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Best Practice Guideline: Color-Coded Syringe Labeling of Anesthesia Induction Drugs

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BEST PRACTICE GUIDELINE: COLOR-CODED SYRINGE LABELING
OF ANESTHESIA INDUCTION DRUGS

by

Ashley Taylor Johnson and Lauren Elizabeth Pilgrim

A Doctoral Project
Submitted to the Graduate School,
the College of Nursing and Health Professions
and the School of Leadership and Advanced Nursing Practice
at The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Nursing Practice

Approved by:

Dr. Michong Rayborn, Committee Chair
Dr. Stephanie Parks, Committee Member

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ABSTRACT

The purpose of this Doctor of Nursing Practice (DNP) project was to propose a safe practice recommendation through the utilization of evidence-based research on the use of the standardized color-coded labeling guidelines for user-filled syringes in anesthesia practice. The primary objective of standardized color-coded labeling is to improve patient safety by facilitating the identification of user-prepared medication syringes. Guidelines developed by the American Society for Testing and Materials International (ASTM) are endorsed by the American Society of Anesthesiologists (ASA) and aim to increase quality care and patient safety. Currently, there is no standardized color-coded labeling system in anesthesia practice that is universally implemented and enforced by accrediting organizations. These inconsistencies can lead to medication errors and adverse patient outcomes. Ubiquitous adoption of a standardized color-coded labeling system is capable of increasing patient safety and decreasing the incidence of medication errors through the facilitation of syringe recognition by anesthesia providers in the perioperative period.

The guidelines developed by ASTM International were used to develop a safe practice recommendation. A survey was sent to current junior and senior students at The University of Southern Mississippi (USM) as well as nurse anesthesia faculty at The University of Southern Mississippi. Data and feedback from the survey was analyzed for further development of the safe practice recommendation.

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We would like to thank Dr. Michong Rayborn for the leadership she displayed throughout the duration of our project. Without her support, encouragement, and patience, the completion of this project would not be possible. We would also like to thank Dr. Stephanie Parks for her support and direction.

DEDICATION

I would like to dedicate this project to my family, fiancé, and friends. Without their unwavering love, sacrifice, and encouragement, the completion of this project and the nurse anesthesia program would not have been possible. I would also like to thank Dr. Collins, Dr. McLain, Dr. Parks, and Dr. Rayborn for the monumental impact they have had on my educational experience and my future in the profession, I am forever grateful.

- Elizabeth Pilgrim

I want to dedicate this project to my parents, Robert and Noreen Johnson, who set an extraordinary example of hard work and dedication. I owe my success to their unfaltering love and support. I also want to dedicate this project to the USM Women's Soccer head coach Mohammed El-Zare. I am forever grateful for his dedication to his players' athletic and academic careers. His unremitting effort provides the necessary tools to ensure their success on the field, in the classroom, and most importantly, in life.

- Ashley Johnson

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LIST OF ABBREVIATIONS

<i>AACN</i>	American Associations for Colleges of Nursing
<i>AANA</i>	American Association of Nurse Anesthetists
<i>ASA</i>	American Society of Anesthesiologists
<i>ASTM</i>	American Society for Testing and Materials
<i>CRNA</i>	Certified Registered Nurse Anesthetist
<i>DNP</i>	Doctor of Nursing Practice
<i>IRB</i>	Institutional Review Board
<i>NPSG</i>	National Patient Safety Goals
<i>SRNA</i>	Student Registered Nurse Anesthetist
<i>USM</i>	The University of Southern Mississippi

CHAPTER I – INTRODUCTION AND BACKGROUND

Benevolence and nonmaleficence are among the essential values that healthcare professionals must uphold in their daily practice. Advancements in healthcare are on a continuum, with new innovation and technology as well as research and information, introduced regularly. Health care providers have a duty to be proponents in integrating clinical expertise with the best available scientific knowledge and evidence-based practice to implement policy change (McCormack et al., 2013). Best practice recommendations are introduced to promote the highest quality care for patients and meet the ever-evolving needs of the population.

In the United States, an estimated 7,000-9,000 medication-related deaths occur each year, costing hospital systems nationwide approximately forty billion dollars annually (Tariq et al., 2020). When compared to other healthcare disciplines, the American Association of Nurse Anesthetists (AANA) describes anesthesia as one of the few areas in health care in which medications are prescribed, mixed, relabeled, and administered without safety checks and secondary verification (Brown, 2014). There is a greater potential for medication errors to occur when considering the process of preparing and administering a vast number of high-risk medications by anesthesia providers in the perioperative setting. It is estimated that one medication error occurs for every 133 anesthetics in the operating room (Fasting & Grisvold, 2000). Interventions focusing on the preparation, specifically the labeling of user-filled syringes, of drugs utilized by anesthesia providers could minimize medication errors and resultant adverse outcomes, improve patient safety, and reduce error-related costs for hospital systems.

Problem Statement

The primary objective of standardized color-coded labeling is to improve patient safety by facilitating the identification of user-prepared medication syringes. Color-coded labeling guidelines exist for high-risk medications commonly utilized by anesthesia providers in the perioperative setting. This system assists providers in syringe recognition and enables them to easily distinguish one medication from another. Guidelines developed by ASTM are endorsed by the American Society of Anesthesiologists (ASA) and aim to increase quality care and patient safety. Currently, there is no standardized color-coded labeling system in anesthesia practice that is universally implemented and enforced by accrediting organizations. The inadequacy of regulation and standardization of color-coding for user-applied syringe labels produces contrariety among areas where anesthesia services are provided. These inconsistencies can lead to misidentification of medication syringes, medication errors, and adverse patient outcomes.

Purpose and Context

Employing our senses to differentiate objects is an invaluable mechanism we as humans rely on daily. As an example, in anesthesia, to reduce the risk of the wrong gas delivery (e.g., nitrous oxide instead of oxygen), a change in the size and design of the oxygen gas delivery knob, found on non-digital anesthesia machines was modified (Ehrenwerth et al., 2013). Not only do we utilize tactile senses, but we also rely heavily on visual cues, such as color, design, and text. The purpose of this project is to propose a safe practice recommendation through utilization of evidence-based research on the use of the endorsed color-coded labeling guidelines for user-filled syringes in anesthesia practice. On a daily basis, anesthesia providers utilize several different high-risk

medications with significantly different mechanisms of action. Currently, there is no standardized system in place concerning color-coding user-filled medication syringes in anesthesia practice. The lack of a disciplined and organized system across all areas of anesthesia creates variance in systems and practice, which in turn provides more room for errors to occur.

Human error makes up an estimated eighty percent of medication errors in health care (Dean et al., 2002). Although human contribution to error cannot be eliminated entirely, human error can be reduced through changes made in environmental factors, or a system-based approach (Fasting & Grisvold, 2000). A system-based approach includes identifying elements that influence outcomes, understanding the relationship between individual factors, and forming policies or modifying existing processes based on the information (Kaplan et al., 2013). This method formulates an organized process in which all aspects of the system are considered. Standardization is a major component of a system-based approach (Fasting & Grisvold, 2000). Standardization decreases variations in systems and products. In health care, standardization increases the quality of care as well as efficiency, while decreasing the incidence of errors. ASTM is an organization that develops and publishes voluntary consensus standards internationally for a wide range of products and services (American National Standards Institute [ANSI], 2020). ASTM International provides a set of guidelines for labeling user-prepared syringes for medications commonly utilized in anesthesia practice.

Available Knowledge

Anesthesia and aviation have an analogous relationship. The quality and safety of anesthesia has increased exponentially since its beginning. Increases in quality and safety

are partly due to the implementation of enforced standards of care and safeguards. Aviation pilots utilize checklists to confirm that critical equipment is inspected and functioning up to standards in the preflight phase, before takeoff, and before landing (Blike & Biddle, 2000). Completion of these checklists is mandatory, must be completed by two people, and must supply documentation on inspection and performance (U.S. Department of Transportation Federal Aviation Administration, 2016). Utilizing checklists is also a common practice in anesthesia. When setting the room up for a procedure, providers have an individualized way of completing a checkoff to ensure they have all of the appropriate equipment and the equipment is functioning properly. However, in anesthesia, checklists are not standardized and a structured and disciplined approach to their routine is typically inadequate (Chopra et al., 2018).

Medication Labeling Requirements

In 2007, The Joint Commission initially presented the National Patient Safety Goal (NPSG) 03.04.01 to improve safe medication practices (Joint Commission, 2020). Accurate and appropriate labeling practices are essential when any medication or solution is transferred from its original packaging to another container. Medication labeling is a risk-reduction strategy that is congruent with basic safe medication management (Joint Commission, 2020). The Elements of Performance for NPSG.03.03.01 define requirements for labeling medications in the perioperative setting (Joint Commission, 2020). As stated in the Elements of Performance for NPSG.03.04.01, labels are required to include the following information: medication or solution name, strength, amount of the medication or solution containing the medication (if not apparent from the container), diluent name, and volume (if not apparent from the container), expiration date when not

used within twenty-four hours, expiration time when expiration occurs in less than twenty-four hours (Joint Commission, 2020).

Role of the Anesthesia Provider

As described by the AANA, the role of the certified registered nurse anesthetist (CRNA) is to provide high-quality, comprehensive, evidence-based anesthesia and pain care services (AANA, 2020). It is the responsibility of anesthetists to provide and maintain safe, patient-centered care throughout the perioperative period. As stated before, the AANA describes anesthesia as one of the few areas in health care in which medications are prescribed, mixed, relabeled, and administered without safety checks and secondary verification (AANA, 2020). Throughout the perioperative phase, anesthesia providers utilize many high-risk medications. Multiple pharmacological agents are utilized in order to achieve the desired type and depth of anesthesia, support basic physiological demands, as well as other preemptive measures to alleviate potential undesirable outcomes (e.g., antibiotics, antiemetics). Anesthesia providers must appropriately identify, prepare, and administer medications in order to provide and maintain safe and effective anesthesia.

When anesthesia providers are preparing their medications in the operating room for their patients, drugs are retrieved from a cart. The medication vial or ampule is inspected, the medication is drawn up into a syringe that is labeled with the drug's information. Anesthesia providers work in high-stress situations and environments. The operating room is a complex environment that presents a multitude of distractions for anesthesia providers. Anesthesia providers must navigate obstacles and maintain patient safety throughout the case.

Current Guidelines

The ASTM International is a standards organization that designs and publishes voluntary consensus technical standards for various materials, products, systems, and services (American National Standards Institute [ANSI], 2020). Standards are developed within committees comprised of technical experts, which include consumers, producers, users, government, and academia with the common goal to provide up-to-date information and recommendations concerning areas with standardization needs. Although ASTM International develops standards, they are not a regulatory body.

Government, industries, and organizations retain the right to adopt standards developed by ASTM International as well as enforce and regulate compliance within them. The ASTM International provides a set of recommended international standards for user applied drug labels commonly used in anesthesiology. The guidelines developed are congruent with principles recognized by the Decision on Principles for the Development of International Standards, Guides, and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee (American Society for Testing and Materials [ASTM], 2017).

The primary objective of implementing standardized labeling is to improve patient safety by facilitating the identification of user-prepared medication syringes (ASTM, 2017). The specifications used to form the Active Standard ASTM D4774 guidelines include the size, color, pattern, and type of label used (ASTM, 2017). The image below (Figure 1) shows the Active Standard ASTM D4774 Guidelines, it is organized by drug class, examples of drugs in that class, and shows a picture of the recommended medication label.

DRUG CLASS ^A	EXAMPLES	PANTONE COLOR (unearned)	LABEL EXAMPLES
1 Induction Agents	Etomidate, Ketamine, Methohexital, Propofol, Thiopental	YELLOW	PROPOfol _____ mg/mL Date _____ Time _____ Int _____
2 Benzodiazepines	Diazepam, Midazolam	ORANGE 151	MIDAZolam _____ mg/mL Date _____ Time _____ Int _____
3 Benzodiazepine Receptor Antagonist	Flumazenil	ORANGE 151 AND WHITE DIAGONAL STRIPES	FLUMAZeni _____ mg/mL Date _____ Time _____ Int _____
4a Muscle Relaxants (Depolarizer)	Succinylcholine ^B	FLUORESCENT RED 805	SUCCINYLcholine _____ mg/mL Date _____ Time _____ Int _____
4b (Non-Depolarizer]	Atracurium, Cisatracurium, Mivacurium, Pancuronium, Rocuronium, Vecuronium	FLUORESCENT RED 805	ROCURonium _____ mg/mL Date _____ Time _____ Int _____
5 Relaxant Antagonist (Non-Depolarizer)	Endrophenonium, Neostigmine, Pyridostigmine	FLUORESCENT RED 805 AND WHITE DIAGONAL STRIPES	NEOSTigmine _____ mg/mL Date _____ Time _____ Int _____
6 Narcotics	Alfentanil, Fentanyl, Hydromorphone, Meperidine, Morphine, Sufentanil, Remifentanil	BLUE 297	FENTanyl _____ mcg/mL Date _____ Time _____ Int _____
7 Narcotic Antagonists	Levallorphan, Naloxone	BLUE 297 AND WHITE DIAGONAL STRIPES	NARcan _____ mg/mL Date _____ Time _____ Int _____
8 Major Tranquilizers	Chlorpromazine, Droperidol	SALMON 156	DROperidol _____ mg/mL Date _____ Time _____ Int _____
9a Vasopressors	Ephedrine, Norepinephrine, Phenylephrine	VIOLET 256	EPHEDrine _____ mg/mL Date _____ Time _____ Int _____
9b Vasopressors	Epinephrine ^B	VIOLET 256	EPINEPHrine _____ mcg/mL Date _____ Time _____ Int _____
10 Hypotensive Agents	Hydralazine, Nitroglycerine, Nitroprusside, Phentolamine, Trimethaphan	VIOLET 256 AND WHITE DIAGONAL STRIPES	NITROGlycerine _____ mg/mL Date _____ Time _____ Int _____
11 Local Anesthetics	Bupivacaine, Chloroprocaine, Lidocaine, Mepivacaine, Procaine, Ropivacaine, Tetracaine	GRAY 401	LIDOcaine _____ mg/mL Date _____ Time _____ Int _____
12 Anticholinergic Agents	Atropine, Glycopyrrolate, Scopolamine	GREEN 367	GLYCOpyrrolate _____ mg/mL Date _____ Time _____ Int _____
13 Beta Blockers	Esmolol ^B , Labetolol ^B , Metoprolol ^B	COPPER 876U	LABETalol _____ mg/mL Date _____ Time _____ Int _____

^A Drugs that do not fit into the above classes should be labeled with black printing on a white background. The examples shown are representative, not re:
^B All printing is to be in black boldtype, with the exception that "succinylcholine" and "epinephrine" shall be printed against the background color as revers letters within a black bar running from edge to edge of the label.

Figure 1. Active Standard ASTM D4774 Guidelines

Observations in the Clinical Setting

Student registered nurse anesthetists (SRNA) undergo a rigorous educational process in order to safely provide anesthesia services to patients. SRNAs develop and master skills, possess a comprehensive understanding of human physiology and disease processes, and acquire an expansive knowledge of pharmacology, among many other components that are required to administer anesthesia safely. The nurse anesthesia

program at The University of Southern Mississippi is partnered with several different institutions throughout the state where students fulfill clinical experience. As students, we have the privilege to gain experience and knowledge in diverse anesthesia settings. Clinical settings include large hospitals, outpatient centers, and rural area hospitals. The patient population ranges across the life-span including pediatrics, obstetrics, adult, and geriatric patients, all with varying levels of acuity.

As students visit several different clinical sites, inconsistencies in labeling are evident. The lack of standardization in facilities increases the risk of wrong syringe selection and potentially a medication error. The following table (Table 1) is comprised of our observations at various clinical sites that we have done clinical rotations. The table shows the inconsistencies of color-coded labeling in different facilities. As the chart shows, some facilities did not have medication labels available for certain drugs.

Table 1

Clinical Site Observations of Medication Labels

	Institute A	Institute B	Institute C	Institute D
Local Anesthetics (<i>Lidocaine, Naropin</i>)	LIDOCAINE 1% Dt. _____ Tm. _____ Init. _____	LIDOCAINE 1% Dt. _____ Tm. _____ Init. _____	Lidocaine _____%	LIDOCAINE 1% Dt. _____ Tm. _____ Init. _____
Induction Agents (<i>Propofol, Ketamine, Etomidate</i>)	Propofol _____ mg/ml Date _____ Time _____ Int. _____	Propofol _____ mg/ml Date _____ Time _____ Int. _____	Propofol _____ mg/ml Date _____ Time _____ Int. _____	Propofol _____ mg/ml Date _____ Time _____ Int. _____
Neuromuscular Blocking Agents (<i>Anectine, Zemuron, Vecuronium</i>)	SUCCINYLCHOLINE 20 mg/ml Date _____ Time _____ Int. _____	SUCCINYLCHOLINE 20 mg/ml Date _____ Time _____ Int. _____	Anectine _____ % Prep Date _____ Exp. Date _____ Initial _____ Exp. Time _____ ROCuronium 10 mg/mL Date _____ Time _____ Int. _____	SUCCINYLCHOLINE 20 mg/ml Date _____ Time _____ Int. _____
Benzodiazepines (<i>Versed</i>)	Versed _____ mg/ml Date _____ Time _____ Int. _____	Versed _____ mg/ml Date _____ Time _____ Int. _____	Versed _____ mg/ml Date _____ Time _____ Int. _____	Versed _____ mg/ml Date _____ Time _____ Int. _____
Narcotics (<i>Fentanyl, Morphine, Dilaudid</i>)	Fentanyl 50 mcg/ml Date _____ Time _____ Int. _____	Fentanyl 50 mcg/ml Date _____ Time _____ Int. _____ MORPHINE mg/ml	Fentanyl 50 mcg/ml Date _____ Time _____ Int. _____	Fentanyl 50 mcg/ml Date _____ Time _____ Int. _____
Anticholinergics (<i>Atropine, Glycopyrrolate</i>)	Atropine _____ % Prep Date _____ Exp. Date _____ Initial _____ Exp. Time _____ Glycopyrrolate 0.2 mg/mL Date _____ Time _____ Int. _____	Glycopyrrolate 0.2 mg/mL Date _____ Time _____ Int. _____	Glycopyrrolate 0.2 mg/mL Date _____ Time _____ Int. _____	Glycopyrrolate 0.2 mg/mL Date _____ Time _____ Int. _____
Precedex	DEXMEDETOMIDINE Strength _____ mcg/ml Exp. Dt./Tm. _____	No label available	No label available	No label available
Vasopressors (<i>Ephedrine, Neo-Syneprine</i>)	Neo-Syneprine _____ mcg/ml Date _____ Time _____ Int. _____	Neo-Syneprine _____ mcg/ml Date _____ Time _____ Int. _____	Neo-Syneprine _____ mcg/ml Date _____ Time _____ Int. _____	No label available

Color-Coding Debate

Even as best-practice recommendations continually improve and evolve over time to increase patient safety, no system can feasibly be considered perfect. However, steps can be taken to improve practice and minimize human error. Syringes containing drugs frequently utilized by anesthesia providers are many times instinctually recognized and chosen based on their location and visual features. Recalling and distinguishing an object relies heavily on shape, color, brightness, and contrast (ASA, 2015). As these characteristics become increasingly distinct, they become increasingly identifiable. Recurrent presentation of an object's characteristics and locality in visual search tasks helps to subsequently identify the object, which is a process known as "priming" (Campana & Kristjansson, 2010). Much of the daily tasks of the anesthetist are repetitive in nature but tailored to every case based on the needs of the patient, the anesthetic requirements for a specific surgery, as well as preferences of the surgeon.

Debate continues over the value of using color-coded drug labels in anesthesia practice. For those in opposition to color-coding, the concern lies with the potential for providers to become overly dependent on colors. Color coding guidelines are organized by drug class. With multiple high-risk medications in each drug class, it would be assumed that they could easily be misidentified for one another. When only one variable is taken into account in syringe selection, such as size or color, there is considerable room for error. Implementation of basic medication safety is vital each time a drug is prepared, diluted, or mixed as well as administered. This includes checking the medication name, concentration, volume, and expiration date as well as confirming it is the correct patient at the correct time. Some may argue that colorless labels would warrant a more thorough

inspection of a selected syringe. However, color is not the only variable used to distinguish one medication from another. Some providers may resort to using other single variables, such as size, as the sole identifier when choosing a medication. There is a lack of evidence that concludes the use of colorless labels produces a more in-depth review of syringes or reduces the incidence of medication errors (Grigg & Roesler, 2018).

Opposing views over whether user-applied, color-coded labels increase patient safety, or contrarily, increases the risk of medication errors occur. Those opposed to a color-coded system claim that this system relies too heavily on color-cues and replaces the act of reading the medication vial and/or label. With this in mind, the purpose of user-applied color-coded labels needs to be revisited. The purpose of the color-coded system is to help identify and distinguish one medication classification from another. User-applied labels are not meant to be the sole identifier when selecting a medication to administer. The user must perform the basic required precautions and safety measures when preparing and administering medications.

As stated previously, the operating room presents a multitude of distractions that present obstacles for anesthesia providers to manage. With numerous coinciding events, it is imperative that the provider maintains situational awareness. Some tasks that require less attentiveness, due to constant repetition, will be accomplished with working memory. Color-coding provides redundancy cues, which lead to working memory. When color-coded labels are not available to provide redundancy cues which lead to working memory, there is the potential for providers to use less reliable identifiers such as syringe size or location (Janik & Vender, 2019). The best way to identify objects during stressful situations is to provide multiple cues (Grigg & Roesler, 2018). Neglecting to implement

color-coding labels deprives providers of an additional visual cue to accurately select medications in high-stress environments.

Rationale

In order for color-coded labels to aid providers in the identification of medication syringes, there must be a consensus on a standardized guideline, and its utilization in practice must be enforced. Areas that anesthesia services are provided would also benefit from enforcing the same standard. These areas include but are not limited to the preoperative area, post-anesthesia care unit, labor and delivery, and the emergency department. Strategies that reduce complexity are most likely to improve safety (Wheeler et al., 2005). Implementation of the standardized guideline across all areas of anesthesia would decrease the complexity of the various labeling practices currently in use.

Specific Aims

The purpose of this project is to propose a safe practice recommendation through utilization of evidence-based research on the use of the standardized color-coded labeling guidelines for user-filled syringes in anesthesia practice. The implementation of this system would decrease the incidence of medication errors and increase patient safety. This project explores anesthesia providers' opinions on implementing a standardized color-coding system. This project also examines the anesthesia providers' awareness of an existing standardized guideline and their experience with medication labels in the clinical setting.

DNP Essentials

The American Associations for Colleges of Nursing (AACN) defines eight essentials required for advanced nursing practice (AACN, 2006). This project addresses seven of the essentials (Appendix C).

- Essential One: Scientific Underpinnings for Practice. This best practice project is based on the most current evidence-based literature and recommended guidelines for color-coded medication labels.
- Essential Two: Organizational and Systems Leadership for Quality Improvement and Systems Thinking. This essential is met through an evidence-based policy regarding universal color-coded labeling for anesthesia medications.
- Essential Three: Clinical Scholarship and Analytical Methods for Evidence-Based Practice. This project incorporated extensive literature research and review to provide a best practice recommendation.
- Essential Five: Health Care Policy for Advocacy in Health Care. This project aims to provide a best practice recommendation to increase patient safety, provide better outcomes for patients, and decrease anesthesia-related medication errors.
- Essential Six: Interprofessional Collaboration for Improving Patient and Population Health Outcomes. This project collaborated with a panel of experts that are well versed in the process and contribute to the creation of a best practice recommendation.
- Essential Seven: Clinical Prevention and Population Health for Improving the Nation's Health. This essential is met by examining the current practices, the current guidelines, and recommendations, in order to propose a best practice

recommendation. The best practice recommendation will aid in preventing anesthesia-related medication errors and will improve patient safety.

- Essential Eight: Advanced Nursing Practice. This project proposes safer practice guidelines through current evidence-based literature as well as through collaborating with anesthesia providers. Anesthesia providers will be encouraged to incorporate these guidelines into their everyday practice.

Summary

The purpose of this project was to develop a safe practice guideline for user-filled medication syringes of anesthesia induction drugs. Though human error cannot be eliminated entirely, it can be reduced. Ubiquitous adoption of a standardized color-coded labeling system is capable of increasing patient safety and decreasing the incidence of medication errors through facilitation of syringe recognition by anesthesia providers in the perioperative period.

CHAPTER II – METHODOLOGY

Context

The purpose of this project is to provide a safe practice recommendation developed by evidence-based research on the use of color-coded labels for user-filled syringes in anesthesia practice. The implementation of this practice can lower the occurrence of medication errors, improve patient outcomes and decrease medication error-related costs for hospital systems. The components of medication errors addressed by this project include the role of the CRNA in the perioperative period, the current recommended labeling guidelines, and the advantages and disadvantages of implementing a standardized color-coding system.

Design

Following a proposal to The University of Southern Mississippi (USM) DNP committee, the project was submitted for approval from the Institutional Review Board (IRB 20-530). Once approved, (Appendix A) a systematic literature search was done using the following databases: CINAHL, MEDLINE, Cochrane, and PubMed. This data was used to guide the development of a safe practice recommendation on the use of the endorsed color-coded labeling for user-filled syringes in anesthesia practice. In addition to evidence-based data collection and the development of a safe practice recommendation, a team of experts was assembled for critiquing and guidance. The panel was presented with the recommended practice change and was asked to complete an evaluation survey provided by the authors of this project. The panel was formed by CRNA professors at USM and SRNAs from USM. The feedback gathered from the

responses of the evaluation survey was then incorporated into the further development of the safe practice recommendation.

Intervention

The intervention for this project was the development of a safe practice recommendation in favor of the use of color-coded labeling for user-filled syringes in anesthesia practice. The foundation for the recommendation is the desire to improve patient outcomes by safer medication administration in the perioperative period. The safe practice recommendation was formed through a combination of evidence-based research and the utilization of evaluation tools.

Data Collection and Analysis

Several individuals aided in the completion of this project. The authors performed a review of evidence-based literature, developed a safer practice guideline, and presented the recommended practice change to a panel of experts and peer SRNAs. The panel of experts consisted of four practicing CRNAs with doctoral degrees and greater than ten years of experience. The SRNAs invited to voluntarily participate were junior and senior students from The University of Southern Mississippi. The committee chair sent an invitational email to the SRNAs and responses were kept anonymous with no identifiable information. The data was collected through anonymous completion of a survey provided to the expert panel and SRNAs (Appendix D). The responses gathered from the survey were reviewed and used to guide adjustments to the recommended safe practice policy for color-coding medications.

Ethical Considerations

Ethical considerations are the two standards of care being delivered in the perioperative period. Evidence-based research supports standardized labeling to decrease the number of medication errors. With the primary focus of health care being the safety of the patient, the CRNA who adopts a standardized labeling method will be delivering evidence-based care to the patient. The patient that receives care from a CRNA that does not implement standardized labeling, will have a higher risk for medication errors to occur.

Summary

This project meets the required fundamental essentials provided by the AACN for advanced practice nursing (Appendix C). This project aimed to address anesthesia-related medication errors by providing a safe practice guideline for anesthesia providers. The utilization of color-coded labeling guidelines for user-filled syringes in anesthesia practice will decrease medication errors, therefore increasing patient safety. The authors of this project collected evidence-based data to develop a safe practice recommendation. This project was then presented to a panel of anesthesia providers, detailing the safe practice recommendation. Following the presentation, the panel provided feedback through an evaluation tool. SRNAs were also encouraged to give feedback. The responses from both the expert panel and SRNAs were used to further guide the development of a safer practice guideline for labeling medications in the perioperative period.

CHAPTER III - RESULTS

Participants completed an evaluation (Appendix D) of the safe practice recommendation, participants were provided with the ASTM current labeling recommendations (Figure 1). The data collection process included a survey sent to 4 Nurse Anesthesia Program faculty at USM and 39 junior and senior students at USM, who are currently completing clinical hours. The survey focused on informing participants of the current recommended guidelines for color-coded syringe labeling for anesthesia drugs provided by ASTM International and the benefits seen by implementing standardized labeling into practice. The following six topics were covered in the survey: (1) consent to voluntary participation, (2) the participants' title- CRNA or SRNA, (3) current knowledge of the recommended guidelines provided by the ASTM on color-coded syringe labels for anesthesia induction drugs, (4) awareness of color-coded labels that differ from ASTM recommendations used for anesthesia induction drugs in institutions, (5) did the project present enough evidence to determine if the implementation of standardized color-coded syringe labels for anesthesia induction drugs in practice could decrease medication errors and improve patient safety, (6) an open-ended question requesting recommendations or feedback that participants could offer regarding best practice recommendations for color-coded syringe labels for anesthesia induction drugs.

The survey was provided to each participant via email. The email included an invitation to participate in the survey, an attached document with the ASTM chart, and the link to Qualtrics, the data collection site for to anonymously complete the survey. A total of 43 people were invited to participate, with only 26 completing the survey. All

participants consented to participate before moving forward in the survey (Question 1). Of the 26 participants, 3 are current practicing CRNAs and 23 are junior and senior SRNAs (Question 2). Results were collected over two weeks. Results for each question were analyzed separately. Question 3 asked the participants about their current knowledge of the recommended guidelines provided by the ASTM on color-coded syringe labels for anesthesia induction drugs. Five participants or 19% reported familiarity with the current ASTM guidelines, 13 participants or 50% reported somewhat familiar with the current ASTM guidelines, while 8 participants or 31% reported no awareness of current guidelines (see Table 2). Question 4 asked participants about awareness of color-coded labels that differ from ASTM recommendations used for anesthesia induction drugs in institutions. Twenty-two participants or 85% reported that they were aware of institutions that used alternative labeling systems, while 4 participants or 15% were not aware (see Table 3). Question 5 asked participants to rate from strongly disagree to strongly agree if after participating in the project, do they believe that the implementation of standardized color-coded syringe labels for anesthesia induction drugs in practice could decrease medication errors and improve patient safety. Most participants summarized strongly agree, while very few disagreed. Question 6 asked for feedback, 23 participants chose not to provide comments or feedback. One participant stated: “Color-coded syringes would be effective in preventing medication errors. It would be interesting to see a cost-benefit analysis of this intervention. Assuming that color-coded syringes would be more expensive than color-coded labels.” A second participant said: “I was surprised to see the antagonists had an assigned color similar to their counterpart.” The third participant stated: “Even though the provider is ultimately responsible for

verifying labels, I think a standard color coding would decrease error and increase patient safety.”

Table 2

Survey Question Three

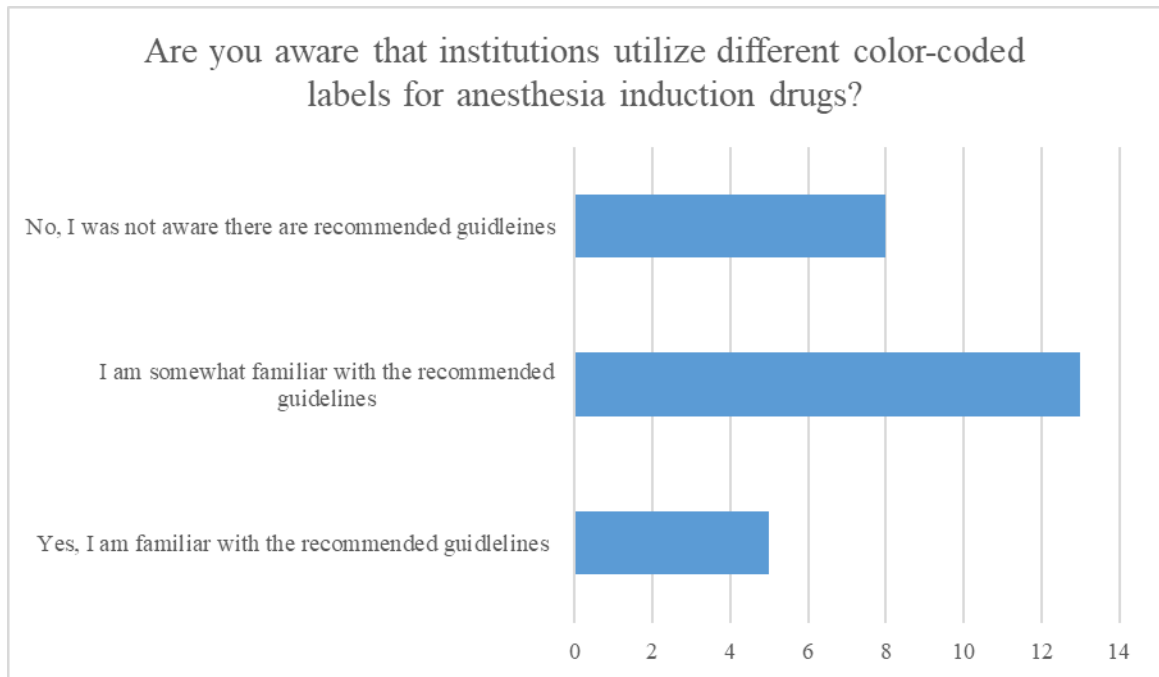
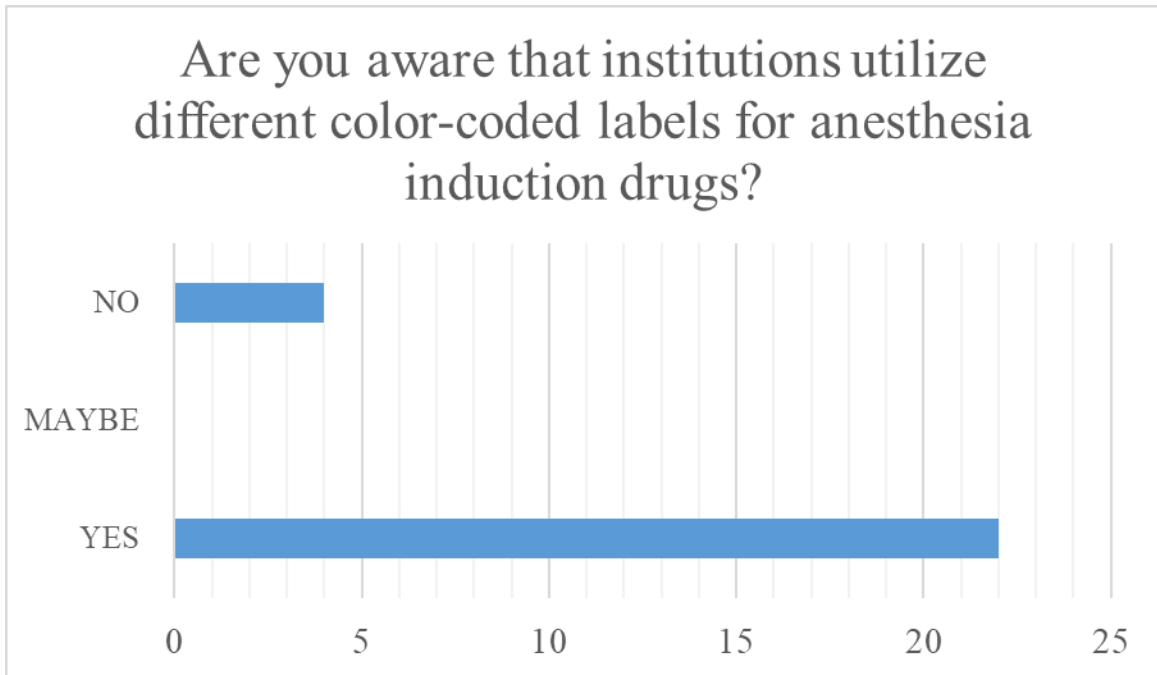


Table 3

Survey Question Four



Summary

The purpose of this DNP project is to prevent anesthesia-related medication errors by providing a safe practice guideline for CRNAs and SRNAs. The objective of the project is to educate CRNAs and SRNAs on standardized color-coded syringe labels for anesthesia induction drugs. Healthcare professionals take an oath to do no harm, by medication error prevention, harm to patients is prevented. With a 66% participation rate, it can be concluded that utilization of the ASTM color-coded labeling guideline for anesthesia induction drugs will decrease medication errors, which will render improved patient safety.

CHAPTER IV – CONCLUSION

The purpose of this DNP project was to develop a best practice guideline for labeling medication syringes of anesthesia induction drugs. This guideline was presented and evaluated by a group of CRNAs and SRNAs with the intention of anesthesia providers adopting it into their own practice. The CRNAs and SRNAs were to evaluate the best practice guideline by completing a six-question survey. The majority of participants concluded that the information provided did encourage them to change their practice. The recommendation was developed based on evidence-based practice and current literature reviews. The methodology used to design this practice guideline meets the required fundamental essentials provided by the AACN for advanced practice nursing (Appendix C).

The limitation of this DNP project was the number of participants. The participation was strictly voluntary with 39 invitations and only 26 participants. A sample size of 26 is relatively small. Of the 26 participants, 23 are SRNAs with very little practice as well as little autonomy over the ability to make changes in their facility. This project could have yielded more specific results with more participants.

For future studies on color-coded labeling syringes of anesthesia induction drugs, the researchers could expand the participation to first-year SRNAs as well as CRNAs that serve as clinical preceptors in USM clinical sites. By including first-year SRNAs as participants, researchers would be educated early on the universal color-coding system. Doing so would employ the SRNA with the knowledge to recognize if this system is being used in their clinical institution. Having CRNAs from clinical sites participate could allow researchers to determine if this best practice guideline could be easily

adapted into local facilities. Future studies looking at cost analysis comparisons of labels would benefit researchers when presenting information to quality improvement coordinators and hospital administration in various facilities.

Summary

The purpose of this DNP project was to propose a safe practice recommendation through utilization of evidence-based research on the use of the standardized color-coded labeling guidelines for user-filled syringes in anesthesia practice. The primary objective of standardized color-coded labeling is to improve patient safety by facilitating the identification of user-prepared medication syringes. Guidelines developed by ASTM International are endorsed by the ASA and aim to increase quality care and patient safety. Currently, there is no standardized color-coded labeling system in anesthesia practice that is universally implemented and enforced by accrediting organizations. Adoption of a standardized color-coded labeling system is capable of increasing patient safety and decreasing the incidence of medication errors through facilitation of syringe recognition by anesthesia providers in the perioperative period. Although the number of participants was limited, enough feedback was received to believe that anesthesia providers would benefit from implementing the ASTM color-coding system into practice.

APPENDIX A – IRB Approval Letter

Office of
Research Integrity



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NOTICE OF INSTITUTIONAL REVIEW BOARD ACTION

The project below has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services regulations (45 CFR Part 46), and University Policy to ensure:

- The risks to subjects are minimized and reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered involving risks to subjects must be reported immediately. Problems should be reported to ORI via the Incident template on Cayuse IRB.
- The period of approval is twelve months. An application for renewal must be submitted for projects exceeding twelve months.
- Face-to-Face data collection may not commence without prior approval from the Vice President for Research's Office.

PROTOCOL NUMBER: IRB-20-530

PROJECT TITLE: Best Practice Guideline: Color-Coded Labeling Syringes of Anesthesia Induction Agents

SCHOOL/PROGRAM: School of LANP, Leadership & Advanced Nursing

RESEARCHER(S): Ashley T. Johnson, Michong Rayborn, Lauren Pilgrim

IRB COMMITTEE ACTION: Approved

CATEGORY: Expedited

7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

PERIOD OF APPROVAL: January 6, 2021

A handwritten signature in cursive script that reads "Donald Sacco".

Donald Sacco, Ph.D.
Institutional Review Board Chairperson

APPENDIX B –Literature Matrix

Author/Year/ Title	Level/ Grade	Design	Sample/Data Collection	Findings	Recommendations
Gariel et al. (2017) Incidence, characteristics, and predictive factors for medication errors in pediatric anesthesia: A prospective incident monitoring study	---	Prospective Study	Prospective incident monitoring study in a pediatric surgical center; children <18 years undergoing general anesthesia	1400 (73%) incident forms completed in 1925 GA cases with 37 reporting at least one medication error	Identification of the mechanisms related to medication errors might allow preventative measure that can be assessed in further studies
Grigg et al. (2017) Assessing the Impact of the Anesthesia Medication Template on Medication Errors During Anesthesia: A Prospective Study	---	Prospective Study	41 anesthetists administered medications using a template or without a template; Medication errors recorded	Utilization of the Anesthesia Medication Template decreased medication errors by anesthesia providers	Standardizing medication organization with the AMT is an intuitive, low-cost strategy with the potential to improve patient safety by reducing medication errors by anesthesia providers
Institute for Safe Medication Practices (2020) Targeted Medication Safety Best Practices for Hospitals	---	Systematic Review	Error reports received through the ISMP National Medication Errors Reporting Program (ISMP MERP); reviewed by an external expert advisory panel and approved by the ISMP Board of Trustees	Best practice recommendations presented in this guidance document	Adoption of consensus-based best practices for specific medication safety issues that continue to cause fatal and harmful errors in patients
Janik et al. (2019) Pro/Con Debate: Color-Coded		Journal of the Anesthesia Patient		Pro: Color-coded medication labels improve patient safety; Con:	Color-coded syringe labels provide a false reassurance of the

Medication Labels		Safety Foundation		Anesthesia drugs should not be color-coded	content of the syringe; Color-coded labels act as redundancy cues in object recognition and promote error mitigation
Nanji et al. (2016) Evaluation of perioperative medication errors and adverse drug events	---	Prospective Observation Study	Anesthesia-trained study staff observed randomly selected operations to identify MEs and ADEs over 8 months	277 operations observed; 3,671 medication administrations of which 193 involved a ME and/or ADE	Technology-based interventions (bar code-assisted syringe labeling systems, point-of-care bar code-assisted anesthesia documentation systems, specific drug decision support, alerts) and process-based interventions
National Coordinating Council for Medication Error Reporting and Prevention (2015)	---	---	---	---	Definition of medication error from the council
Pan et al. (2015) Published costs of medication errors leading to preventable adverse drug events in US hospitals	---	Systematic Review	Literature review on injectable ME in Medline and Embase (2003-2014) identified eleven articles related to the incidence and economic impact of pADEs arising from all ME	Cost estimates varied considerably due to different definitions, study methodologies, and analytic scope; Injectable-related pADEs alone costs \$2.8-5.2 billion	There is a need for updated research aimed at evaluating the economic impact of medication errors using standardized definitions for types of errors, their severity, and the ensuing financial impact

Wahr et al. (2017) Medication safety in the operating room: literature and expert-based recommendations	---	Systematic Review	Literature search to identify publications pertaining to medication error and medication safety in the operating room	A total of 138 specific, unique recommendations were made among the publications and guidelines	Changing the time of medication documentation (scan syringe before injection); Reducing opportunities for workarounds; Connecting infusions to the most proximal port; Rigorous vendor selection and training
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APPENDIX C DNP Essentials

DNP Essentials	How the Essential is Achieved
I. Scientific Underpinnings for Practice	This best practice project is based on the most current evidence-based literature and recommended guidelines for color-coded medication labels.
II. Organizational and Systems Leadership for Quality Improvement and Systems Thinking	The evidence-based policy regarding universal color-coded labeling for anesthesia induction drugs has the potential to decrease medication errors, reduce adverse outcomes, and maintain patient safety.
III. Clinical Scholarship and Analytical Methods for Evidence-Based Practice	The extensive literature research and review that was required to provide a best practice recommendation fulfill this essential.
IV. Information Systems/Technology and Patient Care Technology for the Improvement and Transformation of Health Care	
V. Health Care Policy for Advocacy in Health Care	This project aims to provide a best practice recommendation to increase patient safety, provide better outcomes for patients, and decrease medication errors during the anesthesia induction period.
VI. Interprofessional Collaboration for Improving Patient and Population Health Outcomes	This essential is met by collaborating with a panel of experts that are well versed in the process and contribute to the creation of a best practice recommendation.

<p>VII. Clinical Prevention and Population Health for Improving the Nation's Health</p>	<p>This essential is met by examining the current practices, the current guidelines, and recommendations, in order to propose a best practice recommendation. The best practice recommendation will aid in preventing medication errors during anesthesia induction, improve patient outcomes, and maintain patient safety.</p>
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APPENDIX D – Evaluation

Participation in this evaluation is completely voluntary, however, your feedback can provide valuable information to assist SRNAs and CRNAs.

1. Do you consent to participate in the evaluation of this safe practice recommendation on color-coding labeling for anesthesia induction medications?	YES	NO
2. What is your title? CRNA or SRNA?	CRNA	SRNA
3. Are you aware of the recommended guidelines provided by the ASTM on color-coded syringe labels for anesthesia induction drugs?	YES	NO
4. Are you aware that institutions utilize different color-coded labels for anesthesia induction drugs?	YES	NO
5. After participating in this project, do you believe that the implementation of standardized color-coded syringe labels for anesthesia inductions drugs could decrease medication errors and improve patient safety?	YES	NO
6. Please add any recommendations or comments that you have that would make this practice recommendation more effective.		

RECOMMENDATIONS/ COMMENTS:

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