NEW JERSEY
Hospital Maternity Care Report Card, 2016

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Statute

Summary of the Statute

In 2018, New Jersey legislature enacted P.L. 2018, c.82, which requires the Department of Health to issue a report on hospital maternity care. Specifically, the statute states that:

1. The Commissioner of Health shall gather and compile information necessary to develop a New Jersey Report Card of Hospital Maternity Care (Report Card), as provided for in this act. The Report Card, which shall be updated annually and made available on the website of the Department of Health, shall be designed to inform members of the public about maternity care provided in each general hospital licensed pursuant to P.L.1971, c.136 (C.26:2H-1 et 13 seq.), so that a member of the public is able to make an informed comparison.

2. For each hospital, the Report Card shall include:
    a. the number of vaginal deliveries performed;
    b. the number of cesarean deliveries performed; and
    c. the rate of complications experienced by a patient receiving maternity care:
        i. for a vaginal delivery, which shall include the rate of maternal hemorrhage, laceration, infection, or other complication as prescribed by the Commissioner of Health; and
        ii. for a cesarean delivery, which shall include the rate of maternal hemorrhage, infection, operative complication, or other complication as prescribed by the Commissioner of Health.

3. Notwithstanding the provisions of section 2 of this act to the contrary, the commissioner shall revise or add complications or other factors to be included in the Report Card based on maternal quality indicators as may be recommended by the American Congress of Obstetricians and Gynecologists.

A major goal of this report is to provide important information on maternal health care provided in New Jersey by licensed birthing general acute care hospitals.

Summary of Findings

Overall Complications:

- Of the 49 birthing hospitals in New Jersey, 24 (49%) had significantly higher postpartum hemorrhage rates than the statewide rate.
- Nine birthing hospitals (18%) had significantly higher post-admission infection rates than the statewide rate.
- Nineteen (39%) had significantly higher rates of lacerations ($3^{rd}/4^{th}$ degree perineal lacerations and/or high vaginal lacerations) than the statewide rate.
- Of the 49 birthing hospitals, 10 (or 20%) had significantly higher rates of Severe Maternal Morbidity (SMM) with transfusion than the statewide rate.
- Only 14 of the 49 hospitals (29%) did not have any risk-adjusted rates for any of the complications that were significantly higher than the statewide rate investigated in the current report.

Complication Rates by Race/Ethnicity:

- Asian mothers had the highest rate of third- and fourth-degree perineal lacerations with 49 per 1,000 delivery hospitalizations while the rate for Non-Hispanic White mothers is the lowest at 10 per 1,000 delivery hospitalizations.
- Other/Multi-racial mothers had the highest rate of high vaginal laceration with 32.3 per 1,000 delivery hospitalizations followed by Non-Hispanic White mothers at 31.0 per 1,000 delivery hospitalizations while the rate for Asian mothers is the lowest at 19 per 1,000 delivery hospitalizations.
- Non-Hispanic Black mothers had the highest rate of SMM with transfusion at a rate of 31.2 per 1,000 delivery hospitalizations while the rate for Non-Hispanic White mothers is the lowest at 13.4 per 1,000 delivery hospitalizations.
- Non-Hispanic Black mothers suffered the highest rate of post-admission infections at a rate of 11.8 per 1,000 delivery hospitalizations while the rate for Non-Hispanic White mothers is the lowest at 3.9 per 1,000 delivery hospitalizations.
- Non-Hispanic Black mothers suffered the highest rate of postpartum hemorrhage with 54 per 1,000 delivery hospitalizations and the rate for Non-Hispanic White mothers is 50 per 1,000 delivery hospitalizations while the rate for Other/Multi-racial mothers is the lowest at 40 per 1,000 delivery hospitalizations.

General Observations:

While various clinical factors, such as method of delivery, pre-existing conditions and pre-pregnancy body mass index (BMI), were identified as risk factors for complications, race/ethnicity has been identified as an important risk factor even after controlling for socio-demographic and pre-delivery health status factors.

Key Recommendations

In collaboration with New Jersey Maternal Care Quality Collaborative (NJMCQ):

- Further research will be needed to understand the mechanisms that contribute to postpartum hemorrhage, third- and fourth-degree perineal and high vaginal lacerations, post-admission infections and Severe Maternal Morbidity (SMM) at the hospital level.
- Encourage hospitals to adopt a standard measure for Quantitative Blood Loss (QBL) to ensure accuracy of data.
- Based on the statistically significant risk-adjusted complication rates (i.e. SMM, post-admission infections) amongst mothers who experienced cesarean deliveries, it is important to identify the modifiable risk factors that contribute to cesarean delivery through carefully designed research studies.

While there is a wealth of research and proven methodologies to improve maternal outcomes, the current report highlights the continuing need for improvement in New Jersey. For example, nulliparous status is found to be associated with an increased risk of complications. This suggests that labor and delivery management guidelines should be developed and adopted to address the differences in labor progression and outcomes between nulliparous and multiparous mothers. Through cooperation between hospitals and the NJMCQC, the development and adoption of appropriate quality improvement methods will have a vast impact on the quality of maternity care in New Jersey.

Background

An increasing body of literature documents childbirth as a significant life event that can be both positive and traumatic depending on the woman's experience during delivery (Berg M et al.,2003; Elmir R et al., 2010). This experience is largely influenced by an array of mild adverse effects to life-threatening events or death that can occur during delivery. These morbidities and complications require various levels of intervention from non-invasive (i.e. medication taken by mouth or intravenously) to invasive (i.e. blood transfusion) interventions to save both the woman's life and her offspring's life. To fully understand and reduce maternal morbidities and delivery complications, there is a need for consistent measurement, collection, analysis and dissemination of data related to specifically address labor and delivery. Availability of good quality health care data that allows the construction of performance metrics to support quality improvement efforts is fundamental. Once constructed, patients and their physicians can use these metrics to inform their discussion in determining the best hospital for the patients' health care and labor and delivery needs.

In this report, the Department of Health uses data collected on all hospital-based births in 2016 as reported through the Electronic Birth Certificate (EBC) system. The EBC data was complemented by matching records with hospitalization discharge records in each of hospitals where births occurred. The process also allowed us to capture additional maternal health characteristics that were not included in the EBC.

To account for the patient mix at each birthing facility, risk-adjusted rates of delivery-associated complications, described below, were then calculated. 'Risk-adjusted' rates are rates calculated that reflect the mother's health conditions including her social, demographic, economic statuses. The risk-adjustment process allows for fair comparisons across hospitals which treat diverse patient populations. Risk-adjusted rates are expressed as ratios of expected complications to observed complications harmonized by the statewide complication rate. Statistical significance is assessed by whether the statewide rate crosses the range between the lower and upper bounds of the confidence limits. A difference is considered 'statistically significant' when the statewide rate falls outside the confidence limits estimated for the hospital rate. As an example, a hospital's rate is statistically significantly higher than the statewide rate if the corresponding hospital's rate confidence bound is completely above the statewide rate. By comparison, we say the hospital's rate is statistically significantly lower than the statewide rate when the statewide rate falls below the corresponding hospital confidence bound.

The measures assessed in this report are: third- and fourth-degree perineal laceration, high vaginal laceration, postpartum hemorrhage, post-admission infections and Severe Maternal Morbidity as a surrogate for "Other Complications". In the following sections, we will discuss each measure in more detail.

Postpartum Hemorrhage

The American Congress of Obstetricians and Gynecologists (ACOG) Postpartum Hemorrhage (PPH) is an estimated blood loss more than 500 ml after a vaginal birth or a loss of greater than 1,000 ml after a cesarean birth (ACOG Practice Bulletin No.76, 2006). PPH is common amongst women during delivery or post-delivery: uterine atony, genital tract trauma (i.e. vaginal or cervical lacerations), uterine rupture, retention of placental issue, or maternal coagulation disorders (ACOG Practice Bulletin No.183, 2017). In addition to being strongly associated with severe maternal morbidities, about a quarter of maternal deaths are due to PPH (WHO, 2012). Considering, the potential fetal outcomes linked to PPH, healthcare providers are encouraged to closely assess for the risk factors for PPH and be ready to implement obstetric multidisciplinary and multifaceted guidelines requiring them to maintain hemodynamic stability while identifying and treating the cause of blood loss in cases where it occurs (ACOG Practice Bulletin No.183, 2017).

Severe Maternal Morbidity

The Centers for Disease Control and Prevention (CDC), refers to Severe Maternal Morbidity (SMM) as a list of unexpected outcomes of labor and delivery that result in significant short- or long-term consequences to a woman's health (CDC, 2017). This list of unexpected outcomes of labor and delivery (morbidities) encompasses a continuum of health conditions including life-threatening and disabling diseases, organ dysfunction and/or receipt of invasive therapy, during labor and/or after delivery (Frioz et al., 2013). The 2014 SMM report published by the CDC showed a steady national increase in SMM. It is argued that certain sociodemographic factors (i.e. increase maternal age), chronic disease and increase rate in cesarean deliveries may have warranted this increase (Martin et al., 2017). Considering, the consequences of some of these SMM on a woman's health, the CDC recommends identifying the underlying factors of these SMM and designing interventions to target them with the goal of improving the quality of maternal care.

Post-admission Infections

Bacterial infections that occur during labor or the puerperium (period of approximately six weeks following childbirth) usually have a good prognosis when identified and treated promptly, however, occasionally they can become severe and result in morbidity or rarely mortality (Cantwell R et al., 2011). Beyond the immediate effects of the infection, long-term complications can include chronic pelvic pain, fallopian tube blockage or infertility (WHO, 2015). Factors that can lead to infections include pre-existing maternal conditions, such as diabetes or obesity, as well as conditions that may arise during labor, such as prolonged rupture of the membranes and cesarean birth (Acosta CD et al., 2014). Current recommendations for prevention of infections includes judicious use of prophylactic antibiotics (ACOG Practice Bulletin No.199, 2018). While most postpartum infections are diagnosed after the patient is

discharged from the hospital (Yokoe D et al., 2001), the current report only includes those diagnosed during the initial delivery hospitalization.

Third- and Fourth-Degree Perineal and High Vaginal Lacerations

Vaginal and perineal trauma often occur during vaginal birth, either spontaneously or secondarily from an episiotomy (a surgical incision of the perineum to enlarge the opening for passage of the baby during delivery). Third- and fourth-degree perineal lacerations are severe tears of the vagina and perineum that also involve tissues of the anus (Royal College, 2007 & 2015). High vaginal lacerations do not extend to the perineum. Short-term consequences of these lacerations may include pain and infection (Buppasiri et al., 2014; Fitzpatrick et al., 2005), while long-term complications include incontinence and formation of fistulas (Guise et al., 2007). While lacerations during vaginal birth are not completely avoidable, there are measures that can help avoid or lessen their severity. The American Congress of Obstetricians and Gynecologists (ACOG) has compiled a set of recommendations to mitigate the risk of obstetric lacerations, including the avoidance of routine episiotomy (ACOG Practice Bulletin No.165, 2016).

Methods

Data Sources

Electronic Birth Certificate (EBC) Data: The Health Department's Office of Vital Statistics has been collecting data on all live births in New Jersey since 1966 in electronic format with its most recent birth records reported through the Vital Information Platform (VIP). In addition to registering information about the child, EBC contains demographic information, including the mother's age, race, ethnicity, education status, health insurance status, the mother's health status as well as information about the pregnancy, such as parity, prenatal care and method of delivery.

Inpatient Hospital Discharge Data: The Office of Health Care Quality Assessment (HCQA) of the Centers for Healthcare Quality and Informatics in the New Jersey Department of Health has been collecting data on hospital encounters via the New Jersey Hospital Discharge Data Collection System (NJDDCS) since 1980. As of 2004, NJDDCS includes emergency, inpatient, outpatient and same day surgery discharges. A hospital discharge record contains demographic, geographic, International Classification of Diseases, tenth Revision, Clinical Modification (ICD-10-CM) diagnosis and procedure codes, hospital charges, discharge statuses, types of services provided and other data elements. The department collects all hospital discharges that occurred in each calendar year. Thus, a 2016 birth-related hospitalization could be reported along with 2017 discharges. Moreover, NJDDCS is hospital encounter data where a patient (in this case, a mother) could have multiple hospitalizations with the calendar year. As it will be clear later, only the first birth-related encounter is used for our purposes.

The Report Card uses maternal information as reported in the EBC with additional data elements included by matching each birthing mother's information with her corresponding hospital discharge clinical information as reported through ICD-10-CM diagnosis and procedure codes.

Summary of Steps to Create Analytic File

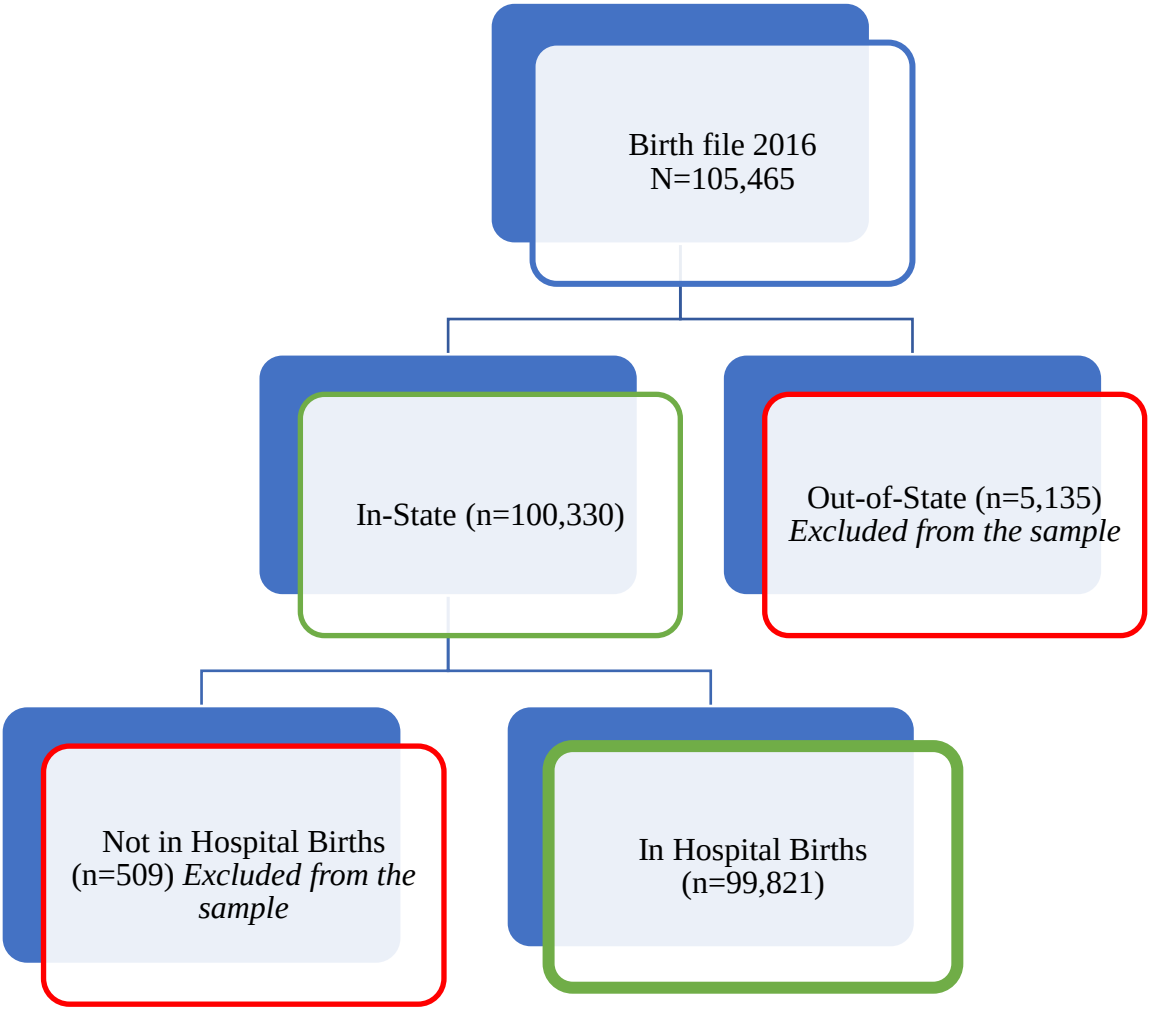
Inpatient Hospitalization Data

- Inclusion criteria
  - All females who gave birth at a Hospital in New Jersey
  - 12 to 65 years of age (for screening purposes)
  - First record for each patient (mother)
  - 2016 birth-related hospitalizations and January & February *2017*
- Exclusion criteria
  - Duplicate records for same encounter
  - Males
  - Younger than 12 years old or older than 65 years old
  - Same Day Surgery, ER outpatient or Other Outpatient discharges

Electronic Birth Certificate Data, 2016

- Inclusion criteria
  - All New Jersey hospital births
    In cases of multiple births, select only 1 record
- Exclusion criteria
  - All out-of-state births
  - Births in freestanding birthing centers, home, clinic/doctor's office, other/unspecified location
  - Multiple babies to same mother except the first record

Figure 1. Birth File Inclusion & Exclusion Criteria



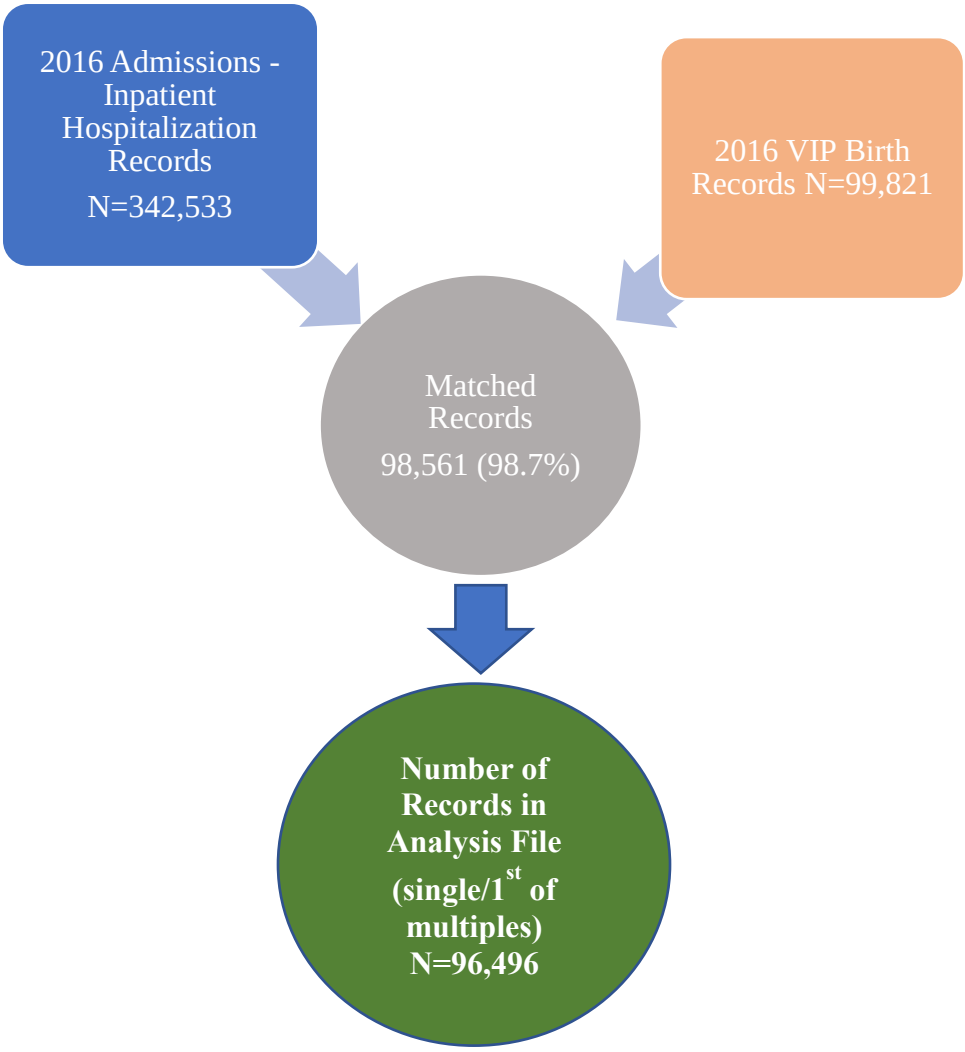
Data Matching

Inpatient delivery hospitalizations and birth certificates records were matched, using an algorithm of identifying variables:

(1) Patient level variables (*Mother*): First and Last Name, Date of Birth, Social Security Number, Medical Record Number, Date of Admission and Discharge
(2) Patient level variable (*Newborn*): Date of Birth
(3) Hospital level variable: Hospital code

In cases of multiple births, each infant's birth certificate was matched to the same mother's hospital discharge record to ensure that only the delivery hospitalization was selected for the purposes of analysis. Each matched record represents a delivery where at least one live birth occurred. The team accounted for mothers who were admitted in late December 2016 and discharged in January-February of 2017, by linking January-February 2017 births with the 2016 birth certificate data.

Figure 2. Summary of Data Matching Process: EBC to Inpatient Hospitalization Records, New Jersey, 2016



The Study Population

As part of the process to obtain data to analyze, the team identified 99,821 in-hospital deliveries out of the 100,330 New Jersey births in 2016. These deliveries were comprised of all records including singleton births and multiple births. Of the 99,821 in-hospital deliveries identified, 98,561 deliveries were successfully matched to hospital discharge records for a match rate was 98.7%.

To identify the number delivering mothers, the first record for each singleton birth or first record of multiple births (e.g. twins, triplets) was used in creating the preliminary analysis file to obtain 96,673 records. After excluding 177 records from Hackettstown Community Hospital which closed its birthing facility in 2016, the final analysis file included 96,496 total deliveries of live births in 49 hospitals of New Jersey.

Once the analytic file was created, the next steps included identifying, defining and reviewing the required reportable measures as suggested in the Statute, namely: hemorrhage (postpartum hemorrhage), laceration (third- and fourth-degree perineal laceration, high vaginal lacerations), infections (post-admission infections), other complications (where Severe Maternal Morbidity is used as surrogate).

Identification of delivery-associated complications

Hemorrhage

Hemorrhage is defined using the American College of Obstetricians and Gynecologist (ACOG) standard for determination of hemorrhage (ACOG Practice Bulletin 76, 2006). The ACOG standard defines hemorrhage as blood loss of greater than 500cc following a vaginal birth or greater than 1,000cc following a cesarean birth. The Quantified Blood Loss (QBL) amount reported in cc in the birth certificate data is used to determine the amount of maternal blood loss (hemorrhage) during the delivery hospitalization. There are two caveats when using the above information to identify hemorrhage. First, there is no specified time-period for the blood loss; it is assumed that all hospitals are measuring blood loss during the same time-period during the hospitalization (following the delivery and not inclusive with the delivery). Second, there is no specification whether signs of hypovolemia were present, which could aid in the final determination of a true diagnosis of hemorrhage.

Severe Maternal Morbidity as proxy for "Other Complications"

Severe Maternal Morbidity (SMM) events were identified during delivery hospitalizations using an algorithm developed by researchers at the Centers for Disease Control and Prevention (CDC) (CDC,2017). The algorithm identifies 18 indicators of SMM that represent either life threatening conditions—such as eclampsia or acute renal failure—or procedure codes for life-saving procedures—such as blood transfusion, ventilation or hysterectomy. The 18 indicators were identified using ICD-10-CM diagnosis codes and procedure codes as prescribed by the CDC (CDC,2017).

In addition to the above algorithm, to ensure the most conservative estimate of SMM, we excluded hospitalizations with a length of stay less than the 90th percentile as calculated separately for vaginal, primary and repeat cesarean deliveries (Callaghan WM et al., 2012). All SMM hospitalizations associated with in-hospital mortality or transfer-in or -out of the delivery facility, as well as those associated with procedure codes were included, regardless of length of stay. In hospital death was identified via the discharge status specifying the patient as 'expired'. Additionally, transfers were identified using both discharge status and admission source information.

Infections

A comprehensive list of ICD-10-CM diagnosis codes, presented in Appendix A of this report, along with information from Electronic Birth Certificate (presence of Intrapartum infection) data are used to identify all cases of delivery-associated infections that occur during

the delivery hospitalization. Additionally, only cases of infection that are not present on admission are included to eliminate instances of pre-admission infections from the final analysis.

Laceration (*vaginal birth only*)

Laceration associated with delivery is divided into two categories: third- and fourth-degree perineal lacerations and high vaginal trauma. Both categories are further differentiated by those with and without instrument. To identify perineal lacerations, we used the Agency for Healthcare Research and Quality (AHRQ) Patient Safety Indicator PSI 18 and PSI 19 definitions and associated ICD-10-CM diagnosis codes. In addition, we used the question which asked about the occurrence of a third- or fourth-degree perineal laceration in the Electronic Birth Certificate data to identify such cases. High vaginal trauma with and without instrument was exclusively identified using the ICD-10-CM O71.4 code.

Risk Factors for Delivery-Associated Complications

The observed complication rate for a measure in each facility is estimated as the number of patients that experienced the complication during the delivery hospitalization divided by the total number of delivery hospitalizations in that facility during the period of investigation. However, this observed complication rate does not provide a fair assessment of the quality of care provided by the facility or providers in the facility, because it does not account for potential risk factors present prior to hospitalization. Hospitals (facilities) that serve patients with pre-existing health conditions, such as cardiac or respiratory diseases, would be expected to have higher rates of complications.

To perform a fairer assessment of the quality of maternal healthcare provided by NJ hospitals that perform deliveries, the Department uses a risk-adjustment method to estimate complication rates to account for the pre-delivery risk factors of each patient. In doing so, hospitals that serve high risk patients will not be at a disadvantage with the estimated complication rates when their numbers are presented side-by-side with facilities that serve healthier patients. The risk adjustment is performed by fitting a mixed effects stepwise logistic regression model by controlling for the social, demographic and pre-hospitalization risk factors and then using the fitted model to obtain the predicted number of complications for each hospital. This predicted number of complications is then used to compare against the observed number of complications for each facility. Further details on the statistical risk adjustment methodology are provided in the following section.

The pre-delivery risk factors used in the statistical models include mothers' socio-demographic characteristics (e.g., race/ethnicity, age, health insurance coverage), clinical and obstetric factors (e.g., parity, method of delivery, body mass index, prenatal care) (Table 1). We also adjusted for clinical comorbidities (e.g., diabetes; hypertension; chronic liver, respiratory, cardiac and renal diseases; placental disorders) as well as behaviors associated with increased risk of complications (e.g., tobacco use, alcohol and illicit drug abuse) (Table1.). These factors were obtained from ICD-10-CM diagnosis codes as reported through the hospitalization database and the information in the Electronic Birth Certificate. A report, which assessed the validity of information obtained from birth files compared with that in hospital discharge data, shows that a

combination of the two data sources is most accurate (Lydon-Rochelle M. et al., 2005). In this report:

- A complication is considered if documented by a corresponding diagnosis code, or if it was identified on the birth file.
- Method of delivery is defined as specified by the Agency for Healthcare Research and Quality Inpatient Quality Indicator 33 to identify primary and repeat cesarean deliveries.

Table 1. List of Covariables Considered for Analysis

	Values/Categories
Sociodemographic Characteristics	
Race/ Ethnicity	Non-Hispanic White Non-Hispanic Black Hispanic Non-Hispanic Asian Other/ Multi-race
Maternal Age	<35 35+
Health Insurance Coverage	Private Insurance Medicaid Self-Pay/Charity Care Other
Clinical & Obstetric factors/ Comorbidities	
Method of Delivery	Vaginal Cesarean *(Primary, Repeat)*
Gestational Age	Premature (before 37 weeks of gestation) Mature (after 37 weeks of gestation)
Diabetes Mellitus (Gestational & Preexisting)	Yes/No
Hypertension (Gestational & Preexisting)	Yes/No
Chronic Disease: Cardiac Renal Respiratory Liver	Yes/No
Placental Disorders (Placenta Abruptio, Previa and /or Accreta)	Yes/No
HIV status	Positive/ Negative
Prenatal Care Utilization	Early (1st Trimester) Late (None, 2nd & 3rd Trimester)

Tables 1 (cont.)

Pre-pregnancy Body Mass Index (BMI)	Underweight (Below 18.5) Normal (18.5 – 24.9) Overweight (25.0 – 29.9) Obese (30.0 and Above)
Length of Labor	Precipitous Labor (Less than 3 hours) Prolonged Labor (Greater than or equal to 20 hours)
Infant Birthweight	Low birthweight less-than 2,500 grams Normal-birthweight between 2,500 grams and 4,000 grams Overweight (macrosomia)- over 4,000 grams
Induction of Labor (Labor induction is the process or treatment that stimulates childbirth and delivery)	Yes/No
Behavioral Risk Factors	
Substance Use	Yes/No
Alcohol Use	Yes/No
Tobacco Use	Yes/No

Statistical Analysis

Assessing Patient Risk Factors

A mixed effects stepwise logistic regression model, which included the previously discussed pre-delivery clinical factors and demographic characteristics, was fitted to the data for each category of delivery-associated complication for the period covered in this report. The models identified the risk factors important in predicting whether a patient would experience the specific complication under investigation. The general form of the mixed effect logistic regression model for estimating the 'logit' of the probability of experiencing the complication of interest is as follows (SAS/STAT 14.3 User's Guide, 2017):

$$E[Y|\gamma] = g^{-1}(X\beta+Z\gamma)$$

Y = (n x 1) vector of observed values of dependent variable, where n = number of observations
X = (n x p) matrix of fixed effects, where n = number of observations, p = proportion of sample elements that have a particular attribute
β = vector of regression coefficients for fixed-effects parameters
Z = (n x r) design matrix for the random effects, where n= number of observations, r = sample correlation coefficient, based on all the elements from a sample
γ = (r x 1) vector of random effects, where r = sample correlation coefficient, based on all the elements from a sample
g = differentiable monotonic link function (g^{-1} is the inverse)

The statistically significant factors for each complication identified by stepwise logistic regression models are presented in Tables 2a-2e. Each list includes only those factors that were statistically significant in predicting the class of complication under investigation with p-values of 0.05 or smaller.

These models were used to predict the number of a given complication type, which was then compared with the observed rates to create the adjustment factor. This adjustment factor was then applied to the statewide rate for the given complication type to produce the risk-adjusted rate for the hospital.

$$Risk\ Adj\ Rate = \frac{Observed}{Expected} \times Statewide\ rate$$

Ninety five percent confidence intervals were calculated for the risk adjusted rate using the following formula (Kahn H., 1989):

$$CI_{ISR} = \pm 1.96 \sqrt{\frac{(Observed/Expected)}{Expected}} \times Statewide\ rate$$

Rates with confidence intervals above the statewide rate were deemed significantly higher than statewide rate, and conversely hospitals with confidence intervals below the statewide rate were considered to have significantly lower rates than the state.

The odds ratios are derived from the coefficients and are used to compare the relative importance of the risk factors in predicting complications during delivery. For each of the risk factors identified in Tables 2a-2e, the odds ratio represents how likely a patient is to develop complications compared to a patient who is in the reference group. So, for example, Table 2a shows that a delivering woman is almost twice (odds ratio = 1.74) as likely to have postpartum hemorrhage after she had surgical/cesarean birth (primary, repeat) compared to a delivering woman who did not have the surgical/cesarean birth and assumes that these delivering mothers have the same set of other risk factors presented in the table.

In another example, the odds of developing post-admission infections during or after delivery for a delivering mother who is Non-Hispanic Black is about twice as likely (odds ratio= 1.97) compared with the odds of a patient who is Non-Hispanic White (Table 2c).

Table 2a. Risk Factors Identified for Postpartum Hemorrhage

	Logistic Regression Results		
	Coefficient	P-value	Odds Ratio
Demographic Factors			
Race/ Ethnicity			
Non-Hispanic White	Ref.		
Non-Hispanic Black	0.1038	0.0386	1.11
Hispanic	0.1723	<.0001	1.19
Non-Hispanic Asian	0.0185	0.7389	1.02
Other/ Multi-race	-0.0798	0.4475	0.92
Maternal Age-35+	0.2322	<.0001	1.26
Clinical & Obstetric factors/ Comorbidities			
Surgical/Cesarean Birth *(Primary, Repeat)*	0.5533	<.0001	1.74
Parity (Nulliparous)	0.4351	<.0001	1.55
Induction	0.1323	0.0003	1.14
Hypertension (Gestational & Preexisting)	0.2473	<.0001	1.28
Placental Disorders (Placenta Abruptio, Previa and /or Accreta)	1.3737	<.0001	3.95
Uterine ruptured and/or Uterine atony	3.0752	<.0001	21.65
Severe Maternal Morbidities without Transfusion	0.5816	0.0001	1.79
Pre-pregnancy Body Mass Index (BMI)	0.0096	<.0001	1.01
Precipitous Labor (Less than 3 hours)	-0.1982	0.0168	0.82
Prolonged Labor (>= 20 hours)	0.4429	<.0001	1.56
3rd/4th Degree Perineal and/or High Vaginal Laceration	0.7633	<.0001	2.15
Infant Birthweight			
Normal birthweight	Ref.		
Low birthweight	-0.03041	0.5929	0.97
Overweight	0.517	<.0001	1.68
Intercept	-3.589		
C-statistic	0.733		
Number of Postpartum Hemorrhage (N)	4,852		

Table 2b. Risk Factors Identified for Severe Maternal Morbidities with Transfusion

	Logistic Regression Results		
	Coefficient	P-value	Odds Ratio
Demographic Factors			
Race/ Ethnicity			
Non-Hispanic White	Ref.		
Non-Hispanic Black	0.4875	<.0001	1.63
Hispanic	0.2768	0.0001	1.32
Non-Hispanic Asian	0.0749	0.4408	1.08
Other/ Multi-race	0.3265	0.037	1.39
Education Attainment			
Less than & High School Graduate	Ref.		
College	-0.2546	<.0001	0.78
Graduate	-0.1781	0.0377	0.84
Clinical & Obstetric factors/ Comorbidities			
Surgical/Cesarean Birth *(Primary, Repeat)*	1.0223	<.0001	2.78
Parity (Nulliparous)	0.1135	0.0368	1.12
Induction	0.2066	0.001	1.23
Gestational Age- Premature	0.8884	<.0001	2.43
Hypertension (Gestational & Preexisting)	0.6572	<.0001	1.93
Pre-pregnancy Body Mass Index (BMI)	-0.0184	<.0001	0.98
Chronic Cardiac Disease	1.0003	<.0001	2.72
Chronic Renal Disease	0.5460	0.0182	1.73
Chronic Respiratory, Liver diseases and /or HIV+)	0.2733	0.0003	1.31
Placental Disorders (Placenta Abruptio, Previa and /or Accreta)	1.0993	<.0001	3.00
Uterine ruptured and/or Uterine atony	1.3436	<.0001	3.83
3rd/4th Degree Perineal and/or High Vaginal Laceration	0.4568	0.0019	1.58
Postpartum Hemorrhage	2.0841	<.0001	8.04
Intercept	-4.4274		
C-statistic	0.818		
Number of Severe Maternal Morbidities with Transfusion (N)	1,718		

Table 2c. Risk Factors Identified for Post-admission Infections

	Logistic Regression Results		
	Coefficient	P-value	Odds Ratio
Demographic Factors			
Race/ Ethnicity			
Non-Hispanic White	Ref.		
Non-Hispanic Black	0.6779	<.0001	1.97
Hispanic	0.5368	<.0001	1.71
Non-Hispanic Asian	0.4529	0.0022	1.57
Other/ Multi-race	0.5009	0.0392	1.65
Health Insurance Coverage			
Private Insurance	Ref.		
Medicaid	0.3429	0.001	1.41
Self-Pay/Charity Care/Other	0.3846	0.0413	1.47
Marital Status-Married	-0.2633	0.0069	0.77
Clinical & Obstetric factors/ Comorbidities			
Surgical/Cesarean Birth *(Primary, Repeat)*	0.9808	<.0001	2.67
Parity (Nulliparous)	0.9521	<.0001	2.59
Induction	0.493	<.0001	1.64
Chronic Cardiac, Renal, Liver, Respiratory diseases and/or HIV+	0.2849	0.0101	1.33
Prolonged Labor (Greater than or equal to 20 hours)	0.8389	<.0001	2.31
Gestational Age- Premature	0.5692	<.0001	1.77
Intercept	-6.9175		
C-statistic	0.787		
Number of Post-admission Infections	640		

Table 2d. Risk Factors Identified for Third- and fourth-degree Perineal Lacerations

	Logistic Regression Results		
	Coefficient	P-value	Odds Ratio
Demographic Factors			
Race/ Ethnicity			
Non-Hispanic White	Ref.		
Non-Hispanic Black	-0.3252	0.0138	0.72
Hispanic	-0.0157	0.8536	0.98
Non-Hispanic Asian	0.8243	<.0001	2.28
Other/ Multi-race	-0.1363	0.4931	0.87
Marital Status-Married	0.6281	<.0001	1.87
Clinical & Obstetric factors/ Comorbidities			
Parity (Nulliparous)	1.6978	<.0001	5.46
Pre-pregnancy Body Mass Index (BMI)			
Normal	Ref.		
Overweight	-0.139	0.04	0.87
Obese	-0.3963	<.0001	0.67
Prolonged Labor (>= 20 hours)	0.4028	0.0144	1.50
Gestational Age-Premature	-1.0934	<.0001	0.34
Infant Birthweight			
Normal birthweight	Ref.		
Low birthweight	-0.9591	<.0001	0.38
Overweight	1.0288	<.0001	2.80
Tobacco use during pregnancy	-0.5471	0.0137	0.58
Intercept	-5.3638		
C-statistic	0.793		
Number of 3rd&4th Degree Perineal Lacerations	1,344		

Table 2e. Risk Factors Identified for High Vaginal Lacerations

	Logistic Regression Results		
	Coefficient	P-value	Odds Ratio
Demographic Factors			
Race/ Ethnicity			
Non-Hispanic White	Ref.		
Non-Hispanic Black	-0.1199	0.159	0.89
Hispanic	0.01664	0.7971	1.02
Non-Hispanic Asian	-0.2487	0.0139	0.78
Other/ Multi-race	0.0838	0.5732	1.09
Clinical & Obstetric factors/ Comorbidities			
Parity (Nulliparous)	0.9534	<.0001	2.59
Prenatal Care Utilization			
Early	Ref.		
Late	0.1466	0.0101	1.16
Unknown	-0.3427	0.0388	0.71
Pre-pregnancy Body Mass Index (BMI)			
Normal	Ref.		
Overweight	0.04721	0.4224	1.05
Obese	0.1522	0.0212	1.16
Precipitous Labor (Less than 3 hours)	-0.3555	0.0178	0.70
Infant Birthweight			
Normal birthweight	Ref.		
Low birthweight	-0.2556	0.0337	0.77
Overweight	-0.1394	0.21	0.87
Intercept	-4.2284		
C-statistic	0.779		
Number of High Vaginal Lacerations	1,790		

Limitations

When looking at complication rates in this report, there are several caveats and limitations to consider.

Postpartum Hemorrhage

Hemorrhage rates should be considered carefully. While they are defined using a nationally recognized standard definition and identified using the report on quantity of blood loss, there are limitations to consider with the reported quantities. There is no standard method for measuring the quantity of blood loss, because there is no universal system of timing and manner of measurement. Additionally, other clinical factors used to assess the clinical impact of blood loss (such as other signs of hypovolemia) are not reported. Moreover, in cases where there is a large amount of amniotic fluid or irrigation, it is difficult to provide an exact quantity for the loss of blood (Lyndon A et al., 2015). Therefore, comparing rates across hospitals should be done with these limitations in mind.

Severe Maternal Morbidities with Transfusion

In the transition from ICD-9-CM to ICD-10-CM coding schema, the codes specified by the CDC to identify transfusion rely on the hospital to identify the route of administration. This coding scheme does not appear to be universally used by all hospitals, which results in difficulty identifying transfusions. This results in an underestimation of the extent of transfusions in some facilities. Additionally, the inclusion of transfusion with other complications, such as eclampsia or aneurysm, implies that transfusion is a negative outcome. However, high transfusion rates may reflect an appropriate recognition and response to the underlying cause for needing a transfusion, i.e. hemorrhage. When considering transfusion rates at a hospital, readers are advised to also take into consideration the total picture of the clinical outcome for a better understanding of a facility's performance.

Post-admission Infections

Currently, there is no standard definition of 'post-admission delivery-associated infection'. The definition used to identify infection in the current report reflects a carefully considered list of diagnoses that reflect clinically rational and significant post-delivery genitourinary tract and other infections that represent quality of maternal care and not just a general infection. Additionally, it is recognized that most delivery-associated infections are diagnosed and treated post-discharge from the hospital (Yokoe D et al., 2001). The current report only examines the delivery hospitalization; therefore, the rate of infections is likely underestimated.

Third- and fourth-degree perineal, High Vaginal Lacerations

The use of rates of third- and fourth-degree perineal lacerations as a performance metric for maternal care has been recently questioned. A study determined that operative delivery and shoulder dystocia were the factors with greatest risk of lacerations. However, the measures to reduce lacerations, such as avoiding operative vaginal delivery, may inadvertently lead to higher rates of cesarean births (Friedman A. et al.,2015). Given the current stated goals of reducing cesarean rates in NJ, lacerations may be unavoidable in certain circumstances. As such, interpretation of rates needs to be done with care and with consideration for the characteristics of

the hospital's patient mix. Based on the findings of the logistic regression analysis on the 2016 data, nulliparous mothers have a much greater risk of lacerations. Providing these first-time mothers with counseling and following guidelines in the ACOG Practice Bulletin on Prevention and Management of Obstetric Lacerations at Vaginal Delivery may help lessen the impact of these types of complications.

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Appendix A: Selected group of ICD-10 Diagnosis Codes for Infection

O85	Puerperal sepsis
O860	Infection of obstetric surgical wound
O8611	Cervicitis following delivery
O8612	Endometritis following delivery
O8613	Vaginitis following delivery
O8619	Other infection of genital tract following delivery
O8620	Urinary tract infection following delivery, unspecified
O8621	Infection of kidney following delivery
O8622	Infection of bladder following delivery
O8629	Other urinary tract infection following delivery
O8681	Puerperal septic thrombophlebitis
O8689	Other specified puerperal infections