Chapter 8
Venom and ECG Signal Processing

Ranjan Maheshwari
Rajasthan Technical University, India

Vinod Kumar
Indian Institute of Technology Roorkee, India

H. K. Verma
Indian Institute of Technology Roorkee, India

ABSTRACT

Venom is toxic substance developed in an animal. The basic purpose of venom is to defend self by immobilizing the opponent, be it a predator or a prey. The nature has blessed many animals with venom. Snakes and spiders house venom in their mouth and scorpions keep it in their tail whereas, honeybees, wasps and other insects have developed special stingers for venom delivery. Venom is primarily not meant against human beings. But, in a survival conflict, one may interact with venom. The innate immune system and the delicate feedback mechanism respond to venom and manifest in the form of various biosignals. ECG being one of the most susceptible and quick signal responds to venom interactions and the responses can be identified as general as well as species specific. Various ECG manifestations of common venom interactions and Digital Signal Processing techniques for ECG analysis are presented here with the objective of improvement in the medical management of victims of venom interactions.

INTRODUCTION

In the continuous quest for survival, some species resorted to venom as a logistic for attack and protection. The venom may be used primarily to capture and initiate the digestion of prey or to deter a potential predator. The venom is meant to enter inside the body of the opponent, may be an aggressor or a prey, and to weaken the strength of the recipient and so it is helpful for the venomous species.

The biological systems in the recipient's body respond assertively to the injected venom. The innate defense mechanism responds to the toxic components in two ways. Firstly, the potentially harmful foreign materials are identified as antigens and antibodies are developed against them by the immune system. Secondly, some of the components in the venom, which are not foreign and whose

DOI: 10.4018/978-1-61520-977-4.ch008

homologues are available in the recipient's body, try to affect the feedback mechanism by enhanced concentration or triggering a few biological processes (Maheshwari, 2007).

The feedback mechanism tries to bring back the balance by taking hyper preemptive measures. In some very complex systems, like the blood coagulation mechanism, the feedback mechanism under the influence of venom, violates its stability limits and may result in a partial or complete impairment of the system. Anaphylactic shock is another example of the hyper preemptive feedback mechanism.

Venom constituents have large inter-species and intra-species variations; as well as the injected venom varies in quantity. Hence, the venom interaction produces so many diverse symptoms that quantification and comparison amongst aggressor species venoms on a single scale are not possible.

Although, it is possible that upto a limited quantity, the venom gets neutralized or deactivated in the recipient's body by the immune system and the related feedback system. But, beyond the safe limits, it may prove to be potentially harmful.

As a measure of lethality, the lethal dose (LD_{50}) per Kg body weight is a universally accepted unit for a particular species. So, if the body weight of the recipient is small, the lethality of the bite enhances, because the aggressor species would inject the same quantity of venom to both small and large recipient, particularly under a survival threat. To decide the neutralization limit for particular venom, often the statistical figure of LD_{50} is employed; which reflects equal probability of survival and non-survival for the recipient when such dose is interacted. It is mentioned in microgram/kg for laboratory experiments or microgram/60 kg for clinical purpose.

A number of venomous species have been tested for the lethality of their venom and their LD_{50} have been estimated. The venom delivery mechanisms of the species have also been observed and average quantities of venom delivered per incidence have also been estimated. If the statistical average of per incidence venom delivered is comparable to the lethal dose, the species may be treated as medically significant. And, if the average venom delivery is very large than the lethal dose, the species may be treated as highly venomous. Otherwise, the species may be not so potent.

It is clarified here that the lethal dose depends upon the size and weight of the recipient, so an average dose of a species may not be significant for a large recipient but may be fatal for a small recipient. The higher mortality rate in children due to scorpion stings is because of their smaller physique.

The effects of venom in the body of the recipient become visible very soon. The microscopic reactions in the body manifest as macroscopic symptoms. Each species has a particular combination of components in the venom and so the manifested symptoms may also have a few typical features. However, due to the posterior knowledge of the complications of snakebite to the victim, it may appear logical that some supposed physiological manifestations may not be due to venom at all but due to the psycho-somatic conditions and the ambiance. It is often difficult to isolate the venom-infested and psycho-somatic symptoms.

VENOMOUS SPECIES COMMONLY FOUND IN INDIA

India, being a tropical country, inhabits number of snake and scorpion species. Chief venomous snakes in India are cobra (*Naja naja*) and common krait (*Bungarus caeruleus*) belonging to Elapidae; while Russell's viper (*Daboia russelli*) and Saw-scaled viper (*Echis carinatus*) belong to Viperidae families. Other venomous species of snakes like king cobra (*Ophiophagus hannah*), banded krait (*Bungarus fasciatus*) and colubrids have less aggression towards human beings and the cases of snake bites of these species are considered medically insignificant in India. In Arachnids (invertebrate phylum arthropoda), spiders, giant