Spring 5-2021

Development of a Heparin Dosing Guideline for Vascular Surgery

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Executive Summary

Introduction

To obtain intraoperative anticoagulation for thrombosis prevention, non-cardiac vascular surgeries often require the use of unfractionated heparin (Tremey et al., 2006). For maintenance of steady-state plasma concentrations throughout the procedure, the measurement of activated clotting times (ACT) becomes necessary to guide dosing regimens. According to the Joint Commission (2008), 9.3% of medication-related sentinel events occurred as a result of anticoagulation administration. Throughout the past ten years, 21 of the 32 sentinel events documented involved heparin administration (Joint Commission, 2008). Through intraoperative ACT evaluation, patient variations in heparin sensitivity are considered which may aid in counteracting the potential for medication-related errors.

By employing over 200 anesthesia providers with 24-hour operating room services, a Level I trauma center in the Midwest recognized the importance of standardizing heparin administration. With less than 20 providers routinely providing anesthesia for non-cardiac vascular surgeries, the organization identified the need for change as providers less familiar were encountering these cases during evening and weekend shifts with limited personnel and resources available. Per facility request, an intraoperative reference tool for non-cardiac vascular surgery heparinization was developed. The reference tool served as a guide for initial heparin dosing, activated clotting time (ACT) goals, and intervals for ACT assessment.

Literature Review

As the most used antithrombotic agent, heparin exhibits anticoagulant properties by inhibiting thrombin through potentiation of an endogenous protein called antithrombin (Hirsh, Anand, Halperin, & Fuster, 2001; Lee & Kong, 2015). Due to variability in patient response to heparin

administration, ACT measurements can be obtained with a point-of-care assay to monitor the anticoagulant effects (Lee & Kong, 2015). Hemochron and Hemotec are two commercially available devices that measure ACT by determining the speed of fibrin formation (Lee et al., 2017). Both systems require a waiting period of three to five minutes after heparin bolus administration to obtain an accurate ACT value. Additional heparin administration should be guided based on ACT values collected every thirty minutes (Contrera, Patterson, & Cushing, 2018; Dirkmann, Nagy, Britten, & Peters, 2019).

The literature review focused on three categories of non-cardiac vascular cases: percutaneous stent interventions, open vascular surgeries, and peripheral vascular interventions. For percutaneous stent procedures, an initial bolus dose of 5,000-10,000 units or 60-100 U/kg and a target ACT of 300-350 resulted in the best outcomes (Niccoli & Banning, 2002; Zeymer, Rao, & Montalescot, 2016). For procedures involving cross-clamping, such as carotid endarterectomies, higher doses of 100 U/kg with goal ACT values greater than 200 seconds are considered optimal due to low incidences of cerebral events (Alves de Sousa et al., 2005; Goldhammer & Zimmerman, 2018). For peripheral vascular interventions, the optimal dose for initial heparin administration was less than 60 U/kg with a goal ACT value of fewer than 250 seconds to minimize bleeding and transfusions rates (Kasapis et al., 2010).

Lastly, the literature review analyzed the necessity of implementing standardized heparin dosing and the ideal format to present the dosing regime intraoperatively. Based on sentient events, the Joint Commission (2008) issued recommendations to improve heparin safety by targeting areas of dosing, monitoring, and administration. According to Wahr et al. (2017) analysis of 138 publications on correcting medication-related errors, an intraoperative guideline was the primary suggestion with the incorporation of cognitive aids and checklists.

Project Methods

Upon completion of the educational institution's IRB process, the project was classified as a non-experimental quality improvement project. The evidence-based reference tool was then submitted to the Level I trauma center as a draft for review purposes. Reference tool adjustments were made based on recommendations from members of the vascular surgery team, including surgeons, certified registered nurse anesthetists (CRNAs), and nurse practitioners. An educational PowerPoint and assessment were then delivered to members of the anesthesia team at the facility for reinforcement and evaluation of knowledge as it relates to intraoperative heparin administration before implementation of the tool.

Following a two-month implementation period, providers were given one month to complete a post-implementation survey to collect their perceptions on the effectiveness of the intraoperative reference tool. The data obtained from the survey was utilized to determine reference tool applicability, provider satisfaction, and barriers to implementation. The overarching goal of the project was to obtain greater than 90% satisfaction among on-call providers surrounding reference tool used for non-cardiac vascular surgeries.

Evaluation

The post-educational evaluation served as a knowledge-based assessment tool consisting of true or false, multiple-choice, and open-ended items. The purpose of the post-implementation survey was to examine provider perceptions of the utility of the reference tool intraoperatively with Likert scale, multiple-choice, and open commentary items. Both forms of evaluation were collected anonymously and incorporated demographic data to gain an understanding of the participant population. For the post-educational evaluation, there were nine CRNA participants of which only four completed the questionnaire in its entirety with a composite score of 100%.

From the open commentary question, all four respondents stated no improvements to the educational PowerPoint were necessary to facilitate the implementation process.

Following the two-month implementation period, twenty-six anesthesia staff members completed the post-implementation survey. One participant was excluded from the data analysis as a result of completing only 8% of the total survey. Based on the demographic data of the twenty-five respondents considered, the majority had 3 to 5 years of anesthesia experience (28%), took one call shift per month (52%), and provided anesthesia for non-cardiac vascular surgery between 5 and 10 days per month (60%). The Likert scale and open-ended commentary gained relevant data on intraoperative reference tool use and barriers to the implementation process. Unanimously, the reference tool was characterized as both thorough in its content and easy-to-use. Most providers (94%; n=17) felt confident in their ability to implement the tool while 89% (n=18) stated the reference tool was readily available for intraoperative use. The overarching goal of the project to gain greater than 90% provider satisfaction was achieved at a satisfaction rate of 93% among respondents (n=14).

Limitations were encountered during both the educational and implementation portions of the project. With over 200 anesthesia providers serving the Level I trauma center, the limitation to the post-educational evaluation was a lack of responsiveness. Due to COVID-19 restrictions, in-person meetings were not practical. Therefore, the educational PowerPoint and its evaluation were distributed utilizing email communication, contributing to limited response rates. The most evident limitation to project implementation was buy-in from the vascular surgery team members in adhering to the dosing and ACT goals outlined by the reference tool. Only 64% of respondents (n=14) either agreed or strongly agreed that the reference tool values were adhered to with the primary reason behind alterations being “surgeon preference”. Within the open commentary

items, 25% of respondents (n=12) suggested increased buy-in or education of surgical colleagues on reference tool use.

Impact on Practice

The immediate impact of project implementation was having a standardized reference tool for heparin administration readily available for intraoperative use during non-cardiac vascular surgeries. Among on-call providers who did not routinely deliver anesthesia for these types of procedures, the tool provided an organized, easy-to-use cognitive aid to assist in achieving adequate levels for anticoagulation.

The long-term goal for project impact would be achieving uniformity in heparinization among procedures for non-cardiac vascular surgery. An important aspect in achieving this uniformity would be obtaining vascular surgeon buy-in for adherence to reference tool dosing and ACT goal guidelines. This became evident through the post-implementation survey reporting non-adherence to reference tool recommendations as a result of surgeon preference. The reference tool would ultimately provide a foundation for balancing potential surgical complications, such as bleeding or thrombus formation, from over or under-dosing heparin. Ongoing implementation could evaluate these complications after non-cardiac vascular surgeries and compare complication rates based on reference tool use.

Conclusion

As the most widely used anticoagulant intraoperatively, heparin offers the advantages of preventing thrombus formation and establishing optimal operating conditions during non-cardiac vascular cases. By employing hundreds of anesthesia providers, a Level I trauma center in the Midwest became the site of project implementation to standardize heparin administration for specific non-cardiac vascular procedures. This institution recognized the need to assist on-call

providers who did not routinely deliver care during these cases with intraoperative heparin dosing and ACT goals. While limitations occurred in the form of vascular team buy-in and the COVID-19 pandemic, the project resulted in the development of a standardized heparin administration reference tool implemented over two months. The overarching goal of obtaining greater than 90% provider satisfaction with intraoperative reference tool use was achieved at 93% satisfaction. Furthermore, ongoing implementation has the potential to assess reference tool impact on patient safety in the forms of reducing complications associated with over or under-dosing heparin through this standardization process.

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