Improving On-Time Vaccine Administration in a Neonatal Intensive Care Unit

Myreda Erickson-O'Brien

Under Supervision of

Mary Ellen Connolly, DNP, CRNP

Second Reader

Carmel McComiskey, DNP, CRNP, FAANP, FAAN

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Abstract

Background

Infants hospitalized in neonatal intensive care units for a prolonged period of time are at risk for not being immunized against vaccine preventable diseases per guidelines outlined by the American Academy of Pediatrics and the Centers for Disease Control and Prevention. The guidelines recommend that premature infants receive routine childhood vaccines at chronologic age versus corrected gestational age. Multiple studies completed in the United States, Europe and Canada demonstrated that these patients lag behind their term gestation peers in receiving their vaccines in a timely manner. This delay places them at risk for acquiring these diseases, and requiring primary care providers caring for these babies after discharge to determine "catch-up" schedules to ensure up to date vaccine status.

Local Problem

Data collected from a chart review completed prior to the initiation of the implementation plan revealed an on time immunization rate of 60%. The chart review did not reveal reasons for delay.

Intervention

This quality improvement project evaluated the use of a best practices alert in the electronic medical record to improve on-time administration of two month vaccines (within 60-70 days of age) or documentation reflecting specific reason for deferral. The project was conducted in a 52 bed, Level IV academic neonatal intensive care unit in the Mid-Atlantic region. Inclusion criteria included all patients hospitalized in the neonatal intensive care unit and two months of

age. A query was submitted to the institution's Investigational Review Board, and determined to be non-human subjects research.

Prior to implementation of the best practices alert, a survey was developed and distributed to neonatal intensive care unit nurses and providers to establish baseline knowledge, attitudes and beliefs regarding immunization practices. The findings of the survey were used to develop and provide education sessions providing clarification of immunization requirements and practices. The education sessions also introduced the use of the best practice alert.

A best practices alert was developed and placed into the electronic medical record to remind providers beginning on the infant's day of life 55 that two-month immunizations were due. The best practices alert provided guidance to providers to discuss immunizations with the parent/guardian and also provided a link to an order set within the electronic medical record to the vaccine products.

Results

Simple descriptive data of the proportion of patients receiving vaccines on time was collected prior to the use of the best practice alert to establish a baseline rate of on-time administration of vaccines. Post-implementation of the best practices alert, data collected via chart audits over the next 13 weeks revealed an on-time administration rate (or documentation of specific reason for deferral) of 83%.

Conclusion

A best practices alert, along with education, is a useful tool for improving vaccination rates in a Level IV neonatal unit. The results of this project showed an increase of on-time immunization

from a rate of 60% immediately pre-implementation of the best practices alert to 85% during the project implementation period.

Improving On-Time Vaccine Administration in a Neonatal Intensive Care Unit

Introduction

Premature birth in the United States occurs at a rate of about 10% of total births, or approximately 380,000 babies each year (CDC Features, n.d.; March of Dimes, n.d.). Many premature infants remain hospitalized in a neonatal intensive care unit (NICU) for months prior to discharge to home, particularly if born less than 30 weeks gestation. During their hospitalization, premature infants receive multiple medications and medical interventions. Unfortunately, routine vaccines are frequently overlooked. While most aspects of development for the premature baby are assessed based on corrected gestational age, the routine childhood healthcare maintenance practice of vaccine administration is based on the infant's chronological age. If medically stable, premature infants are eligible to receive routine vaccines at chronologic age, based on CDC schedules (American Academy of Pediatrics [AAP], 2015).

Premature infants tend to not receive vaccines on schedule, lagging behind their age group peers in up to date status. Macintosh and colleagues (Macintosh, Huggins, Eden, Merrill, & Luthy, 2017) reported in their study of immunization status of NICU graduates from a tertiary care children's hospital in the western part of the United States that only 74% of infants discharged after 60 days of life were up to date on their immunizations. These investigators did not describe the vaccine status of children in the NICU at two months of age specifically, only at the time of discharge after 60 days of life. Within the military health care system in the United States, a study exploring the immunization status of children receiving care within that system noted that low birth weight and former premature infants were much less likely to be fully immunized at two years of age (Nestander, Dintaman, Susi, Gorman, & Hisle-Gorman, 2017). Navar-Boggan and colleagues (2011), using data from six NICUs in northern California, found

that of 668 babies discharged at 60 days of life or older, only 51% were up to date, and 27% had received no immunizations. Consequently, primary care providers are tasked with implementing "catch-up" schedules to ensure adequate protection from vaccine preventable diseases (VPD). A study completed in France revealed that by two years of age, 70% of former premature infants were not yet fully immunized according to recommended schedules (Denizot, Fleury, Gaillaux, Rouger, Roze′, & Gras-Le Guen, 2011). These same authors did note also that if the initial immunizations were given while the premature infant was still hospitalized, that those babies had increased vaccination rates at two years (Denizot et al. 2011). Gopal and colleagues surveyed neonatologists in the United States about immunization practices, noting that of the responses received, 55% did not give vaccines to premature infants until after two months of age, despite current recommendations (Gopal, Edwards, Creech, & Weitkamp, 2018). A quality improvement (QI) project reported by Cuna and Winter (2017) noted that prior to interventions to improve on-time vaccination rate, the baseline immunization rate in their NICU was 36%. Low immunization rates may be related to concerns for poor immune response to vaccines in premature infants. While the immune response to vaccines may not be as robust compared to full term peers, studies demonstrate adequacy providing protection against VPD (AAP, 2015).

The purpose of this quality improvement project was to increase the number of on-time vaccine administrations to NICU patients through an educational program addressing vaccine requirements for premature infants and implementation of a best practice alert (BPA) in the electronic medical record (EMR). The BPA notifies providers of babies nearing 60 days of age, and approaching the due date for their routine two-month immunizations. Many studies demonstrate effectiveness of BPAs as a tool to promote adherence to standards of practice and interventions across various patient populations and clinical situations, including immunization

administration (Ancker et al., 2015; Burrell, Sharon, Davis, Wojcik, & Martin, 2018; Castillo, Chan, Tolia, Trumm, Powell, Brennan, & Kreshak, 2018; Federman et al., 2017; Ha, O'Sullivan, Diamond, Plumb, Sleeth, Greer, & Kling, 2018; Jun, Kwang, Mou, Berube, Bentley, Sheih, & Horn, 2018; Lindberg & Anderson, 2014; Lindberg, DeBoth, & Anderson, 2016; Schulz, Osterby, & Fox, 2013; Sheth, Moreland, Peterson, & Aggarwal, 2017; Shinn, Sharp, Klemp, Peterson, & Sowa, 2017). Table 1 provides a review of these studies.

The goal of the QI project was improvement in on-time (defined as between 60 and 70 days of life) administration of two-month vaccines to patients in a 52-bed Level IV NICU, located in a large Mid-Atlantic city. A chart review conducted in late 2017 revealed just under 40% of babies born between January and July in this NICU and still hospitalized at 60 days received their two-month immunizations on time. A repeat chart audit done for babies admitted between January and May 2018 did show improvement to about 60% of on-time vaccines. A short term goal for this project included development and incorporation of a BPA into the EMR, "triggering" or firing at 55 days of life, allowing time for the provider to counsel parents about immunizations, to provide the appropriate vaccine information statement (VIS) per CDC requirements, and to order the appropriate vaccines. An order set for the two-month vaccines was embedded within the BPA. Additional short-term goals for this project included education of NICU staff regarding safety and timing of immunizations and documentation required, particularly if immunizations needed to be .deferred for a medical reason.

Theoretical Framework

The chosen theoretical framework for this project was the Model for Improvement, which incorporates the Plan-Do-Study-Act (PDSA) model (Institute for Healthcare Improvement,

Science of Improvement: How to Improve website, n.d.). (Figure 1) The model is a step-wise progression involving four phases, Plan, Do, Study, Act (The W. Edwards Deming Institute, PDSA Cycle, n.d.). The initial stage, Plan, involves identifying a purpose or goal, formulating an approach, and determining the expected outcome of a project. This was identified for this project as improvement in the number of babies receiving their immunizations on time. Secondly, the Do stage deploys the approach to the problem, or the implementation of a practice change. After implementation, effects of the practice change are evaluated during the Study phase, then lastly, if determined to be effective, the change is sustained in the Act stage of the model.

The expected outcome for the project was improvement in the proportion of NICU babies receiving on-time immunizations. As part of the Plan stage, an assessment of current beliefs and knowledge of NICU staff regarding immunization practices was completed in April, 2018, informing the second stage, Do. This second stage included development and implementation of the BPA and education of NICU staff regarding vaccine practices in NICU environments. The Study stage of the project, via chart audits, revealed effectiveness of the interventions in improving on-time administration of vaccines. During the final stage, Act, modifications to the BPA may be made in the future to maintain sustainability and on-going monitoring for sustainability, and to ensure higher levels of on-time vaccine administration.

Literature Review

Many tools exist within EMRs to assist clinicians in meeting the goals of improved documentation and clinical outcomes. One tool incorporated into EMRs is the BPA, offering recommendations for management of specific clinical situations, or as a reminder of interventions or preventive care practices that should be considered during a patient encounter.

This literature review discusses studies that evaluated BPAs, based on how the study was conducted.

The use of a BPA was evaluated in an obstetric setting by two cohort studies described by Lindberg and Anderson (2014), and Lindberg and colleagues (2016). Effectiveness of a BPA with the goal of improving documentation of weight gain counseling among pregnant women in accordance with the Institute of Medicine (IOM) guidelines was the aim of the first study. Retrospective data collected from chart reviews included documentation of not only the counseling component of weight gain during pregnancy but also documentation of pre-pregnancy anthropometric measurements. This data was compared to that collected from chart reviews after introduction of the BPA. The results revealed improvement in documentation of both components of care. The second study built upon this same data to determine the incidence of referrals to obesity-related health services (e.g., dietary/nutritional referral, diabetes screening), and by health outcomes (e.g., gestational weight gain in or outside of recommendations, pregnancy complication, mode of delivery, premature birth, birth weight of infant). The pre-BPA and post-BPA cohorts in the second study differed somewhat in number, however, the proportion of women who gained weight appropriately during their pregnancy within IOM guidelines improved significantly in the post-intervention cohort compared to the pre-intervention cohort, as did screening for diabetes and decrease in mean infant birth weight. Both studies revealed positive outcomes when the BPA was initiated into the EMR, with improved documentation, improved referral rates for counseling, improved maternal weight gain based on recommendations, and increased evaluation for gestational diabetes.

A cluster randomized study completed by Federman and colleagues (Federman, Kil, Kannry, Andreopolous, Toribio, Lyons, …Krauskopf, 2017) examined use of a BPA for referral

for hepatitis C testing for adults of "baby boomer" age in ten primary care practices. Six practices were randomized to have the BPA trigger to advise the provider to refer for testing; four practices served as the control group. While the rate of testing for hepatitis C overall remained low, those providers who had a BPA reminder made more referrals for hepatitis C testing.

A retrospective study examined the outcomes of a BPA used during emergency department (ED) visits by homeless individuals, to provide vaccination against hepatitis A during an outbreak of the disease in Southern California. The authors collected data from three points in time; a historical control period, during which no vaccines were given; a pre-implementation period; and a post-implementation period, each of which included six months of data. The findings from the post-implementation phase revealed that over 75% of homeless ED patients received hepatitis A vaccines at that visit, given prior to the visit, or deferred for a medical reason. These authors concluded that the use of the BPA in the ED to suggest that providers screen for and administer the vaccine was helpful during the public health concern in that area (Castillo, et al. 2018)

Anemia screening as part of well child care for one-year old children is recommended by the AAP, but Ha and colleagues (2018) reported that prior to the implementation of a BPA to remind care providers to screen for anemia, the rate of children screened was about 42%. After the introduction of a BPA, the screening rate improved to almost 73%. These authors included providers in both pediatric and family medicine practices; pediatric providers were more likely to order screening tests compared to family medicine providers, who tended to see fewer children in their practice. A post-implementation education program was done as well, but this did not affect post-BPA results.

Three additional quality improvement (QI) articles were reviewed as well. One, however, did not evaluate the use of a BPA (Cuna & Winter, 2017), but rather the use of a "recall" system in the EMR. This recall system consisted of including the need for immunizations to NICU patients as a problem in the daily notes (A. Cuna, personal communication, 2/6/18). This recall system, along with an education program regarding vaccines, feedback to staff, and a standardized consent process increased the on-time vaccination rate in that unit from 36%, based on pre-intervention data from chart reviews, to over 80% after the implementation of all four interventions. A second QI project evaluated rates of herpes zoster immunization in patients with rheumatoid arthritis before and after the introduction of a BPA (Sheth et al., 2017). Comparison of two groups, each with over 1500 patients in each, revealed that the rate of vaccination improved significantly, as did the incidence of documentation regarding vaccine administration or deferral. Lastly, Shinn and colleagues described a BPA that triggered upon dietitian documentation of malnutrition, prompting addition of this diagnosis to patient problem lists in an impatient setting, both pediatric and adult (Shinn, et al, 2017). After implementation of their BPA, the rate of addition of malnutrition to the problem list increased to 70%. Overall, some type of trigger mechanism to alert providers of a diagnosis or intervention in these QI reports led to improved outcomes.

The use of a trigger to alert providers has demonstrated success in several clinical areas. Three additional descriptive studies were reviewed with respect to BPA use. Of these, one discussed vaccine administration to obstetric patients (Morgan, Baggart, Chung, Ritch, McIntire, & Sheffield, 2015).The use of a BPA was introduced for the study evaluating administration of a vaccine to women in obstetric care, but there was also a change in the recommendation of administration from post-natal to prenatal during the study. Between the two interventions, there

was significant improvement in the rate of vaccination, but determining which intervention was more effective was difficult. In another study, a clinical decision support tool that included a BPA designed to enhance antibiotic stewardship was implemented by a pharmacy team in an inpatient setting with the goal of de-escalating antibiotic use. When the BPA was responded to within 72 hours, 69% of the BPAs were accepted, that is acknowledged, with 12% of those accepted leading to modification of the antibiotic regimen, and 18% of the BPAs were rejected. There was a statistically significant decrease in total antimicrobial use as well (Schulz, L., Osterby, K., & Fox, B., 2013). BPAs, as part of a larger study of EMR function use, determined that acceptance of a BPA improved quality metrics in several preventive care as well as specific disease processes (Ancker,et al, 2015). Both of these latter studies support the effectiveness of a BPA in clinical practice.

Lastly, one additional paper revealed the use of a BPA in decreasing inappropriate laboratory testing or thrombophilia in an outpatient setting (Jun, et al, 2018). In this situation, if any of nine thrombophilia tests were ordered, the BPA triggered to alert the clinician and directed the provider to the Choose Wisely guidelines recommended by the American Society of Hematology. Jun and colleagues noted that the BPA decreased the number of tests ordered, particularly among general medicine providers.

The reviewed studies varied in evaluating the effectiveness of BPAs; overall the evidence supports the use of a BPA, across multiple settings, to have an impact on patient outcomes although to differing degrees. Development and implementation of a BPA with the goal of improving rates of immunization in NICU patients is supported by this external evidence using functions of the EMR.

Implementation Plan

A quality improvement (QI) project addressing on-time administration of vaccines was implemented in the NICU. The project included the development of a BPA and an order set for two- and four-month vaccines (Figures 2 and 3). For purposes of this QI project, only two-month immunizations were audited. The parameters for the BPA to trigger included patient age of day 55 to day 65 and no existing order for the vaccines in the EMR. The BPA fired when the "Manage Orders" tab in the EMR was activated. The provider had the option to select the order set at that time, or to acknowledge a reason not to order. There were four acknowledgement reasons. The first two options were "will discuss with guardian," and "unable to contact guardian," which if chosen in either case, the provider does not order the vaccine and the BPA will fire again in 24 hours. If the option for "guardian refused" or "given at another facility" is selected, then the BPA does not fire again. The BPA and order set went "live" in the EMR on September 18, 2018.

The inclusion criteria for this project were infants aged 60 to 70 days who qualified based on age to receive two month vaccines. An estimated sample size at the beginning of the project (n=25) was based on an average number of babies who turn two months of age each week in the NICU. The project was completed in an urban academic medical center Level IV NICU in a Mid-Atlantic state and was completed over a 14 week time frame.

A survey conducted in April 2018 among staff in the NICU, including registered nurses, advanced practice providers (APP), neonatal fellows, neonatologists, and resident staff physicians helped determine knowledge, attitudes, and beliefs regarding immunization practices in the NICU setting. Based on the findings of the survey, educational sessions were developed, one focused for the nursing staff, and another focused for providers (Appendices C and D). The

presentation directed at the nursing staff provided background information regarding vaccines in the NICU, and delineated nursing activities related to immunization practices. The provider program for ordering physicians and APPs discussed in more detail the use of the BPA, as well as CDC requirements. Both of the short programs included applicable results from the immunization practices survey.

The NICU nursing clinical educator recommended providing the education to the nursing staff during small group sessions on the NICU at mutually convenient times. A Power Point presentation focused on a brief description of the scholarly project, the implementation of the BPA, and a review of nursing practices related to vaccine administration, as well as survey results most applicable to nursing. Each session lasted approximately 30 minutes. Approximately 50% of the nursing staff received in-service education regarding the project. Most of the sessions were completed during the first six weeks of the project implementation period. Patient acuity and staffing impacted on the ability to reach more staff during the project time frame.

Provider staff received briefings as well on October 9, 2018. A separate Power Point program was developed for providers that included results of the survey most applicable to their role, review of CDC guidelines concerning vaccines, and an overview of the scholarly project. Nine of the 15 attending neonatologists and seven of the 10 neonatology fellows attended the meeting. Later that same afternoon, the same presentation was given at the advanced practice provider (APP) meeting. However, due to patient care needs and technical difficulties of APPs being unable to join the meeting via web conferencing, only four of the 16 received the information. Considering this circumstance, the Power Point was provided via e-mail on October 14 to the APP group, with narrative notes addressing the information on each slide.

Brief sessions were also held with the pediatric resident physicians rotating through the NICU at monthly intervals. The residents were educated on current AAP guidelines for immunizations, as well as the use of the BPA and order set.

Data collection consisted of a chart audit done weekly over the following ten weeks. A template (Appendix F) was developed and used within an Excel data base, and all babies in the NICU ages 60 to 70 days of age were included in the data collection. The daily progress notes were audited for vaccine deferral reason during this time frame if the immunizations had not been ordered.

Data collected were entered in an Excel spreadsheet for analysis. Descriptive statistics were used to determine the proportion of all infants in the NICU at 60 to 70 days of age, those who received two-month immunizations between 60 and 70 days of age or had a note made of reason for deferral in the medical record during that time. These results were compared to data collected prior to implementation of the BPA. Data security was maintained by password protected digital media and the use of a secured locker on the unit to store hard copy data. A query to the University of Maryland Baltimore (UMB) Institutional Review Board (IRB) for Non- Human Subjects Research determined the project to be non-human subjects research and a QI project.

Results

The BPA went "live" on September 18, 2018. During the implementation period, a total of 29 babies remained in the NICU at 60 days of age, and data were collected on these infants. Nine of the 29 babies were cared for by the pediatric resident service, with the remaining covered by the APP service. Three babies were transferred to a convalescent facility between

days 60 and 62, and one discharged to home on day 60; two of these four patients had notations in the discharge summary that immunizations were due. One baby's parents declined immunizations at 2 months; this family chose later to have their baby receive the immunizations prior to transfer to another pediatric acute care facility, but the immunizations were given after 70 days of age. Thus, 24 babies are included in the data analysis.

Of the babies receiving their two-month vaccines, 83% received them in the on-time period. This included two babies who actually received their two month immunizations at 56 and 59 days of age. (Per CDC guidelines, the earliest that vaccines may be administered and still "count" as two-month vaccines is 55 days). The original goal was to have a 90% on-time vaccine administration rate or deferral reason documented. One baby on the NNP service did not receive vaccines by 70 days of age, with no reason documented in the progress notes. The other three babies who did not get their vaccines by day 70 were all being cared for by pediatric residents. Of these three, one baby had a note written by a neonatal fellow on day 70 that immunizations were being held secondary to need for surgical intervention for a patent ductus arteriosus; there was no mention in the resident's daily progress notes for reason for deferral. One other resident service baby who did not receive vaccines on time had a note of "hold until more stable." Upon review of the chart, this baby was receiving full enteral feedings with no need for respiratory support, and would generally be considered clinically stable. The third infant had no mention of need for vaccines, and no reason for deferral in the daily notes (Table 1).

The medical informatics staff was able to collect data related to the "firing" and actions taken with the BPA. There were 30 babies for whom the BPA fired during the project timeframe. The BPA fired a total of 1253 times; of note, the BPA was activated for use at

another NICU within the hospital system at the same time, and fired 43 times at that facility, bringing the total to 1210 at the project facility. One patient, however, in the project unit was included in this calculation at four months of age, for 64 firings of the BPA for this baby. Excluding these firings, there were 1146 firings of the BPA at two months of age included with this data. Most babies had multiple BPA firings at the two-month point. Of the 1146 firings, "open order set" was chosen 46 times (4%) for 24 babies. It is unclear why there were multiple firings for most patients on the same day; further discussion with the information technology (IT) personnel is warranted, as once the order set is selected, the BPA was to no longer fire. The BPA was acknowledged 75 times (6.5%), with the remaining firings getting a "cancel BPA" response (89.5%), in other words, the BPA was closed without any action taken. Of note, while the BPA was intended to fire once per day per patient, multiple firings per day were noted. Of the original 29 babies for which the BPA fired, the average number of times that the BPA appeared for each patient was 32 times, with a range of 2 to 106 times.

Discussion

The results of the implementation of the BPA as well as staff education correlates well to previously published literature revealing multiple positive examples of the use of BPAs to impact outcomes. Additionally, documentation of deferral of vaccines was increased; this may have been more reflective of the educational sessions related to the project rather than the use of the BPA itself. Currently, the BPA does not direct the provider to document the reason for deferral.

Limitations of the project included small numbers of patients for inclusion. Based on data collected prior to implementation of the BPA, and data collected during the implementation phase, the average number of babies due for two-month immunizations remained constant; this is

not expected to change over time. Additionally, the need to educate the resident physician staff about vaccines in NICU patients, and the use of the BPA was a limitation. Time to provide information to these staff each month can be limited by availability of those staff, as well as identification of the individual to provide that education. The project leader may not always be available, and there might be time constraints for the neonatal fellow who could be in a position to provide this information.

Ongoing use of the BPA is expected to contribute to sustainability of the project, and a continued higher level of on-time administration of vaccines to NICU patients at two months of age. Maintaining a high percentage of on-time vaccine administration can put NICU patients on a timely trajectory of health care maintenance into primary care after discharge. Chart audits will continue to monitor on-going timely administration of vaccines, and continue to be done by the project leader. Problems related to using the BPA, for example the multiple firings per day on any one patient will also continue to be monitored. It is not clear currently why there were multiple firings for the BPA on each day. Based on the information provided by the IT staff, most firings of the BPA resulted in the provider simply closing the BPA, without taking a specific action. Further work with the IT developers to modify the BPA may be anticipated to correct this concern. A prompt within the BPA to remind the provider to document reason for vaccine deferral would be beneficial to maintain the positive outcome of its use.

Additionally, ongoing education for resident staff needs to continue, as these individuals are in the NICU for short periods of time, compared to APP and neonatology fellow staff. A potential opportunity to inform pediatric residents of vaccine practices for the NICU would be the inclusion of a chapter in the NICU handbook that is provided to residents and available on the NICU page of the facility intranet site.

Within the literature discussing the use of BPAs and patient outcomes, particularly those that describe quality improvement projects, staff education is discussed as a component of the QI process (Castillo, et. al., 2018; Cuna & Winter, 2017; Ha, et al., 2018). Staff education for this project included not only education regarding the use of the BPA, but general information regarding the problem of under-immunization in the NICU setting, and other information learned from the pre-implementation survey. Verbal feedback from staff indicated that the education was helpful in increasing knowledge and awareness about vaccine administration in the NICU. A teaching toolkit is being developed for nursing staff to provide on-going education about vaccines and NICU patients.

Refining the consent process for vaccines and defining "medically stable" were both initially identified as part of the original project proposal. Upon review of CDC guidelines after the initial project proposal, informed consent was discovered to not be a legal requirement. The federal requirement, per the CDC is that the parent/guardian be provided a copy of the current VIS for the vaccine(s) to be administered, with the opportunity to have questions addressed. There is no state mandate for informed consent either. Thus, addressing a consent process during this QI project was not pursued.

Defining "medically stable," another goal in the initial project proposal, was determined to be a goal to be pursued separately; coming to consensus among providers was not going to be able to completed within the timeframe of the QI project. Results of the survey showed variability among providers in describing medically stable for the purposes of immunization. As part of the measureable outcome, documentation of deferral was included as "on-time" if daily progress notes anytime between 60 and 70 days reflected a specific reason. Deferral for immunizations was left to the ultimate discretion of the attending neonatologist. Thus, since this

was determined to be a part of the data collected, defining "medically stable" was not included in the project at this time, and may be pursued further in the future to minimize variability.

Conclusion

Overall, implementation of the BPA and provision of education sessions resulted in an increase in the on-time administration rate of two-month vaccines. The BPA is now a permanent part of the EMR, and will continue to remind providers that their NICU patients are in need of this important component of well child care. The education component of the project also raised awareness among providers and nursing staff of overall under-immunization of NICU babies, not only within the project unit, but as a problem across many NICUs.

The BPA was activated at another NICU within the hospital system by the system IT staff; as the system continues to add neonatal units, and as those units transition to using the same EMR program, the BPA can be used in those units as well. Staff within the other system NICUs will have a mechanism to conduct their own QI to assess compliance with vaccine schedules for their patients, if desired. Although the project NICU has few patients that remain patients longer than four months of age, the BPA is designed to fire to remind providers of the timing of four-month vaccines also.

As previously noted, the original project proposal included addressing the consent process and defining "medically stable." While informed consent is not required, a mechanism of documentation to assure that parents have received the VIS and have had the opportunity to have their questions answered is warranted. The current form in use was originally designed to document not only that parents had received the VIS, but included a means to document vaccine administration that included all CDC requirements. Documentation of administration is now included in the EMR, negating the need to use the paper form; however, many nursing staff

continue to use the paper form as well, leading to redundant documentation. Currently, as a result of this project, a new form is being developed, in hopes of streamlining the documentation of parent acknowledgement, and to include barcoding of the form to ensure that the form is included as an official part of the medical record.

Defining "medically stable" may be addressed in the future. This will need to be a collaborative effort between neonatologists and neonatal advanced practice providers. Inquiry with the lead author of a reviewed published QI project revealed that group did not try to address this issue during their QI initiative (A. Cuna, personal communication, 2/6/18). Whether consensus for this definition can be made is questionable, but is worth exploring in the future.

For infants in the NICU, providing immunizations in a timely manner contributes to meeting well child care management. Not only does vaccine administration assist primary care providers after discharge in maintaining a normal trajectory of well child care to former NICU patients, but parents may begin to recognize progress in their child's recovery, and seeing discharge to home in the future. Least of all, on-time administration of vaccines protects these most vulnerable infants from potentially devastating diseases.

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Table 1. Vaccine Administration in the NICU

Babies at 2 months of age	Excluded	Eligible to receive vaccines	Received vaccines	Not given vaccines
29	5	24	20 (83%)	4 (17%)
By Service				
NP n=20 (69%)	3	17	16 (94%)	1 (6%)
Resident n=9	2	7	4 (57%)	3 (43%)

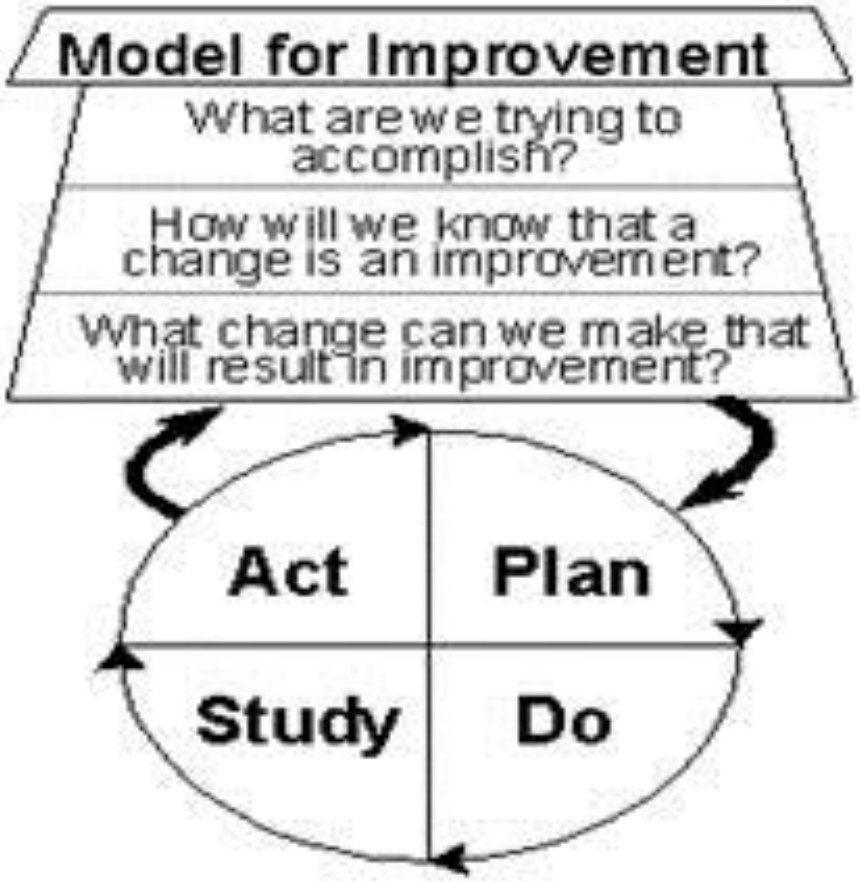

Figure 1. Theoretical Framework

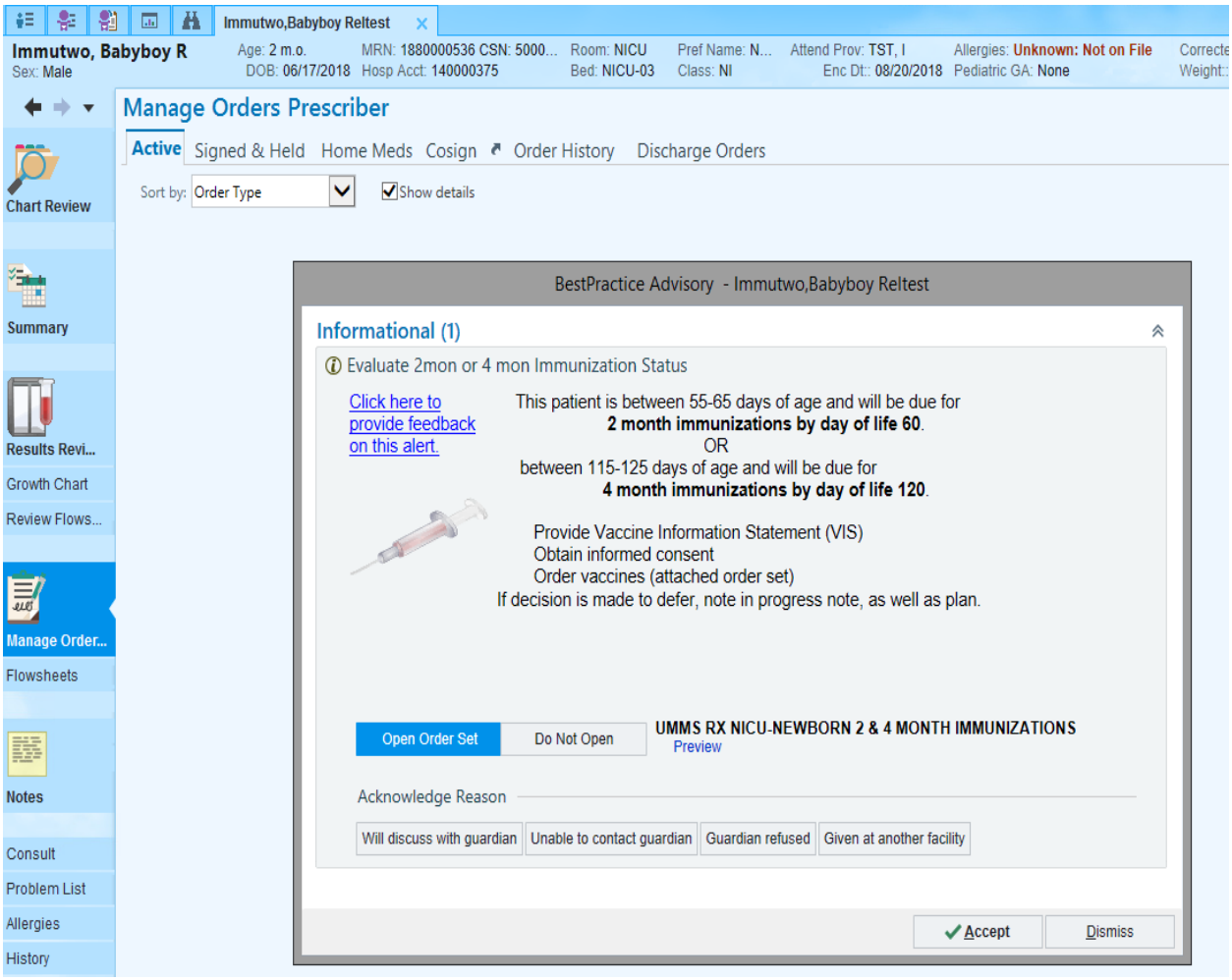

Figure 2. NICU immunization Best Practice Alert—mock up screen shot prepared by IT department prior to activation

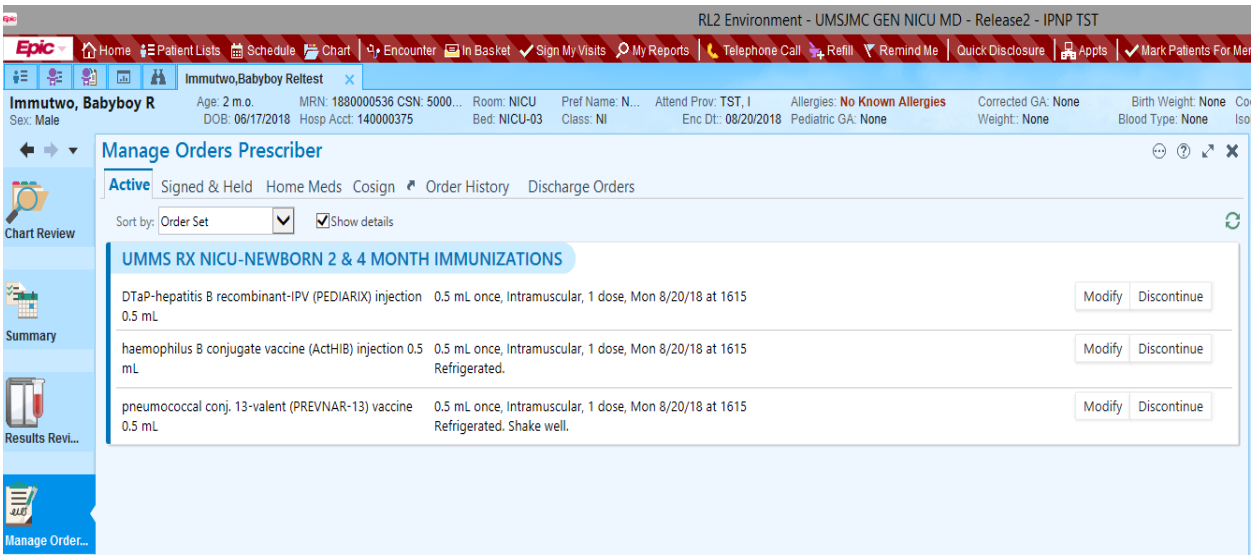

Figure 3. NICU immunization order set—mock up screen shot prepared by IT department prior to activation

Appendix A

DNP Project Name: Improving On-Time Vaccine Administration in a Neonatal Intensive Care Unit: A Quality Improvement Project

DNP Project Purpose Statement: The purpose of this quality improvement project is to improve the on-time administration of vaccines to NICU patients through an educational program addressing vaccines for premature infants and implementing the use of a best practices alert (BPA) in the electronic medical record (EMR).

Short-Term SMART Objective:

1. *By May 5, 2018, the results of the Immunization Practices in the NICU survey will be reviewed, and baseline information regarding knowledge, beliefs, and attitudes about giving immunizations to babies in the NICU will be established and an education plan will be made to be used during the first three weeks of the project (August 27 through September 14 2018) to educate NICU staff (RN, NP/PA, MD on vaccine administration in the NICU, as well as information to be used by the team to begin to formulate a plan to define "medically stable" and to clarify consent process.*
2. *By July 15, 2018, a definition of "medically stable" will be agreed upon by the neonatology division to be used for determining eligibility of NICU patients to receive vaccines.*
3. *By July 30, 2018, the consent process for vaccine administration will be clarified for all NICU staff, delineating responsibility for obtaining consent.*
4. *By September 14, 2018, at least 80% of the RN and provider staff of the NICU will have received education regarding the consent process and planned best practice alert to be embedded in the EMR. Education will be provided to RN staff at scheduled 30 minute sessions (to be done during working hours) over a 3 week time period. Journal club/QI meeting/division meetings will be the opportunity to discuss with the provider staff.*
5. *By September 19, 2018, the BPA will be deployed for use in the EMR.*
6. *By November 15, 2018, at least 70% of eligible NICU patients will have received 2 month vaccines within 60-70 days of life, or have documentation in the medical record (daily progress note) denoting reason for deferral of vaccines, as evidenced by chart review, and if this threshold is not yet met, knowledge gaps will begin to be identified in order to modify the project as necessary.*

Long-Term SMART Objective:
By December 1, 2018, 90% of eligible NICU patients will have received 2 month vaccines within 60-70 days of life, or have documentation in the medical record (daily progress note) denoting reason for deferral of vaccines, as evidenced by chart review.

Population/Context: The population of interest for the project is neonatal intensive care patients who remain hospitalized at 2 months of age and would be due to receive 2 month vaccines in accordance with CDC guidelines. Data collected from 2017 show that just under 40% of infants in the NICU at 2 months of age receive on-time (60-70 days of life) with scant documentation of reasons for deferral at that time for medical reasons.

Mobilize: *WHO will help facilitate the changes in structures and processes (practices)?*
List of Core Team Members Myreda L. Erickson-O'Brien, RN, MS, CRNP, NNP-BC, Team Leader
Abhinav Parikh, MD, Neonatology Fellow
Jessica Biggs, PharmD, NICU Pharmacist
Collen Hughes-Driscoll, MD, NICU QI Coordinator
Jocelyn Leung, MD, NICU EMR Representative

Others I will mobilize after the draft plans have been developed:
3-4 additional champions from within the NICU staff (RN, NNP, neonatal fellow) to assist in supporting and reinforcing the components of the education plan with respect to consent, vaccine administration, and use of the BPA

Assess: *WHAT structures and processes (practices) need to change and WHY? What structure, process, and outcome measures will be used to measure progress?*

1. Definition of "medically stable" needs to be more clearly defined among the provider staff. Results from the Immunization Practices Survey completed during April 2018 will be used to establish current understanding of provider thoughts, and serve as the basis to bring about a comprehensive definition that is acceptable to providers.

2. The consent process for vaccines needs to be clarified, specifically who is responsible. Informed consent is a CDC requirement, but at this time, confusion is expressed among staff regarding who is responsible for providing the required Vaccine Information Statements and having the parent sign for consent, as well as if telephone consent is appropriate.

Plan: *HOW will these changes be made (strategies and tactics)? WHEN will these changes be made?*

1. Strategies for defining "medically stable" will include results from the survey tool, results from a query on a professional organization list serve to elicit ideas from other NICUs (National Association of Neonatal Nurses, Advanced Practice), and literature search. Based on this information, a definition of "medically stable" will be drafted by the core team, the presented to the neonatology division for discussion, and consensus. Alternatively, a list of contraindications for vaccine administration may be created. The target date for completion will be July 1, 2018, with dissemination following via the education plan.

   As part of the educational plan, discussion of documentation of vaccine deferral was had, with ultimate decision making resting on the attending neonatologist. A more definitive approach to this question will be considered in the future.

2. Use of information obtained via the survey regarding the consent process for vaccines will be used to clarify the process of vaccine consent. During the education sessions, CDC requirements for consent, including use of CDC vaccine information statements (VIS) will be reviewed. Vaccine information statements in hard copy will be available for use, and lamination of a set of VIS to available to minimize paper waste will be made available for staff use to use. Target date for completion of this tactic will be July 30, 2018.

   During further exploration into CDC requirements, informed consent as part of the process was discovered to not be a legal requirement. VIS provision to parents is a requirement, with documentation in the medical record of both the date of the VIS edition, and the date provided to the parent. Copies in both English and Spanish were made and laminated, and distributed throughout the NICU for use.

3. Staff education will be completed that will include information regarding vaccine safety in NICU patients, as well as CDC requirements for administration and documentation of vaccine administration. Members of the team will provide this education, and will enlist the assistance of champions to help address ongoing questions. The education plan will be tailored to apply to nursing staff and to provider staff. Target date for completion will be September 14, 2018.

   The education of staff continued throughout the implementation period.

4. The BPA (currently in draft development and being reviewed by the clinical informatics staff) will be deployed for use to remind providers of upcoming 2 month vaccine administration due dates. The target date for deployment of the BPA will be September 17, 2018.

   The BPA went live on the above date.

Implement: *WHAT strategies and tactics were used? WHEN were the desired changes made?*

The vaccine BPA along with an embedded order set was activated for use on September 17, 2018. Education of staff continued during the implementation period. Weekly chart audits were done, and data collected into an Excel spreadsheet for further analysis at the end of the implementation period.

Track: *WHAT structures and processes (practices) were changed based on the metrics we used to measure progress (including frequency of assessment)? HOW did these changes affect outcomes? WHAT do we need to do differently to make greater progress toward improving outcomes?*

Improvement in the timely administration of vaccines at 2 months of age to NICU patients was noted, although not to the hoped for degree. Of note, on-going education of resident pediatric physicians is required to inform them of the use of the BPA, appropriateness of vaccine administration to NICU patients, and specific documentation for deferral of vaccine administration.

Date: _12/21/18

Plan Developed by (List all contributors): ___M. L Erickson-O'Brien, RN, MS, CRNP, NNP-BC; A. Parikh, MD

Reference: Guidry, M., Vischi, T., Han, R., & Passons, O. MAP-IT: a guide to using healthy people 2020 in your community. U.S. Department of Health and Human Services. The Office of Disease Prevention and Health Promotion, Washington, D.C. https://www.healthypeople.gov/2020/tools-and-resources/Program-Planning

Appendix B

Evidence Review Table

Author, year	Study objective/intervention or exposures compared	Design	Sample (N)	Outcomes studied (how measured)	Results	*Level and Quality Rating
Cuna & Winter, 2017	A QI project to improve on-time immunizations of preterm infants in the neonatal intensive care unit	QI project using the PDCA model	Pre project sample 72 Post project sample 77	Primary outcome measurement of interest was on-time vaccination rates for NICU patients	Baseline on-time vaccination rate, determined by chart review was 36%. After the introduction of 4 separate interventions (education, staff feedback, recall system, standard informed consent), the on-time rate was increased to 82%.	6B
Lindberg & Anderson, 2014	A study to test the effectiveness of an intervention, a BPA in the EMR, to improve consistency and accuracy of antenatal gestational weight gain counseling in accordance with IOM recommendations.	Cohort study, whereby retrospective chart reviews were used to evaluate whether the use of a BPA imbedded in the EMR improved consistency and accuracy of weight gain counseling among obstetric providers	Pre project sample 388 Post project sample 345	Primary outcome measurement of the proportion charts with pre-gravid heights, weights, and BMI documented, as well as documentation of weight gain counseling	The introduction of the BPA improved the rate of weight gain counseling in accordance with IOM guidelines (p <0.001), as well as improvement of documentation of prenatal measurements.	6A
Lindberg, DeBoth &Anderson, 2016	A study to evaluate whether an EMR BPA, previously shown in a prior study to improve antenatal gestational weight gain patient education, continued to have a “downstream” effect on service delivery or patient	A secondary analysis of data from an intervention, involving retrospective chart review, controlling for confounders	Pre intervention sample 333 Post intervention sample 268	Service delivery measured by referral to obesity related health services (e.g. dietary/nutritional referral, diabetes screening), and by health outcomes (e.g., gestational	There was an increase in the proportion of women who gained weight during pregnancy within IOM guidelines from 28% to 35% (p= < .05), a decrease in infant birth weight in mean infant birth weight (94g, p= .03), and an increase in proportion of overweight/obese women screened for undiagnosed type 2 diabetes prior to 20 weeks	4B

	health outcomes.			weight gain in or outside of recommendations, pregnancy complication, mode of delivery, premature birth, birth weight of infant.)	gestation from 13% to 25% (p= .01).	
Schulz, Osterby, & Fox, 2013.	The development of a CDS tool using a BPA and antimicrobial stewardship navigator to facilitate antimicrobial stewardship	Analysis of alerts that targeted antibiotic de-escalation, assessing the effectiveness of a navigator as a stewardship tool. The navigator included clinical data, evidence based clinical information, and bidirectional communication capabilities	1285 BPAs over 18 months Of these 249 were done for the purpose of de-escalation of antibiotic therapy, 61% for surgical patients, and 47% for patients in ICUs.	Antimicrobial use and response to the BPA data by the provider receiving the BP Recommendations triggered 48-72 hours after initiation of therapy	18.9% of the BPAs were acted on within 72 hours, with the purpose of de-escalation of antibiotic therapy; of these, 69% were accepted, 12% were accepted with modification of antibiotic regimen, and 18% were rejected There were statistically significant (P<.05) decreases in antimicrobial use in total, as well as in use of broad spectrum antibiotics anti Methicillin resistant *Staphylococcus aureus*, anti-pseudomonal agents).	6A
Sheth, Moreland, Peterson, & Aggarwal, 2017	A study to assess the use of a BPA to improve herpes zoster vaccination rates in rheumatoid arthritis patients at high risk who were receiving immunosuppressive therapy	A QI project using a PDCA model, and a pre and post intervention design. A BPA was developed and incorporated into the EMR.	Pre intervention 1823 Post intervention 1554	HZ vaccination rates of eligible patients; documentation of vaccination	The HZ vaccination rates improved significantly from 10.1% in the pre-intervention group to 51.7% in the post intervention group (p < 0.0001); the documentation rates increased from 28% to 72.9% (p < 0.0001). Additionally, HZ infection rates decreased from 2% to 0.3% (p=0.02) among the group of patients.	4A
Federman, et al, 2017	To examine the impact of an EHR embedded BPA for HCV testing among birth cohort patients	A cluster-randomized trial.	10 primary care locations: 6 practices randomized to receive the HCV testing BPA, 4 as the control (no BPA)	At patient visits at the sites were the BPA was introduced, physicians received an alert via the	The BPA group showed 18.4% more testing for HCV in the intervention group, vs 1.8% of patients being tested in the control group. However, the overall rate for testing for HCV remained low.	3A

			82 clinicians in the intervention group, 46 in the control group 8713 unique individual patients in the intervention group, 5438 in the control group	EHR to order testing, or the medical assistants were prompted to post a testing order for the physician. Incidence of HCV testing was measured with the secondary outcome measurement the number of HCV antibody positive tests		
Morgan, et al, 2015	To evaluate how the implementation of a BPA, in combination with a recommended change in timing of Tdap vaccine changed immunization rates, and to examine the association of vaccination with pertussis incidence	Descriptive study	10201 women	Rate of Tdap vaccine administration during pregnancy with the BPA installed into the EMR, and a change in timing of vaccination from post-natal to pre-natal The BPA designed to trigger beginning at 32 weeks of gestation, and then again at each patient encounter until vaccine administered or patient delivered Acceptance rate of vaccine prenatally compared to previous year's data	The use of the BPA, along with prenatal administration of the vaccine was associated with a immunization rate of 97%. There was a nonsignificant decline in incidence of pertussis in the infants.	6C

				at that institution Rate of pertussis in infants < 4months of age		
Ancker, et al., 2015	To assess the relationship between physician use of EHR functions, including BPA, order sets, and viewing panel-level reports. and healthcare quality	Retrospective cross-sectional study	65 primary care providers 61,977 patients 193,095 visits	Use of condition-specific BPAs, order sets, and panel-level reports by primary care physicians. Eighteen clinical quality measures from the early stages of "meaningful use" of an EMR were abstracted and analyzed for BPA, order sets, and the panel level reports EHR usage metrics were obtained for BPAs with potential to support "meaningful use" performance on 5 preventative services, including tobacco cessation, breast cancer screening, colorectal cancer screening, pneumonia vaccination, and BMI screening, as well as for 4	Increased adherence to recommended care and treatment for specific diseases was noted when providers intensively used certain EHR functions, and higher performance on health care quality metrics. Providers who accepted the BPAs at a higher rate than the median, had higher quality measures for 4 of the preventive services: tobacco cessation interventions (80.6% vs 66.7%, *P* < .001); breast cancer screening (49.4% vs 44.2%, *P* <.005); colorectal cancer screening (47.4% vs 34.4%, *P* <.001); and pneumonia vaccination (70.9% vs 60.8, *P* < .004). Use of the BPA for specific medical conditions was also associated with improved quality metrics: diabetes urine screening (87.1% vs 80%, *P* < .001); LDL testing in diabetes (68.2% vs 59.5%, *P* < .001).	,6A

				medical conditions including diabetes, hypertension, depression, and hyperlipidemia. The percentage of alerts accepted by the provider was measured if the provider clicked "accept" or opened the order set embedded in the BPA.		
Shinn, et al., 2017	A QI project comparing provider responses (adding to the problem list) to a BPA triggered upon dietitian documentation of malnutrition in inpatient units	QI project	439 patients identified by the dietitian as malnourished (5% pediatric, 95% adult)	Percentage of patients having malnutrition added to their problem list in the EHR	70% of both pediatric and adult patients had malnutrition added to the problem list. The BPA can improve documentation of malnutrition. Ensuring adequate training can help providers respond to the BPA in a timely manner	6B
Burrell, et al., 2018	Using the EMR to implement routine HIV and HCV in urgent care settings to increase testing for these problems in eligible patioents	Not clearly specified	27, 230 eligible patients were identified to qualify for testing for either HIV, with 7.2% of those patients (n=1972) agreeing to screening. For HCV screening, 6509 patients were eligible, and 29.1% agreed to be screened (n=1895).	Identification of at risk patients with subsequent referral to definitive care.	31 patients screened positive for HCV, and were directed to infectious disease specialty care by patient navigators. There were no confirmed HIV cases identified	6B
Jun, et. al, 2018	Using a BPA to advise clinicians to consider need for thombopilia testing	Not clearly specified; most likely a QI project	The N is not clearly identified if it is the BPA trigger and what was acted upon, or whether it is number of patients	Adherence to "Choose Wisely" guidelines when ordering laboratory studies for patient with acute venous	In the outpatient setting, thrombophilia testing decreased significantly	6C

				thromboembolism		
Castillo, et. al., 2018	Evaluation of a provider alert in the BPA in increasing hepatitis A vaccinations in the homeless population in the Southern California area during a regional outbreak of the disease	Retrospective study comparing historical data, to pre-implementation data, to post-implementation data; Before and after quasi-experimental study	1482 ED visits by 1131 patients in an academic ED setting	Vaccination rate among the homeless patient population presenting to the ED	There were no hepatitis A vaccines given during the historical data collection timeframe, with 9 patients vaccinated prior to the implementation of the BPA, and 194 vaccines given to eligible patients after the implementation of the BPA. 77.5% of the patients received the vaccine during the visit, had documentation of prior vaccination to hepatitis A, or it was not given based on the medical status at the time of the visit.	4A
Ha, et. al, 2018	Evaluation of a BPA in reminding pediatricians and family medicine physicians to complete anemia screening at one year of age per AAP recommendations	A QI project exploring the compliance of recommended screening for anemia in one year olds, after the implementation of a BPA	There were 2545 clinic visits over a 12 month period prior to the implementation of the BPA, and 2186 visits over the 8 months post-BPA implementation	To increase anemia screening in accordance with AAP guidelines for children at one year of age.	Screening for anemia increased from 48.2% to 72.7%. A follow-on review of the data showed a slight decrease to 70.8% and despite an educational effort, continued to follow this trend. Pediatricians were more likely to obtain screening compared to family medicine providers.	6A

QI—quality improvement, PDCA—Plan, Do, Check, Act, IOM—Institute of Medicine, EMR—Electronic Medical Record, EHR—Electronic Health Record BPA—Best practices alert, CDS—clinical decision support, BMI—Body mass index, HZ—herpes zoster, HCV—hepatitis C virus; HIV—human immunodeficiency virus; ED—emergency department; HCV—hepatitis C virus

Rating System for Hierarchy of Evidence

Level of the Evidence	Type of the Evidence
I (1)	Evidence from systematic review, meta-analysis of randomized controlled trails (RCTs), or practice-guidelines based on systematic review of RCTs.
II (2)	Evidence obtained from well-designed RCT
III (3)	Evidence obtained from well-designed controlled trials without randomization
IV (4)	Evidence from well-designed case-control and cohort studies
V (5)	Evidence from systematic reviews of descriptive and qualitative studies
VI (6)	Evidence from a single descriptive or qualitative study
VII (7)	Evidence from the opinion of authorities and/or reports of expert committees

Melnyk, B.M. & Fineout-Overholt, E. (2014). *Evidence-based practice in nursing & healthcare: A guide to best practice* (3rd ed.). New York: Lippincott, Williams & Wilkins.

Rating Scale for Quality of Evidence
A: High – consistent results with sufficient sample, adequate control, and definitive conclusions; consistent recommendations based on extensive literature review that includes thoughtful reference to scientific literature
B: Good – reasonably consistent results; sufficient sample, some control, with fairly definitive conclusions; reasonably consistent recommendations based on fairly comprehensive literature review that includes some reference to scientific evidence
C: Low/major flaw – Little evidence with inconsistent results; insufficient sample size; conclusions cannot be drawn

Newhouse, R.P. (2006). Examining the support for evidence-based nursing practice. *Journal of Nursing Administration, 36*(7-8), 337-40.

Appendix C

NICU VACCINE TEACHING PLAN—RN STAFF

Learning Objectives Upon completion of the training session, the NICU RN staff will be able to:	Content Outline	Method of Instruction	Time Spent	Method of Evaluation
Describe the CDC requirements	1. Consent process—no requirement 2. Vaccine Information Statement use and availability 3. Documentation requirements 4. Timing of immunizations https://www.cdc.gov/vaccines/index.html	Didactic discussion	10 minutes	Question and answer session, verbalized understanding of CDC requirements
Discuss vaccine practices in the NICU	1. AAP recommendations 2. Medical concerns and safety for the premature and vaccines 3. Administration techniques American Academy of Pediatrics. (2015). Immunization in preterm and low birth weight infants. In D. W. Kimberlin, M. T. Brady, M. A. Jackson, & S. S. Long (Eds.), *Red Book 2015: Report of the Committee on Infectious Diseases* (30, pp. 68-70). Elk Grove Village, IL: American Academy of Pediatrics.	Didactic discussion	10 minutes	Question and answer session, verbalized understanding of the AAP recommendations.
Identify the vaccine products used in the NICU	1. Pediarix components 2. Haemophilus influenza 3. Pneumococcal	Didactic discussion	5 minutes	Question and answer sessions, verbalized understanding of what vaccines are given in the NICU at 2 months of age
Be aware of the BPA once deployed in the EMR	1. Purpose of the BPA 2. What is included in the BPA—reminder at 55 days of life, reminder to provide VIS and obtain consent, link to order set, link to put reason for deferral in progress note.	Didactic discussion	5 mnutes	Question and answer session, verbalized understanding, using the BPA once deployed

Appendix D

NICU VACCINE TEACHING PLAN—PROVIDER VERSION

Learning Objectives Upon completion of the training session, the neonatology physicians, nurse practitioners, and resident staff will be able to:	Content Outline	Method of Instruction	Time Spent	Method of Evaluation
Describe the CDC requirements	1. Consent process—no legal requirement 2. .Vaccine Information Statement use and availability 3. Timing of immunizations https://www.cdc.gov/vaccines/index.html	Didactic discussion	10 minutes	Question and answer session, verbalized understanding of CDC requirements
Discuss vaccine practices in the NICU	1. AAP recommendations 2. Medical concerns and safety for the premature and vaccines American Academy of Pediatrics. (2015). Immunization in preterm and low birth weight infants. In D. W. Kimberlin, M. T. Brady, M. A. Jackson, & S. S. Long (Eds.), *Red Book 2015: Report of the Committee on Infectious Diseases* (30, pp. 68-70). Elk Grove Village, IL: American Academy of Pediatrics.	Didactic discussion	5 minutes	Question and answer session, verbalized understanding of the AAP recommendations.
Identify the vaccine products used in the NICU	1. Pediarix components 2. Haemophelas influenza 3. Pneumococcal	Didactic discussion	5 minutes	Question and answer sessions, verbalized understanding of what vaccines are given in the NICU at 2 months of age
Use the BPA once deployed in the EMR	1. Purpose of the BPA 2. Components of the BPA—reminder at 55 days of life, reminder to provide VIS and obtain consent, link to order set, link to put reason for deferral in progress note.	Didactic discussion	10 mnutes	Question and answer session, verbalized understanding, using the BPA once deployed

Appendix E

Project Proposal Summary

Problem Background: In the United States premature birth occurs at a rate of 10% of total births, or approximately 380,000 babies each year. Many premature infants remain hospitalized in a neonatal intensive care unit (NICU) for many months prior to discharge to home, particularly if born less than 30 weeks gestation. If medically stable, premature infants should receive routine vaccines at chronologic age. Premature infants tend to not receive vaccines on schedule, lagging behind their age group peers in up to date status. A number of studies report on the low rate of current vaccine status in these babies. Within the project site, the rate of on-time vaccination at 2 months of age was just under 40%.

Purpose Statement: The purpose of this quality improvement project is to improve the on-time administration of vaccines to NICU patients through an educational program addressing vaccines for premature infants, standardizing the consent process, and implementing the use of a best practices alert (BPA) in the electronic medical record.

Evidence to support practice change: Many studies demonstrate effectiveness of BPAs as a tool to promote adherence to standards of practice and interventions across various patient populations, including immunization administration

Implementation Plan: The ultimate goal for the proposed QI project is improvement in on-time (defined as between 60 and 70 days of life) administration of two month vaccines to patients in a 52 bed Level IV NICU, located in a large Mid-Atlantic city A short term goal for this project includes the development and incorporation of a BPA into the EMR, "triggering" at 55 days of life, allowing time for the provider to discuss immunizations with the family, provide the appropriate vaccine information statement (VIS) per CDC requirements, and obtain informed consent. An order set for the two month vaccines may be included within this BPA.

Data Collection and Analysis: Data collection will consist of a chart audit done on a regular basis over the following ten week time frame. A template will be used by the DNP student to identify those babies in the NICU ages 60 to 70 days of age, the day of age immunizations were ordered, and the day of age administered. Daily progress notes will be reviewed identify babies for whom immunizations are being deferred for medical reasons. Descriptive statistics will be used to determine the proportion of babies who received two month immunizations between 60 and 70 days of age or had a note made of reason deferral during that time to all babies 60-70 days of age. These results will then be compared to the data collected prior to implementation of the BPA

Human Subjects Protection: Data collected will be kept in a file on a password protected computer; any hard copy data collected will be stored in a locked locker on the NICU. A query to the University of Maryland Baltimore (UMB) Institutional Review Board (IRB) for Non- Human Subjects Research determination will be submitted with a description of this QI project.

Appendix F
Audit Tool

Chart #	VIS provided Y/N	Date provided	Signatures for all vaccines (DTaP, IPV, Hepatitis B, Prevnar, HiB on consent form Y/N	Date vaccines ordered	Date given	Correct VIS date (11/5/15) documented Y/N	Reason for deferral documented in progress note Y/N	Reason for deferral
		00/00/00		00/00/00	00/00/00			