

# Leveraging Longitudinal Clinical Laboratory Results to Improve Prenatal Care

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Pregnant women who receive early and regular prenatal care may increase their likelihood of an uncomplicated gestation and the delivery of a healthy infant.<sup>1-3</sup> The literature also indicates that timely postpartum care reduces maternal and infant mortality,<sup>4</sup> although establishing a causal link has been difficult.<sup>1</sup> Building on this evidence, practice guidelines recommend prompt and frequent prenatal and postpartum care visits,<sup>5-7</sup> defined as the establishment of care in the first trimester, ongoing prenatal care measured through the proportion of expected visits met, and a postpartum care visit within 56 days of delivery.<sup>8</sup> Based on these recommendations, the National Committee for Quality Assurance developed the measure entitled “Prenatal and Postpartum Care” within its Healthcare Effectiveness Data and Information Set (HEDIS).<sup>9</sup>

HEDIS measures have become an important tool within health care. CMS has used quality measures like HEDIS for more than a decade to inform beneficiaries of the performance of health plans.<sup>10</sup> With the implementation of the Affordable Care Act in 2012, states use HEDIS measures to monitor and incentivize the performance of managed care organizations (MCOs) for Medicaid recipients. In New Mexico, HEDIS prenatal care measures play a vital role in the MCOs’ measurement and payment of services, with 72% of all births funded by Medicaid.<sup>11</sup>

In 2016, New Mexico ranked 48th in the United States for live births to women who received prenatal care before the third trimester,<sup>12</sup> with only 63.4% of women having a health care visit in the first trimester of pregnancy compared with the national average of 77.2%.<sup>13</sup> In the same year, the March of Dimes gave New Mexico a “C” rating with a 9.5% preterm delivery rate and a ranking of 30th overall.<sup>14</sup> Study findings have shown that care coordination for pregnant women is linked to a reduction in preterm delivery among women enrolled in Medicaid.<sup>15-18</sup> In an effort to improve New Mexico’s performance in prenatal care and birth outcomes, the New Mexico Human Services Department (NMHSD) instituted a requirement for MCOs to track, report, and improve their performance using the Prenatal and Postpartum Care HEDIS measure, and financially incentivized the MCOs’ continual improvement.<sup>19</sup> NMHSD’s intention was to improve patient outcomes, promote

## ABSTRACT

**OBJECTIVES:** To assess the impact of providing laboratory-generated near-real-time clinical insights for pregnant Medicaid members to managed care organization (MCO) care coordinators.

**STUDY DESIGN:** A prospective, nonrandomized feasibility study was conducted over 11 months to examine the benefits of laboratory-generated clinical insights on prenatal care quality metrics and clinical outcomes. Measures included early identification of pregnancy and births to facilitate care, care gaps with prenatal laboratory testing, emergency department (ED) visits, preterm births, and neonatal intensive care unit (NICU) admissions and length of stay.

**METHODS:** Weekly MCO care coordinators were provided a laboratory-generated prenatal targeted intervention module (TIM) to supplement their existing systems in a longitudinal, patient-centric format. Care coordinators contacted patients for enrollment in prenatal or postpartum services based on the TIM, which identified concomitant health conditions, missing prenatal care, and risks.

**RESULTS:** The prenatal TIM identified 1355 pregnant members, 77% (n = 1040) of whom were detected in the first trimester. A total of 488 births were identified within 24 hours of parturition. Sixty-four percent of women had at least 80% of prenatal care gaps associated with laboratory testing closed. Women with ongoing prenatal care had fewer ED visits (17% vs 23%) and NICU admissions (11% vs 18%) compared with those without prenatal care. After adjusting for confounders, ongoing prenatal care had a borderline effect at decreasing the probability of having an ED visit and a NICU admission.

**CONCLUSIONS:** An innovative collaboration between an MCO and a clinical laboratory improved quality measures for prenatal members enrolled in Medicaid.

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value-based health care, and reduce the total cost of prenatal care for Medicaid beneficiaries.

MCOs utilize medical claims data, communication from health care providers, prescription records for prenatal vitamins, and member self-reporting to identify pregnancies, coordinate prenatal care needs, and detect births. However, in New Mexico, most prenatal care claims are not filed until after the infant is delivered, resulting in latent data.<sup>20,21</sup>

Clinical laboratory data may provide more fidelity due to their high reliance for medical decisions<sup>22,23</sup> and real-time nature.<sup>24</sup>

By combining patient results across providers and locations, a longitudinal picture can be created to facilitate timely obstetric care. For example, tests for human chorionic gonadotropin are commonly performed in the emergency department (ED) or urgent care and can be used to identify pregnancies. Tests performed by rural providers can identify pregnancy before follow-up visits to an obstetric provider are scheduled. Patients in rural locations may lack awareness of or access to obstetric services and use EDs for routine care. Some patients fail to receive ongoing prenatal care and seek no health care services until birth. Although not all prenatal visits include laboratory testing, examination of American College of Obstetricians and Gynecologists (ACOG)–recommended gestational age laboratory testing<sup>6</sup> creates an opportunity for laboratories to verify the presence or absence of routine prenatal care.

To determine if clinical laboratory data could support prenatal care coordination and help MCOs meet the NMHSD incentivized continual improvement plan, a feasibility study was developed. TriCore Reference Laboratories (TriCore), a clinical laboratory operating across New Mexico, partnered with Blue Cross Blue Shield of New Mexico (BCBSNM). The aim of the collaboration was to demonstrate the feasibility of using TriCore's longitudinal laboratory insights to augment current care coordination services for pregnant Medicaid enrollees.

## METHODS

This was a prospective, nonrandomized feasibility study conducted from May 25, 2017, to April 30, 2018. Data were collected for 3 primary objectives: (1) identification of members in the first trimester of pregnancy to support early initiation of prenatal care, (2) identification of births within 24 hours of parturition to facilitate postpartum care, and (3) evidence of ongoing prenatal care as measured through the closure of prenatal care gaps, defined as missing prenatal laboratory testing.

Secondary objectives included (1) identification of members using the ED for routine care to facilitate referral to an obstetric provider; (2) impact on preterm births, defined as births occurring prior to 37 weeks of gestation, when care coordination activities were augmented with laboratory insights; (3) impact on neonatal

## TAKEAWAY POINTS

As health care moves to value-based arrangements, clinical laboratories are in a position to support the care coordination activities of managed care organizations (MCOs) with real-time, longitudinal, laboratory-derived insights. Health conditions, such as pregnancy, are ideal for collaboration due to:

- ▶ need for timely information not available through claims,
- ▶ increased reliance on laboratory testing for treatment decisions, and
- ▶ high costs and morbidity associated with preterm birth.

This article summarizes the first published work describing collaboration between an MCO and a clinical laboratory to develop and implement improved prenatal care management processes and outcomes.

intensive care unit (NICU) admissions when care coordination activities were augmented with laboratory insights; and (4) impact on NICU length of stay when care coordination activities were augmented with laboratory insights.

The intervention was the use of TriCore's prenatal targeted intervention module (TIM) to supplement, but not replace, existing BCBSNM care management processes. TriCore's prenatal TIM, powered by proprietary algorithms and published prenatal care guidelines,<sup>6,25</sup> analyzed longitudinal clinical laboratory test results to identify pregnancies, births within 24 hours of parturition, high-risk patients, and gaps in care. Risk factors were defined as concomitant health conditions (eg, diabetes) or high-risk medical history (eg, advanced maternal age). Gaps in care were defined as missing prenatal laboratory tests appropriate for gestational age. Estimated gestational age was developed using guideline-based testing recommendations. For example, screening for gestational diabetes is recommended between weeks 24 and 28 of pregnancy, thus a patient who completed this test was determined to be in the second trimester. Births and NICU occupancy were identified using information on the location of infant phlebotomy services. For infants admitted to the NICU, the length of stay was determined by calculating the time difference between the dates of the first and last phlebotomies performed.

The TIM was provided weekly to care coordinators as a real-time decision support tool in a longitudinal, patient-centric format. Upon identification of a pregnancy, at least 3 outreach attempts were made, each a week apart, to enroll members in a prenatal care program called "Special Beginnings." Members successfully enrolled were followed throughout the pregnancy and the postpartum periods. High-risk patients, as defined by the TIM, were referred for additional care coordination services. During the feasibility study, no attempt was made to integrate the TIM into BCBSNM data analytics programs or claims. Claims data were not available to TriCore personnel for incorporation into the TIM insights or for data analysis after the feasibility study.

Patients for the feasibility study were identified by matching a monthly BCBSNM member enrollment file to TriCore's data repository. Required exact data elements for a match included first name, last name, sex, date of birth, and Social Security number.<sup>26</sup> All pregnant BCBSNM Medicaid members identified through 1 or

**TABLE 1.** Population Characteristics for Pregnancies and Births

Pregnancy characteristics	n (%) or mean (range)
Pregnancies, n	1355
Women living in metropolitan area, n (%)	876 (64.6)
Maternal age in years at time of pregnancy identification, mean (range)	28.1 (14.9-50.3)
Women with at least 1 prenatal risk factor identified through laboratory data, n (%)	376 (27.7)
Birth characteristics	n (%) or mean (range)
Births, n (%)	488 (36.0)
Births with known gestational age, n (% of 488 births)	159 (32.6)
Gestational age in weeks at delivery, mean (range)	38.5 (30.4-41.3)
Infant's sex, n (% of 488 births)	
Female	230 (47.1)
Male	251 (51.4)
Unknown	7 (1.4)

**TABLE 2.** Primary Outcomes During Prenatal Period as Defined by Treatment Guidelines

	Population n (%); 95% CI	Published comparison
Pregnancies identified in the first trimester	1040/1355 (76.8%); 74.4%-79.0%	63.4% <sup>14</sup>
Births	488/1355 (36.0%); 33.5%-38.6%	55% <sup>30</sup>
Women receiving at least 80% of prenatal care	287/450 (63.8%); 59.3%-68.2% <sup>a</sup>	52% <sup>30</sup>

<sup>a</sup>Defined as the completion of 80% or more of prenatal-associated laboratory tests identified by guidelines in women who continually received prenatal care (group A).

more laboratory pregnancy tests were included in the feasibility study sample. The [eAppendix Figure](#) (available at [ajmc.com](#)) provides a summary of the study population identified.

Prenatal care coordinators attempted to contact all BCBSNM members for enrollment in Special Beginnings, often utilizing the most current demographic metadata available from TriCore. This supported the continuum of care in accordance with the Code of Federal Regulations Title 45 Section 164.506.<sup>27</sup> Data on member enrollment in Special Beginnings were not collected.

The primary analysis examined the TIM's ability to detect pregnancy in the first trimester, recognize births to support postpartum care, and facilitate ongoing prenatal care compared with historic data before implementation. After being identified by the TIM, the secondary objectives compared measurable health care outcomes for 2 groups of BCBSNM members. Group A members had evidence of ongoing prenatal care after outreach for care coordination, defined as the completion of 1 or more prenatal-associated laboratory tests following notification of BCBSNM for care coordination. Group B members did not receive any laboratory prenatal screenings after

identification and thus had no evidence of ongoing prenatal care after outreach for care coordination. Because lack of prenatal care could result in adverse clinical outcomes, establishing a true randomized control group (ie, not offering care coordination services) was not considered.

Descriptive statistics were used to examine the distribution of values for each variable identified. Counts and proportions were used for categorical variables, whereas means, SDs, and shape statistics were examined for continuous variables. Significant skewness of the distribution was determined using normal quantile-quantile plots. Extreme outliers were identified as any data point 1.5 times the interquartile range above the 75th percentile or below the 25th percentile. In comparing group A and group B, Pearson's  $\chi^2$  test was used to assess significant differences for the categorical variables of whether or not there was at least 1 ED visit, premature birth rates, and NICU admission rates. NICU length of stay, a continuous variable, was examined for skewness, and extreme outliers were removed from the study. For skewness in NICU length of stay results, data were transformed to the natural logarithm and a Student's *t* test used to compare the mean of the log of the length of stay between groups. In addition to testing for differences between groups A and B, 17 potential confounding variables were considered and tested using a univariable model to determine its ability to predict each of the secondary clinical outcomes of ED visit, preterm delivery, NICU admissions, and NICU length of stay. Confounders found to have a moderate univariable relationship ( $P < .25$ ) to the secondary outcomes were then tested in a multivariable model in order to determine truly confounding variables. Multivariable logistic regression for binomial outcomes (ED visit, NICU admission, and preterm delivery) and a multiple linear regression for continuous data (log NICU length of stay) were used to determine if the group A outcomes were significantly different from those of group B after adjusting for confounders.

The study was reviewed and approved by the Advarra Institutional Review Board (Columbia, MD) with an approved waiver of informed consent.

## RESULTS

Over the 11-month study, the prenatal TIM identified 1355 pregnancies of 30,822 women using an exact match for first name, last name, sex, date of birth, and Social Security number. [Table 1](#) summarizes the prenatal population characteristics. Nearly two-thirds of the women lived in metropolitan areas, the mean maternal age was 28.1 years, and 28% had at least 1 prenatal risk factor identified in the laboratory data as defined by treatment guidelines. The mean gestational age at delivery was 38.5 weeks (range, 30.4-41.3 weeks).

[Table 2](#) shows results for the primary objectives compared with previously published HEDIS results and comparisons. Seventy-seven percent (n = 1040) of pregnancies were identified in the first trimester compared with 63% previously reported by the New Mexico Legislative Finance Committee.<sup>28</sup> Because women

**TABLE 3.** Secondary Outcomes

	Entire study population (N = 1355)	Group A: evidence of ongoing prenatal care (n = 451)	Group B: limited to no evidence of ongoing prenatal care (n = 904)
Women with at least 1 emergency department visit, n (%)	280 (20.7)	78 (17.3)	202 (22.3)
Births with known gestational age, n	159	88	71
Preterm births, n (%) <sup>a</sup>	24 (15.1%)	10 (11.4%)	14 (19.7%)
NICU admissions, n (%) <sup>b</sup>	66 (15.2%)	19 (10.7%)	47 (18.2%)
NICU length of stay in days, mean (range)	13.5 (0.13-94.2)	16.6 (0.29-94.1)	12.3 (0.13-64.2)

NICU, neonatal intensive care unit.

<sup>a</sup>Denominator is number of births with known gestational age.

<sup>b</sup>Denominator is the 435 infants with known location of first phlebotomy. Group A: n = 177; group B: n = 258.

**TABLE 4.** Univariable Analysis of Group A and B Membership and Confounding Variables With Secondary Outcomes<sup>a</sup>

P values of univariable tests	At least 1 ED visit	Full- or preterm delivery	NICU admission	Log NICU length of stay <sup>b</sup>
Group A or B univariable comparison	.023	.143	.033	.891
<b>Univariable analysis of potential confounders</b>				
Mother's age at enrollment	<b>.023</b>	<b>.111</b>	<b>.020</b>	<b>.210</b>
Section of the state: metropolitan or not	<b>.097</b>	<b>.013</b>	<b>.195</b>	.369
Care gaps present	<b>.031</b>	<b>.248</b>	<b>.072</b>	.906
Care gaps left unclosed	.517	.886	.269	.445
Prenatal risk factor: positive culture (eg, blood, urine, sputum)	<b>.005</b>	.760	.821	<b>.154</b>
Prenatal risk factor: abnormal glucose result	<b>.001</b>	.672	<b>.077</b>	.462
Prenatal risk factor: age-related risk	<b>.006</b>	.292	<b>.168</b>	<b>.217</b>
Prenatal risk factor: positive streptococcal test	.257	.575	<b>.007</b>	.285
Prenatal risk factor: abnormal glycated hemoglobin	<b>.135</b>	NA	<b>.170</b>	NA
Prenatal risk factor: abnormal gestational diabetes test	.973	.564	.822	.872
Prenatal risk factor: abnormal second-trimester aneuploidy screening test	.304	.672	.548	NA
Had prenatal risk factor(s)	<b>.001</b>	<b>.134</b>	<b>.173</b>	<b>.249</b>
Trimester detected	<b>.001</b>	.818	.491	.981
Gestational age at birth	.879	NA	<b>.001</b>	.928
Baby's sex	.552	.727	<b>.026</b>	<b>.224</b>

ED, emergency department; NA, no cases or redundant information; NICU, neonatal intensive care unit.

<sup>a</sup>Bold cells indicate  $P < .25$ .

<sup>b</sup>Extreme outlier removed.

may not seek prenatal care in the first trimester, the study sought to identify pregnancies at any time up to the delivery, with 12% (n = 163) identified in the second trimester and 11% (n = 152) in the third trimester. A total of 488 births (36%) were detected within 24 hours. As an indicator of the frequency of prenatal care, 64% of mothers in group A had at least 80% of all laboratory prenatal care gaps closed. This was compared with the state average of 52% of women fulfilling more than 80% of their recommended visits.<sup>29</sup>

**Table 3** provides comparisons between group A (members with evidence of ongoing prenatal care) and group B (members without evidence of ongoing prenatal care) for the secondary outcomes. Group B patients utilized the ED more than group A patients (22% vs 17%). Of the 488 births, 159 had gestational ages available from ultrasound reports. Using known gestational age, group A had a lower rate of

preterm delivery (11.4%) compared with group B (19.7%). The rate of NICU admissions for group A (10.7%) was less than that for group B (18.2%). The mean length of stay in the NICU for group A was 16.6 days compared with 12.3 days observed for Group B. When a single outlier in group A was removed due to a prolonged stay of 94 days, the mean length of stays for both groups were identical at 12.3 days.

Because randomization did not occur, a univariable analysis of the potential confounding variables was conducted for the secondary objectives. The univariable analysis looked for potential confounders that could be identified using laboratory data with a moderate univariable relationship ( $P < .25$ ) (**Table 4**, bold cells). These variables were further examined in a multivariable analysis that included a variable indicating whether the patient was in group A or group B. Through stepwise regression, variables with

**TABLE 5.** Multivariable Models for Secondary Outcomes

Secondary outcome	Significant confounders in multivariable model	P value in multivariable model	Odds ratio (95% CI)
At least 1 ED visit	Mother's age	<.001	0.947 (0.923-0.972)
	Abnormal glucose in year of pregnancy	<.001	3.661 (1.962-6.831)
	Age-related risk	.038	1.763 (1.031-3.012)
	Presence of risk factor(s)	.013	1.586 (1.101-2.283)
	Trimester detected	<.001	0.640 (0.504-0.813)
Preterm birth	Metropolitan section of state	.017	0.334 (0.219-0.820)
NICU admission	Gestational age at birth	<.001	0.558 (0.424-0.734)
	Baby's sex female	.005	0.113 (0.024-0.521)
Log of NICU length of stay*	No potential confounders had a significant effect on the NICU length of stay.	N/A	N/A

ED, emergency department; N/A, not applicable; NICU, neonatal intensive care unit.  
 \*Extreme outlier removed.

a P value greater than .05 were removed from the model. **Table 5** identifies variables that remained. After adjusting for confounders, membership in group A indicated lower odds of an ED visit (odds ratio [OR], 0.756; 95% CI, 0.560-1.020; *P* = .067), preterm birth (OR, 0.516; 95% CI, 0.210-1.267; *P* = .149), and NICU admission (OR, 0.379; 95% CI, 0.121-1.185; *P* = .95), but these odds were not significant at the .05 level. There were no potential confounders associated with NICU length of stay that were statistically significant.

## DISCUSSION AND LIMITATIONS

Clinical laboratory data have the advantage of providing real-time and longitudinal insights. Although many laboratory-based initiatives focus on a single laboratory result, measuring the value of the laboratory longitudinally across the entire spectrum of a disease or condition can be an effective tool. This concept, defined as Clinical Lab 2.0, seeks to provide meaningful laboratory-generated clinical diagnostic insights for population health initiatives that result in improved short- and long-term patient outcomes and drive cost-effective care.<sup>30,31</sup>

To our knowledge, this is the first report describing an innovative collaboration between an MCO and a clinical laboratory that leverages the Clinical Lab 2.0 concepts. These insights supported care coordinators in the delivery of prenatal and postpartum care, as demonstrated by the primary outcomes (Table 2).<sup>13</sup> Although claims data were not collected in this feasibility study, BCBSNM care coordinators reported that approximately 65% of the pregnancies identified were not found in claims, which led to an increase in more Special Beginnings enrollments during this study time frame (BCBSNM, personal communication). Through the use of these laboratory insights, BCBSNM was able to identify more pregnant members, increase the number of women receiving early prenatal care, monitor ongoing prenatal care, and affect the likelihood of an uncomplicated gestation. With 77% of all pregnancies detected in

the first trimester, BCBSNM improved its HEDIS timeliness of prenatal care measure from 75% to 78% and postpartum care measure from 58% to 61% in 2017.<sup>13</sup> Although laboratory data alone cannot be used to determine frequency of care, 64% of women who continually received prenatal care (group A) completed at least 80% of all ACOG-recommended laboratory tests. The TIM was successful in supporting BCBSNM to meet NMHSD's incentivized continual improvement plan measures.

One important finding was the reduction in ED visits. Women with at least 1 ED visit were evaluated for increased risk factors and were connected to obstetric care and care coordination services. Although this did not reach statistical significance after adjusting for confounding variables, a borderline effect of

fewer ED visits was seen in patients who received ongoing prenatal care (group A) relative to those who did not (group B).

A clinical outcome of interest was the rate of preterm delivery. This rate was not significantly lower among group A but clinically could have important value. Given a total of only 24 preterm births and the use of a multivariable model, a type II error due to small sample size is possible. Obtaining claims data on gestational age for all the births may have helped address this limitation. Living in a rural community was an important social determinant that could account for outcome differences.

The reduction in the frequency of NICU admissions in group A was also notable but did not reach statistical significance when confounding variables were included. Reducing NICU admissions is an important marker for reducing health care costs and improving clinical outcomes after birth. Differences in the 2 groups may have been influenced by lack of randomization and the accuracy of using phlebotomy location to calculate length of stay. Additionally, this study identified only 66 NICU admissions, which reduced the sample size available for analysis.

Although confounding variables were identified and considered as part of the analysis, not all confounders known to impact neonatal outcomes were included, such as race or positive opioid testing. Variables were excluded if not available as part of the laboratory data (eg, race) or if state regulatory requirements prevented the data from being shared with the MCO (eg, opioid test results). Although data on maternal outcomes are important, they were not collected as part of the study. Confounding variables possibly affecting ED visits included higher maternal age, presence of risk factors, and early trimester detection. NICU admission was more likely with a lower gestational age at birth, aligning with published literature.<sup>32-34</sup> Sex of the baby was also identified as a possible confounding variable with NICU admissions but lacked clinical significance.

This was a feasibility study and was not designed or intended to be a clinical trial. All pregnant patients identified by TriCore were

forwarded to BCBSNM for care coordination. Despite not being a randomized clinical trial, this study demonstrated the utility of using clinical laboratory data in novel and unique ways. Specifically, the results showed identification of early pregnancy, births in near-real time, and identification of gaps in care relative to traditional identifiers. Further, providing these laboratory-derived insights to an MCO enhanced its ability to engage patients earlier in their pregnancies and possibly improve outcomes. Similarly designed quasi-experimental studies have provided valuable information.<sup>35,36</sup>

## CONCLUSIONS

The health care industry is experiencing a transformational change and innovation is at an all-time high. This prospective feasibility study demonstrated that a clinical laboratory can innovatively collaborate with an MCO to augment its care coordination efforts in prenatal care. Our results also suggest that pregnant members who receive ongoing prenatal care may experience better outcomes, specifically, fewer NICU admissions and ED visits. Because the relationship of timely prenatal care and outcomes is difficult to establish, more research is needed in this area. This collaborative effort illustrates that when health care organizations work together to utilize data in innovative ways, the system and, most importantly, the patients benefit. ■

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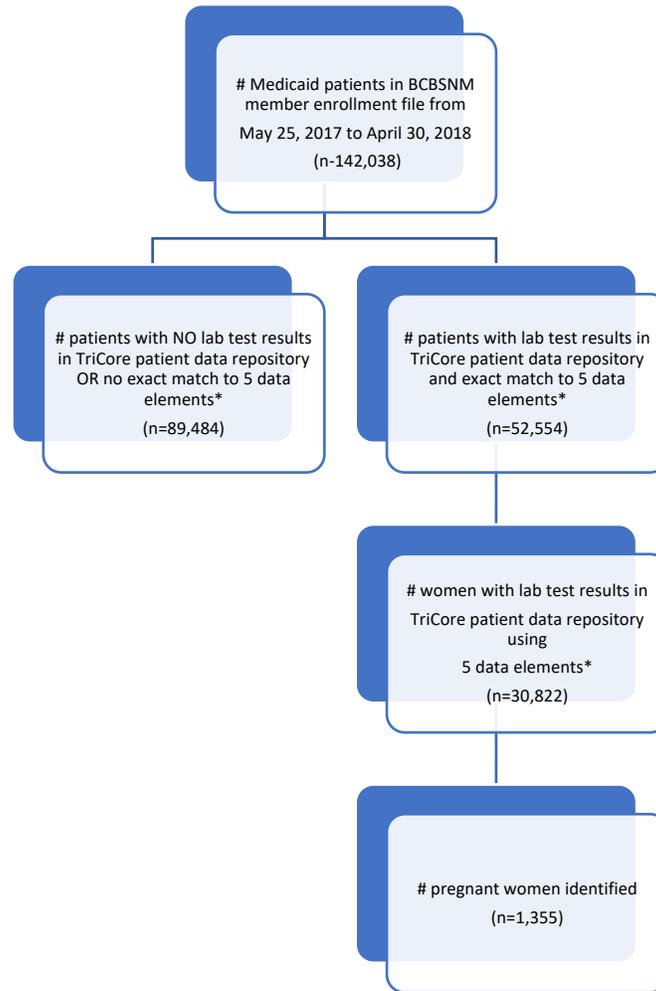
## REFERENCES

- Alexander GR, Kotelchuck M. Assessing the role and effectiveness of prenatal care: history, challenges, and directions for future research. *Public Health Rep.* 2001;116(4):306-316. doi:10.1093/phr/116.4.306
- Early Entry Into Prenatal Care Toolkit: Overcoming Barriers and Improving Access to Care. March of Dimes; 2013.
- Kogan MD, Alexander GR, Kotelchuck M, et al. Trends in twin birth outcome and prenatal care utilization in the United States, 1981-1997. *JAMA.* 2000;284(3):335-341. doi:10.1001/jama.284.3.335
- Goulet L, D'Amour D, Pineault R. Type and timing of services following postnatal discharge: do they make a difference? *Women Health.* 2007;45(4):19-39. doi:10.1300/J013v45n04\_02
- World Health Organization; United Nations Population Fund; UNICEF; The World Bank. *Pregnancy, Childbirth, Postpartum and Newborn Care: A Guide for Essential Practice.* 2nd ed. World Health Organization; 2006.

- American Academy of Pediatrics; American College of Obstetricians and Gynecologists. Preconception and antepartum care; intrapartum and postpartum care of the mother. In: *Guidelines for Perinatal Care.* 7th ed. American Academy of Pediatrics and American College of Obstetricians and Gynecologists; 2012:95-210.
- What is prenatal care and why it is important? National Institute of Child Health and Human Development. January 31, 2017. Accessed August 24, 2018. <https://www.nichd.nih.gov/health/topics/pregnancy/conditioninfo/prenatal-care>
- Kotelchuck M. The Adequacy of Prenatal Care Utilization Index: its US distribution and association with low birthweight. *Am J Public Health.* 1994;84(9):1486-1489. doi:10.2105/ajph.84.9.1486
- HEDIS 2018. *Technical Specifications for Health Plans.* National Committee for Quality Assurance; 2017.
- Find a Medicare plan. CMS. Accessed December 3, 2018. <http://www.medicare.gov/find-a-plan/questions/home.aspx>
- Nathanson R. NM has highest rate of Medicaid-covered births. *Albuquerque Journal.* March 28, 2017. Accessed August 24, 2018. <https://www.abjournal.com/977267/nm-has-highest-rate-of-medicadcovered-births.html>
- CDC Wonder. CDC. Accessed March 18, 2019. <https://wonder.cdc.gov/>
- Complete health indicator report: prenatal care in the first trimester. New Mexico's Indicator-Based Information System. Accessed August 24, 2018. <https://ibis.health.state.nm.us/indicator/view/PrenCare.Cnty.html>
- 2016 prenatal birth report card: New Mexico. March of Dimes. 2016. Accessed August 24, 2018. <https://www.marchofdimes.org/peristats/pdflib/998/prenature-birth-report-card-New-Mexico.pdf>
- Buescher PA, Roth MS, Williams D, Goforth CM. An evaluation of the impact of maternity care coordination on Medicaid birth outcomes in North Carolina. *Am J Public Health.* 1991;81(12):1625-1629. doi:10.2105/ajph.81.12.1625
- Van Dijk JW, Anderko L, Stetzer F. The impact of prenatal care coordination on birth outcomes. *J Obstet Gynecol Neonatal Nurs.* 2011;40(1):98-108. doi:10.1111/j.1552-6909.2010.01206.x
- Roman L, Raffo JE, Zhu Q, Meghea CI. A statewide Medicaid enhanced prenatal care program: impact on birth outcomes. *JAMA Pediatr.* 2014;168(3):220-227. doi:10.1001/jamapediatrics.2013.4347
- Hillemeier MM, Domino ME, Wells R, et al. Effects of maternity care coordination on pregnancy outcomes: propensity-weighted analysis. *Matern Child Health J.* 2016;19(1):121-127. doi:10.1007/s10995-014-1502-3
- Request for proposals for managed care organization contractors for Centennial Care 2.0: RFP # 18-630-8000-0001. September 1, 2017. Accessed December 3, 2018. [https://www.hsd.state.nm.us/uploads/FileLinks/c06b4701fbc84ea3938e646301d8c950/2017\\_MCO\\_RFP\\_#2318\\_630\\_8000\\_0001\\_for\\_Centennial\\_Care\\_2.0\\_9\\_1\\_17.pdf](https://www.hsd.state.nm.us/uploads/FileLinks/c06b4701fbc84ea3938e646301d8c950/2017_MCO_RFP_#2318_630_8000_0001_for_Centennial_Care_2.0_9_1_17.pdf)
- Comparison of managed care encounter data to accounting system data for Blue Cross and Blue Shield of New Mexico. New Mexico Human Services Department. April 7, 2017. Accessed October 4, 2018. [http://www.hsd.state.nm.us/uploads/FileLinks/8087bfcd31b14dfe8b92a626b6890b19/Appendices\\_BCBS\\_A\\_1\\_to\\_A\\_16.pdf](http://www.hsd.state.nm.us/uploads/FileLinks/8087bfcd31b14dfe8b92a626b6890b19/Appendices_BCBS_A_1_to_A_16.pdf)
- Beveridge RA, Mendes SM, Caplan A, et al. Mortality differences between traditional Medicare and Medicare Advantage: a risk-adjusted assessment using claims data. *Inquiry.* 2017;54:46958017709103. doi:10.1177/0046958017709103
- Forsman RW. Why is the laboratory an afterthought for managed care organizations? *Clin Chem.* 1996;42(5):813-816.
- Laposata ME, Laposata M, Van Cott EM, Buchner DS, Kashalo MS, Dighe AS. Physician survey of laboratory medicine interpretive service and evaluation of interpretations on laboratory test ordering. *Arch Pathol Lab Med.* 2004;128(12):1424-1427. doi:10.1043/1543-2165(2004)128<1424:PSDALM>2.0.CO;2
- Ahn CH, Yoon JW, Hahn S, Mon MK, Park KS, Cho YM. Evaluation of non-laboratory and laboratory prediction models for current and future diabetes mellitus: a cross-sectional and retrospective cohort study. *PLoS One.* 2016;11(5):e0156155. doi:10.1371/journal.pone.0156155
- American Academy of Pediatrics; American College of Obstetricians and Gynecologists. *Guidelines for Perinatal Care.* 7th ed. American Academy of Pediatrics; American College of Obstetricians and Gynecologists; 2012.
- Just BH, Fabian DP, Webb LL, Hjort BM. Managing the integrity of patient identity in health information exchange. *J AHIMA.* 2009;80(7):62-69.
- 45 CFR 164.506: uses and disclosures to carry out treatment, payment, or health care operations. GovInfo. October 1, 2004. Accessed May 13, 2019. <https://www.govinfo.gov/app/details/CFR-2004-title45-vol1/CFR-2004-title45-vol1-sec164-506>
- Program evaluation: the Department of Health's role in the early childhood system. New Mexico Legislative Finance Committee. May 8, 2019. Accessed September 17, 2019. [https://www.nmlegis.gov/Entity/LFC/Documents/Program\\_Evaluation\\_Reports/Program%20Evaluation%20-%20The%20Department%20of%20Health%20Role%20in%20the%20Early%20Childhood%20System.pdf](https://www.nmlegis.gov/Entity/LFC/Documents/Program_Evaluation_Reports/Program%20Evaluation%20-%20The%20Department%20of%20Health%20Role%20in%20the%20Early%20Childhood%20System.pdf)
- 2015 accountability report: Medicaid. New Mexico Legislative Finance Committee. 2015. Accessed November 21, 2019. [https://www.nmlegis.gov/Entity/LFC/Documents/Program\\_Evaluation\\_Reports/Medicaid%20Accountability%20Report%202015.pdf](https://www.nmlegis.gov/Entity/LFC/Documents/Program_Evaluation_Reports/Medicaid%20Accountability%20Report%202015.pdf)
- Crawford JM, Shotorbani K, Sharma G, et al. Improving American healthcare through "Clinical Lab 2.0": a Project Santa Fe report. *Acad Pathol.* 2017;4:2374289517701067. doi:10.1177/2374289517701067
- Swanson K, Dodd MR, VanNess R, Crossey M. Improving the delivery of healthcare through clinical diagnostic insights: a valuation of laboratory medicine through "Clinical Lab 2.0." *J Appl Lab Med.* 2018;3(3):487-497. doi:10.1373/jalm.2017.025379
- Weir S, Posner HE, Zhang J, Willis G, Baxter JD, Clark RE. Predictors of prenatal and postpartum care adequacy in Medicaid managed care population. *Women Health Issues.* 2011;21(4):277-285. doi:10.1016/j.whi.2011.03.001
- Harrison W, Goodman D. Epidemiologic trends in neonatal intensive care, 2007-2012. *JAMA Pediatr.* 2015;169(9):855-862. doi:10.1001/jamapediatrics.2015.1305
- de Jongh BE, Locke R, Paul DA, Hoffman M. The differential effects of maternal age, race/ethnicity and insurance on neonatal intensive care unit admission rates. *BMC Pregnancy Childbirth.* 2012;12:97. doi:10.1186/1471-2393-12-97
- Gazmararian JA, Arrington TL, Bailey CM, Schwarz KS, Koplan JP. Prenatal care for low-income women enrolled in a managed-care organization. *Obstet Gynecol.* 1999;94(2):177-184. doi:10.1016/s0029-7844(99)00237-9
- Bevis CC, Nogle JM, Forges B, et al. Diabetes wellness care: a successful employer-endorsed program for employees. *J Occup Environ Med.* 2014;56(10):1052-1061. doi:10.1097/JOM.0000000000000231

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**eAppendix Figure. Selection of the Study Population**



\*Data elements required for a match are first name, last name, sex, date of birth, and social security number.