A Vascular Access Pathway to Decrease Computed Tomography Contrast Extravasations in Emergency Department Patients

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Abstract

Aim: This evidence-based project aimed to create a pathway tool for emergency department staff to utilize during peripheral intravenous (PIV) placement to decrease patient harm secondary to iodinated contrast media extravasations in patients requiring contrast administration.

Methods: A literature review was conducted and utilized to create a vascular access intervention pathway for emergency department clinicians to utilize during PIV placement. The pathway was displayed in the emergency department for clinicians to reference.

Results: The results presented a decrease in iodinated contrast media extravasations by 17% in emergency department patients over a six-month implementation period.

Conclusion: The created vascular access pathway tool could help improve patient satisfaction scores and prevent patient harm secondary to computed tomography.

Keywords: vascular access, peripheral intravenous access, extravasation, pathway

Aim

Background

Over 80 million computed tomography (CT) scans are performed annually in the United States. The CT scan can help clinicians determine patients' diagnoses and treatment plans. Contrast administration during a CT scan can further illuminate anatomic structures in the body to assist in the diagnostic process (Harvard Health Publishing: Harvard Medical School, 2021).

Contrast media extravasation (CMEX) is a complication in which contrast agents intravenously leak into the surrounding soft tissues. The severity of this condition can range from minor swelling to significant injuries such as compartment syndrome, ulceration, and necrosis (Roditi et al., 2022). According to the American College of Radiology, 0.1-1.2% of computed tomography (CT) injections will end with extravasation (2021). This type of patient harm is preventable with accurate peripheral intravenous (PIV) line placement (American College of Radiology, 2021).

At a centrally located North Carolina acute care hospital, the rate of CT extravasations has increased due to incorrectly placed PIVs. The organization needed a vascular access pathway for staff to utilize in the emergency department to decrease the rate of CMEX. According to nursing leadership, over the quarter before this project, the rate of CMEX focused on iodinated contrast had increased, leading to a higher rate of preventable patient harm. The goal would be to eradicate CMEX; however, the focus of this project was to decrease the occurrence of iodinated CMEX through the development and utilization of a vascular access pathway resource in the emergency department.

CT contrast is a crucial diagnostic tool in developing patient treatment plans. An incorrect administration of contrast could delay care and cause harm to patients. A vascular access

pathway could help emergency department staff manage patients with difficult intravenous access, help educate and inform staff of the guidelines of contrast administration, and increase the rate of correctly placed PIVs for contrast administration.

Methods

Framework

The Iowa model is frequently used to implement evidence-based practice in healthcare (Dusin et al., 2023). The steps assist with recognizing problems, researching alternatives, and executing changes. The IOWA model entails the following stages: establishing the question, synthesis of applicable literature, potential research investigation if literature is lacking, development and piloting of a solution; if successful, the solution is implemented across the organization; otherwise, the process is restarted. It emphasizes the importance of pilot testing before implementing changes on a large scale, which is parallel to this evidence-based project.

Difficult Intravenous Access Literature Review

The first theme includes patients requiring PIV access for medication and contrast administration. Correct PIV placement is crucial to avoiding CMEX. The literature search began to identify patients at risk for difficult intravenous access. The research revealed a scale that used patient history factors to identify current risk factors for difficult intravenous access. An observational study from the Journal of Vascular Access of adult surgical patients-helped predict difficult vascular access based on patient-reported information. (Civetta et al., 2018). Participants in the study provided information such as demographics, medical history, vascular history and abnormailites to the peripheral venous system, extremity limitations, and the presence of a long-term vascular device. Technical information about the venipuncture was also included, for example, if the PIV access required multiple attempts, the time required, advanced techniques, and the urgency of the procedure. The study led to an improved adult difficult intravenous access

score (EA-DIVA), which reviews the following: the history of troubled PIV insertion, vascular depletion, including current or past use of intravenous drugs or chemotherapy agents, clotting disorder or use of anticoagulant agents, neurovascular diseases like peripheral neuropathy, skin assessment, BMI, vein evaluation, including palpable or visible veins, and limb restrictions. These characteristics were placed on a numerical scale of 0-3. If the total score was greater than or equal to eight, it was determined to use advanced techniques to achieve vascular access. This study focused on patient history instead of the clinician's skill level in placing PIVs.

A similar study was published in the Journal of Clinical Medicine with the similar goal of predicting difficult vascular access (Van Loon et al., 2019). Demographic information and the procedure of PIV cannulation were collected from a convenience sample of 3,587 inpatients and outpatients at a multicenter institution. The Adult Difficult Intra Venous Access Scale (A-DIVA) was created using five elements from the collected data, including a history of difficult intravenous access, difficult access as expected by the clinician, no palpable veins with a tourniquet, no visible veins with a tourniquet, and finally, the diameter of the selected vein is less than 3mm (Van Loon et al., 2019). Elements from both of these studies would form a basis for a vascular access pathway tool. The goal was to overlap the risk factors of difficult PIV placement with the risk factors of CMEX.

Contrast Media Extravasation Literature Review

The second theme of research for this evidence-based project included research on CMEX. According to the 2021 American College of Radiology guidelines, CMEX is more common in nonverbal patients due to underlying conditions, such as mental status changes, loss of consciousness, or illness acuity. Another risk factor includes those with abnormal blood flow in the extremity where the contrast was injected, similar to those factors listed in the EA-DIVA

score (Civetta et al., 2018). The anatomic PIV site could also pose a risk of extravasation. The hand, wrist, foot, and ankle PIV sites are prone to CMEX and should be avoided whenever possible. CMEX is also more common in small-bore catheters than in large-bore catheters. It was noted that the risk of extravasation is greater in patients for whom ultrasound-guided deep brachial IV access is attained, a technique increasingly used for patients with difficult IV access. The American College of Radiology also sets guidelines for how clinicians should treat extravasation (2021). These 2021 guidelines from the American College of Radiology explain how the risk factors between elements of the DIVA scores and the risk of CMEX overlap to create a pathway to have patients receive the correct vascular access intervention the first time instead of enduring multiple PIV attempts. Another systematic review from the European Society of Urogenital Radiology contrast media safety guidelines reports patient risk factors for CMEX as patients that lack communication, delicate vessels or are in poor condition, lymphatic insufficiency, venous insufficiency, and obesity (Roditi et al., 2022). These themes overlap with those of the American College of Radiology.

Implementation

Before implementation, hospital leadership and nursing management approved the project aim and implementation plan, which are discussed below. The University and Medical Center institutional review board (IRB) prescreened the project and did not require IRB review. Multiple meetings were held with emergency department nursing management and site champions during the draft process of the vascular access intervention pathway to ensure the pathway met facility policy, procedure, and resources. The vascular access pathway was created by reviewing risk factors for challenging vascular access and risk factors for contrast extravasation. These risk factors were then presented for the expert opinions of the vascular

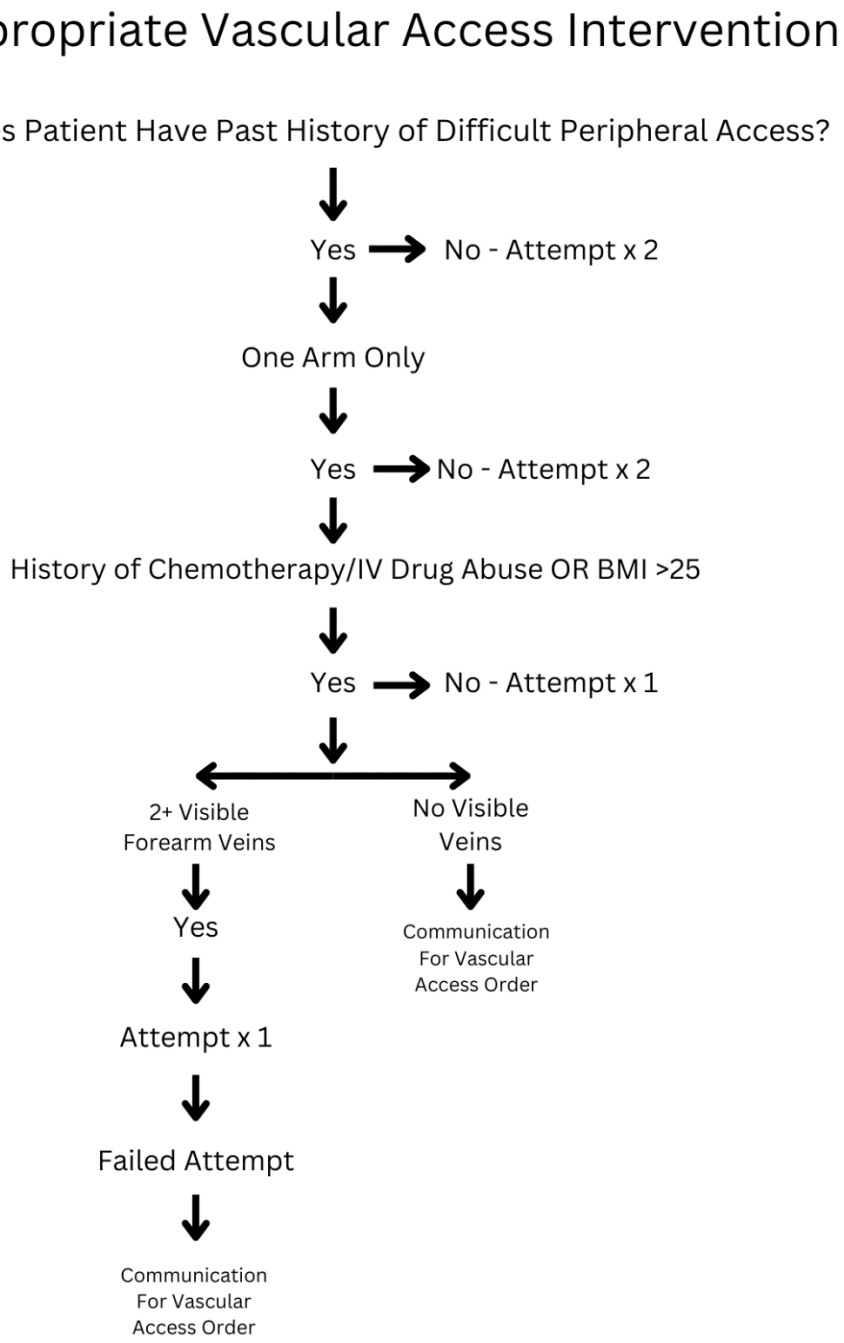
access specialists within the organization for prioritization of the elements for which they are most often consulted. Five elements overlapped with risk factors in the literature search, including history of difficult access, extremity limitations, history of chemotherapy or intravenous drug use, body mass index over 25, and the number of visible veins with the tourniquet applied.

The pathway was emailed to the emergency department clinicians with accompanying information, including the project's purpose and how to apply the pathway to ensure the correct vascular access intervention. The pathway was displayed at numerous nursing stations around the unit, the huddle board for frequent review during shift change staff meetings, and an electronic form on hospital-shared files for quick reference in patient exam rooms. Both quarterly staff meetings were attended to reinforce further use of the pathway and provide an opportunity to answer clinician questions regarding the pathway. Nursing and imaging management teams were updated throughout the implementation period via a newsletter.

Monthly data reports were created from the safety reporting system (SRS) to monitor for new instances of CMEX. Chart audits were performed to overlap details of the SRS report and PIV origin to rule out PIVs not initiated in the emergency department. This data was saved on an encrypted facility-based spreadsheet for tracking and reference.

Figure 1

Appropriate Vascular Access Intervention Pathway



Results

Per institution policy, the CT technician who administered the contrast was responsible for reporting the details of the extravasation to the safety reporting system. The data was reviewed through chart audits of the reports generated by the CT technician. The primary focus of this project was the patients whose PIV was placed in the emergency department and then utilized for contrast administration. The date the extravasation occurred and the origin of the PIV were then saved to an encrypted spreadsheet for tracking.

Pre-implementation Data

From November 2022 to April 2023, thirteen instances of extravasation were documented in the safety reporting system before implementation. Out of these, six cases, or 46%, specifically involved patients in the emergency department.

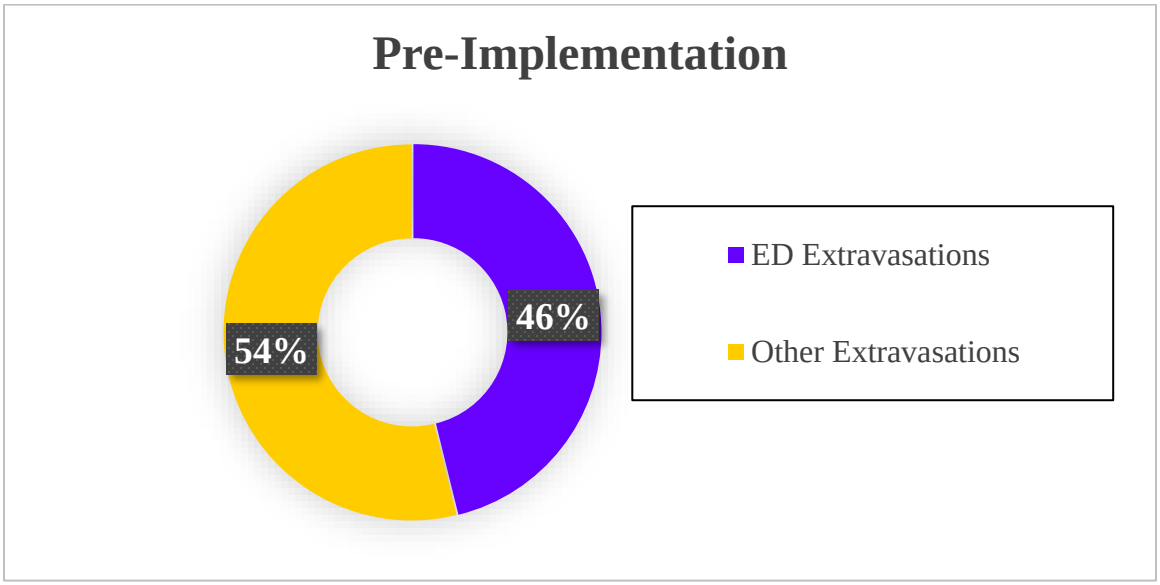
Table 1

Pre-implementation Data

Emergency Department Extravasations	6
Other Extravasations	7
Total Extravasations	13

Figure 2

Pre-Implementation Data



Post-Implementation Data

Seven cases of extravasation occurred throughout the six-month post-implementation period. 29% of extravasations occurred among patients in the emergency department. The rate of extravasation was reduced by 17%.

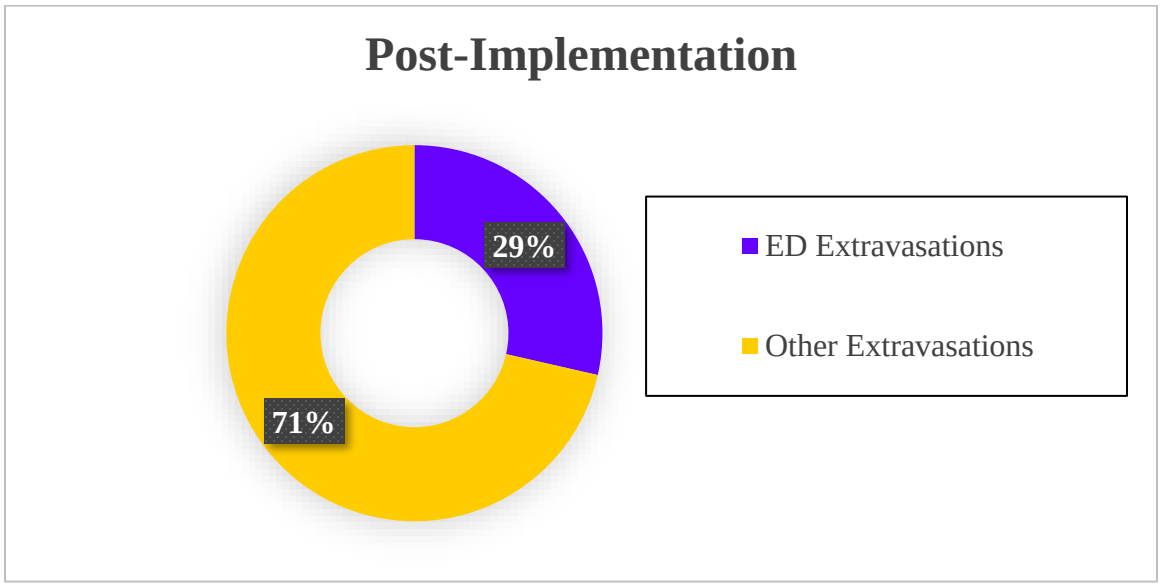
Table 2

Post-Implementation Data

Emergency Department Extravasations	2
Other Extravasations	5
Total Extravasations	7

Figure 3

Number of Extravasations Post-Implementation



Implications

Hospital-wide implementation could help increase patient satisfaction scores due to lower PIV attempts and decreased patient harm secondary to CMEX. With the initiation of the vascular access pathway, patients could have fewer attempts for PIV access by obtaining the correct intervention faster. Patients often find PIV insertion uncomfortable. A lower number of PIV attempts could cause less distress for the patient and improve patient satisfaction scores. Extravasation could also be deemed uncomfortable to the patient, including localized swelling, pain, and redness at the PIV site. With early and correct intervention for vascular access, the amount of patient harm secondary to CMEX decreases. The analysis of these implications was outside the scope of this project.

Limitations

Although there was encouragement and reinforcement to use the pathway throughout implementation, utilizing the pathway was not included in the unit policy. No poll or survey was developed and dispersed to evaluate whether clinicians utilized the pathway during patient assessment. In the future, clinicians could be asked for feedback on the pathway and its usefulness when assessing their patients for vascular access.

Discussion

This evidence-based project aimed to create a pathway tool for emergency department staff to utilize during PIV placement to decrease patient harm secondary to iodinated CMEX. The evidence collected and reviewed during the process created a vascular access pathway incorporating elements of EA-DIVA, A-DIVA, the American College of Radiology guidelines, and expert opinions of vascular access specialists. The initiation of the vascular access pathway reduced the rate of CMEX by 17%. Using evidence-based guidelines to create this tool minimized potential patient harm due to CMEX.

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