SUMMARY

The widespread application of neonatal intensive care appears to have played a major part in producing the improved survival, as well as the improved physical condition, of very low birthweight infants in recent years. Unfortunately, the number of such very small infants is increasing every year, and some survivors continue to suffer from severe handicaps such as mental retardation and cerebral palsy. Rising birth rates and the high level of risk factors, associated with low birthweight, such as teenage pregnancy, smoking, and low socioeconomic status, are likely to create an increasing need for intensive medical care of the high-risk newborn over the next decade.

These findings are based on the present study conducted by the Health Policy Program of the University of California, San Francisco, for OTA. Included in the study and summarized below are sections on the definitions of neonatal intensive care, need and demand, supply and utilization, costs and reimbursement, effectiveness, and economic analysis.

Definitions

Neonatal services reflect a complex mix of people and technologies. In many hospitals, the organization of these services does not reflect the three levels of care defined by the Committee on Perinatal Health. **As a** consequence, the services provided in different facilities classified at the same level can vary considerably, making a standard level of care difficult to identify in practice. The absence of uniform definitions of levels of neonatal intensive care has complicated data collection, making statistical analysis difficult, especially when comparing cost or utilization data for different hospitals,

Need and Demand

The incidence of low birthweight is the most important predictor of illness or death in early infancy and of the need for neonatal intensive care. Since 1966, there has been a 15-percent decline in the overall incidence of low birthweight (2,500 g or less, about 5½ lbs) infants as a proportion of all births, associated with improvements in many of the risk factors (e.g., age of mother, socioeconomic levels, maternal nutrition, and personal health practices). Still, some 230,000 low birthweight infants are born annually. Moreover, the birth rate for the United States has increased by nearly 7 percent since 1975, mainly owing to larger numbers of women entering the childbearing ages, and this has resulted in a new increase in the absolute number of very low birthweight (l,500 g or less, about $3^{1}/_{4}$ lbs) infants born each year since 1974. The main determinants of future demand for newborn intensive care will most likely be the duration of the current "baby boom" and the rates of prematurity and low birthweight. Continued increases in the number of very low birthweight infants will expand the need for neonatal intensive care.

Supply and Utilization

No national data exist that describe the amount of neonatal intensive care currently being delivered in the United States. Only rough estimates based on studies with small sample sizes and variations in definitions of levels of care can be computed. The following estimates of neonatal intensive care supply and use in the United States were extrapolated from data available in the literature and from individual neonatal intensive care units (NICUs):

- NICU admission rates: 6 percent of all live births go to intensive care (about 200,000 admissions annually; range 3.8 to 8.9 percent of all births).
- Estimated average length of stay (ALOS): 8 to 18 days per patient (mean 13).
- Estimated total patient days: 2.6 million.
- Number of hospitals with NICUS: approximately 600.
- Number of intensive care beds (Levels II and III): 7,500 (approximately 2.3 beds per 1,000 live births).

Cost and Reimbursement

The total costs of neonatal intensive care are

similar to the costs of end-stage renal disease and coronary artery bypass surgery. Various sources report neonatal intensive care costs that range from $1,800 to over $40,000 per patient. We estimated average expenditures per patient in 1978 to be about $8,000. For the United States as a whole, this amounts to approximately $1.5 billion. To estimate the total annual costs for neonatal intensive care, we used the following two alternative calculations.

1. Number of births ***(3,300,000)***	x	Percentage of all births admitted to NICUS *(0.06)*	x	Mean cost / patient ($8,000)	=	Total cost $1.58 billion (1978 dollars)
2. Number of Level III beds reported by Ross Laboratories *(7,387)*	x	Estimated occupancy rate *(0.90)*	x	Days / year *(365)*	*x*	Mean cost / day *($545)*	=	Total cost *$1.3* billion (1978 dollars)

Effectiveness

Numerous recent reports claim to demonstrate the effectiveness of intensive care of the newborn. In fact, much of the literature consists of studies with sample sizes too small and populations too diverse for generalization. For the present study, we combined all available data in 5-year blocks and *were* able to conclude that neonatal intensive care has played a major role in improving the chances of survival of many newborns, particularly those of very low birthweight. Mortality rates within birthweight groups have declined over time, strongly supporting the conclusion that neonatal intensive care has helped improve survival. Given the scarcity of randomized clinical trials and the possible contribution of additional medical and nonmedical factors, however, it is impossible to quantify precisely how much of the improvement in survival is due to intensive medical care of the newborn.

Cost data are plagued with even greater problems than utilization and supply data (e.g., NICUs are seldom separate cost centers in hospitals, and reported costs often exclude ancillary services and physician fees). Nevertheless, existing studies do show: 1) total costs for survivors are higher than for nonsurvivors; 2) as birthweight decreases, cost increases; and 3) total costs increase with complications such as hyaline membrane disease or anomalies that require surgery.

The present system of reimbursing neonatal intensive care according to a uniform per diem rate encourages cross-subsidies, so that costs properly attributable to one patient may be borne by other patients. Hospital charges for neonatal intensive care are often not fully reimbursed by medicaid *or* by insurance plans that pay only for "allowable" costs, increasing the incentives for cross-subsidization among payers. Moreover, because it is difficult to adjust charges continuously with varying levels of care, expected revenues often are below costs at the beginning of a stay and exceed costs at the end, allowing for cross-subsidies based on variations in the length of stay.

On the basis of limited morbidity data, it appears that the incidence of serious problems in survivors of neonatal intensive care is probably declining. In any case, the rate of serious handicaps has not increased as had been feared when neonatal intensive care first began to produce survivors of extremely low birthweight. It should be noted, however, that at the same time the incidence of serious problems is decreasing, the absolute number of severely handicapped individuals may be increasing. This seemingly contradictory situation may be occurring, especially with regard to infants weighing 1,000 g or less. Even though the number of normal sur-

vivors has increased eightfold to twentyfold since 1960, the small number of severely handicapped individuals has risen. These results illustrate the dilemma of trying to determine whether intensive care of the newborn is effective. Every year several thousand babies who without neonatal intensive care would have died are now surviving to lead normal lives. Part of the price for this success, however, is a persistently high number of abnormal survivors.

Economic Analysis

Cost-benefit and cost-effectiveness analyses (CBAs and CEAs) conducted to date are of limited value. For example, many reports contain statements that the costs of hospitalization in an intensive care nursery are far less than the costs of life-long institutionalization for a severely defective survivor. Such analyses presume fully beneficial outcomes with treatment and totally unavoidable, severe handicaps without treatment.

A method of economic analysis developed by economist Marcia Kramer is neither CBA nor CEA, but uses elements of both to estimate and compare the actual dollar costs and benefits of different levels of intensity of medical care, each with different outcomes. For purposes of illustration, we applied this methodology to the aforementioned effectiveness data. The tentative findings yielded were that neonatal intensive care of infants weighing 1,500 g or less is marginally cost effective, but that treatment of the subgroup of infants weighing 1,000 g or less is not yet cost effective unless only the most recent reports are used to estimate present outcomes. Data and methodological limitations common to all such analyses preclude developing an estimate of the cost effectiveness of neonatal intensive care about which one could be confident. Unresolved questions include: what percentage of, how long, and at what price abnormal infants are institutionalized, and what discount rate is most appropriate. Without **such information, an accurate** CEA of neonatal intensive care is impossible.

In spite of these limitations, the economic **analysis presented in** this case study does highlight certain important aspects of the present return on the investment in neonatal intensive care. For example, care of the birthweight group 1,000 g or less does not turn out to be cost effective. The primary reason is that the small increase in the chance that a severely abnormal individual in this birthweight group would survive—an increase that occurred between 1960 and 1970-75—outweighed, in economic terms, the fact that the odds of a normal survivor in this group increased from 17 per 1,000 live births to 135 per 1,000 live births during that same period. Withholding care from all newborns weighing 1,000 g or less to avert the exceptional costs of the severely abnormal survivors would take the lives of many potentially normal babies. Clearly, a decision to withhold care from such infants would not be made on cost-effectiveness grounds alone. The considerations in this situation contrast with those in a hypothetical outcome, often discussed in the past: Neonatal intensive care was not cost effective because it resulted primarily in increased survival of defective individuals. In that situation, the hypothetical tradeoff was not between normal and abnormal survivors, but between fewer or greater numbers of defective survivors. Neither situation would be financially cost effective for society, but the factors to be weighed are quite different in each.

The economic analysis in this case study speaks only to the question of whether neonatal intensive care is cost effective when compared with less intensive care of small or ill newborns. It does not address the larger question of whether such care is cost effective when compared with alternative programs to reduce the levels of prematurity and other risk factors in the population. The larger question would require a separate analysis of the costs and effectiveness of socioeconomic initiatives and prenatal medical care.

The question concerning the results that could be expected from trading off some intensive postnatal care in favor of prevention-oriented programs is one which has important racial implications. Our analysis of present utilization and outcomes by race concludes that marked reductions in the availability of intensive care