Manual of Acute Orthopaedic Therapeutics

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Little, Brown and Company
Boston

First Edition

First Printing February 1977
Second Printing August 1977
Third Printing March 1978
Fourth Printing February 1979

Library of Congress Catalog Card No. 76-1046

ISBN 0-316-14712-5

Printed in the United States of America

HAL

Preface

The *Manual of Acute Orthopaedic Therapeutics* was developed over the years by the Department of Orthopaedics at the University of Washington for the benefit of its residents. The inspiration for this updated, published form came from those who have successfully used the departmental manual in the past. Many favorable comments have been made on the manual's content and on its response to the need for basic therapeutic guidelines not only for young orthopaedic residents but also for family physicians, general practitioners, and general surgeons in training and in practice who will encounter musculoskeletal injuries. The present book will also be useful to interns, medical students, and paramedical personnel.

The *Manual* is limited primarily to acute orthopaedic problems. Its intent is to aid in the decision-making and learning procedure by making readily available a discussion of a method of management that has been deemed best by the faculty *at this time*. There is often no single best way to handle many conditions, but it is hoped that this manual will serve as a base for acceptable patient management and a takeoff point for discussing fundamental concepts as well as other methods of management.

For the purposes of this manual and as defined by the American Academy of Orthopaedic Surgeons, orthopaedic surgery is "that medical specialty which embraces the investigation, preservation, development, and restoration of the form and function of the extremities, the spine, and associated structures of the skeleton by medical, surgical, and physical means."

Challenges are expected to the concepts set forth; however, the program of management as presented has proved successful in our hands. When several methods of treatment are equally satisfactory, it usually means that there is an underlying principle that is behind all of them. This manual stresses the *principles*, the application of which may vary with different orthopaedists.

The apparent regimentation of technique is necessary for the following reasons:

1. It is felt desirable that the individual learn and master at least one technique of managing a problem so he can do it with skill and security.
2. In addition to teaching, the University has the responsibility for advancing the science and practice of our specialty. Advance can be made only through careful study of current methods on a scientific basis in order to select and improve methods of orthopaedic care.
3. One of the great problems in the delivery of orthopaedic care in the United States is in having adequate supplies and equipment readily available. It is not financially feasible to keep in stock all the various sizes and types of implants and the tools to insert them. Therefore, some preselection is necessary.

It is felt that the techniques presented in this manual are safe and acceptable when used by the average orthopaedist. Techniques that require unique training and equipment are not described in any detail except for the A.S.I.F. [(Swiss) Association for the Study of Internal Fixation] and intramedullary nailing techniques, which do require special training and experience.

The *Manual* is presented in pocket-size form so that information can be easily accessible. Chapters are referenced when deemed appropriate. Continuous revisions are planned, and readers' comments are solicited.

Many sections of the *Manual* are based upon the expertise of this department's full-time faculty and derived from various courses provided for our residents. It would be impossible to give proper credit to all of those who contributed in some way to this publication. Special thanks are extended to David M. Chaplin, M.B., F.R.C.S., Assistant Professor of Orthopaedics, and Peter J. Bath, M.B., F.R.C.S., Instructor in Orthopaedics, for their valuable critique of the *Manual*'s content. We are proud of the line drawings by Virginia E. Brooks, medical illustrator, and Carol C. Jerome, graphic illustrator, both from University of Washington Health Sciences Illustrations. The *Manual* was prepared with the excellent secretarial assistance of the entire Department of Orthopaedics' secretarial staff. We are indebted to them for their patience and cooperation. Peggy Iversen's editorial advice provided an invaluable contribution.

L. D. I.
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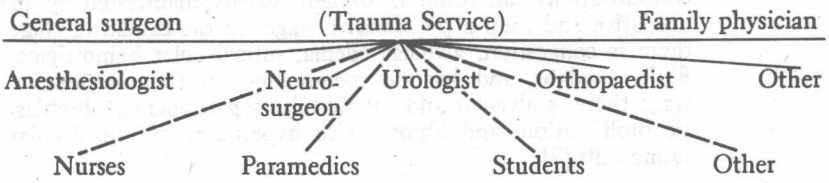
NOTICE

The indications and dosages of all drugs in this manual have been recommended in the medical literature and conform to the practices of the general medical community at the University of Washington. The medications described do not necessarily have specific approval by the Food and Drug Administration (FDA) for use in the disease and dosages for which they are recommended. The package insert for each drug should be consulted for use and dosage as approved by the FDA. Because standards for usage change, it is advisable to keep abreast of revised recommendations, particularly those concerning new drugs.

Contents

1 *The Diagnosis and Management of Musculoskeletal Trauma*

I A TEAM APPROACH TO TRAUMA In many trauma centers the care of the patient with injuries to more than one organ system is handled by a **team of specialists.** The type of physician who coordinates the team varies with the patient's needs.



It is the team leader's responsibility to manage the patient's injuries efficiently and effectively. One approach is to organize the care into three successive stages: revive, review, and repair.

A Revive This stage is concerned with the preservation of life. The following points are useful in the management of acute trauma.

1 The most common cause of preventable death in accidents is **airway obstruction,** so the trauma team leader must immediately check that the patient's airway is adequate. Any obstruction (vomitus, tongue, blood, dentures, etc.) must be removed. If necessary, prevent airway obstruction by positioning the head and the body, by using an airway, or by intubation. An **endotracheal tube** will prevent aspiration of vomitus. Make certain the endotracheal tube is not in a main stem bronchus. An endotracheal tube may be left in place for as long as a week, and during this time the decision regarding tracheostomy can be assessed.

a Emergency tracheostomy should rarely be performed unless injury to the upper airway makes passage of an endotracheal tube impossible. Tracheostomy is accompanied by an impressive list of complications and should not be used merely as a convenient method for giving intermittent positive pressure respiration. If there is poor ventilation (dyspnea, cyanosis, ab-

normal blood gases, etc.) despite an airway, then ventilate the patient using positive pressure with a bag or with mouth-to-mouth ventilation via the airway.

b After airway obstruction has been ruled out, the inability to expand the chest suggests the diagnosis of a **pneumothorax** or **hemothorax**. A tension pneumothorax is diagnosed by signs of massive pneumothorax plus positive pressure in the intrapleural space. This condition might produce a rapidly worsening respiratory status and require aspiration of the air to relieve the symptoms before a roentgenographic diagnosis is available.

c If the patient can ventilate but has persistent cyanosis and dyspnea, a **flail chest** may be the cause. This can be controlled by assisting ventilation. Supplemental oxygen is beneficial only when the arterial O_2 is reduced, as can happen with preexisting problems such as chronic obstructive pulmonary disease or an injury to the chest or abdomen. Prolonged use of high oxygen concentrations can result in oxygen toxicity manifested by an exudative and then a proliferative stage. In the exudative stage there is congestion, alveolar edema, intraalveolar hemorrhage, fibrin exudate, and hyaline membranes. In the proliferative stage there is alveolar and interlobular septal edema, fibroblastic proliferation, and fibrosis with hyperplasia of the alveolar lining cells [7].

2 The **cardiovascular status** must be evaluated immediately and supported. Control of **external bleeding** is accomplished by direct pressure and bandage. Elevation of only the lower extremities will help prevent venous bleeding from the limbs and will raise the blood pressure. The classic Trendelenburg (head down) position is not used as it can interfere with respiratory exchange.

3 Commence the treatment of **shock** by inserting two large-bore venous catheters. The infusion rate is dependent upon the length and internal diameter of the catheter (Table 1–1).

Table 1–1 *Infusion Time for 1 Liter of Lactated Ringer's or Whole Blood Through Various-Sized Catheters*

	Lactated Ringer's (3½ ft elevation)	Whole Blood (300 mm Hg pressure)
24" large (14-gauge needle) catheter (as for CVP line)	38 min	25 min
8" large (14-gauge needle) catheter (as for subclavian)	19 min	14 min
2½" 14-gauge plastic catheter (catheter of choice)	7½ min	7 min

From W. G. Horton, unpublished data, 1972.

a The **first choice** for the type and location of IV catheters is for two 14-gauge 2½ in. plastic catheters to be inserted percutaneously in either the arm veins, the external jugular veins, or, in extraordinary circumstances, the saphenous veins of the ankle.

b If percutaneous catheters cannot be inserted because the veins have collapsed or are too small, the **second choice** depends on the physician's expertise with subclavian vein percutaneous puncture versus a cutdown approach to a vein.

(1) If there are no veins available in the extremities for percutaneous puncture or a cutdown catheterization, **bilateral subclavian** or internal jugular percutaneous punctures can be performed using a 14-gauge needle over an 8 in. plastic catheter.

(2) An alternative approach is to use **two cutdown** catheterizations with No. 10F adult/pediatric feeding tubes inserted into the cephalic or external jugular vein. If no other route is available, use the long saphenous vein at the ankle. Veins in the lower extremities are avoided because of the dangerous potential of thrombophlebitis.

c Do not use veins that drain through the site of injury. *If the patient has no signs of impending or actual shock,* a single large-bore IV catheter will suffice.

d A **central venous catheter** for monitoring is of value.

e Blood is then taken for **typing and cross-matching.** The emergency use of O-negative blood even with a low anti-A titer is discouraged; it takes about ½ hr to obtain typed blood, and about 2 hr to obtain cross-matched blood.

(1) While awaiting the cross-matched blood, rapidly infuse 1 to 2 liters of isotonic Ringer's lactate or a balanced dextrose and saline solution. If the **blood loss is minimal,** the blood pressure should return to normal and remain that way with only a maintenance amount of balanced saline solution.

(2) If the **blood loss has been severe** or the hemorrhage is continuing, the elevation of blood pressure and decrease in pulse rate that occurred with the rapid infusion of lactated Ringer's solution will be transient. By the time this assessment has been made, typed, or, if possible, the more specific cross-matched whole blood, should be available [11].

(3) The following **estimates of localized blood loss** in liters from adult fractures can be useful in establishing baseline blood replacement requirements [9].

Humerus	1.0–2.0	Pelvis	1.5–4.5	Knee	1.0–1.5
Elbow	0.5–1.5	Hip	1.5–2.5	Tibia	0.5–1.5
Forearm	0.5–1.0	Femur	1.0–2.0	Ankle	0.5–1.5

(4) Extracellular fluid might also be lost to the intracellular space. This loss occurs with shock when the cell membrane fails. Blood alone will not replace the **extracellular fluid lost.** Therefore, the functional extracellular fluid loss should be replaced by lactated Ringer's solution. Overhydration can occur. Central venous monitoring by itself is of little value in detecting crystalloid overload. When overload does occur, diuretics are beneficial to treat this condition, especially in acute pulmonary edema and congestive heart failure, provided there is good renal function. The intravenous use of furosemide (40–120 mg) or ethacrynic acid (25–100 mg) for short periods will improve hypoxemic patients. Using diuretics to simply produce urine, however, has no sound physiologic basis and is detrimental because they further deplete the intravascular and extravascular extracellular fluids [11].

f If large quantities of blood are required, a portion of it should be **fresh.** As blood is stored, there is a marked decrease in the 2,3-diphosphoglycerate (DPG). This substance has been shown to be the prime regulator of oxygen binding and oxygen release from hemoglobin. When DPG is decreased, as it is in aged red blood cells, the cells lack the full capacity to deliver oxygen to the tissues. Prolonged blood storage causes other deficiencies (abnormal clotting, cell wall fragility, etc.), so 50 percent of the blood should be fresh.

g **Urine output** is an essential guide to adequate organ perfusion. Therefore, the insertion of an indwelling catheter and the monitoring of urinary output are necessary for treating the shock patient. Normally the urine output ranges from 500 ml to 2500 ml per day.

4 A **flow sheet** (Fig. 1–1) should be established to monitor the patient.

5 Any obvious **fractures or deformities are splinted,** and any **open wounds are covered** with sterile dressings. A more detailed description of fracture and wound management is given later in this chapter (see **III**).

B Review

1 The **history** should include a careful account of the accident, a description of the possible mechanisms of injury, and a statement of the degree of violence involved. Consider concomitant medical disease, drug abuse, and alcoholism as contributing factors.

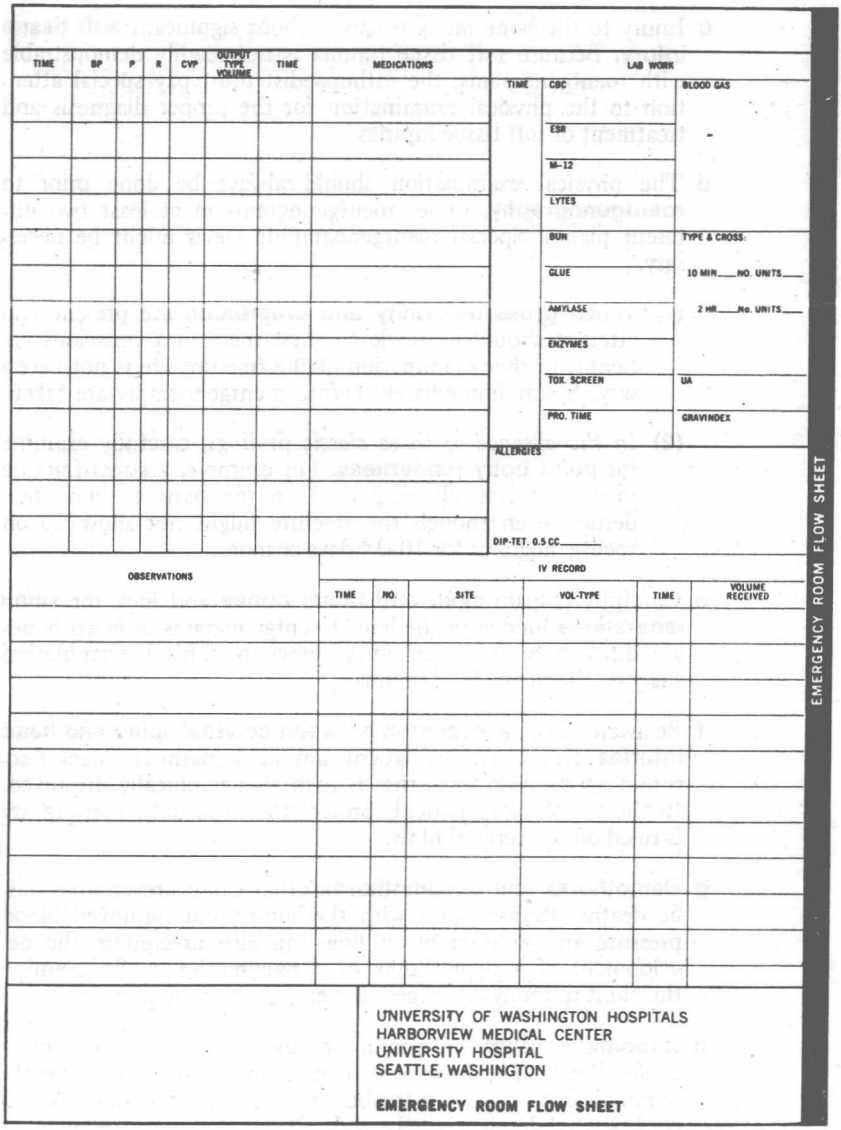


Figure 1–1 An emergency room flow sheet.

a Carefully describe the **level of consciousness** and the response to stimuli, coherence, orientation, etc. Avoid using words like *stuporous* or *comatose* without describing what is meant by these terms.

b Note the **position** of the patient, especially the head, and whether all limbs are moving actively.

c Injury to the bone rarely occurs without significant **soft tissue injury.** Because soft tissue trauma is not readily demonstrable with roentgenograms, the orthopaedist must pay special attention to the physical examination for the proper diagnosis and treatment of soft tissue injuries.

d The physical examination should always be done prior to **roentgenography.** Order roentgenograms in at least two different planes. Special roentgenographic views might be necessary.

(1) When **gross deformity and crepitation** are present (no attempt should be made to elicit them in a conscious patient), further examination of the fracture site is not necessary. Splint immediately before roentgenograms are taken.

(2) *In the absence of these classic findings,* carefully examine for **point bony tenderness.** For example, a stress fracture may be tentatively diagnosed on the basis of bony tenderness even though the fracture might not show up on roentgenograms for 10–14 days or more.

e Carefully palpate **skull and facial bones** and look for **small lacerations** hidden in the hair. Roentgenograms of facial bones are difficult to interpret unless previous clinical examination suggests the presence of trauma.

f Be aware of the **association between cervical spine and head injuries.** In a conscious patient, any neck spasm is a neck fracture or dislocation until that is roentgenographically disproved. In the unconscious patient, protect the neck until bony injury is ruled out by cervical films.

g **Hemothorax** and **pneumothorax** often cause preventable traffic deaths. Resuscitation with the subsequent improved blood pressure and pulmonary air flow can also precipitate the development of a hemothorax or a pneumothorax. So examine the chest carefully and repeat the examination frequently.

h **Abdominal injury** is also a common cause of preventable traffic deaths. The imprint of clothes or a seat belt on the abdominal skin suggests intraabdominal injury. Measure and record the abdominal girth and repeat this measurement at intervals throughout the examination. If intraperitoneal bleeding is suspected, a laparotomy is indicated. Low back pain, pubic tenderness, or pain with compression of the iliac crests can indicate a pelvic girth injury. Pelvic fractures are a serious cause of severe internal bleeding, but surgery to stop such bleeding is very difficult. Instead of surgery, continuous massive transfusions are necessary for significant pelvic fractures. A severe backache can be an indication of retroperitoneal bleeding. A rectal examination should be done on all patients with any pelvic injury.

i Carefully **palpate the back** to detect tenderness or defects of the interspinous ligaments. If there is a possibility of spinal injury, palpation should be done without rolling the patient.

j Major injury to the limbs is usually obvious. One must remember, however, the likelihood of **multiple fractures and joint injuries in the same limb.** Carefully evaluate the circulation of the limb distal to any fracture and record the presence of all wounds.

k The **neurologic examination** is related to the type of injury suspected. Careful peripheral nerve examinations are done with any limb fracture. In the case of a spinal injury the examination must be complete, emphasizing the level of the neurologic lesion and a description of all sensory modalities. Frequently evaluate and record the muscle power, tone, tendon reflexes, and cutaneous reflexes. Chart the neurologic examination with illustrations and mark sensory levels on the skin so that all changes are easily recognized during the subsequent hours.

l Again it must be stressed: **Maintain accurate records** with repeated monitoring. As a rule severely injured patients are minimally medicated and maximally oxygenated. Accompany the patient to Radiology or obtain portable films in the emergency room so that continued monitoring is maintained.

m The following is a list of **commonly overlooked injuries** which must be ruled out with any multiply injured patient.

(1) **Basilar skull fracture.**

(2) **Zygomatic arch and orbital fractures.**

(3) **Fracture of the odontoid process.**

(4) **Injury to the C7 vertebra.**

(5) **Posterior dislocation of the shoulder.** (The patient has no external rotation.)

(6) **Scaphoid, lunate, or perilunate dislocation.**

(7) **Fracture of the radial head.**

(8) **Seatbelt fracture** (T12 or L1).

(9) **Pelvic fracture.**

(10) **Femoral neck fracture.**

(11) **Posterior dislocation of the femoral head.**

(12) Tibial plateau fracture. (A knee hemarthrosis is often present with fat globules which rise to the surface of the aspirate. Oblique roentgenograms of the tibial plateau usually show the fracture.)

(13) Fracture of the talus (may be associated with subluxated peroneal tendons).

2 The **initial examination** of the multiply injured patient must be meticulous and fully documented; this is why it is carried out after resuscitation has started. The patient must be completely undressed.

3 Make **roentgenograms** of any suspected limb fracture, including the joints above and below the injury on the film. Special points to be emphasized are the following:

a All multiply injured patients should have a roentgenogram made of the **chest** and **pelvis.**

b If a spinal injury is suspected, obtain a quality roentgenographic examination of the involved section of the **spine.**

c Bell and Loop [1] developed a list of 21 symptoms and signs that have a significantly high yield of skull fractures found on skull roentgenograms. The presence or absence of these **"high-yield findings"** (Table 1–2) should be established before skull roentgenograms are ordered. Unless at least one or more of these findings is present, a skull roentgenogram is likely to be normal.

d Patients with multiple fractures of the lower rib cage should have an **intravenous pyelogram** (IVP). An IVP or a cystogram may be indicated in the presence of fractures of the pelvis. If a bladder injury is suspected, it is essential to insert an indwelling catheter unless the patient is voiding clear urine.

4 Use **maximal monitoring** and **minimal medication.**

C Repair In the management of the multiply injured patient the repair phase includes various operations and procedures carried out by the **appropriate specialty groups.** The specialists involved should be cognizant of all injuries and should discuss the timing, type, and extent of operative procedures with the trauma team leader.

II PRINCIPLES OF FRACTURE HEALING

A Normal bone is highly vascular and has a great ability to resist infection and to repair itself. On the other hand, avascular bone is defenseless and cannot participate in the reparative process. Therefore, direct **treatment** toward the prevention of further devascu-