Title: Maintaining Central Venous Catheter Patency in Oncology Patients with Pulsatile Push-Pause Saline Flush Technique: A Pre-Post Intervention Study

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Background and Purpose: Central venous catheters (CVCs) play a vital role in the management of oncology patients, providing reliable access for medication administration, chemotherapy, blood draws, and intravenous fluid delivery. However, these port sites may become occluded, impeding treatment delivery and potentially leading to complications like infections or thrombosis. In the event of an occlusion, the AtlantiCare Cancer Care Institute (ACCI) administers the thrombolytic agent Alteplase (Cathflo) to restore normal functioning of the CVC. Maintaining CVC patency is critical in ensuring effective patient care, minimizing treatment delays, and preventing the need for catheter replacement or additional interventions. Traditionally, patients at the ACCI received indwelling heparin with a saline flush to maintain CVC patency. However, heparin may be costly and can lead to serious complications such as heparin-induced thrombocytopenia. The ACCI shifted from indwelling heparin to a saline flush alone, utilizing a push-pause technique which results in short bursts of high-velocity flow, briefly reducing intraluminal pressure and dislodging small particles that may adhere to the catheter walls. The objective of this pre-post study is to assess the effectiveness (non- inferiority margin of 5%) and financial impact associated with the transition from traditional heparin-based flushing to saline flushes alone, utilizing the push-pause technique.

Methods: A drug utilization report was generated by Cerner Discern Analytics, which identified and included patients who received the thrombolytic agent Alteplase to restore catheter patency, pre-transition from October 2022 to September 2023 or post-transition from October 2023 to September 2024. Alteplase use for catheter clearance indicated the presence of a CVC occlusion. Included patients were those with a CVC being followed at the ACCI within the studied timeframes. At the time of transition from heparin with saline flushes to saline flushes alone with push-pause technique in October 2023, ACCI oncology nurses were educated by nursing leadership on proper pulsatile push-pause flush technique for saline flushes. Proper flush technique involves a pulsatile method of first pushing saline, pausing for 1 to 2 seconds, then continuing to repeat this process until 1 to 2 milliliters of saline remains in the syringe. All order sets in the medication ordering section for providers in Cerner PowerChart were updated to

remove heparin by pharmacy informatics and providers were educated on the new flush initiative. The data was compared pre and post intervention utilizing a chi-squared statistical analysis with $\alpha = 0.05$ and non-inferiority margin set at 5%. This study was approved by the hospital's institutional review board.

Results and Discussion: The number of encounters included in the pre-intervention arm was 16,699 with 49 of them having CVC occlusions (0.3% occlusion rate). The number of encounters included in the post-intervention arm was 17,296 with 54 of them having CVC occlusions (0.3% occlusion rate). The incidence of CVC occlusions was determined by the number of Alteplase administrations. No difference was found for CVC occlusions between the pre-intervention and post-intervention groups ($p = 0.75$), determined non-inferior less than 5% difference. In the pre-intervention arm, the use of heparin with saline flushes cost the hospital $18,052 and alteplase use cost $8,132, leading to a total of $26,184. In the post-intervention arm, the use of saline flushes cost the hospital $4,151 and alteplase use cost $8,962, leading to a total of $13,113. A total of $13,071 was saved following the implementation of saline flushes with a pulsatile push-pause technique. By employing the pulsatile push-pause method at the ACCI, we successfully reduced costs for both our patients and the institution while maintaining efficacy. There was no increase in CVC occlusions after the transition while avoiding potential heparin-related adverse events.

Conclusion: Study findings demonstrate that our initiative was successful in maintaining efficacy in preventing CVC occlusions while reducing costs to both patients and the institution.