

BMJ Open Quality Improving adherence to hepatitis B vaccine administration recommendations in two newborn nurseries

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To cite: Germana S, Krishnan G, McCulloch M, *et al.* Improving adherence to hepatitis B vaccine administration recommendations in two newborn nurseries. *BMJ Open Quality* 2021;**10**:e001282. doi:10.1136/bmjopen-2020-001282

Received 19 January 2021
Accepted 16 September 2021

ABSTRACT

Administration of the birth dose of hepatitis B vaccine is an important step in reducing perinatally acquired hepatitis B infection, yet the USA is below the Healthy People 2020 goal for rate of administration.

In response to updated Advisory Committee on Immunisation Practices recommendations to administer the dose within 24 hours of birth, we used quality improvement methodology to implement changes that would increase the vaccination rates of healthy newborns in our nurseries. The goal was to improve the proportion of infants who receive the hepatitis B vaccine within 24 hours of birth to >90% within a 2-year period, with a secondary goal of increasing vaccination rates prior to discharge from the nursery to >95%.

Multiple Plan–Do–Study–Act (PDSA) cycles were performed. Initial cycles focused on increasing nurse and provider awareness of the updated timing recommendations. Later cycles targeted nursing workflow to facilitate timely administration of the vaccine. We implemented changes at our university medical centre and community hospital newborn nurseries.

At the university medical centre nursery, both primary and secondary goals were met; the rate of hepatitis B vaccine administration within 24 hours increased from 81.7% to 96.2%, with vaccine administration prior to discharge increasing from 93.4% to 97.9%. In the community hospital nursery, the baseline rate of hepatitis B vaccine administration within 24 hours was 78.1%, and this increased to 85.8% with the interventions, falling short of the target of >90%. Vaccine administration prior to discharge increased from 87.2% to 92.0%, also not meeting the secondary target of 95%.

Interventions that facilitated workflow had additional benefit beyond education alone to improve timing and rates of hepatitis B vaccine administration in both a university medical centre and community hospital nursery.

PROBLEM

Universal hepatitis B immunisation of infants has been recommended in the USA since 1991. The 2016 National Immunisation Survey indicated that 71.1% of newborns in the USA received the birth dose of the hepatitis B vaccine, below the Healthy People 2020 goal of 85%.^{1 2} Earlier immunisation schedules did not specify timing of administration during the initial newborn nursery

hospitalisation and were more permissive of delay to the outpatient setting. The Advisory Committee on Immunisation Practices (ACIP) issued an updated statement in 2016 specifying that the birth dose should be administered in the first 24 hours of life. This recommendation was subsequently endorsed by the American Academy of Paediatrics (AAP) and was incorporated into the Centers for Disease Control and Prevention (CDC) recommended immunisation schedule in the USA in 2017.^{2 3}

This quality improvement (QI) project sought to quantify baseline hepatitis B vaccine administration rates prior to hospital discharge and within 24 hours of birth in two newborn nurseries following the release of the updated CDC immunisation schedule in 2017. It was hypothesised that failure to comply with these recommendations may occur due to provider, staff and parental lack of awareness of the updated recommendation or lack of understanding of the purpose of this change in practice, as well as inefficiencies in workflow that cause delays in timely vaccine administration. The primary goal was to improve hepatitis B vaccine administration rates within 24 hours of birth to improve compliance in these nurseries with the updated recommendation, with the secondary goal of improving overall hepatitis B vaccine administration rates prior to discharge from the nursery. One nursery is located in a university medical centre and the second is at a community hospital, both in Durham, North Carolina. The university medical centre newborn nursery is staffed by paediatric primary care faculty and residents from the paediatric, internal medicine-paediatric and family medicine programmes. The community hospital newborn nursery is staffed by paediatric primary care faculty and outpatient paediatricians from community paediatric practices. This project focused on healthy newborn infants.



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We aimed to increase the proportion of newborns admitted to both nurseries who receive the hepatitis B vaccine within 24 hours of birth to >90% within a 2-year period. Our secondary goal was to improve overall rates of hepatitis B vaccine administration prior to discharge to >95%.

BACKGROUND

Hepatitis B virus (HBV) is a partially double-stranded DNA virus that can cause chronic infection and lead to cirrhosis and hepatocellular carcinoma. HBV is highly infectious and can be transmitted through mucosal or percutaneous exposure to blood or body fluids, including maternal–child transmission during labour and delivery. Risk of transmission to infants is high when born to mothers who are hepatitis B surface antigen positive at the time of delivery, and 90% of infants infected with hepatitis B at birth or in the first year of life develop chronic hepatitis B infection. Universal screening of pregnant women and immunisation of newborns has significantly decreased rates of perinatal hepatitis B transmission, but new cases of perinatally acquired hepatitis B infection occur in the USA each year. These cases may occur due to lack of maternal testing, false negative test results or errors in the transcription or communication of results. Transmission from household contacts may also occur during early infancy.^{2,3} The US Department of Health and Human Services set a goal of eliminating perinatal transmission of hepatitis B by 2020.⁴ Postexposure prophylaxis with both hepatitis B vaccine and hepatitis B immunoglobulin within 12 hours of delivery, followed by completion of the infant hepatitis B vaccination series has the ability to decrease transmission to 1%.⁵ However, even the hepatitis B vaccine alone administered within 24 hours of birth is estimated to be 75%–95% effective in preventing perinatal transmission of hepatitis B.^{2,3}

Prior QI projects have described interventions to improve rates of hepatitis B vaccine administration prior to discharge as well as timing of administration. A recent 2020 publication details how improvements were made using PDSA cycles focused on nurse, provider and parent education, but rates prior to discharge and prior to 12 hours of life remained below their goals for the project.⁶ Nemerofsky *et al* found most improvement when they addressed workflow by adding the vaccine order to a standard newborn admission order set.⁷ Similarly, Madlon-Kay found that a change in the way the vaccine was ordered was associated with an increase in newborns receiving the hepatitis B vaccine prior to nursery discharge.⁸ These projects demonstrate how efforts to improve rates and timing of administration of the birth dose of hepatitis B vaccine are amenable to a QI approach to improve care.

MEASUREMENT

Data regarding overall rates of administration of the hepatitis B vaccine prior to newborn nursery discharge, as well as rates of administration within 24 hours of

birth, were obtained from the electronic health record (EHR) between January 2016 and January 2018. Medication administration records were reviewed to determine whether the hepatitis B vaccine was administered prior to hospital discharge and, if so, whether it was received within 24 hours of birth.

We defined the rate of administration prior to discharge as the percentage of healthy newborns admitted to our two newborn nurseries at the time of birth who received the vaccine before discharge home. We excluded palliative care patients and newborns admitted directly to the intensive care units. All infants had a birth weight above 2000 g and were 35 weeks gestation or more at delivery. Monthly rates of administration prior to 24 hours of life and prior to discharge were analysed using Statistical Process Control charts.

Baseline rates of immunisation prior to 24 hours of life

Before the introduction of this QI project, 81.7% of newborns (4629 of 5663) admitted to the university medical centre nursery and 78.1% (3425 of 4386) admitted to the community hospital nursery received the birth dose prior to 24 hours of life. At that time, the vaccine was part of a standard newborn admission order set, and the vaccine was ordered to be given prior to hospital discharge without specification of timing. Of the newborns who received the vaccine prior to hospital discharge, 87.5% of newborns at the university medical centre nursery and 93.8% of those at the community hospital nursery received it prior to 24 hours.

Baseline rates of immunisation prior to hospital discharge

Of the 5663 newborns admitted to the university medical centre newborn nursery during the 2-year baseline period, 5288 (93.4%) received the birth dose of the hepatitis B vaccine prior to hospital discharge. Baseline rates at the community hospital nursery were slightly lower at 87.2% (3824 of 4386 newborns). Reasons that parents provided for declining hepatitis B vaccine prior to hospital discharge included an overall plan to defer hepatitis B vaccine administration, a desire to receive the vaccine at their primary care physician office in order to have administration of vaccines all documented in the same location, concern for multiple procedures (blood draws, injections and circumcision) in a short time period, assumption that the newborn was otherwise going to receive additional vaccines at the outpatient newborn visit, or misconceptions about the necessity of the birth dose. More specifically, with the increased use of combination vaccines in clinic, some of the nursing staff were communicating to families that the birth dose of the hepatitis B vaccine was an ‘extra’ dose of the vaccine.

DESIGN

This QI project was conducted in two newborn nurseries in Durham, North Carolina. The university medical centre nursery is staffed by nine paediatric primary care faculty precepting interns in the paediatric, medicine-paediatric

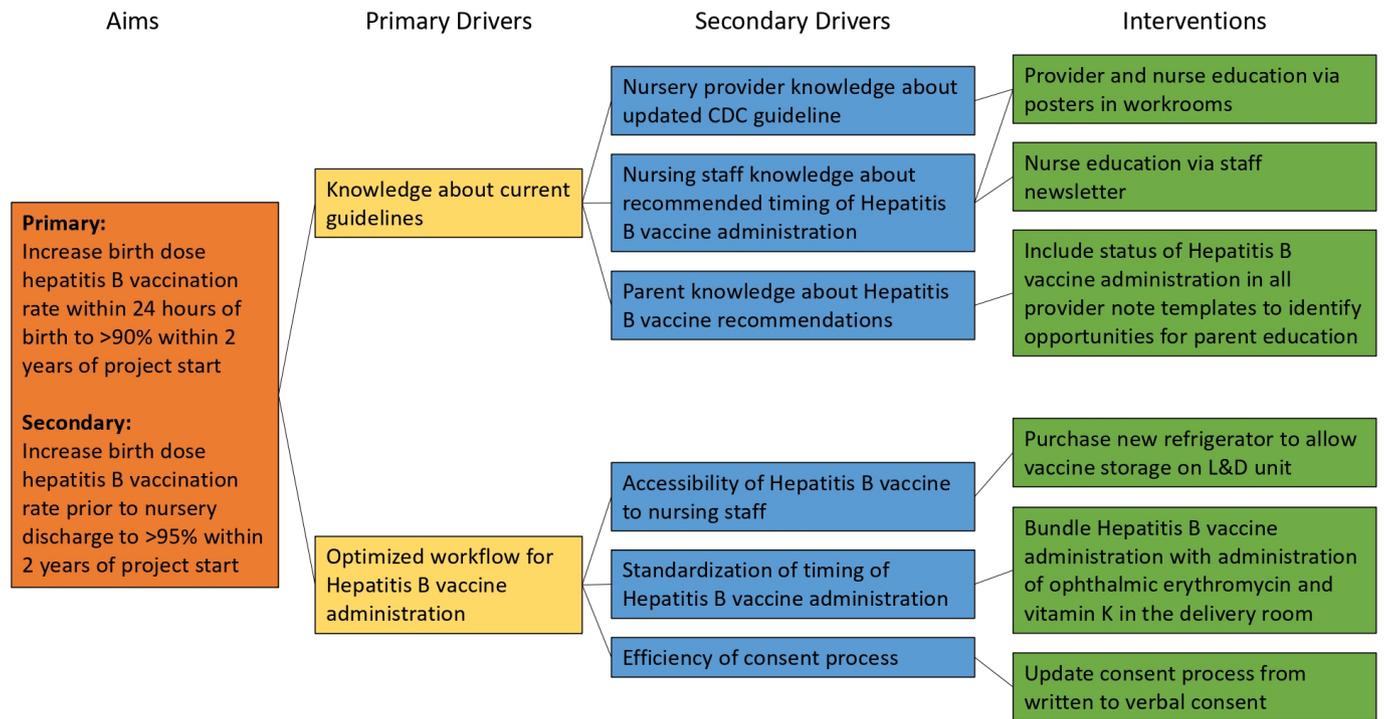


Figure 1 Key driver diagram. Hepatitis B vaccine administration initiative. L&D, labour and delivery.

and family medicine programmes and has approximately 3400 deliveries/year. The community hospital nursery is staffed by 16 paediatric primary care faculty and paediatricians from two community practices and has approximately 2400 deliveries/year. The project was launched in 2018, after the updated ACIP recommendations were incorporated into the 2017 immunisation schedule and AAP policy statement. We developed a QI project in two newborn nurseries, using the Model for Improvement, with a goal of improving timing of administration within 24 hours to >90% over 2 years. A secondary goal was to improve overall rates of hepatitis B vaccine administration prior to discharge to >95%. The project team was composed of resident and attending providers from the two newborn nurseries, and additional input was obtained from pharmacy staff as well as nursing staff and leadership of both nurseries. A key driver diagram was used to identify potential interventions to meet these aims (figure 1). Interventions were targeted first to increase provider and staff awareness of the updated recommendations and then to address any barriers to early administration. Within this framework, PDSA cycles were executed with six interventions including: (1) posting of information for providers about the QI project, (2) education of nursing staff about the updated recommendations, (3) addition of information in the progress note template about whether hepatitis B vaccine had been administered, (4) a change in the location of stored vaccines, (5) bundling of care and (6) a change in the consent process.

Patients and the public were not explicitly involved in the design, conduct, reporting or dissemination plans for this project.

We used Statistical Process Control charts for analysis.

STRATEGY

The goal of this QI project was to increase adherence to the updated recommendation to administer the hepatitis B vaccine within 24 hours of birth in two newborn nurseries. Many staff were not aware of the new guidelines, and there was no specification in nursing policy or orders for recommended timing of administration other than ‘prior to discharge’. The PDSA cycles were aimed at increasing overall rates of administration prior to discharge and, more specifically, before 24 hours of life.

PDSA cycle 1: poster education of providers and staff (Feb 2018, both nurseries)

Providers and staff in both newborn nurseries were introduced to the project by posters in provider and staff workrooms. A survey was administered to nursing staff assessing awareness of the project and soliciting proposals for future interventions.

PDSA cycle 2: newsletter education of staff (Aug 2018, both nurseries)

Nursing staff in the newborn nurseries received additional education through their pre-existing monthly newsletter with more details about the project, updated recommendations and corrections to misconceptions about the birth dose of the hepatitis B vaccine.

PDSA cycle 3: updated vaccine storage location (Aug 2018, university medical centre nursery only)

In the university medical centre nursery, vaccines were originally stored in the hospital pharmacy and required verification by the pharmacist for each individual patient after birth prior to the nurse requesting the dose from the



pharmacy. This process had previously been improved by moving the storage of the vaccines from the pharmacy to the postpartum unit during the period of our baseline data collection, but the move of the vaccine to this location discouraged administration of the vaccine prior to transfer from the labour and delivery unit. Nursing staff provided feedback through both the staff survey and through project meetings with key stakeholders that the process may be improved further by moving vaccine storage to the labour and delivery unit, but limited refrigerator space was a barrier. For this PDSA cycle, the vaccine storage was moved to the labour and delivery unit following purchase of a larger refrigerator.

PDSA cycle 4: EHR optimisation (Sep 2018, both nurseries)

The fourth intervention focused on timing of provider prompts in the EHR note templates. Previously developed note templates only documented hepatitis B vaccine administration in the discharge summary, prompting providers only on the day of discharge to have additional discussion with families whose newborns had not yet received the vaccine. History and physical and daily progress note templates were updated to include information about hepatitis B vaccine administration to prompt providers to have this discussion sooner.

PDSA cycle 5: bundling of care (Oct 2018, university medical centre nursery; May 2019–Jun 2019, community hospital nursery)

Nursing staff and providers identified an opportunity to bundle care because standard workflow included vitamin K and ophthalmic erythromycin administration in the delivery room approximately 1 hour after birth. Nurses routinely prepare for anticipated delivery by gathering a dose of vitamin K and erythromycin, and it was confirmed that the vaccine was sufficiently stable to allow for removal from the refrigerator at the same time that these other medications are collected. This allowed nurses to bundle care and routinely give the Hepatitis B vaccine along with the vitamin K and erythromycin at approximately 1 hour of life.

At the community hospital, this bundling of care was discontinued approximately 3 weeks after it was begun following a vaccine administration error that required further review.

PDSA cycle 6: updated consent process (May 2019, both nurseries)

In preparation for this intervention, we reviewed state law and practices of other parts of the institution. Requirements for parental consent for childhood immunisation vary by state, with North Carolina requiring that a parent or guardian give verbal consent prior to vaccine administration. Prior to adoption of an EHR system in both of these hospitals as well as affiliated paediatric clinics, the practice was to obtain written consent by having a parent or guardian sign a vaccine administration form. With the introduction of the EHR, clinics updated the

process to allow for verbal consent, but the newborn nurseries continued to use this paper form. Nurses identified this paper form as a barrier to timely vaccine administration because it required patient labels that could only be printed from outside the patient room after the newborn was delivered. These patient labels were difficult to obtain promptly after birth as the care nurse remains in the delivery room for the first 2 hours of a mother's recovery from delivery. Based on review of the law and updated practices of the outpatient clinics, the requirement for the paper form was discontinued. Verbal consent is obtained from a parent prior to vaccine administration without requirement for written consent. Risk Management at both hospitals agreed with this change to the consent process.

RESULTS

At baseline, 81.7% of healthy newborns at the university medical centre nursery and 78.1% at the community hospital nursery received the birth dose of hepatitis B vaccine prior to 24 hours of life. 93.4% of newborns admitted to the university medical centre nursery and 87.2% of newborns admitted to the community hospital nursery received the birth dose of Hepatitis B vaccine prior to discharge. Initial PDSA cycles, which were directed largely at increasing provider and nurse awareness of updated recommendations regarding timing of administration, were associated with improvement at the community hospital nursery both in the rate of administration prior to 24 hours of life (to 84.4%, [figure 2](#)) and the rate of administration prior to discharge (to 92.0%, [figure 3](#)). Additional PDSA cycles targeting workflow barriers to early administration resulted in additional improvement in administration prior to 24 hours at the community hospital (to 85.8%) and in both administration prior to 24 hours and administration prior to discharge at the university medical centre nursery (to 96.2% and 97.9%, respectively). Of those newborns who received the hepatitis B vaccine prior to discharge, the rate of administration prior to 24 hours of life improved from 87.5% to 98.6% at the university medical centre nursery and remained stable at the community hospital nursery (93.8% vs 93.3%). The average timing of administration of the birth dose of hepatitis B vaccine at the university medical centre nursery improved from 14.6 to 1.7 hours, while the average time of administration at the community hospital nursery changed only minimally from 12.3 to 11.5 hours.

LESSONS AND LIMITATIONS

Through a series of PDSA cycles, timing of administration of the birth dose of hepatitis B vaccine improved in both of our institution's newborn nurseries. Based on a key driver diagram created at the start of this project ([figure 1](#)), early interventions focused on increasing nursing and provider education and allowing a provider to recognise more promptly when the vaccine was still

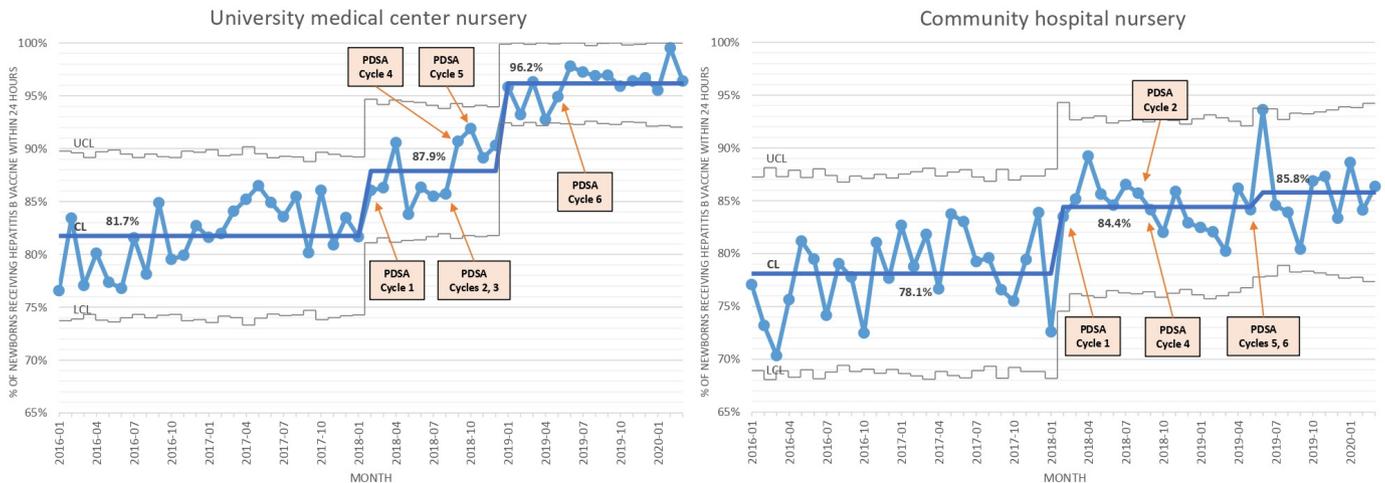


Figure 2 Percentage of newborns receiving Hepatitis B vaccine within 24 hours of birth. PDSA, Plan–Do–Study–Act; LCL, lower control limit; UCL, upper control limit; CL, center line.

pending administration. We solicited frequent feedback on the project from providers and nurses through stakeholder meetings and a survey, and we soon realised the importance of optimising the nursing workflow in order to facilitate earlier administration. Therefore, subsequent PDSA cycles focused on workflow changes.

Changes in vaccine storage location, bundling of care in the delivery room and removal of the requirement for written consent were associated with significant improvements in timing of administration of the vaccine at the university medical centre nursery, where we met our goal of increasing administration of the hepatitis B vaccine to newborns within 24 hours to >90% within a 2-year period. Although significantly improved from baseline, the timing of administration of the vaccine prior to 24 hours of life at the community hospital nursery remained below the goal of 90% at the end of the project. Bundling of care was paused at the community hospital nursery following a vaccine administration error. This error occurred when a newborn received an influenza vaccine instead of the Hepatitis B vaccine. After a review of this safety event with the environment of care team, it was determined that a

pause to bundling should take place until further review of nursing tasks in the immediate postdelivery period. During the 3 weeks that administration of the hepatitis B vaccine was bundled with vitamin K and erythromycin administration, the community hospital nursery had increased to an average rate of administration prior to 24 hours of 92.5%. The occurrence of the vaccine administration error raises the possibility that there may be other unforeseen consequences of this project not yet recognised. Although we encouraged frequent feedback from providers and nurses, we did not outline a formal balancing measure for this project. Relevant balancing measures for others completing similar projects could include monitoring for vaccine administration errors or other safety events.

At the university medical centre, there was a change in the location of the storage of the vaccines from the pharmacy to the postpartum unit during the period of our baseline data collection. It would have been more ideal to have a baseline collection period where no changes were made, and this may make it more difficult to attribute our observed improvements purely to our PDSA

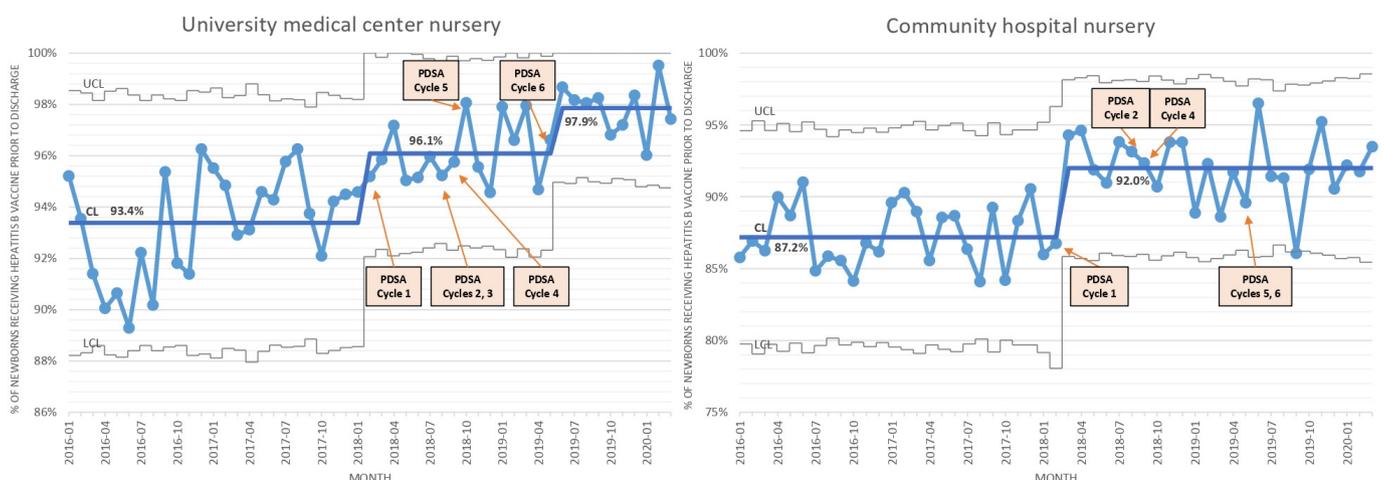


Figure 3 Percentage of newborns receiving Hepatitis B vaccine prior to discharge. PDSA, Plan–Do–Study–Act.



cycles. However, the strong temporal associations of the improvements seen with our PDSA cycles leads us to be confident that the interventions in our PDSA cycles were responsible for the increase in vaccination rates seen.

Baseline rates of vaccine administration prior to discharge were already relatively high in both nurseries, but the timing of administration was not standardised. By the end of the project, the majority of the newborns who received the vaccine prior to discharge did so within 24 hours. A few parents who initially declined the vaccine subsequently agreed to give it once additional education was provided. This project did not specifically target parent education about vaccines beyond that briefly provided by nurses and providers during the initial newborn hospital course. Many parents may have already made decisions about the hepatitis B vaccine prior to the birth of their child. Before additional interventions are planned, it may be helpful to further examine parents' reasons for deferring or declining the vaccine.

Costs for this project were estimated to be minimal except for the cost associated with obtaining a new refrigerator for the labour and delivery unit.

CONCLUSION

To align with updated recommendations on the timing of administration of the birth dose of the hepatitis B vaccine, we were able to use QI methodologies to improve our ability to administer the vaccine within 24 hours of birth. While we only met our primary goal of administration within 24 hours of >90% within one of our two nurseries, both nurseries showed significant improvement over baseline rates. Similarly, we met our secondary goal of increasing vaccination rates prior to discharge to >95% in just the university medical centre nursery, but the community hospital nursery likewise had significant improvement from baseline. Interventions that improved workflow provided additional improvement beyond education alone, similar to findings documented by Nemerofsky *et al* in their QI efforts to improve timing of the birth dose of hepatitis B vaccine.⁷ The improvement in timing of administration has been sustained over a several month period and would be expected to be sustainable long term given that it is based on permanent changes to nursing workflow. Given that our interventions achieved improvements in both a university medical centre and a community hospital nursery setting, we anticipate that other nurseries would be able to use similar interventions to improve rates and timing of vaccine administration.

Attempts to increase our vaccination rates further would likely benefit from focusing on parent education and examination of reasons for declining or deferring the hepatitis B vaccine.

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Acknowledgements The authors would like to acknowledge Archana Krishnan for her assistance with data collection as well as Karen Jooste for her contribution to the implementation of the project.

Contributors SG, GK, MM, JT and SS participated in conception and design of the project. SG and SS collected and analysed data and drafted the manuscript. GK, MM and JT revised the draft manuscript critically for important intellectual content.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

Ethics approval This quality improvement project was reviewed by the Duke University Health System Institutional Review Board and was determined to be exempt from IRB oversight.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon request.

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