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Nursing Care and Pharmaceutical Intervention Regarding the Pathophysiological Components and Molecular Action of Crotalid Snake Venom

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ABSTRACT : Approximately 7,000 to 8,000 people annually in the United States are envenomated by Crotalid snake species (copperheads, water moccasins, and rattlesnakes). With proper medical treatment these bites are rarely fatal but due to the snake's venom, a number of pathophysiological issues can arise with a patient. Snake venom works to shut down major organ systems in the body and can also result in a number of symptoms including pain, edema, renal failure and coagulopathy. The biological effects of venom come from its proteinaceous nature. Venom is a complex concoction of proteins ranging from deadly toxins, nontoxic proteins and hydrolithic enzymes. A comprehensive look at how the venom works within the body can better educate our medical professionals at how to combat venom's affects and the symptoms associated with a bite. Since several thousand people are bitten by venomous snakes each year in the United States it is important for health care professionals to be knowledgeable about the care of snakebite victims so that appropriate medical care is implemented quickly in order to save lives.

KEYWORDS -education**,** nursing care, snake, toxin, venom

I. INTRODUCTION

The snake family Viperidae has representatives throughout the world. This family is divided into three subfamilies, one of which is known as Crotalinae, or the Crotalids which include cottonmouths, copperheads and rattlesnakes. Cottonmouths (Agkistrodon piscivorus), are semi-aquatic pit vipers that range from Texas, east to Florida and north to Virginia. They feed on fish, frogs, and other small vertebrates and are typically found in ponds, lakes and other slow moving bodies of water. Cottonmouths are green to brown or black and have 12 to 15 alternating bands that run the length of their bodies. When startled these snakes curl up and open their white mouths that resemble cotton for which they are named. Copperheads (Agkistrodon contortrix), are named for the coloration on the dorsal part of their heads. These medium sized pit vipers are found from Massachusetts south to Florida and west to Texas. These snakes have beautiful distinct bands that run the entirety of their bodies and vary in color from dark brown to pinkish tan. Copperheads feed primarily on small mammals but will also eat birds, lizards and frogs. Rattlesnakes are probably the most notorious Crotalinae species. They are best known for their defensive behavior in which they rattle loose horny segments making a buzzing, rattling sounding to ward off predators. Rattlesnakes primarily feed on small mammals and birds but will also eat lizards and frogs. These snakes are usually grey to brown in color which allows them to blend in with their sandy or rocky environment (Wozniak et al, 2012, [1]).

II. SNAKE VENOM

Snake venom is a complex mixture of proteins and enzymes that make it almost impossible to label as only "neurotoxic" or "hemotoxic" as these proteins can impact multiple body systems. A Crotalid snakebite may affect the hematologic, cardiac, respiratory & nervous systems. These powerful proteins damage the capillary endothelium leading to plasma membrane destruction and fluid accumulation in the tissues that presents as severe edema, ecchymosis, erythema and bullae at the bite site. Since these proteins also stimulate the coagulation cascade,

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hemoconcentration and hypovolemic shock are potential complications of a severe envenomation (Ashton et al, 2011, [2]).

Crotalid snake venom is made up of a number of different classes of toxins including β-Neurotoxins, cardiotoxins, sarafotoxins, myotoxins, and hemorragines. These toxins work in a number of different ways including affecting acetylcholine transmission and sodium channels as seen in Table 1. There are several different enzymes found in the venom as well, these can be seen in Table 2. These enzymes catalyze different reactions within the body that can lead to detrimental systemic effects (Bouchot, 2006, [3]).

Crotalidae polyvalent immune Fab (FabAV) also know as CroFab is the antivenom of choice for Crotalid envenomation and works by binding and neutralizing the venom toxins and helps eliminate them from the body. Lab values such as CBC, PT, INR, APTT, fibrinogen, fibrin, electrolytes, BMP, & UA are helpful in determining how much CroFab a snakebite victim will need. It is recommended that CroFab be given within 6 hours of the snakebite, but has been given up to 52 hours later with good success. The goal is to administer a quantity equal to the amount of injected venom, typically about 4-6 grams. Additional doses may be given as needed (Ashton et al, 2011, [2]).

Table 1: Toxins found in Crotalid Venom and their Actions

Class of Toxin	Example	Action
β-Neurotoxin	Crotoxin	Neuromuscular transmission blocked by withholding acetylcholine from nerve ends
Cardiotoxins	Cytotoxin Cardiotoxin	Cell plasma membranes destroyed leading to cell death and cardiac arrest
Sarafotoxins	Sarafotoxin c	Constricts the blood vessels leading to cardiac arrest
Myotoxins	Crotamine Myotoxin-a Phospholipase A2	Interferes with sodium channels resulting in muscular degeneration Causes muscular degeneration
Hemorragines	Hemorragic toxin- b	Vessel walls are affected leading to severe hemorrhages

Table 2: Enzymes found in Crotalid Venom and their Actions

Type of Enzyme	Example	Action
Lyases	Glucosamine ammonium lyase	Catalyzes the D-glucosamite reaction (cleaves carbon-nitrogen bonds)
Transferases	Alanine amino transferase	Catalyzes the transfer of amino groups from alanine to α-ketoglutarate (liver functions)
Oxydoreductases	L-Amino-acid transferase	Catalyzes L-amino acid reactions (metabolic pathways)
Hydrolases	Factor X-activator Heparinase α- Fibrinogenases β- Fibrinogenases Fibrinolytic enzyme Prothrombin activator	Activates Factor X enzyme during coagulation cascade Degrades polymeric heparin sulfate molecules (breaks down heparin an anticoagulant) Serine protease that cleaves peptide bonds in proteins Serine protease that cleaves peptide bonds in proteins Dissolves blood clots Activates prothrombin which a coagulation factor

III. NURSING ASSESSMENT

Airway, Breathing & Circulation are priority assessment in the field and in the ED & are ongoing throughout the hospital stay as respiratory failure & cardiac collapse can occur (Ashton et al, 2011, [2]), (Rushing, 2011, [4]). After ABC's are established a baseline circumference measurement should be obtained. The most common reaction to snakebite is terror & fear of death so often initial signs & symptoms may be related to autonomic

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reactions and not systemic symptoms of an envenomation. Signs & symptoms resulting from this "fight or flight" reaction include, fainting, tachycardia, syncope, diaphoresis, nausea, vomiting, diarrhea, cold clammy skin, lethargy & withdrawal (Ashton et al, 2011,[2]), (Gold et al, 2004,[5]).

Signs & symptoms of envenomation usually become evident within 30-60 minutes of the bite. Nursing assessment for local signs & symptoms will include assessing for the presence of fang marks, punctures, scratches, pain, edema, erythema, or ecchymosis at the bite site and surrounding tissue. Edema is usually evident within 10- 30 minutes due to capillary damage so is important to assess pain level. Localized burning pain occurs in about 90% of Crotalis bites about 5 - 10 minutes of the bite due to edema. Ecchymosis occurs within 3-6 hours. Bullae and lymphangitis are also common within hours of the bite (Gold et al, 2004, [5]).

Systemic signs & symptoms may include nausea, vomiting, weakness, lethargy, tingling fingers & toes & perioral paresthesia so must differentiate from autonomic reactions described above. Snakebite victim may also complain of a rubbery or metallic taste. More severe symptoms may include altered mental status, severe hypotension or tachycardia, tachypnea or respiratory distress (Gold et al, 2004, [5]). As shown in Table 1, more severe bites also result in coagulation abnormalities such as prolonged prothrombin time (PT), decreased activated partial thromboplastin time (A-PTT) & a low platelet count of < 20,000/mm. Red blood cell loss &hemolysis can lead to hypovolemic shock, renal failureand cardiac collapse (Ashton et al, 2011, [2]), (Gold et al, 2004, [5]).

After ABC's established, obtain comprehensive medical history including allergies and co-morbidities. Ask specifically about allergies to horse or sheep products & about previous snakebites. Include the time of the snakebite, first aid given, & a description of the snake. Crotalis snakebite victims should be observed in the ED or ICU for at least 8 hours after arrival as sometimes symptoms are delayed.

IV. SNAKE BITES GLOBALLY

In the United States proper medical care and treatment of snakebite victims has greatly minimized the death total from these bites. In many countries, especially countries in tropical areas where snake bites occur often, victims are often not as fortunate. (Gutierrez et al, 2006, [6]). Not only do these countries lack sufficient data regarding total bites, but also lack knowledge and proper medical supplies to help venomous snakebite victims. In places like Nepal, 162 of 100,000 people die from venomous snakebites each year (Gutierrez et al, 2006, [6]). In comparison, the CDC reports only about five deaths from venomous snake bites each year in the United States.

In other countries, snakes of the Viperidae family such as the saw-scaled viper of Nigeria and the fer-de-lance of Costa Rica account for a large number of venomous snake bites in those countries. North American Crotalids are also in the Viperidae family and the biological reactions to their venom are similar to that of all Viperidae venom. This means that the knowledge of medical care and treatment used here in the United States could be implemented in other countries to help save lives. It is important for medical staff to be trained on how to properly treat and care for a snakebite victim.

V. CONCLUSION

In the United States we have adequate medical equipment and educational programs on snake bites to successfully treat the symptoms and reactions of a snake bite. This review condenses more than a decade of Crotalid venom data and highlights key aspects that medical personnel such as nurses should be aware of. Intensified educational programs on Viperidae snake bites should be put in place for both the medical staff and public in developing countries.

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