

The word "trauma," derived from ancient Greek, means "wound." It is the indiscriminate killer of more than 115,000 persons annually in the United States alone. Closely allied is shock, a condition that has been described as 'a pause in the act of dying.' In the vernacular of today's specialist, trauma is considered to mean injury caused by cuts, blows, suffocation, blasts, poisons or burns. In severe cases of trauma, shock, which is a drop in blood pressure, occurs. This loss of circulating blood volume, which can be caused by several factors, means an insufficient supply of oxygen reaches vital organs—brain, lungs, heart, liver and kidneys—as well as other tissue. Research continues to seek to understand this mechanism.

The Maryland Institute for Emergency Medical Services (MIEMS) at the University of Maryland at Baltimore, has developed a comprehensive statewide system for the delivery of emergency medical care. The EMS system assures that every patient receives emergency medical care of the highest caliber regardless of time, place, type of injury or the patient's circumstances.

The Aviation Division of the Maryland State Police works within the system to provide Med-Evac helicopter services. Through the use of rotary-wing aircraft, principally the Bell Jet-Ranger, to transport critically injured patients from any point in the state to specialty care facilities in Baltimore, the program is able to vastly reduce the time required to unite the victim with definitive medical care.

The MIEMS is a product of one heart surgeon's determined regard for human life. R. Adams Cowley, M.D., had long been appalled at the inadequacy of most medical care—the indifference of medical schools to teaching about trauma, the inability of hospitals to provide essential support, and public apathy regarding the number of people who died from trauma. He became convinced that a multidisciplinary approach involving surgeons, mathematicians, biochemists, and other specialists would be required to clarify some of the enigma associated with shock deaths.

In 1956, Dr. Cowley began animal studies in an effort to discover what actually happens to the

body in shock, but his means were limited, and the need existed to study human patients. Financial support was obtained through the office of the U.S. Army Surgeon General in 1960, which permitted the development of clinical shock trauma unit. For the first time anywhere systematized, twenty-four hour data collection on the treatment and care of trauma patients was underway, and a special two-bed unit opened. In 1963, a National Institutes of Health resource grant was made available to construct a special building for the program. The Maryland legislature then voted \$1.2 million in matching funds for the construction of a center for the study of trauma.

The center is now a part of the Maryland Institute for Emergency Medical Services. Its five-story building currently includes admitting areas, diagnostic operating rooms, a twelve-bed Critical Care Recovery Unit, a sixteen-bed Intensive Care Unit and a sixteen-bed Intermediate Care Unit. MIEMS has its own clinical STAT laboratory, which operates twenty-four hours a day and is equipped to conduct approximately thirty different tests. Approximately 500 tests are performed daily. Test results are relayed by teleprinter to bedside, which places them at the disposal of the medical staff within minutes. The center also has its own research laboratories, as well as housing some of the administrative offices for the statewide EMS field operations.

The MIEMS Shock Trauma Center admits approximately 1,200 patients annually. The survival rate hovers above eighty percent. This figure becomes startling in context: every patient brought to the center is in life-threatening condition, suffering from extreme injury to at least two body systems.

About seventy-six percent of MIEMS admissions are traffic accident victims, mostly in the twenty to twenty-four year age bracket. Admissions tend to peak on weekends, nights and holidays. Seventy percent of admissions come directly from the scene of an accident. The remainder are transferred from other hospitals. Most admissions are transported by Med-Evac helicopter. When the helicopter lands at the heliport on a nearby rooftop, it is met by an

anesthesiologist and a nurse, who continue support and quickly assess injuries during a five-minute ambulance ride to the center. There the patient is met by the rest of the multidisciplinary team of doctors and nurses who are scrubbed and waiting. At least one team is always on duty, with a second on standby and a third on call.

Rapid, aggressive resuscitation follows a predetermined protocol. Emergency surgery can be performed in the admitting area, but if possible the patient is moved to an adjacent operating room. Once stabilized, patients are taken to the Critical Care Recovery Unit where their progress is closely monitored. After an average stay of five days, the patient improves enough to be moved to the Intensive Care Unit, to stay another five days, as a general rule. From the ICU, the patient may be transferred to the Intermediate Care Unit, a general hospital bed, a rehabilitation facility or a home.

The clinical staff of the MIEMS Trauma Center is special. The multidisciplinary physician staff is experienced in management of the critically ill and injured and is supplemented by consultants, i.e., other specialists from the adjacent University of Maryland Hospital. Nurses are important members of the team in each of the clinical areas. Their own expertise and judgment is essential in the care of the MIEMS patients.

Although an autonomous Institute within the University of Maryland, MIEMS cooperates closely with the University Hospital and professional schools, sharing resources and working together in education, research and patient care.

The Institute operates on a modest annual budget in the \$6 million range. Approximately eighty percent of the patients bear, through insurance, the cost of their own care, which averages about \$650 per day.

The success of the Institute can be attributed to several factors: the dedication of its medical staff, strict and rapid measures for the diagnosis and treatment of trauma and the regard for the findings of its own research into the causes of shock and trauma. Numerous diagnostic and treatment procedures have been developed at MIEMS. Also important to its success is a unique feature of the system—the simultaneous development of systems of communications, transportation and Emergency Medical Techni-

cian training, which together provide rapid resuscitation, stabilization and evacuation from the field to the Institute.

Through his early studies of shock, Dr. Cowley recognized the importance of the 'golden hour'—the first hour following serious injury. Several reputable studies have indicated the earlier treatment can be initiated, the greater the chance of prolonging life. Because many serious injuries occur in rural areas, far from definitive treatment, a means of transporting victims to care within the limits of the golden hour was sought.

Discussions with the Maryland State Police Aviation Division had begun in 1968 after feasibility had been demonstrated using military helicopters. Maryland State Police Med-Evac transports commenced in 1970, and a specially designed all-weather heliport was built adjacent to MIEMS. The helicopters were to be used mostly for police work, but Med-Evac transports were to be accorded first priority. The observer/medics on the crews completed the standard EMT-A course and took additional training at MIEMS.

The Med-Evac helicopter program was the first element added to the clinical shock trauma center as part of a program designed to establish an integrated, complete emergency medical services system in Maryland. The Maryland EMS system has grown dramatically since 1970, and is now responsible for planning, developing and coordinating all aspects of emergency medical care delivery in the state.

An EMS communications system evolved from the need to coordinate helicopter transports. Now, the System Communications Center (SYSCOM) is the first statewide system in the country linking helicopters, ambulances, central alarms, hospitals and specialty referral centers. A telephone call to SYSCOM activates the network of available medical services. SYSCOM coordinates telephone requests with specialty referral centers and Maryland State Police Med-Evac personnel.

The system assures not only that the patient may be quickly evacuated to a treatment facility previously alerted and prepared to receive him, but also that life-sustaining care will commence the moment emergency medical care personnel reach the patient. Patient medical data can be transmitted through special telemetry units

from patient-side to hospitals. SYSCOM permits medical personnel responding to an emergency to request a helicopter equipped for medical missions and to begin life-sustaining treatment by consulting with physicians at the specialty referral centers. SYSCOM coordinates activities in all the regions and offers backup communications for disasters involving mass casualties.

The Maryland emergency services system is divided into five regions, based upon patient flow patterns. Each has one or more professional regional coordinators and a volunteer Emergency Medical Services Council that assesses the region's needs and current services in the areas of ambulance and communications equipment, rescue manpower and emergency treatment facilities. These councils also coordinate all regional resources and participate in the planning of the statewide EMS system. At the interstate level, a Mid-Atlantic Emergency Medical Services Council composed of representatives appointed by the governors of Delaware, Pennsylvania, Maryland, Virginia, West Virginia and the mayor of Washington, D.C. has been formed to consider cooperative agreements for Emergency Medical Technician certification, EMS standards, reciprocity of services, regulations and reimbursement.

Public education is critical to the efficient function of the EMS system. Professionals and lay people must know how to contact rescue assistance in order to activate the system. At that point, every moment is vital.

Specialty referral centers were added to the EMS system to provide treatment for specific critical problems. The MIEMS Trauma Center receives adult patients with acute life-threatening illness or injuries. Children under fourteen are transported to the Johns Hopkins Pediatric Trauma Center. When an adult and child from the same family are injured, both are taken to MIEMS.

Other specialty referral centers include the Regional Burn Center at Baltimore City Hospital, the Hand Center at Union Memorial Hospital, the State Intensive Care Neonatal Program at Baltimore City Hospital, and University of Maryland and Johns Hopkins Hospitals.

The Institute is the top level of an Echelons of Trauma Care system. At the next level are the specialty referral centers. Helicopter transports

are flown only to the Institute and specialty referral centers. Other levels include the University Centers in Baltimore and the Area-wide Trauma Centers in each of the state's five regions. The centers at each level must meet strict requirements to be included in the system.

The clinical network of the EMS system is based on the assumption that eighty-five percent of emergency victims can be treated in local emergency rooms. The next, more serious ten percent require the more sophisticated care of the Areawide Trauma Center, to which they are transported by ground ambulance. The most critical five percent should be taken by Med-Evac helicopter to the specialty referral centers.

Med-Evac helicopters are on twenty-four hour call to transport patients to specialty referral centers, either from the scene of an accident or from other hospitals. Seventy percent of Med-Evac transports to MIEMS come directly from the scene of an accident. Maryland's ambulance and rescue squads cooperate with the Med-Evac program. Often the first on the scene, they initiate triage and resuscitation and, through the communications system, request a helicopter if they determine the victim requires the care of a specialty referral center. Mean response time from call to pickup is fifteen minutes. The ambulance team sustains the victim until the helicopter arrives and the medic/observer takes over care during the flight to the center.

When transferring a patient from another hospital to a specialty referral center, a senior MIEMS physician is available through the communications network to consult with the physician requesting the transfer. The latter is notified immediately concerning the availability of a helicopter, bed space, time of arrival and other applicable data.

The Med-Evac program is not designed to handle patient transfer except to the specialty referral center within the statewide EMS system. Similarly, it is impractical to permit any physician in the state to summon a helicopter directly, without going through SYSCOM or for use outside the system. This would rapidly saturate the air transportation system, rendering it ineffective. Due to the limited number of helicopters available, central coordination through SYSCOM is imperative. Shared usage of the craft by both medical and law enforcement authorities yields cost-effectiveness of operation. In other sys-

terms, hourly charges can peak in the \$350-per-hour bracket. Helicopters are sensitive, instruments requiring highly paid crews and prolonged downtime for maintenance. Under the present arrangement, a substantial percentage of the cost of helicopter operation is borne by the Maryland State Police. This is prorated based upon the percentage of use as a medical transport vehicle. Under this arrangement, the cost of one Med-Evac helicopter flight averages \$47.

Law enforcement flying time is spent in search and rescue for missing persons, aircraft and boats; criminal investigation support including search for escaped prisoners and persons fleeing crime scenes, general area searches for stolen cars and property that may be abandoned in

rural, wooded or isolated areas, surveillance and trailing of vehicles and persons suspected of involvement in criminal activity; aerial photography and area surveys in connection with murder, arson, etc.; route surveys and security; traffic control; security transports; support in disaster and civil disturbances; and highway patrol. Med-Evac missions always have first priority.

Of all patients transported by Med-Evac to MIEMS, the percent surviving rose from 81.6 in 1972 to 87.4 in 1976. Thus, the Maryland Med-Evac system has proven to be a very important part of a state EMS system in reducing death and disability.

Detail study: Part 2, Aviation Division, Maryland State Police, Pikesville, Maryland (acting in conjunction with Maryland Institute for Emergency Medical Services)

The Aviation Division occupies 'penthouse' offices atop the administration building at Pikesville headquarters, and divides its time 60-40 percent (as of 1976) between law enforcement duties and the medical mission, respectively. Initially, the unit was assigned responsibility for traffic and highway safety. The original equipment was limited to one helicopter, and the staff to two officers. MIEMS and the State Specialty Referral Centers are end-users of the Division's rapid airlift and delivery services at present. Fourteen helicopters—Bell JetRangers, large Sikorsky's and the Huey—in addition to one fixed-wing aircraft, are operated by the unit. The JetRanger is the primary vehicle for medical use. JetRanger crews are available twenty-four hours daily, with the Huey on call as a backup vehicle. The Sikorsky helicopters are allocated strictly to search and rescue, natural disaster work and reconnaissance, and its crews are called to duty on an as-needed basis. The eight-passenger Piper Navajo is used for extra-ditions and out-of-state VIP flights. The Division's rotorcraft burn Jet A fuel, a refined kerosene and direct operating costs have stabilized at an economical fifty-nine dollars per hour.

The stated purpose of the aerial evacuation program is provision of air transport to the critically ill or seriously injured patient whenever this mode of transportation would be the

most rapid and efficacious. In 1969, initial funding was allocated under a Department of Transportation pilot project which, in accordance with the provisions of the Highway Safety Act, took the form of a descending federal grant for three successive years. At the end of the third year, the program reverted to state funding and this has been continued in the period since.

There are seven Specialty Referral Centers: Maryland Institute for Emergency Medical Services, Johns Hopkins Pediatric Trauma Center, Baltimore City Hospital, Regional Burn Center, Washington Hospital Burn Center, State Intensive Care Neonatal Program at Baltimore City Hospital, University of Maryland Hospital, Johns Hopkins Hospital and Union Memorial Hand Center.

Areas of police responsibility are defined as 'sections.' At present, there are three in operation: Baltimore, Maryland; Washington, D.C.; and Frederick, Maryland. These are manned around the clock. However, if only one flight crew is available, coverage of Baltimore is given priority; the District of Columbia is assigned to secondary coverage; and Frederick, third.

Current operational strength of the unit stands at twenty-three pilots and twenty aerial observers, for a total staff of forty-three. The unit

commander reports to the Operations Bureau, which in turn reports to the Superintendent of Police. Officers attached to the Aviation Division are highly-trained to a man. Pilots must hold a commercial helicopter rating. One thousand flight hours logged in turbo-powered helicopters is a desirable criterion, but is not mandatory. All pilots are drawn from police ranks, however, the applicant with suitable qualifications is not necessarily guaranteed entry into the unit. The team concept, as elsewhere within the law enforcement area of rotorcraft operation, is of prime importance to the smooth conduct of this sensitive, and often harrowing mission.

Each crew is composed of a pilot and medical observer, both of whom are uniformed policemen. The medical observer is required to hold an Emergency Medical Technician rating which is granted after the successful completion of an eighty-four hour course of instruction.

After graduating from the police academy, an officer may apply for pilot duty with the Division, however, a recommendation by his commander must accompany the request. If accepted, the officer enters the unit on a temporary basis, and undergoes a seventy-five to 100-hour period of training. His flight instructor determines the point at which the initiate is ready for a final check flight, and as a result of this test the applicant is either accepted or rejected for assignment to the Division.

Following the accumulation of 150 flight hours of training within the Division, the entrant becomes a line pilot. All Division pilots are supervised continuously. Each pilot must pass a quarterly check ride, and an annual full flight crew evaluation. Check rides include both open and closed book exams, an oral exam and a flight check on each type of helicopter for which he is rated. Often, spot checks are performed to ensure proficiency.

Observers undergo special medical training, however, pilots are not trained in this area. Following completion of Emergency Medical Technician training, the observer attends training at MIEMS for one week on trauma, spends one day at Baltimore City Hospital's Burn Center and two days at the Neonatal Unit of University Hospital. Observers are given continuing training in the form of an annual one to four-day exposure at each of these three facilities. Each must be re-certificated every three

years in order to obtain a Maryland Emergency Medical Technician (Ambulance) certificate. A total of twenty-two hours of annual training is received by each observer, at the termination of which he must pass a test with a score of eighty or higher. There are very few failures despite the difficulty of the course.

Police instructors are given instruction in CPR (cardiac pulmonary resuscitation, or closed chest massage), in the digital readout of blood pressure, they are trained to read various types of heartbeat by attaching a device to the patient's finger (other methods are useless due to the noise level generated by the main rotor blades) and they are rated to give intravenous injections in order to offset shock and a loss of blood, among other basic techniques that are employed at the scene. The basic injection given on-site is a .5% dextrose-.045% sodium chloride solution, and lactated ringers. Medical observers ride with the patient and give oxygen, IV fluids and basic life support treatment while en route to the primary medical care facility. Esophageal airways and shock trousers are also included as essential medical equipment.

Each man pulls an eight-hour shift, of which there are three established to permit twenty-four hour operation of the Division: 11-7, 7-3 and 3-11. Average flight time per shift is 2.5 hours, but each airborne unit is authorized to fly for the full eight hours if necessary.

Hotlines have been established to connect each of the State Police barracks, and sections are equipped with radio equipment and staff monitors. Often, the County Fire Board contacts the unit directly, however, calls may come into the unit through county monitoring channels and sheriff's departments, natural resources channels or calls from the general public.

Hospital and infant transfers are coordinated through SYSCOM (Systems Communications Center). The unit does not handle the transfer of patients from one hospital to another except in cases of extreme need, and in all cases police participation is dependent upon the seriousness of the injuries. Most are the result of automobile accidents.

With bases in three locations, soon to be five, Med-Evac responds to calls from anywhere in the state. Within the Baltimore city limits, transfers to speciality referral centers are made by

ground ambulance. Acting on the belief that there is—despite studies which have attempted to pinpoint this statistic—no legitimate means of determining the value of a human life, the unit responds to all incoming calls. It prefers to err on the side of caution. If the presence of the police helicopter is found to be superfluous, the it returns to base.

There are no special incentives provided to members of the Aviation Division—no salary differential, no additional fringe benefits—but the hours are long and overtime rates are paid when an officer must remain on duty beyond the normal tour. Rather, it is a love of flying that, more often than not, draws the applicant into this field and the opportunity to provide assistance to fellow human beings.

But the patina of glamour may be quick to fade as the officer finds himself in direct confrontation with the horror of a serious automobile accident or other human tragedy that leaves him grimy and smeared with blood. This might be considered hazardous duty, mitigated only by the natural tendency of the public service sector, and the rotorcraft industry, to attract people with a strong sense of obligation to the job.

Despite the high percentage of Aviation Division duty that is absorbed by law enforcement duties, priority is assigned to the medical mission. Criminal surveillance, observation for evidence of garbage dumping by ships in the bay, control of violators of FAA regulations, search for armed robbery suspects, surveillance over traffickers in narcotics and abortion rings and an occasional assist to the Baltimore City Police during periods when they experience downtime for maintenance are normal duties. There are many more that are performed as a matter of routine.

Police rotorcraft are assigned to searching for reported overdue boaters during the warm months, skaters on thin ice and other public service functions. They have performed airlift operations, aided in the evacuation of those stranded by snow and perform an average of twelve rescue missions annually in the area of Great Falls along the Potomac River. Some bizarre crimes are handled by the unit, and the unit responds to a maximum of seven to ten suicide attempts per year. Police helicopters are equipped with a 'night sunlite' that provides a 3.5 million candlepower beam capable of

illuminating a football field from an altitude of 1,000 feet and, using this capability, act as a backup for ground units. Additionally, Division members are periodically assigned to make spot checks at various in-state airports, inspecting civilian aircraft for registration and safety violations.

Most of the publicity received by the Division originates with its Med-Evac mission. Several states have sent representatives to Maryland as observers, with a view to the establishment of similar programs. Representatives from Sydney, Australia have also shown interest in the program. North Carolina is presently contemplating the establishment of a medical evacuation program capitalizing on experience gained by the Maryland unit.

There have been few noise complaints since establishment of the Division. In 1975, the unit logged 3,000 takeoffs, with fewer than five complaints. Demonstrations to public groups and educational programs are conducted on the thesis that the more knowledgeable the public, the more receptive and cooperative they become toward the helicopter operation.

Computerization has been largely bypassed by the Division's recordkeeping personnel, and will not be introduced into the unit until the patient load approaches 5,000-6,000 annually. Over the next two to five years, it is expected that personnel strength will expand from forty-three to eighty officers. The Maryland legislature requires periodic cost-effectiveness reports from the Aviation Division, and the Division must justify its crews.

Statistical starvation has begun to affect the Division: a sheer lack of data on other law enforcement aviation units presently active around the United States. There is a need for additional training syllabuses, and further education in the cardiac area. It is generally felt that aerial observer training should be upgraded to the CRT (Cardiac Rescue Technician) level due to the need to administer drugs and analyze heart malfunctions in more acute cases.

The American Medical Association claims that the average survival rate nationwide is forty percent. The MIEMS program averages eighty to eighty-one percent, double this average. Division helicopters continuously strive to transport patients—whether from the accident scene or

from an outlying hospital—within the 'golden hour.'

It is of importance to note that the value of human life is recognized by Maryland funding sources for fiscal purposes. The lifesaving mission of the unit is used as a statistical base rather than dollars-and-cents mathematics.

This particularly high regard for life might well serve as an example in developing the practical philosophies of other organizations wishing to establish similar programs.

In fairness to the man on the street, it should be reported that the Maryland State Police have recently implemented a new system for speed detection from the air throughout the network of beltways and main arteries within its jurisdiction. A trooper is taken aloft by helicopter, and clocks the time an apparent violator enters a pre-marked quarter-mile expanse of roadway. The stopwatch clicks again as the vehicle exits. A description of the speeding vehicle is reported to a ground squad, who make the apprehension.

However, the men and women of the Aviation Division have been endowed with an elite status by the general public, and perhaps for good reason. Their job skills and knowledge are superior to their street counterpart, and continuing specialized training is mandatory for all members of the Division. Flexibility, constant change, awareness of current developments, teamwork and esprit de corps characterize the Division.