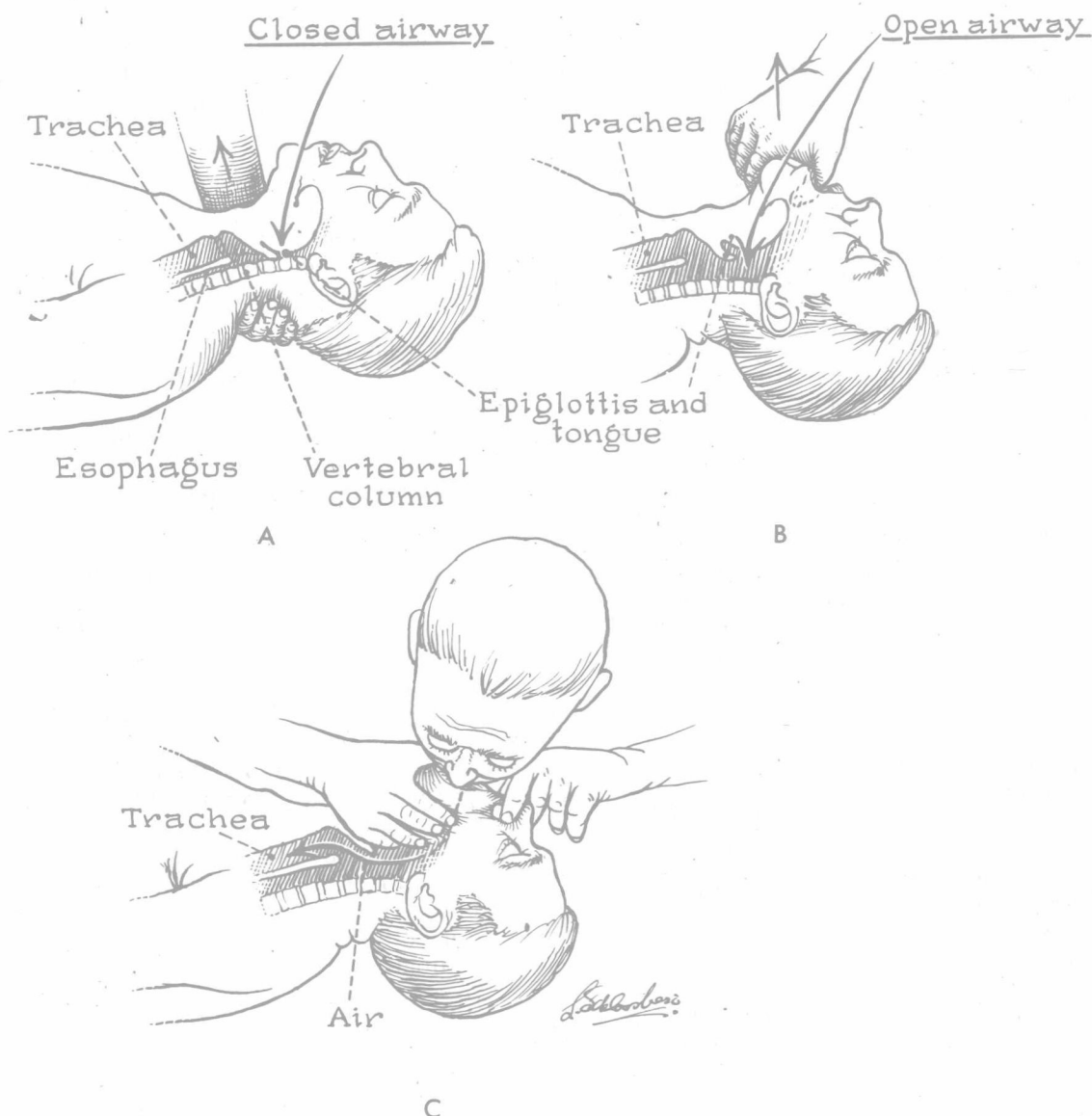
several sources, but in acute trauma upper airway obstruction is the most common. If obstruction is complete, all methods of resuscitation fail until the obstruction is removed. Frequently, such obstruction can be relieved simply. In an unconscious, apneic patient obstruction is frequently caused by the relaxation of the soft tissue of the pharynx, the falling back of the tongue, or blockage of the upper airways by mucus, blood or vomitus. If foreign material is discovered in the mouth or oropharynx, suctioning should be performed immediately. The head should be tilted backward so that the jaw is pointing upward, and the jaw should be pushed or pulled into a jutting position (Fig. 1-1). This maneuver relieves obstruction in the airway by moving the base of the tongue away from the back of the throat. If these measures fail to restore adequate ventilation—if the patient remains apneic or cyanotic, displays retractions of the chest with ventilatory effort, or has only shallow and inadequate respiratory movements—the cause is probably not simple upper airway obstruction. Such a situation occurs in severe neurological damage, in obstruction of the trachea below the glottis, in flail chest injury, in bilateral pneumothorax and in laryngeal fracture. Precise diagnosis is often impossible in the short time allowed to restore adequate ventilation and therefore should not delay treatment. An oral or nasal endotracheal tube should be inserted immediately, preferably with direct laryngoscopy, and positive pressure

ventilation should be instituted with a compressible bag. If an endotracheal tube and laryngoscope are not available, an esophageal airway (Fig. 1-2) is a satisfactory alternative, and its prompt use may be life-saving.

Only in the case of direct laryngeal trauma will an endotracheal tube be inadequate. A direct tracheal airway should then be established. This can be done most quickly by creating a temporary opening in the subcutaneously located cricothyroid ligament in the midline of the neck. The classic tracheostomy performed below the cricothyroid ligament is too time-consuming in real emergency situations. The introduction of large bore needles into the cricothyroid membrane has been recommended, but these needles are frequently not available. Resuscitation by this technique can be continued until an artificial ventilatory apparatus becomes available. At this point, with an endotracheal or tracheostomy tube in place, chest tubes can be inserted if part of the ventilatory inadequacy is secondary to intrapleural air or blood.

### Circulatory Insufficiency

Two varieties of circulatory insufficiency are seen with acute trauma. The first is associated with marked hypovolemia secondary to blood loss, resulting in inadequate delivery of oxygen to tissues, and the second is cardiac arrest.



**Figure 1-1.** A, Illustrates the wrong way of supporting the head during resuscitation. Note that the tongue and epiglottis fall back to obstruct the airway. B, Shows the correct way of handling the patient's airway. Supporting the jaw and tongue provides for an unobstructed airway during resuscitation. C, Demonstrates how support of the patient's jaw is properly combined with mouth-to-mouth resuscitation.

**Figure 1-2.** Illustration of an esophageal airway in place. Note the cuff occluding the esophagus, so that air enters the trachea.

