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Spinal Hematoma Formation Following Neuraxial Anethesia in the Anticoagulated Patient

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SPINAL HEMATOMA FORMATION FOLLOWING NEURAXIAL ANESTHESIA IN THE ANTICOAGULATED PATIENT

by

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ABSTRACT

Spinal hematoma formation continues to be a risk factor following neuraxial anesthesia. This is largely due to the challenges that nurse anesthesia providers are faced with when patients present with altered coagulation. Anticoagulation guidelines have been formulated, but anesthesia professionals have been unable to arrive at a common consensus regarding the implementation of spinal and epidural procedures. Therefore, nurse anesthetists are required to make decisions based on their best judgment, rather than a consistent guideline, in attempt to ensure patient safety. The purpose of this independent project was to explore the association between neuraxial anesthesia, anticoagulant medications, and spinal hematoma formation. Commonly administered anticoagulants, essential laboratory data, and timing of needle placement and catheter removal were reviewed and presented to Registered Nurse Anesthetists and students in training. The ultimate goal of the presentation was to increase the knowledge and comfort level of anesthesia providers performing regional techniques.

A comprehensive literature review that included: available guidelines, retrospective reviews, case reports, and prospective studies was conducted. The findings were compiled and presented in a power point format, which displayed the association between spinal hematoma formation and anticoagulation therapy. The physiologic framework of adaptation and homeostasis was used as the theoretical basis for the project. An informational pocket guide that explored the doses, frequency, and timing of

anticoagulant medication administration in relation to the neuraxial anesthetic technique was developed. Relevant laboratory data that should be assessed prior to needle placement or catheter removal was also incorporated into the guide. The pocket guide was distributed to anesthesia providers and students in training to serve as a reference for the safe administration of regional anesthesia.

CHAPTER I

INTRODUCTION

Spinal hematoma formation, which results from bleeding into the spinal canal, is a rare but potential complication following neuraxial anesthesia. Central neuraxial anesthesia includes epidural and spinal procedures. These techniques can result in the formation of a spinal hematoma, which can occur spontaneously or by needle puncture. Bleeding within the spinal column poses detrimental effects because the canal is not an expandable space. The building of pressure within the spinal canal results in compression of the spinal cord and may eventually lead to very serious neurological complications.

The formation of a spinal hematoma is strongly correlated with the use of anticoagulation medications. Due to this association, significant debate exists as to whether regional anesthesia should be performed on patients with altered coagulation. The number of patients on medications that alter clotting status continues to increase. When patients present with altered coagulation, anesthesia providers are challenged with deciding which anesthetic procedures can be safely performed.

Problem

Spinal hematoma formation continues to be a risk factor following neuraxial anesthesia. This is largely due to the challenges that nurse anesthesia providers are faced with when patients present with altered coagulation. Anticoagulation guidelines have been formulated, but anesthesia professionals have been unable to arrive at a common

consensus regarding the implementation of spinal and epidural anesthesia. Therefore, nurse anesthetists are required to make decisions based on their best judgment, rather than a consistent guideline, in attempt to ensure patient safety.

Purpose

The purpose of this project was to explore the association between neuraxial anesthesia, anticoagulation therapy, and spinal hematoma formation. Commonly administered anticoagulants were examined to help identify the cause of spinal hematoma formation following the administration of regional anesthesia. Anticoagulation guidelines were reviewed to determine when regional anesthesia could be safely performed based on available laboratory data. The appropriate timing of spinal or epidural needle placement and catheter removal relative to the timing of anticoagulant drug administration was also explored. A pocket guide (see Appendix A) was created from the recommendations provided within the guidelines to serve as a reference for nurse anesthesia providers.

Theoretical Framework

The physiologic framework of adaptation and homeostasis was utilized as the theoretical basis for this project. The term homeostasis was first introduced in the 1930s by an experimental physiologist by the name of Dr. Walter Bradford Cannon. The concept of homeostasis was established by Cannon in attempt to explain internal balance, both physiologically and psychologically. Cannon (1932) referred to homeostasis as the stability that occurs within a system. In complex systems, such as the body, mechanisms must occur either simultaneously or successively to maintain a steady state. Conditions that require a tendency toward change should be met by factors that resist change (Cannon, 1932).

Adaptation is the process by which a system attempts to restore or maintain homeostasis (Hanson, 1998). Negative and positive feedback loops are natural mechanisms that attempt to maintain the body's homeostatic state. Homeostasis is most commonly achieved through negative feedback responses. In negative feedback loops, the steady state is maintained by promoting changes in the opposite direction of the disrupting force. However, a positive feedback loop is a maladaptive response that initiates change in the same direction as the interrupting force, leading to further compromise of the system. If the positive feedback system is not interrupted, death can result (Hanson, 1998).

Adaptive responses are physiologically regulated by the nervous system, endocrine system, and by local tissue specific mechanisms in the body. Together, these three systems attempt to maintain homeostasis. If one of the above systems is downregulated, the disrupting force may not be overcome. It should also be noted that if adaptive responses are prolonged, positive feedback loops will prevail and ultimately result in disease. Therefore, attempts should be made, through treatment, to limit the occurrence of these maladaptive responses. When treating patients medically, it is important to recognize that homeostatic reference points vary among individuals. Adjustments based on age, sex, height, or weight may need to be taken into consideration (Hanson, 1998).

The formation and destruction of the fibrin clot is dependent on the stepwise series of the clotting cascade (Hanson, 1998). Blood coagulation is a homeostatic system that centers on proteolytic enzymes. When evaluating the clotting cascade, it is evident that an enzyme produced in an early step of the cascade generates an enzyme of a later

stage of the cascade. In the coagulation of blood, the formation of proteases from inactive precursors is irreversible. Therefore, protease inhibitors are required to inactivate formed enzymes. Examples of inhibitors include "antithrombin III (blood coagulation), alpha 2-plasmin inhibitor (fibrinolysis), and C1 inhibitor (complement)" (Beltrami & Jesty, 1995, p. 8744).

In negative feedback regulation, a portion of the proteolytic system inactivates an enzyme that was required in an earlier stage of the cascade. Thrombin ultimately determines the fate of the clotting cascade. Negative feedback occurs when thrombin activates the protease referred to as protein C. Protein C stops the coagulation cascade by degrading the factors, Va and VIIIa, that are required for the generation of thrombin. When thrombin is inactivated, the formation of the fibrin clot is ceased (Overduin & Beer, 2000).

In positive feedback mechanisms, an enzyme produced in a later stage of the clotting cascade works to continually accelerate an earlier step of the cascade. Factor IXa, which is formed early in the process of coagulation, leads to the formation of thrombin, the final protease of coagulation. Factor Xa and thrombin are the two enzymes formed in this specific portion of the coagulation cascade; however, three positive feedback loops are involved in the regulation of their formation. When the enzymes within a positive feedback loop remain active, the maladaptive loop continues until completed, and the precursors are converted to their enzyme products. Therefore, the absence of enzyme inhibitors adversely affects the process of coagulation (Beltrami & Jesty, 1995).

The physiological inhibition of coagulation caused by the administration of anticoagulant medications has been shown to increase the risk of spinal hematoma

formation. These medications work through the neutralization of activated clotting factors that may enter the circulation. For example, the administration of unfractionated heparin alters homeostasis by accelerating the action of antithrombin III. Antithrombin III greatly inhibits factor Xa and thrombin; however, it is also believed that antithrombin III may have inhibiting effects on every clotting factor to some degree (Kinney, Dunbar, Brunn, Molter, & Cicciu, 1998).

Definitions

The following definitions explain key words and concepts discussed within the study:

Epidural anesthesia: Regional anesthetic technique in which anesthesia is achieved following the injection of anesthetic medication into the epidural space of the spinal canal.

Spinal anesthesia: Regional anesthetic technique in which anesthesia is achieved following the injection of anesthetic medication into the subarachnoid space of the spinal canal. Spinal anesthesia is often times referred to as intrathecal anesthesia.

Neuraxial anesthesia: Sympathetic, sensory, and/or motor blockade following the medications administered through spinal or epidural regional techniques.

Spinal hematoma: Bleeding within the spinal canal which may cause compression of the spinal cord and the potential for severe adverse neurological deficits. This may occur following spinal or epidural anesthesia.

Epidural hematoma: Pooling of blood within the epidural space which may cause compression of the spinal cord and the potential for severe adverse neurological deficits.

Coagulation: The process of blood cells clumping together to form a clot.

Anticoagulation: The delay or prevention of blood clotting that results from the alteration of clotting factors.

Paresthesia: A sensation of numbness or tingling that may result due to the interference of a functional nerve.

Magnetic resonance imaging (MRI): A type of diagnostic radiography that uses electromagnetic energy to detect the formation of a spinal hematoma.

Significance of the Project

The use of anticoagulation medications has become more prevalent due to an aging population. Anticoagulation medications are also commonly administered to patients with severe medical conditions that require such treatment for preventative measures. Due to the use of anticoagulation therapy, it is essential for anesthesia providers to be aware of the fact that a spinal hematoma can result following the administration of neuraxial anesthesia. In attempt to understand the process of spinal hematoma formation, anesthesia professionals must be aware of how these anticoagulant medications alter the clotting cascade.

Available guidelines that focus on anticoagulation and the performance of regional anesthesia vary from source to source. Since a common consensus of these guidelines has not been achieved, anesthesia providers are ultimately responsible for deciding whether regional anesthesia can be safely performed. This project was aimed at compiling the diverse recommendations that are available to serve as a reference for anesthesia providers in attempt to prevent the formation of a spinal hematoma. The recommendations were condensed into a small pocket guide (see Appendix A) that anesthesia providers can conveniently refer to and depend on for accurate information.

The pocket guide will remind the anesthetist of the factors that need to be considered prior to the performance of a regional anesthetic technique in an anticoagulated patient.

Assumptions

For the purpose of this project, the following assumptions were made:

There is a need for further information regarding the interaction between central neuraxial anesthesia and anticoagulation therapy in attempt to prevent the formation of a spinal hematoma. Available anticoagulation guidelines for neuraxial procedures vary. This lack of consistency among guidelines may be a contributing factor to the incidence of spinal hematoma formation. However, the safe performance of central neuraxial blocks on anticoagulated patients may be attributed to the increased awareness, vigilance, and concern of anesthesia providers.

The incidence of spinal hematoma formation may be underreported, leading to skewed statistical results. On the other hand, improved reporting of spinal hematoma formation is possible because anesthesia providers have continued to show an interest in decreasing the occurrence of this complication. It was assumed that the available literature on spinal hematoma formation was accurate and complete.

The assumption was that the readers of this project have an advanced understanding regarding the anatomy and physiology of the spinal column. Policies and procedures may vary between hospitals; however, it was assumed that the readers of this project were familiar with the general performance of regional anesthetic techniques. A broad understanding of the clotting cascade and the medications that alter coagulation will help the readers to grasp the content that was presented in this project.

Limitations

This project was limited to information that was gathered from retrospective reviews, case reports, and ethical prospective studies. If the information presented within the case studies was limited or incomplete, it made it difficult to determine the factors that may have attributed to the formation of the spinal hematoma. Few prospective studies have been conducted on this topic because it would be unethical to perform a study that could potentially lead to the development of a spinal hematoma.

Summary

It is essential for anesthesia providers to have a very thorough understanding of the risks that anticoagulation poses to regional anesthesia. The outcome of a hematoma can be both devastating and permanent. Therefore, anticoagulation guidelines should be followed when determining if neuraxial anesthesia is appropriate for the patient. If a specific guideline is inconclusive, decisions should be made based on the judgment of the responsible anesthesia provider.

Any patient that has received neuraxial anesthesia should be considered at risk for the potential development of a spinal hematoma. A hematoma can develop following spinal or epidural needle puncture. The formation of a hematoma may also develop after discontinuation of an indwelling epidural or spinal catheter. Therefore, neurologic testing of sensory and motor function is essential following the administration of regional anesthesia in all patients.

CHAPTER II

LITERATURE REVIEW

Introduction

Regional anesthesia is utilized to provide intraoperative anesthesia, as well as, postoperative analgesia. Unfortunately, the risk of hemorrhagic complications following regional anesthesia can occur. Bleeding within the spinal canal, which is also referred to as a spinal hematoma, is considered one of the most serious hemorrhagic complications. The formation of a spinal hematoma is often times dependent on the patient, anesthetic technique, and surgical variables. Risk factors associated with the formation of a spinal hematoma include: timing of needle insertion and catheter removal, trauma that is encountered during the neuraxial anesthetic technique, and the degree and duration of anticoagulation stemming from the administration of medications that alter the clotting cascade (Horlocker, 2001).

Review of Literature

Spinal Hematoma

The most common site of spinal bleeding is the epidural space. This is due to the prominent epidural venous plexus. Subarachnoid and subdural bleeds may also occur, but are less frequent than epidural hemorrhage. The reported incidence of epidural hematoma formation in patients with normal coagulation is less than 1:150,000 following epidural

blocks. However, the ratio of hematoma formation decreases slightly with spinal blocks, which has a reported incidence of 1:220,000 (Tyagi & Bhattacharya, 2002).

In a retrospective review of data between the years of 1906 and 1994, there were 61 cases of spinal hematoma identified following the administration of epidural and spinal anesthesia. Five of the cases involved pregnant women, while four of the patients presented with anatomic abnormalities of the spine. The presence of altered hemostasis, resulting in spinal hematoma, was reported in 42 of the 61 patients. Of these 42 patients, 18 had received intravenous heparin, three received subcutaneous heparin, four were administered low molecular weight heparin (LMWH), and five of the patients received heparin during a vascular surgical procedure. In addition, 12 of the patients presented with a coagulopathy or the presence of thrombocytopenia. It was noted that a few of the 12 patients were treated with antiplatelet medications, oral anticoagulants, thrombolytics, or dextran immediately before or after the administration of the regional anesthetic (Horlocker, 2001).

In the same review conducted by Horlocker, both difficult and bloody needle placements were reported to have transpired in 25% of the patients. Multiple attempts at appropriate needle placement, resulting in multiple punctures to the patients back, occurred in 20% of the patients. It was identified that in 20 of the 61 cases, more than one risk factor was present. Spinal anesthesia was administered to 15 of the 61 patients. Epidural anesthesia was performed in 46 of the 61 patients. Of the 46 patients that received epidural anesthesia, 32 had an epidural catheter. Fifteen of the 32 patients with an epidural catheter developed a spinal hematoma immediately after the catheter was removed (Horlocker, 2001).

In the review conducted by Horlocker (2001), only 51 of the 61 cases provided information regarding the cause of the spinal hematoma. Patient characteristics such as: age, gender, medical history, and surgical procedure were not described. The case analysis stated the number of patients that received spinal versus epidural anesthesia; however, it did not relate which technique, in association with the anticoagulant medications, caused the spinal hematoma. Also, the review did not provide any information regarding the dose and duration of anticoagulant medication administration, laboratory data, or timing of needle insertion or indwelling catheter removal.

A MEDLINE search, conducted by Tyagi and Bhattacharya (2002), revealed that 60 cases of spinal hematoma formation occurred between the years of 1995 and 2001. Spinal hematoma formation, resulting from regional anesthesia, occurred in 20 of these 60 cases. The other 40 cases of spinal hematoma formation were spontaneous in origin. What was interesting about Tyagi and Bhattacharya's (2002) findings was that 20 cases of spinal hematoma formation were identified within the past five years. This was especially alarming when compared to Horlocker's (2001) results because the 61 cases of spinal hematoma formation identified within the review occurred over nine decades. The findings presented by Tyagi and Bhattacharya (2002) may indicate that the incidence of spinal hematoma formation is increasing. On the other hand, these findings may represent improved reporting regarding the occurrence of spinal hematoma formation. According to Tyagi and Bhattacharya (2002) "...over the past 5 years, the majority of the spinal hematomas following central neuraxial block were associated with anticoagulant therapy (11/20 cases)" (p. 324).

All of the cases conducted by Tyagi and Bhattacharya (2002) were discovered based on a MEDLINE search. The provided information was based solely on the prevalence of spinal hematoma formation following the administration of regional anesthesia. It did not list any characteristics of the sample, and it did not offer any indication as to why the formation of the spinal hematoma occurred.

Anticoagulation Medications

The catastrophic complications associated with the formation of a spinal hematoma have been strongly correlated to excessive anticoagulation and clotting disorders. The anticoagulant medications reviewed in this project were unfractionated heparin, LMWH, antiplatelet agents, and oral anticoagulants. The American Society of Regional Anesthesia and Pain Medicine (ASRA) have recommended guidelines for the use of regional anesthesia in patients on anticoagulant medications. These guidelines help anesthesia providers to determine when needle puncture and catheter removal can be safely performed in relation to the time and dose of anticoagulation medications. It also explores laboratory tests that should be performed prior to and following the administration of central neuraxial anesthesia. However, it is important to note that these guidelines cannot guarantee a specific outcome. The anesthesia provider is ultimately responsible for determining if regional anesthesia can be safely performed.

Unfractionated Heparin

The anticoagulant effect produced by unfractionated heparin occurs by binding to antithrombin III. This binding accelerates the neutralization of thrombin and activated factors IX, X, XI, and XII (Claerhout, Johnson, Radtke, & Zaglaniczny, 2004). When heparin is administered intravenously (IV), the activated partial thromboplastin time

(aPTT) is utilized to monitor its anticoagulant effect. When patients are receiving subcutaneous (SQ) heparin in doses of 5000 Units or less, the aPTT is not usually monitored (Tyagi & Bhattacharya, 2002). According to Kee (1999), the normal range for an aPTT is 20 to 35 seconds in an adult. The guidelines created by the University of Washington Medical Center (UWMC) revealed that needle insertion and catheter removal can occur at any time following SQ administration of heparin in doses less than 5000 Units. However, in SQ doses greater than 5000 Units, and when heparin is administered IV, needle placement should not occur unless the aPTT is less than 40 seconds. Under these same circumstances, the administration of heparin should be avoided when an indwelling catheter is in place (UWMC, 2006).

The risk of bleeding, following neuraxial anesthesia, may be increased in patients on prolonged heparin therapy. However, bleeding may be decreased by delaying the heparin injection until the block is complete. A platelet count on patients that have received heparin for greater than four days should be drawn before needle insertion or catheter removal (Horlocker et al., 2003). This is necessary because heparin-induced thrombocytopenia can result during the administration of heparin (Horlocker et al., 2003).

If a regional anesthetic technique is planned on a patient that is receiving anticoagulation, the administration of heparin should not occur for one hour following the placement of the needle. The ASRA guidelines (Horlocker et al., 2003) also recommend that providers discontinue indwelling catheters two to four hours after the last administered heparin dose. There is no data suggesting that difficult or bloody needle placement increases the risk of spinal hematoma formation with the use of unfractionated heparin. However, when heparin is administered with other anticoagulant medications

such as LMWH, oral anticoagulants, and antiplatelet therapies, there may be an increased risk of spinal hematoma formation (Horlocker et al., 2003).

In the past five years, a retrospective review conducted by Tyagi and Bhattacharya (2002) revealed that four cases of spinal hematoma had been reported following the performance of a regional block on patients receiving heparin therapy. In one of the cases, the spinal hematoma was thought to be caused by the interaction of nonsteroidal anti-inflammatory agents (NSAIDs) with the coexisting disease of liver failure. The second case was attributed to the fact that multiple attempts at spinal anesthesia were required prior to achieving proper needle placement for the block. The spinal hematoma identified in the third case occurred due to epidural catheter removal during heparin infusion. In the fourth case, the spinal hematoma was attributed to a difficult needle puncture in combination with undiagnosed spinal stenosis. Tyagi and Bhattacharya (2002) noted that the recommendations from the American Consensus Conference were followed in the fourth case.

A total of 60 subjects were evaluated in the review proposed by Tyagi and Bhattacharya (2002). The gender and ages of these patients were not listed within the case. However, the reasoning for why the spinal hematoma was thought to have occurred was included within the data. Risk factors such as the use of anticoagulant medications, multiple needle insertion attempts, and coexisting diseases were identified.

According to the ASRA guidelines (Horlocker et al., 2003), no data supports the mandatory cancellation of the case when difficult or bloody regional needle placement has occurred in a patient receiving heparin therapy. It is also important to note that no recommendations have been provided by the ASRA to determine when neuraxial

anesthesia is safe in patients with coexisting diseases such as liver failure. Due to the fact that some of the recommendations are unclear, or simply not included, it may be difficult for the anesthesia provider to determine when the administration of regional anesthesia can be safely performed.

Low Molecular Weight Heparin

LMWH is chemically and functionally similar to unfractionated heparin. The depolymerization of heparin actually results in a LMWH product. LMWH is most frequently characterized by its anti-Xa and anti-IIa properties (Bick, Frenkel, Walenga, Fareed, & Hoppensteadt, 2005). It is known to contain more fibrinolytic properties than unfractionated heparin. It also results in weaker clot formation due to decreased binding of platelets to fibrinogen. There is a marked reduction in LMWH binding to platelet factor IV and plasma proteins that are not related to anticoagulation. Therefore, the response of LMWH is very predictable, which eliminates the requirement for aPTT monitoring (Tyagi & Bhattacharya, 2002). Unlike heparin, the action of LMWH is only partially reversed by protamine. Enoxaparin, dalteparin, nadroparin, tinzaparin, and clivarine are all LMWHs with different characteristics. However, enoxaparin was reviewed most thoroughly in this project due to the frequency of its use in practice.

Monitoring of the anti-Xa level is not required prior to regional techniques because it does not predict the risk of bleeding. Oral anticoagulant and antiplatelet medications, unfractionated heparin, and dextran can increase the risk of spinal hematoma formation when used in combination with LMWH. The presence of blood and traumatic needle placement may also increase the risk of spinal hematoma formation, but does not necessarily require cancellation of the surgical procedure. It is recommended

that the administration of LMWH be delayed in these situations for at least 24 hours, especially if needle insertion was bloody (Horlocker et al., 2003).

Neuraxial anesthesia, including needle placement and indwelling catheter removal, should be delayed for at least 10-12 hours following a normal dose of LMWH. For example, a normal dose of enoxaparin is 40 milligrams (mg) SQ daily or 30 mg SQ twice daily. The administration of neuraxial anesthesia to patients on higher than normal doses of LMWH should be delayed for at least 24 hours. Higher than normal doses of LMWH include doses of 1 mg/kilogram (kg) twice daily or 1.5 mg/kg daily. The peak anticoagulant activity of LMWH occurs approximately two hours following administration. Therefore, needle placement should be avoided in patients that have received LMWH two hours before the scheduled procedure (Horlocker et al., 2003).

Single-injection needle placement and continuous catheter anesthetic techniques can be safely performed on patients that require postoperative prophylaxis with LMWH. LMWH that is administered twice daily may be associated with an increased risk of spinal hematoma. Therefore, the first postoperative dose of LMWH should not occur anytime before 24 hours. If single daily dosing is planned, the first dose of LMWH can be administered approximately six to eight hours postoperatively. However, the second postoperative dose should not occur prior to 24 hours of the first dose. If possible, indwelling catheters should be removed before a prophylactic dose of LMWH is administered. If continuous epidural anesthesia is planned, the catheter can be left in place overnight and removed the next day. The anesthesia provider should wait approximately two or more hours before administering LMWH to a patient that has just had the indwelling catheter removed (Horlocker et al., 2003).

Tyagi and Bhattacharya (2002) revealed that 14,000 patients safely received regional anesthesia while on LMWH in 1991. On further investigation, it was determined that another 9,000 patients receiving LMWH therapy also successfully underwent central neuraxial anesthesia without the formation of a spinal hematoma. However, two cases of spinal hematoma formation following regional anesthetic techniques were reported between 1991 and 1994. By 1998, a total of 11 cases had been reported, eight of which were related to the administration of enoxaparin. What was most interesting about this finding was that the eight cases had been identified 18 months after enoxaparin was cleared for use within the United States. Between 1998 and 2002, two more cases of spinal hematoma formation were revealed and attributed to the use of enoxaparin.

In 1996, regional anesthetic techniques on patients receiving enoxaparin anticoagulation therapy were considered to be safe. This assumption was soon rejected due to the increasing number of reported cases of spinal hematoma formation. The formation of a spinal hematoma was later determined to be caused by the different dosing regimens of enoxaparin. It was also concluded that the safety associated with unfractionated heparin in a patient undergoing a neuraxial procedure could not be extended to LMWH (Tyagi & Bhattacharya, 2002).

Ain and Vance (2005) presented a case that resulted in the development of an epidural hematoma following the administration of a steroid injection in an 85-year-old female patient. Prior to the injection, neurological examination was normal. A radiography test revealed compression of the first lumbar vertebra, mild scoliosis, and moderate degenerative disease. The patient was taking warfarin due to a history of chronic atrial fibrillation and a past aortic valve replacement; however, it was held for six

days prior to the scheduled procedure. While coumadin was on hold, enoxaparin 1 mg/kg SQ every 12 hours was administered for a total of four days prior to the epidural steroid injection. The day before the appointment, only the morning dose of enoxaparin was administered.

The patient's international normalized ratio (INR) the day of the procedure was 1.2. Atraumatic epidural needle insertion at the fourth to fifth lumbar interspace was performed more that 24 hours after the last dose of SQ enoxaparin. No blood or paresthesias were present during needle placement. Once the epidural space was reached, 80 mg of methylprednisolone was administered. No complications were noted during or following the procedure, so the patient was sent home. The patient was instructed to resume her usual dose of warfarin the evening of the injection and return to the clinic the next morning for further laboratory analysis. Following the interpretation of the prothrombin time (PT), the patient was instructed to take a total of 2.5 mg of warfarin daily and 1 mg/kg of enoxaparin SQ every 12 hours. The anesthesia provider felt that enoxaparin could be safely restarted because 24 hours had passed since the procedure was performed (Ain & Vance, 2005).

However, after a total of three doses, the patient returned to the clinic with excruciating back pain. A spinal hematoma at the third to fourth lumbar interspace was detected by MRI, and the patient's anticoagulation regimen was discontinued. Due to continued neurological complications, a second MRI was performed that showed extension of the hematoma to the first through fifth lumbar vertebral level (Ain & Vance, 2005).

This case illustrated that spinal hematoma formation following regional anesthesia can occur even when the ASRA guidelines are strictly followed. Ain and Vance (2005) clarified that needle insertion and injection occurred at least 24 hours after the last administered dose of enoxaparin. They also ensured that enoxaparin was not restarted for at least 24 hours following the procedure. Oral warfarin therapy was held for six days prior to the procedure and restarted at a low dose the evening of the procedure. Needle placement was atraumatic and no epidural catheter was placed. PT and INR levels were drawn the morning of the scheduled injection and were reported as within normal limits before the regional technique was performed. However, the patient was taking two different classes of anticoagulant medications, LMWH and warfarin, which has been proven to increase the risk of spinal hematoma formation. It should also be noted that the patient was self administering these medications at home after the procedure was completed. Therefore, it is possible that the patient took the wrong dose at the wrong time.

Antiplatelet Agents

Classes of antiplatelet agents include: aspirin and other related cyclo-oxygenase inhibitors, thienopyridine derivatives such as clopidogrel and ticlopidine, direct thrombin inhibitors such as hirudin, and platelet glycoprotein IIb/IIIa antagonists such as abxicimab and eptifibatide (Tyagi & Bhattacharya, 2002). The antiplatelet agents that were reviewed most thoroughly in this project were aspirin, NSAIDs, and clopidogrel. The platelet count generally ranges from 150,000 to 400,000 mm^3 in an adult (Kee, 1999). Aspirin consumed in low doses, such as 30-300 mg once daily, inhibits thromboxane A2 and eventually leads to decreased platelet aggregation (Katzung, 2004).

The effect of aspirin therapy lasts the entire lifetime of the platelet, which is generally 8 to 10 days. Other NSAIDs also alter platelet aggregation, but have a shorter duration of effect. Platelets resume normal function approximately one to three days after the NSAIDs are discontinued (Katzung, 2004).

Clopidogrel and ticlopidine administration irreversibly inhibits platelet function through the adenosine diphosphate pathway (Katzung, 2004). Therefore, the effect of therapy with thienopyridine derivatives lasts approximately 7 to 14 days after the drug has been stopped. The antithrombin properties of hirudin are what classify it as an antiplatelet agent. It works on both circulating and clotted thrombin by directly binding to its active site (Katzung, 2004). The glycoprotein (GP) IIb/IIIa antagonists block platelet aggregation at the final common pathway, which prevents the accumulation of platelets at the site of injury. This eventually leads to reduced availability of platelets for further coagulation (Katzung, 2004).

Unfortunately, there is no accepted laboratory test that can be utilized as a guide for antiplatelet therapy. Therefore, evaluation of the patient's medical conditions that may contribute to bleeding is essential. Some conditions that may lead to an increase in bleeding are: easy bruising, increased age, and female gender (Horlocker et al., 2003).

According to Horlocker et al. (2003), the use of NSAID therapy does not increase the risk of spinal hematoma formation following neuraxial anesthesia; however, the risk of spinal hematoma formation following thienopyridine and GP IIb/IIIa administration is unknown. Therefore, ticlopidine should be discontinued 14 days prior to receiving neuraxial anesthesia and clopidogrel should be discontinued seven days prior to the scheduled regional procedure (Horlocker et al., 2003). Platelet function must be normal

before regional anesthetic techniques are performed. Normal platelet aggregation occurs four to eight hours after eptifibatide and tirofiban therapy, but does not occur for 24 to 48 hours following the administration of abciximab. Due to the delay in normal platelet function following the administration of these medications, spinal injection or catheter placement need to be avoided for eight hours after eptifibatide or tirofiban therapy. Likewise, needle or catheter placement should not occur for at least 48 hours following the administration of abxicimab (UWMC, 2006). GP IIb/IIIa antagonists should not be administered prior to four weeks postoperatively (Horlocker et al., 2003).

Aspirin. In a prospective study conducted in 1994, Tyagi and Bhattacharya (2002) reported that 1422 out of 2783 pregnant patients receiving epidural therapy were randomly administered doses of aspirin until the day of delivery. It was reported that there were no differences observed between the aspirin and placebo groups. These findings led to the conclusion that antiplatelet therapy does not increase the risk of spinal hematoma formation following the performance of regional anesthesia. The ASRA continues to support this conclusion.

In a case presented by Hyderally (2005), a 55-year-old male patient developed an epidural hematoma following a combined spinal-epidural regional technique for a total hip replacement. The patient had a history of ankylosing spondylitis (AS) and insulin dependent diabetes, but was reported as neurologically intact. He had received epidural anesthesia 17 years earlier without any difficulties. No known risk factors were present other than AS; therefore, his daily regimen of aspirin 81 mg was continued to the day of surgery. A nontraumatic combined spinal-epidural was successfully performed after one attempt with no blood or paresthesias noted at the time of needle insertion.

Following the surgical procedure, an epidural infusion of fentanyl was initiated for pain control. Aspirin, 325 mg, was the only medication administered after the patient returned to the surgical floor. By the second postoperative day, the patient had complete motor and sensory loss of the lower extremities. An MRI revealed an epidural hematoma from the fifth through tenth thoracic vertebral level. Following the detection of the hematoma, the epidural catheter was removed and found to be free of blood (Hyderally, 2005).

The case presented by Hydrally (2005) provided very detailed information regarding the patient and the clinical factors that were associated with the formation of the spinal hematoma. In this particular case, the 81 mg dose of aspirin was not discontinued prior to the procedure. It was also noted that a 325 mg dose of aspirin was resumed immediately postoperatively. The decision to perform the regional technique while the patient was on aspirin therapy was in accordance with the ASRA guidelines. The patient was diagnosed with AS, which may be considered a potential risk factor. It would be interesting to know if the spinal hematoma was thought to have occurred due to the patient's history of AS, the aspirin therapy, or a combination of the two.

Cullen, Bogdanov, and Htut (2004) presented a case in which a 79-year-old female, diagnosed with multiple myeloma and postherpetic neuralgia, was scheduled to receive an epidural steroid injection for pain relief. The patient did not receive any anticoagulants or antiplatelet agents prior to the procedure. However, it is unknown whether the patient was on NSAIDs or aspirin therapy. No preexisting coagulopathy was present. The patient's PT, aPTT, and platelet count were within normal limits prior to the epidural injection. The patient did complain of thoracic spine pain prior to the procedure,

which may have been due to the multiple compression fractures of the lower thoracic spine.

The epidural injection was performed at the ninth thoracic level. The patient experienced a sharp severe pain with needle insertion; however, the needle was not repositioned prior to the administration of the medications. Following the injection of the steroids, an epidural catheter was threaded and later removed after all the medications were given. The patient complained of back pain, leg pain, and the inability to move one hour after the epidural was performed. Eight hours after the procedure, the patient still lacked sensation and movement of the lower extremities. An MRI was performed, and massive intradural and subdural hematomas were revealed. Despite an emergency laminectomy, the patient remained a paraplegic (Cullen, Bogdanov, & Htut, 2004).

The patient presented in this case was female and elderly. She received epidural anesthesia despite the presence of multiple compression fractures of the thoracic spine. These three characteristics, in combination with epidural anesthesia, are reported to increase the risk of spinal hematoma formation. It was unknown as to whether or not the patient had been taking aspirin or NSAID therapy. Therefore, these medications may have been potential risk factors.

NSAIDs. Horlocker et al. (2002) conducted a prospective study on 1035 individuals undergoing a total of 1214 epidural steroid injections in ambulatory pain clinics. The patients' age ranged from 19 to 95. There were 739 epidural steroid injections performed on women, and 475 performed on men. The epidural injection was indicated in 592 patients with acute radiculopathy, 384 patients with spinal stenosis, 118 patients with chronic back pain, 29 patients with foraminal stenosis, 12 patients with

failed back syndrome, and eight patients with postherpetic neuralgia. A history of bruising or bleeding was reported in 176 of the patients, and the platelet count was assessed in 77 patients prior to the epidural injection. The use of NSAID therapy was reported in 383 of the patients, 34 of which admitted to using multiple medications. The patients taking the NSAIDs were not the patients that reported a history of easy bruising or bleeding (Horlocker et al., 2002).

Approximately 80% of the injections were performed with an 18-gauge needle at the lumbar level of the spine. Of the epidural injections, 1124 were performed midline while 56 were accomplished through a paramedian approach. Both approaches were required for correct placement in nine of the patients. Placement was successful in 751 of the patients following a single needle pass; however, three or more passes were required for proper epidural placement in 151 of the patients. The anesthesiologist attempted needle placement in 151 of the patients while residents performed 1040 of the needle punctures. More than one anesthesia provider was required for successful needle placement in 23 of the patients. An epidural catheter was placed in 14 of the cases. Paresthesias were noted in 40 of the patients and dural puncture occurred following 10 of the epidural attempts. Injection volumes ranged from 5 to 11 milliliters (mL) (Horlocker et al., 2002).

Blood was noted in 63 of the patients undergoing needle or catheter placement. However, the incidence of a bloody needle following the anesthetic technique was not affected by NSAID therapy or platelet count. Multivariate analysis displayed that independent risk factors included: increased age, multiple needle punctures, and injection

volumes of less than 8 mL. These risk factors were shown to increase the potential for hemorrhagic complications (Horlocker et al., 2002).

In 79% of the patients, follow-up occurred within seven days of the procedure. Approximately 40% of the patients had self administered NSAIDs at some point between the epidural injection and follow-up interview. Bruising at the site of needle insertion occurred in 97 of the patients interviewed after the procedure. Patients with a history of easy bruising and bleeding were found to be strongly associated with the development of post procedural bruising. However, bruising at the injection site was not affected by NSAID therapy (Horlocker et al., 2002).

After evaluating the results of this prospective study, it was apparent that no association was found between NSAID therapy and spinal hematoma formation. However, other risk factors such as: increased age, large needle gauge, needle approach and placement, and multiple needle passes were associated with hemorrhagic complications. It was interesting to find that indwelling epidural catheter placement was not linked to hemorrhagic complications in this study. The results were very believable because the sample size was large and the probability of each risk factor was less than 0.05. It is also important to note that approval from the Institutional Review Board (IRB) was achieved prior to conducting the study.

In a case presented by Gilbert, Owens, and Mulroy (2002), a 35-year-old woman underwent epidural anesthesia for a left knee arthroscopy and screw removal. The patient denied the presence of bleeding problems and easy bruising. She had undergone epidural anesthesia without complications three times prior to this scheduled procedure. The patient had taken ibuprofen and ketorolac in the past without any problems. The third to

fourth lumbar epidural space was identified on the first attempt with an 18-gauge needle. Following placement of the epidural catheter, the patient complained of paresthesia of the right leg; however, the indwelling catheter was left in place, and ketorolac 30 mg was administered IV. Upon completion of the procedure, the tip of the catheter was noted to be bloody but intact following the removal of the indwelling epidural.

The block was completely resolved within two hours of the procedure, and the patient was discharged. On the way home, the patient experienced excruciating back pain and elected to return to the surgical center. Upon readmission, multiple doses of IV fentanyl and a second dose of ketorolac were administered with minimal relief. Due to the inadequate response to IV fentanyl, a second epidural procedure was performed and 50 micrograms (mcg) of fentanyl was administered. Bilateral neurological deficits were soon noted and an MRI was performed. A very large posterior epidural hematoma was present from the first to third lumber levels. Laboratory values drawn prior to the surgical evacuation of the hematoma revealed normal results (Gilbert, Owens, & Mulroy, 2002).

The patient presented in this case was younger than most of the other female patients represented within earlier cases of this literature review. Although no presenting risk factors were identified upon completion of the epidural procedure, the patient did complain of paresthesia at the time of catheter insertion. Upon discontinuation of the indwelling catheter, the tip was noted to be bloody. It was also reported that two doses of the NSAID ketorolac were administered. According to the ASRA guidelines, NSAIDs are not associated with spinal hematoma formation.

Clopidogrel. Tam, Soo, and Pretorius (2006) presented a case in which an 80-year-old woman developed a spinal hematoma while undergoing a combined spinal-

epidural anesthetic for an elective left total knee arthroplasty. The patient's medical history included: atrial fibrillation, moderate tricuspid regurgitation, congestive heart failure, renal failure, and hemorrhagic gastritis from low doses of aspirin. The patient was on a variety of medications including clopidogrel 75 mg daily, which was stopped seven days before the operation. Laboratory evaluation of the patient's blood revealed normal clotting times. Ten hours prior to the scheduled procedure, the patient received 5000 Units of SQ dalteparin.

The next day, a combined spinal-epidural anesthetic was administered. Following the injection of medication into the subarachnoid space, a catheter was threaded into the epidural space. The procedure was reported as atraumatic with no blood noted on the needle tip or in the catheter. After the operation was completed, a continuous infusion of bupivacaine was started through the epidural catheter at 7 mL per hour. That evening, pain over the lumbar spine and operative site were reported by the patient. It was treated with a bolus dose of bupivacaine followed by an increase of the infusion rate to 9 mL per hour. Dalteparin, 5000 Units, was administered SQ for thromboprophylaxis 24 hours after the first preoperative dose. This administration occurred 14 hours after the insertion of the epidural catheter (Tam, Soo, & Pretorius, 2006).

The following morning, the patient was inadvertently administered 75 mg of clopidogrel. Numbness and weakness of the patient's right leg was noted; however, it was attributed to the epidural analgesia. The indwelling epidural catheter was in place for 72 hours prior to discontinuation on the third postoperative day. Catheter removal occurred 12 hours after the last dose of dalteparin and 48 hours after the administration of clopidogrel. Although motor weakness of the right leg remained, an MRI was not

conducted for 48 hours because an imaging facility was not available within the hospital (Tam, Soo, & Pretorius, 2006).

In this case, the ASRA guidelines for LMWH administration were followed; however, clopidogrel was inadvertently administered on the first postoperative day while the epidural catheter remained in place. Clopidogrel was initially stopped seven days before the procedure, but it is important to note that the co-administration of anticoagulants to patients that are normally on antiplatelet medications increases the risk of spinal hematoma formation. The fact that the patient was diagnosed with renal failure may also have contributed to the formation of the spinal hematoma in this case.

Litz, Gottschlich, and Stehr (2004) reported a case regarding an 81-year-old female that received spinal anesthesia for a scheduled fasciotomy and perforator vein ligation operation. The patient's medical history included: ischemic heart disease, atrial fibrillation, hypertension, insulin-dependent diabetes, and compensated renal insufficiency. She was on a variety of medications including 75 mg of clopidogrel, which was discontinued seven days prior to the procedure. The PT, aPTT, and INR were within normal range prior to the spinal technique. However, the platelet count of 161,000 mm^3 was at the lower limit of the normal range. The first spinal anesthetic attempt, which failed, occurred at the third to fourth lumbar level. Blood was noted, but the anesthesia provider presumed that the puncture was outside of the epidural space. The second attempt at the fourth to fifth lumbar interspace was successfully performed.

Following the uneventful surgical procedure, two doses of enoxaparin 40 mg SQ were administered for prophylaxis 8 and 36 hours after the spinal technique was performed. After the second dose of enoxaparin, the patient reported difficulties with

voiding; however, no motor or sensory deficit appeared to be present. On the second postoperative day, the patient complained of numbness and weakness of the lower extremities. Interpretation of the MRI revealed the formation of a spinal hematoma extending from the twelfth thoracic level to the third lumbar vertebral space (Litz, Gottschlich, & Stehr, 2004).

The elderly female represented in this case was diagnosed with impaired renal function, which may have prolonged the therapeutic response of enoxaparin. It was also noted that a bloody needle puncture had occurred; therefore, an epidural vein may have been nicked during the first attempt at spinal needle placement. The platelet count was only 161,000 mm^3 prior to the neuraxial attempt, which may represent that the clopidogrel effect was prolonged. However, the ASRA guidelines for enoxaparin and clopidogrel administration were followed. It is important to note that the additive effects of these anticoagulant medications may increase the risk of spinal hematoma formation.

Oral Anticoagulants

Warfarin inhibits the formation of vitamin K, resulting in depletion of the procoagulant factors VII, IX, and X. Anticoagulant protein C is also depleted due to the inhibition of vitamin K. The rapid decrease in factor VII is reflected by an increase in the INR or PT. With chronic administration of coumadin, the PT is reflective of factor X. After coumadin therapy is discontinued, the early recovery of factor VII may cause the PT and INR to normalize. However, factors II and X remain depleted (Tyagi & Bhattacharya, 2002). Kee (1999) reported that a PT generally ranges from 10 to 13 seconds in an adult. The INR is an international standardized test for PT that should only

be used after the patient has been stabilized on warfarin (Kee, 1999). Central neuraxial anesthetic procedures should be delayed until the INR is within the range of 1.0 to 1.3.

Warfarin administration must be stopped four to five days before a regional procedure is performed. If a dose of warfarin is administered more than 24 hours before a scheduled surgery, a PT and INR level need to be checked prior to initiating a regional block. The same actions ought to be taken if a second dose of oral anticoagulant has been administered. The PT and INR need to be assessed prior to discontinuing an indwelling catheter on a patient that has received low doses of warfarin, 5 mg or less, throughout continuous epidural therapy. The catheter should not be removed until the INR is less than 1.5. If the INR is greater than three, the warfarin dose needs to be held or reduced. Catheter removal should be delayed until laboratory results normalize. Concurrent use of medications that alter clotting may increase the risk of spinal hematoma formation without affecting the PT and INR. These medications include: unfractionated heparin, LMWH, clopidogrel, ticlopidine, aspirin, and NSAIDs (Horlocker, 2003).

Warfarin. Tyagi and Bhattacharya (2002) noted that within the last five years, two cases of spinal hematoma formation related to the use of warfarin therapy were reported. In both cases, the removal of the epidural catheter occurred when the PT was prolonged. These findings demonstrate the importance of daily PT and INR monitoring prior to indwelling epidural catheter removal in patients receiving low doses of warfarin therapy.

Horlocker, Wedel, and Schlichting (1994) performed a retrospective chart review of patients that received postoperative epidural analgesia while on low dose warfarin therapy between the years of 1988 and 1992. It was discovered that 192 procedures were completed on 188 patients. Of the 192 total knee arthroplasty (TKA) procedures, 88 were

unilateral, 78 were bilateral, and 26 were revisions. The age of these patients ranged from 59 to 77. There were 105 females and 83 males. Aspirin therapy was taken by 23 of the patients in the week preceding the operation. The platelet count ranged from 204,000 to 356,000 mm^3 in 188 of the patients. One of the patients had a platelet count of 96,000 mm^3. The three remaining patients had a platelet count that was greater than 100,000 mm^3. Nineteen of the patients had a preoperative PT level drawn, and all were within normal limits. The aPTT was assessed preoperatively in eight of the patients, but only seven were within normal limits.

All epidural catheters were placed through an 18-gauge needle. The needle approach was midline for 168 of the cases, paramedian in 12 of the cases, combined in 10 of the cases, and undetermined in two of the cases. Blood was noted during needle or epidural catheter placement in 13 of the patients. It was reported that the epidural catheters were left in place for 0 to 1 day in 69 of the cases, 1 to 2 days in 101 of the cases, 2 to 3 days in 20 of the cases, and 3 to 4 days in the remaining 2 cases (Horlocker et al., 1994).

In the study conducted by Horlocker et al. (1994), low dose warfarin therapy was administered postoperatively in attempt to attain a therapeutic PT between 15 and 17.3 seconds. The dose of warfarin ranged from 0.4 mg to 6 mg. Most of the PTs were not increased until the third postoperative day. However, it is important to note that 36 of the patients had a PT greater than 12.8 seconds after the first dose of warfarin therapy. Of the 36 patients, two had already reached their therapeutic levels. On average, the therapeutic level was usually not achieved until the seventh postoperative day. In 45 of the patients, the PTs were 15 seconds or less while four of the patients had PTs that did not increase

above the normal range. The PT prior to epidural catheter removal ranged from 11.4 to 15.4 seconds. It was also noted that 36 of the patients were taking NSAIDs in addition to warfarin while their indwelling catheters were in place. After reviewing the data, Horlocker et al. (1994) concluded that none of the patients developed a spinal hematoma.

The results of this study displayed that the administration of low dose warfarin therapy in patients with indwelling catheters is safe. IRB approval was achieved prior to the retrospective review. However, it is important to note that the sample size was very small, thus, the potential for error exists.

Summary

Throughout this chapter, retrospective reviews, case reports, and ethical prospective studies were presented to display the association between spinal hematoma formation and anticoagulation therapy. It was evident that spinal hematoma formation was strongly associated with the use of anticoagulant medications, especially when different classes of anticoagulants were administered in conjunction. A majority of these hematomas occurred even though the ASRA guidelines were followed, which proves that these recommendations alone do not ensure that the administration of neuraxial anesthesia can be safely performed. In attempt to reduce the occurrence of spinal hematoma formation, anesthesia providers need to be aware of all the risk factors, in addition to anticoagulant medications, that may contribute to this undesirable complication. This may be achieved by conducting a more complete assessment of the patient's physical presentation, medical history, laboratory data, and current medication history prior to the administration of regional anesthesia.

There has been a strong association between spinal hematoma formation in relation to gender, age, anticoagulation medication administration, spinal pathology, and epidural anesthesia in the cases presented within this literature review. Most of the patients were of female gender and over the age of 55. It was also noted that a majority of the patients had a physical abnormality of the spine. As stated earlier, the epidural space is the most common site of spinal bleeding. This statement was well represented in many cases where hematoma formation followed epidural needle or catheter insertion, as well as, indwelling catheter removal.

CHAPTER III

METHODS

Introduction

After completing clinical rotations with anesthesia providers at a variety of midwestern health care facilities, it was discovered that questions regarding the exact timing of anticoagulant administration in relation to regional anesthetic procedures were often discussed. Anesthesia providers continue to research available literature focusing on regional anesthesia in attempt to find definitive recommendations as to when it is safe to perform these techniques. Unfortunately, the information that is offered in available guidelines cannot always guarantee positive outcomes for the patient. Therefore, spinal hematoma formation remains a risk factor following central neuraxial anesthesia. In attempt to learn more about and express the severity of this complication, an extensive literature review was conducted and presented to anesthesia professionals and students in training.

Target Audience

This project was addressed to Student Registered Nurse Anesthetists (SRNAs), Certified Registered Nurse Anesthetists (CRNAs), and Nurse Anesthesia Specialization faculty. A 30-minute power point presentation (see Appendix B) was delivered to 12 SRNAs and two CRNA faculty members at a Nurse Anesthesia program located in the midwest. A second 15-minute presentation (see Appendix C) was presented at a

midwestern state Nurse Anesthesia conference in which CRNAs, program faculty, and first and second year students in training were in attendance.

Procedures and Plans

The program director of a Nurse Anesthesia Specialization program in the midwest was contacted so that a 30-minute educational in-service, addressing first year nurse anesthesia students, could be scheduled. A power point presentation (see Appendix B) that included published guidelines, case studies, retrospective reviews, and prospective studies was formulated and presented. An informational pocket guide (see Appendix A), compiling diverse recommendations and guidelines, was created and made available to the students and Nurse Anesthesia faculty in attendance. The pocket guide provided information regarding the doses, frequency, and timing of anticoagulant medication administration in relation to regional anesthetic techniques. Relevant laboratory values were also incorporated in the guide to help determine when needle insertion and catheter removal could be safely performed.

Evaluation Plan

A pre- and post-test format (see Appendix D) was used to evaluate the results of this project. Prior to administering the tests, the 12 SRNAs were assigned a random number to be placed on the top of each questionnaire. This was completed so that the pre- and post-test results could be compared. The 10 question pre-test was administered to determine the audiences' knowledge of the subject matter before the topic was presented. Immediately following the power point presentation, the same 10 question post-test was delivered. The audience was not allowed to use the printed power point handouts while completing the questionnaire. This tactic was used to determine how informed the

listeners were with the content before the presentation compared to after the presentation. The correct answers to the questionnaire were reviewed with the participants after the post-tests were collected. Questions and comments regarding the subject matter were welcomed throughout the 30-minute presentation.

Expected Results

A review of anticoagulation and spinal hematoma formation was presented in attempt to increase the knowledge and comfort level of students and anesthesia professionals performing regional techniques. Upon completion of the presentation, CRNAs and SRNAs should be able to identify the following: different anticoagulation medications, essential laboratory values and their normal ranges, and anatomical features that place patients at increased risk for the development of a spinal hematoma. The appropriate timing of spinal or epidural needle placement and catheter removal relative to the timing of anticoagulant medication administration should also be understood. It is expected that anesthesia providers and students in training will be more confident in deciding whether a regional anesthetic procedure can be safely performed. The ultimate goal is to decrease the incidence of spinal hematoma formation following the performance of central neuraxial procedures.

Nursing Practice

Spinal hematoma formation is a very serious complication that can result following regional anesthetic procedures. In attempt to reduce the incidence of spinal hematoma formation, anesthesia providers must be able to identify patient risk factors such as: coexisting disease, physical presentation, and altered coagulation. Due to the large number of patients on medications that alter clotting status, anesthesia professionals

must also be comfortable with anticoagulants, assessment of laboratory data, and timing of needle insertion. It is essential that anesthesia caregivers have a thorough understanding of existing anticoagulation guidelines in addition to remaining current on updated information regarding complications of neuraxial anesthesia. These tactics will help the providers determine when a regional anesthetic technique can be performed safely.

Nursing Research

The performance of central neuraxial procedures has increased in popularity due to the many benefits that they offer patients undergoing surgical procedures. Continued research on this topic would help update available recommendations on regional anesthetic techniques in the anticoagulated patient. The ASRA has proposed guidelines for the use of regional anesthesia in patients on anticoagulant medications; however, these guidelines cannot always guarantee a positive outcome. Therefore, anesthesia providers must use their own clinical judgment to decipher whether these procedures can be safely performed. It would be valuable if, through research, conclusive guidelines could be developed to further decrease the risk of spinal hematoma formation to ensure favorable outcomes for patients.

Nursing Education

To ensure safe and reliable care for our patients, education must be ongoing. Continuing education will allow anesthesia providers to learn more about the risks of regional anesthesia and how they can be prevented. Anesthesia caregivers should strive to review current literature and attend educational in-services to further increase their

knowledge of the subject matter. Through education, the anesthesia profession can create a more solid foundation to optimally serve the community.

Nursing Policy

It is essential for health care institutions to create and frequently update policy and procedure manuals focusing on regional anesthetic techniques. The development of an accurate and reliable policy is vital because it serves as the standard for which employees practicing within the facility are required to adhere to. Detailed guidelines would help anesthesia professionals decide when regional procedures could be performed safely. By maintaining current and updated policies, a higher standard of care could be provided to the community.

Summary

Anesthesia providers work very hard to ensure patient safety while performing regional techniques. However, complications associated with the administration of these procedures remains a common concern. It is important for anesthesia professionals to stay current on information regarding spinal hematoma formation. This could be accomplished through ongoing research so that new and updated information could be incorporated into the practice. It would also be beneficial if more frequent educational in-services, focusing on regional anesthesia in the anticoagulated patient, were presented to anesthesia professionals.

CHAPTER IV

RESULTS

Introduction

The results of the pre- and post-tests were evaluated and presented in table format. Individual tables were created for both the pre-test and the post-test. The tables incorporated the 10 test questions and indicated whether the 12 participants answered each question correctly or incorrectly. The pre- and post-test responses were then compared to determine if scores improved following the presentation. Refer to Table 1 for pre-test results and Table 2 for post-test results. A description of the results was created to help the readers understand the information that was collected and presented in the tables.

Drastic improvements were noted when comparing the post-test results to the pre-test results. Question one had the most dramatic increase in scores. Eight of the participants answered incorrectly on the pre-test while only one of the participants answered incorrectly on the post-test. Each of the 12 participants answered questions 2, 8, and 10 correctly on the post-test. However, for question eight, all of the participants answered correctly on the pre-test and the post-test. Perhaps the students knew this information prior to the presentation.

The most alarming finding was that there was no improvement on question six. Only four students answered the question correctly on the pre-test, as well as, the post-

test. Actually, some of the participants that answered it correctly on the pre-test answered it incorrectly on the post-test. Perhaps this particular topic could have been emphasized or presented in more thorough detail. Possibly the post-test results would have been higher if the question was reworded or simplified. Pre- and post-test scores were also low for question nine. Four of the participants answered the question correctly on the pre-test and six answered correctly on the post-test. These results show that there was slight improvement on the post-test; however, this question appeared to be difficult for the participants.

Summary

There are many aspects of regional anesthesia in an anticoagulated patient that are difficult to understand. The students did a wonderful job processing the information, which was evident by the increase in post-test scores. The presentation itself went smoothly, and the students appeared to appreciate the information that they obtained. The students were very attentive throughout the educational session and were more than willing to ask questions following the presentation. However, it was later discovered that the students had already completed one exam and one unexpected quiz prior to the presentation and pre-/post-testing. It would have been optimal to present the information to the students at a less hectic time. This would have allowed them to focus on the presented material rather than other topics that had been addressed that day. Overall, the experience was positive and proved to be beneficial for those who were involved.

Table 1. Pre-test Results

Pre-test Questions:	Participants By Number:											
	# 1	# 2	# 3	# 4	# 5	# 6	# 7	# 8	# 9	# 10	# 11	# 12
Question # 1 Spinal and epidural needle insertion and catheter removal can occur at any time following subcutaneous (SQ) administration of heparin in doses less than 5000 units?	I	I	C	C	I	I	C	I	I	I	C	I
Question # 2 The anticoagulant effect produced by unfractionated heparin occurs by binding to antithrombin III?	C	C	I	C	I	C	C	C	C	C	C	C
Question # 3 The response of low molecular weight heparin (LMWH) is very predictable, which eliminates the requirement for activated partial thromboplastin time (aPTT) monitoring?	C	C	C	I	I	I	C	C	C	C	C	I
Question #4 The action of LMWH is fully reversed by protamine?	C	I	C	I	C	I	C	C	C	I	I	C
Question #5 Neuraxial anesthesia, including needle placement and indwelling catheter removal, should be delayed for at least 10-12 hours following a 40 milligram (mg) SQ dose of enoxaparin?	I	C	C	I	C	C	C	C	C	C	C	C
Question # 6 If single daily dosing of enoxaparin 40 mg SQ is planned, the first dose of LMWH can be administered approximately 2-4 hours after epidural needle or catheter placement?	C	I	I	C	I	I	I	C	I	C	I	I
Question # 7 The effect of aspirin therapy lasts the entire lifetime of the platelet, which is generally 8-10 days?	I	C	C	C	I	I	C	C	C	C	C	C
Question # 8 Ticlopidine should be discontinued 14 days prior to receiving neuraxial anesthesia and clopidogrel should be discontinued seven days prior to the scheduled regional procedure?	C	C	C	C	C	C	C	C	C	C	C	C
Question # 9 Warfarin administration should be stopped 8-10 days before a regional procedure is performed?	C	I	I	I	I	I	C	C	C	I	I	I
Question # 10 Concurrent use of medications such as: unfractionated heparin, LMWH, clopidogrel, ticlopidine, and aspirin may increase the risk of spinal hematoma formation without affecting the prothrombin time (PT) and international normalized ratio (INR)?	C	C	C	I	C	C	C	C	C	I	C	C

C = Correct Answer I = Incorrect Answer

Table 2. Post-test Results

Post-test Questions:	Participants By Number:											
	# 1	# 2	# 3	# 4	# 5	# 6	# 7	# 8	# 9	# 10	# 11	# 12
Question # 1 Spinal and epidural needle insertion and catheter removal can occur at any time following subcutaneous (SQ) administration of heparin in doses less than 5000 units?	C	C	C	C	C	C	C	I	C	C	C	C
Question # 2 The anticoagulant effect produced by unfractionated heparin occurs by binding to antithrombin III?	C	C	C	C	C	C	C	C	C	C	C	C
Question # 3 The response of low molecular weight heparin (LMWH) is very predictable, which eliminates the requirement for activated partial thromboplastin time (aPTT) monitoring?	C	C	C	C	I	C	C	C	C	C	C	C
Question #4 The action of LMWH is fully reversed by protamine?	C	I	C	C	C	C	C	C	C	C	C	C
Question #5 Neuraxial anesthesia, including needle placement and indwelling catheter removal, should be delayed for at least 10-12 hours following a 40 milligram (mg) SQ dose of enoxaparin?	C	C	C	I	C	C	C	C	C	C	C	C
Question # 6 If single daily dosing of enoxaparin 40 mg SQ is planned, the first dose of LMWH can be administered approximately 2-4 hours after epidural needle or catheter placement?	I	I	C	C	I	I	C	I	I	I	C	I
Question # 7 The effect of aspirin therapy lasts the entire lifetime of the platelet, which is generally 8-10 days?	C	I	C	C	C	C	C	C	C	C	C	C
Question # 8 Ticlopidine should be discontinued 14 days prior to receiving neuraxial anesthesia and clopidogrel should be discontinued seven days prior to the scheduled regional procedure?	C	C	C	C	C	C	C	C	C	C	C	C
Question # 9 Warfarin administration should be stopped 8-10 days before a regional procedure is performed?	I	C	C	I	I	I	C	C	C	I	I	C
Question # 10 Concurrent use of medications such as: unfractionated heparin, LMWH, clopidogrel, ticlopidine, and aspirin may increase the risk of spinal hematoma formation without affecting the prothrombin time (PT) and international normalized ratio (INR)?	C	C	C	C	C	C	C	C	C	C	C	C

C = Correct Answer I = Incorrect Answer

APPENDICES

Appendix A
Pocket Guide

Anticoagulant (dose)	Labs (normal range)	Timing of Needle Insertion	Timing of Catheter Removal
Unfractionated Heparin			
< 5000 Units SQ	aPTT not monitored	Anytime	Anytime
≥ 5000 Units SQ and IV administration	Assess aPTT (20-35 seconds) prior to neuraxial procedure	Not unless aPTT is <40 seconds	Catheter can be removed 2-4 hours after last heparin dose if aPTT is <40 seconds.
	Platelet count on patients that have received heparin for >4 days	Heparin should not be given for 1 hour following needle insertion.	Re-heparinization can occur 1 hour after catheter removal.
Low Molecular Weight Heparin (LMWH)			
Enoxaparin (Lovenox) 40 mg SQ daily or 30 mg SQ bid	No need to monitor aPTT	Delay for 10-12 hours	Delay for 10-12 hours
Enoxaparin (Lovenox) 1mg/kg bid or 1.5 mg/kg daily	No need to monitor aPTT	Delay for 24 hours	Delay for 24 hours
Single daily dosing		1st postoperative LMWH dose can be given 6-8 hours after the procedure. 2nd postoperative dose should not occur prior to 24 hours of the first dose.	Catheter may be removed 10-12 hours after the last dose of LMWH. Re-dosing may occur 2 hours after catheter removal.
Twice daily dosing and high doses of LMWH		1st postoperative LMWH dose can be given 24 hours after the procedure.	Indwelling catheter can be left in place overnight and removed the next day. Re-dosing may occur 2 hours after catheter removal.

Anticoagulant (dose)	Labs (normal range)	Timing of Needle Insertion	Timing of Catheter Removal
Oral Antiplatelet Medications			
NSAIDs Reversibly inhibit platelet function. Platelets altered for 1-3 days after discontinued.	Assess platelet count (150,000-400,000 mm^3)	Anytime if platelet count is >100, 000 mm^3	Anytime if platelet count is >100, 000 mm^3
Aspirin (ASA) Irreversibly inhibit platelet function	Assess platelet count (150,000-400,000 mm^3)	Anytime if platelet count is >100, 000 mm^3 Discontinue aspirin 7 days prior to needle insertion.	Anytime if platelet count is >100, 000 mm^3
Clopidogrel (Plavix) Irreversibly inhibit platelet function	Assess platelet count (150,000-400,000 mm^3)	Anytime if platelet count is >100, 000 mm^3 Discontinue plavix 7 days prior to needle insertion.	Anytime if platelet count is >100, 000 mm^3 Avoid plavix administration while catheter is in place.
Ticlopidine (Ticlid) Irreversibly inhibit platelet function	Assess platelet count (150,000-400,000 mm^3)	Anytime if platelet count is >100, 000 mm^3 Discontinue ticlid 14 days prior to needle insertion.	Anytime if platelet count is >100, 000 mm^3 Avoid ticlid administration while catheter is in place.
Oral Anticoagulant Medications			
Warfarin (Coumadin)	Assess PT (10-13 seconds) and INR (1.0-1.3)	Anytime if PT and INR are within normal range. Discontinue warfarin 4 -5 days prior to needle insertion. Monitor PT and INR for 24 hours after procedure.	Monitor PT and INR daily while catheter is in place. Assess PT and INR before removal of catheter. INR should be <1.5 prior to discontinuing catheter.

Appendix B
Power Point Presentation 1

Spinal Hematoma Formation Following Neuraxial Anesthesia in the Anticoagulated Patient

PRESENTED BY: LISA ETTL
UNIVERSITY OF NORTH DAKOTA
MARCH 20, 2008

Spinal Hematoma

- Spinal hematoma formation, which results from bleeding into the spinal canal, is a rare but potential complication following neuraxial anesthesia.
- The most common site of spinal bleeding is the epidural space. This is largely due to the prominent epidural venous plexus.
- The reported incidence of epidural hematoma formation is 1:150,000 following epidural blocks.
- The ratio of hematoma formation decreases slightly with spinal blocks, which has a reported incidence of 1:220,000.

(Tryg & Bhattacharya, 2002)

Guidelines For Regional Anesthesia

- The American Society of Regional Anesthesia and Pain Medicine (ASRA) have recommended guidelines for the use of regional anesthesia in patients on anticoagulant medications.
- These guidelines help anesthesia providers to determine when needle puncture and catheter removal can be safely performed in relation to the time and dose of anticoagulation medications.
- It also explores laboratory tests that should be performed prior to and following the administration of central neuraxial anesthesia.

Unfractionated Heparin

- The anticoagulant effect produced by unfractionated heparin occurs by binding to antithrombin III.
- When heparin is administered IV, the activated partial thromboplastin time (aPTT) is utilized to monitor its anticoagulant effect.
- When patients are receiving subcutaneous (SQ) heparin in doses of 5000 Units or less, the aPTT is not usually monitored. (Tryg & Bhattacharya, 2002)
- The normal range for an aPTT is 20-35 seconds in an adult. (Kee, 1999)

Unfractionated Heparin

- Guidelines created by the University of Washington Medical Center (UWMC) revealed that needle insertion and catheter removal can occur at any time following SQ administration of heparin in doses less than 5000 Units.
- In doses greater than 5000 Units, and when heparin is administered IV, needle placement should not occur unless the aPTT is less than 40 seconds. Under these same circumstances, the administration of heparin should be avoided when an indwelling catheter is in place. (UWMC, 2006)
- A platelet count on patients that have received heparin for greater than four days should be drawn before needle insertion or catheter removal. (Horlocker et al., 2003)

Unfractionated Heparin

- If a regional anesthetic technique is planned on a patient that is receiving anticoagulation, the administration of heparin should not occur for one hour following the placement of the needle.
- Indwelling catheters should not be discontinued for 2-4 hours after the last administered heparin dose.
- When heparin is administered with other anticoagulant medications such as: low molecular weight heparin (LMWH), oral anticoagulants, and antiplatelet therapies, there may be an increased risk of spinal hematoma formation.

(Horlocker et al., 2003)

LMWH

- LMWH is chemically and functionally similar to unfractionated heparin.
- It results in weaker clot formation due to decreased binding of platelets to fibrinogen.
- The response of LMWH is very predictable, which eliminates the requirement for aPTT monitoring.
- Unlike heparin, the action of LMWH is only partially reversed by protamine.

(Tsui & Bhattacharya, 2009)

LMWH

- A normal dose of enoxaparin is 40 mg SQ daily or 30 mg SQ twice daily.
- Needle placement and indwelling catheter removal should be delayed for at least 10-12 hours following a normal dose of LMWH.
- Higher than normal doses of LMWH include doses of 1 mg/kg twice daily or 1.5 mg/kg daily.
- The administration of neuraxial anesthesia to patients on higher than normal doses of LMWH should be delayed for at least 24 hours.

(Horlocker et al., 2003)

LMWH

- The peak anticoagulant activity of LMWH occurs approximately two hours following administration.
- Single-injection needle placement and continuous catheter anesthetic techniques can be safely performed on patients that require postoperative prophylaxis with LMWH.
- LMWH that is administered twice daily may be associated with an increased risk of spinal hematoma.

(Horlocker et al., 2003)

LMWH

- If single daily dosing is planned, the first dose of LMWH can be administered approximately 6-8 hours postoperatively. However, the second postoperative dose should not occur prior to 24 hours of the first dose.
- If possible, indwelling catheters should be removed before a prophylactic dose of LMWH.
- When continuous epidural anesthesia is planned, the catheter can be left in place overnight and removed the next day.
- The anesthesia provider should wait approximately two or more hours before administering LMWH to a patient that has just had the indwelling catheter removed.

(Horlocker et al., 2003)

Antiplatelet Agents

- Platelet count generally ranges from 150,000 to 400,000 mm^3 in an adult. (Lee, 2009)
- Aspirin consumed in low doses, such as 30-300 mg once daily, inhibits thromboxane A2 and eventually leads to decreased platelet aggregation.
- The effect of aspirin therapy lasts the entire lifetime of the platelet, which is generally 8 to 10 days.
- Other NSAIDs also alter platelet aggregation, however, normal platelet function is resumed approximately 1-3 days after the NSAIDs are discontinued. (Katung, 2004)

Antiplatelet Agents

- Clopidogrel and ticlopidine administration irreversibly inhibits platelet function through the adenosine diphosphate pathway. (Katung, 2004)
- The use of NSAID therapy does not increase the risk of spinal hematoma formation following neuraxial anesthesia, however, the risk of spinal hematoma formation following thienopyridine administration is unknown. (Horlocker et al., 2003)

Antiplatelet Agents

- Ticlopidine should be discontinued 14 days prior to receiving neuraxial anesthesia and clopidogrel should be discontinued seven days prior to the scheduled regional procedure.
- Platelet function must be normal before regional anesthetic techniques are performed.

(Horlocker et al., 2003)

Warfarin

- Warfarin inhibits the formation of vitamin K, resulting in depletion of the procoagulant factors II, VII, IX, and X.
- The rapid decrease in factor VII is reflected by an increase in the international normalized ratio (INR) or prothrombin time (PT).
- With chronic administration of coumadin, the PT is reflective of factor X.
- After coumadin therapy is discontinued, the early recovery of factor VII may cause the PT and INR to normalize; however, factors II and X remain depleted.

(Tsui & Bhattacharya, 2009)

Warfarin

- A normal PT generally ranges from 10 to 13 seconds in an adult.
- The INR is an international standardized test for PT that should only be used after the patient has been stabilized on warfarin.
- Central neuraxial anesthetic procedures should be delayed until the INR is within the range of 1.0 to 1.3.

(Kee, 1999)

Warfarin

- Warfarin administration must be stopped 4 to 5 days before a regional procedure is performed.
- If a dose of warfarin is administered before a scheduled surgery, a PT and INR level need to be checked prior to the regional technique.

(Horlocker et al., 2003)

Warfarin

- The PT and INR also need to be assessed prior to discontinuing an indwelling catheter on a patient that has received low doses of warfarin, 5 mg or less, throughout continuous epidural therapy.
- The catheter should not be removed until the INR is less than 1.5.
- Concurrent use of medications such as: unfractionated heparin, LMWH, clopidogrel, ticlopidine, and aspirin may increase the risk of spinal hematoma formation without affecting the PT or INR.

(Horlocker et al., 2003)

Risks

- Anatomic abnormalities of the spine
  - Spinal stenosis
  - Scoliosis
  - Degenerative disease
  - Ankylosing spondylitis
- Thrombocytopenia
- Difficult/bloody needle placement
  - Large needle gauge
  - Multiple needle passes
- Easy bruising
- Increased age
- Female gender
- Epidural catheter placement
- Liver failure

Summary

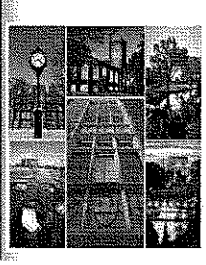
- In attempt to reduce the occurrence of spinal hematoma formation, anesthesia providers need to be aware of all the risk factors, in addition to anticoagulant medications, that may contribute to this undesirable complication.
- This may be achieved by conducting a more complete assessment of the patient's physical presentation, medical history, laboratory data, and current medication history prior to the administration of regional anesthesia.

References

- Horlocker, T.T., Benzon, H.T., Brown, D.L., Enneking, F.K., Hoff, J.A., Mulroy, M.F. et al. (2003). Regional anesthesia in the anticoagulated patient: Defining the risks. Retrieved April 15, 2007, from http://www.asra.com/consensus-conference.pdf
- Katzung, B.G. (2004). *Basic and clinical pharmacology* (9th ed.). New York: McGraw-Hill Companies.
- Kee, J.L. (1999). *Laboratory diagnostic tests with nursing implications* (5th ed.). Stamford, CT: Appleton & Lange.
- Tryba, A., & Bhattacharya, A. (2002). Central neuraxial blocks and anticoagulation: A review of current trends. *European Journal of Anesthesiology, 19*, 317-329.
- University of Washington Medical Center. (2006). Anticoagulation guidelines for neuraxial procedures: Guidelines to prevent spinal hematoma following epidural/intrathecal/spinal procedures. Retrieved April 15, 2007 from: http://www.uwmedcen.org/pdf/neuraxial.pdf

Appendix C
Power Point Presentation 2

Spinal Hematoma Formation Following Neuraxial Anesthesia in the Anticoagulated Patient



Independent Project
Presented By: Lisa Bell
April 25, 2008

The University of North Dakota

Introduction

- The formation of a spinal hematoma is strongly correlated with the use of anticoagulation medications.
  - Incidence of epidural hematoma formation is 1:150,000.
  - Ratio of hematoma formation decreases slightly with spinal blocks, with a reported incidence of 1:220,000.
- The number of patients on medications that alter clotting status continues to increase.
- When patients present with altered coagulation, anesthesia providers are challenged with deciding which regional anesthetic procedures can be safely performed.

(Tyagi & Bhattacharya, 2002)

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Problem

- Available guidelines that focus on anticoagulation and the performance of regional anesthesia vary from source to source.
- Therefore, nurse anesthetists are required to make decisions based on their best judgment, rather than a consistent guideline, in attempt to ensure patient safety.

The University of North Dakota

Purpose

- The purpose of this project was to explore the association between neuraxial anesthesia, anticoagulation therapy, and spinal hematoma formation.
- Anticoagulation guidelines were reviewed to determine when regional anesthesia could be safely performed based on available laboratory data.
- The appropriate timing of spinal or epidural needle placement and catheter removal relative to the timing of anticoagulant drug administration was also examined.

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Significance

- This project was aimed at compiling the diverse recommendations that are available to serve as a reference for anesthesia providers in attempt to prevent the formation of a spinal hematoma.
- The recommendations were condensed into a small pocket guide to remind anesthetists of the factors that need to be considered prior to the performance of a regional technique in an anticoagulated patient.

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Methods

- A comprehensive literature review that included: available guidelines, retrospective reviews, case reports, and prospective studies was conducted.
- The findings were compiled and presented in a power point format which displayed the association between spinal hematoma formation and anticoagulation therapy.
- The physiologic framework of adaptation and homeostasis was used as the theoretical basis for the project.

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Unfractionated Heparin

- When heparin is administered IV, the activated partial thromboplastin time (aPTT) is utilized to monitor its anticoagulant effect.
  - The normal range for an aPTT is 20-35 seconds in an adult. (Kee, 1999)
- When patients are receiving subcutaneous (SQ) heparin in doses of 5000 Units or less, the aPTT is not usually monitored. (Tyagi & Bhattacharya, 2002)
- Needle insertion and catheter removal can occur at any time following SQ administration of heparin in doses less than 5000 Units. (UWMC, 2006)
- In doses greater than 5000 Units, and when heparin is administered IV, needle placement should not occur unless the aPTT is less than 40 seconds. Under these same circumstances, the administration of heparin should be avoided when an indwelling catheter is in place. (UWMC, 2006)

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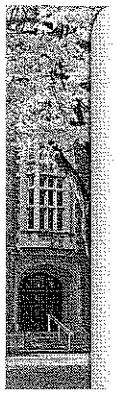

Unfractionated Heparin (cont.)

- If a regional anesthetic technique is planned on a patient that is receiving anticoagulation, the administration of heparin should not occur for one hour following the placement of the needle.
- Indwelling catheters should not be discontinued for 2-4 hours after the last administered heparin dose.
- When heparin is administered with other anticoagulant medications, there may be an increased risk of spinal hematoma formation.
- A platelet count should be drawn prior to needle insertion or catheter removal on patients that have received heparin for greater than four days.

(Horlocker et al., 2003)

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Low Molecular Weight Heparin (LMWH)

- The response of LMWH is very predictable, which eliminates the requirement for aPTT monitoring.
- A normal dose of enoxaparin is 40 mg SQ daily or 30 mg SQ twice daily.
- Needle placement and indwelling catheter removal should be delayed for at least 10-12 hours following a normal dose of LMWH.
- Higher than normal doses of LMWH include amounts of 1 mg/kg twice daily or 1.5 mg/kg daily.
- The administration of neuraxial anesthesia to patients on higher than normal doses of LMWH should be delayed for at least 24 hours.

(Horlocker et al., 2003)

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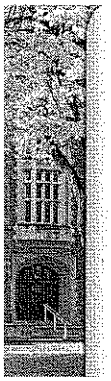

LMWH (cont.)

- If single daily dosing is planned, the first dose of LMWH can be administered approximately 6-8 hours postoperatively. However, the second postoperative dose should not occur prior to 24 hours of the first dose.
- When continuous epidural anesthesia is planned, the catheter can be left in place overnight and removed the next day.
- The anesthesia provider should wait approximately two or more hours before administering LMWH to a patient that has just had the indwelling catheter removed.

(Horlocker et al., 2005)

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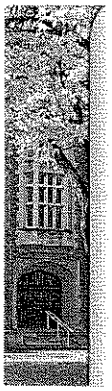

Antiplatelet Agents

- Platelet function must be normal before regional anesthetic techniques are performed.
  - A normal platelet count generally ranges from 150,000 to 400,000 mm^3 in an adult. (Kee, 1999)
- The effect of aspirin therapy lasts the entire lifetime of the platelet, which is generally 8-10 days. (Katzung, 2004)
- Other nonsteroidal anti-inflammatory agents (NSAIDs) also alter platelet aggregation, however, normal platelet function is resumed approximately 1-3 days after the NSAIDs are discontinued. (Katzung, 2004)
- The use of NSAID therapy does not increase the risk of spinal hematoma formation following neuraxial anesthesia. (Horlocker et al., 2003)

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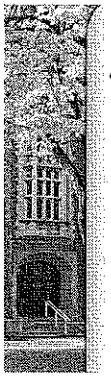

Antiplatelet Agents (cont.)

- Clopidogrel and ticlopidine administration irreversibly inhibits platelet function. (Katzung, 2004)
- Ticlopidine should be discontinued 14 days prior to receiving neuraxial anesthesia and clopidogrel should be discontinued seven days prior to the scheduled regional procedure. (Horlocker et al., 2003)
- The risk of spinal hematoma formation following thienopyridine administration is unknown. (Horlocker et al., 2003)

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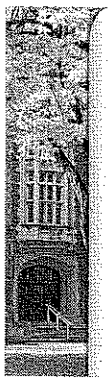

Warfarin

- Prothrombin time (PT) and international normalized ratio (INR) are utilized to monitor the anticoagulant effect of warfarin therapy.
  - A normal PT generally ranges from 10-13 seconds in an adult. (Kee, 1999)
  - The INR is an international standardized test for PT that should only be used after the patient has been stabilized on warfarin. (Kee, 1999)
- Central neuraxial procedures should be delayed until the INR is within the range of 1.0-1.3. (Horlocker et al., 2003)

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Warfarin (cont.)

- Warfarin administration must be stopped 4-5 days before a regional procedure is performed.
- If a dose of warfarin is administered before a scheduled surgery, a PT and INR level need to be checked prior to the regional technique.
- The PT and INR also need to be assessed prior to discontinuing an indwelling catheter on a patient that has received low doses of warfarin, 5 mg or less, throughout continuous epidural therapy.
- The catheter should not be removed until the INR is less than 1.5.
- Concurrent use of anticoagulation medications may increase the risk of spinal hematoma formation without affecting the PT or INR.

(Horlocker et al., 2003)

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Summary

- In attempt to reduce the occurrence of spinal hematoma formation, anesthesia providers need to be aware of all the risk factors, in addition to anticoagulant medications, that may contribute to this undesirable complication.
- This may be achieved by conducting a more complete assessment of the patient's physical presentation, medical history, laboratory data, and current medication history prior to the administration of regional anesthesia.

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References

- Horlocker, T.T., Benzon, H.T., Brown, D.L., Enneking, F.K., Helt, J.A., Mulroy, M.F. et al. (2003). Regional anesthesia in the anticoagulated patient: Defining the risks. Retrieved April 15, 2007, from http://www.asra.com/Consensus_Conferences
- Katzung, B.G. (2004). *Basic and clinical pharmacology* (9th ed.). New York: McGraw-Hill Companies.
- Kee, J.L. (1999). *Laboratory diagnostic tests with nursing implications* (5th ed.). Stamford, CT: Appleton & Lange.
- Tyagi, A., & Bhattacharya, A. (2002). Central neuraxial blocks and anticoagulation: A review of current trends. *European Journal of Anesthesiology*, 19, 317-329.
- University of Washington Medical Center. (2006). Anticoagulation guidelines for neuraxial procedures: Guidelines to prevent spinal hematoma following epidural/intrathecal/spinal procedures. Retrieved April 15, 2007 from http://www.uwmcacc.org/pdf/neuraxial.pdf

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Appendix D
Pre-test / Post-test

1.) Spinal and epidural needle insertion and catheter removal can occur at any time following subcutaneous (SQ) administration of heparin in doses less than 5000 Units?

True or False

2.) The anticoagulant effect produced by unfractionated heparin occurs by binding to antithrombin III?

True or False

3.) The response of low molecular weight heparin (LMWH) is very predictable, which eliminates the requirement for activated partial thromboplastin time (aPTT) monitoring?

True or False

4.) The action of LMWH is fully reversed by protamine?

True or False

5.) Neuraxial anesthesia, including needle placement and indwelling catheter removal, should be delayed for at least 10-12 hours following a 40 milligram (mg) SQ dose of enoxaparin?

True or False

6.) If single daily dosing of enoxaparin 40 mg SQ is planned, the first dose of LMWH can be administered approximately 2-4 hours after epidural needle or catheter placement?

True or False

7.) The effect of aspirin therapy lasts the entire lifetime of the platelet, which is generally 8-10 days?

True or False

8.) Ticlopidine should be discontinued 14 days prior to receiving neuraxial anesthesia and clopidogrel should be discontinued seven days prior to the scheduled regional procedure?

True or False

9.) Warfarin administration should be stopped 8-10 days before a regional procedure is performed?

True or False

10.) Concurrent use of medications such as: unfractionated heparin, LMWH, clopidogrel, ticlopidine, and aspirin may increase the risk of spinal hematoma formation without affecting the prothrombin time (PT) and international normalized ratio (INR)?

True or False

References

Ain, R.J., Vance, M.B. (2005). Epidural hematoma after epidural steroid injection in a patient withholding enoxaparin per guidelines. *Anesthesiology, 102*(3), 701-703.

Beltrami, E., & Jesty, J. (1995). Mathematical analysis of activation thresholds in enzyme catalyzed positive feedbacks: Application to the feedbacks of blood coagulation. *Proc. Natl. Acad. Sci. USA*, *92*, 8744-8748.

Bick, R.L., Frenkel, E.P., Walenga, J., Fareed, J., & Hoppensteadt, D.A. (2005). Unfractionated heparin, low molecular weight heparins, and pentasaccharide: Basic mechanism of actions, pharmacology, and clinical use. *Hematology/Oncology Clinics of North America, 19*(1), 1-51.

Cannon, W.B. (1932). *The wisdom of the body*. New York: W.W. Norton Company.

Claerhout, A.J., Johnson, M., Radtke, J.D., & Zaglaniczny, K.L. (2004). AANA journal course: Update for nurse anesthetists. Anticoagulation and spinal and epidural anesthesia. *AANA Journal*, *72*(3), 225-231.

Cullen, D.J., Bogdanov, E., & Htut, N. (2004). Spinal epidural hematoma occurrence in the absence of known risk factors: A case series. *Journal of Clinical Anesthesia, 16*, 376-381.

Gilbert, A., Owens, B.D., & Mulroy, M.F. (2002). Epidural hematoma after outpatient epidural anesthesia. *Anesthesia and Analgesia, 94*, 77-78.

Hansen, M. (1998). *Pathophysiology: Foundations of disease and clinical intervention.* Philadelphia: W.B. Saunders Company.

Horlocker, T.T. (2001). Low molecular weight heparin and neuraxial anesthesia. *Thrombosis Research, 101*, 141-154.

Horlocker, T.T., Bajwa, Z.H., Ashraf, Z., Khan, S., Wilson, J.L., Sami, N. et al. (2002). Risk assessment of hemorrhagic complications associated with nonsteroidal anti-inflammatory medications in ambulatory pain clinic patients undergoing epidural steroid injection. *Anesthesia and Analgesia, 95*, 1691-1697.

Horlocker, T.T., Benzon, H.T., Brown, D.L., Enneking, F.K., Heit, J.A., Mulroy, M.F. et al. (2003). Regional anesthesia in the anticoagulated patient: Defining the risks. Retrieved April 15, 2007, from http://www.asra.com/Consensus_Conferences/Consensus_Statements.shtml

Horlocker, T.T., Wedel, D.J., & Schlichting, J.L. (1994). Postoperative epidural analgesia and oral anticoagulant therapy. *Anesthesia and Analgesia, 79*, 89-93.

Hyderally, H.A. (2005). Epidural hematoma unrelated to combined spinal-epidural anesthesia in a patient with ankylosing spondylitis receiving aspirin after total hip replacement. *Anesthesia and Analgesia, 100*, 882-883.

Katzung, B.G. (2004). *Basic and clinical pharmacology* (9th ed.). New York: McGraw-Hill Companies.

Kee, J.L. (1999). *Laboratory diagnostic tests with nursing implications* (5th ed.). Stamford, CT: Appleton & Lange.

Kinney, M.R., Dunbar, S.B., Brunn, J.A., Molter, N., & Cicciu, J.M. (1998). *AACN: Clinical reference for critical care nursing* (4th ed.). St. Louis: Mosby, Inc.

Litz, R.J., Gottschlich, B., & Stehr, S.N. (2004). Spinal epidural hematoma after spinal anesthesia in a patient treated with clopidogrel and enoxaparin. *Anesthesiology, 101*(6), 1467-1469.

Overduin, M., & Beer, T.D. (2000). The plot thickens: How thrombin modulates blood clotting. *Nature Structural Biology, 7*(4), 267-269.

Tam, N.L., Soo, C.P., & Pretorius, P.M. (2006). Epidural haematoma after a combined spinal-epidural anaesthetic in a patient treated with clopidogrel and dalteparin. *British Journal of Anaesthesia, 96*(2), 262-265.

Tyagi, A., & Bhattacharya, A. (2002). Central neuraxial blocks and anticoagulation: A review of current trends. *European Journal of Anesthesiology, 19*, 317-329.

University of Washington Medical Center. (2006). Anticoagulation guidelines for neuraxial procedures: Guidelines to prevent spinal hematoma following epidural/intrathecal/spinal procedures. Retrieved April 15, 2007, from http://www.uwmcacc.org/pdf/neuraxial.pdf