

what in many communities were considered "insoluble" problems. By identifying existing medical resources in community hospitals, colleges, industries, and even prisons, and by assisting in federal grant applications, the Trauma Coordinator has been instrumental in introducing ambulances of nationally accepted design criteria for the first time to many rural areas. Previously, many of these communities had no real comprehension of an acceptable ambulance. In addition to improving primary ambulance response capability, Illinois is developing a secondary transportation system which includes helicopters, fixed-wing airplanes, and mobile intensive care vans.

The lasting benefits of a medical program depend on the quality of the medical personnel providing those essential emergency services. The Illinois Program has placed a major emphasis on the training of emergency health and trauma care workers at all levels, including: the Emergency Medical Technician-Ambulance (EMT-A) and the advanced EMT-A; the trauma nurse and her educator, the Trauma Nurse Coordinator; and a new administrative professional, the Trauma-EMS Coordinator. Educational programs for emergency physicians, Trauma and Critical Care Fellows, and trauma surgeons are also being developed as postgraduate training programs. Young traumatologists, well-equipped and trained in the team approach to accident care, will further the apparent progress that is now being realized in this field.

Evaluation at all levels of the system is necessary. Illinois has pioneered in this area with the

development of a Trauma Registry (1). Data are now available which document some of the results of change in patient distribution and demonstrate the need for specialty backup as well as the allocation of critical care manpower. These studies are also pointing the way to better cost and clinical effectiveness in trauma care. These evaluation programs are being extended to measure public awareness and accessibility of entry routes into the trauma-EMS system in times of need.

In order to initiate a total systems approach to trauma and emergency medical care, a simple, practical, controlled implementation plan was developed. By defining the problem for critically injured patients, and by categorizing hospital emergency capabilities for this group, significant progress has been realized. One enthusiastic individual, agency, or association will not solve this massive problem. It will require a consortium of all interested health agencies working together rather than in competition. These participants will need to realize that individual efforts must be consistent with the overall program. This controlled systems approach is being accomplished in Illinois, where death and disability from accidental injury are no longer neglected diseases (2).

#### REFERENCES

1. BOYD DR: Computerized trauma registry (editorial). *J Trauma* 11:449-450, 1971
2. NATIONAL ACADEMY OF SCIENCES, NATIONAL RESEARCH COUNCIL, COMMITTEE ON TRAUMA AND COMMITTEE ON SHOCK: *Accidental Death and Disability: The Neglected Disease of Modern Society*. Washington, NAS-NRC, 1966

### A SYSTEMS APPROACH TO STATEWIDE EMERGENCY MEDICAL CARE

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Emergency death and disability can no longer be justifiably classified as an insoluble health

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problem. Medical expertise and technology are  
 now available which can easily and efficiently be  
 applied to this previously neglected health prob-  
 lem. In fact, it is only with the better utilization  
 of presently available resources through areawide  
 implementation that an immediate beneficial im-  
 provement can be effected in a badly organized  
 emergency health system. In Illinois, the develop-  
 ment of a Statewide Trauma Program has shown  
 that through regionalization expert care, which  
 was previously available only in the university  
 centers, can now be effectively and efficiently  
 provided throughout the state, especially in the  
 rural community. The success of the Trauma  
 Program on a statewide basis has provided the  
 groundwork for the development of a Total  
 Emergency Medical Service System in the State  
 of Illinois (4, 10).

In a special message on health care, Governor  
 Richard B. Ogilvie discussed the future develop-  
 ment of some 40 specialized centers for the care  
 of the critically injured patient to be designated  
 throughout the state (13). The Trauma Care  
 Plan was to be the first component of a Total  
 Emergency Medical Service System (2), which  
 is being developed on a controlled and system-  
 atic implementation schedule.

A controlled systems approach to the problems  
 of an emergency medical service is the most  
 practical and sensible, and will yield the most  
 return. The Illinois Trauma Care Program has  
 been developed in stages by: defining a specific  
 problem, "The Critically Injured Patient"; de-  
 veloping a plan based on established principles  
 of clinical management; and implementing this  
 plan in a systematic manner by utilizing and  
 augmenting existing care facilities, professional  
 talent, and technologic resources within a given  
 community. The Illinois Trauma Program is con-  
 tinuously monitored by a specially designed in-  
 formational system for accidental injury (1, 5,  
 8). Because of the statewide systems develop-  
 ment of a trauma care network, a healthy and  
 practical implementation environment has de-  
 veloped where problems have been approached  
 on an empirical basis and studied as ongoing  
 events by the entire health community. The suc-  
 cessful implementation of the Illinois Trauma  
 Program is now leading the way for a similar  
 regionalization of all categories of emergency  
 health care.

STATUS OF THE TRAUMA PROGRAM

The Illinois Trauma Program plan has been  
 previously reported in this *Journal* (3). The  
 trauma care program has to date been imple-  
 mented in almost every part of the state with the  
 establishment of 21 Local, eight Areawide, nine  
 Regional, and two special Regional Centers.  
 From each trauma center there has been a re-  
 organization of the communitywide patient dis-  
 tribution and referral patterns, the initiation of  
 trauma care education and training efforts for all  
 professionals and allied emergency personnel,  
 implementation of a uniform and disciplined  
 communications system, a reorientation and up-  
 grading of the transportation capability, and an  
 ongoing evaluation process for all patients  
 treated within the system.

All trauma centers are staffed by a new  
 health professional, the Trauma Coordinator  
 (11). These professionals are military-trained  
 medical personnel with many years of casualty  
 experience. These new health experts are em-  
 ployed by the Illinois Division of Emergency  
 Medical Services and Highway Safety, and are  
 located at trauma centers to assist in the various  
 administrative and managerial aspects of the  
 Trauma Program. Trauma Coordinators are re-  
 sponsible for the ongoing collection of data for  
 the Trauma Registry. They have also established  
 the basic training course for ambulance emer-  
 gency technicians. At present Illinois has the  
 largest number of nationally registered EMER-  
 GENCY Medical Technicians-Ambulance (EMT-  
 A's). Working with hospital medical chiefs of  
 staff, trauma surgeons, and administrators, the  
 Trauma Coordinators are developing improved  
 liaisons with the community and ambulance,  
 rescue, and law enforcement personnel. These  
 professionals have been instrumental in develop-  
 ing the Statewide Program at the community  
 level, and have made significant contributions to  
 the care of the critically injured by improving the  
 organization of the Illinois Emergency Medical  
 Care System.

Special educational programs for trauma care,  
 e.g., surgical grand rounds, symposiums, and  
 conferences for physicians, surgeons, and medical  
 students, nurses, and ambulance attendants  
 (EMT-A's) are being offered at the trauma  
 centers across the state. The Trauma Nurse  
 Intensive Training Course is providing post-

graduate training at the Regional Centers for nurses across the state. These nurses have returned to their communities to provide improved patient care to the accident victims at their hospitals. It is these educational efforts that will continually improve the quality of trauma and emergency medical care in every part of Illinois.

The newly expanding total emergency medical care effort is extending these educational efforts to include more centers providing the training of EMT-A's and mobile teaching vans for more remote rural communities. The trauma nurse program is expanding to include all other areas of emergency and critical care medicine. There has been the establishment of two residency programs for emergency physicians, and 20 stipends for Trauma Critical Care and Emergency Medical Services Fellows have been provided to various communities and university hospitals to support young professionals in their pursuit of special knowledge in their respective clinical fields.

#### PROGRAM EVALUATION

In the first year of operation (July 1971 through June 1972), 12,000 patients were admitted to 20 Trauma Centers with an overall mortality of 2.0% (7). The anticipated number of patients to be treated in this system in the second year is over 30,000 patients, as more trauma centers come into it.

An evaluation of the highway deaths in a 15-county area of central Illinois has shown significant results (6). All highway or vehicular-related deaths of calendar year 1971 and of the first 6 months of 1972 in Region III-A of Illinois were studied. Region III-A, an 18-county area in central Illinois, was chosen for this study because of the initiation of the Statewide Regionalization Program in this area. In the well-defined central 15-county portion of this area, four trauma centers were designated between 1 July and 1 December 1971.

The patient distribution of all vehicular-related deaths in this area has been studied for the effects of regionalization of patient care for the critically injured. The special emphasis of this report is the effect of the changing character of patient redistribution and the time constants surrounding these changes. There are 290 patient deaths in this study. Information for evaluation was obtained from the hospital and emer-

gency records, autopsy reports, records from the Illinois Highway Department, State Police Department, Department of Vital Records, and county coroner reports. These patient records were investigated in detail. Special emphasis was placed on vital statistics and epidemiologic information (including time and transportation factors when available), status of the patient on admission, time and type of operation, area of injury, organ involvement, and major contributing cause of death. All patient information was entered into a computerized informational system, the Trauma Registry, which utilizes direct entry and retrieval through remote video terminals.

A highway fatality study was chosen to establish baseline data for future evaluations. One major problem in evaluating this new program is that of obtaining baseline information. The study period includes the first year of operation, July 1971 through June 1972, and the 6-month period just prior to this. Coroners' reports, state police records, and autopsies from the pre-program (control) period, January to June 1971, were analyzed to provide the baseline data of this study. This information, along with the hospital and emergency patient records from the established trauma centers, was utilized. Three cases in this study, in which conclusive evidence with regard to the mechanism of injury (vehicle) could not be determined, are not included in this report. Several terms are used in this study relating to time/death factors. An accident victim who was killed instantaneously or died within minutes at the accident scene is defined as "Dead at Accident" (DAAC). "DOA" refers to a victim who was considered alive during transportation but died before arrival at a hospital emergency room and was pronounced dead on arrival. All other patient deaths in this study occurred after hospital admission.

#### MORTALITY EVALUATION

##### PATIENT REDISTRIBUTION

Evaluation of the Trauma Program has shown several positive findings in the first year of operation. The 290 deaths studied were divided into three groups: 1) the pre-program period from 1 January to 30 June 1971; 2) the program implementation period for 1 July to 31 December 1971; and 3) the first 6 months of full operation



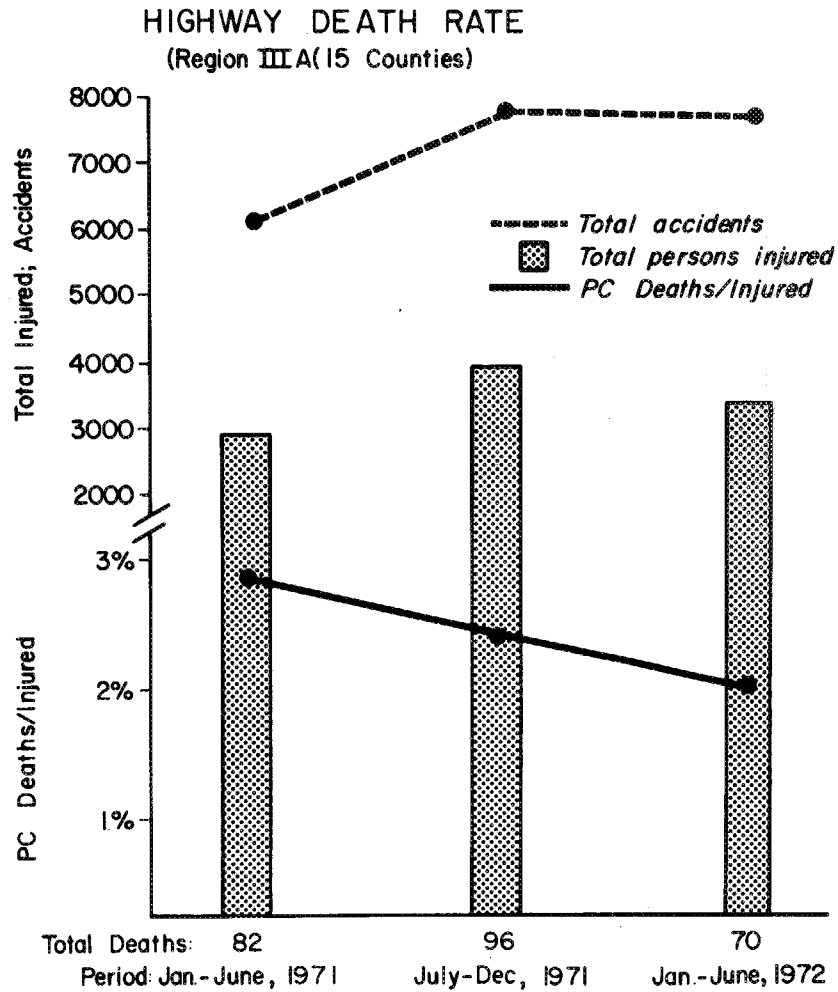


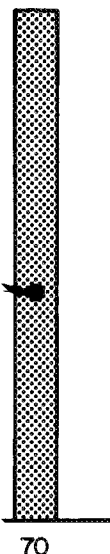
FIG. 1. Highway accidents, injuries, and mortality. Note the increase in the number of accidents (auto) and injuries (individual) during the study period. The percentage of patient deaths per individuals injured (PC Deaths/Injured) has decreased from 2.8% to 2.1% in this study period.

regionalization of care, and, more recently, the development of a uniform communications system upgrading the transportation capability, and establishment of lay and professional educational programs. These subsystem components have been sequentially integrated into the trauma system over the past year, and will be evaluated for their effectiveness in the very near future.

The Trauma Program has identified the terms Regional, Area-wide, and Local for trauma centers (Fig. 3). These definitions are now being broadened in scope to include the entire community. The level of clinical care capability,

communications and transportation resources, and educational potential are now taking on a community and area-wide significance for all other categories of emergency medical care. The development of a Regional Health System has been an exciting proposition, and its benefits have been anticipated for some time. The State of Illinois has embarked on a Regionalization Program for the Care of the Critically Injured Patient, and is now developing a similar program on a wider spectrum for all emergency medical care. Program development and overall results will require adequate monitoring and documentation with supportive evidence. On-line data

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### TIME DEATH INDICES (Region III A (15 Counties))

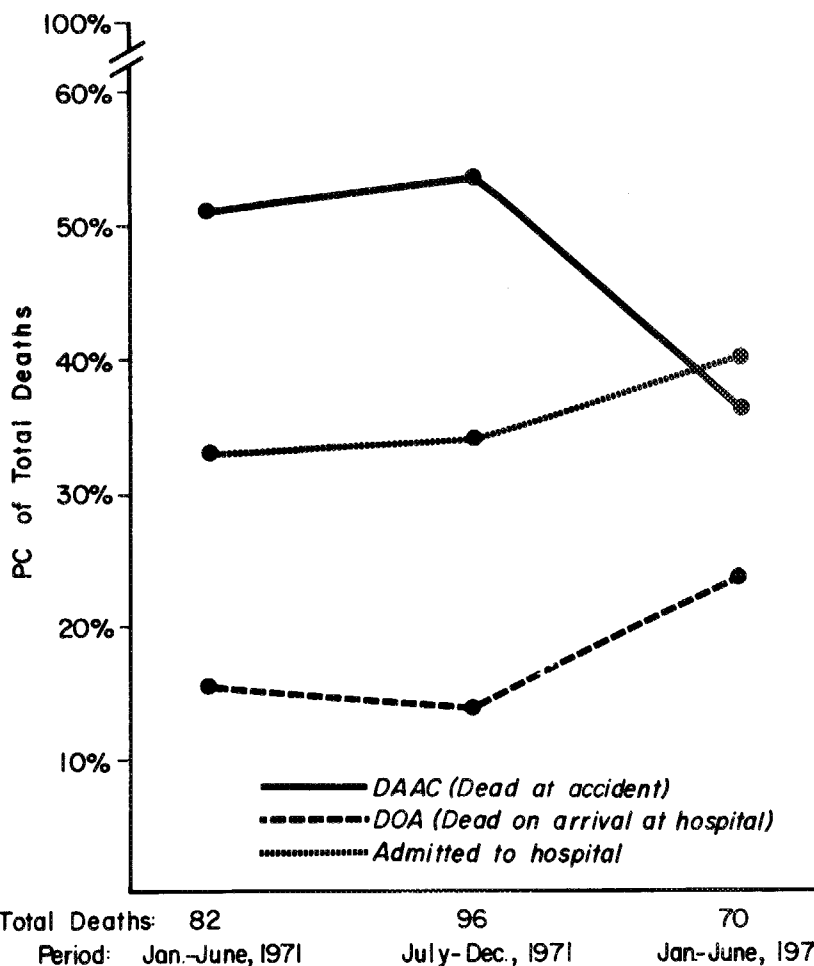


FIG. 2. The time of death: Dead at accident (DAAC), Dead on arrival at hospital (DOA), and those dying after admission to trauma centers. Shown is the decrease in DAAC from 51.2% to 37.1%, while the DOA and after admission deaths correspondingly increase.

acquisition and analysis using the Registry approach are essential for the success of such a program, and are now being developed.

The basic trauma system is now functioning as a model for other categories of emergency medical care, e.g., Cardiac (Fig. 4), Pediatrics, Poisoning, Drug Intoxication, and Psychiatry. By expanding the principles of the Statewide Trauma System, a Total Emergency Medical System (EMS) is now being established for all the citizens of Illinois. Categorization of all emergency departments is now mandatory by Illinois law (P.A. 76-1858), and must be done in concert

with areawide EMS planning. All categorization proposals must be approved by the Illinois Division of Emergency Medical Services and Highway Safety by January 1973 and implemented by July 1973. Categorization and areawide planning are being accomplished by local planning agencies and newly established Emergency Medical Service Councils. Because of the Trauma Program, many communities in the state have already gained a great measure of sophistication in comprehensive areawide planning and implementation.

Technical implementation of the communi-

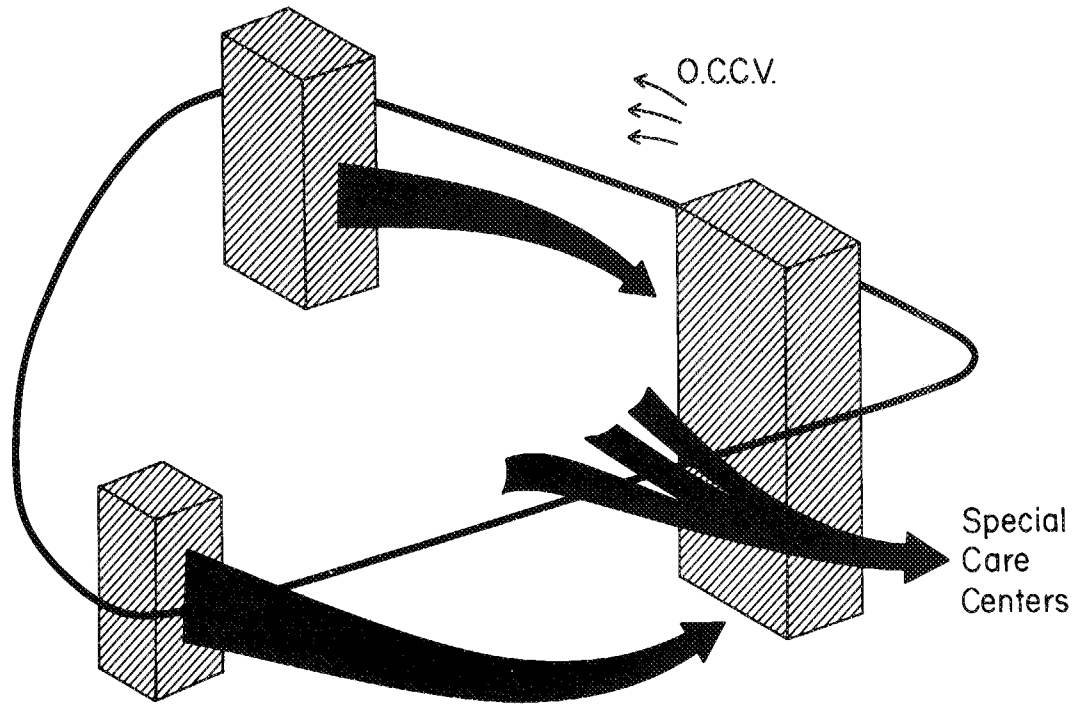


FIG. 3. A graphic conceptualization of the areawide categorization of hospitals in the Trauma Program. Small "Local" and medium-sized "Areawide" Trauma Centers selectively refer patients to the larger Regional Center. Patients with unique problems leave the basic catchment area to Special Trauma Treatment Centers.

cations and transportation subsystems has become achievable, now that an areawide planning mechanism is working. Education of health personnel is an ongoing program throughout the statewide system. These educational programs are being developed in conjunction with community colleges and universities across the state.

Medical emergencies other than trauma are being added along regional designs in a time-phase sequence. Additional clinical registries are being developed to evaluate the progress in each category. In Illinois an unstructured program for pediatric emergencies and poison control already exists, and is being phased into the trauma emergency medical services network. Clinical cardiac and critical care programs will be integrated into the Total EMS System along with their corollary training and education programs. Psychiatric emergency care in Illinois is currently fragmented, scattered, and nonregionalized. Considerable time will be necessary for the planning with the Department of

Mental Health for improved emergency services in most of the geographic areas of Illinois.

The initial results of the Trauma Program are very satisfactory: a 7.4% decrease in death from highway accidents throughout the state and 15.4% in the Region III-A (6). This regional approach to accident care can decrease the high death rate now being experienced across the nation. The change in patient distribution, as well as the time factors in patient deaths in this study, point to the beneficial effects of a controlled systems modification approach. The major emphasis in the trauma system has been the establishment of an inter-relating hospital (trauma center) network. The secondary benefits gained in the transportation of the critically ill include the redirection of patient flow and a change in the time constants for the time of death after a fatal injury.

Approximately 60% of all heart attack victims die of their major symptoms within the first hour (9). Death usually occurs outside the hospital and without professional assistants in

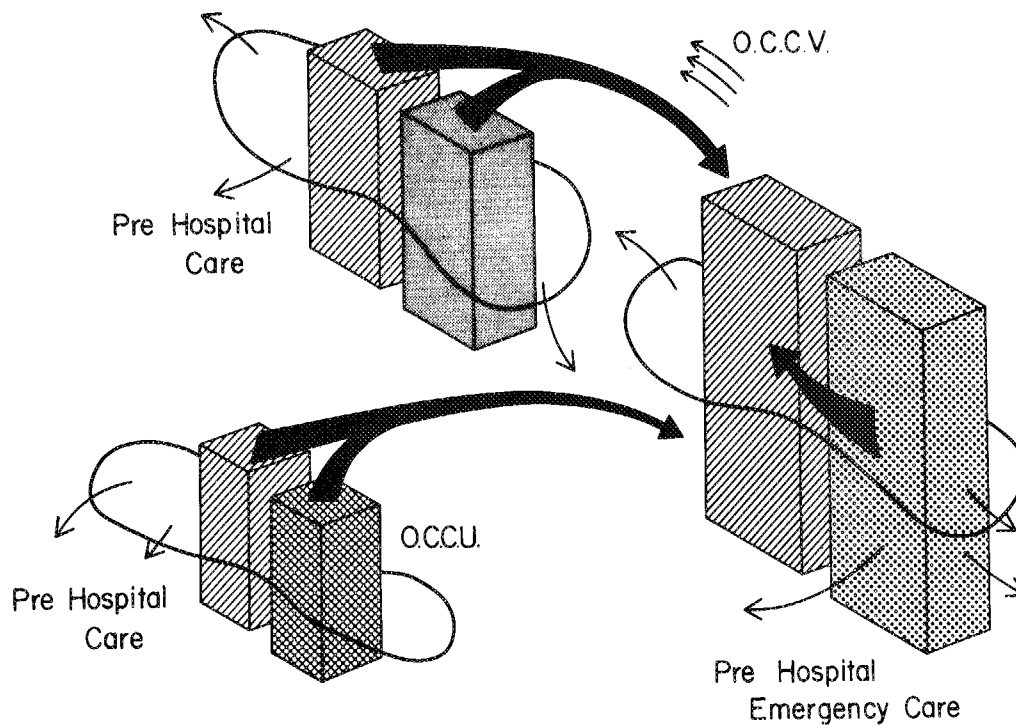


FIG. 4. A graphic conceptualization of the developing Cardiac Care System. Multiple hospitals in each local, areawide, and regional community will be involved with primary emergency cardiac care. Outlying Critical Care Units (OCCU's) and Overland Critical Care Vans (OCCV's), as well as prehospital emergency care programs, are being developed. As emergency coronary care improves, including acute open-heart surgery, a referral system will be implemented as shown.

attendance. The hospital coronary care unit (CCU) has reduced the in-hospital death rate for heart attacks by 20% through arrhythmia detection and treatment (9). Much of this highly specialized care is given by well-trained nurses. The total impact of the hospital CCU is limited by the fact that the majority of patients do not reach the hospital alive. It is the intent of the Illinois Total Emergency Medical Care System to improve coronary and critical care medicine in remote community hospitals by establishing Outlying Critical Care Units (OCCU). These remote hospital intensive care units will be linked to advanced Regional Centers for expert on-line medical consultation (2). A regionally based mobile intensive care ambulance will facilitate the delivery of sophisticated critical care during the prehospital and interhospital periods. The Overland Critical Care Van (OCCV) (Fig. 4) is a mobile, multiple-purpose intensive care unit that will utilize the special medical talent available at each Regional Cen-

ter to provide optimal intensive critical care for a large geographic area of responsibility (2).

It is estimated that thousands of acute respiratory failure and drug intoxication deaths occur needlessly outside of competent hospitals. Most of these deaths occur because expert medical care is not available when these critical emergencies arise. These conditions can be effectively treated in the proper intensive care unit or OCCU and then the patient can be transported to an advanced center in an OCCV.

#### SUMMARY

The following is a list of program goals which are being implemented in the State of Illinois's Total Emergency Medical Service System.

*Goal I.* To provide accessibility and emergency medical service to every citizen of Illinois in order that they may receive benefits of emergency and critical care medicine.

*Goal II.* To develop a comprehensive emergency and critical care system which will fully

utilize existing resources while stimulating the development of new care capabilities where these are insufficient or totally lacking.

*Goal III.* To develop practical and workable solutions to the emergency medical service problem utilizing accepted forms of health care application.

*Goal IV.* To plan and develop all phases of the program utilizing community and areawide planning.

*Goal V.* To evaluate and monitor programs continuously in order to determine all critical factors to provide for ongoing modifications and analysis.

*Goal VI.* To develop a total system that will be financially and administratively self-supporting without continued subsidization from external sources or reliance on a state or federal bureaucracy.

Fortunately for the State of Illinois, a vast amount of experience in problem identification and systems remodeling in the area of emergency medical service has been gained. With the successful development of the Statewide Trauma Care Program, specific problems and their solutions have been identified and tested. By using the positive and negative feedback approach, the entire health community of the state has gained a considerable degree of sophistication in the area of emergency care systems development. Because of the statewide systems development of a trauma care network, there has been the emergence of a healthy and practical implementation environment where problems approached on an empirical basis have been studied as ongoing events by the entire health community. It is the effort over the past 2 years that is enabling Illinois to step forward to a total systems approach to emergency and critical care medicine on a statewide basis. Emergency medical care is no longer a neglected disease in Illinois (13).

## REFERENCES

1. BOYD DR: Computerized trauma registry (editorial). *J Trauma* 11:449-450, 1971
2. BOYD DR: A total emergency medical service system for Illinois: a preview. *Ill Med J* 142:486-488, 1972
3. BOYD DR, DUNEA MM, FLASHNER BA: The Illinois plan for a statewide system of trauma centers. *J Trauma* 13:24-31, 1973
4. BOYD DR, FLASHNER BA: *The Critically Injured Patient—Concept and the Illinois Statewide Plan for Trauma Centers*. Springfield, Ill., Department of Public Health Printers, 1971
5. BOYD DR, LOWE RJ, BAKER RJ, et al: Trauma registry: new computer method for multifactorial evaluation of a major health problem. *JAMA* 223:422-428, 1973
6. BOYD DR, LOWE RJ, FLASHNER BA: A controlled systems approach to statewide emergency medical services implementation. Presidential-elect paper presented at the American Public Health Association meeting 14 Nov. 1972
7. BOYD DR, MAINS KD, FLASHNER BA: Status report: Illinois statewide trauma care system. *Ill Med J* 141:56-62, 1972
8. BOYD DR, RAPPAPORT DM, MARBARGER JP, et al: A computerized trauma registry: a method for a comprehensive investigation of a major health problem. *Proceedings of San Diego Biomedical Symposium*, Feb. 1971, p. 209-218
9. CON RD: The prehospital care of medical emergencies. *Proceedings of Maryland National Conference of Emergency Health Services, Dec. 2, 1971*. U.S. Department of Health, Education, and Welfare, 1972, p. 17
10. FLASHNER BA, BOYD DR: The critically injured patient: a plan for the organization of a statewide system of trauma facilities. *Ill Med J* 139:256-265, 1971
11. MAINS KD, BOYD DR, FLASHNER BA: A new health professional: the trauma coordinator. *Ill Med J* 142:158-160, 1972
12. NATIONAL ACADEMY OF SCIENCES, NATIONAL RESEARCH COUNCIL COMMITTEE ON TRAUMA AND COMMITTEE ON SHOCK: *Accidental Death and Disability: The Neglected Disease of Modern Society*. Washington, NAS-NRC, 1966
13. OGILVIE RB: Special message on health care. Springfield, Ill., State of Illinois Printing Office, 1971