A Process for Pre-Scan Intravenous Fluid Hydration Orders to Prevent Contrast-Induced Nephropathy

DNP Final Project

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Abstract

Using contrast medium (CM) in computed tomography (CT) scans has become increasingly common in therapeutic evaluation and diagnostic purposes for cancer patients. There is significant health risks associated with the use of CM especially for acute kidney injury (AKI). These risks depend upon the patients' comorbidities, and they can be mitigated through pre-scan hydration. At a designated NCI-NCCN outpatient skin oncology clinic, a process for ordering pre-scan hydration for cancer patients during the clinic focusing on patients age 70 years or older, was developed. The object was to provide education on prevention of contrast-induced nephropathy (CIN) with the goals of increasing the number of pre-scan intravenous fluid (IVF) hydration orders placed when ordering scans and identify barriers to placing these orders from providers. For this quality improvement project, the Plan-Do-Study-Act (PDSA) cycle was utilized as the methodology. The project included an educational intervention targeting clinicians, nurses, and schedulers. This intervention also included questions about the barriers to ordering the pre-scan IVF hydration. The expected outcome was to increase the hydration orders by 10% within two months. After two months of implementation, the results showed an increase in pre-scan IVF hydration orders from 17.6% (pre-implementation) to 24% after implementation. In summary, the project showed that developing a process for ordering pre-scan IVF hydration and education on CIN improved the rates of pre-scan IVF hydration orders in the outpatient skin oncology clinic.

Keywords: contrast-induced nephropathy (CIN), outpatient oncology, acute kidney injury (AKI), pre-scan hydration, contrast medium computer tomography (CM CT), quality improvement, PDSA

Section 1: Problem Identification & Recommendations Best Evidence-Based Practice

Statement of the Problem

Contrast media computed tomography (CM CT) scans are increasing used for evaluating tumors, staging cancer, assessing treatment response, and detect risks of progression or relapse, according to the National Comprehensive Cancer Network (NCCN) Guidelines version 3.2024. It is recommended that stage III to stage IV cancer be monitored and evaluated through CT scans approximately every three months (NCCN, 2024). CM CT is associated with an increased risk of acute kidney injury (AKI) (Gupta et al., 2023; Salahudeen et al., 2012; Schilp et al., 2014; Vemireddy & Bansal, 2023; Wee et al., 2021). The probability of developing AKI due to CM CT in patients with normal kidney functions, when creatinine levels are more than 25% above baseline, is approximately 20%. In contrast, this risk rises to 78% in patients with renal impairment (Davenport et al., 2020).

For cancer patients, the risk of AKI from CM CT increases from 17.5 % in the first year following diagnosis to 25% within five years (Christiansen et al., 2011). Those with a 50% increase in serum creatinine (SCr) levels are at an even higher risk for AKI (Christiansen et al., 2011). Since there is no definitive treatment for AKI, preventing contrast-induced nephropathy (CIN) becomes crucial.

Definition of AKI and Pathophysiology

Historically, contrast-induced acute kidney injury (CI-AKI), also known as CIN, refers to the occurrence of AKI following the administration of CM. Currently, there is no direct evidence linking CM as a definitive cause of AKI; rather, it appears to result from multiple factors.

Consequently, the proposed new term is contrast-associated acute kidney injury (CA-AKI) (Vemireddy & Bansal, 2023).

The Kidney Disease Improving Global Outcomes (KDIGOs) has defined AKI based on several criteria, rather than grading levels of AKI. These criteria include: an increase in SCr by ≥ 0.3mg/dl (≥ 26.5lmol/l) within 48-hour period; a rise in SCr to ≥ 1.5 times baseline, known or presumed to have occurred within the preceding seven days; or urine output of less than 0.5ml/kg/h for six consecutive hours (KDIGOs, 2025).

Due to its high osmolarity and ionic strength, CM can induced AKI. This may alter tubular flow rates and lead to local ischemia by increasing the energy demands for reabsorbing this elevated osmolar load (Vemireddy & Bansal, 2023). Additionally, cancer can create metabolic obstructions caused by changes in humoral factors and nephrotoxic treatments, which can impair renal function and contribute to a higher incidence of CIN (Cicin et al., 2014).

Organizational assessment of the problem and readiness for changes.

Research shows that AKI significantly increases mortality rates, length of hospital stays (LOS), and healthcare costs across different age groups, genders, and among patients with chronic kidney disease (CKD) (Chertow et al., 2005). Notably, the LOS for patients with AKI is an average of 3.6 days longer (Schilp et al., 2014). In cancer population, those with AKI have a LOS that is double that of non-AKI cancer patients, averaging 10 days compared to 5 days. Additionally, the cost of hospitalization for AKI cancer patients is $82,835, compared to $40,164 for those without AKI (Salhudeen et al., 2012).

Oncology patients typically undergo restaging CT scans with contrast at least every three months to evaluate their disease and response to treatment. However, the increased use of CT

scans has elevated the risk of CIN, highlighting the urgent need to prevent further medical complications and reduce healthcare costs. At a Midwestern National Cancer Institute (NCI)-Designated Cancer Center outpatient skin oncology clinic, there is no standardized procedure for ordering pre-scan intravenous fluid (IVF) hydration.

Therefore, this Doctor of Nursing Practice (DNP) quality improvement (QI) initiative was to develop a procedure for ordering pre-scan IVF hydration in the high-risk CA-AKI oncology population at the clinic. This project was carried out in collaboration with stakeholders and is designed to be attainable and sustainable, with measurable and positive outcomes that could be replicated.

Background and significance of the problem

Several risk factors are associated with impaired kidney function following CM CT scans. These factors include CKD, older age, dehydration, diabetes mellitus, hypertension, congestive heart failure, cirrhosis, various cancers such as lymphoma, leukemia, multiple myeloma, kidney cancer, liver cancer, and peritoneal carcinomatosis (Christiansen et al., 2011; Cicin et al., 2014; Davenport et al., 2020; Gupta et al., 2023; Hong et al., 2016; Latcha et al., 2018; Ng et al., 2020; & Salahudeen et al., 2012). The use of nephrotoxic medications including NSAIDs, and ACE inhibitors/angiotensin receptor blockers (ARBs), or the administration of repeat CM within 48 hours or less than 60 days, can increase the risk of AKI (Cicin et al., 2014; Davenport et al., 2020; Gupta et al., 2023; & Latcha et al., 2018).

The preliminary data for this project was collected from January 1, 2024, to June 6, 2024. The selection criteria for data included participants age 70 years or older along with information on gender, the number of CT scan orders, and the number of pre-scan IVF

hydration orders placed. Age was chosen for evaluation because it is a significant risk factor that is not consistently monitored in the clinic, despite being supported by the evidence-based practice (EBP) literature. Other important risk factors considered were elevated creatinine levels and decreased estimated glomerular filtration rate (eGFR) values; however, these measures were unavailable for the deidentified dataset. The internal radiology team monitored these risk factors before the scheduled CT scans, according to their internal protocol. Additionally, other comorbidities such as cancer diagnoses, diabetes mellitus, and hypertension could not be included in the deidentified dataset. Preliminary findings revealed that only 11 IVF orders were placed out of 133 CM CT scans, resulting in an 8% rate of IVF hydration orders for the requested scans.

PICO(t) and search strategy

The PICO question formulated for the literature search was: In adult cancer patients receiving contrast scans (P), how does screening (I) compare to no screening (C) in terms of its effect on contrast-induced nephropathy (O)?

The search primarily utilized the nursing database CINAHL, with additional records reviewed through PubMed, Embase, and Cochrane. The search terms included "contrast CT scans," "contrast media," "adult/s," "older adult/s," "elderly," "cancer," "contrast-induced nephropathy," "intravenous fluids," and "outpatient." The search results were limited to clinical trials, meta-analyses, randomized controlled trials, reviews, systematic reviews, full texts, free full texts, and articles published in English within the last ten years. All relevant resources were identified, screened for eligibility, and appraised for final inclusion (see Appendix A). The EBP

articles were reviewed for critical appraisal of literature and synthesis review for the project (see Appendices B, C, D).

Review of the literature

Hydration, whether administered orally or intravenously, increases intravascular volume, dilutes the overall intravascular contrast load in the bloodstream, and promotes diuresis. Therefore, it is one of the most important interventions for preventing CA-AKI (Cicin et al, 2014; Davenport et al., 2020; Schilp et al., 2014; & Wee et al., 2021). However, preventative measures are often underutilized (Lee et al., 2014).

These recommendations and studies primarily apply to the inpatient population. In outpatient settings, there is often a time constraint regarding hydration administration. A retrospective study indicates that it is safe to provide hydration over a short period such as using 250 ml of normal saline intravenously for half an hour before and after CM CT in patients with an eGFR of 30-40 mL/min/1.73m^2 (Wee et al., 2021). For patients with an eGFR of 45-60 mL/min/1.73m^2, providing a 500 ml bottle of mineral water with encouragement to drink as much as possible before the scans and the remainder afterward is also effective.

Additionally, patients can take a total of 500 ml of fluid through combination of oral and intravenous routes (Wee et al., 2021). This approach alleviates inconvenience, reduce costs, and allows for more efficient scheduling by minimizing the need to reschedule or postpone cases, ultimately freeing up slots for more acute inpatients (Wee et al., 2021).

Recommendations

One recommended approach to preventing AKI is perform a pre-screening for various risk factors. These risk factors include CKD, age, congestive heart failure, dehydration, diabetes

mellitus, hypertension, cirrhosis, nephrosis, anemia, a cancer diagnosis, and the use of nephrotoxic medications. Although there is no clear consensus on when these factors begin to pose a threat, the literature suggests that the starting age could be 48 and 70 (see Appendix C). For the purposes of this project, we propose the evaluation of individuals aged 70 years or older.

For high-risk cancer patients, it is recommended to implement pre-scan IVF hydration following the outpatient guidelines from Wee et al. (2021). To enhance the convenience for outpatient skin oncology patients, we are administering 500 ml NS over an hour. Additionally, to further improve patient convenience, IVF hydration provided during the hour when patients consume the oral contrast prior to their CT scan. Please refer to Appendices B-D for the relevant literature and evidence synthesis tables.

Section 2: Project Planning

Project Purpose and Objectives

The purpose of this DNP QI project was to implement a process for ordering pre-scan IVF hydration for the high-risk CA-AKI cancer population aged 70 or older at an outpatient skin oncology clinic. The aims of the project were to:

1. Increase the number of pre-scan IVF hydration orders by 10% for high-risk CA-AKI cancer patients aged 70 years or older.
2. Identify barriers to entering the pre-scan IVF hydration orders in high-risk CA-AKI cancer patients aged 70 years or older when placing the CT scan orders.

Framework/Models to drive process

The framework for this QI project was the Plan-Do-Study-Act (PDSA) (Sideris & Stosky, 2012) (Figure 1). PDSA is one of the multiple quality improvement methods used for healthcare evaluation. It has a four-step problem-solving model used to improve processes or implement change. The first step was the *Plan,* which is identifying the goal of the project. The second step was *Do*, which was implementing the *Plan* to meet the goal. The *Study* step compares the predicted data outcomes to achieve data outcomes. The last step was *Ac*t, where the data from the three previous steps were reviewed and analyzed to create an improved executed plan.

Population

This midwestern NCCN-designated comprehensive cancer center skin oncology patient clinic population included, on average, 78% malignant melanoma, 9.6% cutaneous squamous cell carcinoma, 3.5% basal cell carcinoma, 4.4% Merkel cell carcinoma, and 4.5 % other cancers. The skin oncology patient population had approximately 19.2% of Stage II, 27% Stage III, and 53.3% Stage IV cancers. The medical providers included in this clinic were medical oncologists and advanced practice providers (APPs) for skin cancer treatment and surveillance. The standard recommendation for this patient population is to receive restaging CT scans with contrast at least every 3 months to evaluate the tumor and treatment response (NCCN, 2024).

Section 3: Implementation

The Plan-Do-Study-Act (PDSA) cycle is an interactive process for continual quality improvement (CQI) in healthcare (Sideris & Stosky, 2012). Therefore, implementing evidence-based practices (EBP) for screening patients with a potential risk of developing contrast-induced nephropathy (CIN) and providing the appropriate pre-scan IVF hydration recommendation was critical for a quality improvement project.

Variables influencing ordering IVF hydration when entering scan orders were individual, patient, education/training, teamwork, working conditions, equipment/resources, communication, and organizational factors. The project's two most significant changes or variables were providing synthesized EBP findings to stakeholders to persuade them to participate in the project and educating clinicians (physicians and advanced practice practitioners (APPs)), nurses, schedulers, and patients about the benefits of preventing CA-AKI by having pre-scan hydration. The student author of this project was an APP within this clinic. The planned outcome measures were the number of scan orders, and the number of IVF hydration orders placed during the skin oncology clinic visit during the implementation period, compared to the time immediately before the implementation, expressed as a percent change. Additional demographic de-identified data collected were age, gender, and type of skin cancer. Clinician-perceived barriers to placing orders were collected during the education session.

The following section describes the steps that were taken for this project from inception to completion under the first three (PDS) headings of the PDSA cycle steps.

Plan

The project's plan started with a spirit of inquiry, framed by a PICO question. This was followed by a literature review and the establishment of goals for the QI project. The stakeholders identified included the primary clinic nurses, clinicians, patients, the scheduling team, and the nurse manager. A physician champion, who was part of the clinical team at the outpatient skin oncology clinic, supported the project. The student obtained permission to use de-identified institutional data (see Appendix E), and the Human Subjects Determination form was completed (see Appendix F).

Do

The QI project education was presented, individually, to four outpatient skin oncology clinic clinicians. This educational document was 1-2 pages long and included information on the following topics (see Appendix G):

1. Evidence to support screening patients at risk for Contrast-Associated Acute Kidney Injury (CA-AKI).

2. The recommended pre-scan IVF hydration orders and rationale, and data demonstrating renal improvement associated with pre-scan IVF hydration.

4. Instructions on how to utilize the appropriate IVF order set available in the EPIC medical record system.

5. Long-term cost benefits of implementing these practices.

The EPIC standardized order set prompted clinicians to complete all necessary information for the hydration nurses on the scan day. It also assisted the scheduling team in ensuring that patients were scheduled in the correct location and at the appropriate time on the day of their scan. The schedulers and nurses were educated about the reason for the additional order and the appropriate scheduling of pre-scan IVF with the patient's upcoming CT scans. This process created an approach for outpatient skin oncology cancer patients who met the criteria for pre-scan IVF hydration to receive the appropriate pre-scan IVF hydration at the time of ordering the CT scan at the time of the clinic visit. The specific order set utilized was "Ambulatory Referral to Infusion Clinic," which included a note for "pre-scan IVF of 500 ml NS over an hour" and used the "Encounter for Hydration Prior to CT Scan" diagnosis, code Z29.89. During the QI project education sessions, clinicians were given the opportunity to identify their

barriers to ordering pre-scan IVF hydration using the EPIC order set when placing the CT scan orders during the clinic visit.

Study

For this phase of the process, a request was made to the cancer data analytics team to provide de-identified demographic data (age, gender, cancer diagnosis, the number of pre-scan hydration orders, and the number of ordered CT scans) two months before the implementation and every two weeks after the start of the implementation. Receiving data every 2 weeks would have allowed for the identification of barriers to placing orders early on and allow for prompt mitigation, however, the data were only able to be provided for the two months before to implementation and at the end of the two months of implementation.

Since data were unavailable every two weeks during the process, open communication was crucial to ensuring successful project implementation in a multidisciplinary team that included clinicians, patients, schedulers, and staff. Informal meetings were held during the clinics with the four clinicians to discuss any issues that occurred during the intervention. The APN student nurse provided the support by being in person or through electronic communications such as email, internal messaging, or phone calls/texting. Intermittently, the student was present in each clinician's clinic to reinforce the education printout displayed in the clinic room as a reminder. Positive feedback and constructive inputs

During the project, Hurricane Helen caused an IVF hydration shortage, which affected extensive facilities that produced IVF bags. However, this did not affect the cancellation of IVF hydration orders during the project's implementation. As data were only provided and analyzed one time "**Act**" will be described in the discussion.

Section 4: Results

Results

During the project implementation period (November 25, 2024- January 25, 2025), ninety patients had a diagnosis of skin cancer, were at least 70 years old, and had a CT scan ordered during their visit. Of these, twenty-two had pre-scan IVF hydration orders placed at the time of their visit (24%). This result was compared to the pre-implementation period where 17.6% of the CT orders placed during the clinic visit also had pre-scan IVF hydration orders placed (See Table 1).

Table 1: Pre-implementation* and Post-implementation# Data

	Pre-Implementation	**Post-Implementation**
CT Scan orders placed	102	90
Male	62	46
Female	40	44
Age Range	70-94	70-91
Pre-scan IVF hydration order placed	18	22
Male	12	14
Female	6	8
Age Range	70-94	70-91
Percentage of Pre-Scan IVF hydration order placed	17.6%	24.4%

***September 24, 2024 - November 24, 2024**
#November 25, 2024- January 25, 2025

The clinician reported barriers from the QI project education sessions as “lack of time” during a busy clinic to review patients’ comorbidities for CA-AKI, “patient refusal,” and medically contraindicated (congested heart failure).

Interpretation/Discussion/Implications

The first aim of this implementation for the process of ordering pre-scan IVF hydration was to increase the number of pre-scan IVF orders by 10 percent for high-risk CA-AKI cancer

patients age 70 years or older. The data showed that during the two months of implementation, the percentage of IVF orders increased from 17.6% to 24%, which was below the targeted increase of 10%. Of note, there was an increase in the percentage of IVF orders placed for CT scan visits between the preliminary data collection (January 1, 2024, to June 6, 2024) of 8%, to the pre-implementation data collection (September 24, 2024 - November 24, 2024) of 17.6%. This increase between the preliminary data and pre-implementation periods could be due to discussions about this project with the clinical team and during clinic time. The increase in the percentage of IVF orders between the preliminary data collection period and the post-implementation period was higher than 10%. As a result, the implementation had an improvement in the number of pre-scan IVF hydration orders.

The project faced several limitations. The plan was to have the data available every two weeks to align with the PDSA framework, which would facilitate necessary intervention changes during implementation; however, this data was not available. There was no tracking of the number of patients who received the IVF hydration as ordered. Additionally, the actual number of patients who received the IVF hydration may be more then recorded due to another internal CIN prevention program from the radiology team, which mandate that the ordering team be contacted for IVF hydration orders placed if eGFR was <30mL/min/1.73m^2. Furthermore, the data on IVF hydration orders placed after clinic was not included in the information gathered. There was also a lack of documentation regarding the patient's perspectives or feedback on their hydration or scheduling experiences. Lastly, no education was provided to the primary nurses about the ordering process, as one of the clinicians depended on the primary nurses to assist with entering the orders.

The second aim of the project was to identify barriers to entering the pre-scan IVF hydration orders from the clinicians. The main consensus from the four clinicians was the lack of time to enter the orders during busy clinics. To streamline the ordering process, the clinicians were able to add the orders to their 'favorites' order set. However, there was no follow-up on clinician's feedback after the project was implemented.

Another limitation during the implementation was the occurrence of two major holidays, Thanksgiving and Christmas, within the two-month period. During these weeks, there were fewer clinics due to clinician vacations. Once the clinics were back to full capacity, there could have been a reintroduction of the project to remind clinicians about the implementation and the pre-scan hydration order sets. Although a one-page education sheet was displayed in the clinic provider team rooms, it might not have been sufficient to reinforce the changes.

Sustainability Plan

The sustainability points from the project implementation:

1. The "ambulatory referral infusion" order with the comment "pre-scan IVF hydration of 500 ml over an hour" was saved in each clinician team member's 'favorite' orders in IHIS for easy access.

2. The one-page EBP education on contrast-induced nephropathy was displayed in the clinic as a reminder to evaluate patients for pre-scan IVF hydration.

Recommendations for next steps

Despite the short timeframe for the project implementation, there was a noticeable increase in the number of pre-scan IVF hydration orders at the time of the CT scan. It is recommended to continue reinforcing education on screening the patients for CA-AKI

comorbidities and to order appropriate IVF hydration accordingly. The education paper should be available in the clinic room to serve as a reminder of the recommendations.

Additionally, it is important to provide CA-AKI education to our nursing and scheduling teams, enabling them to emphasize the hydration orders with patient. A significant next step could be to integrate CA-AKI prevention education into the orientation process for all new clinicians. Raising awareness about CA-AKI prevention in the high-risk skin oncology population undergoing CM CT scans will require ongoing efforts with education until it becomes a standard part of clinic practice.

Section 5: Dissemination

The findings from this DNP project will be shared during the internal team meetings, including the monthly Melanoma Disease Specific, as well as through a poster presentation at external conferences, such as the Annual APP Conference at The Ohio State University Wexner Medical Center and the Ohio Association of Advanced Practice Nurses Statewide Conference.

This project addressed all ten essentials of the ACCN's *The Essentials: Core Competencies for Professional Nursing Education* (2021 for DNP education. Nevertheless, two primary essentials guided this DNP initiative: Essential 5 and Essential 7. As a DNP-prepared nurse, the focus on Essential 5 is to utilized data-driven benchmarks from the EBP literature reviews to enhance the process of implementing pre-scan IVF hydration orders in the outpatient oncology clinic during the project. The object was to improve the prevention of CA-AKI for patients undergoing CM CT scans by increasing the number of orders for pre-scan IVF hydration. Completing the EBP DNP project has positively impacted patient safety and has contributed to mitigating the risk of CA-AKI in the cancer patient population.

Essential 7 focused on systems-based practice. According to Saluhudeen et al., (2012), the average cost for a cancer patient with AKI was approximately $82,835, leading to an extended hospital stay of 10 days. By introducing evidence-based practice (EBP) literature to the clinical team, we aimed to enhance education about preventing contrast-induced nephropathy. This education was specifically designed to increase the number of pre-scan intravenous fluid (IVF) hydration orders. By concentrating on this critical aspect of patient care, we helped prevent the potential damage to kidney functions caused by contrast used in CT scans. Additionally, this approach reduced the costs associated with interventions or hospitalizations due to AKI resulting from contrast exposure.

The other ACCN, "The Essentials: Core Competencies for Professional Nursing Education" (2021), was also integrated into this DNP QI project. Essential 1 provided the necessary knowledge of nursing practice for the DNP project. Essential 2 emphasized person-centered care, which aligned with the project's focus on creating a care plan for the outpatient oncology population. Essential 3, addressing population health, systematically identified patients aged 70 or older who may not have been receiving evidence-based recommendations for prevention of CIN.

Essential 4 focused on the scholarship within the nursing discipline, which was integrated using synthesized EBP literature for the QI project. Essential 6, which emphasized interprofessional partnership, was crucial for the project's success and involved collaboration between the DNP student, the clinical team, nurses, and schedulers. Essential 8, concentrating on informatics and healthcare technologies, played an important role in evaluating the PICOT question and analyzing project data. Lastly, the professionalism described in Essential 9, along

with the personal, professional, and leadership qualities outlined in Essential 10 were key factors in driving the completion of the QI project and representing the DNP profession.

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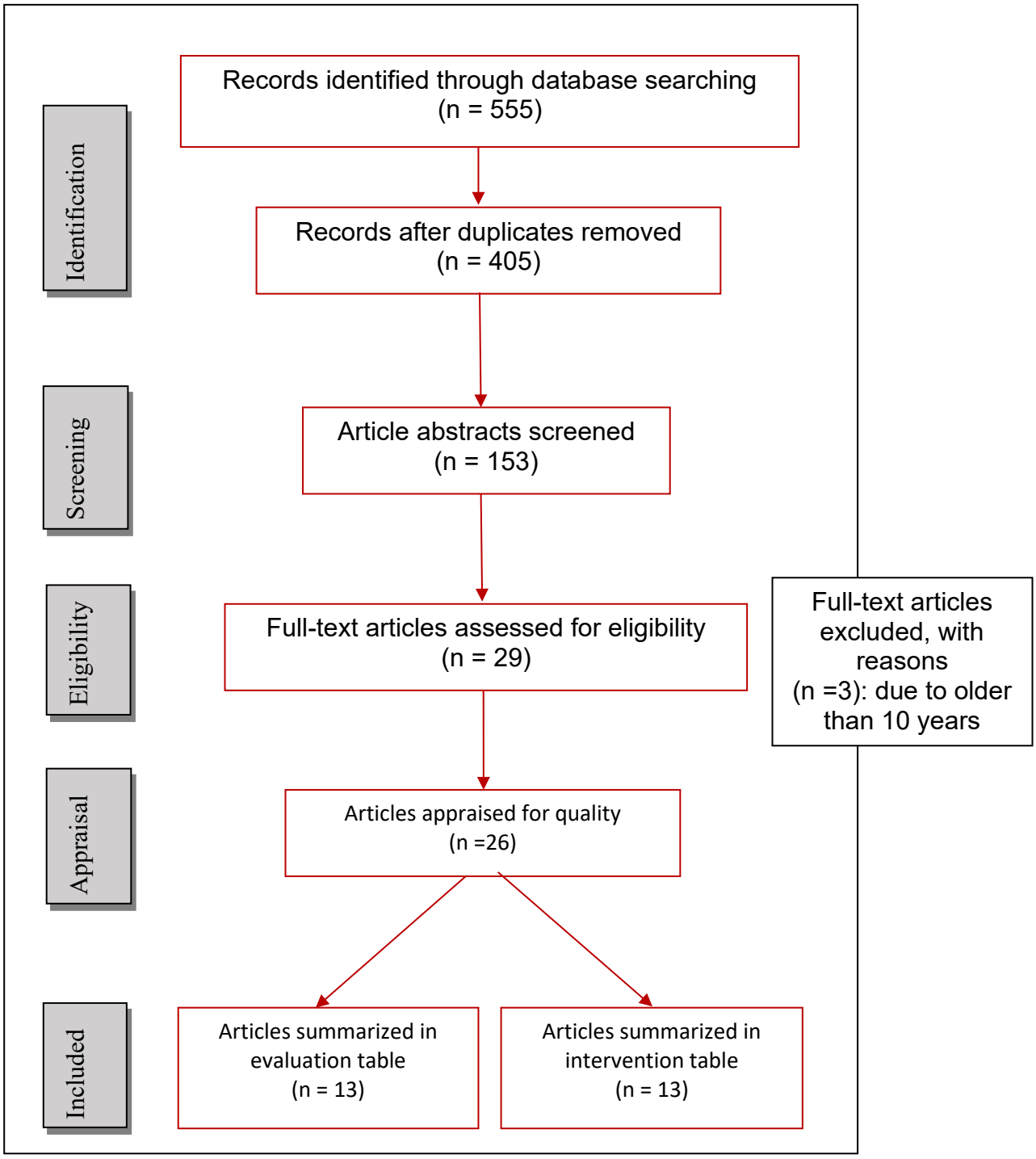
Appendix A. PRISMA flowchart



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For more information, visit www.prisma-statement.org.

Critical appraisal and synthesize of Literature Review (Tables)

Appendix B: Evaluation/Summary and Synthesis Table

Levels of Evidence Synthesis Table

Levels of Evidence	1	2	3	4	5	6	7	8	9	10	11	12	13
Systematic Review/Meta-Analysis (Level I)													
Randomized Control Trials/CCTs (Level II)													
Control Trials without Randomization (Level III)													
Case Control Study/Cohort Study Observational study/nonexperimental (Level IV)	X	X	X		X	X	X	X	X	X	X	X	X
Systematic Review of Descriptive or Qualitative Studies (Qualitative Meta-Synthesis) (Level V)													
Single Descriptive, Qualitative, Literature Review, EBP, Clinical Practice Guideline (Level (VI)													
Expert Opinion (Level VII)				X									

Legend:

1.Chertow et al, 2005; 2. Christiansen et al, 2011; 3. Cicin et al, 2014; 4. Davenport et al, 2020; 5. Gupta et al, 2023; 6. Hong et al, 2016; 7. Latcha et al, 2018; 8. Lee et al, 2014; 9. Ng et al, 2020; 10. Salahudeen et al, 2012; 11. Schilp et al, 2014; 12. Vemireddy & Bansal, 2023; 13. Wee et al, 2021.

Appendix C. STUDY COMPILATION/SYNTHESIS TABLE

Study Name	Level of Evidence	Outcome Knowledge	Application of EBP	Design	Sample Size	Study Limitations	Pertinence to PICO(T)
Chertow et al, 2005. Acute kidney injury, mortality, length of stay, and costs in hospitalized patients.	Level IV	X	X	Case Control Study / Cohort Study Retrospective Study	19,982 patients admitted at Brigham and Women's Hospital, an urban academic medical center in Boston, MA from September 1997 to April 1998.	The process for estimating baseline and peak SCr may have overestimated the number of patients with AKI. This misclassification would have biased the associations among AKI, mortality, LOS, and cost toward the null so the effect estimates presented her may be conservative. There were few available covariables. What was used were commonly used for risk factors. Whether adverse outcomes can be attributed to AKI or residual confounding by severity of disease is unknown. No data on physiology of AKI and used proxies to distinguish prerenal from other causes of AKI.	Findings showed AKI increased mortality, LOS, and costs were large across age, gender, CKD and non-CKD, and ICD-9-CM group. AKI was significant in older patients who had lower baseline creatinine clearances and higher severity of illness.

Christiansen et al, 2011. Incidence of acute kidney injury in cancer patients: a Danish population-based cohort study.	Level IV	X	X	Case Control Study / Cohort Study Prospective Observational Study	37,267 cancer patients in Northen Denmark 1999 - 2006	The creatinine levels were without data on urine output. The study depended on available baseline creatinine measurements.	Yes. Provide data that AKI is a common complication in cancer patients particularly in kidney and liver cancers, multiple myeloma, and metastatic disease. First year cancer -risk for AKI is 17.5%; 5 years at 25%.
Cicin et al, 2014. Incidence of contrast-induced nephropathy in hospitalized patients with cancer.	Level IV	X	X	Case Control Study / Cohort Study Prospective Observational Study	90 cancer patients at Trakya University Medical Oncology Clinic 10/2010 – 11/2012	The small number of patients. Lack of control group	Yes. Provide data on cancer patients effect on contrast-induced nephropathy. Patients who received chemotherapy within 45 days have increased risk of CIN by 4-5 times, especially bevacizumab/irinotecan.
Davenport et al, 2020. Use of Intravenous Iodinated Contrast Media in Patients with Kidney Disease: Consensus Statements from the American College of Radiology and the National Kidney Foundation.	Level VII	X	X	Expert Opinion	Joint statements by a multidisciplinary group of radiologists and nephrologists	No limitation but recommend for a prospective controlled date on adult and pediatric populations to clarify the risk of CI-AKI.	Davenport et al, 2020. Use of Intravenous Iodinated Contrast Media in Patients with Kidney Disease: Consensus Statements from the American College of Radiology and the National Kidney Foundation. CKI - 78% developed CIN with >25% increased SCr from based compared to non-CKI at 20 % developed CIN with >25% increased SCr from baseline. True risk of CI-AKI remains unknown. Prophylaxis with IVF NS is indicated for patients without contraindications (eg. Heart failure), AKI or GFR <30 ml/min/1.73m^2 and

							no on dialysis. Patients with eGFR of 30 -40 then IVF is at the discretion of the ordering clinician. Holding nephrotoxic medications if possible before contrast but should not initiate or altered replacement based on CM administration.
Gupta et al, 2023. Development and Validation of a Risk Model for Predicting Contrast-Associated Acute Kidney Injury in Patients with Cancer: Evaluation in Over 46,000 CT Examination.	Level IV	X	X	Case Control Study / Cohort Study Retrospective Study	25,184 cancer patients with 46,593 CM CT scans from 3 academic medical centers-Massachusetts General Hospital, Brigham and Women's Hospital, and Dana-Farber Cancer Institute in Boston, Massachusetts. 1/1/2016 – 6/20/2020. The mean age was 6.3 +/- 13.7[SD] years.	Limitations: Development and validation sets were from the same health system without external generalizability. Retrospective study may have susceptible to residual confounding despite the spectrum of included factors. Analysis did not consider whether patients were using a prophylactic regiment for CA-AKI. Did not consider the type and osmolality of contrast medium. No data on patient survival or downstream outcomes. SCr level is imperfect marker of CA-AKI. Multivariable model excluded BMI. Evidence of a causative	Yes. CA-AKI defines as >25% increased SCr from baseline. All SCr lab obtained within 14 days after CMCT scans. CA-AKI increased with the use of diuretic, NSAID, ACEI/ARB, lower CKD, lower hgb (<10 g/dL), lower platelets, higher proteinuria, higher frequency of HTN or DM, and the volume CM. Validate that CDK stage 4 or 5 and low serum albumin level of <3.0 g/dL are the strongest predictors of CA-AKI. High frequency CA-AKI in cancer patients may be due to the concomitants nephrotoxic chemotherapy and decreased effective circulating volume. Create a summary of major consensus statements on CA-AKI

						relationship between iodinated contrast media and AKI was not directly assessed.	
Hong et al, 2016. Contrast-induced nephropathy in patients with active cancer undergoing contrast-enhanced computed tomography.	Level IV	X	X	Case Control Study / Cohort Study Retrospective Study	820 cancer patients in the emergency department at Asan Medical Center from October 2014 to March 2015.	Did not compared results with the general populations. No consideration to the diversity of the different cancer diagnoses. The only patients included in the study were patients who had serum creatinine levels done several times after IV contrast medium.	Cancer patients with baseline SCr <1.5 mg/dL has an 8.0% risk for CIN. Hypotension, liver cirrhosis, dehydration, and peritoneal carcinomatosis-increased risk for CIN.
Latcha et al, 2019. Rate and risk factors for AKI after CT scans in a cancer cohort.	Level IV	X	X	Case Control Study / Cohort Study Retrospective Study	7,512 CT scans in 4,456 patients from 1/1/2012 – 12/30/2014 at Memorial Sloan Kettering Cancer.	Limitation of all retrospective studies is the small number of patients with eGFRs</= 29mL/min/1.73 m^2 who received contrast. Data set was only for CT head, neck, and chest.	Yes. The study showed AKI was significantly associated with lower baseline eGFRs but independent of contrast exposure. Other risks noted were chemotherapy < 60 days of CT, CHF, & prior AKI.
Lee et al, 2014. Contrast-induced nephropathy in patients undergoing intravenous contrast-enhanced	Level IV	X	X	Case Control Study / Cohort Study Retrospective Study	140,838 CT with contrast in 101,487 patients at 16 tertiary hospitals in Korea in 2008.	May have included a small number of dialysis patients (peritoneal dialysis were excluded). Data was not directly compared to the population	Yes. Confirmed that DM, CHF, and decreased eGFR (<45mL/min/$1.73m^{2)}$ significantly associated with CIN and preventative measures were underutilized.

computed tomography in Korea: A multi-institutional study in 101487 patients.						without contrast CT scans. Interval of SCr measurements were irregular due to them not collected retrospectively which may cause bias to underestimate the CIN incidence. Timing and rate of hydration were not available. Cannot identified any difference in the incidence between inpatients and outpatients since the data was not collected.	
Ng et al, 2020. Risk of renal events following intravenous iodinated contrast material administration among inpatients admitted with cancer a retrospective hospital claims analysis.	Level IV	X	X	Case Control Study / Cohort Study Retrospective Study	29,850,475 patients admitted over 611 hospitals in the Premier Hospital Database from 1/10/2010 to 9/30/2015. Exclusion of patients with ESRD requiring dialysis; kidney transplantation; & cancer treatment admissions. Primary cancer diagnosis	Limitations: possible ICD-9 coding errors. The data source does not track patients longitudinally so no information after hospital discharge. Values for SCr and GFR were not available so have to rely on ICD-9 code to identify CI-AKI.	Yes. Baseline for AKI in patient without cancer or CKD and no CT or contrast was 0.5%. With CT contrast, the risk increased to 1.5%. Patient with CKD with CT scans, the risk increased to 2.5 to 8.1% depending on the stage of CKD. Cancer patient has an increased risk of 0.9% from baseline and range from 0.3 % for endocrine and 2% in leukemia and urinary cancer. Cancer pt without CKD has an increased risk of 2.4% for AKI compared to 4.9 – 10.5 % with CKD depending on the stage.

					was included.		
Salahudeen et al, 2012. Incidence rate, clinical correlates, and outcomes of AKI in patients admitted to a comprehensive cancer center	Level IV	X	X	Case Control Study / Cohort Study Cross-sectional analysis of prospective collected study	3558 patients admitted to the University of Texas M.D. Anderson Cancer Center from May to July 2006.	Data have not provided details on the causes of AKI in this population. Data were collected prospectively, and the analysis was still based on a database; therefore, the findings and hypothesis generated are confirmed prospectively.	LOS is double for AKI (10 days) compared to non- AKI cancer pts (5 days). Cost is greater than double for hospital admission ($82,835 vs $40,164). Increased risk of AKI for leukemia, DM, chemo, antibiotics, IV contrast, ICU transfer, and hyponatremia.
Schilp et al, 2014. Guideline adherence for identification and hydration of high-risk hospital patients for contrast-induced nephropathy.	Level IV	X	X	Case Control Study / Cohort Study Longitudinal retrospective evaluation.	4297 patient records at 92 hospitals in Dutch from November 2011 to December 2012.	The only information available on eGFR and risk factors are mentioned in the records and no information on whether the hospital recognized high-risk patients. Hydration was not documented in patient record. Uncertain if hydration was executed but incorrectly recorded. Due to this, 46 records were removed (7% of the total) from evaluation. No information on the extend of CIN prevention.	Mean age was 65.4 years; 54% male; LOS 3.6 days; 23 % of the patients was acutely admitted. 96% of patients had CT CM in the Dutch hospital but only 69% of the high-risk patients for CIN were hydrated before CM. Need process to identify high-risk CIN patients for prevention hydration.

Vemireddy & Bansal, 2023. Contrast-associated acute kidney injury: definitions, epidemiology, pathophysiology, and implications.	Level VII	X	X	Expert Opinion	Review of standard protocols and terminologies	Limited to the number of articles reviewed by the authors.	Not possible to establish causality of AKI. AKI is a common occurrence after CM. The term CA-AKI is widely accepted for AKI postcontrast. CA-AKI definition is per the recommendation of KDIGO: increased SCr >/= 0.3 mg/dL within 48 hours or >/= 50 % within 7 days after CM.
Wee et al, 2021. Safety of a rapid outpatient hydration protocol for patients with renal impairment requiring intravenous iodinated contrast media for computed tomography.	Level IV	X	X	Case Control Study / Cohort Study Retrospective Study	226 outpatients' facility from June to November 2015.	Different methods were used to derive the baseline eGFR, were measured at different times, and follow up at different times. Limited to hydration status and underlying renal functions as risk factors for long-term eGFR decline. No data on acute or chronic comorbidities.	Rapid outpatient hydration protocol-short period is safe in an outpatient setting. eGFR of 30-44 mL/min/1.73m^2 received 250 ml NS before and after contrast over ½ hour each. eGFR 45-60 mL/min/1.73m^2 received 500 ml bottle of mineral water and encouraged to drink as much before the scans and remainder after the scans. A combination of IVF and oral for a total of 500 ml was permitted.

Appendix D: Synthesis of the Evidence: Identify risks and outcomes for Contrast Induced Nephropathy (CIN) or Acute Kidney Injury (AKI) from Contrast Media (CM)

Identify risks/outcomes	1	2	3	4	5	6	7	8	9	10	11	12	13
Iodinated CM volume					↑					↑	↑	↑	↑
Chronic kidney disease-elevated creatinine;	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Serum creatinine >/=25% or >/= 0.5 mg/dL before CM @>/0.3mg/dL within 48 hours or >/= 50% within 6 days	↑		↑	↑	↑	↑						↑ @	
GFR <30 mL/min/1.73m^2				↑			↑	↑ <45					↑
Length of hospital stay	↑									↑	↑		
Cost	↑									↑			
Nephrotoxic medications i.e., chemotherapy, NSAIDs, ACEI/ARB or CM repeated <48 hours @ bevacizumab/irinotecan; within 45 days			↑ @	↑	↑		↑ <60 days			↑	↑		
Older age	↑ 52.8 - 58.8	↑ Age 60 +	↑ 70-79	↑ 59.3	↑ 64	↑ 57.3	↑ 65+	↑ >70	↑ 48	↑ 55+	↑ Age mean 65.4	↑	↑ 71.5
Hg <10 g/L			↑		↑								
Cancer patients: @kidney cancer, liver cancer, multi myeloma, metastases. *PC peritoneal carcinomatosis		↑@	↑		↑	↑ PC*			↑				↑
Hematologic malignancy										↑			
hypertension					↑	↓							
dehydration			↑			↑							
diabetes			↑		↑			↑		↑		↑	
CHF				↑			↑	↑				↑	
cirrhosis						↑							
Hydration PO/IVF @ 250 ml NS before/after over ½ hour or 500 ml PO/IV			↓	↓							↓		↓@
Underuse prevention									↑				

Legend:

1.Chertow et al, 2005; 2. Christiansen et al, 2011; 3. Cicin et al, 2014; 4. Davenport et al, 2020; 5. Gupta et al, 2023; 6. Hong et al, 2016; 7. Latcha et al, 2018; 8. Lee et al, 2014; 9. Ng et al, 2020; 10. Salahudeen et al, 2012; 11.Schilp et al, 2014; 12. Vemireddy & Bansal, 2023; 13. Wee et al, 2021.

↑ (positive)↑ (negative) ↓(positive) ↓ (negative)

Appendix E: Approval for De-identified Institution Data

The James

THE OHIO STATE UNIVERSITY
WEXNER MEDICAL CENTER

Arthur G. James Cancer Hospital and
Richard J. Solove Research Institute
Professional Practice
460 W. Tenth Ave., Suite B160
Columbus, OH 43210

McMahon, DNP, RN, OCN Director
of Professional Practice
614-366-1783

10/30/24

Phuong Hoang has the support of The James Cancer Hospital to implement his OSU College of Nursing DNP project *Prevention of contrast-induced nephropathy* in FY *24-25*.

Thank you for submitting your proposal to The James Feasibility Committee for review.

Sincerely,

Diana McMahon

Diana McMahon, DNP, RN, OCN
Director for Professional Practice

Appendix F: Human Subject Research Determination Form

Human Subject Research Determination Form

It is important to ensure the protection of human subjects in research and quality projects. Please complete the survey below.Thank you!

Response was added on 10/28/2024 3:01pm.

Instructions:
1. Please complete the requested project information, as this form may be used for documentation that neither IRB review nor an exemption is required.

2. Please select the appropriate answers to each question in order as they appear. If all of the questions are answered without receiving an error message, the form must be printed AND signed as certification that the project is "not human subjects research," and does not require IRB review or exemption.

If you are unsure how to answer any of the questions, please contact ORRP for additional guidance at ORRPDeterminations@osu.edu.

PROJECT INFORMATION	
Name of PI, advisor, or mentor	Kristine Browning
Advisor Email	browning.99@osu.edu
Student Name:	Phuong Hoang
Project Title	PREVENTION OF CONTRAST-INDUCED NEPHROPATHY
Brief Description of Project/Goals:	The purpose of this project is to implement a systematic process for ordering pre-scan IV fluid (IVF) hydration for the high-risk contrast-induced nephropathy in cancer population age 70 or older at an outpatient skin oncology clinic. The aim is to increase the number of pre-scan IVF hydration orders. (This information is important and provides the necessary information to determine if the project requires IRB review.)

QUESTIONS	
1. Will the project involve testing an experimental drug, device (including medical software or assays), or biologic?	◯ Yes ⊗ No (This question determines if additional federal regulations, like FDA regulations, apply to the project. This information is based on the Common Rule (45 CFR 46.102(d)) that states "Research means a systematic investigation, including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge." If the answer to this question is 'YES' - IRB review is likely required.)

2. Has the project received funding (e.g. federal, industry) to be conducted as a human subjects research study?	◯ Yes ⊗ No (This question is to determine if the project received funding to be conducted as a research study, quality improvement, or program evaluation. If the funding source requires a specific level of IRB review and oversight or considers the project to constitute human subjects research, you may be required to submit an IRB application.)
3. In addition to any other purposes, is the project intended to develop or contribute to generalizable knowledge (e.g. testing a hypothesis) AND/OR has the project been designed in such a way that the findings will be generalizable (e.g. randomization of subjects; comparison of case vs. control)?	◯ Yes ⊗ No (This question is to evaluate project intent and design. The project design plays a key role in determining intent. If the project uses standardized research methods like testing a hypothesis or randomization to determine results, then it is research. If the intended outcome is simply to report on what happened at the institution/program, even if another site does something similar and sees benefit, this does not indicate research design or intent.)
4. Will the results of the project be published, presented or disseminated outside of the institution conducting it?	⊗ Yes ◯ No (The purpose of this question is to determine if and how project results will be disseminated. Note that program evaluation and QI projects can be published or presented without being considered research projects; not all information that is published or presented represents generalizable knowledge. Lack of intent to disseminate the information is generally a strong indicator that a project does not constitute research.)
5. Will the project occur exactly as proposed regardless of whether individuals conducting it may benefit professionally from it?	⊗ Yes ◯ No (This question is not focusing solely on whether an individual will professionally benefit, but rather whether they would conduct the project (or conduct it in the exact same way) regardless of the potential for professional benefit (e.g. adding it to a CV or getting funding based on the results).)
6. Is the project intended to improve or evaluate the practice or process within a particular institution or a specific program?	⊗ Yes ◯ No (If the intention upon designing and conducting the project is not to improve or evaluate a specific practice/program, then the answer should be "No" indicating research intent and IRB review is likely required. If the project is intended to create knowledge or draw conclusions applicable beyond the particular institution or specific program, then the project is likely research as defined by the federal regulations and IRB review or exemption is required.)

If no message appears above indicating the certification is not valid, IRB Review is not required because, in accordance with federal regulations, the project does not constitute human subjects research as defined under 45 CFR 46.102(d).

Student: Sign this form below attesting to the accuracy. Download and save a copy of the completed form, print or

email the form to your advisor for signature. This serves as record that IRB review is not required for this project.

Are you using data collected or procured from the institution your project is being implemented?	⊗ Yes ○ No
Has written approval been received by authorized personnel from the institution?	⊗ Yes ○ No

Student: I certify that the information provided is accurate.

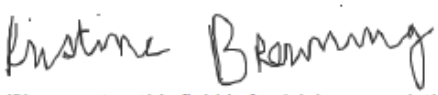
Student Signature date: 10-28-2024

The following information is to be completed by the student's advisor once the student has completed and submitted the form.
Please note -
* If the student and advisor are completing the form together, the advisor can digitally sign the document

* If the student and advisor are not completing the form together:
1. Student adds their signature and then clicks on the Save and Return Later button (Not Submit).
2. The student then records the ID# of the form that pops up when clicking the Save and Return Later button and provides this ID# to the advisor. The student exits out of the form.
3. The advisor then accesses the link and clicks on the "returning" link in the top right-hand corner.
4. The advisor will be prompted to enter the ID# and this will bring up the student form.
5. The advisor reviews the questions/answers selected, enters the student email for the confirmation, and signs the form.
6. The advisor submits the form.
7. The student will get the email confirmation with the PDF of the completed/signed form and retains it to include in the appendix of the final project document.

A copy of the final fully executed form (both student and advisor signatures visible) should be retained for addition to the final project.

Advisor: I have reviewed the student project and agree to the information provided.



(Please note - this field is for Advisor completion)

Advisor Signature date: 10-28-2024

Appendix G: Prevention of contrast-induced nephropathy (CIN) Education

Contrast-induced nephropathy statistics

- 11% of cases in any type of cancer vs 5% in patients with normal kidney functions and 12% - 27% in CKD
- Hospitalized patients are at 20% risk and at 4-5 times higher risk with chemotherapy
- Increased by 50% in advanced kidney dysfunction and co-morbidities such as DM.
- Cost $42,671 per patient per incidence.
- Cancer patients- Increase in death (4.7 times); average 3 more days in the hospital
- 3rd most frequent cause of acute kidney injury
- 2 risk factors increase CIN by 5%
- 3 risk factors increase CIN by 30%

Risk factors for CIN

- **Age 70 year and older**
- Female > Male
- CHF
- Dehydration
- Cirrhosis
- Nephrosis
- Atherosclerosis
- Anemia
- **Cancer**
- **Cancer treatments**

Multimodality Moorehouse 4 Patient Population

- 78.0% MM
- 9.6% cSCC
- 3.5 % BCC
- 4.4% MCC
- 4.5% other cancers

Staging

- 19.2% Stage II
- 27% Stage III
- 53.5 % Stage IV

Data collection 1/1/24 to 6/6/24

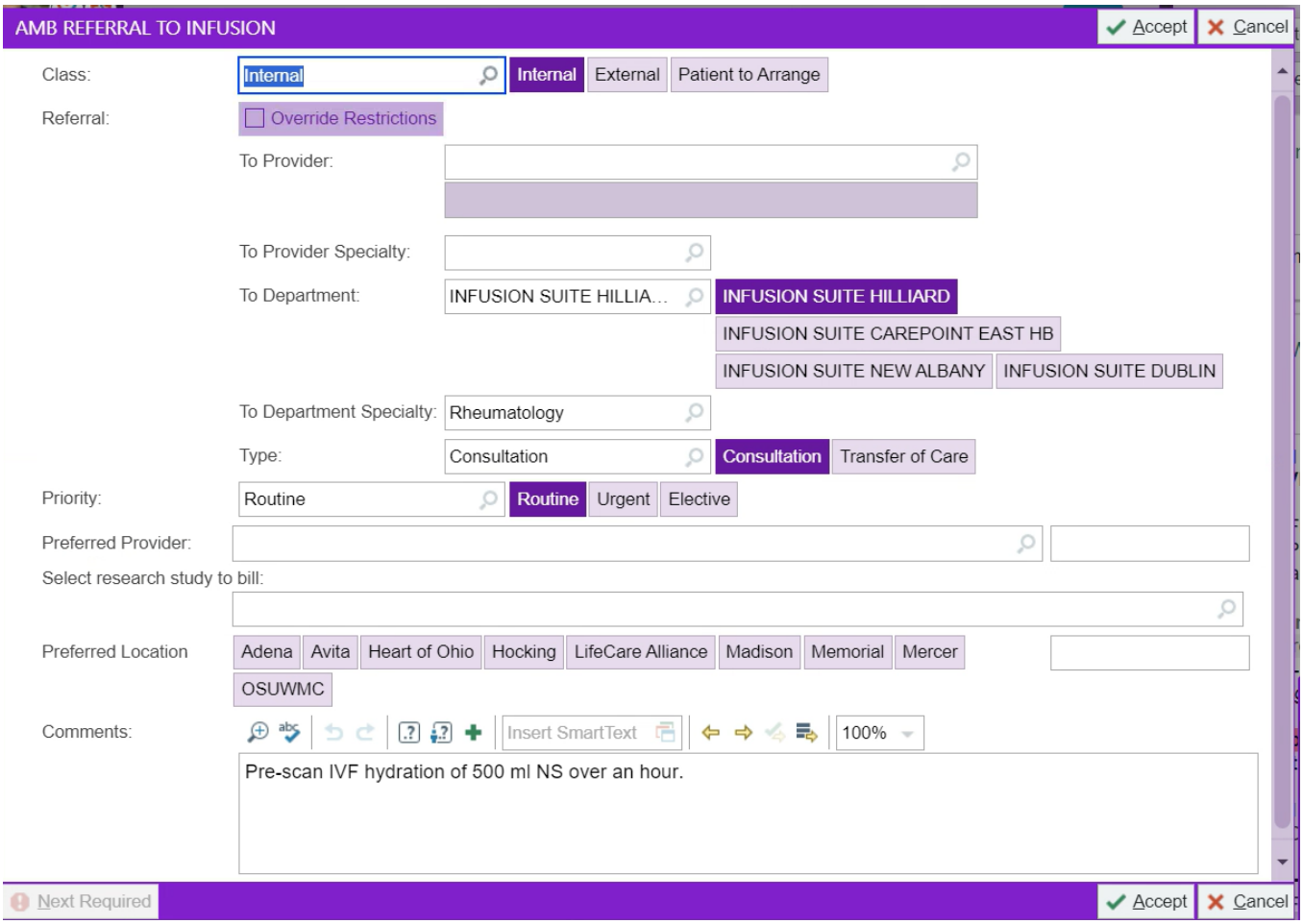
- 11 out of 133 or 8% hydration orders **place at the time of CT scan order (during clinic visit)**

GOAL for the project: increase pre-scan IVF hydration orders placed at the time of CT scans ordering (during clinic visit) for patients 70 years or older.

Outcome: increase at least by 10% of IVF hydration order placed with contrasted CT scans within 2 months of this education session.

Recommendations

- Hydration (oral or IV) increase intravascular volume, dilute overall intravascular contrast load, and promote diuresis.
- Outpatient dosing is different than inpatient due to time constraint, reduce expenditure, free up slots to accommodate acute inpatients, avoiding rescheduling and postponed case due to AKI
- NS 500 ml over an hour
- Educate patient on the importance of pre-scan IVF hydration
- **Place AMB REFERRAL TO INFUSION CLINIC**
- Select location
- Enter **COMMENT** note: pre-scan IVF hydration with 500 ml NS over an hour
- Associate order with **"ENCOUNTER FOR HYDRATION PRIOR TO CT SAN (CODE Z29.89)**
- Pharmacy will enter the order plan and sent to provider for signature.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Cancel
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Internal
Internal
External
Patient to Arrange
Referral:
Override Restrictions
To Provider:
To Provider Specialty:
To Department:
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INFUSION SUITE HILLIARD
INFUSION SUITE CAREPOINT EAST HB
INFUSION SUITE NEW ALBANY
INFUSION SUITE DUBLIN
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Rheumatology
Type:
Consultation
Consultation
Transfer of Care
Priority:
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Urgent
Elective
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Preferred Location
Adena
Avita
Heart of Ohio
Hocking
LifeCare Alliance
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Mercer
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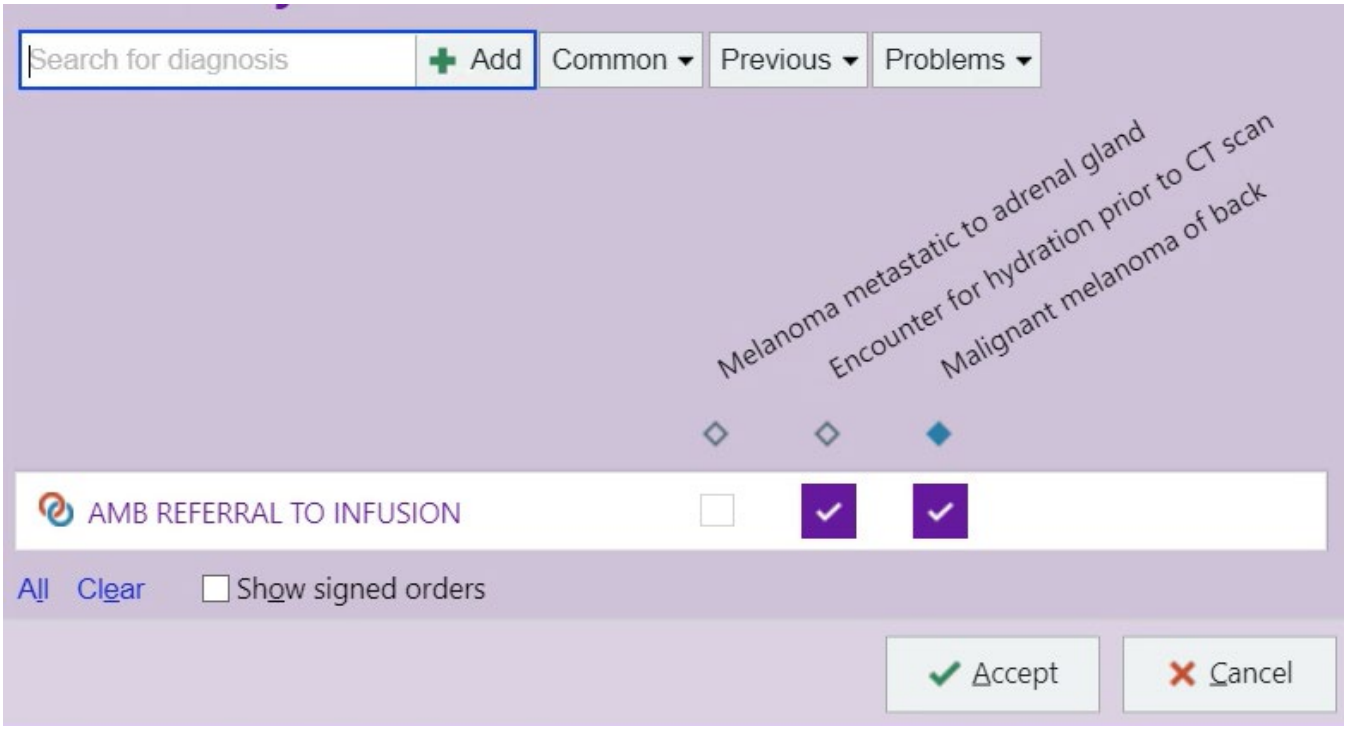
Pre-scan IVF hydration of 500 ml NS over an hour.
Next Required
Accept
Cancel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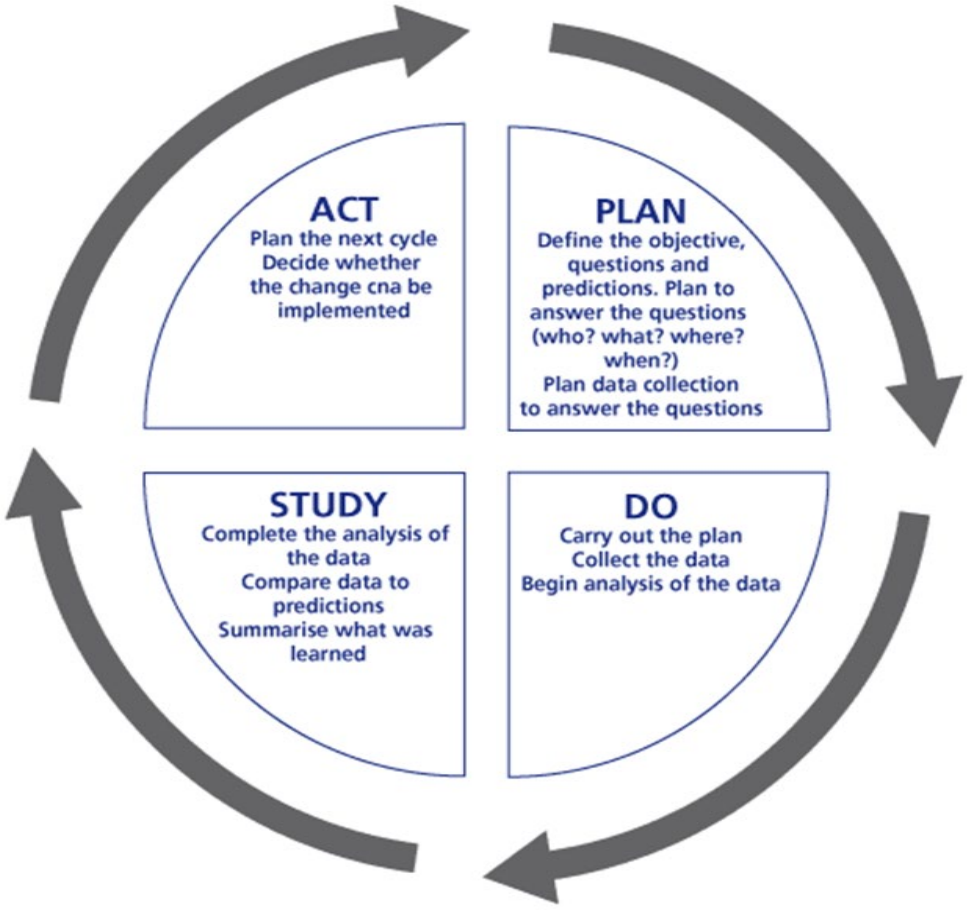
Add
Common
Previous
Problems
Melanoma metastatic to adrenal gland
Encounter for hydration prior to CT scan
Malignant melanoma of back
AMB REFERRAL TO INFUSION
All
Clear
Show signed orders
Accept
Cancel

Education Process

- Brief introduction on the purpose of the meeting:
    - review the DNP project - improve the contrasted induced nephropathy in our cancer patient population by increasing the orders for pre-scan IVF hydration in age 70 years and older.
- Review the barrier question to each of the clinician and record the answer on the paper. "What are the expected barriers to entering the pre-scan hydration order at the time of the CT scan order?"
- Anticipated barriers: Individual, patient, education/training, teamwork, working conditions, equipment/resources, communication, & organizational factors.
- Present the education materials.
- Outcome is to increase the number of pre-scan IVF hydration orders with contrasted CT scans.
- Email the result every two weeks with the aggregate data for an update on the status throughout the 2 months post this education.
- Individual date is available upon request.
- Answer questions.
- Review the barrier question again and discuss the solutions to the barriers for a positive outcome to the project.
- **Thank you for your time.**

Figure 1: PDSA Cycle



Sideris, A., Stosky, J. PDSA Cycle.
https://coachingandleading.wordpress.com/presentation1/pdsa-and-types-of-change/