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SHOCK TRAUMA MANUAL

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SHOCK TRAUMA MANUAL

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THE WILLIAMS & WILKINS COMPANY
Baltimore



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The Williams & Wilkins Company
428 E. Preston Street
Baltimore, Md 21202, U.S.A.

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Made in the United States of America

Library of Congress Cataloging in Publication Data

Gill, William, 1937-

A shock trauma manual.

1. Wounds—Treatment—Handbooks, manuals, etc. 2. Resuscitation—Handbooks, manuals, etc. 3. Hospitals—Emergency service—Handbooks, manuals, etc. I. Long, William B., joint author. II. Title. [DNLM: 1. Wounds and injuries—Therapy. 2. Emergency health services—Maryland. WO700 G475m]

RD93.G54 617'.21 77-15777

ISBN 0-0683-3527-4

Composed and printed at the
Waverly Press, Inc.
Mt. Royal and Guilford Aves.
Baltimore, Md 21202, U.S.A.

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Shock Trauma Manual

Dedication

This book is dedicated to the late Professor Sir John Bruce—our mentor, former Governor Marvin Mandel, for his courageous support of the new concepts of Emergency Medicine, and Maryland Senator Mary Nock, for her unflagging efforts on our behalf.

Preface

THIS MANUAL was written with the aim of providing precise guidelines for the emergency resuscitation and initial treatment of major trauma victims. A successfully adapted system from modern warfare is described and this has been applied to treat major trauma throughout the state of Maryland.

During the years when we were responsible for all medical management in the Maryland Institute for Emergency Medicine we were vividly aware of the dilemma facing outlying physicians suddenly confronted with a patient who was exsanguinating or asphyxiating. Action must be automatic and decisions are both critical and numerous.

A philosophy of treatment and an effective systems approach are described. We have confined ourselves to the emergency resuscitation of an unstable patient and devoted sections to some techniques involved and to overall priorities. It is not our intent to encroach on the excellent existing texts of descriptive operative surgery or attempt an indepth description of trauma management, but to add perspective to the maneuvers that may be required to achieve stabilization of the patient and highlight recent therapeutic advances. A striking absence of practical advice is present in existing literature and it is hoped that the inclusion of such aspects as the technical appendix, the organization of an emergency operating room, and the instrumentation required may find a receptive audience.

The dogmatic style of the text is intentional because the contents are well worn in successful application.

Introduction

ACCIDENTAL DEATH is the leading cause of death in the United States of America for citizens up to the 37th year. One hundred and fifteen thousand persons were fatally injured in 1971 and 54,764 of these deaths related specifically to motor vehicle accidents. In terms of statistics, 1 out of every 4 Americans was injured at work, home or play during 1971 and the overall cost of these accidents to the nation was approximately \$30 billion. Of the 52 million citizens injured annually, 11 million required bed care for a day or more, and 40,000 suffer long term disability. Those patients hospitalized occupy approximately 65,000 beds for 22 million bed days under the care of 88,000 hospital personnel—a load which is equivalent to 30 500-bed hospitals.

In Maryland, 70,000 people are injured annually of which 55,000 are related to motor vehicle accidents with 1,574 deaths in 1971. Many of the deaths are directly related to such factors as speeding, alcohol and drugs, high traffic density areas, tardy evacuation and transport of the injured, and inadequate medical treatment and facilities. In collaboration with the Medical Examiner's Office it was shown that half of the road traffic accident patients showed alcohol in the blood and 20%–25% were above Maryland's legal limit.

A number of attempts have been implemented to reduce the mortality and morbidity arising from civilian trauma, and include the tactics found effective in the evacuation of injured troops for the war arenas. The key approach revolves around rapid transport to expert facilities and differs from the "flying squad" concept and the "mobile O.R. or I.C.U." which appear less practical, economical, or efficient.

A sophisticated systems approach of triage, communication, and transport is of little avail if medical expertise of the highest order does not await the victim's arrival.

There has long been a need for a practical guide in the management of multiple trauma. The absence of Board accreditation for Traumatology or Emergency Medicine has meant that many emergency room physicians and even surgeons have received only sporadic exposure to experienced care of this type. The lack of traumatology training programs has resulted in a variety of approaches to the problem and the lack of standardization and communication of techniques. It should be clearly recognized that Critical Care Medicine programs, and Departments of Emergency Medicine produce physicians quite distinct from the Trauma Surgeon (Traumatologist), each serving a totally different function.

1968 AMERICAN COLLEGE OF EMERGENCY PHYSICIANS

"To improve the quality of Emergency Medical Services throughout the country."

1972 *Journal of the American College of Emergency Physicians (JACEP)*

1970 THE UNIVERSITY ASSOCIATION FOR EMERGENCY MEDICAL SERVICES

"To improve the quality and delivery of care to the acutely ill and injured through educational programs centered in teaching hospitals."

1975 Joint Sponsors of JACEP

1970 SOCIETY OF CRITICAL CARE MEDICINE

A multidisciplinary society "To improve the care of patients with acutely life-threatening illnesses and injuries and promote the development of optimal facilities for such care."

1973 *Journal of Critical Care Medicine*

CURRENT STATUS OF EMERGENCY MEDICAL CARE

1. American College of Emergency Physicians (1968) Emergency Room Physicians
General Practitioners—Occasional Surgeon and Internist New Emergency Medicine Residents
2. Society of Critical Care Medicine (1970) Medical I.C.U. Directors (Intensivist) Anesthetists—Internists
3. American Board for Surgery of Trauma Surgical I.C.U. Directors—Traumatologist (Trauma Center) General Surgeon

Although in 1970 only one Department of Emergency Medicine existed for the training of Emergency Physicians, there are currently some 31 available programs.

A mere handful of institutions exist in the country which specialize exclusively in the treatment of the critically ill emergency patient. One such center is the Maryland Institute for Emergency Medicine which was created by an Executive Order issued by Governor Mandel on February 26, 1973. This independent State Institute within the University of Maryland evolved from the pre-existing Center for the Study of Trauma which had been part of the medical school's Department of Surgery. This natural evolution occurred because of the dramatically increasing magnitude of the trauma problem in the country and because the nature of the work necessarily crosses many of the traditional boundaries inside a medical school.

Because this systems approach to emergency medicine appeared relatively successful in this environment and reduced overall mortality rate from 40% to less than 15% over a period of 3 years, we felt it worthwhile to share our experiences in this type of medical care with others.

Acknowledgments

THE AUTHORS wish to thank the many people who helped them in their efforts to produce this manual. Although individual appreciation to all is expressed we feel a special mention must be made of Mary Kellogg, Nurse Chairman in the Maryland Institute for Emergency Medicine and Head Nurse of its operating rooms, whose contributions were invaluable to "Aids to Organization." Also to Susan Puterbaugh, Carol Curran, Carol Benner, Steven Wilson, Dr. William Sacco, Dr. Howard R. Champion, and Dr. John Richmond for their contributions. We are naturally indebted to all our colleagues in the Shock Trauma program and the many residents and fellows who passed through the unit without whom it would have been at times difficult to continue. To Theodore Holt, a Physician Assistant, our thanks for the illustrations. A special word of gratitude is due to Mrs. Ruby Richardson and latterly Susan Vitale whose firm belief it was that the manual had something to offer, encouraged its production, and whose polite tolerance of our delayed production was most gracious. Finally our gratitude to Pat (Wright) and Nancy (Wilson) our long suffering secretaries throughout our erratic productivity.

Credits

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The Maryland Statewide Emergency Medical System

1

**Access, Accident and Triage
Communication System**

**Ambulance Transportation
Helicopter Transportation**

**Medical Facility
Patient Profile**

On February 26, 1973, Governor Mandel by Executive Order created within the Department of Health and Mental Hygiene, the Division of Emergency Medical Services. His intention was to formalize an emergency health care delivery system already partly active and to develop and coordinate emergency health efforts throughout the state. Dr. R Adams Cowley, the Director of the Center for the Study of Trauma in the University of Maryland, was appointed to implement this program which he had initiated and conceptualized 3 years earlier.

The program evolved because of glaring deficits in available medical manpower and resources for emergency health care and the rising toll in deaths and disability from road traffic accidents. Hospitals, physicians, administrators, and community health planning agencies had failed in the preceding years to anticipate and provide for the numerous trauma patients and the occasional critically injured victims who more frequently than before arrive at the emergency rooms. Most emergency rooms are staffed by doctors-in-training or by family practitioners hired primarily to cope with out-patient and minor surgical problems and most lack the facilities to diagnose as well as treat the critically ill or injured patient. At nights and weekends when accidents are most numerous, there is a dearth of operative facilities, staff, laboratories, and patient support systems. The employment of increasing numbers of full-time emergency physicians and the formal training programs for them should somewhat ameliorate this unsatisfactory state of affairs.

Ambulance services in Maryland are required by departmental rulings (because of the medicolegal implications) to take an accident victim to the nearest hospital irrespective of the availability of medical staff and facilities. The delay encountered by the subsequent referral of the patient to a larger hospital

may cost him his life. Our experience and that of others have shown that the mortality rate of accident victims doubles with each subsequent hour of delay after the initial post-injury hour.

A system's approach (Table 1.1) has been developed in Maryland through education, communication, and transportation whereby critically injured patients can be carried from the scene of the accident to the appropriate treatment center in the shortest possible time. Existing services such as the state police and volunteer and professional ambulance organizations are coordinated with the relatively new aviation (helicopter) division of the state police to provide a network of accident location and rapid evacuation.

Access, Accident, and Triage

As yet no unified telephone alert (e.g., 911 system) is available for emergency calls in the state of Maryland and frequently the first official at the scene of the accident will be a state trooper. Either he or a member of the public will then call the nearest Ambulance Central Alarm who in turn dispatches an ambulance and notifies the State Police Aviation Center. If the trooper is first on the scene he may notify the Aviation Communication Center direct. Thereafter, the arrangement is a flexible cooperative effort between the state trooper on road patrol, the ambulance personnel, and the medical observer of the helicopter division (a state trooper with special medical training). Between them they will render first aid to the patient and decide on the mode of evacuation and appropriate destination, i.e., whether to await the helicopter if the ambulance arrives first and vice versa. Both ambulance men and state troopers of the aviation division receive an extra period of orientation to triage techniques from the institute staff and spend 2 weeks working in its reception

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areas. Refresher, continuous education courses are provided thereafter at 6-month intervals.

The priorities of triage at the scene of the accident are:

1. Maintenance of an airway
2. Control of external hemorrhage
3. Immobilization of obvious fractures.

Indications for direct referral to the Maryland Institute for Emergency Medicine include injuries which require the specialized services of neurosurgery, ophthalmology, plastic surgery or cardiothoracic surgery and would encompass:

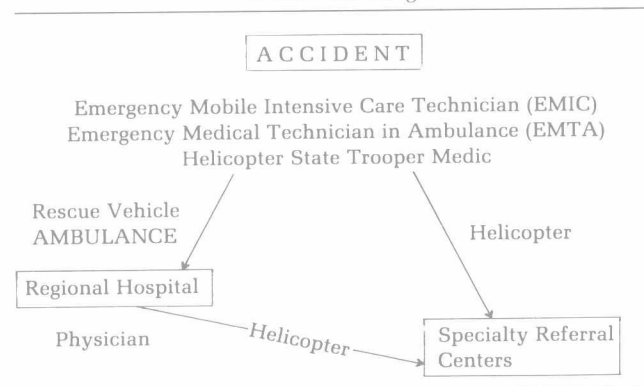
1. Head injury usually associated with loss of consciousness or a deteriorating level of consciousness
2. Acute spinal cord injuries and suspected cervicodorsal vertebral fractures
3. Cardiovascular injuries or suspected myocardial contusion
4. Severe thoracic injury—flail chest, pulmonary contusion
5. Maxillofacial injury
6. Eye injury
7. Multiple injuries requiring urgent resuscitation and treatment (i.e., obvious involvement of more than one body system).

All triage is carried out by paramedical personnel except for the referrals from physicians at other hospitals (Table 1.2). An open admission policy exists and no trauma victim is ever refused access to the system. Despite this relatively crude triage system, only approximately 10-15% of admissions are inap-

TABLE 1.1. A Systems Approach to Trauma

1. Triage
2. Communication network
3. Transportation
4. Regionalization
5. Hospital categorization
6. Medical facility
7. Patient management
8. Education
9. Evaluation

TABLE 1.2. Triage



propriate and undergo re-triage to another area of our own hospital and one nearer their home.

Physicians referring serious multiple trauma victims from emergency rooms in small community hospitals are not interrogated by a hostile resident, but are given automatic acceptance of the patient with a minimum of information requested and immediate help to transport the patient. Dying patients do not wait for clerical work or detailed discussion!

Communication System

A statewide communication system is in the process of implementation which will interlink the scene of the accident, ambulances, helicopters, hospital, and specialty referral centers without interfering in any way with existing networks such as those of the present ambulance dispatch methods, law enforcement agencies, or Civil Defense. Subsystems exist within each region of the state, and these are coordinated by a central communication center in Baltimore (Tables 1.3-1.5).

Each of the state's five regions will have a regional Emergency Medical Center coordinating that region's communication network. This regional center will have a direct telephone link to the central alarm system for the fire department in that area and also to the state police barracks, which in turn will have radiolinks with the ambulances, the state police squad cars, and the helicopters.

TABLE 1.3. Communication and Transportation Subsystems

Inter-Hospital (wire)
Ambulance to hospital (radio)
ECG telemetry (UHF radio)
Remote link from patient to ambulance
Repeater link from ambulance to hospital
Can be used only for ECG transmission

TABLE 1.4. Communication and Transportation

<i>Hospital to Hospital</i>
Leased phone lines for primary net
Hospital radios for limited emergency capability
Wire-wire, wire-radio patch facilities at regional centers
<i>Ambulance to Hospital Radio</i>
Low or high band UHF special emergency frequency
Remote base stations to obtain full coverage
Contact via central alarms in outlying areas

TABLE 1.5. Communication and Transportation System Functions

Function	Center
1. Designate appropriate hospital	Regional
2. Call Maryland State Police for helicopter	Regional
3. Notify ambulance and dispatcher of helicopter time of arrival	Regional
4. Alert hospital to receive victim	Regional
5. Give advice to ambulance crews	Regional
6. Coordinate resources on regional basis	Regional
7. Coordinate resources on statewide basis	Baltimore

The system is activated by an accident phone. A call to a special emergency operator number alerts the regional E.M. Center, the state police, and the central alarm of the local fire department. An ambulance and a state police car proceed to the scene of the accident. After triage, information regarding the patient's condition and injuries is transmitted to the regional communications center which determines what hospitals are available to receive the patient(s) and whether a helicopter is required.

The regional communications center maintains a census board of surrounding hospital status, consultant and specialty coverage, and occupancy of emergency rooms and can consequently advise ambulancemen at the scene of the accident which hospital is most appropriate for the patient's injuries. Direct referral to a regional E.M. center will depend on the description of the patient's injuries from the scene of the accident.

If, after further assessment, a patient requires referral to facilities not available at that hospital, the regional communications center arranges transportation to a specialty referral center.

The statewide or central communications center keeps abreast of the situation in each region and coordinates overall state activity especially concerning helicopter utilization. The advantages of such a system are obvious during times of disaster and multiple accidents. No one area or hospital can be overwhelmed by critically ill patients and inadequate staff or facilities. Interhospital transfers of patients can be coordinated and transportation arranged according to the status of the patient.

The five proposed regions of Maryland are *Appalachia Region*, with Cumberland as the regional center serving Allegheny and Garrett Counties, collaborating with the adjacent portions of Pennsylvania and West Virginia; *Mid-Maryland*, involving Frederick and Washington Counties; *Metropolitan Baltimore*, including Baltimore City and five surrounding counties with Baltimore as the regional center; *Metropolitan Washington*, involving five counties and the District of Columbia; and the *Eastern Shore* with Salisbury as its regional center.

Specialty referral centers for the state system include the Kiwanis Burn Unit (Baltimore City Hospital). Neonatal Units (Baltimore City Hospital and University of Maryland Hospital), a Hand Center (Union Memorial Hospital), a Pediatric Trauma Center (Johns Hopkins University), and the Maryland Institute for Emergency Medicine, which accepts predominantly critical adult multiple trauma.

Ambulance Transportation

Ambulance services in Maryland are provided by volunteer and municipal companies associated with the fire department. The only exception is Garrett

County in Western Maryland which has privately owned companies.

The service is activated by a call from a citizen or the police to the local fire department (Central Alarm) which dispatches an ambulance to the scene of the accident. Ambulance men are emergency medical technicians. The state recognizes the curriculum as approved by the Department of Transportation, National Highway Traffic Safety Administration for the 81-hour EMT-A course. Presently over half of the state's 8000 ambulance attendants are certified EMT-A's. They provide triage and basic resuscitation and life support to the critically injured at the scene and during transport.

In accord with National Safety Council Standards, the ambulances are equipped with oxygen, Ambu bags, suction apparatus, splints, stretchers, and assorted first aid materials. Room is available for only one patient at a time and one observer.

Advantages of the ambulance service are local availability, ability to reach areas inaccessible to the helicopter, and transportation during bad weather. The disadvantages include, vulnerability to poor road conditions, and traffic congestion and relatively slow transport.

Helicopter Transportation

Helicopter transportation (the state police Med-Evac Program) of critically ill patients has been effective, lifesaving, and economical by a joint program developed between the Maryland State Police and the University of Maryland (Tables 1.6-1.8). The helicopters, purchased by the State of Maryland, are in constant use for routine police work giving absolute priority to emergency medical calls channeled through the Central Communications System or direct from the scene of the accident. When practical, assignment of helicopters to regions within the state not only provide excellent coverage of an area, but also minimizes delay in response to a call. By utilizing

TABLE 1.6. Maryland Air MED-EVAC System Helicopter Use

1. Provide rapid transportation
2. Make large medical centers available to the rural community
3. Provide emergency inter-hospital transport
4. Transfer organs and drugs

TABLE 1.7. Maryland Air MED-EVAC System

The helicopter:	5 Bell Jet Ranger (2-litter capacity)
	2 Sikorsky (8-litter capacity)
Advantages:	Speed Cover great distances Areas inaccessible to land vehicles
Disadvantages:	Weather Suburban areas Cost

TABLE 1.8. *MEDI-VAC Airborne Ambulance Role*

To be effective and economical must:

1. Confine activities to an area it can serve in reasonable time limit
2. Be maintained on a full 24-hr alert
3. Maintain liaison and communication with:
 - Police departments
 - Ambulance units
 - Treatment centers
4. Proper medical facility available
5. Transport only life-threatening cases to avoid competition
6. Maintain cost effectiveness by:
 - Routine police vehicle work
 - Highest priority for evacuation of emergency critically ill

this dual role, the cost of a single patient-transportation is reduced to approximately \$42.00 per patient.

The helicopter currently used is the Bell Jet Ranger with a carrying capacity of four people including the pilot. In the event of a medical evacuation, the medical observer converts the front and back seats on one side to two stretcher supports. The observer or medical corpsman can then sit behind the pilot and administer to the patient. The craft are equipped with oxygen, i.v. fluids, an Ambu bag, suction apparatus, first aid equipment, including splints and a cardio-beeper for monitoring the heart beat in flight. More recently miniature pressure cycled respirators (approximately 6 × 8 × 4 inches) have been utilized (Logic) with success.

Continuing triage and stabilization are carried out during the flight by the medical observer or an accompanying physician.

The advantages of the helicopter are early arrival on the scene and rapid transportation, the fact that any part of the state is within 1 hour's flight time to Baltimore, and the avoidance of natural obstacles and traffic congestion. The main disadvantage is that the helicopter may be grounded during fog and bad weather, although in our experience this has resulted in grounding only on an average of 3–4 weeks per annum. In this event, recourse is made to conventional transportation services.

Medical Facility

The Maryland Institute for Emergency Medicine (MIEM) was created in February 1973 by an Executive Order of Governor Mandel and replaced the existing Center for the Study of Trauma in name. The Center had been a part of the Department of Surgery in the University of Maryland Medical School. Some of the reasons for the Institute's evolution included:

1. The new name which encompassed any life-threatening condition rather than trauma alone.
2. The massive increase in the patient load which was occurring (1972—500 patients; 1973—850 patients; 1974—1200 patients) and the complex

organization required to deal with this could no longer be contained in an orthodox medical school department.

3. Because the critical emergency patient frequently involved not only all the surgical subspecialties, but also the medical staff and the anesthesiologists and because the system was so closely integrated with communications, transportation mechanisms, life support systems and others, it was no longer realistic for it to occupy a traditional medical school slot.
4. By granting the center the independence of a true state institute, participation from physicians and other universities in the state became more feasible.
5. The new Division of Emergency Medical Services for the state required a guiding hub of medical and organizational expertise which might be centered in the Institute.

At present MIEM consists essentially of a wing of the University Hospital with a bed capacity of 32. Approximately 300 personnel are employed to operate the Institute and include 30 physicians and 145 nurses. The physicians are predominantly, but not entirely, general surgeons and are divided into five Trauma Teams, each of which also contains an anesthesiologist and a Physician Assistant. Most surgeons on the team have completed a residency training program and an experienced senior surgeon is always present. These teams provide *on the spot* 24-hr coverage and are present to meet all admissions—the surgeons await the patient's arrival rather than the reverse situation!

The Institute has its own reception areas immediately adjacent to the two operating rooms and surgery begins within minutes in an attempt to staunch hemorrhage.

An open ended admission policy is vigorously enforced and any physician in the state who requires help for what he regards as a life-threatening medical emergency is automatically provided access to the system.

Unlike many other centers, the patient population in the Maryland Program consists predominantly of blunt automobile trauma sustained outside major metropolitan areas. The statistics are briefly discussed over a 2-year period because of their relevance to eventual salvage rates.

Between January 1973 and December 1974, 1866 patients were admitted to the facility, of which 1469 suffered major trauma while the remainder had urgent surgical conditions or complications of surgery performed elsewhere. Triage was carried out either by a referring emergency physician in a community hospital, a helicopter medical observer (specially trained helicopter state trooper) or an EMT-A ambulance person. The 10% error in triage which results

is a small price to pay for the relatively inexpensive system of a paramedical triage system.

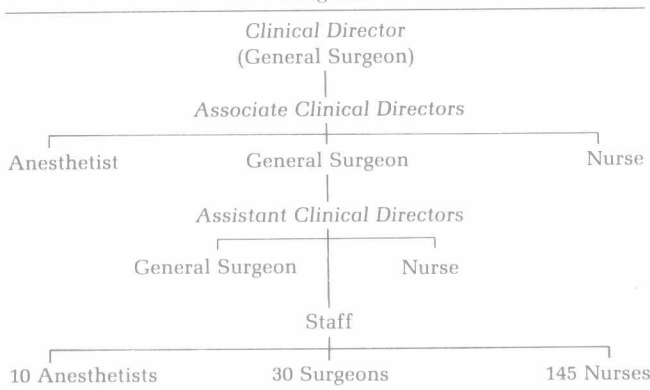
The Institute itself comprises primary care systems of health care delivery with physicians, physician assistants, and nurses divided into coordinated teams for patient care. Physical capabilities include special, centralized admitting areas immediately adjacent to dedicated operating rooms with 24-hr in-house staffing. Twelve beds are of the ultrasophisticated monitored variety, 14 are equivalent to an orthodox intensive care unit, and 6 are for recovering patients. Three hundred personnel work in the area, 30 of whom are physicians; over 145 are nurses who have or are undergoing specialized training and the remainder are administration, secretaries, and auxiliary personnel.

The Clinical Program (Table 1.9) is under the charge of a general surgeon representing the traumatologist, and the core medical staff is composed of general surgeons with a special interest and experience in trauma. They work closely with a group of full-time anesthesiologists who are structurally under the Clinical Director, as are all other medical specialties involved. The position of Clinical Director is dissimilar from most intensive care settings, in that it conferred real authority and total responsibility for the patient's medical management, surmounting the deficiencies of committee medicine.

Patient Profile

The Institute records admission and discharge data for all patients. This patient profile was stored on IBM punch cards and subsequently computerized. A number of statistical programs existed to provide a functional analysis of the system. More recently an independent clinically sophisticated digital computer system has been installed with data collection terminals at the bedside and in relevant areas such as the clinical laboratory, the resuscitation areas, the operating rooms, and the metabolic research rooms.

TABLE 1.9. Maryland Institute for Emergency Medicine Clinical Program



This facility permits the storage of all information relating to each patient in the critical care area of the unit and also allows instant recall and visual display of results and trends. Although such programs which exist elsewhere have proved of most value in data analysis and associated research, they may well prove of practical patient care value in the not too distant future.

For the purpose of this chapter, only those patients who had multiple major trauma and were transferred to the Institute within 12 hr of injury are considered.

During a 24-month period, the 1469 multiple trauma victims who were admitted to the Institute comprised 79% of the total admissions. An overall survival rate of 78% encompassed all those patients who were dead on arrival; 1032 (77%) were male and 337 (23%) were female with no statistically significant difference in the respective mortality rates. Fifty percent (742) of all admissions were 16-30 years of age and of these 139 (19%) died.

Of the 1469 acute trauma admissions, 1192 (82%) were transported to the Institute by helicopter; 277 patients arrived direct by ambulance from the scene of triage. Seven hundred twenty-one patients (48%) were referred to us from physicians in other hospitals and 748 (51%) were triaged at the scene of injury by the paramedical personnel manning the state ambulance services and the helicopters. The respective mortality in these two groups was 22.59% and 20.45%.

One thousand two hundred and eighty-six patients (88%) sustained blunt injury of which 1031 were related to road traffic accidents (Table 1.10). The remaining 255 patients, who sustained blunt trauma from a variety of causes including falls, crush injuries, etc., had a 19.61% mortality.

Only 131 (8.6%) of all admissions suffered penetrating trauma involving 98 gunshot or shotgun injuries with 22 (22.45%) deaths and 33 stabbings with a mortality of 12.12%.

Fifty-two patients (3.5%) were victims of burns, drowning, poisoning, etc. The mortality in this group was 13.45%.

Peak admissions occur at 1600-1800 hours (direct admissions), 2200 hours (direct and referred admissions) and 0300 hours (referred admissions); 60% of admissions occur at weekends or national holidays with a seasonal variation favoring the summer months.

TABLE 1.10. Road Traffic Accidents

	Total	Mortality %
Automobile occupants	815	21.84
Pedestrians	118	30.51
Motorcycles	98	10.39
Total:	1031	