Articles

The Cost Effectiveness of Prenatal Care in Reducing Low Birth Weight in New Hampshire

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This study calculates the cost effectiveness of adequate prenatal care in reducing the low birth weight rate for each of three socioeconomic groups of women: those with less than 12 years of education, those with 12 years, and those with more than 12 years. Target low birth weight rates for each group were those actually achieved by New Hampshire women receiving adequate prenatal care within respective education groups. The estimated total cost associated with low birth weight births among the 1981–1984 cohort of New Hampshire resident births was more than $38 million. With universal adequate prenatal care, the low birth weight costs would be less than $32 million, a cost savings of $6.5 million. Since the additional cost of providing adequate prenatal care to all women was estimated to be $2.5 million, the net cost savings were estimated to be $4 million, or $1 million per year. For each additional $1 spent on prenatal care, $2.57 in medical care costs would be saved.

Low birth weight is a major public health problem in the United States. It is the principal determinant of infant mortality and a leading cause of childhood morbidity. The long periods of intensive medical care required by many low birth weight babies present an economic

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burden to families and society. It is estimated that each low-weight birth averted would save nearly $15,000 in costs associated with neonatal intensive care, rehospitalization, and long-term morbidity (Institute of Medicine 1985). The fact that low birth weight rates are highest among low socioeconomic groups means that much of the financial cost of caring for these babies is paid for with public money.

A large body of research has shown that early and adequate prenatal care is effective in preventing low birth weight, especially among members of high-risk medical and socioeconomic groups (Gregory 1984; Korenbrot 1984; Showstack, Budetti, and Minkler 1984; Leveno, Cunningham, Roard, et al. 1985; Moore, Origel, Key, et al. 1986; Fisher, LoGerfo, and Daling 1985). A few studies have addressed the cost effectiveness of prenatal care in preventing low birth weight (Leveno, Cunningham, Roard, et al. 1985; Moore, Origel, Key, et al. 1986; Joyce, Corman, and Grossman 1986; Lennie, Klun, and Hausner 1987). An Institute of Medicine study (1985), focusing on mothers on public assistance from high-risk socioeconomic groups, estimated that every additional dollar spent on prenatal care would result in savings of $3.38 in medical care of low birth weight infants. The study's findings were based on the assumption that providing first-trimester prenatal care to all low-socioeconomic-status mothers on public assistance would reduce low birth weight to the Surgeon General's 1990 objective of 9 percent. Because of data limitations, the Institute of Medicine study was unable to examine the direct association between prenatal care and low birth weight within the high-risk target population.

This study adapts the Institute of Medicine (IOM) model to estimate the economic cost of low birth weight in the state of New Hampshire and to assess the cost effectiveness of prenatal care in reducing low birth weight. It departs from the IOM methodology in two important ways. First, the IOM study focused exclusively on a high-risk target population. The current study examines the cost effectiveness of prenatal care for each of three socioeconomic groups as defined by educational level (< 12 years, 12 years, and > 12 years). The second methodological departure of this study from the IOM study involves the target low birth weight rates employed. As noted above, the target rate of the IOM study was the Surgeon General's 1990 objective for the nation. Ours employs what is probably a more conservative target rate for each of the three socioeconomic groups: the actual low birth weight rate achieved by women who received adequate prenatal care in each group. The implication of this difference in target rates is addressed in the discussion section of this article.

It is important to note that we address only financial barriers to prenatal care and not other barriers, such as lack of awareness of prenatal care programs, lack of available transportation, inclement weather, or unavailable child care. The assumption is made that women who fail to receive adequate prenatal care do so solely because of financial constraints. Although the calculated dollar expenditures will not assure adequate prenatal care for all women, this is the return that would be obtained in cases where the barriers are financial. To the extent that there are additional financial barriers, the additional costs of providing adequate prenatal care may be underestimated.

METHODS

Data on prenatal care, birth weight, infant survival, and mother's level of education are from birth and death certificates collected by the New Hampshire Bureau of Vital Records and Health Statistics. The study population is the 1981–1984 birth cohort of New Hampshire residents. Variables calculated from birth and death certificate information are listed:

- *Kessner Index of Prenatal Care Adequacy (1973)* is an index based on the month prenatal care began, number of prenatal visits, and gestational age (as calculated from birth date and last menses date). The index is divided into three classes: adequate, intermediate, and inadequate.
- *Birth weight* is divided into three categories: very low birth weight (VLBW, < 1,500 grams); moderately low birth weight (MLBW, 1,500–2,499 grams); and "normal" birth weight (2,500 grams or more). Low birth weight (LBW, < 2,500 grams), which combines VLBW and MLBW, is also employed in the analysis.
- *Mother's Level of Education* is used as a proxy for socioeconomic status (National Center for Health Statistics 1980). Cases are divided into three categories according to their socioeconomic risk of low birth weight: less than 12 years (high risk); 12 years (moderate risk); and greater than 12 years (low risk).
- *Survival Rates of VLBW and MLBW Infants* at one month and one year are calculated to determine costs associated with rehospitalization and long-term morbidity of LBW infants.

Cost data (based on 1984 costs), rehospitalization rates of LBW infants, and average length-of-stay (LOS) information are from the Institute of Medicine (1985) report:

Adequate prenatal care costs	$400
Initial hospitalization costs	$13,616
Rehospitalization costs	$372/day
Percent rehospitalized:	
VLBW	38.3%
MLBW	19.0%
Average length of stay:	
VLBW	16.2 days
MLBW	12.5 days
Long-term morbidity costs	$1,405/year
Percent with long-term morbidity:	
LBW	18.9%

Data were not available for New Hampshire-specific costs.

Several assumptions made by the Institute of Medicine (1985) are included in this analysis: (1) the reduction in LBW rates from the provision of universal adequate prenatal care would not affect the rates of initial hospitalization, rehospitalization, and long-term morbidity due to LBW births; (2) the content of universal adequate prenatal care would not differ significantly from that currently provided; (3) the costs represent reasonable estimates of charges, in 1984 dollars, and may not include all charges, particularly high-technology diagnostic procedures; and (4) prenatal care for high-risk women may be more costly than that estimated.

To determine the total economic cost of low birth weight in New Hampshire for the 1981–1984 period, the following analysis was performed:

1. *Initial Hospitalization Costs.* The number of LBW infants was multiplied by initial hospitalization costs ($13,616 per LBW infant).
2. *Number of Rehospitalized Infants.* The number of one-month VLBW and MLBW survivors was multiplied by rehospitalization rates of the respective weight groups (38.3 percent and 19.0 percent).
3. *Rehospitalization Costs.* The number of rehospitalized one-month survivors was multiplied by the rehospitalization

costs of the respective weight groups ($372 × 16.2 days for VLBW; $372 × 12.5 days for MLBW).

4. *Number of Infants with Long-Term Morbidity*. The number of one-year survivors was multiplied by the long-term morbidity rate (18.9 percent of one-month survivors).
5. *Long-Term Morbidity Costs*.The number of long-term morbidity LBW infants was multiplied by the long-term morbidity costs ($1,405 per year).
6. *Total Cost of LBW*. The costs of initial hospitalization, rehospitalization, and long-term morbidity were summed.

The second phase of the analysis estimated the costs associated with low birth weight that would be saved if all New Hampshire women received adequate prenatal care. As stated at the beginning of this article, the assumption is made that women who fail to receive adequate prenatal care do so only because of financial constraints. Savings estimates were based on the assumption that the LBW rate of mothers with less-than-adequate prenatal care would be reduced to the rate of mothers receiving adequate prenatal care within the same education group.

The total cost of LBW infants under the condition of universal adequate prenatal care was determined by substituting the expected number of VLBW and MLBW infants, if universal adequate prenatal care were obtained, for the actual numbers of LBW infants in the preceding steps 1-6. Total costs saved by providing universal adequate prenatal care are defined to equal the total estimated costs using the actual (observed) data less the total estimated costs using the target (calculated) data.

Calculation of the cost effectiveness of providing universal adequate prenatal care was the final phase of the analysis. The cost effectiveness was calculated for each education group. The cost of providing universal adequate prenatal care to New Hampshire women was calculated by multiplying the number of mothers who received intermediate and inadequate prenatal care by $200 and $400, respectively. These are the estimated costs per individual of providing the added prenatal care, in 1984 dollars. This total additional cost of providing adequate prenatal care to those receiving intermediate and inadequate care was subtracted from the total costs saved (the total cost savings) to arrive at the net cost savings of providing universal adequate prenatal care. Cost effectiveness can also be defined as a ratio: total costs saved by providing universal adequate prenatal care to total additional cost of providing universal adequate prenatal care.

Table 1: Rates of Prenatal Care and Low Birth Weight by Maternal Years of Education—New Hampshire Resident Births, 1981-1984

	Maternal Years of Education		
Prevalence	*< 12*	*12*	*> 12*
Adequate prenatal care (PNC)	58.7%	79.4%	86.5%
Intermediate prenatal care	32.6	18.0	12.3
Inadequate prenatal care	8.7	2.6	1.2
Low birth weight (LBW)	7.7	5.1	4.0
LBW and adequate PNC	5.9	4.1	3.5
LBW and less-than-adequate PNC	9.6	8.6	7.0

The costs (Institute of Medicine 1985) used in this analysis are based on the cost of prenatal care by trimester of initiation rather than on the adequacy measure employed in this study. The high rate of agreement between these two measures allows the use of these figures in this study. New Hampshire data indicate that all mothers in the adequate prenatal care category initiated care in the first trimester; 75 percent of intermediate prenatal care mothers were second-trimester initiators (the remaining 25 percent began care in the first trimester); and 77 percent of mothers with inadequate prenatal care initiated care in the third trimester (14 percent in the second and 10 percent in the first trimester).

RESULTS

Prenatal care inadequacy is associated with low birth weight in New Hampshire, as shown in Table 1. The data clearly show that the low-education group compares unfavorably with the middle- and high-education groups, both in terms of prenatal care adequacy and birth weight distribution. Only 59 percent of low-education mothers received adequate prenatal care during 1981-1984 compared to 79 percent of mothers with 12 years of education and 87 percent of high-education mothers. Conversely, 8.7 percent of mothers with less than 12 years of education received inadequate prenatal care, compared to 2.6 percent and 1.2 percent of mothers with 12 years and more than 12 years of education, respectively. Low-education women had an almost twofold greater chance of delivering a low birth weight infant than high-education women, 7.7 percent to 4.0 percent, respectively. Women with 12 years of education had a low birth weight rate of 5.1 percent.

Table 2: Calculation of Low Birth Weight Outcomes—New Hampshire Resident Births, 1981–1984, to Women with Less Than 12 Years of Education

	Low Birth Weight		*Very Low Birth Weight*		*Moderately Low Birth Weight*
Initial hospitalization	601‡	=	93	+	508
	(479)§	=	(81)	+	(398)
One-month survival rate*			63.1%		98.0%
One-month survivors	557	=	59	+	498
	(441)	=	(51)	+	(390)
Rehospitalization rate†			38.3%		19.0%
Rehospitalizations			23		95
			(20)		(74)
One-year survival rate*	97.5%				
One-year survivors	543				
	(430)				
Long-term morbidity rate†	18.9%				
Long-term morbidity	103				
	(81)				

*Actual rate, as determined from New Hampshire Vital Records and Health Statistics.

†Rate used in the Institute of Medicine report *Preventing Low Birthweight* (1985).

‡Actual number of LBW, VLBW, and MLBW infants in this population.

§Estimated number of LBW infants, if LBW were decreased in this population.

An association between prenatal care adequacy and birth weight distribution is apparent within all three education groups (see Table 1). The relationship of prenatal care to birth weight appears stronger for the middle- and high-education groups than for the low-education group. Within the higher groups, mothers who received less-than-adequate care had a twofold greater risk of delivering a low birth weight infant than did mothers who received adequate prenatal care. The corresponding relative risk for the low-education group was 1.6.

COSTS

Using the formula adapted from the Institute of Medicine (1985) report and described in the methods section of this article, the total cost of low birth weight in New Hampshire for the 1981–1984 period is estimated to be $38,245,519, approximately $9.6 million per year. Tables 2–4 provide calculations of the actual and target numbers of low birth weight infants for each education level. Table 5 provides the

Table 3: Calculation of Low Birth Weight Outcomes—New Hampshire Resident Births, 1981–1984, to Women with 12 Years of Education

	Low Birth Weight		*Very Low Birth Weight*		*Moderately Low Birth Weight*
Initial hospitalization	1,183‡	=	196	+	987
	(970)§	=	(158)	+	(812)
One-month survival rate*			52.2%		98.1%
One-month survivors	1,070	=	102	+	968
	(879)	=	(82)	+	(797)
Rehospitalization rate†			38.3%		19.0%
Rehospitalizations			39		184
			(31)		(151)
One-year survival rate*	98.1%				
One-year survivors	1,050				
	(862)				
Long-term morbidity rate†	18.9%				
Long-term morbidity	198				
	(163)				

*Actual rate, as determined from New Hampshire Vital Records and Health Statistics.

†Rate used in the Institute of Medicine report *Preventing Low Birthweight* (1985).

‡Actual number of LBW, VLBW, and MLBW infants in this population.

§Estimated number of LBW infants, if LBW were decreased in this population.

total cost figures derived from the actual number of low birth weight infants born during 1981–1984.

The highest proportion of total costs is for the middle-education group, 12 years of education ($17.5 million), followed by the high-education group ($11.9 million) and the low-education group ($8.9 million). The $8.9 million cost for births to mothers with less than 12 years of education represents 23 percent of the total cost of low birth weight, despite the fact that this group accounts for only 15 percent of all births.

It is estimated that the cost of low birth weight in New Hampshire with universal adequate prenatal care would be $31,773,955 (or $7.9 million per year), as shown in Table 6. This represents a savings of $6,471,564 ($1.6 million per year) compared to the estimated costs of actual low-birth weight births. The proportion of low birth weight costs accounted for by the high-risk, low-education group would be reduced from 31 percent to 22 percent of the total costs.

The additional cost of adequate prenatal care to New Hampshire

Table 4: Calculation of Low Birth Weight Outcomes— New Hampshire Resident Births, 1981–1984, to Women with More Than 12 Years of Education

	Low Birth Weight		*Very Low Birth Weight*		*Moderately Low Birth Weight*
Initial hospitalization	805‡	=	171	+	634
	(702)§	=	(152)	+	(550)
One-month survival rate*			57.9%		89.8%
One-month survivors	668	=	99	+	569
	(582)	=	(88)	+	(494)
Rehospitalization rate†			38.3%		19.0%
Rehospitalizations			38		108
			(34)		(94)
One-year survival rate*	95.0%				
One-year survivors	635				
	(553)				
Long-term morbidity rate†	18.9%				
Long-term morbidity	120				
	(105)				

*Actual rate, as determined from New Hampshire Vital Records and Health Statistics.

†Rate used in the Institute of Medicine report *Preventing Low Birthweight* (1985).

‡Actual number of LBW, VLBW, and MLBW infants in this population.

§Estimated number of LBW infants, if LBW were decreased in this population.

Table 5: Estimated Actual Costs Due to Low Birth Weight— New Hampshire Resident Births, 1981–1984

	Maternal Years of Education		
Costs ($)	*< 12*	*12*	*> 12*
Initial hospitalization costs	$8,183,216	$16,107,728	$10,960,880
Rehospitalization costs			
Very low birth weight	138,607	235,030	229,003
Moderately low birth weight	441,750	855,600	502,200
Long-term morbidity costs	144,715	278,190	168,600
Total	8,908,288	17,476,548	11,860,683

mothers who received less-than-adequate prenatal care in 1981–1984 is estimated to be $2,522,200 (Table 7). This includes $1,077,200 for mothers with 12 years of education, $800,000 for low-education mothers, and $645,000 for high-education mothers.

Table 6: Estimated Target Costs Due to Low Birth Weight—New Hampshire Resident Births, 1981-1984

Target Costs ($)	*Maternal Years of Education*		
	< 12	*12*	*> 12*
Initial hospitalization costs	$6,522,064	$13,207,520	$ 9,558,432
Rehospitalization costs			
Very low birth weight	120,528	186,818	204,898
Moderately low birth weight	344,100	702,150	437,100
Long-term morbidity costs	113,805	229,015	147,525
Total	7,100,497	14,325,503	10,347,955

Table 7: Cost of Providing Additional Prenatal Care—New Hampshire Resident Births, 1981-1984

Additional Prenatal Care Costs ($)	*Maternal Years of Education*			*1981-1984 Total*
	< 12	*12*	*> 12*	
Adequate*	$ 0	$ 0	$ 0	$ 0
Intermediate†	511,600	824,800	531,400	1,867,800
Inadequate‡	288,400	252,400	113,600	654,400
Total	800,000	1,077,200	645,000	2,522,200

*$0 per birth with adequate prenatal care.

†$200 per birth with intermediate prenatal care.

‡$400 per birth with inadequate prenatal care.

It is estimated that an additional $2.5 million in prenatal care expenditures over the four-year period would save $6.5 million in costs associated with the care of low birth weight infants (Table 8). This is a net savings of $4 million for 1981-1984, or approximately $1 million per year. This is due to the estimated 438 fewer low birth weight infants who would be born during this period. The average medical cost savings per low-weight birth averted is calculated to be $14,775. The savings can also be expressed as a ratio: $2.57 in medical care costs would be saved for each additional $1.00 spent on prenatal care. The cost effectiveness of prenatal care in reducing low birth weight was estimated to be highest among mothers with 12 years of education ($2.93 saved for each additional prenatal care dollar), followed by high-education mothers ($2.35) and high-risk, low-education mothers ($2.26).

Table 8: Low Birth Weight Cost Savings Associated with Additional Prenatal Care—New Hampshire Resident Births, 1981-1984

1981-1984	*Maternal Years of Education*			*Total*
	< 12	*12*	*> 12*	
Actual costs*	8,908,288	17,476,548	11,860,683	38,245,519
Target costs†	7,100,497	14,325,503	10,347,955	31,773,955
Total cost savings	1,807,791	3,151,045	1,512,728	6,471,564
Additional PNC costs‡	800,000	1,077,200	645,000	2,522,200
Net savings	1,007,791	2,073,845	867,728	3,949,364
Ratio: Total Cost Savings / Additional PNC costs	2.26	2.93	2.35	2.57
Number LBW births averted§	122	213	103	438
Ratio: Total Cost Savings / LBW births averted	$14,818	$14,794	$14,686	$14,755

*From Table 5.

†From Table 6.

‡From Table 7.

§From Tables 2-4.

DISCUSSION

A large body of research has shown that adequate prenatal care is an effective means of reducing the risk of low birth weight (Institute of Medicine 1985; Gregory 1984; Korenbrot 1984; Showstack, Budetti, and Minkler 1984; Leveno, Cunningham, Roard, et al. 1985; Moore, Origel, Key, et al. 1986; Fisher, LoGerfo, and Daling 1985). The current study offers evidence that prenatal care is not only medically effective but also is *cost* effective in preventing low birth weight.

The results of this study show prenatal care to be an effective means of preventing low birth weight for all socioeconomic groups. In fact, the association between prenatal care and birth weight is found to be stronger in the middle and high socioeconomic groups than in the low socioeconomic group. This finding is contrary to evidence from previous research that has shown the association between prenatal care and birth weight to be strongest among low socioeconomic groups (e.g., Moore, Origel, Key, et al. 1986; Fisher, LoGerfo, and Daling 1985).

One possible reason for this finding may be the differences in the

sensitivity of prenatal care indicators. The prenatal care scale employed in the current analysis is the Kessner index, which has been shown to be a more sensitive indicator of prenatal care adequacy than the more commonly employed "trimester of prenatal care initiation" index (Showstack, Budetti, and Minkler 1984). An unpublished comparison of these two scales using New Hampshire vital records data (New Hampshire Bureau of Vital Records and Health Statistics 1987) found no association between prenatal care and birth weight for the high-education group using the trimester index but a strong relationship using the Kessner index. The other two education groups showed significant associations between prenatal care and birth weight for each index. This means that if the trimester index had been employed in the current analysis, prenatal care would not have been shown to be a cost-effective means of reducing low birth weight in the high-education group.

Another somewhat unexpected finding in this study was that the cost-savings estimates were considerably lower than those of the IOM (1985) study. The discrepancy is probably due to the difference between the target low birth weight rates employed in the respective studies. Target rates for the New Hampshire (NH) study were the low birth weight rates actually achieved by women who received adequate prenatal care. The IOM target rate was the Surgeon General's 1990 objective of 9 percent. Due to data limitations, it would not have been possible for the IOM to use the selection criteria employed in the NH study. If the same criteria had been used, there is little doubt that the resulting target rate would have been considerably higher than 9 percent. The IOM's high-risk target group was defined as women with less than a high school education and on public assistance. As of 1984, the low birth weight rate of all U.S. mothers with less than 12 years of education was 10 percent (National Center for Health Statistics 1984, 1985, 1986, 1987). The rate for women within this education group who received first-trimester prenatal care was 9.3 percent. The IOM estimated the low birth weight rate of its target group to be 11.5 percent. It is therefore likely that the low-birth weight rate for those receiving first-trimester care within this group would be considerably higher than 9.3 percent. The IOM report noted that if their high-risk group achieved a low birth weight rate of 10 percent, the medical care cost savings would be $2.03 for each prenatal care dollar spent. This is more comparable to the NH low-education group estimate of $2.26 and the Obstetrical Access Project estimate of $2.60 (Lennie, Klun, and Hausner 1987).

Another possible explanation for the discrepancy in cost savings

Table 9: Comparison of New Hampshire and U.S. Demographics—Selected Risk Factors as Percentages of All Births, 1981-1984

	Percent of All Births		
Risk Factors	*New Hampshire*	*United States*	*United States Whites*
Unmarried	12.1%	19.9%	12.5%
Maternal Age < 20 years	9.5	14.0	11.9
Education < 12 years	14.9	21.6	18.7
Birth weight < 2,500 grams	5.1	6.8	5.6
Race = nonwhite	1.7	20.0	—
Prenatal care = third trimester or none	2.3	5.1	4.0

Source: New Hampshire data: Bureau of Vital Records and Health Statistics (1982, 1983, 1984, 1985); United States data: National Center for Health Statistics (1984, 1985, 1986, 1987).

between this and the IOM study has to do with population composition. New Hampshire mothers compare favorably to U.S. mothers with respect to educational attainment, teenage birth rates, births to unmarried mothers, and other major risk factors (Table 9). In addition, fewer than 2 percent of NH mothers are nonwhite, compared to approximately 20 percent for the United States as a whole. This low-risk profile is reflected in New Hampshire's low overall low birth weight rate. If the effect of prenatal care on low birth weight is greater for higher-risk groups (Institute of Medicine 1985; Lennie, Klun, and Hausner 1987; Kleinman and Kessel 1987), then the cost effectiveness of prenatal care may also be greater for the higher-risk IOM target group than for the New Hampshire population.

As noted at the beginning of this article, the current study addresses only financial barriers to the provision of prenatal care and not other barriers, such as lack of awareness of available services, lack of availability of transportation and child care, or inclement weather. The assumption in this study, as in the IOM study, is that women who fail to receive adequate prenatal care do so solely because they are unable to pay for the care itself. This oversimplifies the actual situation and may result in underestimates of the true economic cost of ensuring that a woman receives adequate care.

There is one major group, however, for which additional prenatal care cost estimates are possibly *overestimated*: women whose prenatal care and delivery are funded by Medicaid. A preliminary analysis of Medicaid-funded pregnancy care in New Hampshire illustrates this

point. Most Medicaid-funded pregnancies involve a global care package that pays the physician for 11 prenatal visits, delivery (vaginal or cesarean section), and 3 postpartum visits. There is a set price for the global package, regardless of the actual number of visits the client makes or the month in which she initiates prenatal care. Analysis of New Hampshire births occurring in the first half of 1984 provides evidence of underutilization of prenatal care by Medicaid mothers (New Hampshire Bureau of Vital Records and Health Statistics 1986). Only 55 percent of mothers with the global care package began prenatal care in the first trimester; 35 percent initiated care in the second trimester; the remaining 10 percent began care in the third trimester. In addition, among Medicaid mothers who began prenatal care in the first trimester, 39 percent had fewer than the 11 prenatal visits covered by the global package. Thus, a full two-thirds of Medicaid-funded births involved women who received less than adequate prenatal care, despite the fact that for most of these women the financial costs for this care were already covered. Thus, cost estimates calculated in this study may be overestimates to the extent that the cost of overcoming these other barriers to prenatal care is less than the cost of paying for additional direct care.

The current study is a population-based retrospective analysis of aggregated vital-records data and average direct medical care costs. In addition to contributing to the growing body of research on the cost effectiveness of prenatal care, this study provides state and local health departments with an inexpensive method of assessing the cost effectiveness of prenatal care within their own populations. The study is based on an adapted version of the Institute of Medicine cost-effectiveness model. The major departure of this study from the IOM model is the use of a more conservative (and therefore more readily achievable) target low birth weight rate. The current study also expands on the IOM approach by including all socioeconomic groups in the analysis. Further refinements of the IOM model, such as employing the actual local costs of prenatal and medical care, may provide even more accurate cost-effectiveness estimates. The model might also be expanded to include quantification of the economic costs of removing barriers to prenatal care other than the direct-cost factor. Many states are currently engaged in surveys designed to determine the nature and extent of prenatal care barriers in their population. If the prevalence of these barriers can be ascertained, and incorporated into the IOM model, then it may be possible to provide a more complete picture of the cost of removing barriers to prenatal care.

There are many who believe, on the basis of the overwhelming

evidence, that prenatal care promotes positive pregnancy outcomes and that society has an obligation to make prenatal care available universally—regardless of cost and ability to pay—and to encourage its full utilization by all pregnant women. The current study provides evidence that *not* providing universal adequate prenatal care is more costly to society than providing it, because of the costs due to the results of low birth weight.

REFERENCES

Fisher, E. S., J. P. LoGerfo, and J. R. Daling. "Prenatal Care and Pregnancy Outcomes during the Recession: The Washington State Experience." *American Journal of Public Health* 75, no. 8 (1985):866–69.

Gregory, M. *Final Evaluation of the Obstetrical Access Pilot Project, July 1979–June 1982*. HCFA Grant No. 11-P-97578/9-03. Sacramento: State of California, Dept. of Human Services, December 1984.

Institute of Medicine. *Preventing Low Birthweight*. Washington, DC: National Academy Press, 1985.

Joyce, T. J., H. Corman, and M. Grossman. "A Cost-Effectiveness Analysis of Strategies to Reduce Infant Mortality." Presented at the Conference on Prenatal Care and Infant Mortality, sponsored by the Bush Foundation, Washington, DC, 27–28 May 1986.

Kessner, D. M., J. Singer, C. E. Kalk, and E. R. Schlesinger. "Infant Death: An Analysis by Maternal Risk and Health Care." In *Contrasts in Health Status*, Vol. 1. Washington, DC: Institute of Medicine, National Academy of Sciences, 1973.

Kleinman, J. C., and S. S. Kessel. "Racial Differences in Low Birthweight." *New England Journal of Medicine* 317, no. 12 (17 September 1987): 749–53.

Korenbrot, C. C. "Risk Reduction in Pregnancies of Low-Income Women: Comprehensive Prenatal Care Through the OB Access Project." *Mobius* 4, no. 3 (1984):35–43.

Lennie, J. A., J. R. Klun, and T. Hausner. "Low-Birth-Weight Rate Reduced by the Obstetrical Access Project." *Health Care Financing Review* 8, no. 3 (Spring 1987):83–86.

Leveno, K. J., F. G. Cunningham, M. L. Roard, S. D. Nelson, and M. L. Williams. "Prenatal Care and the Low Birth Weight Infant." *Obstetrics and Gynecology* 66, no. 5 (1985):599–605.

Moore, T. R., W. Origel, T. C. Key, and R. Resnik. "The Perinatal and Economic Impact of Prenatal Care in a Low-Socioeconomic Population." *American Journal of Obstetrics and Gynecology* 154, no. 1 (1986): 29–33.

National Center for Health Statistics. Public Health Service. Office of Health Research, Statistics, and Technology. *Factors Associated with Low Birth Weight, United States, 1976*. Series 21, Number 37. DHEW Publication No. (PHS) 80-1915. Hyattsville, MD: Public Health Services, April 1980.

National Center for Health Statistics. *Vital Statistics of the United States: Volume II, Natality*. 1981 annual edition. Hyattsville, MD: Dept. of Health and Human Services, 1984.

_____. *Vital Statistics of the United States: Volume II, Natality*. 1982 annual edition. Hyattsville, MD: Dept. of Health and Human Services, 1985.

_____. *Vital Statistics of the United States: Volume II, Natality*. 1983 annual edition. Hyattsville, MD: Dept. of Health and Human Services, 1986.

_____. *Vital Statistics of the United States: Volume II. Natality*. 1984 annual edition. Hyattsville, MD: Dept. of Health and Human Services, 1987.

New Hampshire Bureau of Vital Records and Health Statistics. "A Comparison of Medicaid and Non-Medicaid Births: New Hampshire 1984." Unpublished report, Division of Public Health Services, Dept. of Health and Human Services, State of New Hampshire, September 1986.

_____. "Comparison of Two Measures of Prenatal Care: Trimester of Prenatal Care and the Kessner Index." Unpublished report, Division of Public Health Services, Dept. of Health and Human Services, State of New Hampshire, September 1987.

_____. *New Hampshire Vital Statistics* 1981, 1982, 1983, 1984. New Hampshire: State Center for Health Statistics 1982, 1983, 1984, 1985.

Showstack, J. A., P. P. Budetti, and D. Minkler. "Factors Associated with Birthweight: An Exploration of the Roles of Prenatal Care and Length of Gestation." *American Journal of Public Health* 74, no. 9 (1984):1003–07.