

Abstract

Background: Planning safe and effective nurse staffing can be challenging for nurse leaders of labor and delivery units due to the dynamic nature of birth and unpredictable fluctuations in census and acuity. The electronic health record (EHR) has a vast source of patient data that can be used to retrospectively review patient needs and nurse staffing gaps that can serve as a basis for prospective planning for nurse staffing.

Purpose: This quality improvement project was initiated with the goal of developing real-time and longitudinal reports to quantify hourly nurse staffing needs based on patient census, acuity, and required clinical interventions from data that are contained within the EHR. The plan was to determine trends and nurse staffing needs for each 24-hour period every day of the week and identify ongoing staffing patterns to meet the Association of Women's Health, Obstetric, and Neonatal Nurses' (AWHONN) staffing guidelines.

Methods: The obstetric nursing leadership team worked with the information technology specialists and developed an algorithm that identifies patient acuity level, indicated clinical interventions, and outlines necessary staffing requirements to provide safe high-quality care. Various reports were built in the EHR to inform the nursing leadership team about nurse staffing on a real-time and historical basis.

Results: The reports provided quantitative data that supported a budgetary increase in nurse staffing and a more flexible nurse staffing scheduling system to meet the needs of the patients. The project was successfully implemented in all four of the hospital system maternity units.

Clinical Implications: Use of EHR in labor and delivery units is nearly universal. Working with the information technology specialists to integrate nurse staffing data into the EHR is one way to align nurse staffing with the AWHONN nurse staffing standards in real-time and for projections of nurse staffing needs based on unit historical patient data.

Key words: Algorithms; Electronic health records; Hospital; Information technology; Nursing staff; Obstetric nursing; Patient acuity; Quality improvement; Workforce.

ACUITY-BASED STAFFING IN LABOR AND DELIVERY USING ELECTRONIC HEALTH RECORD DATA

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Problem Description

Staffing in labor and delivery (L&D) units has historically proven challenging due to rapid and wide fluctuations in patient volume and acuity, and the unpredictable nature of labor and birth. Perinatal care of mothers and babies has evolved over the past 3 decades. This includes changes in the frequency and type of maternal, fetal, and infant assessments based on the phase of labor, birth, and the immediate recovery period, and the addition of complex medical and nursing interventions. Women with increasing comorbidities and the rise of childbearing age have been cited by L&D nurses as reasons nursing care needs have increased. Nurses also note that budget concerns lead to chronic staffing shortages (Simpson & Lyndon, 2017). Identification of appropriate staffing numbers for safe patient care must be balanced with financial stewardship (American Nurses Association [ANA], 2018; Begley et al., 2020). Objective data identifying nurse staffing gaps can be used to support budgetary increases in nurse staffing and flexible staffing models. Registered nurse (RN) staffing needs should be assessed periodically throughout a shift due to fluctuations in patient needs and volume (Simpson, 2015). Adjustments to staffing patterns should be initiated to meet these patient care needs and volume fluctuations (ANA, 2015).

Available Knowledge

In 2010, The Association of Women's Health, Obstetric and Neonatal Nursing (AWHONN, 2010) published *Guidelines for Professional Registered Nurse Staffing for Perinatal Units* to address the

challenges of staffing in perinatal units. These guidelines were an update to the nurse staffing guidelines that have had been included in each edition of the *Guidelines for Perinatal Care* since the first edition (American Academy of Pediatrics & American College of Obstetricians and Gynecologists, 1983, 2017). A corresponding acuity grid was developed (Simpson, 2013) and tested as one way to assess and predict nurse staffing needs for an L&D unit (Simpson, 2015) that are consistent with the AWHONN (2010) nurse staffing guidelines. Scheich and Bingham (2015) advocated using birth volumes and acuity as considerations when proposing a model to meet nurse staffing needs as per AWHONN (2010). They reported on uptake of the staffing guidelines during the AWHONN Nurse Staffing Collaborative in 2011 and 2012. In a 2016–2017 survey study of 615 labor nurses from 67 hospitals across three states, Simpson et al. (2019) found most L&D RNs who completed the survey reported their units were staffed to meet the AWHONN (2010) guidelines. Results from the Simpson et al. study found a substantial increase in nurse staffing consistent with the AWHONN (2010) staffing guidelines as compared with Scheich and Bingham project data from 5 years previous.

Insufficient staffing or inappropriate allocation of resources to provide safe high-quality care during labor and birth can result in omission, partial completion, or delay of essential aspects of care (Roth et al., 2020; Simpson et al., 2019). Delays in identification of maternal or

fetal deterioration can increase risk of near miss or adverse perinatal outcomes (Guglielminotti et al., 2021; Simpson, 2022; Society for Maternal-Fetal Medicine et al., 2021). Nurses who work in environments where nurse staffing is inadequate report stress, job dissatisfaction, burnout, and plans to leave their position (ANA, 2015; Roth et al., 2020; Simpson et al., 2019), which can result in significant costs to hospitals and health care systems (ANA, 2018; NSI Nursing Solutions, 2021).

There is minimal published evidence describing use of the electronic health record (EHR) to predict, support, and evaluate nurse staffing needs in L&D units; however, the majority of acute care hospitals in the United States use a certified EHR (The Office of the National Coordinator for Health Information Technology, 2021) that have a considerable amount of data about patient care needs. Thus, results of this project may be of value to nurse leaders in L&D units.

The electronic health record (EHR) has a vast source of patient data that can be used to retrospectively review patient needs and nurse staffing gaps that can serve as a basis for prospective planning for nurse staffing.



Rationale and Specific Aims

This quality improvement project was initiated with the goal of developing real-time and longitudinal reports to quantify hourly nurse staffing needs based on patient census, acuity, and required clinical interventions that is reflected within the EHR. The plan was to analyze these data to determine trends and nurse staffing needs for each 24-hour period every day of the week and identify ongoing staffing patterns to meet the professional organization's (AWHONN, 2010) staffing guidelines.

Methods

Context

Historically, this unit used a large paper spreadsheet containing categories of the AWHONN guidelines. The charge nurse was asked to complete this manually every 4 hours. This was done for 1 month twice a year and was considered burdensome by the charge nurses. There were often large gaps in data using this manual method because the charge nurse frequently became busy with clinical care and was unable to consistently complete the spreadsheet. We proposed that the EHR could assist in obtaining more reliable and frequent data. We hypothesized that objective and frequent data obtained from the EHR that reflected the staffing requirements would have a greater impact with our financial colleagues to achieve budgetary changes and with the unit nurses to make staffing pattern changes.

Epic is the EHR used at our hospital, the Johns Hopkins Hospital. It has been harmonized across our enter-

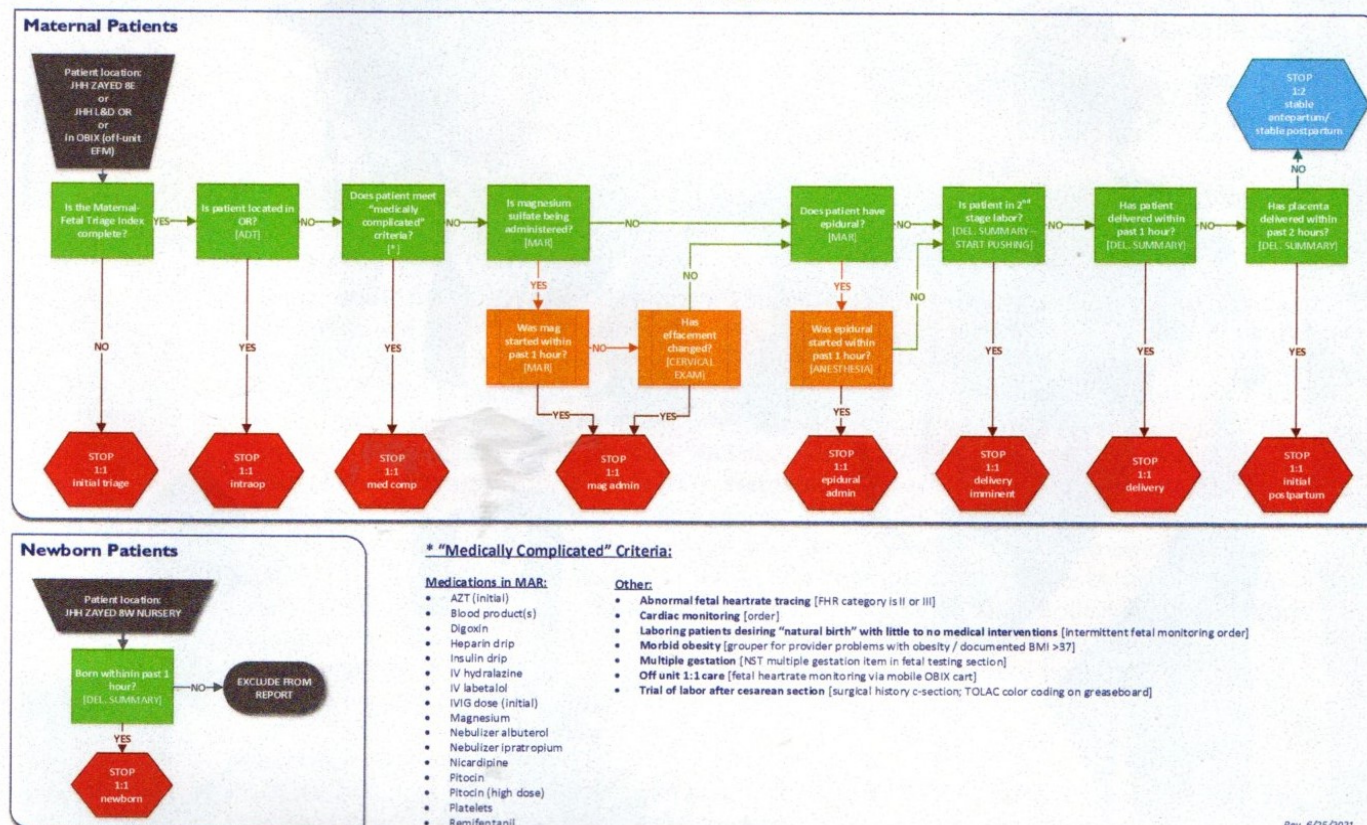
prise for all inpatient and outpatient encounters at all six Johns Hopkins Health System hospitals and associated clinic locations. The four health system hospitals offering labor and delivery and inpatient maternity care use the Stork module of Epic.

Interventions

This project team was led by the assistant director of nursing in gynecology and obstetrics. Members of the team included three highly experienced bedside L&D nurses, the department-based informatics administrator who understood the L&D workflow and use of the Stork module, three Epic analysts from the hospital Epic project team, and an onsite Epic Boost consultant. These team members collaborated on the design, testing, implementation, and data analysis of the L&D acuity-based staffing reports. Modifications of the reports were made as part of the ongoing Plan-Do-Study-Act approach to quality improvement.

The project design included development of an algorithm that identified patient acuity level, indicated clinical interventions, and outlines necessary staffing requirements to provide safe high-quality care as recommended in the AWHONN (2010) nurse staffing guidelines, the *Labor and Delivery Staffing Acuity Algorithm* (Figure 1). Part of the algorithm noted whether the patient had an initial acuity score filed based on the AWHONN (2015) Maternal Fetal Triage Index (MFTI) tool. After the MFTI score is filed, additional criteria are reviewed throughout

FIGURE 1. LABOR AND DELIVERY STAFFING ACUITY ALGORITHM



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FIGURE 4. HEAT MAP

HEAT MAP: AVERAGE NEEDED RNS								DATA START: 12/1/2019	DATA END: 8/31/2020
	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	Averages	
00:00:00	9.30	9.30	11.08	11.00	11.85	12.54	11.03	10.86	
01:00:00	9.38	9.10	10.72	10.67	11.77	12.33	11.15	10.72	
02:00:00	9.23	9.03	10.28	10.62	11.54	12.03	10.54	10.45	
03:00:00	8.70	8.70	9.72	10.41	11.03	11.62	10.51	10.09	
04:00:00	8.53	8.60	9.64	10.31	11.03	11.59	10.21	9.97	
05:00:00	8.43	8.43	9.62	10.41	11.08	11.26	9.79	9.85	
06:00:00	8.50	8.43	9.82	10.36	11.15	11.33	9.64	9.88	
07:00:00	8.33	8.83	10.00	10.36	11.28	11.67	9.15	9.93	
08:00:00	8.70	9.38	10.10	10.79	11.90	12.05	9.31	10.31	
09:00:00	9.00	10.78	11.69	11.87	12.69	12.87	10.18	11.29	
10:00:00	9.13	11.60	12.33	12.56	13.31	13.69	10.62	11.88	
11:00:00	9.08	12.40	12.67	12.90	13.74	13.92	10.59	12.17	
12:00:00	9.18	13.00	12.90	13.21	14.23	14.33	10.64	12.49	
13:00:00	9.08	13.25	13.05	13.67	14.44	14.46	10.69	12.65	
14:00:00	8.90	13.55	12.62	13.85	14.38	14.18	10.62	12.57	
15:00:00	8.78	13.20	12.87	13.21	14.62	13.85	10.26	12.39	
16:00:00	8.60	12.60	12.95	12.92	14.21	13.72	9.92	12.12	
17:00:00	8.58	12.55	12.85	12.64	13.82	13.56	9.82	11.96	
18:00:00	8.55	12.30	12.33	12.44	13.56	13.00	9.92	11.72	
19:00:00	8.73	11.93	11.95	12.23	13.21	12.28	9.77	11.43	
20:00:00	9.03	12.00	12.21	12.74	13.33	12.79	9.85	11.70	
21:00:00	9.15	11.88	12.08	12.59	13.69	12.51	10.05	11.70	
22:00:00	9.23	11.85	11.79	12.59	13.08	11.69	9.64	11.40	
23:00:00	9.10	11.48	11.49	11.95	12.82	11.31	9.46	11.08	
Averages	8.88	11.01	11.53	11.93	12.82	12.69	10.14	11.28	

Note. Heat map visualization. Green = Low Average RNs Needed, Yellow = Low-Mid Average RNs Needed, Orange = Mid-High Average RNs Needed, Red = High Average RNs Needed.

the L&D admission to determine appropriate nurse to patient care ratio. After the algorithm was in place, the team proceeded with development of a series of reports generated from the EHR. These reports discussed below provided the data needed to impact staffing and budget decision-making.

Application and Study of the Interventions

The *Labor and Delivery Staffing Acuity Algorithm* was reviewed and tested with clinical bedside nurses to assure it reflected accurate staffing ratios. Changes were made after inaccuracies were identified by the bedside L&D RNs and informatics expert during the initial testing and validation process, such as identification of additional medication and provider order criteria necessitating one-to-one nursing care. The team then progressed with development of a real-time EHR report via an Epic Reporting Workbench report that identified all patients' needs on the L&D unit and the total direct care RN staffing requirements to meet these needs. This was an iterative process to assure the EHR developers understood where in the record these data could be found, clarification of

terms used in the algorithm, and specific patient locations on the unit. A report was developed that could be run at any time from the EHR indicating the number of RNs needed at that time for direct patient care. This was tested, changed as needed, and tested again. It is important to note that this report did not account for the required charge nurse or triage nurse who did not take a patient assignment. The *Labor and Delivery Staffing Acuity Reporting Workbench Report* (Figure 2; Supplemental Digital Content at <http://links.lww.com/MCN/A77>) computes the direct patient care staffing need in real-time when the report is run.

After the real-time report was tested, the team then developed a monthly longitudinal report within the EHR that provides the required direct nursing care staffing need for every hour of every day of the month. The EHR was configured to file a discrete value denoting 1 nurse to 1 patient (1:1) or 1 nurse to 2 patients (1:2) nursing care for every patient meeting the algorithmic criteria hourly. The longitudinal report compiled these discrete values, providing counts for total count of 1:1 and 1:2 patients and equivalent nurses needed for every hour of each day.

The plan for this project was to determine trends and nurse staffing needs for each 24-hour period every day of the week and identify ongoing staffing patterns to meet the Association of Women's Health, Obstetric, and Neonatal Nurses' nurse staffing guidelines.

This report was also tested by comparing report output with manual analysis of patient acuity, nurse staffing, and the real-time report. The *Labor and Delivery Staffing Tool Clarity Report* (Figure 3; Supplemental Digital Content at <http://links.lww.com/MCN/A77>) allows for monthly averages and longitudinal analysis by time of day and day of week.

Once these data were available, the report output was then analyzed using Excel pivot tables to provide ongoing analysis of the unit staffing needs and trends over time. High-risk times and days are easily visualized and can be monitored using a *Heat Map* (Figure 4) of average nurse staffing needs revealing high census and high acuity times by hour and day of week. Analysis over time by day

of the week and time of day indicates trends that can be used to alter staffing patterns, such as staggered shift start and end times to meet the need. See Figure 5, *Average Needed Nurses Based on Day of Week and Time of Day*. Additional analysis between the needed nursing staff versus the actual nursing staff was performed using an upload of data from the scheduling and payroll system and produced a report *Hourly Variance between Needed Nurses and Staffed Nurses* (Figure 6). This report provides a visual to identify areas of risk when there were not enough nurses and opportunities to further adjust and enhance nurse staffing based on patient care needs. These reports are made available to the maternity nursing leadership team and are reviewed monthly for needed changes to staffing patterns or levels. The summarized 12-month trends are presented to the executive and finance teams for approval of a change in budgeted staffing levels.

It is important to note that all L&D units in our hospital system have an on-call procedure used for the normal fluctuations in census and acuity and staff call outs that is typical for this specialty. Use of this on-call procedure is also closely monitored to assure frequency that staff are called in is at acceptable levels.

Results

After monitoring the hourly staffing need for several months, we determined a change in the nurse staffing pattern was warranted. Whereas previously, the unit was

FIGURE 5. AVERAGE NEEDED NURSES BASED ON DAY OF WEEK AND TIME OF DAY

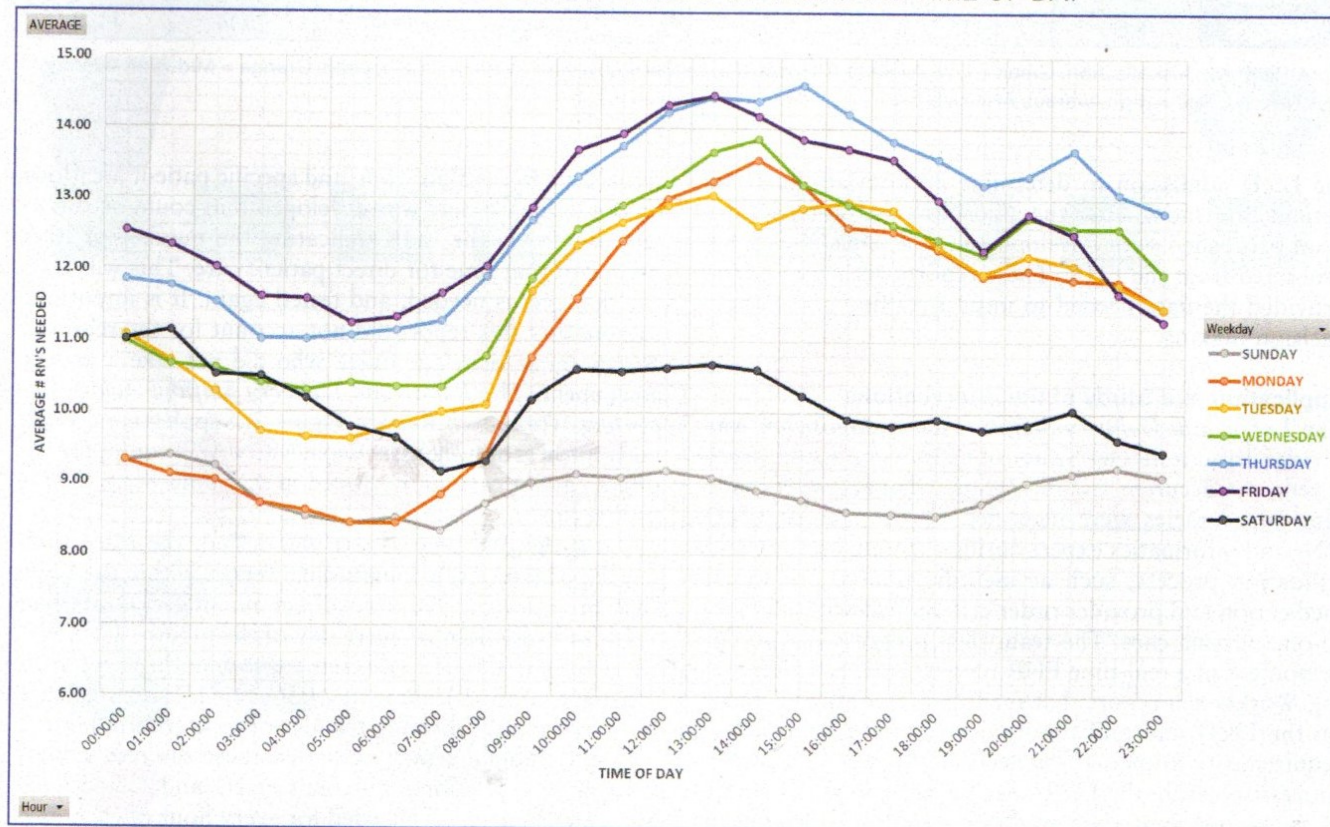
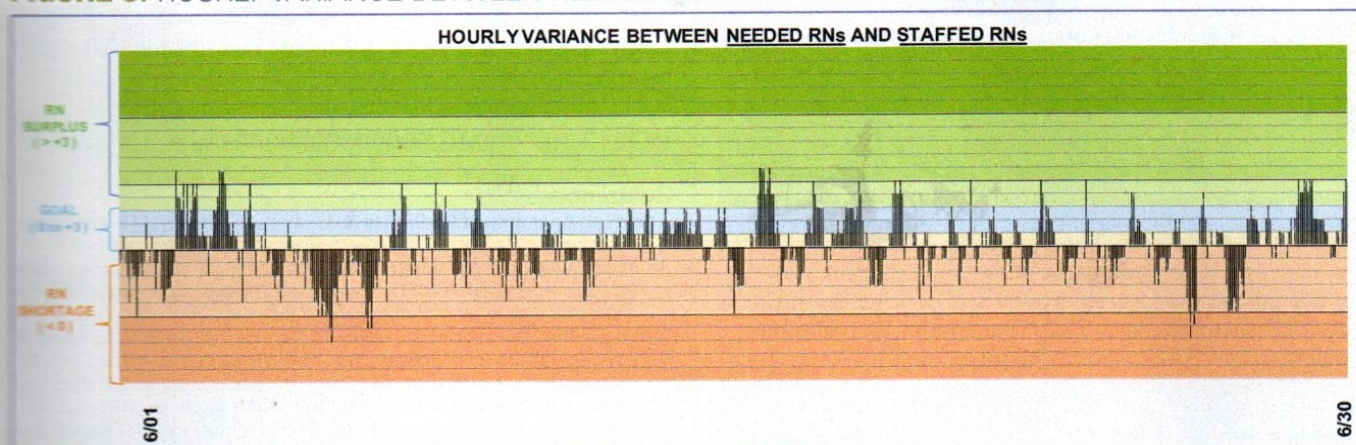


FIGURE 6. HOURLY VARIANCE BETWEEN NEEDED NURSES AND STAFFED NURSES



staffed with the same number of nurses for the day and night 12-hour shifts from 7 a.m. to 7 p.m. and from 7 p.m. to 7 a.m., our data revealed the need for a more staggered staffing plan. Several new shifts were added so fewer nurses reported at 7 a.m. and more came in as the volume dictated based on our data. An additional RN reported from 8 a.m. to 8 p.m., two additional RNs reported from 11 a.m. to 11 p.m., and one additional RN reported from 3 p.m. to 3 a.m.

This proposed change to better balance nurse staffing to patient care requirements and volumes was presented to the nurses at a staff meeting using the trended data to show the rationale. Several nurses volunteered to work these modified shifts. The nurses on the day shift were comfortable starting the shift at 7 a.m. with less nurses knowing that additional nurses arrive at 8 a.m. and again at 11 a.m. to assist with all scheduled obstetric operating room cases such as fetal therapy cases, dilation and curettage cases, scheduled cesareans, and inductions of labor. It was important to the nurses to match the 3 p.m. to 3 a.m. shift with an 11 a.m. to 11 p.m. shift so the night shift did not feel they were “losing a nurse” at 11 p.m. when the need for staffing remained. The data consistently showed a decreased need after 3 a.m.

The longitudinal trended data were presented during the yearly budget request process, and we were able to achieve an approved increase in staffing of 2% in FY21 and an increase of 6% in FY22. We continue to routinely monitor the data by comparing the needed nurse staffing to the actual staffing. Use of the data generated from the EHR as a basis for planning nurse staffing that is in sync with patient acuity and census has been very helpful in providing objective real-time and retrospective evidence and trends to support our staffing decisions.

Discussion

These data have been monitored monthly since implementation and the resulting analysis has been used to inform decision-making about nurse staffing needs over the last 2 years. Justification to support the AWHONN (2010) nurse staffing guidelines becomes very apparent in the face of objective patient data. Changes were made in the opera-

tional budget because of these data. A segment of the operational budget is the salary dollars required to staff the unit appropriately. An increase in the budget for nurse staffing was possible based on reports of staffing needs generated from the EHR as a result of this project. Other segments of the budget are benefits, supplies, and purchased services. We plan to review the required staffing at the yearly budget review process based on the data obtained through these reports.

Lessons Learned

Clear communication with information technology (IT) developers was required to ensure understanding of the parameters and the overall goal of the project. Thorough testing of the algorithm was required to assure data accuracy. Changes may be needed to the algorithm in the future as changes to maternity care standards are developed. It is also important to note that nurse staffing decision-making is very complex. Issues of experience mix on any given shift and the current unprecedented RN staffing shortages in acute care hospitals influence this decision-making. These data assisted in approval for ongoing agency and traveler needs on this unit during the current shortage.

This project was also conducted in the midst of the worldwide COVID pandemic. Monitoring of these data continued during the subsequent opening of a Bio Mode unit on the L&D unit to provide specialized care to antepartum, intrapartum, and postpartum mothers who tested positive for COVID-19. These bed locations were easily added to the tool within Epic and then removed once the Bio Mode unit was dismantled. Two additional nurses were added beyond the charge nurse and triage nurse to account for a Bio mode triage nurse and safety officers who assisted the nurses working in the Bio mode unit. The data obtained from this project assisted to justify these staffing needs.

We encourage L&D nurse leaders to quantify the nurse staffing need using objective measures at frequent intervals due to the unpredictable nature of the specialty. This algorithm, based on the AWHONN guidelines (now AWHONN standards), provides an objective tool to quantify this need.

SUGGESTED CLINICAL IMPLICATIONS

- Consider integrating a Labor and Delivery Staffing Acuity Algorithm into the electronic health record (EHR) to assist with nurse staffing planning.
- The nursing leadership team in every L&D unit likely has the ability to obtain objective clinical data from their EHR that can identify and drive nurse staffing requirements in L&D. Consult with the EHR team to discuss feasibility.
- A real-time report imbedded within the EHR that provides the required nurse-patient ratio consistent with AWHONN standards to assist managers with real-time staffing needs is a valuable resource.
- A longitudinal report imbedded within the EHR that provides trends over time for budget and nurse allocation decision-making is possible.
- The ability to share these objective data with nurses and develop scheduling guidelines using a shared governance approach promotes patient safety, teamwork, and financial support for changes in budgeted nurse staffing.

Conclusions

The reports generated from the EHR based on the *Labor and Delivery Staffing Acuity Algorithm* provide nurse leaders in L&D units with tools to obtain objective data about nurse staffing needs and assure adherence to the AWHONN (2010) nurse staffing guidelines and the updated AWHONN (2022) nurse staffing standards. This algorithm was presented to the chief nursing officers at all system hospitals who provide maternity care and has been implemented in all four L&D units across our health system, both academic and community hospitals. Each hospital has used these data to propose additional staffing needs with varied levels of success. Each hospital reviews these data on an ongoing basis and more work is beginning in the development of dashboards using business intelligence tools. This approach could be used to develop similar reports in EHR systems to evaluate current nurse staffing practices and adherence to AWHONN nurse staffing standards in L&D units. Hospitals using Epic EHR that are interested in replicating this project should contact their assigned Epic Stork technical services representatives to obtain EHR build guidance and access to Johns Hopkins resources for this project that are available on the internal Epic customer websites. Resources include a Johns Hopkins presentation at the 2021 Epic Users Group Meeting (UGM) and a Johns Hopkins Epic Project Team recording discussing the custom Epic build for this project. ✦

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The authors declare no conflicts of interest.

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