SPECIAL COMMUNICATION

A Crisis in the Delivery of Care to the Critically Ill and Injured*


THE DILEMMA

Astonishing advances in biological science since World War II have provided remarkably potent methods for sustaining life and function in critically ill patients. All who are afflicted with serious heart attacks, overwhelming infections, severe burns or loss of kidney function; accident victims suffering from excessive blood loss; the emotionally distressed who are hospitalized after an overdose of sleeping tablets or narcotics—all these share a common plight: survival is unlikely unless their life-threatening defects can be promptly inventoried and artificial methods immediately applied to support the functions of their vital organ systems. Today medical science has the know-how to provide this essential lifesaving support, but neither resources of skilled manpower nor equipment is available to deliver it to more than a minority of our citizens.

SCOPE OF THE NATIONAL PROBLEM

Approximately two million Americans die each year. More than one half of these deaths are the direct result of diseases of the heart and blood vessels. Cancer accounts for the next largest number. Traumatic injuries, acute diseases of the lung, certain diseases of early infancy, diabetes, and suicide account for the majority of the remainder.

Most of these causes of death present as acute life-threatening defects and we look to effective critical care facilities to increase the salvage of life.

The dimensions of the problem become even more readily apparent when we review the incidence of disabilities in addition to fatalities. Besides the 115,000 Americans who die each year from accidental causes, 400,000 suffer permanent disabilities and 10 million more are temporarily disabled. When these data are interpreted in relationship to the life span of an individual, the likelihood that any one individual will sustain a permanent disability due to accidental injury exceeds 13 percent. The incentive for incisive action is particularly great since the majority of injuries occur in Americans who are less than 45 years old.

A majority of deaths after acute injury or critical illness are the direct result of respiratory failure. The patients simply cannot breathe for themselves and unless they are temporarily provided with the artificial support of a breathing machine, they die. National mortality rates due to respiratory problems have increased twice as rapidly as all other causes of death. This is in part because of an increase in chronic respiratory diseases, particularly pulmonary emphysema. Equally important, however, are problems that stem from trauma. It is estimated that 75 percent of all accidental deaths involve injuries to the chest and lung. In addition, a fatal form of lung failure has now emerged as the single largest cause of death in patients who are effectively resuscitated after shock states. Methods for artificial lung support of critically ill patients by the use of tubes in the airway and mechanical ventilators came into use less than ten years ago at about the same time that the hospital was confronted with the need to implement coronary care, renal dialysis, and open heart surgery. The medical, nursing, and
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Administrative staffs of even the most forward looking community hospitals were overwhelmed by these developments. Good opportunity to save lives was at hand, but the means by which this could realistically be accomplished with limited resources of technically expert professional and supporting staffs and available facilities were and continue to be disappointing.

The delivery of critical care is contingent not only on adequate facilities but even more on the availability and utilization of highly trained professional and technical personnel. Yet a realistic assessment of current circumstances throughout this country indicates that not enough physicians, nurses, and technical specialists are available to fill even half of the estimated need for critical care services. A conservative estimate indicates that more than 10,000 additional physicians and 40,000 additional registered nurses or specialists with equivalent competence are currently needed to staff those hospital units which give lifesaving care.8 This shortage of trained personnel currently necessitates limitations on bed usage or curtailment of services so that the level of specialized care is compromised. At this very time, major hospitals in an urban community such as Los Angeles are unable to supply critical care service to the extent requested and needed. Our own Center for the Critically Ill during August, 1971 was able to staff only 29 of 38 active beds, and highly trained intensive care nurses could not be recruited for some mortally ill patients who might otherwise have survived. Programs for training medical corpsmen and other paramedical personnel to fill this void warrant a somewhat more optimistic outlook for partial relief of the very critical shortage of qualified personnel in some parts of the country. However, the number of candidates who commit themselves to a career which involves 24-hour availability and current facilities for the training of such personnel are now so stringently limited that no short-term improvement is in sight. We must look to alternatives other than expansion in staff as a means of resolving our critical staffing problems.

BEDS FOR CRITICAL CARE

Between 1960 and 1969 the number of short-term general hospitals6 with critical care facilities increased 440 percent. The proportion of total hospital beds devoted to intensive care varies between 3 percent and 25 percent.7 Although the specific characteristics of the hospital must be taken into account, it is estimated that as many as 3 percent of acute care beds are likely to be reserved for intensive coronary care,8 as many as 5 percent for intensive respiratory care,8 and an additional 4 percent for other components of critical care. We estimate that only 43,000 acute care beds—5 percent rather than the 12 percent warranted—are presently allocated for critical care services. Approximately 55,000 additional critical care beds are needed.

The benefits that stem from systematized care of traumatized and critically ill patients have accrued primarily to patients in large medical centers. These centers are more likely to have sophisticated systems for patient monitoring and management and better provision for the dedicated services of physicians and technical personnel at the bedside. Simple devices for automation of selected components of routine care which reduce the commitment of bedside staff, such as infusion of fluids and mechanical ventilation, are therefore likely to be of greatest benefit in community hospitals.

POTENTIAL FOR SAVING LIVES

With respect to lung failure, the largest single cause of death in our critical care units, the impact of expert respiratory care on mortality, has been objectively evaluated. Pontoppidan and his colleagues10-12 at Massachusetts General Hospital, Boston, have recently reported a decrease in mortality to one-third of what it was prior to opening of the respiratory unit. O'Donohue and his associates13 report a fivefold reduction in mortality in their acute respiratory failure unit at the Medical College of Virginia. These statistics have been further corroborated by Petty14 in Denver.

The remarkable decrease in the mortality of battle casualties, beginning with the Crimean War (16.7 percent) and continuing with World War I (8.2 percent), World War II (4.5 percent), and the present Viet Nam War (1 percent),15 reflects not only the availability of improved methods of patient care and facilities for implementing such methods but to a large extent the very rapid evacuation of patients to specialized centers. During an operational experiment on evacuation of casualties in Viet Nam, helicopters were reserved and hospital units were kept in readiness for immediate care of wounded servicemen. These provisions15 resulted in further reduction in mortality to only 0.368 percent (five deaths out of 1,368 casualties). The average time interval between injury and arrival at the operating table was from 15 to 20 minutes and as little as 7.5 to 10 minutes for the most seriously injured patients. Extrapolation of this experience to civilian practice leaves little doubt of the lifesaving impact of rapid transfer of a seriously traumatized patient to a center which is uniquely prepared for his medical care.

For patients who reach the hospital alive and

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who are admitted to coronary care units, control of otherwise fatal disturbances of the rhythm of the heart is estimated to reduce mortality after heart attacks from 30 percent to 35 percent to a range of 10 percent to 15 percent. There is also evidence that mortality may be further decreased through the use of mobile intensive care units which make possible effective treatment within one hour after onset of chest pain.

Neonatal intensive care units have increased the survival of critically ill infants by approximately 50 percent.

Our own experiences give further indications of the lifesaving potential of expert critical care. Of a total of 70 patients who had attempted suicide by taking barbiturates, tranquilizers or narcotics in lethal amounts and who at the time of admission to the hospital were in collapse, 19 (27 percent) ultimately died. However, there has been a progressive reduction in mortality. Five of the first eight patients treated in our specialized unit died, but only one of the last 21 patients died.

We have made a conservative estimate of the potential national impact on the survival of Americans if these advances were implemented. On the basis of the available data, it is evident that effective critical care services have been capable of reducing mortality by 50 percent or more. However, a portion of this improvement can be attributed to implementation of new techniques of resuscitation, pacemakers, defibrillators, drugs, and other effective therapy, the use of which is not restricted to those specialized units which are reserved for the care of the critically ill. To assure a conservative estimate, we therefore attribute only half of the improvement in survival rates to the selective impact of organized critical care services.

Our computation of the numerical effect of this improvement assumes that 5 percent of all acute hospital beds are currently reserved for critical care, that the average stay in critical care units is five days, the average bed occupancy 70 percent, and the overall mortality 20 percent. If the mortality rate were lowered to 15 percent—a 25 percent reduction—more than 100,000 lives would be saved.

Opportunities for Technologic Development

Major technologic advances which have provided efficient systems of automation and communication now common in other service industries have as yet had limited application in the medical field. If techniques comparable to those presently used in hospitals were applied to the delivery of electrical power or water supplies to our communities, only a few fortunate subscribers could be served. Time after time, a nurse must adjust an intravenous drip with a screw clamp rather than simply pushing a button which delivers a known volume of fluid over a known period of time, or even better, entering a command into a computer-operated system that predictably executes an order and automatically takes care of the record keeping. Bedside care, whether it is the measurement of urine output or the administration of fluids and drugs, is entirely a manual process. Record keeping and record retrieval impose inordinate demands on the time of the overworked doctor and nurse.

A systematic reorganization of the methods for delivering medical service to the critically ill, utilizing the benefits of automation, is urgently needed. Only such a reorganization is likely to resolve the crisis that now exists in the delivery of care to the critically ill and injured.

The effectiveness of trained personnel who are in such short supply and the efficient use of available facilities must be increased. Techniques for dependable delivery of crisis care surely must not lag behind methods which assure the availability of a broad array of consumer products and services, most of them substantially less essential.

Economic Implications

The economic implications may be assessed in terms of the direct benefit to the critically ill and injured patient, the cost of the health delivery service, and the impact on third parties who provide the funding for operation of critical care facilities. The economic impact of disabilities and deaths due to trauma is staggering because of the disproportionately high incidence of traumatic injury in relatively young and productive persons. More than 77 percent of all injuries occur in patients less than 45 years of age and 40 percent in those under 17. In addition, the mortality for men is more than double that for women.

Trauma accounts for the loss of more productive man-years than any one disease and its cost is estimated at $23 billion. This estimate does not include the continuing costs of maintaining patients with permanent disabilities. Long-term sequelae of injuries in children have a disproportionately greater medical and social significance. More than 100,000 children are permanently crippled each year by accidents. Thus even a small reduction in morbidity in children would substantially reduce the burden on our national economy if those youngsters are restored to lifelong productivity.

The high cost of critical care, quite aside from the unavailability of staff, is worthy of comment. Our analysis leads us to anticipate that, through automa-
tion, the total commitment of critical care nurses to mechanical tasks may be reduced by one third. This alone would make $270 million available for improving those components of care which cannot be automated. If each year only 2.5 percent of the total costs for nursing care were expended for research and development of automated methods—a much smaller allocation than is current practice in technologic industries in which such allocations typically range from 7 percent to 12 percent—approximately $20 million would be budgeted for this practical and humanitarian undertaking.

A PLAN FOR MEETING THE CRISIS

Our national leaders should be and want to be apprised of this current dilemma involving critical care medicine. Health care delivery is now the nation's second largest industry, accounting for more than $67 billion or 7 percent of the gross national product during fiscal 1969-1970. Yet during this period only $18 million were spent on research in this area. Dr. J. Glen Beall cites the fact that we cannot find a major American industrial enterprise which funds research and development so poorly.20

Applied research involving close liaison between practice-oriented research physicians, engineers, nonclinical scientists, and medical administrators must be further encouraged and financially supported. At the present time there is remarkably little government support for applied biomedical engineering: $6.5 million during 1970.21 Applications for public funding of these technologically important endeavors fall into the crack between established programs for support of basic medical research and those reserved for programs which relate to administrative components of medical care.

A very few programs exist as examples of what can be done. Automated critical care facilities at the Latter Day Saints Hospital in Salt Lake City, at the Pacific Medical Center in San Francisco, at the University of Alabama in Birmingham, and at the Center for the Critically Ill at the University of Southern California in Los Angeles serve as an indication of the potential value of research initiated to improve clinical care of the traffic accident victim, the open heart surgery patient, and the man whose life is being snuffed out by breathing difficulties caused by emphysema. Automated pumps for the delivery of fluid and medication, breathing machines, body temperature controlling devices, all of which operate on a remote-control basis, are already available but only on a small experimental scale. Instrumentation at the bedside, which at present often hinders the patient from the medical and nursing staff, has been streamlined and miniaturized.

Substantial incentives may have to be created—possibly with subsidies—to encourage industry to develop and market already available devices for lifesaving medical care. Public support for development and packaging of those items which are badly needed but not yet available must be recruited. With good support we estimate that seven years will be needed for the engineering, evaluation, and marketing of competent systems by which major components of critical care may be automated. Routine use of these systems in small community hospitals may be anticipated within the next ten years.

SPECIFIC PROPOSAL

We recommend that specific funds be provided in the amount of at least $20 million annually for dedicated research and development of systems by which services in critical care centers can be facilitated. More specifically, categorical monies are needed for support of applied biomedical engineering efforts by which suitable instrumentation is designed, prototype units are developed, rigorous routines of preclinical and clinical testing are established, and orderly provisions are made to recruit the participation of industry in packaging and early marketing of systems of proved value. The funds should also serve for development and operation of at least ten pilot facilities which might serve as testing and training centers.

The allocation of these funds may be directly related to Catastrophic Health Insurance (S1376), the details of which have been published in the Congressional Record for May 12, 1971. This bill, submitted on March 24, 1971, and sponsored by Senator Russell B. Long (and cosponsored by Senator Alan Cranston,22 who has demonstrated special and continuing interest in the problems detailed in this statement), is intended to provide $2.5 billion annually for the support of Catastrophic Health Insurance. We propose that of this amount, a sum approximately equivalent to 0.5 percent, or $20 million, be reserved and committed for applied clinical engineering. This appears to us to be a uniquely rational and supportable component of such a bill if it is to improve catastrophic medical care. Funding of services without assuring that services can actually be delivered with the total resources now at hand would be likely to thwart the very purposes of such legislation. Concurrent efforts to expand the technologic resources with which to serve those who are enfranchised is therefore regarded not only as important foresight but also as appropriate insurance.
REFERENCES

2 National Center for Health Statistics: Current estimates from the Health Interview Survey. United States, 1967, Series 10, No. 52
6 The nation's hospitals: A statistical profile. Hospitals 44: 466, 1970
7 Borrow ML, Craft NB: ICU and CCU facilities. Hospitals 45:47, 1971
18 Status of research in trauma and the critically injured, a report by the Surgery Training Committee of the National Institute of General Medical Sciences, National Institutes of Health 1970
20 Beall JC Jr: A proposed institute of health-care delivery. Congressional Record 15, S 9086, June, 1971
22 Cranston A: Funding for health: An excellent investment. Congressional Record 117, S 11406, July 19, 1971

It's Not All Honey

Most honey bees nest in man-made hives; escaped swarms usually nest in hollow trees. Honey bees are extremely valuable insects, not only because of the honey and beeswax they produce, but because of their pollinating activities; their pollinating services are 15 to 20 times as valuable as their honey and wax. It is often possible to increase greatly the yields of such crops as orchard fruits and clover seed by introducing hives of Honey bees into the orchards or clover fields when the crop is in bloom.

The normal yield of red clover seed, for example, (about 1 bushel per acre) can be increased to 4 or more bushels per acre with a dense honey bee population in the clover fields.