# Improved Birth Outcomes Among HIV-Infected Women With Enhanced Medicaid Prenatal Care

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## ABSTRACT

*Objectives.* This study evaluated the impact of enhanced prenatal care on the birth outcomes of HIV-infected women.

*Methods.* Medicaid claims files linked to vital statistics were analyzed for 1723 HIV-infected women delivering a live-born singleton from January 1993 to October 1995. Prenatal care program visits were indicated by rate codes. Logistic models controlling for demographic, substance use, and health care variables were used to assess the program's effect on preterm birth (less than 37 weeks) and low birthweight (less than 2500 g).

*Results.* Of the women included in the study, 75.3% participated in the prenatal care program. Adjusted program care odds were 0.58 (95% confidence interval [CI] = 0.42, 0.81) for preterm birth and 0.37 (95% CI = 0.24, 0.58) for low-birthweight deliveries in women without a usual source of prenatal care. Women with a usual source had lower odds of low-birthweight deliveries if they had more than 9 program visits. The effect of program participation persisted in sensitivity analyses that adjusted for an unmeasured confounder.

*Conclusions.* A statewide prenatal care Medicaid program demonstrates significant reductions in the risk of adverse birth outcomes for HIV-infected women. (*Am J Public Health*. 2000; 90:85–91)

High rates of adverse birth outcomes in infants of low-income women mobilized federal policymakers in the mid-1980s to expand Medicaid eligibility for pregnant women.[1] Along with this initiative, many states introduced programs designed to improve the comprehensiveness of prenatal care services for Medicaid-enrolled women. Research on these initiatives has shown significant improvement in the adequacy of prenatal care for low-income women[2–4] but contradictory results in regard to birth outcomes.[5–7]

New York has been one of the most aggressive states in regard to developing initiatives to improve birth outcomes of low-income women.[8] New York's Prenatal Care Assistance Program contracts with a widely distributed network of hospital clinics, county health departments, and free-standing diagnostic/treatment centers to deliver a broad range of prenatal services in return for enhanced payments. The program's broad components include (1) patient outreach to facilitate timely prenatal care, (2) meeting frequency and content of prenatal care standards set by the American College of Obstetricians and Gynecologists, (3) comprehensive risk assessment for adverse outcomes, (4) development of a prenatal care plan and coordination of care, (5) nutritional services, (6) health education, (7) psychological assessment, and (8) HIV-related services involving testing, counseling, and management referrals.[9]

If a prenatal care initiative such as the New York program were to result in improved birth outcomes, previous research indicates that this effect might be even more evident in women at greater risk of poor outcomes.[5] HIV-infected women constitute such a high-risk population.[10,11] This study not only examined the Prenatal Care Assistance Program's overall effect on HIV-infected women's birth outcomes but explored possible mediating factors such as reductions in risky maternal behaviors and facilitation of access to appropriate prenatal care services. We also examined the susceptibility of our estimates of the program's effects to potential bias associated with self-selection of women into the program.

## Methods

### *Study Population and Data*

A methodology designed to identify HIV-infected women was updated[10] to account for changes in coding of HIV infection, treatments, and services. The update was based on physician reviews of more than 1000 randomly selected clinical and treatment histories of women enrolled in New York State Medicaid who delivered in 1993–1994 and who had at least one *International Classification of Diseases, 9th Revision*[12] diagnosis, treatment, or service code suggestive of HIV disease. The revised HIV case finding required (1) one

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inpatient or two outpatient diagnoses of HIV seropositivity/infection, (2) one outpatient diagnosis of HIV seropositivity/infection with one HIV care rate code, (3) an AIDS-defining diagnosis, or (4) antiretroviral therapy. This methodology was 98% sensitive and 93% specific when applied (during the same time frame), after institutional review board approval, to 114 HIV-infected and uninfected Medicaid-enrolled parturients at Bellevue Medical Center.

For all New York State Medicaid-enrolled women identified as HIV infected and delivering a live-born infant from January 1993 through September 1995 (n = 2241), a longitudinal claims and eligibility file was created for up to 3 years preceding delivery through the delivery year or longer. Social Security number, delivery admission date, site of delivery, child's date of birth, and father's name were used in linking vital statistics files for 2068 (92%) of these women. Vital statistics offered demographic data, education, parity, weight gain in pregnancy, gestational age at delivery (from the doctor's estimate or the mother's self-report of most recent menstrual cycle), birthweight, and self-reported substance use during pregnancy. Claims offered diagnoses (up to 5 per inpatient claim and 2 per outpatient claim), procedures (up to 3 per inpatient or outpatient clinic claim and 1 per outpatient physician claim), payment rates, and filled prescriptions.

Mothers of twins (n = 59) were excluded owing to their increased risk of adverse birth outcomes. For women delivering more than one singleton in the study years (n = 121), we randomly selected one of the deliveries to avoid analytic complexities resulting from multiple observations for the same woman. Women without any prenatal care (n = 142) were excluded because they did not have an opportunity to receive Prenatal Care Assistance Program services; their inclusion in the nonprogram group could have led to an overestimate of the program's benefit. As a result of small sample sizes, we excluded 9 women without racial/ethnic data and 14 women of Asian or Native American descent. The final analysis file totaled 1723 deliveries.

### *Maternal Characteristics*

We did not have access to viral load or CD4 T-lymphocyte data. To evaluate maternal HIV disease stage, we identified diagnoses reported to be predictive of maternal–child HIV transmission.[13] Three HIV clinical groups were defined: (1) severe (AIDS-defining condition before delivery or less than 1 year postdelivery [e.g., *Pneumocystis carinii* pneumonia]),[14] (2) moderate (pneumonia or anemia in pregnancy), and (3) low (no moderate or severe conditions). Although anemia occurs commonly in pregnancy, it is probably more significant when explicitly listed as the diagnosis on a claim. Anemia is associated with increased risk of disease progression and death in HIV-infected populations.[15,16] Chronic medical conditions, including hypertension, asthma, and diabetes, were identified from claims during and outside of pregnancy.

Illicit drug use was identified through an established approach[17] in which claims are searched for methadone maintenance service codes, medically supervised non-drug-treatment service codes, or illicit drug use diagnoses (i.e., opioid, cocaine, amphetamine, hallucinogen, other psychostimulant, or unspecified drug dependence or abuse). In addition, vital statistics records were examined for self-reported illicit drug use. Women were classified into 5 drug use categories: (1) methadone treatment during pregnancy, (2) medically supervised drug treatment during pregnancy, (3) illicit drug use during pregnancy, (4) illicit drug use or drug treatment outside of pregnancy, and (5) no evidence of illicit drug use. Women who qualified for more than one of these categories were grouped into the first applicable category. Smoking and drinking during pregnancy were determined from vital statistics self-reports.

### *Measures*

Low birthweight was defined as less than 2500 g. A preterm delivery was defined as one occurring at less than 37 weeks according to the physician's estimate or, when a physician's estimate was unavailable (3.7% of subjects), the mother's estimate of her most recent menstrual cycle date.

Participation in the Prenatal Care Assistance Program was defined as 1 or more visits during pregnancy billed at a program rate code. We also determined the number of program visits during pregnancy. Adequacy of the timing and number of prenatal care visits was assessed with Kotelchuck's adequacy measure[18] as applied to visits to primary care, obstetrics/gynecology, or HIV-specific physicians or clinics (i.e., infectious disease, allergy/immunology, hematology/oncology).

We have found that applying the Kotelchuck index to administrative data on prenatal visits to this broader range of providers is more predictive of birth outcomes than is applying the index to obstetrics/gynecology visits alone or to self-reported visits.[19] The index's intermediate care category (50%–79% of expected visits) was grouped with the adequate care category (80%–109%) as recommended.[20] The adequate-plus care according to the Kotelchuck index (≥110% of expected visits) was kept separate because of their greater expected risk of poor outcomes.

Usual source of prenatal care was defined as the source visited (1) at least twice and (2) for more than 50% of all prenatal visits. An indicator was created for any prenatal visit to a physician or clinic contracted by the state to deliver a wide array of HIV-specific ambulatory services and to offer care coordination in exchange for an increased payment. Receipt of care from a provider enrolling patients in the Pediatric AIDS Clinical Trials Group 076 Protocol was identified from prenatal visits to participating centers; however, we were unaware of which women participated in the trial. Receipt of nutritional services through the Special Supplemental Food Program for Women, Infants, and Children (WIC) was identified from vital statistics records. We identified use of antiretroviral drugs via pharmacy claims for zidovudine, didanosine, dideoxycytidine, or stavudine during gestation.

### *Statistical Analysis*

Unadjusted associations of Prenatal Care Assistance Program care and maternal demographic, clinical, and behavioral characteristics with birth outcomes were estimated and examined for statistical significance. To estimate a baseline logistic regression model of maternal demographic and clinical characteristics associated with each outcome, we used backward selection ($P < .20$) but forced in maternal characteristics with significant bivariate associations ($P < .05$) with program care. We then estimated additional models, forcing in other variables that might influence the program's association with birth outcomes.

We searched for significant ($P < .01$) interactions that substantively altered the program effect estimate or that involved the program participation term. Only one such interaction appeared, and this interaction involved the program participation term in the low-birthweight model. The Hosmer–Lemeshow statistic was examined in each final model to evaluate fit; for all models, the fit was acceptable ($P = .46$ or higher). To examine dose–response effects of the number of program visits, we reestimated our final model, substituting a system of 4 dummy variables representing quartiles of visits.

To determine the susceptibility of our final model findings to selection effects, we extended the "unobserved" confounder sensitivity analysis approach described by Marcus for least squares regression[21] to multiple logistic regression. This approach allowed

calculation of adjusted odds ratios (ORs) for a dichotomous program care variable in multivariate models including all terms from our final models as well as an additional hypothetical confounder. This confounder reflected potential subject selection effects not explained by the independent variables in our final models.

Assumptions about the direction and degree of confounding introduced by this term were varied. Three magnitudes of positive and negative associations between the hypothetical confounder and program participation were considered. For positive associations, the alternative prevalence estimates for the potential confounder in women with and without program visits were 40% and 30% (weak association), 60% and 40% (moderate), and 80% and 20% (strong), respectively. For negative associations, the prevalence estimates were reversed among women with and without program visits.

We also considered 3 magnitudes of positive and negative associations between the confounder and the birth outcomes. For positive associations, we chose 3 alternative adjusted odds ratios: 1.25 (weak association), 1.50 (moderate association), and 2.00 (strong association). The reciprocal adjusted odds ratios (0.80, 0.67, and 0.50) were used for negative associations. The various assumptions resulted in 36 different scenarios for each outcome. As delineated by Frick and Lantz,[22] 2 types of selection bias would lead to an overestimate of the effect of program care on birth outcomes: 9 of the scenarios related to favorable selection (women at lower risk of poor birth outcomes being more likely to seek program care), and 9 related to estrangement selection (women at greater risk for adverse birth outcomes being less likely to take advantage of the availability of the program).

## *Results*

Nearly three quarters of our cohort of 1723 HIV-infected, pregnant women underwent care through the Prenatal Care Assistance Program (Table 1). Program services were more likely to be used by younger women, women at lower educational levels, women residing outside of New York City, women delivering in 1994 or 1995, women reporting no drug use during pregnancy, and women reporting no drug use at any time. Preterm birth and low birthweight each occurred in 15% of deliveries. These outcomes were more common in women who were older, Black, unmarried, residing in New York City, born in the United States, and smokers, alcohol users, or illicit drug users during pregnancy. They were also more common in women who had lost weight or had gained a smaller amount of weight during pregnancy, women with chronic diseases such as asthma, and women with more advanced HIV disease.

As shown in Table 2, the proportions of both adverse birth outcomes were much lower in Prenatal Care Assistance Program participants. Women who had undergone program care were more likely to have (1) prenatal care rated as intermediate/adequate or adequate-plus, (2) a usual source of prenatal care, (3) WIC nutritional services, and (4) care from a provider with enhanced HIV services.

Table 3 shows adjusted odds for Prenatal Care Assistance Program care from a sequence of models. In models adjusting only for maternal demographics, women with program care had 47% lower adjusted odds of preterm birth and a similar odds of reduction in low birthweight. Further adjustment for maternal substance use and health care/social services showed that about 20% of the effect of program participation on preterm birth was explained by these factors, and this effect was not diminished by adjustment for the Kotelchuck index.

The low-birthweight analysis included an interaction between Prenatal Care Assistance Program participation and having a usual source of prenatal care. Among women without a usual source of care, the program had a strongly protective effect that was not modified by adjustment for the Kotelchuck index. Yet, among women with a usual source of care, program services appeared to add no benefit.

When we included a 4-category program variable in a reestimation of the final models, we found a clear dose–response effect of program visits on preterm birth and low birthweight among women without a usual source of care. Although the models with a dichotomous program variable suggested no effect on low birthweight among women with a usual source of care, a protective effect of program participation can be seen to emerge at the 2 higher quartiles of program visits; however, this effect achieved significance only for women with 12 or more visits.

In our final preterm birth model, the following maternal characteristics were associated with statistically significant adjusted odds ratios: Black (adjusted OR = 1.94, 95% confidence interval [CI] = 1.09, 3.47) or Latina (adjusted OR = 2.08, 95% CI = 1.15, 3.77), US born (adjusted OR = 1.88, 95% CI = 1.15, 3.05), treatment with methadone during pregnancy (adjusted OR = 1.90, 95% CI = 1.28, 2.82), illicit drug use during pregnancy (adjusted OR = 1.90, 95% CI = 1.28, 2.82), or illicit drug use outside of pregnancy (adjusted OR = 1.64, 95% CI = 1.00, 2.72). The respective reference groups were White women, foreign-born women, and women reporting no drug use.

Among health care factors, WIC services produced lower odds of preterm delivery (adjusted OR = 0.73, 95% CI = 0.53, 0.99), as did maternal antiretroviral therapy (adjusted OR = 0.70, 95% CI = 0.50, 1.00). Relative to women with inadequate prenatal care, women with prenatal care rated as intermediate/adequate were at lower risk of preterm birth (adjusted OR = 0.64, 95% CI = 0.41, 0.99), whereas women with prenatal care rated as adequate-plus were at higher risk (adjusted OR = 1.41, 95% CI = 1.00, 2.00).

In the final low-birthweight models, adjusted odds were higher for Black women vs White women (adjusted OR = 1.81, 95% CI = 1.01, 3.26), women delivering in New York City (adjusted OR = 1.83, 95% CI = 1.07, 3.12), women who gained less than 38 lb (17 kg) during their pregnancy (monotonic increases in adjusted odds ratios from 1.96 to 4.21 by decreasing weight gain category; see Table 1 for categories), women with moderate (adjusted OR = 1.73, 95% CI = 1.25, 2.40) or severe (adjusted OR = 2.60, 95% CI = 1.56, 4.33) AIDS complications, women with chronic diseases (adjusted OR = 1.64, 95% CI = 1.23, 2.20), and women who smoked (adjusted OR = 1.57, 95% CI = 1.08, 2.28). Also, relative to odds for women with no history of illicit drug use, odds were higher for women undergoing methadone treatment during pregnancy (adjusted OR = 2.74, 95% CI = 1.65, 4.54), women using illicit drugs during pregnancy (adjusted OR = 1.78, 95% CI = 1.18, 2.69), and women with a history of illicit drug use outside of pregnancy (adjusted OR = 1.70, 95% CI = 1.02, 2.84).

Adjusted odds of low birthweight were lower for married women (adjusted OR = 0.56, 95% CI = 0.35, 0.92). Of the health care factors, only prenatal care rated as intermediate/adequate was significantly associated with low birthweight (adjusted OR = 0.62, 95% CI = 0.39, 0.96).

Each bar in Figure 1 represents findings from our sensitivity analysis. Shown are adjusted odds for Prenatal Care Assistance Program care (any/none) in the final preterm birth model with added adjustment for a dichotomous variable serving as a proxy for possible unmeasured self-selection effects. The selection effect scenarios can be determined from the x-axis and z-axis labels. The back left bar shows the circumstance of strong favorable selection (i.e., the hypothet-

**TABLE 1—Association of Maternal Characteristics With Prenatal Care Assistance Program (PCAP) Participation and Birth Outcomes (n = 1723): New York State, 1993–1995**

| Characteristic | No. | PCAP Participation % | PCAP Participation *P* | Low Birthweight (<2500 g) % | Low Birthweight (<2500 g) *P* | Preterm Delivery (<37 wk) [a] % | Preterm Delivery (<37 wk) [a] *P* |
|---|---|---|---|---|---|---|---|
| Age, y | | | .02 | | .001 | | .001 |
| <20 | 154 | 82.5 | | 12.3 | | 12.3 | |
| 20–24 | 406 | 78.3 | | 9.9 | | 10.6 | |
| 25–29 | 538 | 75.1 | | 15.1 | | 14.5 | |
| 30–34 | 415 | 73.3 | | 18.6 | | 17.8 | |
| 35+ | 210 | 69.1 | | 22.9 | | 22.4 | |
| Race | | | .96 | | .001 | | .001 |
| White | 229 | 74.7 | | 7.9 | | 7.9 | |
| Black | 707 | 75.3 | | 18.7 | | 18.8 | |
| Hispanic | 787 | 75.6 | | 14.6 | | 14.0 | |
| Education | | | .004 | | .06 | | .20 |
| High school graduate | 789 | 72.0 | | 13.4 | | 13.6 | |
| Not high school graduate | 822 | 78.2 | | 16.8 | | 15.8 | |
| Missing | 112 | 6.7 | | 7.9 | | 9.2 | |
| Marital status | | | .92 | | .02 | | .001 |
| Married | 285 | 75.1 | | 10.9 | | 8.4 | |
| Unmarried | 1438 | 75.4 | | 16.3 | | 16.5 | |
| New York City residence | | | .002 | | .001 | | .001 |
| Yes | 1420 | 73.9 | | 16.7 | | 16.7 | |
| No | 303 | 82.2 | | 9.2 | | 7.9 | |
| Country of birth | | | .16 | | .001 | | .001 |
| United States | 1384 | 75.9 | | 16.8 | | 17.1 | |
| Other | 324 | 72.9 | | 8.0 | | 8.3 | |
| Missing | 15 | 86.7 | | 20.0 | | 13.3 | |
| Parity | | | .25 | | .24 | | .06 |
| 0 | 468 | 76.7 | | 15.0 | | 12.2 | |
| 1–2 | 727 | 76.3 | | 13.8 | | 15.8 | |
| 3+ | 528 | 72.7 | | 17.2 | | 17.6 | |
| Year of delivery | | | .001 | | .34 | | .87 |
| 1993 | 532 | 67.9 | | 13.4 | | 14.9 | |
| 1994 | 697 | 78.9 | | 16.4 | | 15.9 | |
| 1995 | 494 | 78.3 | | 15.4 | | 15.2 | |
| Medicaid eligibility level in pregnancy, % | | | .66 | | .33 | | .49 |
| <50 | 120 | 71.7 | | 14.2 | | 15.8 | |
| 50–99 | 441 | 74.4 | | 14.5 | | 14.1 | |
| 100 | 1107 | 76.2 | | 15.5 | | 16.0 | |
| Missing | 55 | 74.5 | | 19.8 | | 20.0 | |
| Weight gain in pregnancy, lb | | | .001 | | .001 | | .001 |
| –15–18 | 270 | 76.7 | | 26.3 | | 24.4 | |
| 19–26 | 255 | 79.2 | | 15.3 | | 16 5 | |
| 27–37 | 262 | 80.9 | | 11.8 | | 11.5 | |
| 38–99 | 251 | 82.9 | | 6.8 | | 8.7 | |
| Missing | 685 | 68.5 | | 15.0 | | 15.3 | |
| HIV severity | | | .34 | | .001 | | .03 |
| Low | 1140 | 75.1 | | 11.9 | | 13.8 | |
| Moderate | 346 | 73.7 | | 19.7 | | 17.9 | |
| Severe | 237 | 78.9 | | 24.1 | | 19.4 | |
| Chronic disease | | | .42 | | .001 | | .001 |
| Yes | 697 | 74.3 | | 20.8 | | 19.2 | |
| No | 1026 | 76.0 | | 11.3 | | 12.8 | |
| Drug use | | | .007 | | .001 | | .001 |
| Methadone treatment during pregnancy | 139 | 69.1 | | 33.1 | | 27.3 | |
| Illicit drug use during pregnancy | 313 | 70.6 | | 23.3 | | 24.0 | |
| Medically supervised treatment during pregnancy | 67 | 71.6 | | 20.9 | | 20.9 | |
| Illicit drug use or treatment outside of pregnancy | 141 | 74.5 | | 19.9 | | 20.0 | |
| No drug use | 1063 | 77.9 | | 9.4 | | 10.4 | |
| Smoking during pregnancy | | | .10 | | .001 | | .001 |
| Yes | 314 | 71.7 | | 22.9 | | 22.0 | |
| No | 1409 | 76.2 | | 13.4 | | 13.9 | |
| Alcohol use during pregnancy | | | .63 | | .001 | | .02 |
| Yes | 168 | 73.8 | | 25.0 | | 21.4 | |
| No | 1555 | 75.5 | | 14.1 | | 14.7 | |
| Total | 1723 | 75.3 | | 15.4 | | 15.2 | |

[a] n = 1711 (12 observations missing data on pregnancy date).

ical factor is twice as likely in women with program care, and the odds of preterm birth are halved). The front right bar represents strong estrangement selection (i.e., the hypothetical factor is half as likely in women with program care, and the odds of preterm birth are doubled). Only in the extreme scenarios does the program no longer have lower adjusted odds of preterm birth.

Because of the interaction between program participation and usual source of care, the sensitivity analyses with respect to low birthweight were performed only for the subgroup without a usual source of care (data not shown). The adjusted odds ratios for women without a usual source of care were even more robust to the effect of a hypothetical confounder than those revealed in the preterm analysis. Adjusted odds ratio estimates were below 0.65 even under the strongest favorable and estrangement selection situations (in which low birthweight had a very skewed distribution in program and nonprogram women and was strongly associated with the outcome).

## *Discussion*

While federally mandated Medicaid eligibility expansions have eased access to prenatal care for many low-income women, additional initiatives designed to address the components and quality of prenatal care appear necessary to improve such women's

**TABLE 2—Association of Health Care Services With Prenatal Care Assistance Program (PCAP) Participation and Birth Outcomes: New York State, 1993–1995**

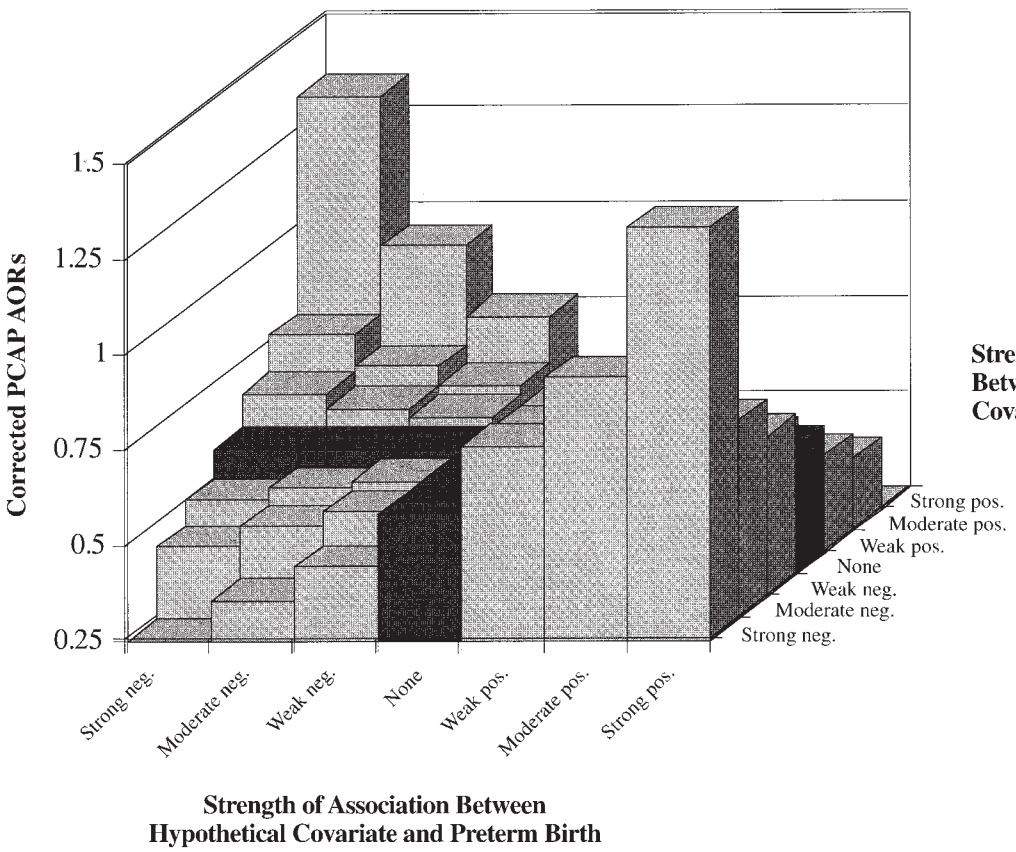
| Characteristic | No. | PCAP Participation % | PCAP Participation *P* | Low Birthweight (<2500 g) % | Low Birthweight (<2500 g) *P* | Preterm Delivery (<37 wk) % | Preterm Delivery (<37 wk) *P* |
|---|---|---|---|---|---|---|---|
| PCAP care | | | | | .001 | | .001 |
| Any | 1298 | . . . | . . . | 13.0 | | 13.0 | |
| None | 425 | . . . | . . . | 21.6 | | 22.6 | |
| No. of PCAP visits by users | | | | | .001 | | .001 |
| 1–4 | 375 | . . . | . . . | 18.1 | | 20.0 | |
| 5–8 | 351 | . . . | . . . | 16.5 | | 16.8 | |
| 9–11 | 279 | . . . | . . . | 9.7 | | 7.9 | |
| 12+ | 291 | . . . | . . . | 5.2 | | 4.1 | |
| Kotelchuck index | | | .001 | | .01 | | .01 |
| Adequate-plus | 863 | 84.0 | | 14.5 | | 15.8 | |
| Intermediate/ adequate | 354 | 75.1 | | 11.3 | | 8.2 | |
| Inadequate | 506 | 60.7 | | 19.4 | | 18.4 | |
| Usual source of care | | | .001 | | .001 | | .001 |
| Yes | 906 | 83.7 | | 12.9 | | 12.1 | |
| No | 817 | 66.1 | | 17.6 | | 19.0 | |
| WIC participation | | | .002 | | .03 | | .01 |
| Yes | 992 | 80.3 | | 14.0 | | 13.5 | |
| No | 585 | 73.5 | | 18.1 | | 18.6 | |
| Missing | 146 | 48.6 | | 11.0 | | 15.1 | |
| PACTG 076 site care | | | .997 | | .02 | | .68 |
| Yes | 308 | 75.3 | | 10.7 | | 14.6 | |
| No | 1415 | 75.3 | | 16.1 | | 15.6 | |
| HIV-focused services | | | .001 | | .49 | | .04 |
| Yes | 846 | 86.8 | | 14.5 | | 13.6 | |
| No | 877 | 64.3 | | 15.7 | | 17.1 | |
| Antiretroviral therapy | | | .415 | | .02 | | .72 |
| Yes | 431 | 76.8 | | 18.8 | | 14.9 | |
| No | 1292 | 74.9 | | 13.9 | | 15.6 | |

*Note.* PACTG = Pediatric AIDS Clinical Trials Group Protocol.

**TABLE 3—Adjusted Odds Ratios for PCAP Care and Number of Visits From a Series of Logistic Regression Models: New York State, 1993–1995**

| Model | Independent Variable[a] | PCAP Variable[b] | Preterm Birth: All Subjects OR | Preterm Birth: All Subjects 95% CI | Low Birthweight: All Subjects OR | Low Birthweight: All Subjects 95% CI | Low Birthweight: No Usual Source of Care OR | Low Birthweight: No Usual Source of Care 95% CI | Low Birthweight: Usual Source of Care OR | Low Birthweight: Usual Source of Care 95% CI |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Maternal characteristics[c] | Any/no care | 0.53 | 0.40, 0.70 | 0.56 | 0.42, 0.76 | . . . | . . . | . . . | . . . |
| 2 | Substance use in pregnancy | Any/no care | 0.57 | 0.42, 0.76 | 0.61 | 0.45, 0.82 | . . . | . . . | . . . | . . . |
| 3 | Health care and social service use in pregnancy[d] | Any/no care | 0.63 | 0.46, 0.86 | . . . | . . . | 0.38 | 0.25, 0.56 | 1.10 | 0.47, 2.58 |
| 4 | Kotelchuck index | Any/no care | 0.58 | 0.42, 0.81 | . . . | . . . | 0.37 | 0.24, 0.58 | 1.09 | 0.46, 2.60 |
| 5 | Dose–response[e] | 1–4 visits | 0.83 | 0.57, 1.21 | . . . | . . . | 0.50 | 0.30, 0.83 | 1.26 | 0.65, 2.45 |
| | | 5–8 visits | 0.69 | 0.46, 1.04 | . . . | . . . | 0.28 | 0.15, 0.53 | 2.07 | 1.09, 3.95 |
| | | 9–11 visits | 0.30 | 0.17, 0.52 | . . . | . . . | 0.28 | 0.13, 0.62 | 0.74 | 0.35, 1.58 |
| | | 12+ visits | 0.12 | 0.06, 0.24 | . . . | . . . | 0.07 | 0.02, 0.25 | 0.40 | 0.02, 0.89 |

*Note.* PCAP = Prenatal Care Assistance Program; OR = odds ratio; CI = confidence interval.
[a]Additive in each succeeding model.
[b]Reference in all models is no PCAP visit.
[c]Age, race, marital status, place of residence, US native, HIV severity, chronic disease, and maternal weight gain.
[d]Zidovudine use, WIC nutritional services, dominant provider for more than 50% of outpatient prenatal care visits in pregnancy, duration of Medicaid eligibility, and treatment by a provider offering HIV-focused services.
[e]Final model includes all variables in model 4.




*Note.* neg. = negative; pos. = positive.

**Figure 1—Corrected Prenatal Care Assistance Program (PCAP) adjusted odds ratios (AORs) from sensitivity analysis for preterm birth models.**

birth outcomes.[1] New York State's Prenatal Care Assistance Program exemplifies such an intensive effort to raise the quality of prenatal care for all Medicaid-enrolled women. If compliance with the dictates of the program is to be evaluated, program providers must accept close monitoring via chart review and various reporting mechanisms. In return, payment for prenatal services is approximately double that of nonprogram providers.

HIV-infected women on Medicaid are a key target for such an initiative because they are twice as likely to bear a low-birthweight child as uninfected women on Medicaid.[23] New York's efforts appear to be richly rewarded; we found that program care was associated with at least a 40% reduction in the adjusted odds of preterm delivery in our study population of 1700 HIV-infected women.

Program participation had a more complex association with low birthweight. Program care exhibited a strong effect among women who did not have a usual source of prenatal care, reducing the adjusted odds of low birthweight by 60%; however, there was no benefit for women with a usual source of prenatal care. Perhaps the effect of program participation was attenuated among women with a usual source of care because they already had accrued substantial benefits from their continuity of care with 1 provider. Yet, a dose–response analysis showed that women with a usual source of care who had a greater number of program visits had a lower risk of low-birthweight deliveries. Perhaps additional benefit was realized among women with better continuity of care in pregnancy only when substantial contact was made with the program provider.

In women without a usual source of care, preterm birth and low birthweight both showed a monotonic reduction with increasing program care. These data add further support to our conclusion that the Prenatal Care Assistance Program is improving women's birth outcomes.

We adjusted for a broad range of covariates known to influence birth outcomes, including illicit drug use, use of cigarettes, Kotelchuck index,[10] and receipt of WIC nutritional services.[24] However, these covariates did not explain much of the program's beneficial effect. Prenatal Care Assistance Program participation may help women in ways that we could not measure, such as greater medical risk assessment and management through a plan of care that addresses nutritional, psychosocial, genetic, and environmental factors. Furthermore, women enrolled in the program may act to reduce other factors that disrupt (especially among HIV-infected individuals) access to health care (e.g., poor health-related quality of life,[25] fear of health care providers,[26] and coordination among multiple providers[27]).

Because of concern about selection of women at lower risk of adverse outcomes into the Prenatal Care Assistance Program, we conducted a novel analysis in which we estimated the possible effect of an unmeasured confounder on the adjusted program participation odds ratios for each of our 2 birth outcomes. Such factors could include the extent to which the pregnancy is desired,[28] the woman's attitude toward health care, the

expertise or experience of the prenatal care provider,[29] the presence of bacterial vaginosis, and the woman's body mass index.[30] For a substantial reduction in the estimate of the program's protective effect on preterm birth, the adjusted association of such a hypothetical selection factor (or combination of factors) with preterm birth would need to be as strong as that seen for racial/ethnic group (a 2-fold increase) and extremely maldistributed across program and nonprogram women. In regard to low birthweight, this degree of selection did not modify the effect of program participation among women without a usual source of care.

Further evidence against favorable selection is the fact that women receiving program services were significantly younger and less educated than those not receiving services. These young, poorly educated women were unlikely to have been shopping around for particular providers.

Our analysis focused only on women with Medicaid-file evidence of HIV infection. On the basis of anonymous newborn HIV surveillance data in New York State, we estimate that we identified approximately 85% of all HIV-infected, Medicaid-enrolled women delivering in the study time frame. Furthermore, we studied only live-born hospital deliveries; we did not assess stillbirths, miscarriages, and out-of-hospital deliveries. It is not known whether the rates of poor birth outcomes were lower in women with program care because more of their high-risk pregnancies ended in these unmeasured outcomes. However, we have no reason to believe that this was the case.

This analysis adds to an expanding literature that supports providing enhanced services[27] from and access to persons with HIV care expertise[31,32] to improve clinical outcomes in persons with HIV infection. If the benefits seen in this HIV-infected cohort are generalizable to other women enrolled in New York State Medicaid, the Prenatal Care Assistance Program is likely to yield both clinical and financial benefits. A cost–benefit analysis of the program remains to be done, but the costs of adverse birth outcomes such as low birthweight are enormous, estimated to account for about 10% of all costs of care for children.[33] Additional expenditures for such initiatives may reap both clinically meaningful and financially significant rewards. □

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