COAGULATION PARAMETERS AS PREDICTORS OF OUTCOMES IN SNAKE BITE ENVENOMATION: A PROSPECTIVE STUDY IN RURAL INDIA

Dr. Mrs.Patange Aparna P.

Department of General Medicine, Krishna Institute of Medical Sciences,Krishna Vishwa Vidyapeeth, Karad, Maharashtra, India, Email : aparnapatange@gmail.com

Dr. SUSHRUT JAYANT PATIL

Department of Medicine,Krishna Institute of Medical Sciences Krishna Vishwa Vidyapeeth, Karad, Maharashtra

Dr. Rohit Gosavi

Department of Medicine,Krishna Institute of Medical Sciences Krishna Vishwa Vidyapeeth, Karad, Maharashtra

	ABSTRACT – **Background:** Snake bites are a serious concern in rural areas and are a major cause of morbidity and mortality globally. Activated Partial Thromboplastin Time (APTT) and Prothrombin Time (PT), in particular, are the focus of this study's investigation of the association between coagulation parameters and the consequences of snake bite envenomation. **Materials and Methods:** At Krishna Institute Medical Sciences, Karad, 100 patients who had been admitted with snake bites to the Medical Intensive Care Unit were the subject of an 18-month prospective study (November 2020–April 2022). The study looked at coagulation factors, clinical characteristics, and consequences. Statistical analysis methods, such as t-tests and chi-square tests, were used with OpenEpi Software version 2.3 and SPSS version 21. **Results:** Vipers were to blame for 80% of the bites among the 100 patients, mostly on the lower limbs (78%). In 85% of the cases, there were fang marks, and in 56% of them, there was bleeding. Renal failure (26.7%) and cellulitis (13.3%) were among the complications (30%). In 80% and 70% of difficult cases, respectively, prolonged APTT and PT were noted. All of the deaths had extended APTT and PT, with a mortality rate of 7%. **Conclusion:** Prolonged APTT and PT at appearance were related to issues and death, highlighting their importance as indicators of how a snake bite envenomation will turn out. Health care professionals use coagulation measures like APTT and PT as crucial markers to help them make decisions and improve patient outcomes. **Keywords:** Activated Partial Thromboplastin Time, Prothrombin Time, Complications, Rural India, Snake Bite Envenomation

INTRODUCTION –

Snake bites pose a significant and life-threatening medical emergency, particularly in rural areas where incidents are frequent. However, the true incidence of snake bites is often underestimated due to insufficient epidemiological data (Eslamian et al., 2016). Worldwide,

venomous animals, especially snakes, contribute significantly to morbidity and mortality. It is estimated that over 5 million people are bitten by snakes annually, with around 100,000 developing severe complications. It is estimated that there are over 30,000 fatalities each year in India alone *(Chippaux, 2014).*

Epidemiological surveys provide crucial insights into the prevalence of snake bites. For instance, a study conducted in the Burdwan district of West Bengal revealed an annual incidence of snake bites at 0.16%, resulting in a mortality rate of 0.016% per year among 19,000 individuals across 26 villages. In Maharashtra, the incidence was reported at 70 bites per 100,000 population, with a mortality rate of 2.4 per 100,000 persons annually. High incidence states in India include Tamil Nadu, West Bengal, Maharashtra, Uttar Pradesh, and Kerala *(Playfer, 2004).* In Myanmar, Russell's vipers are responsible for 90% of snake bite cases, leading to thousands of bites and deaths in certain years (Hati, 1992). Similar situations are observed in countries like Bangladesh and Vietnam, where snake bites, particularly from cobras and pit vipers, cause numerous fatalities. Even specific occupational groups, such as rubber plantation workers and fishermen, face significant risks. Pakistan reports an alarming estimate of 20,000 snakebite-related deaths annually *(Chaudhary et al., 2020).*

The focus of this study lies in understanding the outcomes of patients claiming snake bites, particularly in relation to coagulation parameters such as activated partial thromboplastin time (APTT) and prothrombin time (PT). Snake venoms often induce haematological complications due to their anticoagulant effects, which include inhibiting clotting factors, direct action on fibrin leading to fibrinolysis, and interference with prothrombin activation. The coagulation pathways involve various factors, including tissue thromboplastin, factor VII, X, V, prothrombin, and fibrinogen *(Gaitonde, 1980).* Plasma prothrombin time measures the extrinsic and common pathways of fibrin production, while activated partial thromboplastin time assesses intrinsic coagulation, excluding factors VII and XIII *(Thein-Than et al., 1991, Ahmed et al., 2008).*

A comprehensive evaluation of clinical and laboratory parameters is crucial for early identification of coagulopathy, which in turn can reduce hospital stays. Understanding the patient's clinical profile is vital for determining appropriate treatments. By studying coagulation profiles and parameters like APTT and PT, this research aims to improve the management of snakebite patients, particularly in regions where snake bites are prevalent *(Rajeev et al, 2021).*

Thus, snake bites constitute a major public health concern, especially in rural areas of various countries. Despite underreporting, epidemiological data highlights the substantial impact of snake bites on human populations. This study's emphasis on coagulation parameters provides valuable insights into the haematological complications caused by snake venoms. By understanding and analyzing these parameters alongside clinical profiles, healthcare professionals can make more informed decisions, leading to improved outcomes for snakebite patients.

MATERIALS AND METHODOLOGY -

This research was conducted at Krishna Institute Medical Sciences in Karad and adopted a prospective, observational descriptive approach. The study, which took place over 18 months from November 2020 to April 2022, focused on patients admitted to the Medical Intensive Care Unit. Its primary goal was to investigate the coagulation issues arising from snake bites by analyzing activated partial thromboplastin time (APTT) and prothrombin time (PT).

One hundred patients were included in the study based on specific criteria: they must have had a documented history of snake bites. Certain groups, including individuals with existing coagulation problems, those using anticoagulant medications, and those with pre-existing liver conditions, were excluded from participation.

Data collection involved obtaining written consent from patients or their guardians, ensuring comprehension in native languages such as Marathi/Hindi. Detailed examinations were conducted using a carefully structured questionnaire, covering essential details like the patient's name, age, gender, address, and occupation. Comprehensive information about the snake bite incident was also collected. Subsequently, patients were interviewed and examined, and their coagulation status in terms of APTT and PT was assessed.

The collected data underwent thorough organization and analysis using Microsoft Excel 2010. Quantitative data were expressed through statistical measures like mean, median, mean with standard deviation, and standard deviation itself. Qualitative data were presented as percentages or proportions. Advanced statistical tools, specifically SPSS version 21 and OpenEpi Software version 2.3, were employed for detailed analysis. Quantitative data underwent tests of significance such as the student t-test, while qualitative data were subjected to the Chi-square test.

RESULTS –

This prospective observational study involved 100 patients who claimed to have been bitten by snakes. The average age of the participants was 32.2 years, with a range from 17 to 64 years. Most of the patients (59%) were between 21 and 40 years old. Additionally, 24% were over 40 years old, and 17% were between 15 and 20 years old. Among the total participants, 70% were male, indicating a higher incidence of snake bites among males, possibly due to their more frequent outdoor activities.

The study found that snake bites predominantly occurred on the lower limbs, affecting 78% of the patients. Only 22% had been bitten on the upper limbs, making the lower limbs the most common site of snake bites. Regarding the timing of hospital arrival, 48% of patients reached within 30 to 60 minutes, 38% arrived after 60 minutes, and 14% arrived within 30 minutes of the snake bite.

In terms of snake species, Viper snakes were identified in 80% of the cases, making them the most common type. Cobras were the second most prevalent, accounting for 15% of the cases, while Kraits were the least observed, present in only 5% of the cases.

Table 1 – Clinical presentation profile of patients with envenomation from a snakebite

Symptoms	Subjects present (n=100)	Percent
Fang marks	85	85
Bleeding from site of bite	56	56
Local reaction	52	52
Petechial rashes	45	45
Epistaxis	15	15
Gum bleeding	8	8

Patients reporting snake bites might exhibit a range of symptoms. Among the 100 patients studied, 18% experienced haematuria, 8% had oliguria, and approximately 6% suffered from chemosis following the snake bite. On admission, 70% of patients displayed tachycardia, while 32% showed pallor. Edema around the bite site was prevalent, affecting 26% of the patients.

Tachycardia was the most common observation during general examinations. Laboratory findings indicated an average hemoglobin level of 10.3 ± 0.8, a mean total leukocyte count of $11,000 \pm 7543.2$, and an average platelet count of 2.01 ± 0.6 lakhs. The mean Activated Partial Thromboplastin Time was 45.7 ± 13.8 seconds, the mean Prothrombin time was 15 ± 2.4 seconds, and the mean INR was 1.8 ± 0.6 as shown in table 2.

Table 2 - Laboratory investigations in subjects with snake bite envenomation

Investigation	Mean	SD
HB	10.3	0.8
TLC	11000	7543.2
Platelet in lakhs	2.01	0.6
APTT (sec)	45.7	13.8
PT(sec)	15	2.4
INR	1.8	0.6

The Whole Blood Clotting Test (WBCT) holds significant importance in evaluating the coagulation mechanism in blood following snake bite envenomation. Among the 100 patients examined, 65% displayed a WBCT exceeding 20 minutes, indicating the impact of snake bite envenomation on blood coagulation. Specifically, a WBCT exceeding 20 minutes suggests a disruption in the blood's coagulation mechanisms due to the snake bite. Additionally, both Activated Partial Thromboplastin Time (APTT) and Prothrombin Time (PT) were assessed in

this study as measures of blood clotting pathways. Of the patients, 68% exhibited prolonged PT, and 64% had prolonged APTT, signifying complications in the clotting processes caused by snake bites. Hospital stays varied, with 68% of patients requiring treatment for 5-10 days, 18% for more than 10 days, and 14% for less than 5 days, highlighting the prevalent need for extended medical care in snake bite cases.

Table 3 depicts patients reporting snake bite envenomation received Anti-snake venom therapy. In this study, all 100 patients were administered Anti-snake venom vials. Moreover, due to complications arising from snake bites, 25% of the patients required fresh frozen plasma, 23% needed platelet transfusion, and 16% necessitated packed red cells transfusion.

Table 3 - **Supportive care is provided to patients who have been envenomated by a snake bite.**

Supportive treatment	Number of subjects	Percent
Anti-Snake Venom (ASV)	100	100
Packed red cells	16	16
Platelet transfusion	23	23
Fresh-Frozen Plasma (FFP) transfusion	25	25

These additional treatments underline the complexity of managing snake bite envenomation cases, emphasizing the diverse medical interventions required to address the diverse complications resulting from snake bites.

Table 4 illustrates snake bite envenomation often leads to various complications, a phenomenon explored in this study involving 100 patients. Notably, 30% of the patients experienced complications, with renal failure being the most common issue. Among these patients, 26.7% developed renal failure alone, 13.3% had renal failure along with sepsis, and 30% experienced renal failure alongside cellulitis. Additionally, 13.3% suffered from cellulitis alone, while 16.7% had cellulitis coupled with sepsis. Local reactions like swelling and bleeding occurred in a significant portion of patients, with 80% displaying site-specific swelling and 70% exhibiting bleeding. Furthermore, 40% experienced nosebleeds, and 30% had gum bleeding was shown in table 5.

Table 4 – Distribution of the type of complication amongst complicated patients with envenomation from a snakebite

Complication	Number of participants (n=30)	Percentage
Renal failure	8	26.7
Renal failure with sepsis	4	13.3

Renal failure with cellulitis	9	30
Cellulitis only	4	13.3
Cellulitis with sepsis	5	16.7

Table 5 – Clinical presentation of complicated patients with envenomation from a snakebite

Complication	Number of participants (n=30)	Percentage
Local reaction	24	80
Bleeding from site of bite	21	70
Epistaxis	12	40
Gum bleeding	8	30

Among the patients with complications, coagulation tests like Activated Partial Thromboplastin Time and Prothrombin Time were often prolonged at presentation. Specifically, 80% of patients had prolonged APTT, and 70% showed prolonged prothrombin time. Significantly, the development of complications was statistically linked to these prolonged coagulation times, as depicted in table 6.

Table 6 – Prothrombin time and activated partial thromboplastin time in complex patients with snake bite envenomation (n=30)

Laboratory parameter	Prolonged at presentation		Normal at presentation		P value
	Number of subjects (n=30)	Percent	Number of subjects (n=30)	Percent	
APTT	24	80	6	20	<0.01
PT	21	70	9	30	<0.01

The study found that a majority of patients (90%) arrived at the hospital more than an hour after the snake bite, indicating delayed medical attention. Despite the complications, 93% of the patients were eventually discharged, while 7% unfortunately succumbed to the complications.

Among the 100 patients studied, 93 were discharged, while 7 patients unfortunately passed away. Out of the total patients, 64 displayed prolonged Activated Partial Thromboplastin

Time (APTT), with 57 of them recovering and 7 succumbing to death. Importantly, all patients who died had prolonged APTT, demonstrating a significant association between prolonged APTT and mortality (P value: 0.01). Additionally, 68 patients had prolonged Prothrombin Time, out of which 61 were discharged, and 7 patients passed away. Similarly, all deceased patients exhibited prolonged Prothrombin Time, indicating a notable relationship between prolonged Prothrombin Time and mortality (P value: 0.03).

DISCUSSION –

The patients in this study ranged in age from 17 to 64, with an average age of 32.2 years. A substantial majority (59%) fell within the 21-40 age bracket, with 24% being over 40 years old and 17% between 15-20 years old. In terms of gender, 70% were male, a trend often seen in India where men, being the primary earners, tend to work outdoors, making them more vulnerable to snake bites. This aligns with similar studies indicating a higher incidence of snake bites in males.

When it comes to the location of the snake bites, the lower limbs were most commonly affected (78%), likely due to the natural behavior of snakes being closer to the ground. Regarding the time taken by patients to reach the hospital after a snake bite, 48% arrived within 30 to 60 minutes, 38% arrived after 60 minutes, and 14% reached the hospital within 30 minutes. Notably, complicated cases often resulted in delayed hospital arrivals, with 90% of such cases taking more than 60 minutes to access medical care.

In terms of the specific snake species responsible for the bites, Vipers were identified in the majority of cases (80%), followed by Cobras (15%), and Kraits (5%). Vipers are notably common in India, a fact consistent with the findings of other studies that have also highlighted Vipers as the most frequently encountered snake in snake bite incidents.

In this study, a significant majority of patients, approximately 85%, displayed fang marks at the site of the snake bite, and 56% experienced bleeding from the affected area. Additionally, more than half of the patients, around 52%, exhibited local reactions around the bite site and limb, while 45% showed petechial rashes on their bodies. Hematuria, observed in 18% of cases, was a prevalent finding during examinations. Tachycardia was common, seen in 70% of patients, along with pallor in 32% and edema around the bite site in 26%. In cases with complications, local reactions were the primary presentation in 80% of instances, followed by bleeding from the bite site (70%), epistaxis (40%), and gum bleeding (30%).

Regarding laboratory results, the mean haemoglobin level was 10.3, the average total leukocyte count was 11,000, and the platelet count averaged 2.01 lakhs. The mean activated partial thromboplastin time (APTT) was 45.7 seconds, and the mean prothrombin time (PT) was 1.5 seconds, with an international normalized ratio (INR) averaging 1.8. In 64% of instances, extended APTT was found, whereas in 68% of cases, prolonged PT was seen. In terms of hospital stays, a majority of patients, constituting 60%, required hospitalization for more than 10 days, with an average stay of 5.6 days.

All patients in the study received Anti Snake Venom vials. Additionally, 16% of cases necessitated packed red cell transfusions, 23% received platelet transfusions, and 25% were

administered fresh frozen plasma transfusions. The final outcomes revealed that 93% of cases were discharged, whereas 7% unfortunately succumbed to the complications. Notably, these findings are consistent with previous research, highlighting the seriousness of snake bites and the varying outcomes and treatments observed across different studies.

The study revealed a significant link between the final outcomes and crucial coagulation indicators, specifically Prothrombin Time (PT) and Activated Partial Thromboplastin Time (APTT). Unfortunately, all patients who passed away had prolonged APTT and PT. Additionally, among cases with complications, there was a notable association between prolonged APTT and PT during initial presentation and the subsequent emergence of complications. The majority of these complex cases, constituting 80%, exhibited prolonged APTT, while 70% displayed prolonged PT upon presentation. These findings emphasize the potential importance of APTT and PT as valuable markers for predicting outcomes in individuals affected by snake bite envenomation.

A comparative examination with similar studies provides valuable insights into the research findings. Larréché et al., highlighted the distinct occurrence of thrombosis in large vessels due to B. lanceolatus envenomation, although the exact mechanisms remain unclear *(Larréché et al., 2021).* Alvarez-Flores and team stressed the substantial contribution of snake toxin research in unraveling the activation and inhibition processes of clotting factors *(Alvarez-Flores et al., 2017).* Yong Jun Jeon et al. cautioned against excessive antivenom doses and transfusions in the absence of bleeding, underscoring the need for precise treatment approaches *(Jeon et al., 2019).* In contrast, Kalana Maduwage et al. suggested that Fresh Frozen Plasma could hasten the recovery of coagulopathy, particularly in cases involving bleeding *(Maduwage & Isbister, 2014).*

Isbister and colleagues advocated for the combined use of Prothrombin Time (PT) and Activated Partial Thromboplastin Time (aPTT) as a cost-effective endpoint for treating venom-induced consumption coagulopathy (VICC), acknowledging their prolonged normalization after venom neutralization (Isbister et al., 2006). Pongpit et al. proposed using PT in conjunction with International Normalized Ratio (INR) as an alternative method to assess coagulopathy in green pit viper bites, aiming for enhanced standardization across laboratories *(Pongpit et al., 2012).* Achara Tongpoo and team suggested exploring fibrinogen levels and thrombin time to evaluate fibrinogen status, noting the possibility of isolated thrombocytopenia in Green Pit Viper (GPV) envenomation *(Tongpoo et al., 2020).*

Moreover, H S Harshavardhan et al. emphasized the necessity of a comprehensive assessment, integrating both clinical and laboratory parameters, to promptly identify coagulopathy, thereby reducing hospital stays and mortality rates (Harshavardhana et al., 2014). Finally, Narumon Thongtonyong et al. highlighted the superior diagnostic accuracy of 20-Whole Blood Clotting Time (WBCT) and specific INR thresholds compared to APTT, showcasing their potential for precise evaluations of coagulation status. Additionally, Dang XT and colleagues unveiled the intricate coagulation effects of viperid snake bites, including hypo coagulation in ROTEM, elevated INR, APTT, and D-dimer levels, coupled with decreased fibrinogen concentration and platelet count, underscoring the multifaceted nature of snakebite-induced coagulopathy *(Dang et al., 2021).*

CONCLUSION -

Snake bite envenomation is prevalent in rural parts of India, underscoring the urgency of promptly identifying the snake and administering anti-snake venom to prevent complications and lower mortality rates. In this study, patients experiencing complications such as bleeding from the bite site, epistaxis, and gum bleeding exhibited extended Prothrombin Time (PT) and Activated Partial Thromboplastin Time (APTT) during presentation. The study noted a 7% mortality rate, with all deceased patients displaying prolonged PT and APTT. These results stress the crucial importance of monitoring PT and APTT in snake bite envenomation cases, urging healthcare providers to be vigilant in assessing coagulation parameters like Prothrombin Time and Activated Partial Thromboplastin Time.

REFERENCES –

Ahmed, S., Ahmed, M., Nadeem, A., Mahajan, J., Choudhary, A., & Pal, J. (2008). Emergency treatment of a snake bite: Pearls from literature. Journal of Emergencies, Trauma, and Shock, 1(2), 97. https://doi.org/10.4103/0974-2700.43190

Alvarez-Flores, M. P., Faria, F., De Andrade, S. A., & Chudzinski-Tavassi, A. M. (2017). Snake venom components affecting the coagulation system. Snake venoms, 417-436.

Ammonia and Alcohol in Snake Bite. (1885, December 1). Scientific American, 1(2build), 35–35. https://doi.org/10.1038/scientificamerican12011885-35fbuild

Chaudhary, M. K. (2020). A review on snake bite and its managements.

Chippaux, J. P. (2014, January). About Snake bites in children at the Fez University Hospital (Morocco). Médecine Et Santé Tropicales, 24(1), 111–111. https://doi.org/10.1684/mst.2014.0296

Dang, X. T., Xuan Nguyen, T., Nguyen, T. T. H., & Ha, H. T. (2021, May). Coagulopathy After Viper Snakebite in Vietnam and Relationship with Time of Admission. Journal of Multidisciplinary Healthcare, Volume 14, 1259–1265. https://doi.org/10.2147/jmdh.s311556

Eslamian, L., Mobaiyen, H., Bayat-Makoo, Z., Piri, R., Benisi, R., & Naghavi Behzad, M. (2016, September 10). Snake bite in Northwest Iran: A retrospective study. Journal of Analytical Research in Clinical Medicine, 4(3), 133–138. https://doi.org/10.15171/jarcm.2016.022

Gaitonde, B. B., & Bhattacharya, S. (1980). An epidemiological survey of snake bite cases in India. Snake, 12, 129-33.

Harshavardhana, H. S., Pasha, I., Prabhu, N. S., & Ravi, P. (2014). Snake bite induced coagulopathy: a study of clinical profi le and predictors of poor outcome. International journal of scientific study, 2(1), 2-5.

Hati, A. K., Mandal, M., De, M. K., Mukherjee, H., & Hati, R. N. (1992). Epidemiology of snake bite in the district of Burdwan, West Bengal. Journal of the Indian Medical Association, 90(6), 145-147.

Isbister, G. K., Williams, V., Brown, S. G., White, J., & Currie, B. J. (2006, December). Clinically applicable laboratory end-points for treating snakebite coagulopathy. Pathology, 38(6), 568–572. https://doi.org/10.1080/00313020601024045

Jeon, Y. J., Kim, J. W., Park, S., & Shin, D. W. (2019, November 30). Risk factor, monitoring, and treatment for snakebite induced coagulopathy: a multicenter retrospective study. Acute and Critical Care, 34(4), 269–275. https://doi.org/10.4266/acc.2019.00591

Kalantri, S., Singh, A., Joshi, R., Malamba, S., Ho, C., Ezoua, J., & Morgan, M. (2006, January). Clinical predictors of in-hospital mortality in patients with snake bite: a retrospective study from a rural hospital in central India. Tropical Medicine and International Health, 11(1), 22–30. https://doi.org/10.1111/j.1365-3156.2005.01535.x

Kim, J. S., Yang, J. W., Kim, M. S., Han, S. T., Kim, B. R., Shin, M. S., Lee, J. I., Han, B. G., & Choi, S. O. (2008, May 30). Coagulopathy in patients who experience snakebite. The Korean Journal of Internal Medicine, 23(2), 94–99. https://doi.org/10.3904/kjim.2008.23.2.94

Larréché, S., Chippaux, J. P., Chevillard, L., Mathé, S., Résière, D., Siguret, V., & Mégarbane, B. (2021, September 6). Bleeding and Thrombosis: Insights into Pathophysiology of Bothrops Venom-Related Hemostasis Disorders. International Journal of Molecular Sciences, 22(17), 9643. https://doi.org/10.3390/ijms22179643 (Larréché et al., 2021)

Maduwage, K., & Isbister, G. K. (2014, October 23). Current Treatment for Venom-Induced Consumption Coagulopathy Resulting from Snakebite. PLoS Neglected Tropical Diseases, 8(10), e3220. https://doi.org/10.1371/journal.pntd.0003220

Playfer, J. R. (2004, April 13). Oxford Textbook of Medicine - 4th Edition Edited by D. A. Warrell, T. M. Cox, J. D. Firth and E. J. Benz, Jr Oxford: Oxford University Press, 2003. 4574 pp, ISBN 019-262922-0. 275.00 (hardback). Age And Ageing, 33(4), 416–416. https://doi.org/10.1093/ageing/afh119

Pongpit, J., Limpawittayakul, P., Juntiang, J., Akkawat, B., & Rojnuckarin, P. (2012, July). The role of prothrombin time (PT) in evaluating green pit viper (Cryptelytrops sp) bitten patients. Transactions of the Royal Society of Tropical Medicine and Hygiene, 106(7), 415–418. https://doi.org/10.1016/j.trstmh.2012.04.003

Rajeev, P. K., Koteshwar, B., & Rani, G. U. (2021). Clinical Profile and Outcome of Snakebite in Children Admitted at Tertiary Care Teaching Hospital in Hyderabad, Telangana. Volume 9 Issue 3, 9(3), 254-259.

Thein-Than, Tin-Tun, Hla-Pe, Phillips, R., Myint-Lwin, Tin-Nu-Swe, & Warrell, D. (1991, May). Development of renal function abnormalities following bites by Russell's vipers (Daboia russelii siamensis) in Myanmar. Transactions of the Royal Society of Tropical Medicine and Hygiene, 85(3), 404–409. https://doi.org/10.1016/0035-9203(91)90307-k

Tongpoo, A., Niparuck, P., Sriapha, C., Wananukul, W., & Trakulsrichai, S. (2020, January). Utility of Thrombin Time in Management of Patients with Green Pit Vipers Bite. SAGE Open Medicine, 8, 205031212096646. https://doi.org/10.1177/2050312120966468