Chapter 6

Economic Analysis of Neonatal Intensive Care

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INTRODUCTION

This case study has shown that neonatal intensive care is a high-cost technology that demonstrably saves the lives of low birthweight babies. But the long-term consequences of providing intensive care are more difficult to evaluate. Over the lifetimes of the infants treated in neonatal intensive care units (NICUs), are medical care costs increased or reduced? Likewise, what are the effects on the pain and suffering of patients and their families? Is it possible that some severe handicaps in children are considered by families to be worse than death?

Cost-effectiveness analysis (CEA) can provide insight to these issues by comparing the costs, benefits, and quality of life implications of neonatal intensive care in a single economic evaluation. Ideally, CEA compares the costs and the health effects of alternative strategies, such as the provision of neonatal intensive care with another kind of intervention for low birthweight babies. The expected changes in health effects are arrayed against the net medical care costs incurred by providing each alternative approach to neonatal care.

Unlike CEA, cost-benefit analysis attempts to place dollar values on all consequences, both positive (benefits) and negative (costs), arising from alternative courses of action. The alternative with **the** highest level of monetary net benefit (or lowest net cost) is preferred to others. If the net benefit is greater than zero, the alternative is "cost saving" and considered worthwhile on efficiency grounds alone. Because it is so difficult to place a value on the benefits of a strategy, cost-benefit analysis often proves inadequate. Some researchers have calculated the lifetime economic productivity of survivors, but this is certainly an incomplete surrogate for the benefits of a life-saving intervention. How can a value be placed on the pain, suffering, anxiety, emotional distress, or grief in patients and their families, especially when these consequences occur at different times in the future? These psychosocial benefits (or losses) defy measurement (179).

Cost-effectiveness analysis escapes the problem of trying to value benefits by using the effectiveness measure (e.g., quality-adjusted life years) as a proxy. Net costs per unit of health effectiveness are calculated and compared with other programs with similar health goals. The interpretation of results from cost-effectiveness analyses remains problematic, however, because methodological differences in study design make it difficult to directly compare one CEA evaluation to another.

COST= EFFECTIVENESS AND COST-BENEFIT STUDIES

The earlier OTA study on neonatal intensive care by Budetti and his colleagues concluded that neonatal intensive care for infants weighing 1500 grams or less was marginally cost saving when the value of the lifetime economic productivity of survivors was estimated. Treatment of the subgroup weighing under 1000 grams cost more in net medical costs than was saved in productivity if outcomes from 1971 to 1975 were used. When mortality and morbidity rates from later in the 1970s were used in the calculation, however, treatment of the extremely low birthweight infants also became cost saving. The benefits accruing from the lifetime earnings of the increased number of normal survivors outweighed the costs incurred by the increase in the absolute number of severely handicapped **(25).**

Budetti and his colleagues compared the costs of neonatal intensive care with less intensive care of ill newborns. Using mortality and morbidity rates gleaned from the literature, they relied on a cost-benefit economic model that assigned dollar values based on the assumptions that normal survivors are economically productive; nonsurvivors are relatively inexpensive; and seriously defective survivors are both expensive and not productive. These hypothetical scenarios may not have adequately mirrored the true life experience of NICU survivors. In addition, their analysis did not take into account the psychosocial costs and benefits of neonatal intensive care that were discussed previously.

The most comprehensive economic evaluation conducted to date was undertaken by a group of Canadian researchers (19). They studied the mortality and morbidity of all very low weight infants born to the residents of a southern Ontario county before (1964 to 1969) and after (1973 to 1977) the introduction of neonatal intensive care. The assessment of survivors' health included a classification of health states that measured physical, social, role, and emotional function as well as health problems. To take into account these psychosocial costs, a sample of parents was then surveyed on the desirability or undesirability of the health states relative to one another. For example, parents rated some chronic dysfunctional states as worse than death. The survey results were then used to weight life-years for quality. These quality-adjusted life-years (QALYs) were the measure used to adjust additional years of life (decreasing mortality) for the long-term disabilities that some survivors have as they live out their life expectancies.

Health outcomes were calculated for two birthweight groups: infants weighing 1000 **to** 1499 grams and infants weighing 500 to 999 grams. Like many other studies, the Canadian group found that the rate of survival to hospital discharge increased with neonatal intensive care. And, while the introduction of neonatal intensive care also resulted **in increases in quality-adjusted life-years for the very low birthweight infants as a whole, for the subgroup of infants weighing less than** 1000 grams, the increase in quality-adjusted life-years was lower than the increase in unadjusted additional life-years, implying a poor quality of life for many of these tiniest surviving infants. In fact, although the proportion of serious handicaps among survivors did not increase significantly, the increased absolute number of survivors resulted in a greater number of handicapped children (70).

Costs were estimated for all neonatal care and for lifetime followup health care and other special services, **such as institutional care or special education. The results of the economic evaluation performed by the Canadian group are shown in table** 16. For the group weighing 1000 to 1499 grams at birth, the incremental cost of neonatal intensive care was $82,969 per survivor at hospital discharge. Similarly, for the 500- to 999-gram birthweight group, the neonatal intensive care program cost $142,929 per survivor.

By every economic measure, neonatal intensive care for infants weighing 1000 to 1499 grams was more cost-effective than neonatal intensive care for infants weighing under 1000 grams. Projected over a lifetime,[1] the neonatal intensive care pro-

I Neonatal intensive care requires the early expenditure of large sums of money to achieve later gains. Therefore, a discount rate of 5 percent was applied to costs, earnings, and effects (QALYs) occurring in the future in order to convert future values to their equivalent present value.

Table 16.– Measures of Economic Evaluation of Neonatal Intensive Care for Very Low Birthweight Infants (5 Percent Discount Rate), 1984[a]

	Birthweight (grams)	
Period	1000-1499	500-999
To hospital discharge:[b]		
Cost/additional survivor. . . .	$82,969	$142,929
To age 15 (projected):		
Cost/life-year gained	8,506	17,012
Cost/QALY gained[c].	10,737	55,917
To death (projected):		
Cost/life-year gained	4,044	12,968
Cost/QALY gained[c].	4,462	31,235
Net economic benefit (loss)/live birth	(3,626)	(22,450)
Net economic cost/QALY gained[c].	1,394	24,403

[a]Values were converted to 19& U.S. dollars from 1978 Canadian dollars.
[b]All costs and effects occurred in Year one.
[c]QALY denotes quality-adjusted life-years.

SOURCE: M.H. Boyle, G.W. Torrance, J.C. Sinclair, et al., "Economic Evaluation of Neonatal Intensive Care of Very -Low-Birth-Weight Infants, " *N. Eng. J. Med.* 308(22):1330-1337, June 2, 1983.

gram cost $4,462 per quality-adjusted life-year gained for the 1000- to 1499-gram birthweight group and $31,235 per quality-adjusted life-year gained for the under 1000-gram group. Borrowing from cost-benefit analysis, the researchers also calculated net economic benefit (or loss) by taking into account the anticipated future earnings of survivors. In this analysis, there was a net economic loss in employing neonatal intensive care over nonintensive care for both weight groups. However, for infants weighing 1000 to 1499 grams the increased costs of treatment were very nearly offset by increased lifetime earnings. When the discount rate was set lower than 3½ percent, the net economic benefit per live birth was positive. Not so for the birthweight group weighing under 1000 grams. Gains in survival and quality-adjusted life-years were obtained at a considerable increase in neonatal costs and subsequent health care costs. These costs could not be repaid through lifetime earnings.

CONCLUSIONS AND POLICY IMPLICATIONS

The results of the Canadian study raise a number of issues. One is whether the same conclusions would be reached if the study were conducted today. For the time period studied, the mortality, morbidity, and cost figures used by the Canadian group did not differ markedly from other population-based and institutional reports for the same birthweight groups. However, since 1977 there have been both substantial gains in survival and increases in costs. During the period studied by the Canadians, the risk of mortality declined more rapidly for the 1000- to 1500-gram birthweight group than for smaller babies. Since then, the most rapid reduction in mortality risk has been for the 750- to 1000-gram birthweight group. (See ch. 3.) Better rates of survival would tend to improve the cost-effectiveness of neonatal intensive care, and this impact would be greater for the under 1000-gram birthweight group.

OTA calculated the incremental cost of neonatal intensive care in producing a survivor by using the recent data on mortality and hospital costs that are developed in this case study (table 17). Baseline survival rates, prior to the introduction of neonatal intensive care, were taken for the years 1961 to 1965 and compared with the most recent, available survivor rates, those for 1981 to 1985. OTA's results are remarkably similar to those found in the Canadian study. (Both tables 16 and 17 are in 1984 U.S. dollars.) Compared with the Canadian costs, OTA found the cost per additional survivor to be about $3,000 more expensive for infants with birthweights between 1000 and *1500* grams and about *$24,500* *less* *ex*pensive for infants with birthweights under 1000 grams. The impact of improved survival rates for extremely low birthweight infants was very strong, because the average hospital costs in the Canadian study for the under 1000-gram birthweight group were less than one-half the average costs used in the OTA calculation. If only mortality is taken into account, the cost-effectiveness of neonatal intensive care relative to no special care for the smallest babies (those under 1000 grams) has improved since 1977.

Limitations of data prevented OTA from examining the implications of long-term morbidity on costs in a separate cost-effectiveness analysis. The proportion of NICU survivors with serious handicaps has remained stable since the Canadian study, but the rate of severe disability increases with decreasing birthweight. (See ch. 3.) The recent declines in mortality mean that, especially among the under 1000-gram birthweight group,

Table 17.—Cost of Neonatal Intensive Care Per Additional Survivor, 1984

	Birthweight (grams)	
	1000-1499	500-999
Average hospital cost[a]	$36,153	$ 49,617
Additional survivors per 1,000 live births from 1960 to 1980[b]	419	419
Cost per additional survivor	$86,284	$118,418

[a]From table 4, mean of the average hospital costs per infant reported by the three groups of hospitals.
[b]From table g, change in inborn neonatal mortality rates per 1,000 live births from 1961-65 to 1981-85.

SOURCE: Office of Technology Assessment, 1987 there are now both more normal survivors and more handicap victims, (See figures 2 and 3 in ch. 3.) It is unclear how the new mix of survivors would affect the economic equation.

Costs have increased since 1978, and these increases have outpaced inflation by more than 75 percent in the United States. Infants treated in neonatal intensive care use resources more intensively than previously, and resource use is inversely correlated with birthweight. (See ch. 2.) These increases in medical care costs, though they contribute to improved health outcomes, would tend to decrease the cost-effectiveness of neonatal intensive care. Moreover, the lifetime costs for custodial care for a severely disabled person have risen too. A recent estimate of the cost for caring for a severely handicapped child (in 1982 dollars) is $22,590 per year (170).

In all likelihood the conclusions of the Canadian study would still pertain today. Neonatal intensive care results in both increased survival and increased costs, Moreover, neonatal intensive care becomes more expensive as it is employed in increasingly marginal cases.

One way to increase the cost-effectiveness of neonatal intensive care is to try to identify which newborns are most likely to survive, and, in particular, experience higher quality lives (14). For example, because birthweight is such a powerful predictor of both survival and morbidity, analysis of birthweight groups by 100 gram increments can lead to refinements in the conclusions of the Canadian group. Researchers in Rhode Island analyzed lifetime costs for infants weighing 500 to 1000 grams and born between 1977 and 1981 (180). Taking into consideration long-term therapeutic and custodial care for handicapped children as well as initial hospitalizations, they estimated costs in 1982 dollars ranging from $362,992 per survivor for infants with birthweights between 600 and 699 grams to $40,647 per survivor for those weighing 900 to 999 grams. Their cost-benefit analysis showed that when estimates of lifetime earnings were added to the equation, only infants with birthweights from 900 to 999 grams had future earnings that exceeded total costs.

Such analyses help to refine the economic equations, but the question should not be whether to *deny care to any particular infant on the basis of high costs.* It is expected that a successful intervention like neonatal intensive care will add to overall medical costs. Moreover, there are many ethical, social, and legal reasons why intensive care should not be withheld from a newborn, no matter what its size and gestational age. (See ch. 5.) Most importantly, neonatologists are unanimous in stating that it is impossible to predict outcome at birth. Many healthy babies would be lost if blanket policies of withholding care were promulgated. Doctors, in conjunction with parents, have traditionally grappled with decisions about individual patients and they must continue to do so. Data on cost-effectiveness can be one component of what are, ultimately, value judgments.

Policymakers can more directly use the results of cost-effectiveness analyses to guide priorities in expenditures for health care. For example, it is not clear that society is spending more per quality-adjusted life-year for neonatal intensive care than for other programs such as dialysis, kidney transplantation, coronary artery bypass surgery, or bone-marrow transplantion (14,186). In such a comparative context, neonatal intensive care can be judged to be more or less worth its costs. Better cost-effectiveness information about diverse programs can help both policymakers and physicians make consistent and well-founded choices.