The Cost Effectiveness of Prenatal Care

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This study uses hospital records for 7,000 births in McLennan County, Texas, during the period June 1987-July 1989 to examine the association between prenatal care and birth outcome and the implications for hospital costs of newborn infants. After controlling for a variety of maternal and birth factors, a significant relationship between prenatal care and birth outcome remained. Females who failed to receive prenatal care were almost three times as likely to have a low-birth-weight infant (weighing less than 2,500 grams) than females who did. Using an ordinary least squares (OLS) estimating equation (R^2 = .24), the net expected hospital cost savings for females who received prenatal care was over $1,000.

INTRODUCTION

During the past two decades, medical research has provided substantial evidence supporting the hypothesis that length of gestation and birth weight affect infant mortality and childhood morbidity (Gortmaker, 1979; Showstack, Budetti, and Minkler, 1984). Infants weighing less than 2,500 grams (or 5.5 pounds) have a mortality rate that is 40 times greater during the neonatal period than infants weighing more than 2,500 grams (McCormick, 1991). Not only do infants weighing less than 750 grams have lower survival rates, but they have an increased risk of serious neurologic and developmental impairment (Hack and Fanaroff, 1989).

Despite the importance of birth weight in birth outcome, the primary cause of perinatal mortality in the United States is preterm birth (Kleinman and Madans, 1991). Although this is an issue of individual medical importance, it is also a matter of national policy concern. Even though infant mortality rates by birth-weight category in the United States are among the lowest in the developed world, the overall infant mortality rates are among the highest. This statistical anomaly is because of the higher rates of preterm infants born in the low-birth-weight categories (Behrman, 1987).

Perhaps even more troubling is the mounting evidence that the incidence of low-weight births is rising. Joyce (1990) estimated that by 1990 the percentage of low-weight births among black females in New York City would exceed the rates of 20 years earlier, with most of the increase in the late 1980s. Although data limitations make conclusions tentative, Joyce offered the increase in substance abuse, particularly cocaine and crack, as the most likely cause of the increased incidence of low birth weight.

The challenge to medical practitioners is to develop programs that reduce the incidence of preterm delivery and low birth weight, especially among females of lower socioeconomic status, both white and black. Evidence seems to indicate that a comprehensive prenatal care program focusing on prematurity prevention may be able to reduce the incidence of low birth weight among females of all ages (Buescher et al., 1988). In fact, early prenatal care (beginning in the first trimester) among white teenagers has been shown to be associated with a 27-percent reduction in low-weight births (Frank et al., 1989).

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Although the association between prenatal care and birth outcome is indisputable, there is still no clear cut causal relationship between the two. The primary issue addressed in this study is the cost effectiveness of prenatal care. Although proponents of prenatal care programs stress the potential cost savings, estimates vary widely depending on the population studied and the methodology used. Murray and Bernfield (1988) have estimated that the annual cost savings of adequate prenatal care is approximately $230 per mother (1986 dollars). This includes the cost savings from neonatal intensive care and rehospitalization within the first year. Monmaney (1988) reported that a Virginia program, if adopted statewide, could save the State almost $50 million annually by reducing the incidence of certain types of mental retardation due to low birth weight. If this program were adopted nationally, it would save between $14,000 and $30,000 for every low-birth-weight baby avoided.

Lifetime and aggregate estimates of savings tell an even more dramatic story. The National Commission to Prevent Infant Mortality (1991) has estimated the cost of lifetime custodial care of low-birth-weight babies to be as much as $500,000 per child. Additionally, this report estimated that 80 percent of the females at high risk for low-birth-weight babies can be identified in the first prenatal visit. The Congressional Office of Technology Assessment (1987) has estimated the cost of caring for babies who weigh less than 1,140 grams (2.5 pounds) at birth to be an average $140,000 per patient, bringing the annual cost of neonatal intensive care in the United States to a total of $1.5 billion. A survey conducted by the Institute of Medicine and reported by Droste (1988) estimated that for every dollar spent on prenatal care, $3.38 is saved in the cost of caring for low-birth-weight infants.

Despite the evidence that high quality prenatal care is associated with improved pregnancy outcomes (and lower overall costs), only 76 percent of all pregnant females receive care in their first trimester. For black and Hispanic females, the corresponding figure is 61 percent (Health Resources and Services Administration, 1991). If the cost savings have not been overstated, utilization of prenatal care programs appears to be at suboptimal levels.

Previous research into the cost effectiveness of prenatal care has been limited because of the lack of individual cost data. Most of the studies previously cited use birth certificate data to examine the relationship between prenatal care and birth outcome, and payment rate schedules to estimate cost savings. This study develops a simple model of birth outcome measured by the infant's birth weight. From this model, the hospital cost differential between females who received prenatal care and those who did not is estimated. An estimate of the cost differential can be more accurate than before because of the availability of a detailed microdata base that contains individual observations on birth outcome and hospital costs incurred.

METHODOLOGY

Data for this study were provided by Hillcrest Baptist Medical Center and Scott and White Hospital. More than 7,000 records for infants and mothers were obtained, representing virtually all births in McLennan County from June 1987 through July 1989.[1] The procedure for matching

[1]Approximately 100 babies are born annually in the West Community Hospital in McLennan County. As many are born at Scott and White Hospital in Bell County, and have not been included. Thus, this sample represents approximately 95 percent of the babies born in the county. A relatively small number of females were included in the data base twice, representing two separate pregnancies—one early in the study period and one late in the period.

babies to mothers resulted in the loss of fewer than 20 records for the period under study. For each record, the relevant demographic data, including age, race, marital status, and ZIP Code, were obtained. In addition, diagnosis and cost information for the infant and mother are included. Actual hospital procedures were also recorded, controlling for cesarean delivery, premature labor, and whether the infant died or was discharged to the home or to another hospital with a neonatal intensive care unit (i.e., Scott and White Hospital in Temple, Texas). Finally, mothers who did not receive prenatal care were identified from a survey conducted by the nursing staff of the hospital nursery at the time of admittance into labor and delivery.[2] Prenatal care is described as any type of medical care received by a prospective mother, such as physician visits or any organized prenatal program provided by a medical practitioner.

RESULTS

The Study Population

Characteristics of the study population are summarized in Table 1. The data are presented to provide easy comparison with those used in previous studies. Mean birth weight for McLennan County babies was 3,365 grams (7.4 pounds), compared with that of the California study cohort reported by Showstack, Budetti, and Minkler (1984) of 3,388 grams (also 7.4 pounds). Factors important in determining birth outcome (Kessel et al., 1984) are: the ethnic group and marital status of the mother (60.6 percent white and 70.1 percent married); the percentage of the population in the high-risk age groups (13.7 percent are either under age 18 or over 34 years of age); the type of delivery (20.7 percent cesarean); the percentage premature (4.9 percent); the percentage of multiple births (6.2 percent); and the percentage of females who received no prenatal care (5.4 percent).

Differences between the white and non-white populations are also recorded. These follow the same pattern reported in Murray and Bernfield (1988). The data reveal that non-white infants are smaller (3,265 grams versus 3,430 grams), and non-white mothers are younger (23.3 years versus 25.8 years of age) and more likely to be unmarried (52.4 percent versus 15.2 percent).

Prenatal Care and Birth Outcome

The first task was to examine the relationship between prenatal care and birth outcome. The mean birth weight for babies whose mothers received prenatal care was 3,380 grams (7.4 pounds). Those babies whose mothers received no prenatal care weighed an average of 3,100 grams (6.8 pounds). These mean birth-weight differences remain when the data are divided according to race and marital status.

Table 2 presents the characteristics according to race and marital status. In all eight categories, mothers who received prenatal care gave birth to babies who weighed more. The differences ranged from 105 grams for non-white married females to 379 grams for white single females. The distribution of birth weights shows the same basic pattern: Females with prenatal care are more likely to give birth to babies weighing more than 2,500 grams and less likely to have babies weighing less than 1,500 grams.

The odds of having a low-birth-weight baby are substantially higher for females who do not receive prenatal care. Using the

[2]Data on the duration and scope of the prenatal care received are not available. Females who had no admitting physician or whose admitting physician was a resident at the Family Practice Center (a family practice residency program affiliated with the University of Texas Southwestern Medical School) were screened to determine if they had received prenatal care. This information was cross-referenced with the labor and delivery survey for the final determination.

Table 1

Characteristics of McLennan County Births: June 1987-July 1989

Characteristic	Total	White	Non-White
Sample Size	7,055	4,263	2,775
Birth Weight			
Mean Grams	3,365	3,430	3,265
		Percent	
More Than 2,500 Grams	89.4	91.0	87.0
1,500-2,500 Grams	5.0	4.0	6.5
Less Than 1,500 Grams	5.6	5.0	6.5
Sex			
Male	49.0	49.2	48.9
Female	51.0	50.8	51.1
Ethnic Group			
White	60.6	100.0	0
Non-White	39.4	0	100.0
Age			
Mean Years	24.8	25.8	23.3
		Percent	
Under 18 Years	8.4	4.2	14.2
18-34 Years	86.3	89.7	81.7
Over 34 Years	5.3	6.1	4.0
No Prenatal Care	5.4	2.4	9.9
Marital Status			
Married	70.1	84.8	47.6
Not Married	29.9	15.2	52.4
Type of Delivery			
Normal	79.3	76.9	82.8
Cesarean	20.7	23.1	17.2
Other Data			
Premature Birth	4.9	4.2	5.9
Multiple Delivery	6.2	6.0	6.1

SOURCE: Henderson, J., Baylor University, 1994.

approach suggested by Wartenberg and Northridge (1991) for calculating an odds ratio, females who receive no prenatal care are 2.68 times more likely to give birth to a low-birth-weight infant (one weighing less than 2,500 grams) than females who receive at least some care. In fact, white females increase their risk of having a low-birth-weight infant 3.92 times by failing to obtain prenatal care; the increase for non-white females is only 1.85 times. The cause of this white and non-white differential is open to speculation. Several confounding factors may contribute to it, including intracategory differences in socioeconomic status, alcohol and cigarette use, and drug abuse. The small sample sizes for the no-care groups may also play a role. At any rate, there is no way to know for sure because data on these variables were not collected.

Another observation worth noting is the apparent association between prenatal care and the likelihood of cesarean delivery. Does prenatal care increase the odds of having a cesarean section, or is some other mechanism at work? The high incidence and related causes of cesarean deliveries have been the object of considerable medical research (Taffel, Placek, and Liss, 1987; Myers and Gleicher, 1988). It is unlikely that females who receive prenatal care have a higher incidence of factors that are the primary indicators for

Table 2
Characteristics of McLennan County Births, by Race and Marital Status

	White Single		White Married		Non-White Single		Non-White Married	
Characteristic	Care	No Care	Care	No Care	Care	No Care	Care	No Care
Total	603	44	3,556	60	1,278	177	1,222	98
Birth Weight								
Mean Grams	3,283	2,904	3,468	3,206	3,203	3,024	3,360	3,255
				Percent				
More Than 2,500 Grams	87.7	81.8	91.8	81.7	85.6	79.1	89.4	89.8
1,500-2,500 Grams	4.8	4.5	3.7	11.7	6.8	13.0	5.6	4.1
Less Than 1,500 Grams	7.5	13.6	4.5	6.7	7.7	7.9	5.1	6.1
Premature Birth	5.3	9.1	3.9	5.0	6.2	13.6	4.6	5.1
Multiple Delivery	7.1	9.1	5.7	10.0	6.5	6.2	6.1	1.0
Transferred	0.8	9.1	0.7	3.3	0.6	1.1	0.7	1.0
Infant Death	0.3	4.5	0.3	3.3	0.7	1.7	0.2	1.0
Cesarean Delivery	18.6	4.5	24.3	8.3	14.8	9.0	21.3	11.2
Age								
Mean Years	22.1	21.8	26.5	24.8	21.7	22.4	25.3	22.8
				Percent				
Under 18 Years	17.6	13.6	1.8	5.0	23.5	16.9	4.7	8.2
18-34 Years	79.9	84.1	91.4	91.7	74.1	79.7	89.3	90.8
Over 34 Years	2.5	2.3	6.8	3.3	2.4	3.4	6.0	1.0

SOURCE: Henderson, J., Baylor University, 1994.

cesarean section (i.e., previous cesarean section, dystocia, breech presentation). One avenue worth future exploration is the impact of defensive practices by caregivers to avoid possible malpractice lawsuits.

Females who received prenatal care had fewer babies transferred to acute-care facilities, fewer infant deaths, and a higher incidence of cesarean deliveries. Although this does not rule out intrinsic differences between females who receive and those who do not receive prenatal care, it does demonstrate a clear association between prenatal care and birth outcome within narrowly defined demographic cohorts.

Because other factors also contribute to differences in birth weights, OLS regression was used to adjust for the following characteristics. Equation 1 shows the estimating equation for birth outcome.

$$\text{BWT} = a_0 + a_1\text{Age} + a_2\text{Male} - a_3\text{MB} + a_4\text{Married} - a_5\text{Premat} - a_6\text{Non-White} - a_7\text{No-Care} + u \quad (1)$$

where:

BWT = birth weight (in ounces);
Age = maternal age upon admission to hospital;
Male = dummy variable equal to 1, if child is male;
MB = dummy variable equal to 1, if multiple birth;
Married = dummy variable equal to 1, if mother is married;
Premat = dummy variable equal to 1, if labor is premature;
Non-White = dummy variable equal to 1, if mother is black or Hispanic; and
No-Care = dummy variable equal to 1, if mother did not receive prenatal care.

Table 3 presents the regression results of birth weight (measured in ounces) on these explanatory variables. All coefficients have the expected signs. The data suggest that the lack of prenatal care has a negative effect on birth outcome. Even after adjusting for the other independent variables, babies born to mothers who received no prenatal care weighed about 145 grams (5.09 ounces) less than those whose mothers received prenatal care.

Increased maternal age is associated with bigger babies. For each additional year of the mother's age at delivery, the baby's weight increases by 6 grams (0.20 ounces). The use of age categories, though not reported in Table 3, displays a similar pattern. Females who are under 18 years of age give birth to babies who weigh an average of 60 grams (2.2 ounces) less than those of females between 18 and 34 years of age. The age coefficient for females more than 35 years of age is insignificant, indicating that the relationship between age and birth weight is likely to be non-linear. Age may serve, in part, as a proxy for birth order, with a higher incidence of first births (and thus smaller babies) to those in their early teens.

Birth weight is also associated with marital status. Married females have babies who weigh 140 grams (4.09 ounces) more. Marital status may be a proxy for healthy behavior. For example, it is well documented that single females have a higher incidence of cigarette smoking than married females. Multiple births reduce birth weight by 659 grams (23.06 ounces) and premature delivery is associated with birth weights that are 943 grams (33.02 ounces) lower. After adjusting for all these characteristics, non-white females still give birth to babies who weigh 80 grams (2.79 ounces) less than white females. Additionally, when the population is divided into white and non-white cohorts, the regression results are quite similar. However, several coefficients differ significantly. The impact of multiple births is more pronounced on white than non-white babies. Birth weights are 740 grams (26 ounces) lower for white multiple births and only 456 grams (16 ounces) lower for non-white multiple births. Prematurity has the opposite impact. White premature babies weigh 884 grams (31 ounces) less than those born at term; non-white premature babies weigh 1,026 grams (36 ounces) less than those born at term.

Table 3

Ordinary Least Squares Regression Coefficients: Dependent Variable Birth Weight in Ounces

Independent Variable	Total	White Persons	Non-White Persons
Age	0.20	0.23	0.15
	(4.04)	(3.98)	*(1.65)
Baby's Sex (If Male=1)	4.63	4.94	4.07
	(9.09)	(8.71)	(4.26)
Multiple Birth	-23.06	-26.42	-16.26
	(13.20)	(14.22)	(4.54)
Marital Status (If Married=1)	4.90	5.39	4.48
	(7.66)	(6.42)	(4.45)
Premature Labor	-33.02	-30.75	-35.77
	(27.29)	(21.06)	(17.44)
No Prenatal Care	-5.09	-8.40	-3.54
	(4.45)	(4.56)	**(2.21)
Non-White Infant	-2.79	—	—
	(4.86)	—	—
Intercept	110.88	109.69	109.68
R^2	0.1866	0.2064	0.1475
Number of Observations	6,702	4,075	2,626
F-value	219.46	176.33	75.57

* Significant at the .10 level.
**Significant at the .05 level.

NOTES: *t*-values in parentheses. All coefficients significant at the .01 level except as previously noted.

SOURCE: Henderson, J., Baylor University, 1994.

One of the more interesting differences is the impact of prenatal care between the two groups. White females who receive prenatal care give birth to babies who weigh 326 grams (11.49 ounces) more than those who do not. The effect of prenatal care on non-white birth outcome is much less pronounced. Non-white females who receive prenatal care give birth to babies who weigh about 172 grams (6.05 ounces) more.

Prenatal Care and Hospital Costs

As previously stated, prematurity and its resulting low birth weights are major contributing factors leading to complications that result in higher costs, such as transfers to intensive-care unit (ICU) facilities. There was a much higher incidence of prematurity, low birth weights, and transfers to acute-care facilities among females who did not receive prenatal care. Only 4.60 percent of the females who received prenatal care experienced premature labor, whereas 9.50 percent of those who did not receive prenatal care delivered prematurely. Transfers to acute-care facilities involved 0.71 percent of the babies whose mothers received prenatal care, and 1.85 percent of those whose mothers did not receive prenatal care. Infant mortality was more pronounced among mothers who did not receive prenatal care; 2.11 percent of their babies died in the hospital, compared with 0.38 percent of those babies born to mothers who received prenatal care. Hospital charges for infants with prenatal care are on average $1,198.42 less than those without prenatal care ($1,045.69 versus $2,244.11).

The regression equation for hospital charges was estimated using birth weight (Equation 2.1) as an independent variable, and birth-weight categories (Equation 2.2). Three birth-weight categories were defined: BWT1 for normal birth weights greater than 2,500 grams, BWT2 for low birth weights from 1,500 to 2,500 grams, and BWT3 for very low birth weights less than 1,500 grams.

$$\text{Charges} = b_0 - b_1\text{BWT} + b_2\text{Transfer} + b_3\text{Stay} + b_4\text{Died} + u \quad (2.1)$$

$$\text{Charges} = c_0 + c_1\text{BWT2} + c_2\text{BWT3} + c_3\text{Transfer} + c_4\text{Stay} + c_5\text{Died} + u \quad (2.2)$$

where:

Charges = hospital charges for infant (in dollars);

Transfer = dummy variable equal to 1, if infant was transferred to an acute-care facility;

Stay = length of infant's hospital stay (in days); and

Died = dummy variable equal to 1, if infant died in hospital.

Regression results for these two equations are reported in Table 4. As expected, birth weight and hospital charges are negatively associated. The hospital charge for the infant was lowered by $10.24 for every ounce the baby weighed. The use of birth-weight categories in estimating Equation 2.2 shows a somewhat different perspective on this relationship. Other things equal, coefficient estimates indicate that infants in the BWT2 category (from 1,500 to 2,500 grams) had charges that were $1,065.41 lower than normal-birth-weight infants (more than 2,500 grams). This may be because of the large proportion of infants in this category that can be classified "small-for-term," weighing between 2,240 and 2,500 grams.[3] The added expense for very low-birth-weight infants (less than 1,500 grams) was $13,638.32 because of the medical complications evident in extremely low-birth-weight infants.

Infants who were transferred had charges that were more than $48,091 higher than those who were not. Each extra day in the hospital increased the charges by $438.55.

[3] The remainder of the infants in this birth-weight category have a much higher incidence of ICU transfers and longer hospital stays. Overall, this makes this category of infants more expensive.

Table 4
Ordinary Least Squares Regression Coefficients: Hospital Charges for Infant

	Total Sample		White Infants		Non-White Infants	
Independent Variable	(2.1)	(2.2)	(2.1)	(2.2)	(2.1)	(2.2)
Birth Weight in Ounces (BWT)	-10.24	—	-19.45	—	-6.02	—
	*(2.00)	—	*(2.04)	—	(2.40)	—
Birth Weight 1,500-2,500 Grams (BWT2)	—	-1,065.41	—	-1,876.65	—	149.53
	—	*(2.04)	—	*(2.03)	—	**(0.57)
Birth Weight Less Than 1,500 Grams (BWT3)	—	13,638.32	—	26,077.08	—	8,364.34
	—	(8.29)	—	(8.31)	—	(10.74)
Transferred	48,091.43	47,119.67	52,919.93	52,099.91	35,864.35	34,760.26
	(31.80)	(31.25)	(23.37)	(23.16)	(36.79)	(36.01)
Stayed	438.55	335.13	511.97	341.07	317.90	219.90
	(12.98)	(8.88)	(9.78)	(5.90)	(15.63)	(9.55)
Died	-7,084.12	-16,891.20	-10,371.15	-29,261.59	-3,982.25	9,966.78
	(4.10)	(8.01)	(3.35)	(7.55)	(4.61)	(9.79)
Constant	692.74	-228.82	1,647.20	-228.73	499.80	34.67
R^2	0.2381	0.2466	0.2223	0.2366	0.5228	0.5422
N	6,702	6,702	4,075	4,075	2,626	2,626
F-value	523.4	438.5	290.9	252.3	718.1	620.7

* Statistically significant at the .05 level.
**Not statistically significant at the .10 level.
NOTES: *t*-values in parentheses. All coefficients significant at the .01 level except as previously noted.
SOURCE: Henderson, J., Baylor University, 1994.

Goodness of fit as measured by R^2 is greater than .23, depending on the specification of the equation.

DISCUSSION AND CONCLUSIONS

Although the results of this study do not demonstrate a causal relationship between prenatal care and birth outcome, they do suggest an association between prenatal care and positive birth outcome. The independent effect of prenatal care on birth weight, adjusted for differences in other regressors in Equation 1, is 145 grams (5.09 ounces). In other words, even after adjusting for other differences, infants born to females who receive prenatal care weigh about 145 grams more than those whose mothers do not receive prenatal care. Referring to Table 5, these babies also are less likely to fall into the low- and very low-birth-weight categories (10.23 percent versus 17.42 percent), proportionately fewer are born prematurely (4.60 percent versus 9.50 percent), the incidence of transfer to an acute-care facility is less than one-half (0.71 percent versus 1.85 percent), and the incidence of early death is much lower (0.38 percent versus 2.11 percent).

The main contribution of this study is that it brings into the analysis for the first time cost information based on actual hospital charges rather than estimates based on surveyed prices. The predicted value of the cost of care can be determined using the results presented in Table 4 from Equation 2.1. Babies whose mothers received prenatal care have a predicted hospital cost of $1,064.61, compared with $2,068.66 for those whose mothers did not receive care prior to the onset of labor—a difference of $1,004.05.

Table 5
Mean Values for Predictive Variables

Variable	Received Care	No Care
Birth Weight in Ounces (BWT)	3,380	3,100
	Percent	
Birth Weight More Than 2,500 Grams (BWT1)	89.82	82.59
Birth Weight 1,500-2,500 Grams (BWT2)	4.76	9.50
Birth Weight Less Than 1,500 Grams (BWT3)	5.47	7.92
Premature	4.60	9.50
Transferred	0.71	1.85
Died	0.38	2.11
	Days	
Length of Stay	2.90	3.99
Mean Charges	$1,045.69	$2,244.11

SOURCE: Henderson, J., Baylor University, 1994.

The basis of the cost savings associated with prenatal care seems to be in the associated lower incidence of extremely low-birth-weight babies among females who receive prenatal care. As previous studies have indicated (e.g., Lennie, Klun, and Hausner, 1987), low-birth-weight infants have significantly higher medical expenses than normal-birth-weight infants. Table 6 provides a breakdown of the average hospital charges and proportion of births in each of the three birth-weight categories. For females who received prenatal care, the hospital charges for low-birth-weight infants (1,500 to 2,500 grams) were more than 4 times those of normal-birth-weight infants. Very low birth weights resulted in charges of more than 33 times those for normal birth weights. For females who did not receive prenatal care, the results were worse. Low-birth-weight infants had almost 6 times the charges of normal-birth-weight infants, and very low-birth-weight infants had charges of more than 70 times normal.

Fortunately, only 5.72 percent of the births to females with prenatal care fall into the two low-birth-weight categories. However, this contrasts with more than 14 percent of the births in these low-birth-weight categories to females who received no prenatal care. Although it is unreasonable to expect that low and extremely low birth weights will be eliminated completely, it seems reasonable to expect that were they to receive prenatal care, the distribution of birth weights for the mothers who received no prenatal care would converge toward that of the mothers who received prenatal care. Using this as a working assumption, if the 364 mothers who received no prenatal care had the same birth-weight distribution as the 6,344 mothers who received prenatal care, their average hospital charges would fall from $2,297.42 to $926.19, a reduction of $1,371.23. Note that this calculation holds constant the average charges within each category, to allow for differences in the distribution of charges within each category.

This figure is actually $103.31 less than the charges for those infants whose mothers had prenatal care. One reason for this phenomenon may be that women in this category had fewer cesarean deliveries and thus the infants with normal birth weights had shorter average hospital stays. Females delivering normal-sized babies had lower cesarean-section rates than females delivering extremely low-birth-weight babies (23.0 percent versus 40.7 percent for white females; 17.2 percent versus 20.6 percent for non-white females). If the rate for non-white females adjusts to the higher rate for white females within each birth-weight category, overall the non-white group would have 154 more cesarean deliveries. Using the coefficient on length of stay from Equation 2.1 in Table 4 (i.e., 317.90), the average cost would increase by approximately $20 per infant for every day the average stay increased. Thus the average stay for babies

Table 6

Mean Hospital Charges by Birth-Weight Categories for Females With and Without Prenatal Care

Birth Weight	With Prenatal Care		Without Prenatal Care	
	Charges	Percent Distribution	Charges	Percent Distribution
Average	$1,029.50	100.00	$2,297.42	100.00
More Than 2,500 Grams	735.14	94.28	534.91	85.99
1,500-2,500 Grams	3,215.19	5.00	3,080.01	9.89
Less Than 1,500 Grams	24,395.90	0.72	37,204.90	4.12

SOURCE: Henderson, J., Baylor University, 1994.

delivered by cesarean section would have to be more than 5 days above the average for normally delivered babies.[4]

The use of population-based data is an important addition to the analysis of cost-of-care questions. Although the study sample is regionally isolated and too small to make sweeping generalizations, the demographic characteristics of the McLennan County population are representative of those of metropolitan areas across the country. This includes age and ethnic composition, socioeconomic characteristics, and, unfortunately, drug use and abuse. The possible net cost savings attributable to prenatal care are substantial. A savings of $1,371.23 per birth for this group of women translates into a group savings of more than $499,000. With more than 3.8 million births annually in the United States, if the same percentage of females fail to receive prenatal care nationally (5.43 percent), this translates to 208,000 births for this group. Prenatal care for this group could potentially save $285 million nationally in hospital charges in the perinatal period alone. Thus, to the extent that prenatal care can be provided for less than $1,371 per patient, there will be a net system savings because of the better care.[5]

Despite the evidence that prenatal care is associated with desirable birth outcomes, it is not an easy step to conclude cost effectiveness. Although the incidence of low and very low birth weights, premature labor, transfers to acute-care facilities, and early death was significantly greater for those women who had no prenatal care, the combined impact on total cost of care is not large in an absolute sense.

This is not meant to imply that prenatal care is unimportant from an economic perspective. Because the most important prenatal visit is the first one, it is important that it be early in the pregnancy. If the medical data gathered during this examination can identify those women who are most at risk for premature labor and its associated low birth weights, then these women can be targeted for special treatment. Prenatal care cannot control for the socioeconomic and environmental differences that result in poor birth outcome. However, it has proven its worth in identifying factors that affect birth outcome, such as cigarette smoking, alcohol consumption, drug use, and poor diet. Once these confounding factors have been identified, a strict regimen can be prescribed to eliminate or reduce the compromising activity. By carefully screening prospective mothers' medical histories, factors such as health status, emotional well-being, and attitudes toward the pregnancy can be used to identify those at risk for problems later on.

[4]Another interesting issue is the observed higher rate of cesarean deliveries among females with private insurance compared with those without it, which may also be a contributing factor to this differential.

[5]During the study period, the Family Practice Center provided prenatal care (excluding labor and delivery charges) for around $400. This indicates a net savings to the system of approximately $1,000 for each woman shifting from the no-care group to the care group.

Further study should be undertaken to determine whether prenatal care is an important factor in preventing prematurity, or whether it is merely a proxy for health status or some other socioeconomic consideration. More information on medical histories, occupation, and education is needed to better understand this relationship.

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REFERENCES

Behrman, R.E.: Premature Births Among Black Women. *New England Journal of Medicine* 317(12):763-765, September 17, 1987.

Buescher, P.A., Meis, P.J., Ernest, J.M., et al.: A Comparison of Women In and Out of a Prematurity Prevention Project in a North Carolina Perinatal Care Region. *American Journal of Public Health* 78(3):264-267, March 1988.

Congressional Office of Technology Assessment: *Neonatal Intensive Care for Low Birthweight Infants: Costs and Effectiveness.* OTA-HCS-38. Washington, DC. Office of Technology Assessment, December 1987.

Droste, T.: Prenatal Care Education Insures Healthy Future. *Hospitals* 62:74-76, February 20, 1988.

Frank, R., Strobino, D., Salkever, D., and Jackson, C.: *Poverty Programs, Initiation of Prenatal Care, and the Rate of Low Birthweight Births.* NBER Working Paper No. 3215. Cambridge, MA. National Bureau of Economic Research, December 1989.

Gortmaker, S.L.: The Effects of Prenatal Care Upon the Health of the Newborn. *American Journal of Public Health* 69(7):653-660, July 1979.

Hack, M., and Fanaroff, A.A.: Outcomes of Extremely-Low-Birth-Weight Infants Between 1982 and 1988. *New England Journal of Medicine* 321(24):1642-1647, December 14, 1989.

Health Resources and Services Administration: *Healthy Children 2000: National Health Promotion and Disease Prevention Objectives Related to Mothers, Infants, Children, Adolescents, and Youth.* DHHS Pub. No. HRSA-M-CH-91-2. Washington, DC. U.S. Department of Health and Human Services, September 1991.

Joyce, T.: The Dramatic Increase in the Rate of Low Birthweight in New York City: An Aggregate Time-Series Analysis. *American Journal of Public Health* 80(6):682-684, June 1990.

Kessel, S.S., Villar, J., Berendes, H.W., and Nugent, R.P.: The Changing Pattern of Low Birthweight in the United States: 1970-1980. *Journal of the American Medical Association* 251(15):1978-1982, April 20, 1984.

Kleinman, J.C., and Madans, J.H.: The Effects of Maternal Smoking, Physical Stature, and Educational Attainment on the Incidence of Low Birth Weight. *American Journal of Epidemiology* 121:843-855, 1991.

Lennie, J.A., Klun, J.R., and Hausner, T.: Low-Birth-Weight Rate Reduced by the Obstetrical Access Project. *Health Care Financing Review* 8(3):83-86, Spring 1987.

McCormick, M.C.: The Contribution of Low Birth Weight to Infant Mortality and Childhood Morbidity. *New England Journal of Medicine* 312(2):82-90, January 10, 1985.

Monmaney, T.: Preventing Early Births: Prenatal Care Not Only Works, It's a Bargain. *Newsweek* 111(2):70, May 16, 1988.

Murray, J.L., and Bernfield, M.: The Differential Effect of Prenatal Care on the Incidence of Low Birth Weight Among Blacks and Whites in a Prepaid Health Care Plan. *New England Journal of Medicine* 319(21):1385-1390, November 24, 1988.

Myers, S.A., and Gleicher, N.: A Successful Program to Lower Cesarean-Section Rates. *New England Journal of Medicine* 319(23):1511-1516, December 8, 1988.

National Commission to Prevent Infant Mortality: *Infant Mortality within Minority and Rural Communities: A Global Perspective on Causes and Solutions.* A Symposium Sponsored by the Select Committee on Hunger, U.S. House of Representatives and the National Commission to Prevent Infant Mortality. Washington. U.S. Government Printing Office, 1991.

Showstack, J.A., Budetti, P.P., and Minkler, D.: Factors Associated with Birthweight: An Exploration of the Roles of Prenatal Care and Length of Gestation. *American Journal of Public Health* 74(9):1003-1008, September 1984.

Taffel, S.M, Placek, P.J., and Liss,T.: Trends in the United States Cesarean Section Rate and Reasons for the 1980-85 Rise. *American Journal of Public Health* 77(8):955-959, August 1987.

Wartenberg, D., and Northridge, M.: Defining Exposure in Case-Control Studies: A New Approach. *American Journal of Epidemiology* 133(10):1058-1071, 1991.

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