

## Quality Improvement

# Effect of an Electronic Order Set on Newborn Hepatitis B Immunization Rates

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### Abstract

#### Objective

Hepatitis B is an infectious deoxyribonucleic acid virus which can cause significant morbidity and mortality. There is no current definitive treatment, however in the United States immunization is widely available. A paper published by the Advisory Committee on Immunization Practices/Centers for Disease Control (ACIP/CDC) in 2018 made updated recommendations regarding vaccination practices in the United States. The most notable change made was that all healthy newborns weighing  $\geq 2000$  g with a negative hepatitis B-status mother should receive hepatitis B immunization within 24 hours of birth. This quality improvement project studied the effect of the electronic medical record newborn admission order set, altered to reflect current societal recommendations, and the resulting newborn hepatitis B immunization rates.

#### Methods

The electronic medical record admission order set was modified to reflect the most recent recommendations made by ACIP/CDC. Hepatitis B immunization rates were then analyzed prior to and following the order set changes.

#### Results

The most significant effect was seen in the overall rate of hepatitis B immunization achieved prior to hospital discharge. In the 12 months before order set modifications were implemented the rate was 9.5%. Following electronic medical record changes it improved to over 90%. In addition, the immunization rate performed within the first 24 hours increased from 74.1% to 91.1%. Finally, these records were made accessible to outpatient providers via a statewide immunization database.

#### Conclusions

This project serves as an example of how modifying order sets can have a dramatic effect on ordering practices and therefore allows for quality improvement.

#### Keywords

quality improvement; immunization; immunization schedule; hepatitis B; pediatrics; public health; electronic health records

### Introduction

Hepatitis B is a highly infectious deoxyribonucleic acid (DNA) virus transmitted through blood and bodily fluids via percutaneous or mucosal contact.<sup>1</sup> Hepatitis B infection can potentially lead to serious long term complications including liver cirrhosis and malignancy.<sup>1</sup> Newborns are especially vulnerable via vertical and horizontal transmission of the virus.

Chronic infection occurs among 80–90% of those infected during infancy versus <12% of those infected as an older child/adult.<sup>2</sup> Once an individual is chronically infected, there is no current treatment that entirely eradicates the virus.<sup>3</sup> Immunization is thus a vital strategy to reduce morbidity and mortality.<sup>4</sup>

Since 1991, the United States (US) has endorsed universal administration of hepatitis B

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immunization of infants.<sup>1</sup> Notably on January 12, 2018 the Advisory Committee on Immunization Practices/Centers for Disease Control (ACIP/CDC) updated its recommendations.<sup>5</sup> The most significant change made was a recommendation for all stable newborns weighing  $\geq 2,000$  g born to an uninfected mother to receive hepatitis B vaccine within 24 hours of birth.<sup>5</sup> Since 2005, the recommendations advised administration of hepatitis B vaccine at any time prior to hospital discharge.<sup>6</sup> The new recommendations also eliminated wording which could be used to delay vaccine administration until after hospital discharge. These new recommendations were endorsed by multiple professional organizations including the American Academy of Family Physicians (AAFP), the American Academy of Pediatrics (AAP) and the American College of Obstetricians and Gynecologists (ACOG).<sup>5</sup> The objective of our study was to assess ordering practices and ensure they mirrored current recommendations. We achieved this by modifying the newborn admission order set in the hospital electronic medical record (EMR), and then compared the immunization rates before and after the changes were enacted.

### Materials and Methods

A multi-disciplinary team comprised of pediatricians, obstetricians, obstetric nurse leadership, pharmacists, information technology and hospital senior leadership met with the goal of altering the EMR newborn order set. The primary modification included a pre-checked or-

der for hepatitis B immunization based on baby weight and mother viral status in accordance with recent national recommendations. A new workflow protocol for administration of the vaccine was enacted and access to a statewide online database (FloridaSHOTS) was provided for outpatient record availability. Hepatitis B immunization rates were then compared prior to and following electronic order set and policy changes. The data set for pre-modification analysis included all healthy newborns delivered in our facility from 12/1/17–11/30/18 weighing  $\geq 2000$  g. The data set for post-modification analysis included all healthy newborns delivered in our facility from 12/1/18–3/15/19 weighing  $\geq 2000$  g. Both data sets excluded any newborns that were transferred into or out of our facility. All data was retrieved from our hospital database. Hepatitis B vaccine administration in both groups was analyzed, including the time frame of immunization administration. The hepatitis B immunization rates for each time frame prior to and following electronic order set modifications were calculated and compared between both groups.

### Results

Prior to electronic order set modifications, 1,174 live births were recorded from 12/1/2017 through 11/30/2018. Of these, 112 (9.5%) were immunized against hepatitis B. (**Table 1**) **Figures 1 and 2a** illustrate our findings. Of the total immunized (n=112), 83 (74.1%) received the vaccine within the first 24 hours. Within the next 24 to 48 hour period an additional 27 newborns

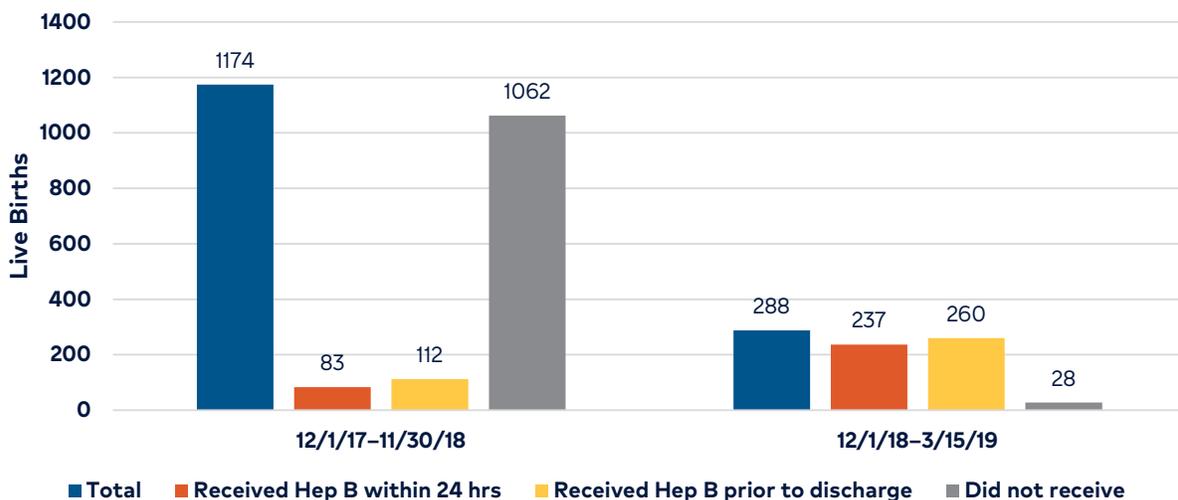


Figure 1. Hepatitis B Newborn Immunization Rates.

**Table 1.** Total Hepatitis B Newborn Immunization Rates Prior to EMR/Policy Changes (12/1/17–11/20/18).

<b>Newborns at Our Facility (12/1/17–11/30/18) (n=1174)</b>	<b>n</b>	<b>%</b>
Received Hepatitis B Immunization	112	9.5
Did NOT Receive Hepatitis B Immunization	1062	90.5
<b>Total</b>	<b>1174</b>	<b>100.0</b>

(24.1%) received the vaccine. Finally, one newborn (0.9%) was immunized between 48 and 72 hours and one (0.9%) between 72 and 96 hours, respectively in this group. (**Figure 1; Table 2**) A total of 1,062 newborns did not receive the vaccination (90.5%). Following electronic order set modifications, 288 live births were recorded from 12/1/2018 through 3/15/2019. Of these, 260 (90.3%) were immunized against hepatitis B. (**Table 3**) **Figures 1 and 2b** illustrate our findings. Of the total immunized (n=288), 237 (91.2%) received the vaccine within the first 24 hours. Within the next 24 to 48 hour period an additional 22 newborns (8.4%) received the vaccine. Finally, one newborn (0.4%) was immunized between 48 and 96 hours in this group. (**Figure 1; Table 4**) A total of 28 newborns did not receive the vaccination (9.7%). (**Table 3**)

### Discussion

Based on our data, admission order set modifications driven by current ACIP/CDC recommendations made a considerable difference in newborn hepatitis B immunization rates. At our facility, during the 14-week period following electronic order set changes immunization rates increased dramatically, going from 9.5% to 90.3% of newborns receiving immunization prior to discharge. These changes appear somewhat more pronounced than what was seen in some previous studies examining the effects of order set modifications.<sup>7-9</sup> In our study, electronic newborn admission order set

changes resulted in a dramatic improvement of immunization rates, from 9.5% to 90.3%. (**Figure 2**) Additionally, the rate of immunization administration within the first 24 hours, concurrent with new ACIP/CDC recommendations, improved from 74.1% to 91.1%. Finally, the number of newborns who received immunization within 24 to 48 hours decreased from 24.1% to 8.4%. (**Tables 2 and 4**)

An unexpected finding of our study was that 9.7% of newborns remained unvaccinated prior to hospital discharge, (**Table 3**) and 8.8% remain unvaccinated within 24 hours following order set changes. (**Table 4**) The reason for this remains unclear. One possibility is parental attitudes and beliefs regarding immunizations. The term “vaccine hesitancy” refers to the delay in acceptance or the refusal of vaccines despite availability of vaccination services.<sup>10</sup> In the US, vaccine hesitancy is common, affecting 25–33% of parents.<sup>11</sup> Our facility is located in a county that ranked 49th (out of 67) in the state for fully immunized kindergarten students entering the 2018–2019 academic school year.<sup>12</sup> This seems to suggest geographic factors may play a role in the hesitancy of those who remain unimmunized against hepatitis B prior to hospital discharge.

While our facility’s current newborn hepatitis B immunization rate of 90.3% is higher than the national average of 71% (2016), there is

**Table 2.** In-Hospital Hepatitis B Newborn Immunization Rates Prior to EMR/Policy Changes (12/1/17–11/20/18).

<b>Newborns at Our Facility Receiving Hepatitis B Immunization (12/1/17–11/30/18) (n=112)</b>	<b>n</b>	<b>%</b>
<24 hours (relative day 0)	83	74.1
24-48 hours (relative day 1)	27	24.1
48-72 hours (relative day 2)	1	0.9
72-96 hours (relative day 3)	1	0.9
<b>Total</b>	<b>112</b>	<b>100.0</b>

**Table 3.** Total Hepatitis B Newborn Immunization Rates After to EMR/Policy Changes (12/1/17–11/20/18).

<b>Newborns at Our Facility (12/1/18–3/15/19) (n=288)</b>	<b>n</b>	<b>%</b>
Received Hepatitis B Immunization	260	90.3
Did NOT Receive Hepatitis B Immunization	28	9.7
Total	288	100.0

still room for improvement.<sup>2</sup> Further investigation into the remaining 9.7% of unimmunized newborns, as well as a deeper look at the immunization process is needed. The order set changes and workflow modifications in this study addressed areas pertaining to healthcare systems, providers and delivery. However, many factors remain unstudied. More research into geographic factors and other aspects of the population served by our facility is necessary.

**Limitations**

This study does have some limitations. First, hepatitis B seropositive mothers were not excluded from the results. It is notable that a mother who is hepatitis B seropositive would affect the timing of newborn hepatitis B immunization, as workflow dictates administration within 12 hours. This portion of the workflow was not the focus of this study, but could potentially affect results by increasing immunization rates within the first 24 hours. Notably, the number of mothers included in the study who were hepatitis B seropositive was likely minimal as the estimated prevalence of hepatitis B surface antigen is fairly low, only 0.36% among all adults in the US (between 2011 and 2016).<sup>13</sup> Additionally, there was a discrepancy between the length of data collection and sample sizes between the two comparison arms. Data prior to the order set modification covered 12 months and 1,174 total births while the data following the modification covered only 14 weeks and 260 total births. A longer follow up arm would provide more comparable numbers.

**Implications**

The EMR system has become central to the delivery of health care, in both the outpatient and inpatient settings. In 2017, it was found that 97% of US hospitals used electronic health records, and 85.9% of outpatient clinics utilized an electronic health/medical record.<sup>14,15</sup> This study investigated immunization rates following changes made to an electronic order set, a part of the EMR. The results are encouraging, as order sets are part of most EMR systems. While this study dealt specifically with hepatitis B immunization rates, it may be generalizable to other immunizations and possibly to a wide variety of required quality and core measures.

**Conclusion**

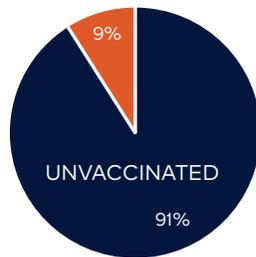
Based on the results of this study it appears that modifying an electronic order set can have a powerful and immediate effect on ordering practices, therefore allowing for rapid quality improvement. This effect is similar to what has been seen in prior isolated, similar studies; however, the effect appears to be more pronounced in our case. This effect is significant and could serve as a template for larger scale quality improvement planning and projects. In our study it does appear to infer a strong relationship between electronic order sets and hepatitis B immunization administration. Additionally, further study focusing on vaccine hesitancy factors may help determine how to improve upon the 9.7% of those infants who remain unimmunized against hepatitis B after

**Table 4.** In-Hospital Hepatitis B Newborn Immunization Rates After to EMR/Policy Changes (12/1/17–11/20/18).

<b>Newborns at Our Facility Receiving Hepatitis B Immunization (12/1/18–3/15/19) (n=260)</b>	<b>n</b>	<b>%</b>
<24 hours (relative day 0)	237	91.2
24-48 hours (relative day 1)	22	8.4
48-96 hours (relative day 2–3)	1	0.4
Total	260	100.0

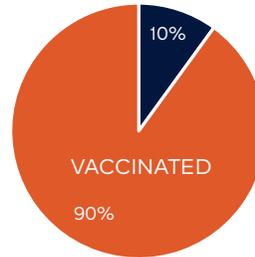
**(a) Prior to Order Set Modification**

Hep B Newborn Immunization Rates **PRIOR** to EMR/Policy Changes (12/1/17–11/20/18)



**(b) Following Order Set Modification**

Hep B Newborn Immunization Rates **AFTER** to EMR/Policy Changes (12/1/18–3/15/19)



■ Did NOT receive Hep B vaccination ■ RECEIVED Hep B vaccination

**Figure 2.** Total Hepatitis B Newborn Immunization Rates (a) Before and (b) After Order Set Modification.

leaving our facility. Overall, this project serves as an example of how higher quality care can be rendered for patients with dramatic effect using electronic order sets in a facilities EMR.

**Conflicts of Interest**

The authors declare they have no conflicts of interest.

Drs. Pedersen, Rodriguez and King are employees of Oak Hill Hospital, a hospital affiliated with the journal’s publisher.

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