

# Trauma

*Accidental and intentional injuries account for more years of life lost in the U.S. than cancer and heart disease. Among the prescribed remedies are improved preventive efforts, speedier surgery and further research*

by Donald D. Trunkey

**T**rauma is the medical term for a personal injury or wound. Including both accidental and intentional injuries, physical trauma is the principal cause of death among Americans between the ages of one and 38. In 1982 there were about 165,000 deaths from trauma in the U.S., and for each death there were at least two cases of permanent disability. Statistics compiled by the Department of Health and Human Services indicate that for Americans between the ages of 15 and 24 the combined death rate from motor-vehicle accidents, homicides and suicides has risen by 50 percent since 1976. Among young whites motor-vehicle accidents are the leading cause of death, accounting for about 40 percent, whereas among young blacks homicide is the leading cause of death, accounting for approximately the same percentage. In large cities black males have a one-in-20 chance of being murdered before the age of 30. Increased urban violence has been a major contributor to the rise in the national homicide rate: from 8,464 in 1960 to more than 26,000 in 1982. Overall the death rate for American teenagers and young adults is 50 percent higher than it is for their contemporaries in other industrialized societies.

Because trauma primarily affects people at or near the beginning of their most productive work years, its cost measured in lost productivity from both death and disability is high: more than \$63 million per day in lost wages from accidental trauma alone, according to a recent estimate by the National Safety Council. The total annual cost of accidental trauma, including lost wages, medical expenses and indirect work losses, comes to about \$50 billion.

Trauma patients currently take up a

total of about 19 million hospital days per year in the U.S., more than the number needed by all heart-disease patients and four times the number needed by all cancer patients. In the past decade the death rate from heart disease and stroke has fallen by 22 and 32 percent respectively. In contrast the death rate from accidents has risen by about 1 percent per year since 1977. Trauma is clearly a major medical and social problem in the U.S. To a large extent, however, it is being neglected by physicians, hospital administrators, government officials and the general public.

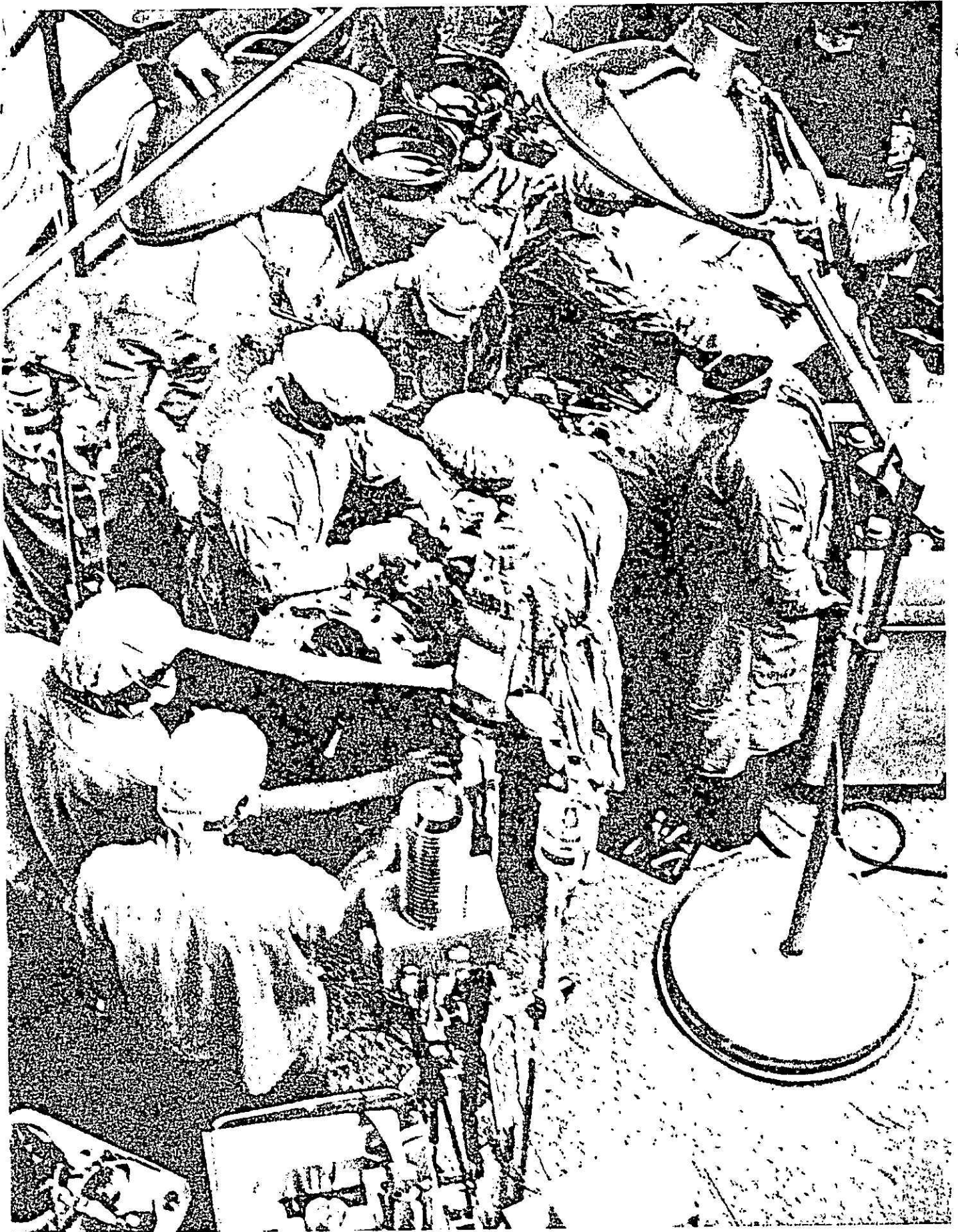
Data from several parts of the country show that death from trauma has a trimodal distribution: when the death rate is plotted as a function of time after injury, three peaks appear in the resulting graph [see illustration on page 31]. The first peak, characterized as "immediate deaths," represents people who die very soon after an injury. Invariably these deaths are caused by lacerations of the brain, the brain stem, the spinal cord, the heart or one of the major blood vessels. Only a fraction of the patients in this category could in principle be saved, even under the most favorable medical conditions.

The second peak, characterized as "early deaths," represents people who die within the first few hours after an injury. These deaths are usually caused by major internal hemorrhages of the head, the respiratory system or the abdominal organs, or by multiple lesser injuries resulting in severe blood loss. Almost all injuries of this type are considered treatable by currently available medical procedures. The interval between injury and definitive treatment, however, is critical to the probability of recovery.

The third peak, characterized as "late deaths," represents people who die days or weeks after an injury. In almost 80 percent of these cases the cause of death is either infection or multiple organ failure. Here time is less of a factor than the quality of medical care and the extent of medical knowledge. In what follows I shall discuss the pathology of each peak in somewhat greater detail, with particular reference to the prospects for reducing the rate of mortality and disability resulting from the associated set of medical conditions.

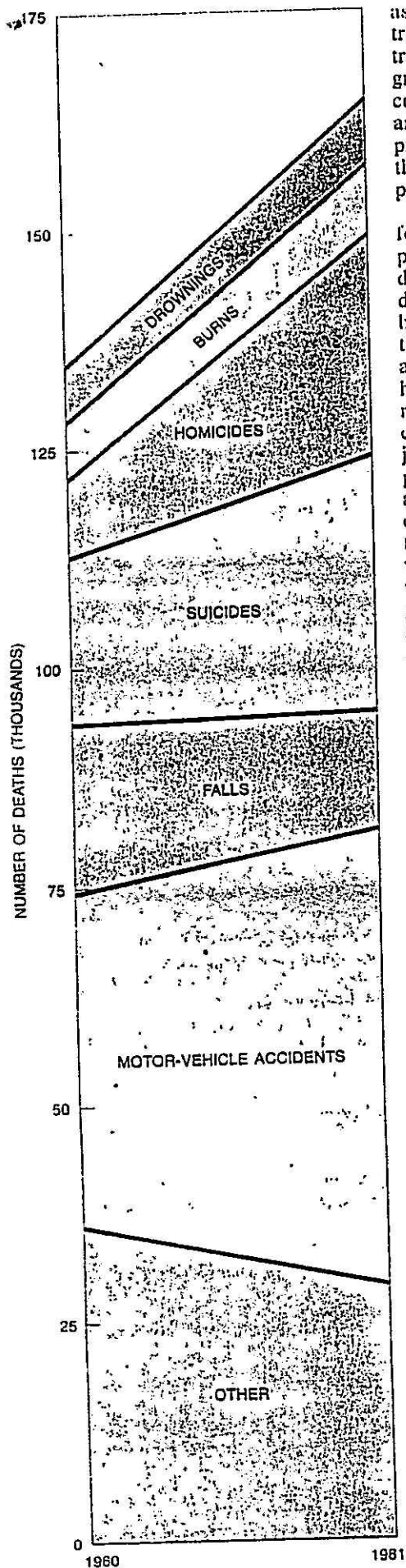
**M**ore than half of all trauma deaths are classified as immediate. The small number of patients in this category who could be saved are those in the few large cities where rapid transportation is available and special facilities called trauma centers are in operation. A trauma center is a hospital where the medical staff has made a commitment to provide 24-hour "in house" coverage by surgeons, anesthesiologists and supporting staff to care for trauma patients. Recent medical records from two of these centers, one in Seattle and the other in San Francisco, indicate that if there are signs of life at the scene of an accident or on the way to the hospital, 20 percent of the patients who are classified as "dead on arrival" can be resuscitated in the emergency room and will eventually leave the hospital without permanent neurological damage.

This remarkable rate of recovery will probably never be achieved in most suburban and rural settings, because of the longer time it usually takes there between injury and definitive treatment. The only way to reduce the number of immediate deaths in these circumstances is through prevention. Perhaps



**OPERATING ROOM** at San Francisco General Hospital is the scene of efforts by surgeons, anesthesiologists and other specialists to treat a critically wounded patient. Medical records from trauma

centers established in such major metropolitan hospitals indicate that the elapsed time between an injury and definitive surgical care is a critical factor in determining the survival rate of trauma victims.



as many as 40 percent of all deaths from trauma could be averted by the introduction of various prevention programs. Most of these programs involve controversial social issues, however, and so their chances of success are unpredictable. I shall cite here just a few of the more important trauma-prevention programs that have been proposed.

According to the Insurance Institute for Highway Safety, between 50 and 60 percent of the fatal motor-vehicle accidents in the U.S. are caused by drunk drivers. Efforts to reduce drunk driving by increasing the penalties for infractions have generally failed in the U.S., and similar programs in Europe have had only mixed results. For example, reports from a number of Scandinavian countries indicate that after mandatory jail sentences for drunk driving were imposed a significant reduction in fatal accidents was observed. In time, however, there was usually a reversion to the same mortality rate that had prevailed before the stronger measures were introduced. Rehabilitation programs for drunk drivers, introduced in several parts of the U.S., have also been found to be ineffective.

In spite of this generally negative record there is some evidence that the suspension or revocation of a driver's license after a drunk-driving conviction can have a significant effect on the subsequent rate of drunk-driving arrests in the affected population. Recently a "grass roots" group called Mothers against Drunk Drivers (MADD) was organized in California to promote such stronger measures to reduce the carnage caused by drunk drivers. The impact of this campaign, which is now spreading to other parts of the country, remains to be seen.

Another vexing social issue with a bearing on the current rate of trauma focuses on the mandatory use of safety devices such as automobile seat belts and motorcycle helmets. Legislation requiring the use of seat belts has been introduced in at least 20 countries. The results of these measures vary, depending on the degree of enforcement and compliance. So far the best record has been achieved in Australia, where after a law was passed requiring the use of seat belts there was a 27 percent decrease in the death rate from motor-

vehicle accidents. Mandatory seat-belt legislation has not been popular in the U.S., however, in part because of the active resistance of groups opposed to such forms of Federal regulation.

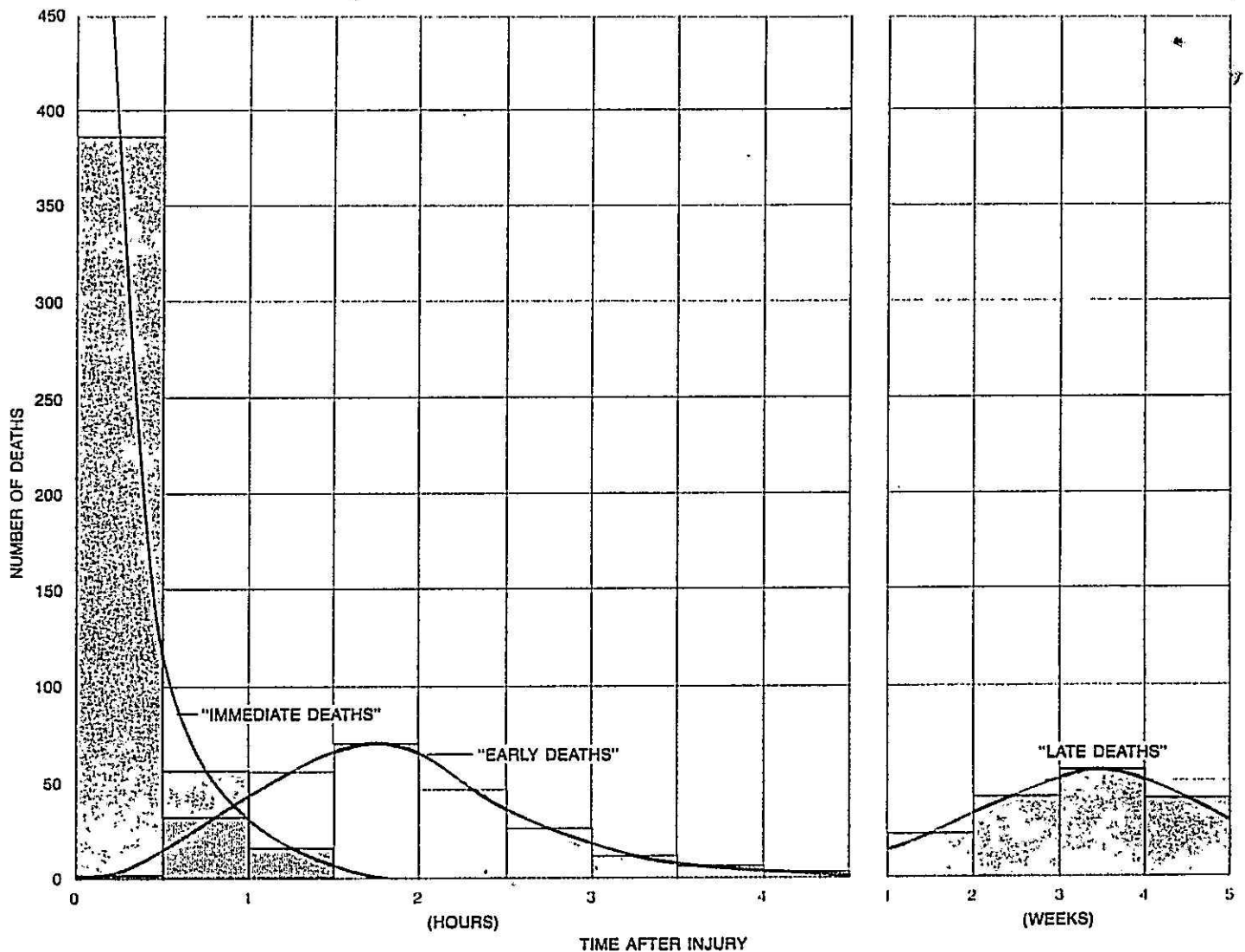
The situation is equally unsettled in the case of laws requiring the use of motorcycle helmets. Beginning in 1967 a Federal highway-safety standard required that all states enact and enforce motorcycle-helmet laws. In the next decade fatalities from motorcycle accidents decreased by 50 percent nationally. Then in 1976 Congress revoked the sanctions against states not in compliance with the Federal standard. Over the next three years 27 states repealed or weakened their motorcycle-helmet laws. The result so far has been a 40 percent increase in the death rate from motorcycle accidents in those states. A recent study sponsored by the National Highway Traffic Safety Administration concluded that "the use of a safety helmet is the single most critical factor in the prevention or reduction of head injury" from motorcycle accidents.

The burden placed on society by un-helmeted motorcyclists can be demonstrated. In one study of 71 motorcyclists admitted to Denver General Hospital it was found that only 38 percent were covered by commercial medical insurance or workman's compensation; most of the unpaid bills were borne by the taxpayers. Similarly, in a survey done at the Maryland Institute for Emergency Medical Services it was found that 40 percent of the 65 motorcyclists hospitalized did not have insurance coverage.

Perhaps the most controversial trauma-prevention issue in the U.S. is that of handgun control. According to advocates of greater restrictions on the availability of handguns, more than 11,000 of the 26,000 murders recorded in the U.S. in 1982 were committed with such weapons. In addition, suicides and accidents involving handguns accounted for at least 10,000 deaths. Both figures are extraordinarily high, particularly in comparison with other industrialized societies, where handguns are controlled. There are at present some 60 million handguns in the U.S., and it can be argued that it would be difficult, if not impossible, to eliminate them entirely, even if the political will to do so were to prevail in Congress. In the meantime other approaches to handgun control, such as the institution of mandatory jail sentences for the criminal use of a handgun, might help to reduce the death rate from gunshot wounds. Laws of this kind have been passed in several states, and the results, particularly in Michigan, seem to be quite positive.

Another controversial issue is that of the decriminalization of narcotic drugs. In the 15 years that I have worked

**TRENDS IN MORTALITY** from trauma in the U.S. are plotted according to the cause of death in this graph, representing data gathered by the National Center for Health Statistics. The figures for 1960 are either actual totals for that year or averages for the period from 1952 through 1963; figures for 1981 are based on a 10 percent sample of that year's deaths.



**TRIMODAL DISTRIBUTION** of trauma deaths is observed when the death rate for a large enough sample of such deaths is plotted as a function of time after injury. The first peak (*"Immediate deaths"*) corresponds to people who die very soon after an injury; the deaths in this category are typically caused by lacerations of the brain, the brain stem, the upper spinal cord, the heart or one of the major blood vessels. The second peak (*"Early deaths"*) corresponds to people who

die within the first few hours after an injury; most of these deaths are attributable to major internal hemorrhages or to multiple lesser injuries resulting in severe blood loss. The third peak (*"Late deaths"*) corresponds to people who die days or weeks after an injury; these deaths are usually due to infection or multiple organ failure. The graph is based on a sample of 862 trauma deaths recorded over a two-year period by the author's group at San Francisco General Hospital.

as a surgeon at the University of California at San Francisco General Hospital Medical Center the number of victims of penetrating trauma (primarily gunshot and stab wounds) has increased to approximately 40 percent of the total trauma caseload. Almost all of these injuries are related to drug trafficking. Most drug addicts must pay for their habit by illegal means, and violent crime is a common recourse. The decriminalization of drugs could help to solve at least this part of the drug problem.

Supporters of decriminalization argue further that the prevalence of drug abuse is not significantly dependent on the legal status of the drug in question. The experience of this country in the 1920's suggests that the consumption of alcohol was not reduced by prohibition; indeed, it may even have been increased.

There is no reason to believe drug abuse would be greatly affected one way or the other by decriminalization. What is certain is that many of the negative social effects accompanying drug abuse would be alleviated.

Finally, there is the problem of burn injuries, which in many respects is representative of the larger trauma-prevention problem. More than two million Americans per year suffer from burns of one kind or another, and of them some 70,000 are admitted to a hospital. Of the latter group 8,000 or so eventually die of their burn injuries. More than a third of these deaths are attributable to cigarette smoking. The average American cigarette contains additives in both the paper and the tobacco that cause the cigarette to burn for approximately 28 minutes. If these additives were omitted, the

cigarette would burn out in less than four minutes. As it happens, most furniture, upholstery and mattresses made in the U.S. need more than four minutes' exposure to a burning cigarette for ignition. The problem and the solution are obvious. Omitting the incendiary additives from cigarettes would not change the taste of the cigarette smoke, but it would make smoking safer by reducing fire-related deaths, disabilities and property losses.

Of course, the cigarette manufacturers are not about to remove these additives voluntarily. That change undoubtedly calls for Federal legislation. Just as in the case of motor-vehicle accidents caused by drunk driving, fires caused by cigarette smoking bring death and disability to innocent people as well as to the individuals responsible for the acci-

dent. Beyond the question of controlling cigarette additives, other burn-prevention proposals call for measures to promote such practices as the manufacture of flame-resistant clothing, the installation of smoke alarms, the shortening of cords on appliances and the reduction of water-heater temperatures to prevent scalds of small children.

Although the preceding discussion is not a complete catalogue of trauma-prevention issues, it does indicate some of the problems such proposals face in the U.S. Clearly these issues are complex and impinge on long-established social customs. Nevertheless, prevention remains the only feasible way to reduce the toll of immediate deaths from trauma. It is not only the most effective way to save lives but also the cheapest: crisis intervention after the fact is always expensive. Ultimately prevention could also help to reduce the other two death peaks from trauma, topics I shall now address.

Roughly 30 percent of the deaths from trauma fall into the category of early deaths. This category can in turn be subdivided into two major pathological conditions: neurological injuries and various kinds of hemorrhage. According to a recent nationwide survey of head and spinal-cord injuries, head injuries account for about .2 percent of all hospital admissions in the U.S. On this basis one can calculate that roughly 34,000 cases of traumatic intracranial bleeding are treated annually in the U.S.

The results of another recent study, done by a group at the Health Sciences Division of Virginia Commonwealth University, point to the need for prompt management of such head injuries. The

Virginia group found that if surgical intervention for intracranial bleeding was delayed for more than four hours after an injury, the most probable outcome was death or permanent disability. If definitive surgical care was provided within four hours after an injury, however, the likelihood of a favorable outcome was significantly enhanced.

The need for prompt, definitive surgical intervention is also critical in the treatment of patients with injuries resulting in hemorrhage. For the sake of discussion hemorrhage can be divided into three grades: severe, moderate and minor. In cases of severe hemorrhage the rate of blood loss exceeds 150 milliliters per minute. In the first 10 minutes of severe hemorrhage the patient will lose at least 1,500 milliliters of blood, or roughly a third of his blood volume. If this rate continues unchecked, the patient will lose more than half of his blood volume within 20 minutes of the injury. In such cases little can be done in the prehospital setting to control the hemorrhage. Prompt, definitive surgical care offers this patient his only chance of survival.

In cases of moderate hemorrhage the bleeding rate is between 30 and 150 milliliters per minute, and there will be a life-threatening blood loss within an hour of the injury. Rapid transport of the patient to a place where prompt surgical intervention is available is also the preferred treatment. Patients with minor hemorrhage (bleeding rates of less than 30 milliliters per minute) may have the "luxury" of an hour or more before surgical intervention is necessary. In addition intravenous lines started in the prehospital setting may keep up with the bleeding. In any case the main point re-

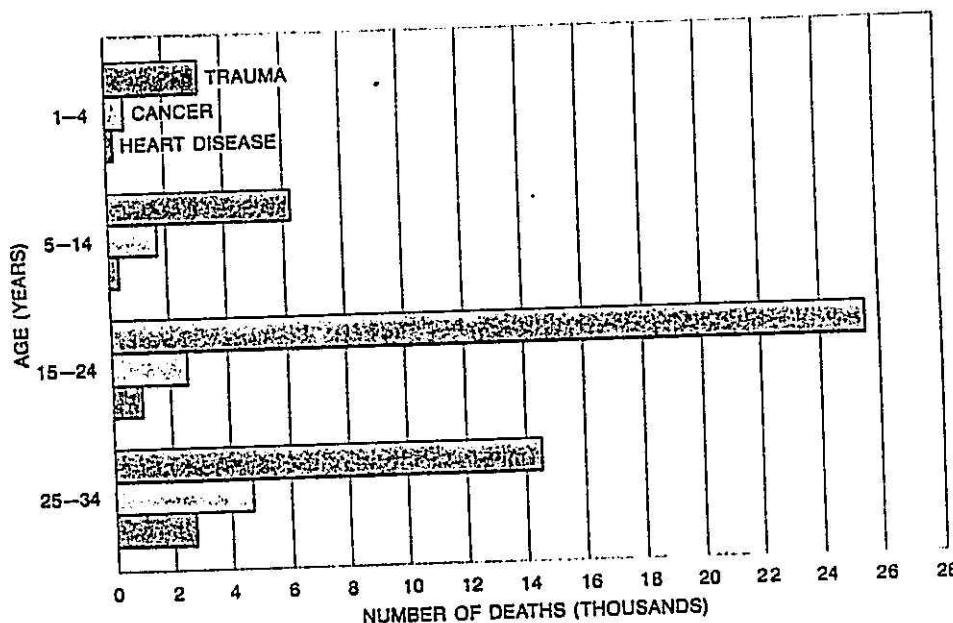
mains that many early deaths from trauma could be prevented by rapid transport of the injured patient to a trauma center.

Are trauma patients in the U.S. receiving the kind of timely medical care these studies indicate they need? Several sources show that with the exception of a few communities having modern trauma centers the answer is no. For example, in 1960 investigators from the Surgeon General's office in Texas examined the deaths of 606 soldiers injured in accidents and treated in community hospitals. They found that 96 of the patients would have survived if appropriate treatment had been administered in time, and an additional 103 patients might have been saved if they had been treated appropriately. Another study, done by workers at the University of Michigan in 1969, showed that 28 of 159 patients who died as a result of trauma were inadequately treated. Still another study, reported by a group at Johns Hopkins University in 1972, showed that a third of the deaths resulting from motor-vehicle accidents involving abdominal injuries in the Baltimore area could have been prevented by prompt surgical intervention.

I have been personally involved in several studies of this kind in the San Francisco Bay area. The first study, reported in 1974, compared the death records from the trauma center at San Francisco General Hospital with those from several community hospitals in the surrounding area. The results showed that patients with injuries from motor-vehicle accidents treated in a hospital without a trauma center had a significantly greater chance of dying than those treated in the one with a trauma center. A subsequent study compared deaths caused by motor-vehicle accidents in one part of California where there was no trauma center (Orange County) with those in a part of the state that had a single designated trauma center (San Francisco). Again the outcome was significantly worse in the region without a trauma center.

The latter finding led to a follow-up study, initiated by physicians in the Orange County area. The data were re-evaluated by an independent group of general surgeons, neurosurgeons and emergency-room physicians. Their report showed that non-neurological trauma care was inadequate in the hospitals without a designated trauma center. As a consequence five trauma centers were established in the Orange County area in 1980.

Another pertinent study was recently completed by the same group. It showed that the preventable-death category in Orange County dropped from 73 percent to 4 percent when patients were tak-



THREE LEADING CAUSES OF DEATH among young Americans are compared. The mortality figures, compiled by workers at the National Center for Health Statistics, are for 1977.

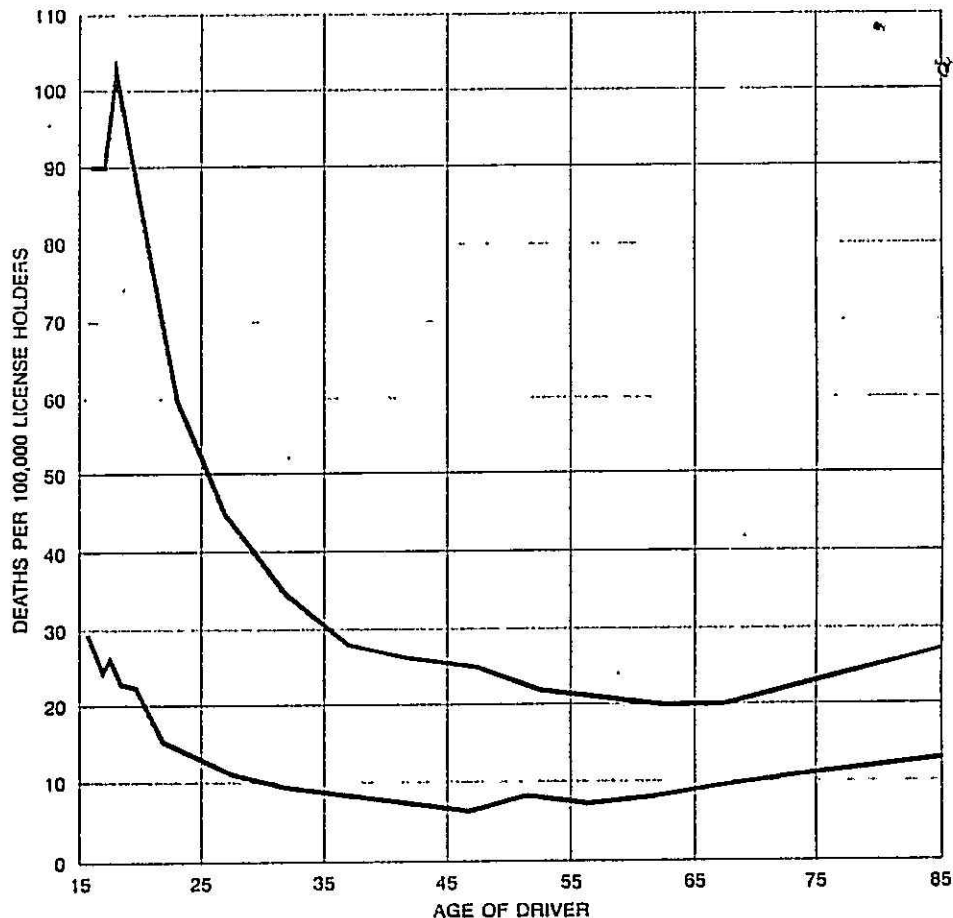
en to a trauma center rather than to a conventional hospital. Furthermore, the group found that none of the patients in the study died as a result of bypassing a conventional hospital in order to get to a trauma center. This finding emphasizes the importance of regional trauma care. Numerous other studies in various parts of the country lend further support to the conclusion that injured patients taken to hospitals without a trauma center are at a marked disadvantage. On the average the incidence of preventable deaths resulting from inadequate trauma care was found in these studies to vary between 30 and 40 percent.

Perhaps the most comprehensive study of this kind was done in 1980 by Daniel K. Lowe and his associates at the Oregon Health Sciences University. The study included 23 hospitals in a six-county region around Portland. The region has a total extent of 5,724 square miles and a population of 1,257,450, distributed over urban, suburban and rural areas. Originally 763 trauma patients were enrolled in the study; of these 104 had minor injuries and were excluded from further consideration. Of the 659 remaining patients there were 105 cases of inappropriate care, as determined by an independent trauma panel composed of general surgeons, neurosurgeons and emergency-room physicians. Of the 278 deaths registered 135 occurred in the hospital, and of these 34 were judged preventable by the panel. The latter group included 15 patients with brain injuries and 19 with various kinds of hemorrhage.

Of particular interest in the Portland results was the finding concerning the response time of the surgical consultants. In general the surgical consultants (there were 304 in all) took an average of 1.26 hours to get to the hospital after being called into the case. Neurological consultants responded somewhat more promptly: the average was .98 hour. The independent panel considered delayed response to be a significant factor in some of the cases of inadequate care. This finding draws attention to another problem: the popular misconception that any physician can treat a trauma patient adequately in a hospital emergency room. The emergency-room physician can start resuscitation, but a surgeon is almost always needed to provide definitive care. The sooner this care is provided, the better the outcome will be.

These findings all lead to one conclusion: There is a major shortfall in the delivery of trauma care in the U.S. The number of preventable deaths resulting from the existing system (or nonsystem) of trauma care is clearly unacceptable. What can be done to organize a better system of trauma care in the U.S.?

The concept of organized trauma care



**YOUNG MALE DRIVERS** account for a disproportionately high percentage of deaths from motor-vehicle accidents, as is shown in this graph of the death rate for male drivers (color) and female drivers (black). Curves, for 1978, are from the Insurance Institute for Highway Safety.

is not a new one; indeed, it can be traced back in military history to antiquity. The earliest mention of organized battlefield care is in the *Iliad*. According to Homer, Greek soldiers wounded in the fighting for Troy were carried off the battlefield and cared for in barracks (called *klisiai*) or on nearby ships. The *Iliad* contains references to 147 different wounds and implies a mortality rate of 77 percent.

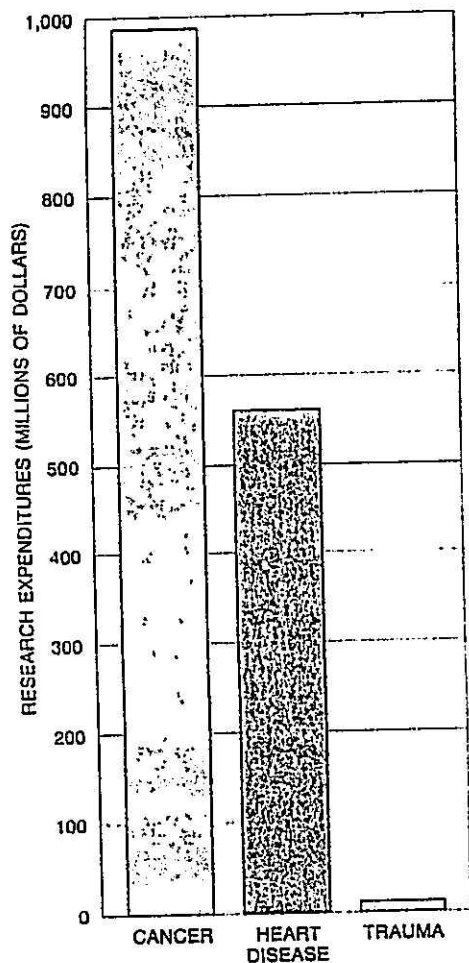
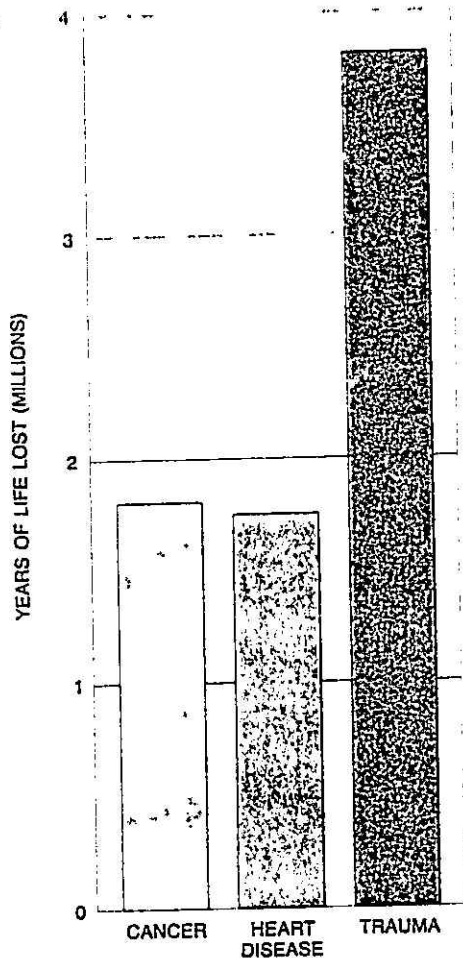
The Romans also had considerable experience with emergency care for the injured; as early as 480 B.C. wounded soldiers were reportedly assigned to the care of patrician families. By the first century A.D. special hospitals (called *valetudinaria*) had been established along the borders of the Roman Empire to care for wounded legionaries. Archaeologists have identified at least 25 of these structures, which were quite sophisticated in design.

In the early 19th century Baron Dominique Jean Larrey, the chief surgeon in the army of Napoleon, made two improvements in the care of wounded soldiers that have persisted to modern times. The first was the *ambulance volante* ("flying hospital"), an innovation that sharply reduced the time it took to provide definitive care to the wounded.

Before the advent of Larrey's horse-drawn ambulances injured soldiers often lay on the battlefield for periods of a day or more. Larrey's second innovation was to concentrate the casualties in one area and to operate on them as close to the front lines as possible.

During World War I the time lag between injury and surgery was still between 12 and 18 hours, and the overall mortality rate was 8.5 percent. The time lag was reduced in World War II to between six and 12 hours, and the mortality rate fell to 5.8 percent. Perhaps the most dramatic reduction in the time lag from injury to definitive surgical treatment came during the Korean conflict. A decision was made in the U.S. Army Medical Corps to bypass the battalion aid station and to take injured soldiers directly from the battlefield to a mobile army surgical hospital (M.A.S.H.). The average time lag between injury and definitive care during the Korean conflict was between two and four hours, and the mortality rate was 2.4 percent.

This tactic was further improved on during the U.S. involvement in Vietnam, where casualties were taken directly from the battlefield to the corps surgical hospital. According to one study, the average time lag between injury and de-



linitive surgical care was reduced to 65 minutes, and the mortality rate fell to 1.7 percent. This military experience, one might think, should have served as an incentive and a model for the improvement of civilian trauma-care systems. With the exception of a few isolated instances, however, that has not happened.

One example of excellent regional trauma care can be found in West Germany. During the late 1960's West German health officials observed the U.S. methods of providing battlefield care in Vietnam. In 1970 the decision was made to apply these procedures throughout most of West Germany, establishing trauma centers along the main autobahns. Integral to the trauma-center concept in West Germany is rapid prehospital transport, which primarily entails the use of helicopters but also includes ground vehicles. There are now 32 air-rescue stations in the country with a standard mission radius of 50 kilometers. It is estimated that 90 percent of the population are within 15 minutes of a trauma center.

More important than the prehospital system is the system of integrated trauma care within the hospitals. West German hospitals have been classified according to their ability to provide trauma care. Furthermore, there is an in-house team of surgeons in every designated trauma center on a 24-hour basis. The teams include not only surgical residents but also a chief surgeon. The other important members of the trauma team are a neurosurgeon and an anesthesiologist. The chief trauma surgeon also cares for the patient in the postoperative period, including the time spent in the intensive-care unit. Overall the quality of surgical care is excellent.

The West German system also has a strong rehabilitation program, the primary goal of which is to get the accident victim back to gainful employment as soon as possible. I do not mean to imply that the system there is perfect. Some of

the trauma centers are not as strong as they should be, but in general the system is an excellent model for the U.S.

As a consequence of this regionalized system the mortality rate from motor-vehicle accidents in West Germany has dropped from 16,000 per year in 1970 to 12,000 per year at present, a reduction of 25 percent. It is probably more than a coincidence that the magnitude of this reduction is remarkably close to the preventable-death estimate made in most American studies (between 30 and 40 percent). By applying simple arithmetic and assuming that the 4,000 additional German patients who now survive each year return to work, a rough estimate of the financial benefit to that society can be made. If one assumes that each survivor over the past 10 years now earns the equivalent of \$10,000 per year and pays \$2,500 in taxes, the gross national product of West Germany would be increased by \$220 million per year and tax revenues would rise by \$55 million. The value of a trauma center, therefore, lies not only in a reduction in deaths and disabilities but also in a positive financial contribution to society. If the U.S. were to introduce a similar system and could achieve the same reduction in mortality, then over the first 10 years this country's G.N.P. could be increased by more than \$2 billion and the additional taxes paid would amount to more than \$550 million.

The final category in this discussion, late deaths, accounts for approximately a fifth of all trauma deaths. Of these deaths 80 percent are attributable to infection and multiple organ failure. The two conditions seem to be causally related. The common risk factors that have been identified so far include shock, head injury, peritoneal contamination and malnutrition, all of which can lead to infections late in the course of a patient's injury. This development may in turn be related to the failure of the patient's immune system, but the exact causes have not been elucidated. Once infection is obvious the patient often develops progressive organ failure. The resulting mortality rate is high and is directly related to the number of organ systems involved.

The answer to the question of why the trauma patient is at risk for infection and multiple organ failure can only come from further research. Even this solution, however, is not without difficulties. At present the U.S. spends very little of its research funds on trauma. National priorities are clearly directed to cancer and heart disease, even though trauma accounts for more years of life lost than cancer and heart disease combined. One solution would be to establish a National Institute of Trauma, on the model of the National Cancer Insti-

**MISMATCH** between the cost of trauma, in terms of the number of years of life lost, and the national effort to solve the trauma problem, in terms of dollars spent on research, is particularly striking in the context of a comparison with the corresponding figures for cancer and heart disease. The bars in the top chart are based on an estimate published in the Surgeon General's report for 1975. The bars in the bottom chart are based on 1982 figures from the National Institutes of Health; they refer only to research funds spent under the auspices of the National Cancer Institute, the National Heart, Lung, and Blood Institute and (in the case of trauma research) the National Institute of General Medical Sciences.

tute or the National Heart, Lung, and Blood Institute. Such an institute could serve many purposes. It could focus on trauma both as a medical issue and as a social one. It could approach trauma in such a way as to place equal emphasis on prevention, health-care delivery and research aimed toward the solution of the late-deaths problem. It could also serve as a focus for innovative ideas in research funding. For example, since drunk driving is a major contributor to the national trauma rate, perhaps it would be feasible to devote part of the tax on alcoholic beverages to help support trauma research.

Finally, there is the problem of rehabilitation. One of the most pronounced deficiencies in trauma care in the U.S. is the lack of an integrated rehabilitation system. Most disabling injuries are caused by neurological and orthopedic injuries. With the exception of some excellent rehabilitation centers for spinal-cord injuries the U.S. has not placed enough emphasis on returning the injured patient to work. This approach should involve not only physical rehabilitation but also job retraining and treatment of the emotional trauma that often accompanies physical trauma. In order to have an effective rehabilitation system the nation must also address

some of the existing worker's compensation laws and disability-reimbursement programs. For example, an employed person or union member currently takes five times as much disability time as a person who is self-employed. Any proposed rehabilitation system must address the disincentives that affect the decision to return to work.

In summary, trauma is a seriously neglected public-health problem in the U.S. Each of the three peaks in the trimodal distribution of trauma deaths has

its own set of associated problems. If the U.S. is to achieve a significant reduction in the rate of mortality and disability from trauma, each of these issues must be addressed vigorously. The solutions will not be easy, and they will inevitably engage some controversial social issues. It is my contention, however, that the U.S. can no longer afford the present rate of preventable death and disability resulting from trauma. The search for solutions to the trauma problem must become a national priority.

**Luftrettung**

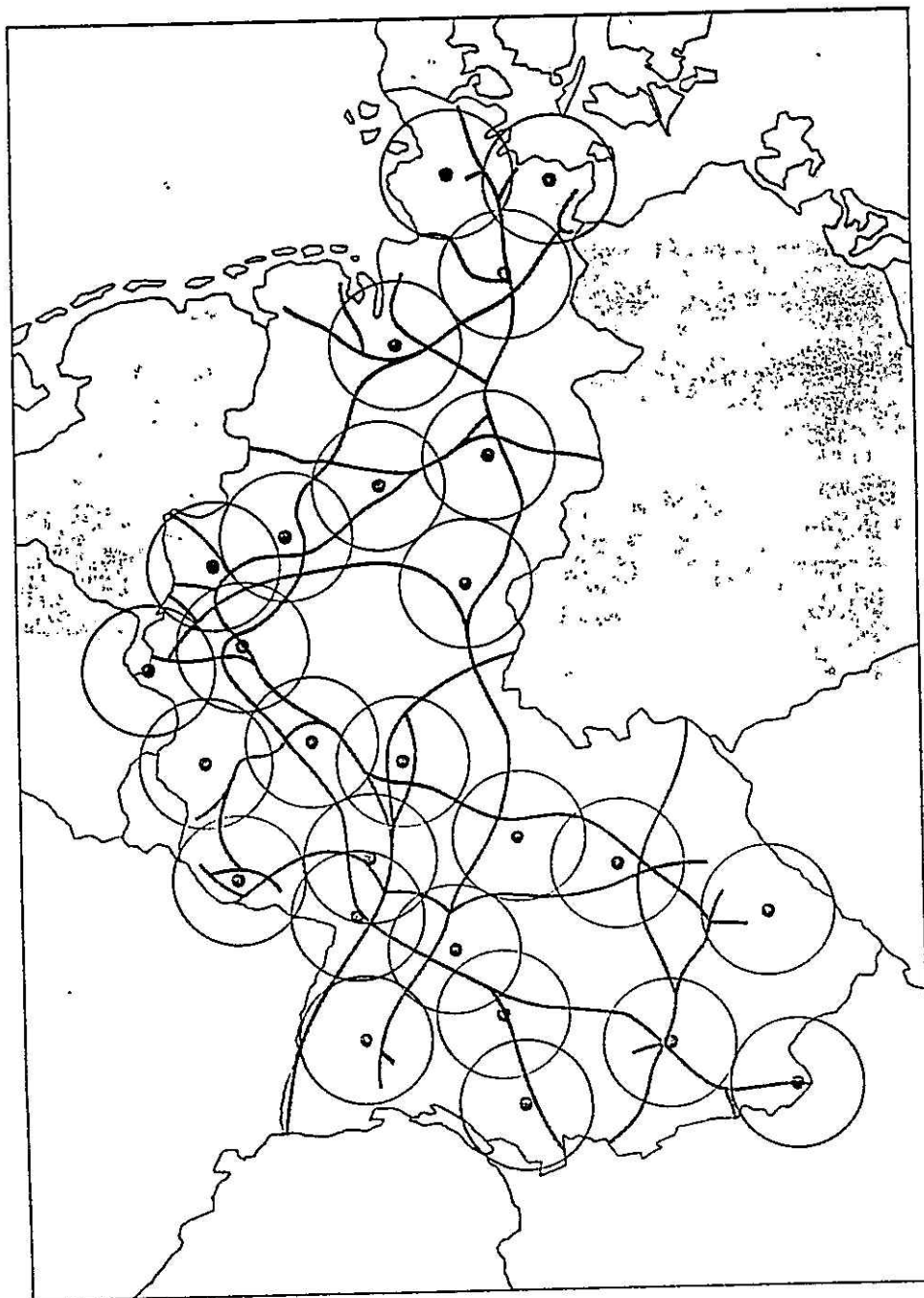
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Radius: 50 km

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 Rendsburg (04331) 27788  
 Hamburg (040) 248281  
 Bremen (0421) 30303  
 Hannover (0511) 19481  
 Rheine (05971) 3402  
 Bielefeld (0521) 69021  
 Lünen/Uena (02303) 18001  
 Göttingen (0551) 112  
 Dulsburg (0203) 63334  
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 Aachen (02473) 7000  
 Würselen  
 Kassel (0561) 12520  
 Koblentz (0611) 441033  
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 Wittlich (0261) 44100  
 Ludwigshafen (0621) 573303  
 Saarbrücken (0681) 65552  
 Karlsruhe (0721) 23332  
 Stuttgart (0711) 551044  
 Vödingen-Schwenningen (07721) 51014  
 Ulm (0731) 62222  
 Friedrichshafen (07541) 22055  
 Kempten (0831) 22222  
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**ADAC**



MODEL SYSTEM for the delivery of trauma care has been established in West Germany. In the past decade or so specialized trauma centers have been set up at hospitals along the main autobahns. Most patients are transported to the designated trauma centers by helicopter. The red dots on the map at the right designate the system's principal air-rescue stations; the red circles mark the standard

50-kilometer operating radius associated with each station. According to West German health officials, 90 percent of the population are now within 15 minutes of a trauma center. The smaller version of the map reproduced at the left is on a sticker distributed by the German automobile club ADAC. Telephone numbers accompany names of the stations; an alternative emergency number (110) is also given.



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