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First Name: * Hilarie Last Name: * Rankin Student ID: *

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DNP Clinical Coordinator Signature	Electronically signed by Lori McGrath on 06/28/2021 5:00:13 PM
DNP Program Coordinator Signature	Electronically signed by Donna Dunn on 06/29/2021 8:33:02 AM
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REDUCING INCIDENCE OF CONTRAST-INDUCED ACUTE KIDNEY INJURY THROUGH NURSING EDUCATION

A DNP Project Submitted to the
Graduate Faculty
of Jacksonville State University
in Partial Fulfillment of the
Requirements for the Degree of
Doctor of Nursing Practice

By

HILARIE HINCY RANKIN

Jacksonville, Alabama

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ABSTRACT

Contrast-induced acute kidney injury (CI-AKI) occurs commonly in patients following percutaneous coronary intervention (PCI) and has been linked to increased patient morbidity, higher risk for cardiovascular mortality, and a large burden of annual healthcare costs. The implementation of evidence-based care standards by nursing staff has been shown to reduce incidence of CI-AKI. Current discrepancies in nursing care have been linked to increased incidence of CI-AKI; therefore, the need for enhanced nurse buy-in with evidence-based protocols is paramount. The primary investigator sought to increase knowledge of CI-AKI and nursing compliance with an established evidence-based protocol at a single center hospital. After evaluating nursing knowledge and compliance with the current protocol, education was provided with visual aids, written materials, and group discussions. Finally, nursing staff were re-evaluated on their knowledge base and self-reported compliance with facility protocols. Results showed an overall increase in nursing knowledge and reported compliance with hospital protocols following education. These outcomes provide evidence that in-service education can increase nursing knowledge of CI-AKI, and compliance rates with nursing care that will aid in reducing this dangerous PCI complication. The same concept could possibly be applied to reduce other common surgical complications in the future.

Keywords: acute kidney injury, contrast, nursing, continuing education

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Introduction

Contrast-induced acute kidney injury (CI-AKI) following percutaneous coronary intervention (PCI) has been shown to increase cardiovascular mortality by 86%, along with independently increasing the risks for acute myocardial infarction, heart failure, and stroke (Odutayo et al., 2016). The exact incidence of CI-AKI varies due to its multiple accepted definitions in the medical literature (Bottinor et al., 2020). Reducing the incidence of CI-AKI drastically decreases cost of healthcare spending and improves patient outcomes. The purpose of this project was to increase nursing knowledge related to CI-AKI and increase compliance with established facility protocols based on standards of care that have been shown to reduce the overall incident rate of this post-procedure complication.

Background

PCI has been on the rise in the United States for the last decade. With the growing number of cases, there have also been reports of increasing numbers of CI-AKI. CI- AKI is the third leading cause of AKI in hospitalized patients, with rates that vary between 3- 14% based on the patient population and the applied definition of AKI (Brown et al., 2016). This seemingly small percentage of patients affected is significant due to the fact that this complication carries serious implications for morbidity and mortality. In a meta-analysis published in the *Journal of the American Society of Nephrology*, it was noted that CI-AKI increased the risk of mortality in hospitalized

patients by 86% while also increasing the risk of heart failure and stroke by 58% and 15%, respectively (Odutayo et al., 2016). It is also noteworthy that CI-AKI accounts for greater than $14 million in healthcare spending annually (Amin et al., 2020).

In the last decade, there have been significant strides in reducing CI-AKI. Due to its' water soluble nature, it has long been acknowledged that the risks associated iodinated contrast can be mitigated with intravascular volume expansion (McCullough et al., 2016). A large multi-center randomized controlled trial has demonstrated the importance of volume expansion with crystalloids as a way to reduce the incidence of CI-AKI (McCullough et al., 2016). Studies have also shown promise in the cost-effective method of allowing patients to orally self-hydrate pre-procedure (Akyuz et al., 2014; Lambert et al., 2017). While new medical interventions to reduce CI-AKI are developed, it is essential to explore the importance of the nursing role in reducing CI-AKI.

Problem Statement

This study examines if increased education regarding contrast-induced acute kidney injury, evidence-based practice (EBP), and hospital policy during training at the time of hire increased reported nurse compliance with completion of hospital EBP-based orders directed at reducing CI-AKI in post percutaneous coronary intervention patients over a 4-week period

Organizational Description of Project Site

CI-AKI is a complication of PCI that will never be completely unavoidable; thus, the goal at the study facility was to keep the percentage of affected patients at less than two percent. During cycles where this goal is not met, root-cause analyses have revealed that some affected patients did not receive adequate intravenous fluid administration pre- or post-catheterization or were kept strictly nothing by mouth (NPO) for an extended period of time before the case. The facility granted the primary investigator the opportunity to evaluate the effectiveness of peer education on increasing compliance with evidence-based nursing interventions that have been linked to reducing the incident rate of CI-AKI.

Review of the Literature

The care of patients undergoing cardiac catheterization has significantly evolved over the last decade. The following literature review synthesized how interventions throughout the catheterization process have changed to reduce CI-AKI and how continuing education of nurses on evidence-based protocols influences the care they provide.

Intravenous Fluids

Iodinated contrast used in cardiac catheterization is water-soluble; thus, it is responsive to fluid volume expansion and increased renal tubular filtration as a means to reduce the likelihood of CI-AKI (McCullough et al., 2016). Before the landmark POSEIDON (Prevention of Contrast Renal Injury with Different Hydration Strategies) trial, all patients undergoing cardiac catheterization received standardized fluid administration at approximately 3 ml/kg/hour for one hour pre-operatively followed by 1.5 ml/kg/hour for four hours post-operatively (McCullough et al., 2016). The POSEIDON trial demonstrated that catering post-catheterization fluid administration to left ventricular end-diastolic pressures (LVEDP) allowed for more aggressive fluid resuscitation. In the LVEDP-guided group, patients received 5 mL/kg/hour if LVEDP was lower than 13 mmHg, 3 mL/kg/hour if LVEDP was between 13 and 18 mmHg, and 1.5 mL/kg/hour if LVEDP was greater than 18 mmHg (McCullough et al., 2016). These parameters remain as the current recommendation set by the American College of Cardiology Foundation (McCullough et al., 2016). This strategy was shown to provide an absolute risk reduction for developing CI-AKI when compared to the previous standard of care and was a landmark study in cementing LVEDP guided fluid volume resuscitation as the standard of care in hospitals nationwide (Brar et al., 2014). The POSEIDON trial has been criticized for only including patients at moderate risk for AKI, and only a small proportion of those with an elevated LVEDP (Brar et al., 2014). More extensive trials examining the effects of LVEDP guided fluid administration in those with high LVEDP are needed to weigh the risk versus benefit ratio for reducing

CI-AKI. Of note, a recent meta-analysis published in the Journal of Interventional Cardiology found that the use of a RenalGuard system for fluid administration, diuretic dosing, and output measurement provided greater benefit in safely reducing CI-AKI than hemodynamic guided volume resuscitation alone; however, this product is still currently in clinical trials in the United States (Cai et al., 2020).

Oral Hydration

Studies conducted in the early 2000s showed that oral hydration before and following cardiac catheterization played a significant role in decreasing the incidence of CI-AKI. In a study published by the *Journal for Interventional Cardiology* comparing the incidence of AKI in patients undergoing coronary angiography (CAG), it was noted that "Oral hydration with or without sodium bicarbonate prior to and following CAG is not inferior to intravenous hydration and sodium bicarbonate with respect to contrast-induced nephropathy (CIN)" (Cho et al., 2010, p.466). A second study published during the same year focused on the outcomes of diabetic patients undergoing coronary angiography and found no statistical significance in the reduction of CI-AKI in patients who hydrated orally and those who received a standardized dose of intravenous normal saline (Wrobel et al., 2010). Due to its low cost and comparable benefit to intravenous saline, peri-operative and post-operative intake of oral fluids is strongly encouraged by most facilities performing coronary angiography. Clear liquids are allowed up until two hours prior to the procedure per recommendations by the American Society of Anesthesiologists (ASA) (American Society of Anesthesiologists [ASA], 2017).

Unproven Interventions

There are several unproven interventions for the prevention of CI-AKI that are heavily discussed in the literature. However, the use of sodium bicarbonate, ascorbic acid, high dose statins, and n-acetylcysteine have shown little benefit in reducing AKI (Sadat et al., 2013; Solomon et al., 2015; Subramaniam et al., 2016). The use of these unproven interventions have not demonstrated a significant enough benefit over the administration of normal saline alone to justify the increase in cost and associated risks to patients (Rudnick, 2020).

Continuing Nursing Education

The focus of this project was to observe how the education of nursing staff on current hospital evidence-based protocols would impact their future behavior that is correlated with reducing the incidence of CI-AKI. The International Prospective Register of Systematic Reviews (PROSPERO) trial examined how e-learning affects nursing knowledge, skills and reactions. Researchers showed that continuing education, provided in an electronic format, produced positive outcomes on nurses' reports of increased knowledge and attitude toward the taught topics (Rouleau et al., 2019). The authors point out that more research is needed to show how e-learning knowledge generated by nursing staff translates into patient care.

Another study published in 2017 by the journal *Critical Care Nurse* examined the incidence of CI-AKI in a 10-hospital healthcare system before and after nursing education on standardized protocols for pre-, intra-, and post-operative care. The study was significantly smaller than the systematic review of PROSPERO but did show

promise for improved patient outcomes with continuing nursing education. The researchers reported a 21% decrease in the incidence of AKI in their hospital network following nursing education (Lambert et al., 2017). Limitations in the study included a short inpatient stay that may not have allowed for tracking of all cases of CI-AKI and survey responder bias, which the authors noted along with the notation that radial access was also introduced during their study timeframe pulling attention away from the CI-AKI improvement project (Lambert et al., 2017).

Conclusions

The use of aggressive LVEDP guided fluid resuscitation for volume expansion and guided oral hydration pre- and post-catheterization has been shown to reduce the incidence of CI-AKI. In addition, much promise was shown in reducing the risk of this common catheterization complication by utilizing nursing continued education to increase nursing compliance with evidence-based interventions (Lambert et al., 2017; McCullough et al., 2016).

Evidenced-Based Practice: Verification of Chosen Option

This project focused on the education of nurses regarding the use of LVEDP guided fluid resuscitation in combination with oral hydration as a means to reduce the incidence of CI-AKI. These two nursing interventions were shown to be the most cost-efficient way to reduce CI-AKI, while the application of in-service training was shown to enhance nursing compliance with reviewed topics (Lambert et al., 2017).

Theoretical Framework/Evidence-Based Practice Model

This project was designed using the Training Evaluation Framework developed by the United States President's Emergency Plan for AIDS Relief's Human Resources for Health Technical Working Group in 2013 (O'Malley, Perdue & Petracca, 2013). Researchers reported that this framework was a reformed version of the Kirkpatrick Model, primarily used to evaluate training models in the industrial setting, which addresses the outcomes of education for healthcare workers (Kirkpatrick & Kirkpatrick, 2009; O'Malley, Perdue & Petracca, 2013). Through data collection and key informant reviews and revisions, the researchers constructed a framework that would examine nine different outcomes related to an educational intervention with healthcare workers. These nine outcomes were categorized into three "nests": individual, organization, and population outcomes. Within each nest, there are three different addressed outcomes. As noted by O'Malley et al., (2013):

> The outcome types are (1) individual knowledge, attitudes, and skills; (2) individual performance; (3) individual patient health; (4) organizational systems; (5) organizational performance; (6) organizational-level patient health; (7) health systems; (8) population-level performance; and (9) population-level health. (p. 1)

The model, demonstrated in Appendix A, shows how the framework divides outcomes into individual nests and interconnects the importance of each.

With this project, we implemented nursing education/training on CI-AKI and the current facility policy regarding pre- and post-care of patients undergoing cardiac catheterization. The education emphasized the fluid resuscitation protocol because it

was shown to be the most cost-efficient intervention to prevent CI-AKI when done correctly. The primary investigator touched on the importance of identifying at-risk patients for this common complication. Nursing staff were evaluated pre- and post-education for their knowledge of CI-AKI pathophysiology, incidence, and hospital fluid resuscitation protocol to assess for knowledge growth. In addition, nurses' competency regarding hospital policy pre- and post-intervention were evaluated to identify growths in individual performance and self-reported compliance. This data allowed us to identify trends pre- and post-education in regard to nursing behavior and how this type of education could affect a larger population of nurses/patients in regard to reducing CI-AKI. Outcomes in the individual nest of this project were reflected in how units of nursing staff performed on knowledge exams pre and post-education. The primary investigator also examined how effectively nursing staff implemented treatment protocols before and after in-service training. Organizational nest outcomes addressed increased compliance with facility protocol. Finally, population outcomes included decreased CI-AKI and decreased morbidity and mortality following PCI.

Goals, Objectives, and Expected Outcomes

The goals of this project were to assess the need for nursing education on CI-AKI following coronary angiography, implement education based on knowledge gaps in regards to pathophysiology of CI-AKI and the current evidenced-based hospital fluid administration policy for patients undergoing PCI, and to evaluate the effectiveness of this education by re-examining nursing knowledge and reported compliance pre and post-education. The objectives of this project were as follows: 1) to increase knowledge of nursing staff at the study hospital in regard to CI-AKI and the current hospital policy for prevention of catheterization complication through in-service education and visual aids displayed in nursing units over a four-week period; and 2) to decrease the incidence of variation from the current evidence-based hospital protocol for fluid administration and oral intake for patients undergoing CI-AKI by hospital nursing staff by reinforcing policy guidelines over a four-week period.

The objectives of this project were measured by administering pre-education exams to establish the knowledge gaps and anonymous surveys that evaluated nursing adherence to the current policy orders. After in-service training was provided, the same exams and surveys were re-administered four weeks later, and the results were compared to the pre-interventions scores and responses. The expected outcomes of this project were: 1) an increase in post-education CI-AKI exam scores of 10 % when compared to pre-education CI-AKI exam scores after four weeks of education; and 2) an increase in post-education compliance with hospital policy regarding fluid administration by 10% when

compared to pre-education compliance rates after four weeks of education.

The PROSPERO systematic review noted an improvement in nursing knowledge in 59% of the included articles and an improvement in nursing attitudes and efficacy in 41% of the included articles (Rouleau et al., 2019). However, the degree of improvement on a scale was not noted within the article as this was a systematic review of 22 studies (Rouleau et al., 2019). Review of the source articles revealed a majority of systematic reviews that also remarked only on the general improvement in scores, but not to a measured degree. After discussing scaling options and goals with facility leadership, it was decided that 10% improvement in knowledge assessment scores and compliance questionnaire responses would be the target outcome for this project. The accomplishment of these outcomes would provide a strong link between the importance of in-service training and increasing the quality of evidence-based nursing care and decreasing the risk for significant morbidity and mortality following PCI.

Project Design

The quality improvement project was designed to reinforce evidence-based protocols in place at the study facility. This study involved evaluating the current nursing staff knowledge on CI-AKI and hospital policies for PCI, educating on these topics, and then re-evaluating their knowledge. A qualitative survey was used to determine compliance with the current policy, and an education assessment pre-and post-training was used to assess the effect of in-service training on nursing knowledge regarding CI-AKI.

Project Site and Population

The project facility was a privately-owned 230-bed acute care hospital in the Southeast United States, providing full-service cardiac care to all regions surrounding the facility and parts of the neighboring state. The facility is owned and operated by a large multi-organization healthcare system that is one of the largest providers of private healthcare in the United States, with over 180 hospitals spanning 21 states (Hospital Corporation of America Healthcare [HCA], 2020). The patient population in this facility was primarily Caucasian and insured, with indigent patients more often seeking care at the local county hospital. The level of patient healthcare literacy varies widely from illiterate to very well versed. Hospital nursing staff had varying levels of education from associate-trained registered nurses (RNs) to master's prepared RNs. Typically, there are low levels of contract nurses in use; however, due to the nursing shortage caused by Covid-19, there was an influx of travel nursing staff throughout the facility.

The hospital has three intensive care units, six stepdown/floor units, and an inpatient rehab unit, along with a wide range of outpatient services. All units, aside from inpatient rehab, cared for patients either pre-or post- PCI. Of the nine areas, two intensive care units are primarily medical intensive care units, with one 12-bed unit designated as the coronary care unit for medically unstable cardiology patients. The other 12-bed area was being used as a Covid-19 intensive care unit. There is an additional 16-bed cardiothoracic intensive care unit and one 34-bed cardiac step-down floor. Aside from the newly designated Covid-19 ICU, these areas provide care for the majority of cardiology patients. Pre- and post- PCI patients were also housed on the

cardiothoracic/vascular step-down floor and the telemetry overflow unit although less frequently than the cardiac step-down floor. The final three inpatient floors (medical-surgical, neuro-ortho, and medical overflow/Covid-19) housed pre-catheterization patients but only retained these patients post-catheterization if there was no coronary intervention. The outpatient cardiac procedures unit prepared and recovered patients following PCI along with performing several other outpatient cardiac procedures that required moderate sedation. In this project, participating nurses were recruited from the coronary care unit, cardiothoracic intensive care unit, outpatient cardiac procedures units, and all inpatient areas described above that participate in PCI care and were not being used for the care of actively infected Covid-19 patients. All participants were age 19 and older. Exclusions from this study included those younger than 19, staff who chose not to participate, and nursing staff employed in units designated as Covid-19 units during the time of project implementation.

Setting Facilitators and Barriers

The project was supported and guided by nursing administration and leadership in the facility. The facility tracked data on CI-AKI for PCI patients, which was intended to be utilized for comparison of CI-AKI incidence rates pre-and post- nursing education. Unfortunately, due to staffing problems associated with the Covid-19 pandemic, the hospital stopped tracking this data, so no post-intervention data was available to the primary investigator. Possible barriers included: a lack of nursing participation and difficulty in distributing education. Education was provided in three different formats (printed copies, power-point via email, and direct in-service) through

work-sponsored emails to ensure delivery to all staff, and nurses were encouraged to participate by nursing leadership.

Implementation Plan and Procedures

Measurement Instruments

Instruments used to measure outcomes for this project included anonymous compliance surveys and knowledge assessments designed by the primary investigator (PI). Copies of the compliance survey and education assessment can be found in Appendix B and C, respectively.

Initially, data on the incident rate of CI-AKI in all patients undergoing PCI who remained in the facility for at least one night was to be gathered for the month directly preceding intervention. However, due to restrictions in staffing secondary to the recent Covid-19 pandemic, the facility was no longer collecting this data. Therefore, the primary investigator obtained the last available data for CI-AKI within the facility for a baseline measurement of incident rate but could not compare this rate to any post-intervention incident rates due to lack of available data. For this DNP Project, CI-AKI was defined as a rise in serum creatinine of 0.3 mg/dL or a 50% increase from the patient's baseline values at 24 hours post-contrast exposure during PCI as recommended by the American College of Cardiology (Zhang et al., 2017).

Participating nursing staff had their pre-training knowledge assessment scored on a 15-point scale with all questions weighed evenly. This information was gathered throughout February 2021, before nursing education was provided. Staff also answered questions on the anonymous compliance questionnaire and provided qualitative

feedback for barriers to care during this same timeframe. The same knowledge assessment and compliance questionnaire were redistributed to participating nursing staff in early December 2020 with identical scoring for comparison of average knowledge in the areas of interest. The pre-and post-intervention data were used to compare improvements in nursing knowledge and compliance rates to evaluate effectiveness of achieving proposed outcomes of the DNP Project.

Data Collection Procedure

Project implementation began with a transparent discussion with nursing staff about the current in-house CI-AKI rate as of August 2020, and how that number compares to national standards. The primary investigator discussed with the nursing staff that this was a voluntary quality improvement in-service for a DNP project, supported by Jacksonville State University, and they could opt-out at any point in time. This same information was communicated with the nursing staff through work-sponsored emails so that 100% of nursing staff would have access to it 24 hours a day. Nurses who wished to participate then received a pre-education test along with a consent form shown in Appendix D. The pre-education test assessed three different key learning points: pathophysiology of CI-AKI, evidenced-based recommendations for volume expansion with intravenous fluids and oral hydration, and current hospital order sets for pre-and post-catheterization procedures. Participants were concurrently provided with a confidential survey which assessed compliance with current order sets in regards to volume expansion and allowed the nurse an opportunity to describe barriers to complying strictly to the hospital protocol.

After participating nurses completed their pre-education screening, the primary investigator began to disseminate education on topics covered in the aforementioned testing. Education was provided in the form of PowerPoints accessed through participants' work emails with hard copies distributed throughout the nursing units and breakrooms. The PI worked in conjunction with the education department at the test facility to determine the most trafficked areas to display pertinent hard copies of the PowerPoint. Face-to-face in-services were conducted in every applicable nursing unit on at least one weekend day shift, one weekend night shift, and one Monday through Friday day and night shift. After education was completed, all participants were given the same educational screening tool to assess retained knowledge on each of the key learning points.

Data Analysis

Knowledge assessments were gathered before and following education on applicable nursing units, and average unit scores were calculated in all units with at least two participants in both pre-and post- education testing. Three of the seven participating units were excluded from the final analysis due to sample sizes of less than two in either pre-or post-intervention testing. The four remaining units for analysis included the cardiology step-down unit (CSD), cardiothoracic/vascular step-down unit (CTSD), cardiac procedures units (CPU), and the coronary care unit (CCU). The number of participants for CSD, CTSD, CPU, and CCU during pre-intervention testing were as follows: 8, 6, 9, and 8. The number of participants during post-intervention testing was 4, 2, 5, and 3, respectively. The mean scores of each unit all

rose following intervention; however, the rise on CSD floor was not statistically significant with a *p*-value of 0.26. The increase in mean values on CTSD, CCU, and CPU were all determined to be statistically significant with *p*-values less than .05. Mean scores, along with *p*-value and confidence intervals, are displayed in the table in Appendix E.

Five questions on the compliance survey were assessed using a five-point Likert scale with one = never and five =always. On all questions, five was the most desirable response indicative of nursing compliance. The same three units excluded in the assessment scores analysis were also excluded in the compliance survey analysis due to a sample size of less than three. For the remaining four units, there was no noted statistically significant change in the average Likert score for question one, with all *p*-values noted to be greater than .05. CSD had an increase in average Likert scores for questions two and four; CTSD had an increase in average Likert scores for questions two and five. Of note, the CTSD unit had identical values in the pre- and post-intervention assessment for question four, which prohibits the analysis of intervention impact on the behavior assessed by this question. CPU had an average increase in Likert scores for questions two, three, and four. CCU had no statistically significant change in Likert scores for any of the five questions. All average scores, along with *p*-values and confidence intervals, are represented in Appendix F.

Results

All four units that had sample sizes large enough for analysis demonstrated an increase in assessment scores greater than 10% when compared to pre-intervention scores. This change was statistically significant in all units with the exception of CSD. Increased knowledge assessment scores provided evidence that in-service education on CI-AKI and hospital policies increased nursing knowledge on both topics, respectively.

Questions in the compliance survey were analyzed individually to target changes in specific behaviors following intervention. Question one coincided with the administration of pre-catheterization fluids. All units reported, on average, a pre-intervention score of at least 4 (corresponding to almost always), and although there were improvements in all of the units' average scores, the increase in average scores was less than 10% and not statistically significant. Question two assessed nursing compliance with administration of ordered oral intake of fluids before catheterization. All of the units had improved compliance scores greater than 10% on question two. Question three assessed the compliance with administration of post-catheterization fluids. CSD, CPU, and CCU areas all had average scores that increased by at least 10% in post-intervention assessments; however, the CTSD floor had decreased average scores in the post-intervention data. Question four corresponded to ensuring patients consumed ordered oral fluids post-catheterization and CCU, CPU, and CSD all had at least a 10% increase in average scores in the post-intervention survey. For this question, the CTSD floor had identical average scores in pre-and post-intervention data. Question five assessed reported compliance with documentation of oral intake of

water in the electronic health record. CCU, CSD, and CTSD all had a greater than 10% increase in reported compliance with this behavior following intervention.

The increase in Likert scores following in-service education reflected an increased level of compliance with evidence-based care and hospital policies that corresponded with reduced incidence of CI-AKI as supported by earlier literature.

Interpretation/Discussion

Unexpected findings uncovered during data analysis included a reported decreased compliance with administration of post-catheterization fluids on CTSD following intervention, and identical average scores on question four of the compliance survey pre-and post-intervention also on CTSD. The reported decrease in compliance could be attributed to new staff hired during the project implementation process that took the post-intervention survey without taking the pre-intervention survey. It could also be attributed to the smaller sample size in the post-intervention data. As for the identical average scores for question four, this is likely related to the fact that most patients returning to this unit following PCI remain for inpatient care and receive meal trays with fluids upon arrival back in their room.

Limitations of this project included a small sample size secondary to limited participation in light of the current Covid-19 pandemic. Staffing shortages made it difficult to obtain data and encourage increased participation from nursing staff or nursing leadership. Time constraints also limited the ability to provide more in-depth education regarding CI-AKI or allow for more volunteers to complete assessments and surveys. While the sample size was large enough to show a correlation between in-

service education and increased knowledge and compliance, these results could be better demonstrated, with the possibility of more statistically significant data, with a larger population. The lack of data available on facility CI-AKI rates post-intervention, secondary to the facility halting this tracking in light of the Covid-19 pandemic, also limited the ability to assess how nursing knowledge and behaviors directly impacts this adverse outcome. Previous studies have shown that increased nursing compliance can reduce CI-AKI rates, but this could not be replicated for this project without post-intervention CI-AKI rates.

This project revealed that in-service education could positively impact nursing knowledge regarding CI-AKI and improve compliance with evidence-based practice to reduce this common and costly PCI complication. This provides hospitals with a low-cost, effective way to help address CI-AKI. It also provides evidence that the same training model could reduce other common surgical complications in the future. Further studies with larger sample groups will be needed to draw a direct correlation between nursing education and CI-AKI rates, and a similar format could also be used to assess how nursing education affects many other common adverse outcomes.

The data from this project will no longer be tracked at this facility, and there will be no ongoing QI project addressing the problem due to staffing shortages and an upcoming management change. However, this project could be easily replicated and implemented by the facility should they choose to do so at a later time.

Cost/Benefit Analysis

The monetary costs for this project were minimal and included cost for producing hard copies of nursing education and assessments/surveys primarily. This cost was covered by the author alone. Time requirements for nursing participants did not exceed more than one hour total, with approximately 30 minutes spent on education and 15 minutes spent on each of the pre-and post- evaluations/surveys. There were no costs to patients as this project focused primarily on quality improvement. The leadership team's time spent on this project was minimized to approving project design, evaluations/surveys, and advising the author on engagement opportunities. The project provided the facility with a zero-cost way to assess the knowledge deficit regarding CI-AKI and hospital policies within the nursing staff, and barriers that prevent nurses from providing complete, evidence-based care. Findings from this project will aid the facility in future projects to eliminate or reduce these barriers.

Timeline

The primary investigator began research, project design, and development in May 2020, with a first draft proposal presented for PERC review in October 2020. Initial IRB approval was obtained in October 2020, but due to changes in facility data collection secondary to Covid-19, revision, and resubmission of IRB was started in early February 2021. The project approval was complete by February 8, 2021, and the primary investigator met with leadership teams within the facility to discuss the implementation of the project for included nursing units on February 9,

2021. On February 12, 2021, nursing staff received the first project notification by direct email from the primary investigator with consent forms and pre-intervention knowledge assessments and questionnaires. Over the week of February 12th- 19th, the author began enlisting nurses into the project and dispersing hard copies of consent forms along with pre-education evaluations and surveys to nursing units. Beginning February 19, education was sent to all nursing staff through work provided email addresses and placed throughout the hospital. This week the primary investigator also began in-person in-service sessions that were completed by February 26. Education materials remained posted throughout the month of February, and nursing staff was encouraged to review the material by both the author and nursing leadership. Starting March 5, 2021, post-education evaluations/surveys were dispersed. Post-education evaluations and surveys were collected by March 12, 2021. Data synthesis on compliance and nursing knowledge began in early March and concluded in April 2021. Poster development and manuscript finalization began in early May, with an anticipated symposium on July 15, 2021. Project findings were also provided to the host facility during the month of July 2021. The timeline appears in Appendix G.

Ethical Considerations/Protection of Human Subjects

The Jacksonville State University Institutional Review Board (IRB) approval was obtained before initiating the DNP project and is located in Appendix H. Approval was also obtained from the study facility before project implementation as seen on the document in Appendix I. Patient privacy was protected by the Health Insurance

Portability and Accountability Act of 1996 (HIPAA) which, among other guarantees, protects the privacy of patients' health information (U.S. Department of Health and Human Services, 2013). All data collected on patients in this project did not contain any specific patient identifiers. There were no risks to patients in this project as it did not involve changing established pre-and post- PCI care, and there was no direct patient care involvement. Participating nurses were given a complete description of the project purpose and aims before implementation, and provided with consent forms that explained the time, costs, and option to opt out of the study. Their evaluation scores and qualitative responses on the survey remained anonymous because data was not evaluated on an individual scale. All responses were stored in a location away from the facility accessible only by the author.

Conclusion

CI-AKI incident rates are a growing problem in the United States as the number of cases of PCI rise (Brown et al., 2016). Studies have shown a link between nursing compliance with evidenced-based volume resuscitation protocols and decreased incidence of this catheterization complication (Lambert et al., 2017; McCullough et al., 2016). The PROSPERO Trial demonstrated links between in-service education for nurses and reported positive changes in nursing behavior and knowledge sets regarding in-service topics (Rouleau et al., 2019). With this knowledge, the primary investigator sought to utilize in-service education regarding CI-AKI and evidence-based protocols to both increase nursing knowledge and modify behaviors that may lead to non-compliance with hospital protocol; thus, actively reducing the risk of CI-AKI in an at-risk population

and subsequently decrease patient morbidity and mortality following PCI.

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APPENDIX A

Framework Model

Figure A1 Model of the Training Evaluation Framework

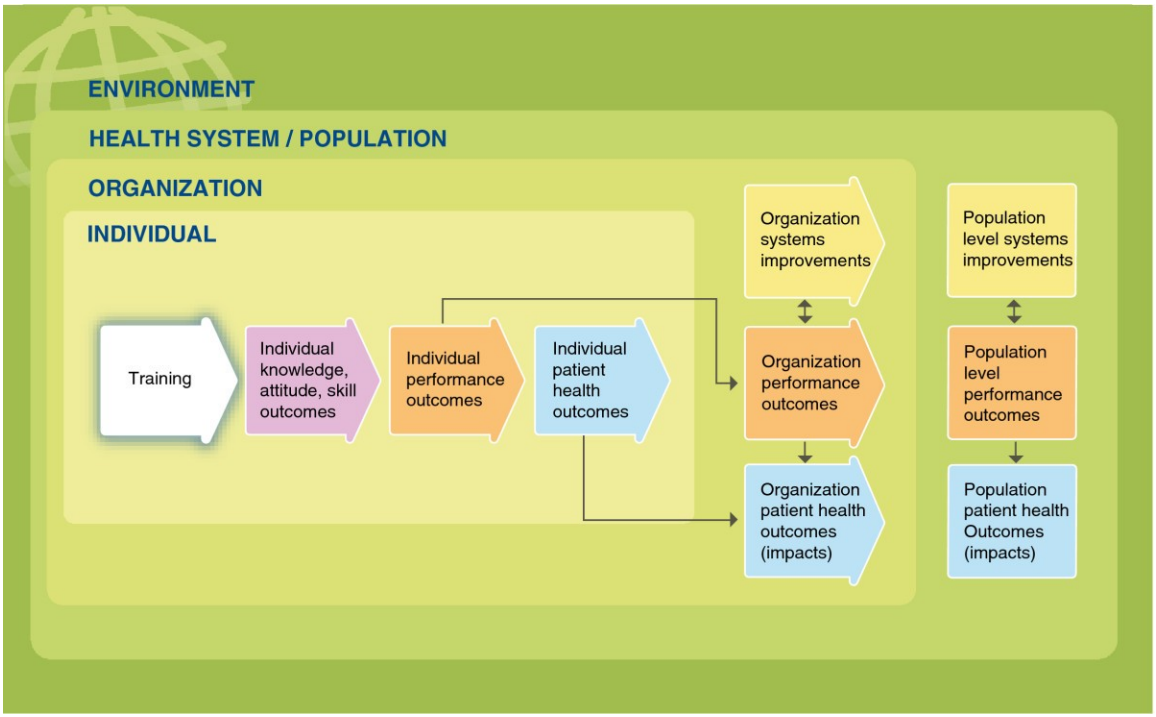


Figure A1. Model of the training evaluation framework with demonstrated outcomes and nests. The three inner most nests represent agents of change while the outermost nest represent the environment in which change occurs. Adapted from "A framework for outcome-level evaluation of in-service training of healthcare worker," by O'Malley, G., Perdue, T., and Petracca F, (October 1, 2013), *Human Resources for Health, 11*(50), p.7. Copyright 2013 by BioMed Central Ltd.

APPENDIX B

Compliance Questionnaire

Figure B1 CI-AKI Anonymous Compliance Questionnaire

CI-AKI Questionnaire

Demographics: Please circle the answer that best applies to you

Education Completed: ADN BSN MSN

Years of experience as an RN: less than 1 year 1-3 years 3-5 years 5-10 years > 10 years

Years of service at the study facility: less than 1 year 1-3 years 3-5 years 5-10 years > 10 years

Years of experience caring for cardiology patients: less than 1 year 1-3 3-5 5-10 > 10 years

# of pre/post catheterization patients cared for weekly: _____

Please rate the following questions from 1 (Never) to 5 (Always). All answers are anonymous and not individually reportable to administrators at the study facility. Group data will be used for quality improvement initiatives within the facility.

1) My patients receive the full ordered volume of their pre-catheterization fluids.
1- Never 2- Rarely 3- Some of the time 4- Most of the time 5- Always

2) My patients consume 16 oz of water within two hours of the start of their heart catheterization.
1- Never 2- Rarely 3- Some of the time 4- Most of the time 5- Always

3) My patients receive the full ordered volume of their post catheterization fluids.
1- Never 2- Rarely 3- Some of the time 4- Most of the time 5- Always

4) My patients consume 16 oz of water post catheterization.
1- Never 2- Rarely 3- Some of the time 4- Most of the time 5- Always

5) I document my patients pre and post procedure water either in Meditech or on intake/output flowsheets.
1- Never 2- Rarely 3- Some of the time 4- Most of the time 5- Always

For any answers where you indicated a value less than 5, please address the reasons for not being able to complete the pre- or post- catheterization order set in its entirety.

_____
_____
_____
_____

Figure B1. CI-AKI compliance questionnaire with Likert scoring and area for subjective answers. Created by Rankin, H., 2020, *Reducing the incidence of contrast-induced acute kidney injury through nursing education*. Unpublished manuscript, Department of Nursing, Jacksonville State University, Jacksonville, Alabama.

APPENDIX C

Contrast-Induced Kidney Injury Assessment

Figure C1. CI-AKI Knowledge Assessment Page One

CI-AKI Knowledge Assessment

1) What portion of the kidney is directly injured by iodinated contrast?
a) Nephron tubules
b) Renal cortex
c) Nephron arterioles
d) Loop of Henle

2) CI-AKI is linked to an oxidative stress reaction that leads to which of the following:
a) Decreased glomerular filtration rate
b) Medullary hypoperfusion
c) Increased blood viscosity through the nephron
d) All of the above

3) Higher osmolarity contrast is associated with a greater risk for cytotoxicity
a) True
b) False

4) Renal cells experience prolonged exposure to contrast media secondary to:
a) Decreased interstitial pressures
b) Decreased urinary output
c) Increased viscosity
d) both B and C

5) The consumption of nitric oxide causes which of the following systemic reactions
a) vasodilation
b) Dehydration
c) Vasoconstriction
d) Tachycardia

Figure C1. CI-AKI knowledge assessment page one with multiple choice questions addressing pathophysiology of CI-AKI. Created by Rankin, H., 2020, *Reducing the incidence of contrast-induced acute kidney injury through nursing education*. Unpublished manuscript, Department of Nursing, Jacksonville State University, Jacksonville, Alabama.

APPENDIX C

Contrast Induced Acute Kidney Injury Assessment

Figure C2. CI-AKI Knowledge Assessment Page Two

CI-AKI Knowledge Assessment

6) Current recommendations for prevention of CI-AKI include the use of sodium bicarbonate
a) True
b) False

7) The current recommendation for fluid administration for prevention of CI-AKI is based largely off left ventricular end diastole pressure (LVEDP) measurements. A patient with an LVEDP of 20 requires which hydration strategy:
a) 5 ml/kg/hr for four hours post catheterization
b) 1.5 ml/kg/hr for four hours post catheterization
c) 3 ml/kg/hr for four hours post catheterization
d) 2 ml/kg/hr four four hours post catheterization

8) According to current CI-AKI prevention recommendations, patients should be advised to hold NSAIDs for:
a) 12 hours pre procedure
b) 72 hours pre procedure
c) 24 hours pre procedure
d) 36 hours pre procedure

9) In patients with an LVEDP less than 13, the current hydration recommendation would be:
a) 5 ml/kg/hr for four hours post catheterization
b) 1.5 ml/kg/hr for four hours post catheterization
c) 3 ml/kg/hr for four hours post catheterization
d) 2 ml/kg/hr four four hours post catheterization

10) Best practice dictates that patients be advised to remain strictly NPO for at least 12 hours pre-catheterization
a) True
b) False

Figure C2. CI-AKI knowledge assessment page two with multiple choice questions addressing evidence-based practice related to CI-AKI. Created by Rankin, H., 2020, *Reducing the incidence of contrast-induced acute kidney injury through nursing education*. Unpublished manuscript, Department of Nursing, Jacksonville State University, Jacksonville, Alabama.

APPENDIX C

Contrast-Induced Acute Kidney Injury Assessment

Figure C3. CI-AKI Knowledge Assessment Page Three

CI-AKI Knowledge Assessment

11) Patients at the study facility are allowed, and encouraged to consume up to 16 oz, clear liquids until two hours prior to catheterization to promote adequate hydration:
a) True
b) False

12) Your patient, who does not have CHF, returns from the catheterization lab with normal saline infusing at 0.5 ml/kg/hr with no defined stop time. Upon searching Meditech you find no post catheterization orders. You should contact:
a) The attending hospitalist
b) Cath lab staff
c) The cardiologist who performed the procedure
d) Cardiology clinical navigator at extension 8218
e) C or D

13) For inpatient catheterization patients, IV fluids are to be started at 2100 the night prior to the procedure at a rate determined by the cardiologist
a) True
b) False

14) Patients at the study facility receive acetylcysteine to prevent CI-AKI:
a) True
b) False

15) Post PCI order sets at the study facility contain an order for PO water. How many ounces of water are you ordered to encourage and document to assist in adequate hydration status?
a) 20 oz
b) 12 oz
c) 16 oz
d) 8 oz

Figure C3. CI-AKI knowledge assessment page three with multiple choice questions addressing hospital policies related to CI-AKI. Created by Rankin, H., 2020, *Reducing the incidence of contrast-induced acute kidney injury through nursing education*. Unpublished manuscript, Department of Nursing, Jacksonville State University, Jacksonville, Alabama.

APPENDIX D

Participation and Consent Form

Figure D1. Facility Consent Form for CI-AKI Project

Reducing Incidence of Contrast Induced Acute Kidney Injury Through Nursing Education

Purpose: Assess the role of education on nursing knowledge of contrast induced acute kidney injury (CI-AKI), nursing compliance with hospital policies, and rate of CI- AKI.
Method: This is a quality improvement project designed to reinforce the evidenced-based protocols in place at the study facility. This study will involve evaluating the current nursing staff knowledge on CI-AKI and hospital policies for PCI, educating on these topics, and then re-evaluating their knowledge. We will use a qualitative survey to determine the compliance with the current policy and use education assessments pre- and post- training to assess the effect of the in-service training on nursing knowledge and self-reported compliance with hospital evidenced based policies and CI-AKI.
Location: Medium sized rural acute care hospital in Northwest Georgia
Estimated Length of Participation: 4 weeks
Risk: Time required to participate, approximately one-hour total
Benefits: Participants will increase their knowledge base regarding CI-AKI and hospital policies. The facility will glean an insight into reasons why nurses may not be able to complete prevention protocols. Patients could potentially see reduced risk of CI-AKI.
Confidentiality: No identifying information will be present on knowledge assessments or questionnaires. Consent forms will contain participant signature and will located in a secured filed cabinet accessible only by Hilarie Rankin (primary author). These records will be maintained for up to one-year post study.

****Participation is voluntary, refusal to participate will involve no penalty or loss of benefits to which the participant is otherwise entitled. Participants may withdraw from the study at any time without penalty. For questions related to the study contact Hilarie Rankin, Stephanie Jones or Dr. Jolie Wildinger at**
Hilarie.Rankin@hcahealthcare.com
Stephanie.Jones3@hcahealthcare.com
Jolie.Wildinger@jsu.edu

Figure D1. CI-AKI DNP Project Consent forms provided to nursing staff with copies of pre-education assessments, education packets, and post-education assessments. Created by Rankin, H., 2020, *Reducing the incidence of contrast-induced acute kidney injury through nursing education*. Unpublished manuscript, Department of Nursing, Jacksonville State University, Jacksonville, Alabama.

APPENDIX E

Knowledge Assessment Data By Unit

Table E1

Sample size, mean scores, p-values, and confidence intervals for each nursing unit. Created by Rankin, H., 2020, *Reducing the incidence of contrast-induced acute kidney injury through nursing education*. Unpublished manuscript, Department of Nursing, Jacksonville State University, Jacksonville, Alabama.

UNIT	SAMPLE SIZE PRE	SAMPLE SIZE POST	MEAN SCORE PRE	MEAN SCORE POST	*P*-VALUE	CONFIDENCE INTERVAL
CSD	8	4	70.0	85.0	0.2578	-0.18- 0.48
CTSD	6	2	65.6	93.3	0.0003279	0.20-0.36
CCU	9	5	75.6	94.6	0.0006811	0.10-0.28
CPU	8	3	72.5	91.1	0.001466	0.09-0.28

APPENDIX F

Compliance Questionnaire Data By Unit

Table F1

Mean scores, p-values, and confidence interval to each question represented on the compliance survey. Created by Rankin, H., 2020, *Reducing the incidence of contrast-induced acute kidney injury through nursing education*. Unpublished manuscript, Department of Nursing, Jacksonville State University, Jacksonville, Alabama.

QUESTION NUMBER	UNIT	SAMPLE SIZE PRE	SAMPLE SIZE POST	MEAN SCORE PRE	MEAN SCORE POST	*P*-VALUE	CONFIDENCE INTERVAL
1	CSD	8	4	4.13	4.25	0.6751	-0.615 - 0.865
	CTSD	6	2	4.40	4.50	0.8879	-2.230 - 2.430
	CCU	9	5	4.00	4.20	0.4615	-0.386 - 0.786
	CPU	8	3	4.00	4.00	1	-0.774 - 0.774
2	CSD			3.75	5.00	0.001565	0.659 - 1.841
	CTSD			3.83	5.00	0.01268	0.377- 1.957
	CCU			3.33	4.20	0.1151	-0.253 – 1.987
	CPU			4.38	5.00	0.0112	0.192 - 1.058
3	CSD			4.13	4.25	0.6751	-0.615 - 0.865
	CTSD			4.50	4.00	0.07559	-1.075 - 0.075
	CCU			4.67	4.80	0.6205	-0.453 - 0.720
	CPU			4.63	4.00	0.0112	-1.058 - 0.192
4	CSD			4.00	5.00	0.007247	0.368 – 1.632
	CTSD	NO DATA ANALYSIS SEE DISCUSSION					
	CCU			3.78	4.60	0.1445	-0.342 - 1.986
	CPU			4.50	5.00	0.03315	0.053 - 0.947
5	CSD			3.22	4.25	0.1694	-0.529 - 2.584
	CTSD			2.83	5.00	0.01545	0.622 - 3.711
	CCU			3.78	4.20	0.241	-0.324 - 1.168
	CPU			4.50	4.67	0.7131	-0.943 - 1.277

APPENDIX G

Project Timeline

Table G1 Project development, implementation and analysis outlined by month. Created by Rankin, H., 2020, *Reducing the incidence of contrast-induced acute kidney injury through nursing education*. Unpublished manuscript, Department of Nursing, Jacksonville State University, Jacksonville, Alabama.

Task	May-Aug 2020	Sep 2020	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	March 2021	April 2021	May 2021	June 2021	July 2021
Project Design and Development	X	X	X	X		X	X					
PERC and IRB application/ revision		X	X									
PERC and IRB approval			X				X					
Manuscript revisions	X	X	X	X	X	X	X	X	X	X	X	
Obtaining/Communications with Preceptor	X	X	X	X	X	X	X	X	X	X	X	X
Meetings with Site Leadership							X Feb-9th					
Deployment of Pre-intervention assessments and questionnaires							X Feb 12-19th					
Education of nursing staff							X Feb 19-th28th					
Deployment of Post-intervention assessments and questionnaires								X March 5th- 12th				
Data synthesis								X	X	X		
Poster design										X	X	
DNP symposium/Findings distributed to host site												X

APPENDIX H

IRB Approval Letter

Figure H1. DNP Project IRB Approval Letter

October 15, 2020

Dear Hilarie Rankin:

Your proposal submitted for review by the Human Participants Review Protocol for the project titled: "Reducing Incidence of Contrast Induced Acute Kidney Injury Through Nursing Education" has been approved as exempt. If the project is still in process one year from now, you are asked to provide the IRB with a renewal application and a report on the progress of the research project.

Sincerely,

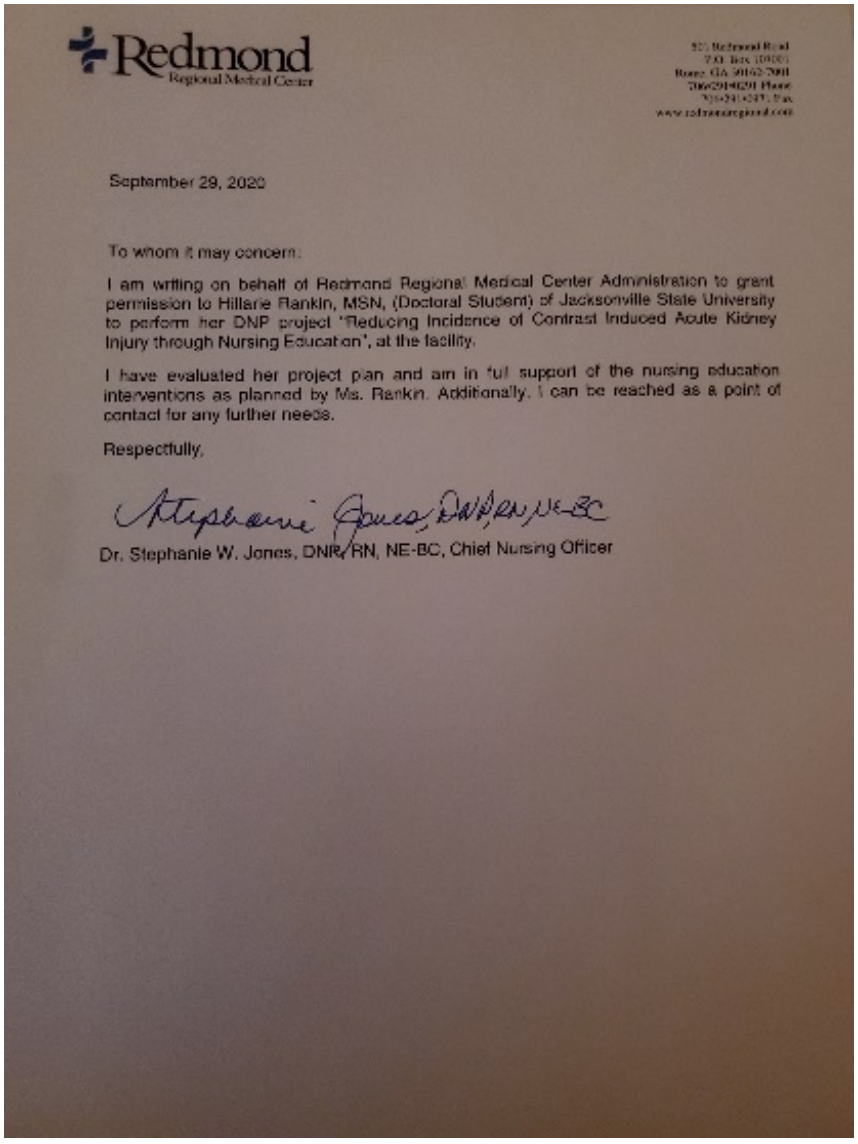
Joe Walsh
Executive Secretary, IRB

JW/dh

APPENDIX I

Facility Approval Letter

Figure I1 Facility Approval Letter for DNP Project



Redmond Regional Medical Center

[redacted]

September 29, 2020

To whom it may concern:

I am writing on behalf of Redmond Regional Medical Center Administration to grant permission to Hillarie Rankin, MSN, (Doctoral Student) of Jacksonville State University to perform her DNP project "Reducing Incidence of Contrast Induced Acute Kidney Injury through Nursing Education", at the facility.

I have evaluated her project plan and am in full support of the nursing education interventions as planned by Ms. Rankin. Additionally, I can be reached as a point of contact for any further needs.

Respectfully,

Stephanie Jones, DNP, RN, NE-BC

Dr. Stephanie W. Jones, DNP, RN, NE-BC, Chief Nursing Officer