Assessment of Perinatal Hepatitis B and Rubella Prevention in New Hampshire Delivery Hospitals

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ABSTRACT. *Objective.* **To evaluate current performance on recommended perinatal hepatitis B and rubella prevention practices in New Hampshire.**

Methods. **Data were extracted from 2021 paired mother–infant records for the year 2000 birth cohort in New Hampshire's 25 delivery hospitals. Assessment was done on the following: prenatal screening for hepatitis B and rubella, administration of the hepatitis B vaccine birth dose to all infants, administration of hepatitis B immune globulin to infants who were born to hepatitis B surface antigen–positive mothers, rubella immunity, and administration of in-hospital postpartum rubella vaccine to rubella nonimmune women.**

Results. **Prenatal screening rates for hepatitis B (98.8%) and rubella (99.4%) were high. Hepatitis B vaccine birth dose was administered to 76.2% of all infants. All infants who were born to hepatitis B surface antigen–positive mothers also received hepatitis B immune globulin. Multivariate logistic regression showed that the month of delivery and infant birth weight were independent predictors of hepatitis B vaccination. The proportion of infants who were vaccinated in January and February 2000 (48.5% and 67.5%, respectively) was less than any other months, whereas the proportion who were vaccinated in December 2000 (88.2%) was the highest. Women who were born between 1971 and 1975 had the highest rate of rubella nonimmunity (9.5%). In-hospital postpartum rubella vaccine administration was documented for 75.6% of nonimmune women.**

Conclusion. **This study documents good compliance in New Hampshire's birthing hospitals with national guidelines for perinatal hepatitis B and rubella prevention and highlights potential areas for improvement.** *Pediatrics* **2005;115:e594–e599. URL: www.pediatrics.org/cgi/doi/10.1542/peds.2004-2057;** ***hepatitis B vaccine, hepatitis B surface antigen, rubella, rubella vaccine, postpartum, congenital rubella syndrome.***

ABBREVIATIONS. HBV, hepatitis B virus; ACIP, Advisory Committee on Immunization Practices; AAP, American Academy of Pediatrics; HBsAg, hepatitis B surface antigen; HBIG, hepatitis B immune globulin; CRS, congenital rubella syndrome; NH DHHS, New Hampshire Department of Health and Human Services; CI, confidence interval.

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Prenatal health care providers and delivery hospitals play a crucial role in preventing vertical transmission of the hepatitis B virus (HBV) and congenital rubella infection.[1] HBV infection is an established cause of both acute and chronic hepatitis, as well as cirrhosis of the liver[2]; transmission from a chronically infected woman to her infant accounts for ~24% of chronic HBV infections in the United States.[3,4] To prevent perinatal HBV infection, the Advisory Committee on Immunization Practices (ACIP) and the American Academy of Pediatrics (AAP) recommend routine prenatal screening to identify women who carry the hepatitis B surface antigen (HBsAg); newborns who are born to such women should receive the first dose of hepatitis B vaccine and hepatitis B immune globulin (HBIG) within 12 hours of birth.[5,6]

First-trimester congenital rubella infection can result in fetal death, premature delivery, and an array of congenital abnormalities known as congenital rubella syndrome (CRS).[7,8] The number of reported rubella and CRS cases in the United States has declined dramatically since licensure of rubella vaccine in 1969,[9] and elimination of indigenous rubella and CRS is a national public health goal.[10] However, 7.5% to 17.4% of women of childbearing age may be rubella nonimmune, and their unborn children may be at risk for CRS.[11] To prevent future cases of CRS, the ACIP and American College of Obstetrics and Gynecology recommend prenatal rubella immunoglobulin G screening and postpartum vaccination of women who lack evidence of rubella immunity.[7,9] To evaluate current performance on recommended perinatal hepatitis and rubella prevention practices, we conducted a statewide hospital record review of maternal and infant medical records from the year 2000 birth cohort in New Hampshire.

METHODS

Paired mother–infant records for births in 2000 were sampled from New Hampshire's 25 delivery hospitals. Assuming 10% rubella nonimmunity, a target sample of 1800 records was determined to be sufficient to estimate with 95% confidence the proportion (±7 percentage points) of nonimmune women who received postpartum rubella vaccination. Hospital records were systematically sampled proportional to the size of their birth cohorts; oversampling was done to make up for missing charts and incomplete data. Hospital Medical Record Department managers were instructed to generate a line list of year 2000 births for their facility and select infant records on the basis of the sample interval (total births per hospital/sample size needed for that hospital) provided to them by New Hampshire Department of Health and Human Services (NH DHHS) staff. They then selected the corresponding maternal record to complete the pair. Maternal

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and newborn medical chart abstractions were conducted by trained staff from NH DHHS using a standardized abstraction form to collect maternal and infant characteristics, as well as delivery payor, results of prenatal HBsAg and rubella immunity tests, and, when applicable, infant hepatitis B vaccine and HBIG administration and maternal postpartum rubella vaccination. Patient identifiers were not collected unless a woman found in the study sample had positive HBsAg test results; this is reportable by state statue and ensured that appropriate follow-up could be done. Prenatal laboratory reports were not part of the hospital record in most cases. Therefore, the screening test results for HBsAg and rubella were based on handwritten documentation; laboratory testing methods were not apparent for this study and are not reported.

The proportions of the mothers who were screened and seropositive for HBsAg were assessed. The receipt of the birth dose of hepatitis B vaccine among all infants and receipt of HBIG among infants who were born to HBsAg-positive mothers were also described. To examine risk factors for infant hepatitis B vaccination status, we performed univariate and multivariate analyses. χ^2 tests and logistic regression analyses were conducted using SPSS software version 9.0 and Epi Info version 6.0.

For rubella, the proportion of mothers who had documentation of rubella screening and the proportion of nonimmune women (including those with equivocal results) were assessed. We also assessed univariate and multivariate predictors of rubella immunity, as well as the relative immunity among age groups. Among rubella nonimmune women, the proportion that received postpartum rubella vaccination was evaluated.

RESULTS

The final sample included 2021 mother–infant pairs of records. The maternal and infant demographics in our study sample reflect demographics of all New Hampshire hospital births for the same year (Table 1).

TABLE 1. Demographics: New Hampshire Hospital Births, 2000

	Total Births, (N = 13 841) n (%)	Study Births, (N = 2021) n (%)
Maternal characteristics		
Race		
White	13 299 (96.1)	1842 (91.1)
Black	160 (1.2)	19 (0.9)
Asian/Pacific Islander	190 (1.4)	38 (1.9)
Other	144 (1.0)	52 (2.6)
Unknown	48 (0.3)	70 (3.5)
Age group, y		
10–14	5 (0)	1 (0)
15–24	3643 (26.3)	539 (26.7)
25–34	7832 (56.6)	1153 (57.1)
35–44	2347 (17.0)	325 (16.1)
45–54	14 (0.1)	3 (0.1)
Prenatal care		
Yes	13 587 (98.2)	2012 (99.6)
No	24 (0.2)	7 (0.3)
Unknown	230 (1.7)	2 (0.1)
Delivery payor		
Private insurance	10 437 (75.4)	1511 (74.8)
Medicaid	2873 (20.8)	460 (22.8)
Self-pay	283 (2.0)	42 (2.1)
Other	35 (0.3)	0 (0)
Unknown	213 (1.5)	8 (0.4)
No. of pregnancies		
1	4487 (32.4)	623 (30.8)
2	4409 (31.9)	635 (31.4)
≥3	4928 (35.6)	761 (37.7)
Unknown	17 (0.1)	2 (0.1)
Infant characteristics		
Gender		
Male	7264 (52.5)	1092 (54.0)
Female	6577 (47.5)	929 (46.0)
Birth weight		
Normal (≥2500 g)	13 037 (94.2)	1912 (94.6)
Low (<2500 g)	800 (5.8)	109 (5.4)
Unknown	4 (<0.1)	0 (0)
Gestational age		
≥37 wk	12 685 (91.6)	1866 (92.3)
<37 wk	1072 (7.7)	132 (6.5)
Unknown	84 (0.6)	23 (1.2)

Perinatal Hepatitis B Prevention

Overall, 98.8% of maternal records had documented HBsAg screening before delivery (Table 2). Among these women, 0.2% (4) were HBsAg positive and 1.2% (25) had unknown status. Only 1 of the 4 HBsAg-positive pregnant women was reported to the NH DHHS. Of the women with unknown HBsAg status, 7 were screened after hospital admission. Of those 7, 4 were HBsAg negative, 1 result was still pending on hospital discharge, and 2 had the appropriate screening test (HBsAg) ordered by the physician but the wrong test (HBsAb) processed.

Approximately 76% of infants received hepatitis B vaccination while in the hospital, including the 4 infants who were born to HBsAg-positive mothers (Table 3). All 4 of these infants received the first dose of hepatitis B vaccine within 12 hours of birth. Three of these infants also received HBIG within 12 hours of birth, and the fourth received HBIG within 24 hours of birth. Multivariate logistic regression showed that the month of delivery (in year 2000) and infant birth weight were independent predictors of HBV vaccination status; the odds of receipt of vaccination among infants who were born in January and February 2000 were less than that of infants who were born in December 2000 (odds ratio: 8.2 [95% confidence interval (CI): 4.4–15.1]; odds ratio: 3.7 [95% CI: 1.9–6.9] respectively; data not shown). The proportion of infants who were born in January and February 2000 and received the HBV birth dose (48.5% and 67.5%, respectively) was less than the proportion of infants who received the birth dose during any other months. In contrast, the proportion of infants who were born in December 2000 and received the birth dose (88.2%) was the highest (Fig 1).

Approximately 24% of the infants in the study did not receive hepatitis B vaccination before hospital discharge, and of these, 40.6% had no documented explanation. For the remainder of the records, documented reasons for not vaccinating at birth varied and include parent refusal (27.9%), deferral of hepatitis B vaccination until first office visit (16.3%), and medical complications (5.0%). Records in the category "other" (10.2%) did not fit in the above categories and included prematurity, "NA" handwritten in the infant chart, the vaccine order crossed out, or inclusion of a medical exemption form signed by the parent agreeing to delay hepatitis B vaccination until 6 months of age because of concerns regarding thimerosal (Table 3).

The odds of vaccination among infants who weighed ≥2500 g were 2.8 times (95% CI: 1.9–4.2) greater than the odds of vaccination among infants who weighed <2500 g. Similarly, the odds of vaccination among infants who were 37 or more weeks of

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TABLE 2. Prenatal HBV and Rubella Screening and In-Hospital Postpartum Rubella Vaccination

	n (%)	95% CI
HBV screening and results (women in study, *n* = 2021)		
Screened for HBsAg prenatally	1989 (98.4)	97.8–98.9
Screened for HBsAg in hospital	7 (0.4)	0.2–0.7
HBsAg status unknown	25 (1.2)	0.8–1.8
Among screened (HBsAg test results, *n* = 1996)		
HBsAg negative	1989 (99.6)	99.3–99.8
HBsAg Positive	4 (0.2)	0.1–0.5
HBsAg unknown*	3 (0.2)	0.1–0.4
Rubella screening and results (women in study, *n* = 2021)		
Screened prenatally	2003 (99.1)	98.6–99.4
Screened in hospital	5 (0.3)	0.1–0.6
Rubella status unknown	13 (0.6)	0.4–1.1
Among screened (rubella test results, *n* = 2008)		
Rubella immune	1873 (93.3)	92.1–94.3
Rubella nonimmune†	135 (6.7)	5.7–7.9
Documentation of postpartum rubella vaccination (rubella nonimmune women, *n* = 135)		
Rubella vaccination administered	102 (75.6)	67.7–82.0
No documentation of vaccination	33 (24.4)	18.0–32.3
If not vaccinated, reason (nonimmune women not vaccinated, *n* = 33)		
Patient refused/declined	5 (15.2)	6.7–30.9
Allergy to vaccine/contraindication	1 (3.0)	0.5–15.3
Medical complications, patient transferred	1 (3.0)	0.5–15.3
Postpartum tubal ligation performed	3 (9.1)	3.1–23.6
Unknown‡	23 (69.7)	52.7–82.6

* Includes 3 screened in hospital: results are pending (*n* = 1) or HBsAb test was done instead of HBsAg (*n* = 2).
† Includes equivocal and nonimmune test results.
‡ Includes records with inconsistent documentation or transfer of information (*n* = 5) and records for which physician deferred vaccination (*n* = 3).

gestational age were 3 times greater than the odds (95% CI: 2.1–4.3) among infants who were <37 weeks of gestational age. Infants with both low birth weight (<2500 g) and early gestational age (<37 weeks) were 75% less likely to receive the hepatitis B vaccination as compared with infants of normal birth weight and gestational age (relative risk: 0.25; 95% CI: 0.16–0.39).

Rubella Prevention

Almost all (99.4%) mothers were screened before delivery, either prenatally or during hospital admission (Table 2). Of these, 6.7% were rubella nonimmune. The highest proportion of nonimmune women were among the birth cohort born between 1971 and 1975 (9.5% nonimmune), who were 1.8 times more likely than women who were born from 1966 to 1970 to be rubella nonimmune (Table 4).

The in-hospital postpartum rubella vaccination rate of the 135 rubella nonimmune women was 75.6% (Table 2). Among the 33 nonvaccinated, 10 (30.3%) had documented reasons, such as a contraindication, refusal of vaccine, or procedure to prevent further pregnancies (Table 2). Univariate and multivariate logistic regression revealed no significant associations between mother's age, parity, payment, or month of delivery and whether maternal rubella vaccination was received (data not shown).

DISCUSSION

This study documents generally good compliance with ACIP, AAP, and American College of Obstetrics and Gynecology guidelines for perinatal hepatitis B and rubella prevention among health care providers in New Hampshire but also highlights potential areas for improvement. Universal infant HBV vaccination protects infants whose mothers' screening status "falls through the cracks" (eg, infants whose mothers' HBsAg screening tests were not ordered or ordered incorrectly) and infants who may be exposed to the virus in early childhood.[12] Hepatitis B vaccination in the hospital increases the likelihood that a child will complete the recommended 3-dose hepatitis B vaccine series.[13] Also, beginning with the 2002 harmonized immunization schedule, approved by the ACIP, AAP, and the American Academy of Family Practitioners, a preference is stated for the first dose to be administered soon after birth.[14]

The overall 76.2% infant hepatitis B vaccination rate seen in this study is slightly lower than the 81% found in a 1996 survey (New Hampshire unpublished data 1996). In July 1999, the United States Public Health Service and the AAP recommended the temporary suspension of the birth dose of hepatitis B vaccine to infants who were born to HBsAg-negative women because of concerns at that time that thimerosal-containing vaccines could expose infants who were <6 months of age to cumulative levels of mercury that exceeded the federal guidelines for methyl-mercury.[15,16] Although the suspension was lifted at the end of 1999, when manufacturers had removed thimerosal from most vaccines, including hepatitis B vaccine, the changes in policy statements have been shown to have an impact on newborn hepatitis B vaccine coverage levels.[17–19] These policy changes likely contributed to the delay in the resumption of the birth dose in early 2000 found in this study, with the lowest hepatitis B vaccination rates in

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TABLE 3. Hepatitis B Vaccine Administration Before Hospital Discharge

Hepatitis B Vaccination	Infants in Study (n = 2021), n (%)	GA			GA <37 Wk and Birth Weight <2500 g (n = 73), n (%)	Birth Weight	
		≥37 Wk (n = 1866), n (%)	<37 Wk (n = 132), n (%)	Unknown (n = 23), n (%)		≥2500 g (n = 1912), n (%)	<2500 g (n = 109), n (%)
Vaccine administered*	1541 (76.2)	1453 (77.9)	71 (53.8)	17 (73.9)	32 (43.8)	1482 (77.5)	59 (54.1)
Not vaccinated before discharge	480 (23.8)	413 (22.1)	61 (46.2)	6 (26.1)	41 (56.2)	430 (22.5)	50 (45.9)
	(n = 480)	(n = 413)	(n = 61)	(n = 6)	(n = 41)	(n = 430)	(n = 50)
If not vaccinated, reason							
Parent refused	134 (27.9)	118 (28.6)	11 (18.0)	5 (83.3)	3 (7.3)	128 (29.8)	6 (12.0)
Deferred to first office visit	78 (16.3)	66 (16.0)	12 (19.7)	0 (0)	8 (19.5)	69 (16.0)	9 (18.0)
Medical complications†	24 (5.0)	15 (3.6)	9 (14.8)	0 (0)	7 (17.1)	16 (3.7)	8 (16.0)
Other‡	49 (10.2)	29 (7.0)	19 (31.1)	1 (16.7)	17 (41.5)	31 (7.2)	18 (36.0)
Unknown§	195 (40.6)	185 (44.8)	10 (16.4)	0 (0)	6 (14.6)	186 (43.3)	9 (18.0)

GA indicates gestational age.
* Includes infants who were born to HBsAg-positive mothers (n = 4). Three received their first dose of hepatitis B vaccine and HBIG within 12 hours of birth, and the fourth received hepatitis B vaccine within 12 hours and HBIG within 24 hours of birth.
† Includes infants who died within 24 hours of birth (n = 3) and infants who were transferred to another facility (n = 18).
‡ Includes charts with the following documentation: prematurity (n = 15); "NA" (n = 13); vaccine order crossed out (n = 10); and signed medical exemption form to delay vaccination until 6 months because of thimerosal (n = 5).
§ Includes records (n = 10) for which vaccine was ordered or noted in discharge summary but no documentation was found to indicate that the vaccine was given.

January (48.5%) and February (67.5%). This is demonstrated by findings in records of infants who were born in January and February in a single hospital (n = 5) of a medical exemption form signed by the parent agreeing to delay HBV vaccination until the infant was 6 months of age because of concerns regarding thimerosal. It should be noted that thimerosal-free hepatitis B vaccine became available to New Hampshire birthing hospitals in December 1999 and that health care providers were informed of this by NH DHHS in late November 1999 (NH DHHS written communication, November 23, 1999). However, although there may have been a delay in resumption of administration of the birth dose, New Hampshire health care providers' newborn hepatitis B vaccination practices improved as the year progressed, with the highest vaccination rate seen in December 2000 (88.2%).

New Hampshire statute requires laboratories and health care providers, including hospitals, to report cases of HBsAg-positive pregnant women to the NH DHHS. This is important to ensure follow-up of their infants for completion of the 3-dose hepatitis B series and serologic posttesting, as well as to provide education and services (testing and, if appropriate, hepatitis B vaccination) for their sexual and household contacts. The finding that only 1 of 4 of the HBsAg-positive pregnant women found in this study was reported to the NH DHHS suggests that additional efforts are needed to improve compliance with reporting statutes, including ongoing education of all prenatal care providers, laboratories, and delivery hospitals.

Our findings highlight potential areas to improve perinatal hepatitis B prevention. First, attention must be given to accurate hepatitis B test ordering and processing, by laboratories as well as providers. Second, all maternal records should include a copy of prenatal laboratory reports to validate any handwritten notes and reduce the possibility of errors made in transcribing and/or interpreting test results. Third, providers need to be especially attentive to perinatal prevention among high-risk infants, such as those with low birth weight and gestational age <37 weeks.

In this study, 6.7% of pregnant women were rubella nonimmune, which is less than the 7.1% among women 13 to 51 years of age reported by a multistate cohort study[20] and less than the 7.5% to 17.4% among women 12 to 49 years of age in the Third National Health and Nutrition Examination Survey.[11] The relatively high immunity among New Hampshire women may be attributable, at least in part, to the relatively low (4.4%) foreign-born population in New Hampshire compared with the 11.1% foreign-born population in the United States as a whole[21,22] (2000 US Census Bureau data). The age group with the highest level of rubella susceptibility (9.5%) in this study occurred among the 25- to 29-year-olds (born between 1971 and 1975), which is consistent with trends seen in Third National Health and Nutrition Examination Survey; this "lost generation" of young adults probably missed acquisition of rubella antibodies because they were too old to be affected

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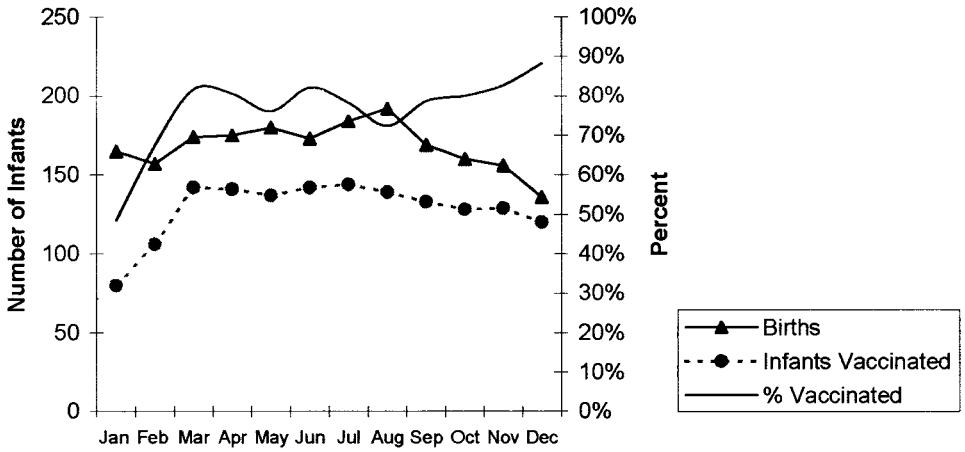

Fig 1. Study sample births and in-hospital infant hepatitis B vaccination according to month: 2000.

TABLE 4. Rubella Immunity According to Maternal Age, Gravidity, and Parity

	Immune (n = 1873), n (%)	Unknown (n = 13), n (%)	Nonimmune (n = 135), n (%)*	Relative Risk (95% CI)†
Rubella status by age group, y (year of birth‡)				
<15 (1986)	1 (100)	0	0	NC
15–19 (1981–1985)	138 (95.2)	4 (2.8)	3 (2.1)	0.32 (0.1–1.04)
20–24 (1976–1980)	366 (92.9)	2 (0.5)	26 (6.6)	0.69 (0.44–1.09)
25–29 (1971–1975)	540 (90.0)	3 (0.5)	57 (9.5)	1.81 (1.18–2.79)
30–34 (1966–1970)	522 (94.4)	2 (0.4)	29 (5.2)	0.83 (0.43–1.46)
35–39 (1961–1965)	265 (93.3)	1 (0.4)	18 (6.3)	1.27 (0.31–5.28)
40–44 (1956–1960)	38 (92.7)	1 (2.4)	2 (4.9)	—
45–49 (1951–1955)	3 (100)	0	0	NC
Rubella status by gravidity				
1	566 (90.9)	5 (0.8)	52 (8.3)	1.27 (0.86–1.88)
2	592 (93.2)	1 (0.2)	42 (6.6)	1.01 (0.63–1.63)
3	357 (92.0)	6 (1.5)	25 (6.4)	2.25 (0.94–5.39)
≥4	357 (95.7)	1 (0.3)	15 (4.0)	0.54 (0.20–1.48)
Unknown	1	0	1	—
Rubella status by parity				
0	775 (91.0)	6 (0.7)	71 (8.3)	1.59 (1.08–2.33)
1	663 (94.3)	3 (0.4)	37 (5.3)	0.90 (0.53–1.54)
2	304 (93.0)	4 (1.2)	19 (5.8)	1.67 (0.51–5.50)
3	82 (96.5)	0	3 (3.5)	0.46 (0.11–1.97)
≥4	48 (92.3)	0	4 (7.7)	—
Unknown	1	0	1	NC

NC indicates not calculated.
* Includes rubella equivocal and nonimmune.
† Reference groups for relative risk calculations were performed in Epi Info 6.0 and are based on individual calculations of each group with the group immediately below it.
‡ Year of birth is approximate and based on recorded maternal age at time of delivery.

by mandatory school entry vaccination, implemented by state immunization laws in the late 1970s, and not exposed to wild rubella virus infection because of widespread vaccination of younger cohorts.[11,23]

In this study, 75.6% of rubella nonimmune women received rubella vaccine, which is better than the 65.7% reported by Schrag et al[20] in a multistate cohort study. Postpartum rubella vaccination rarely occurs outside the hospital setting,[24] and failure to vaccinate a nonimmune woman before discharge is a missed opportunity for CRS prevention. When relevant documentation existed in the reviewed charts, "patient refusal" was the most frequent explanation (Table 2), suggesting that perhaps provider explanation of the risks and benefits of vaccination could be improved. Other means of improving postpartum vaccination rates is by implementing clear standing orders accompanied by protocols that include provider education.

It is important to note several limitations of this study. First, prenatal laboratory reports were not consistently available in hospital records and the accuracy of handwritten documentation of prenatal screening test results could not be verified. Second, the variety of rubella laboratory tests used, each with their differing cutoffs for immunity, may introduce error in our interpretation of rubella immunity patterns. Third, because the sampling of records was not supervised by the authors, selection bias possibly could have been introduced. In addition, these data are regional and may not reflect accurately the experience in other settings.

Despite these limitations, the large sample size

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allowed us to document rubella and hepatitis B perinatal prevention practices in the state of New Hampshire. Such benchmarking allows state health departments to monitor progress toward public health goals of perinatal hepatitis B and CRS elimination.

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