Standardizing Pediatric Intravenous Push Medication Dilution: A Quality Improvement Project

Victoria J. Girod, BSN, RN, CPN

Oregon Health & Science University School of Nursing

Submitted to: Sandra Banta-Wright, PhD, RN, NNP-BC - Chair

This paper is submitted in partial fulfillment of the requirements for

the Doctor of Nursing Practice degree.

Abstract

Unsafe practices and lack of standardization exist with preparation and administration of intravenous push medications (IVPM). Consensus standards for safe IVPM state to never dilute IVPM by drawing up the contents into a commercially available, prefilled, normal saline (NS) flush syringe. Despite Institute for Safe Medication Practices (ISMP) guidelines, lack of practice standardization persists, creating increased medication error risk with unnecessary dilution an ongoing issue. The purpose of this quality improvement project was to 1) identify current IVPM preparation and administration practices at a Children's Hospital in the Pacific Northwest and 2) measure nurses' adherence to national standards for IVPM post education. Pediatric nurses completed an anonymous survey identifying current IVPM practices. Afterwards, face-to-face education was provided with the focus on reviewing ISMP administration guidelines and changing IVPM practices to align bedside nursing practice with ISMP practice guidelines for IVPM. Post education, nurses completed a survey exploring how their practice was affected by education. Surveys were repeated at 1- and 3-months post education to determine if the change in practice had persisted. Pre education, 66% (*n*=19) diluted IVPM using commercially prepared, prefilled NS syringes. One month post education, 65% of Pediatric Intermediate Care (PIMC) unit nurses stopped diluting medications into an NS syringe. This change persisted at 3 months post education. In this PIMC unit, there was improvement in IVPM practices and adherence to national standards, but barriers to achieving adherence persist.

Disclosures

This author is a full time Doctor of Nursing Practice student paying tuition to the institution and is a staff nurse on the same unit where the QI project was completed. Otherwise, this author has no conflicts of interest or financial relationships to disclose.

Introduction

Problem Description

Medication errors, particularly intravenous (IV) medication errors, pose a serious threat to patient safety. It has been estimated that more than 90% of hospitalized patients receive some form of IV therapy (Paparella & Mandrack, 2016). IV medications are advantageous as they provide direct administration into the bloodstream; however, they also pose potential risk to patient safety due to the multiple steps in preparation and administration, resulting in an increased risk of medication errors and patient harm (Lenz et al., 2017). Furthermore, bedside nurses may gain much of their IV medication delivery information and experience from a coworker or preceptor during initial unit orientation, creating a lack of standard practice across organizations (Shastay, 2016). To address unsafe practices and lack of standardization associated with the preparation and administration of IV push medications (IVPM), the Institute for Safe Medication Practices (ISMP) created and released safe practice guidelines for IVPM. Correspondingly, in 2016, the Infusion Nurses Society published the *Infusion Therapy Standards of Practice,* highlighting administration of IVPM in a safe manner.

Despite recommendations and guidelines, lack of standardization of IVPM preparation and administration practices still remains, creating increased risk for error. More specifically, unnecessary dilution of IVPM has emerged as an ongoing issue (Degnan et al., 2020). Consensus standards for safe IVPM practices state to never dilute or reconstitute IVPM by drawing up the contents into a commercially available, prefilled normal saline (NS) flush syringe (Shastay, 2016). This recommendation focuses on the FDA regulation of commercially available prefilled NS syringes as devices, not medications, approved only for the flushing of vascular access devices. Use of these devices for reconstitution, dilution, and/or subsequent administration of IVPM would be considered “off label” and when used in this manner, the practitioner or employer bear the legal liability for any adverse events occurring from this practice (Shastay, 2016).

Available Knowledge

The 2015 ISMP safe practice guidelines for adult IVPM represent consensus for safe practice, with the goal to standardize and simplify the safe administration of parenteral medications to adults through the IV push administration route (ISMP, 2015). The guidelines recommend against dilution of IVPM, especially those in ready to administer (RTA) form, unless recommended by the manufacturer, supported in the literature, or in accordance with institutional policies and procedures (Lenz et al., 2017). Likewise, ISMP states that health care practitioners should not dilute or reconstitute IVPM by drawing up contents into commercially available, prefilled NS flush syringe (ISMP, 2015).

Despite recommendations from the ISMP, The Joint Commission, the Anesthesia Patient Safety Foundation, the American Association of Nurse Anesthetists, the American Society of Health-System Pharmacists, the Centers for Disease Control and Prevention, and the Infusion Nurses Society, unsafe dilution practices persist. Nevertheless, 83% of nurses report diluting medications for adult patients (Lenz et al., 2017). In a 2018 follow-up survey, ISMP found that unsafe IVPM administration practices persisted, in direct opposition to the 2015 guidelines (ISMP, 2018). Notably, this survey found that 84% of respondents reported further diluting medications prior to IV push administration (Degnan et al., 2020). A 2020 literature review concluded that the unnecessary dilution of IVPM is an unsafe practice that occurs routinely (Degnan et al., 2020).

Manipulation of parenteral products and the complexity of IVPM preparation and administration can lead to higher rates of medication errors related to dilution, which could result in wrong dose and/or wrong concentration errors, wrong drug due to mislabeling, as well as the risk of product contamination (Degnan et al., 2020). Manipulation of RTA IVPM introduces an often-unnecessary step in the preparation process and increases the risk of a medication error (Lenz et al., 2017). Furthermore, a systematic review of studies reporting errors in IV therapy identified the reconstitution step of IV medication preparation as the most error prone (Degnan et al., 2020).

Consequently, opportunities to reduce the number of steps in preparation, particularly dilution, may be the most impactful in reducing medication errors (Degnan et al., 2020).

Rationale

This project utilized the Institute for Healthcare Improvement (IHI) Quality Improvement's Plan-Do-Study-Act (PDSA) cycles to document and improve standardization of IVPM preparation and administration practices. The use of a PDSA cycle supports an iterative, problem-solving approach to assess whether change leads to improvement using a methodical learning process (IHI, 2022). This framework was chosen as it achieves incremental progress, quickly and efficiently piloting current ideas in a structured way while ensuring conclusions are drawn from the effectiveness of each intervention (Chen et al., 2021). In this way, the PDSA cycles allow for review of current state and implementation of IVPM education with reevaluation for effectiveness.

A cause-and-effect diagram (Appendix A) was used as a graphic tool to explore and display the causes of lack of standardization for IVPM practice. This tool identified many causes that contribute to lack of standardization of practice, graphically displayed these causes and their relationship to the effect, and helped to identify areas for improvement (IHI, 2022). During the root cause analysis, a knowledge gap was identified regarding IVPM education leading to lack of standardization of practice. By implementing unit-based education, this cause was addressed.

A review of the literature and creation of the cause-and-effect diagram highlighted that despite readily available IVPM guidelines and professional and accreditation standards, unsafe IVPM practices persist on the Pediatric Intermediate Care (PIMC) unit. By implementing education, this quality improvement project aims to align bedside nursing practice with ISMP safe practice guidelines for IVPM.

Specific Aims

This QI project aims to measure IVPM preparation and administration practices of bedside pediatric nurses, identify barriers to safe practice, and educate pediatric nurses on current IVPM

preparation and administration standards. This standardization includes reducing the total number of medications diluted and stopping the use of NS flush for dilution. Seventy-five percent of PIMC staff nurses will report alignment with these standard practices by February 2023.

Methods

Context

This QI project was conducted at an 80-bed children's hospital within the only academic medical center in the state from August 2022 to February 2023. Registered Nurses (RN) from a 16-bed PIMC (*n*=37*)* were invited to complete pre- and post-education surveys. Currently, Oregon Health & Science University (OHSU) policy states, "unless medications require specific preparation, medications are to be left in the original packaging until just before administration" (OHSU, 2022a). If reconstitution or removal of a medication from a vial is necessary, policy dictates products may be "further diluted in a 10ml syringe if the medication is to be administered as an intravenous push, by an authorized workforce member" (OHSU, 2022b). In this way, IVPM preparation and administration is currently dictated by the actions of the bedside RN. Improvement work surrounding safe IVPM practices began in 2020 but was delayed following the onset of SARS-CoV-2 pandemic in March 2020.

Intervention

The primary intervention for this QI project was to align bedside nursing practice with professional standards for IVPM administration. Team members included two RNs, who serve as staff educators for the PIMC and hematology/oncology units at the Children's Hospital, and a Doctor of Nursing Practice student who is also a PIMC staff member. Between August 2022 and September 2022, PIMC bedside nurses were invited to complete an anonymous practice survey exploring their current IVPM practices. Following this survey, PIMC nurses attended an in-person education, led by the DNP student team member, who explained the focus on change in practice, current ISMP IVPM administration guidelines, and reviewed medication examples. Post education, PIMC nurses were

invited to complete an anonymous survey, which explored how the face-to-face education affected their nursing practice. A similar survey was repeated at 1- and 3-months post-education to evaluate continued adherence to the ISMP guidelines

Study of the Intervention

Interventions included review of individual, unit, organizational, and national IVPM administration practice guidelines and expectations. This monitoring facilitated analysis of current IVPM administration practices and the impact of staff education on alignment of bedside nursing practice with professional standards. The primary outcome of this QI project was the percentage of PIMC nurses reporting a change in their IVPM administration practice to align with ISMP guidelines following education, measured using anonymous surveys completed at 1- and 3-months post education.

Measures

Process measures reflect intended evidence-based best practice, ensuring the steps in the system are performing as planned and the project is on track in its efforts (IHI, 2022). Process measures for this QI project included the percentage of PIMC nurses who completed pre-education surveys, percentage of PIMC nurses who attended IVPM administration education, and percentage of PIMC nurses who completed post education surveys.

Analysis

Data for this QI project was collected using Qualtrics©, an online survey tool, analyzed using Microsoft Excel©, and displayed via tables, pie, and bar graphs. Analysis of IVPM preparation and administration standardization was tracked and reported as a percentage at 1- and 3-month post education time periods. PIMC staff nurses' demographics were summarized using means and standard deviations for continuous variables and frequency counts and percentages for nominal variables.

Ethical Considerations

A request for determination was submitted to the Institutional Review Board (IRB) and was deemed a quality improvement project not utilizing human subject research (Appendix B). Ethical considerations included maintaining anonymity and confidentiality of survey responses and data. To maintain anonymity, survey responses did not require any identifying information and demographic questions were not required responses. Data and survey responses were kept secure via OHSU encryption and two-factor authentication. Nursing staff autonomy was protected through the right to not participate without impacting their employment on the PIMC unit. The participating clinical site gave consent to the QI project by signing the letter of support (Appendix C).

Results

Participants

Participants were eligible to participate if they were staff nurses on the PIMC unit (*n*=37). Overall, the PIMC nursing staff were white females. Most of the staff RNs were between 20-40 years of age, with a range of 20 to 60 years of age. Overall, the nursing staff had an average of 5 years of experience with a range between 0-18 years. All nurses had their Bachelor of Nursing degree. The demographics of the participants are summarized in Table 1.

Pre-Education: PDSA Cycle 1

During July 2022, staff nurses (*n*=29, 78%) from the PIMC unit completed an anonymous pre-education survey analyzing current IVPM practices. These results are summarized in Figure 1 and Figure 2. Nurses (*n*=25, 86%) reported they further diluted IVPM packaged as ‘ready to administer’ while two-thirds of nurses (*n*=19, 66%) diluted IVPM using commercially prepared, prefilled NS syringes. Only 14% of the nursing staff (*n*=4) do not dilute IVPM. Most nurses shared they learned how to dilute IVPM from unit preceptors (*n*=24, 83%) and peers on the unit (*n*=18, 62%). The majority of nurses (*n*=26, 90%) agreed that having a standardized practice for administering IVPM would be beneficial.

Post-Education: PDSA Cycle 2

During October 2022, staff nurses (*n*=35) attended in-person education on IVPM preparation and administration. Following education, eighty-five percent of staff nurses (*n*=30*)* completed an anonymous post education survey, these results are summarized in Figure 3. After this education session, a greater number of nurses (*n*=28*,* 93%) agreed their IVPM dilution knowledge and administration skills improved. The majority of staff nurses (*n*=28, 93%) responded that the provided education would change their IVPM practice with 80% (*n*=24) stating they would no longer dilute medications using a commercially prepared NS syringe.

One month post education

In December 2022, PIMC staff nurses (*n*=17*)* completed an anonymous survey to measure their IVPM preparation and administration practices. These results are summarized in Figure 4. The majority of nurses (*n*=15, 88%) reported an overall reduction in the total number of medications diluted. Many of the nurses (*n*=11, 65%) stopped diluting medications into a NS flush syringe and felt motivated (*n*=16, 94%) to change their nursing practice for IVPM preparation and administration.

Shared barriers to practice change included unit stock of NS vials (*n*=7, 41%), unit stock of mini-spike dispensing devices (*n*=3, 18%), location of required supplies for dilution (*n*=3, 18%), further education on IVPM preparation (*n*=3, 18%), directions in the MAR stating whether or not to dilute (*n*=6, 35%), understanding of which medications require dilution and which do not (*n*=6, 35%), and verbiage in institutional policies (*n*=4, 24%). The barriers identified by the participants are summarized in Figure 5.

Three-month post education

In February 2023, PIMC staff nurses (*n*=21) repeated the same anonymous survey from 1-month, measuring changes to IVPM preparation and administration practices. These results are summarized in Figure 6. Majority of the nurses (*n*=18, 86%) reported a persistent overall reduction in

the total number of medications diluted. The overall percentage of nurses who stopped diluting medications into a NS flush syringe persisted (*n*=14, 67%), and the majority (*n*=20*,* 95%) felt motivated to change their nursing practice for IVPM preparation and administration. Persistent barriers to practice change included unit stock of NS vials (*n*=7, 33%), location of required supplies for dilution (*n*=7, 33%), directions in the MAR stating whether or not to dilute (*n*=6, 29%), and understanding of which medications require dilution and which do not (*n*=7, 33%). The barriers identified by the participants are summarized in Figure 5.

Discussion

Summary

The primary outcome of this QI project was the percentage of PIMC nurses who reported a change in their IVPM preparation and administration practice to align with ISMP guidelines post education. This standardization includes reducing the total number of medications diluted and stopping the use of NS flush for dilution. This QI project demonstrated strong outcomes as 65% and 67% of PIMC nurses stopped diluting medications into an NS flush syringe at 1 month and 3 months post education, respectively. At the same time, 88% of staff RN reported a persistent overall reduction in the total number of medications at 1 month and 86% of staff RN at 3 months.

Interpretation

Results from the first survey of PIMC nursing staff compared to the results of surveys at 1- and 3-months post education demonstrated this QI project was successful in aligning bedside IVPM preparation and administration practice with ISMP guidelines. In addition, most PIMC nurses reduced the total number of medications diluted and stopped using a NS flush for dilution. The persistent change in practice at 3 months reflects a continued adherence to ISMP guidelines and further supports the education facilitated change in the bedside nurse IVPM practice. This project met its specified goal of seventy-five percent of PIMC staff RN reporting alignment with ISMP standards in regard to reduction of

medication dilution, but it did not meet the goal when reviewing the use of NS flush syringes for dilution. The success of the QI project to align bedside practice to national guidelines was well received by the nursing staff and provides an opportunity for continued improvement in aligning bedside practice with ISMP standards with the use of future PDSA cycles.

Limitations

The data was collected from a convenience sample at one academic medical center in the Pacific Northwestern part of the United States. The focus of this QI project was on a single nursing unit, the PIMC unit, within the Children's Hospital of the academic medical center. On this unit, patients typically were transferred from the pediatric intensive care unit and may be ventilated, have tracheostomies, and various feeding tubes as well as intravenous lines.

There was variation in survey response numbers across project implementation affecting the ability to track persisted change. The variability in the survey response aligns with the timing of the Respiratory Syncytial Virus surge beginning November 2022. This combined with continued SARS-CoV-2 pandemic and the usual flu season placed unforeseen stress on the hospital system, as well as bedside nurse morale and stamina. In this situation, even though the nursing team provided the best care to their patients and families, they had no time, resources, or ability to take on any additional work, such as anonymous QI surveys. In addition, the PIMC unit has faced recurrent staffing shortages and increased staff turnover since the beginning of the SARS-CoV-2 pandemic in March 2020, impacting survey responses and unit morale.

Conclusions

Implementation of this QI project showed improvement in the alignment of bedside nursing IVPM practices with ISMP consensus guidelines. Continued education and support from organizational leaders are vital to sustain this improvement. Evaluation of the impact of this improvement on patient safety and financial savings are areas for future study.

References

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Tables and Figures

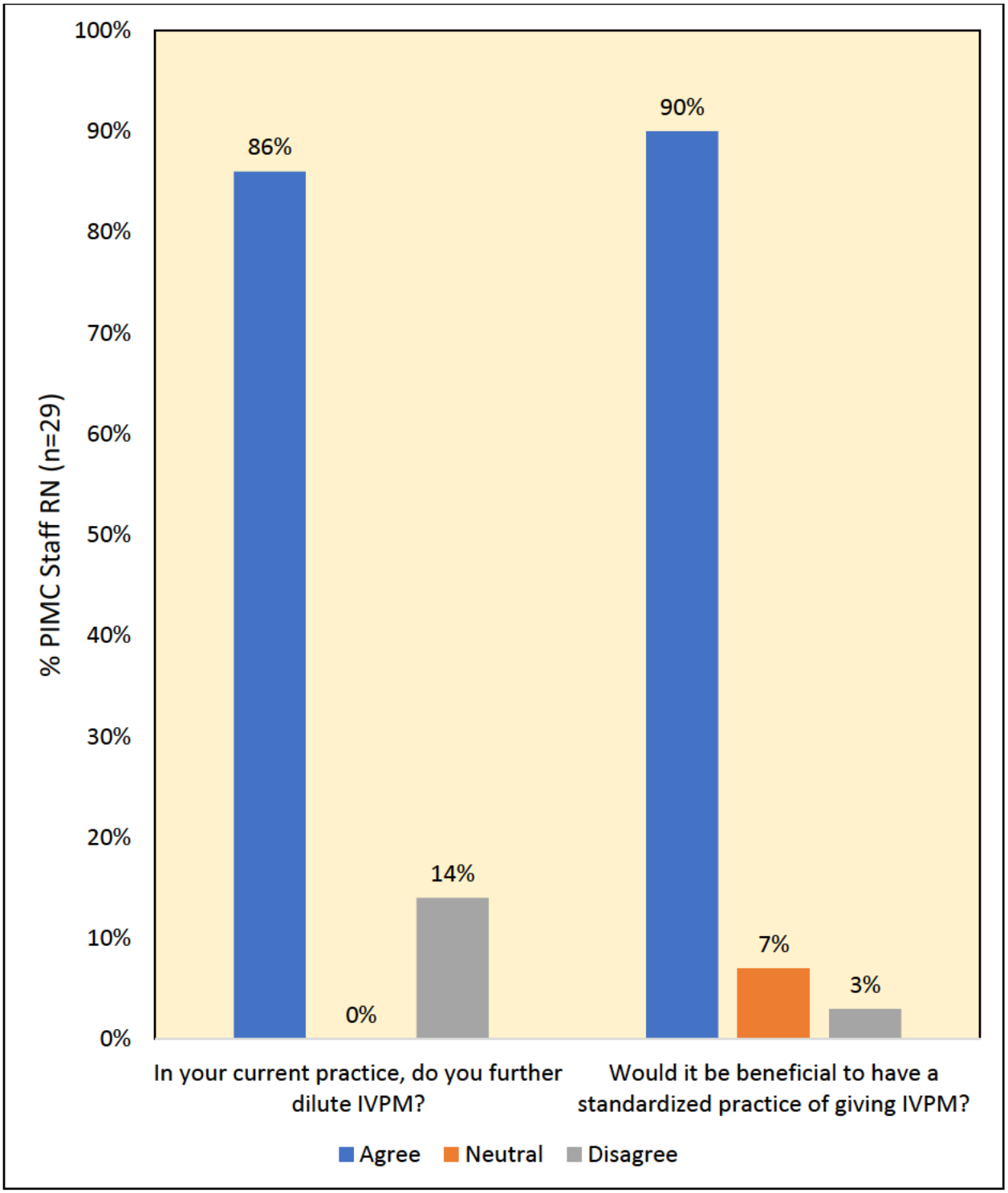
Table 1

Demographic characteristics of the Pediatric Intermediate Care Unit Staff

Demographics (*n* = 37)	Mean ± SD (range)
Nursing experience (years)	5 ± 4.5 (0-18)
	n (%)
Sex (female)	33 (89%)
Race (White)	34 (92%)
Highest nursing degree obtained (BSN)	37 (100%)
Age range (20-40 years)	26 (70%)

Figure 1

Pre-Education Survey Results



*IVPM = Intravenous push medication

Figure 2

PIMC Staff RN Process for Intravenous Push Medication Dilution

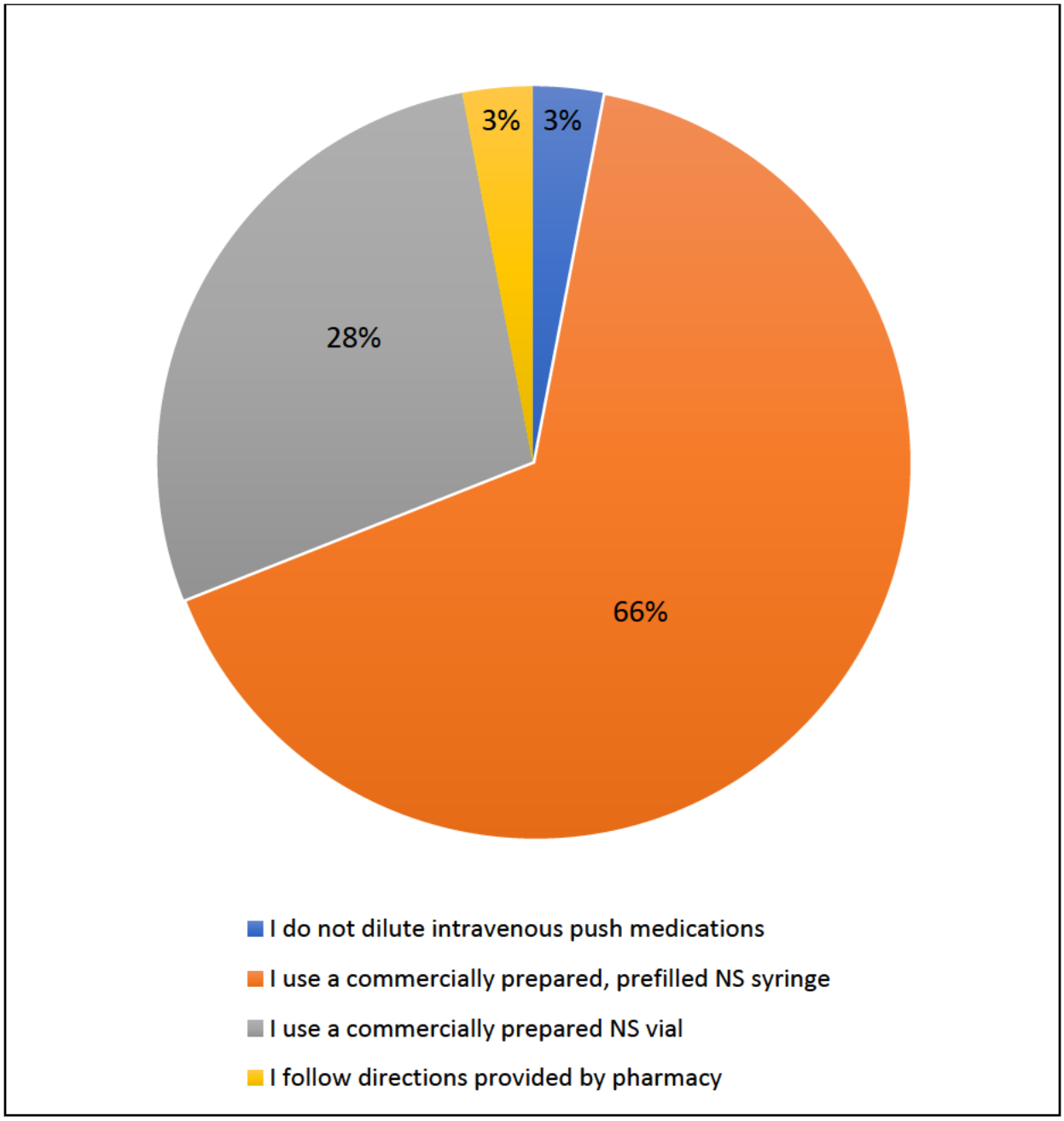
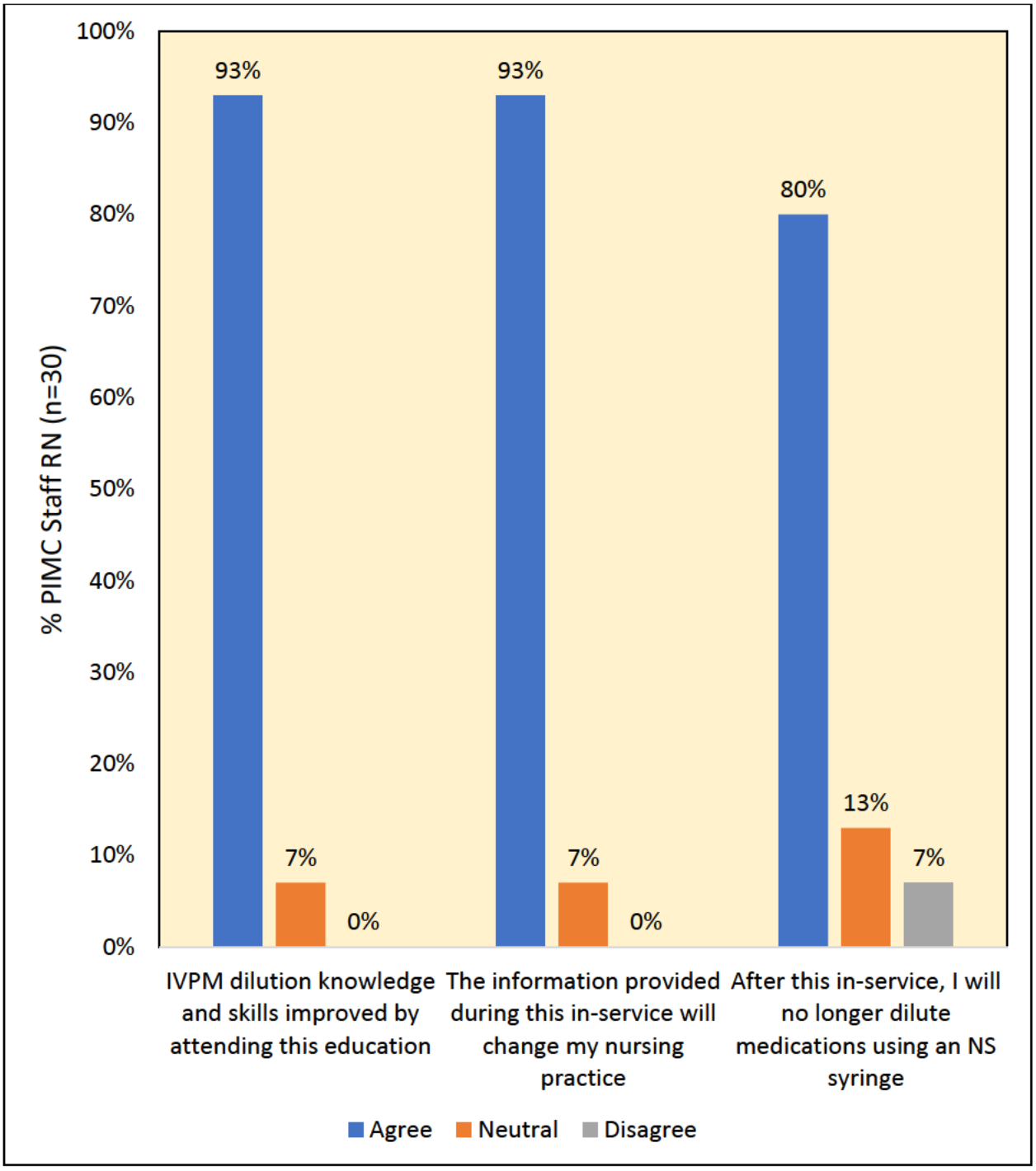


Figure 3

Post Education Survey Results



*IVPM = Intravenous push medication

Figure 4

One Month Post Education Survey Results

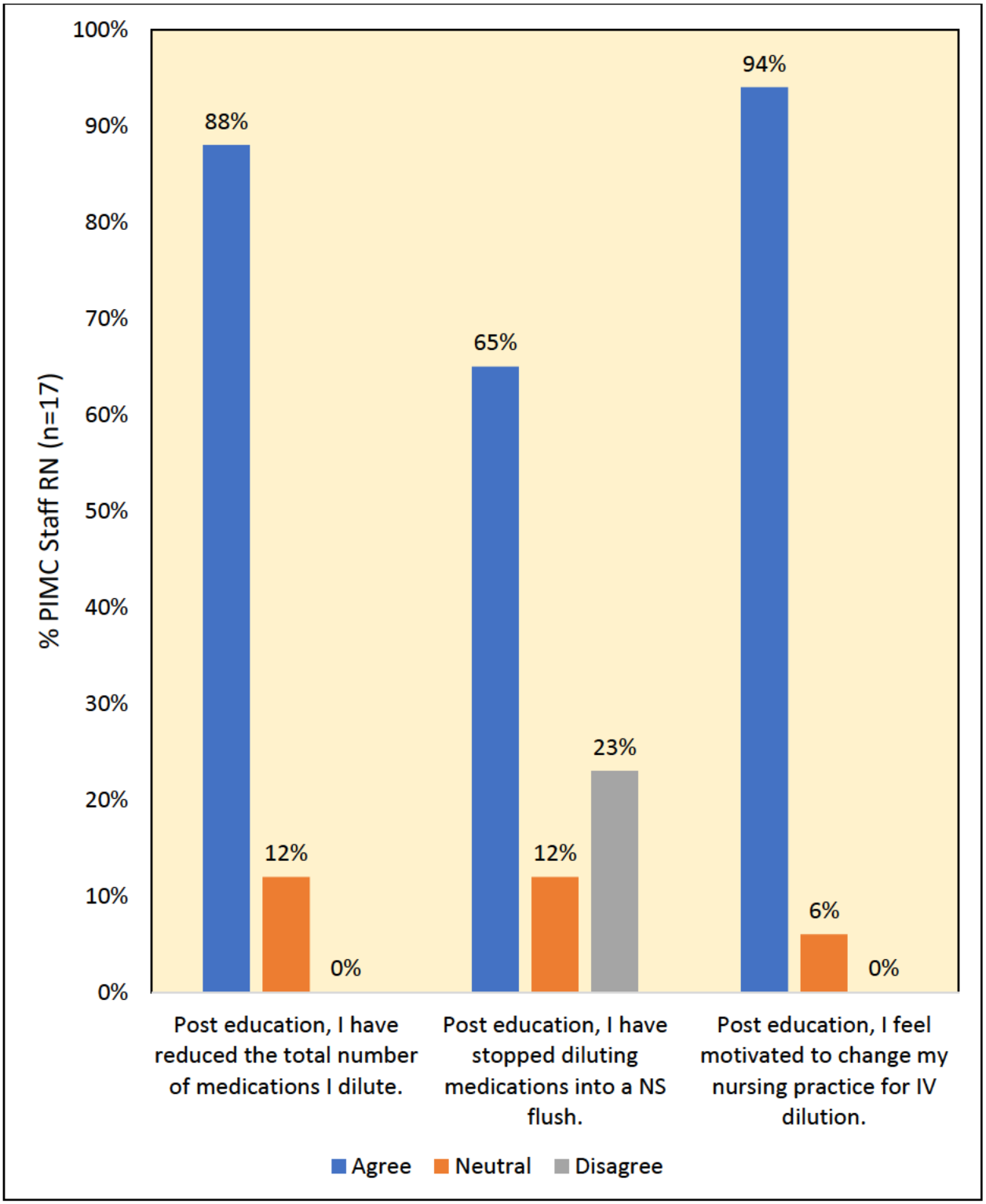
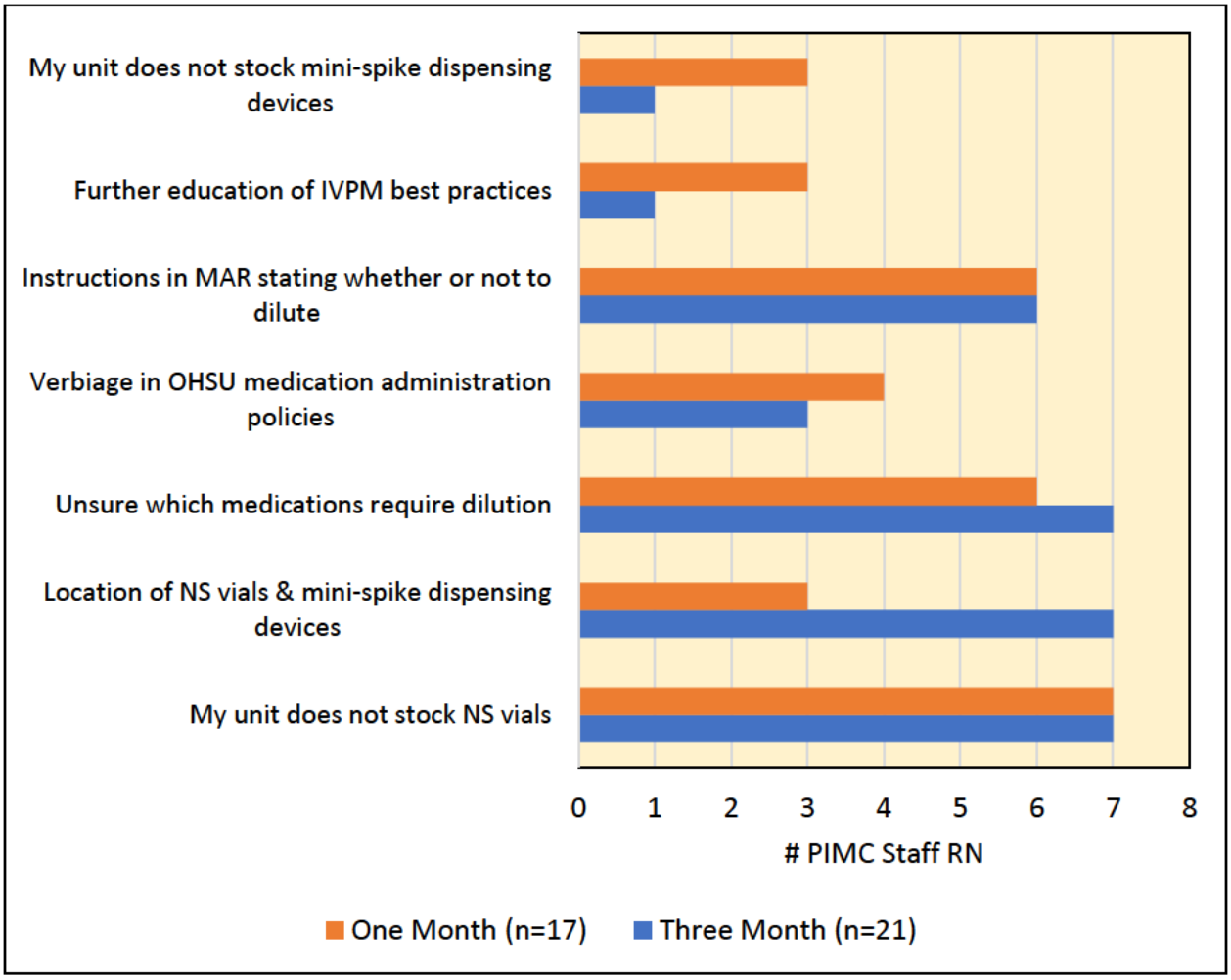


Figure 5

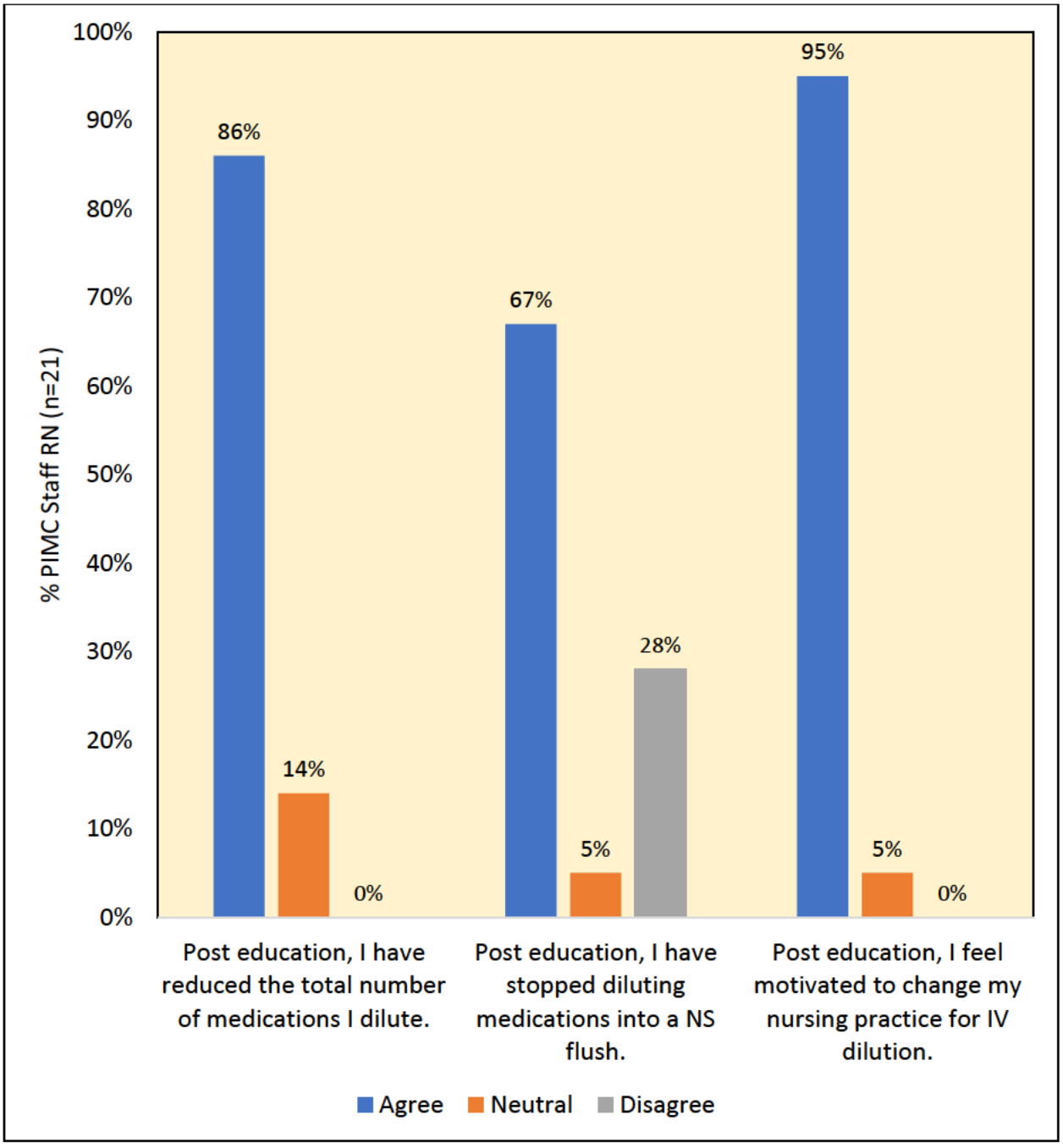
*Reported Barriers to Practice Change**



* More than one response could be selected.

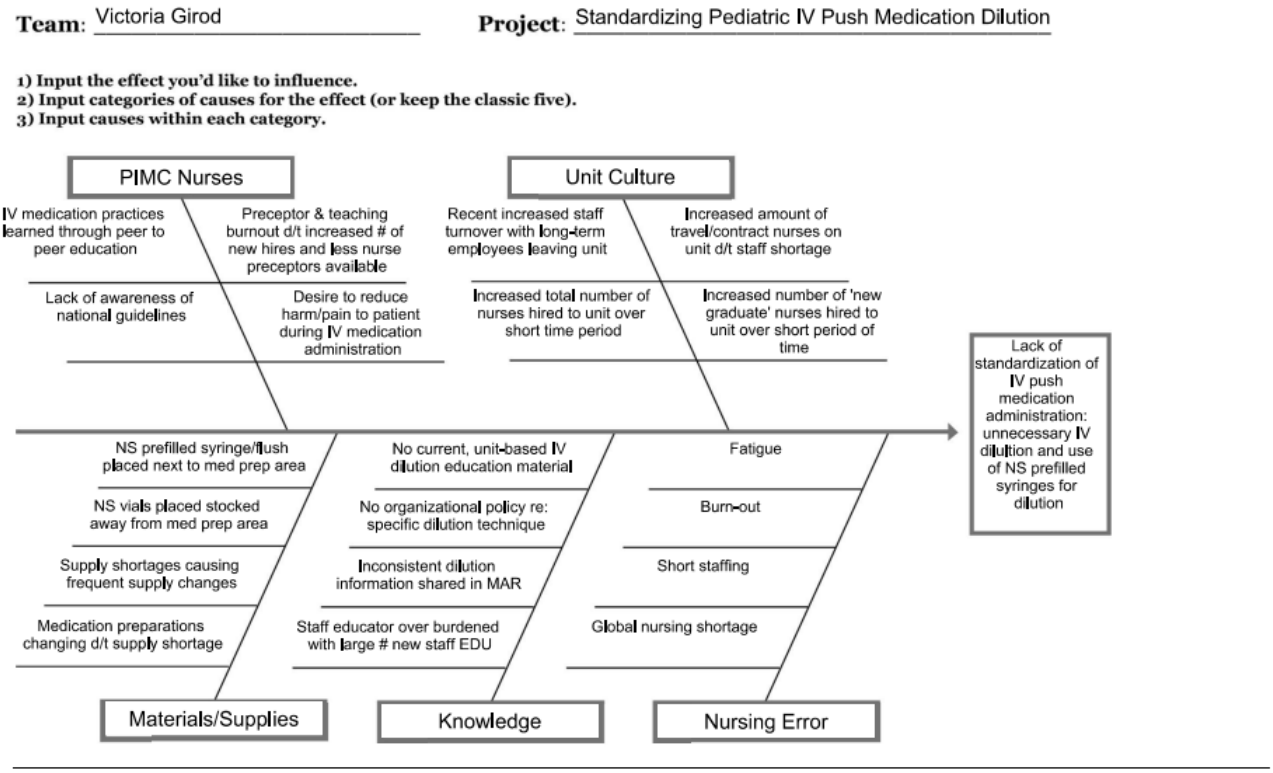
Figure 6

Three Month Post Education Survey Results



Appendix A

Standardization of Pediatric IV Push Medication Dilution: Cause and Effect Diagram



Appendix B

Oregon Health & Science University IRB Determination

NOT HUMAN RESEARCH

June 16, 2022

Dear Investigator:

On 6/16/2022, the IRB reviewed the following submission:

Title of Study:	Standardizing Pediatric Intravenous Push Medication Dilution: A Quality Improvement Project
Investigator:	Sandra Banta-Wright
IRB ID:	STUDY00024570
Funding:	None

The IRB determined that the proposed activity is not research involving human subjects. IRB review and approval is not required.

Certain changes to the research plan may affect this determination. Contact the IRB Office if your project changes and you have questions regarding the need for IRB oversight.

If this project involves the collection, use, or disclosure of Protected Health Information (PHI), you must comply with all applicable requirements under HIPAA. See the HIPAA and Research website and the Information Privacy and Security website for more information.

Sincerely,

The OHSU IRB Office

Appendix C

Letter of Support from Clinical Agency

Letter of Support from Clinical Agency

Date: June 1, 2022

Dear Victoria Girod,

This letter confirms that I, Lisa Jungwirth, allow Victoria Girod (OHSU Doctor of Nursing Practice Student) access to complete her DNP Final Project at our clinical site. The project will take place from approximately August 2022 to December 2022.

This letter summarizes the core elements of the project proposal, already reviewed by the DNP Project Preceptor and clinical liaison (if applicable):

Project Site:
OHSU Doernbecher Children's Hospital, Pediatric Intermediate Care Unit, 10N
700 SW Campus Dr., Portland, OR 97239

Project Plan

Medication errors, particularly intravenous (IV) medication errors, pose a serious threat to patient safety. To address unsafe practices and lack of standardization associated with the preparation and administration of IV push medications, the Institute for Safe Medication Practices (ISMP) created and released safe practice guidelines for IV push medications. Despite recommendations and guidelines, lack of standardization of IV medication preparation and administration practices still remains, creating increased risk for error. This project aims to explore why pediatric nurses at a pediatric academic medical center adopt or reject ISMP safe practice guidelines for IV push medication administration. More specifically, this project will use The Institute for Healthcare Improvement Quality Improvement's Plan-Do-Study-Act (PDSA) cycles to document and improve standardization of IV medication preparation and administration practices.

This quality improvement project aims to review and outline the current IV push medication preparation and administration practices of bedside pediatric nurses, identify barriers to safe practice, and educate pediatric nurses on current IV medication preparation and administration guidelines and standards. Primary objectives include distributing anonymous surveys within a pediatric intermediate care (PIMC) unit at a pediatric academic medical center to explore current IV medication preparation and administration practices, analyze survey results, conduct staff education to align bedside practice with safe practice guidelines and standards, and complete post intervention surveys by December 2022. Process measures will include percentage of PIMC nurses that have completed pre-education surveys, percentage of PIMC nurses that have completed 30-minute IV push medication administration education, and percentage of PIMC nurses that have completed post education surveys. Analysis of outcomes will include a pre and post education comparison of PIMC RN IV push medication administration practices. This will be accomplished using bar graphs and pie charts. Ethical considerations include maintaining anonymity and confidentiality of survey responses and data. To maintain anonymity, survey responses will not require identifying information and demographic questions will not be required responses. Data and survey responses will be kept secure via OHSU encryption and two-factor authentication.

DCH 10N authorizes Victoria Girod to distribute questionnaires to staff and participate in education alongside Koree Leisering, BSN, RN and Nicole Hubiak, BSN, RN, CPN.

During the project implementation and evaluation, Victoria Girod will provide regular updates and communicate any necessary changes to the DNP Project Preceptor.

Our organization looks forward to working with this student to complete their DNP project. If we have any concerns related to this project, we will contact Victoria Girod and Sandra Banta-Wright (student's DNP Project Chairperson).

Regards,

DNP Project Preceptor (Name, Job Title, Email, Phone):