



# Measurement of Plasma Fibrinogen Levels, PT and APTT among HIV Infected Patients: A Critical Bio-Marker for Coagulation Dysfunctions

Allageya Yousif Khailfa Ahmed <sup>a</sup>, Nasr Eldeen Ali Mohammed Gaufri <sup>a</sup>,  
Sara Abdelgani <sup>b</sup> and Lienda Bashier Eltayeb <sup>c\*</sup>

<sup>a</sup> Hematology Department, Faculty of Medical Laboratory Science, Al-Neelain University, Khartoum Sudan.

<sup>b</sup> Department of Parasitology, Faculty of Medical Laboratory Sciences, Al-Neelain University Khartoum-Sudan, Sudan.

<sup>c</sup> Department of Medical Laboratory Sciences, College of Applied Medical Sciences, Prince Sattam Bin Abdul-Aziz University, Al-Khari-Riyad, KSA.

## Authors' contributions

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

## Article Information

DOI: 10.9734/JPRI/2021/v33i57B34066

## Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/80182>

**Original Research Article**

**Received 06 October 2021**

**Accepted 12 December 2021**

**Published 14 December 2021**

## ABSTRACT

**Background:** The literature stated that Human immunodeficiency virus (HIV) infection led to activation of coagulation, and habitually linked with an augmented risk of venous and arterial thrombosis. So the purpose of the study was to determine the plasma fibrinogen level in Sudanese HIV-infected patients.

**Materials and Methods:** A total of one hundred participants were recruited, and classified into two groups; the case group include (50) HIV patients, and the control group enrolled (50) healthy individuals. Three ml of blood was collected. Fresh Poor Plasma was prepared from citrated venous blood by centrifuged for 15 minutes at 3000 pm. Fibrinogen levels were measured by an automated coagulation analyzer (Thrombolyzer XRC Germany). Data were collected using a directly structured questionnaire. Data were analyzed using SPSS Version 21.

**Results:** The present study showed that the mean of plasma fibrinogen levels was statistically significantly higher in HIV infection in comparison with those normal healthy control (470.50 ±67.75 vs 214.75±21.25 with P-value 0.00). There was a significantly decreased level of PT, and PTT

among the HIV group comparing with the control (9.575±0.64, and 22.39±4.94) VS (12.483±0.72, and 30.78±3.55) consequently, (P-value ≤0.001). Fibrinogen levels were significantly increased with the progression of HIV disease (469.84 ±67.15, 472.74 ±87.75, 478.47 ±61.92) in stage I, stage II, and stage III respectively.

**Conclusions:** An HIV-infected patient had elevated plasma fibrinogen levels, as well as other coagulation dysfunctions.

*Keywords: HIV; CD4; fibrinogen; coagulation.*

## 1. INTRODUCTION

Infection with the Human Immunodeficiency Virus (HIV) induces a gradual worsening of the immune system due to a decrease in the amount of CD4+, and helper T cells in circulation, the immune system becoming compromised [1]. HIV-associated thrombus formation during the HIV interval is ascertained and is well documented in the literature [2,3]. Numerous hemostatic errors have been established in HIV patients, enabling mechanisms for hypercoagulability and an elevated chance of thrombosis [4,5]. Infection with HIV causes systemic inflammatory disease with prominent hematological disorders. Such abnormalities increase in the last stage of disease, and are caused by a variety of factors, including immune-mediated cell destruction, direct cytopathic consequences of the virus, secondary to potential pathogens and malignancies, and drug toxicity [6,7].

The pathophysiology of HIV propose that enhanced microbial product and migration through intestinal mucosa, as a result of persistent destruction to lymphatic tissue mucosa, result in the stimulation of monocyte, representation of tissue factor, and pathogenic hypercoagulability [8]. Coagulation disruptions in HIV patients can be related to the virus's effect, which can cause a variety of abnormalities that potentially contribute the patients to coagulation disorders. Thrombocytopenia [4], endothelial cell dysfunction, activation of coagulation factors, and the presence of anti-phospholipids antibody are all symptoms of HIV infection. HIV has the ability to bind to host cells via their receptor found on the surface of the host cells, according to both in vivo and in vitro models. Host cells with the CD4 receptor, coreceptor chemokines ligand 4 (CXCR4), and chemokines receptor 5 (CCR5), for example, interact with HIV via Glycoprotein 120. (gp120). This affect nitric oxide expression, which causes endothelial cell dysfunction and impedes vascular endothelial cell immune function [9-11]. Megakaryocytes have already been found to contain CD4 receptors on their

coats, and then both megakaryocytes and platelets have been found to have the cytokine (CXC motif) receptor on surfaces, making them vulnerable to HIV infection [12]. Platelets have been proved in vitro to incorporate particles of HIV, and virus-infected platelets have been demonstrated to produce activating signs [13].

### 1.1 Aim

The present study was aimed at the measurement of fibrinogen levels and related hematological parameters (platelets, PT, and APTT) among Sudanese HIV patients.

## 2. MATERIALS AND METHODS

An analytical case-control study was carried out during the study period from September to December 2018. Totally of 100 participants were recruited for the study. 50 subjects were HIV known patients, diagnosed by (ELSIA and PCR) technique, among them 25 (50%) were males and 25 (50%) were females: who are followed at the clinic at Omdurman Teaching Hospital, Khartoum/Omdurman during the study period and designated as the case group. Further 50 were healthy volunteers 26 (52%) were males and 24 (48%) were females, designated as a healthy control group (Age and sex were matched between case and control group). Non probability sampling technique, namely Convenience Sampling' was followed.

Under the full aseptic technique, a total of 3 mL of venous blood was drawn from all participants in 3.2% anticoagulant tri-sodium citrate containers in a 9 to 1 ratio, then Platelet Poor Plasma (PPP) was instantly processed by centrifugation at 3000 rpm for 15 min. An automated coagulation analyzer was used to determine plasma fibrinogen concentration (Thrombolyzer XRC Germany). HIV patient who had liver diseases, inflammatory, cancer, under heparin or warfarin therapy, and coagulopathy disorders were excluded. Pregnant women were excluded from the study in both study groups.

## 2.1 Data Collection and Analysis

The data was collected using a directly structured questionnaire include demographic and clinical data, and analyzed by computer software SPSS Version 21. The parameters were compared in mean and Standard Deviation (SD) using the T-test. The P-value was set as significant when  $< 0.05$ .

## 3. RESULTS

Among a total of one hundred subjects participates in the present study for measurement of plasma fibrinogen their age range between 20-50 years old, the mean ages of HIV patients group were  $35.5 \pm 1.34$  SD years old, and the mean age of healthy control was  $37.1 \pm 0.91$  SD, with equal gender distribution. The majority of HIV patients were in stage II, and infection duration from 2-4 years old (64%, and 56%) respectively. All data are provided in Table 1.

Table 2 displays the mean level of Fibrinogen levels and other coagulation profiles among HIV patients and the control group. Findings revealed that the mean of plasma fibrinogen levels (mg/dl) was statistically significantly higher in the case group when compared with those healthy control group ( $470.50 \pm 67.75$  vs  $214.75 \pm 21.25$  with a P-value of 0.001), nevertheless, there was the significantly decreased level of PT, and PTT among HIV group comparing with control ( $9.575 \pm 0.64$ , and  $22.39 \pm 4.94$ ) VS ( $12.483 \pm 0.72$ , and  $30.78 \pm 3.55$ ) consequently, (P-value  $\leq 0.001$ ). the platelets count was significantly decreased among HIV patients comparing with control ( $189.78 \pm 83$ , and  $295.33 \pm 63$ ).

Table 3 shows the mean level of fibrinogen and coagulation factors at different HIV stage - our findings documented that fibrinogen levels were significantly increased with the progression of HIV disease ( $469.84 \pm 67.15$ ,  $472.74 \pm 87.75$ ,  $478.47 \pm 61.92$ ) in stage I, stage II, stage III respectively.

**Table 1. Baseline data of study subjects**

	Patients n=50 (%)	Control n=50 (%)	P value
Gender			
Male	25 (50%)	26 (52%)	0.473
Female	25 (50%)	24 (48%)	
Age			
20-30 years old	15 (30%)	24 (48%)	
31-40 years old	21 (42%)	10 (20%)	0.582
41-50 years old	14 (28%)	16 (32%)	
HIV Stage			
Stage I	16 (32%)	-	
Stage II	32 (64%)	-	-
Stage III	2 (4%)	-	
Period of infection			
2-4 Years	28 (56%)	-	
4-6 Years	20 (40%)	-	-
$\geq 6$ Years	2 (4%)	-	
Total	50 (100%)	50 (100%)	

**Table 2. Mean level of fibrinogen levels and other coagulation profiles among HIV patients and control group**

Parameters	Case (n=50) Mean $\pm$ SD	Control (n=50) Mean $\pm$ SD	P-value
HBG	$13.462 \pm 0.791$	$14.867 \pm 0.851$	0.001
WBCS	$4.321 \pm 1.21$	$6.972 \pm 1.75$	0.001
Platelets	$189.78 \pm 83$	$295.33 \pm 63$	0.000
PT	$9.575 \pm 0.64$	$12.483 \pm 0.72$	0.002
PTT	$22.39 \pm 4.94$	$30.78 \pm 3.55$	0.005
Fibrinogen levels	$470.50 \pm 67.75$	$214.75 \pm 21.25$	0.001

• A P-value less than 0.05 is considered significant

**Table 3. Comparison of Fibrinogen levels and other coagulation profiles among HIV patients**

Parameters	HIV Stage			P-value
	Stage 1	Stage II	Stage III	
WBCS	5.024±0.21	3.711±0.84	2.537±1.21	0.023
Platelets	202.18±67	194.32±59	186.89±78	0.054
PT	10.446±0.59	11.958±0.341	12.325±0.322	0.005
PTT	22.39±3.86	23.57±3.23	25.14±1.87	0.041
Fibrinogen levels	469.84 ±67.15	472.74 ±87.75	478.47 ±61.92	0.001

#### 4. DISCUSSION

Human immunodeficiency virus (HIV) affects coagulation system activation and increases the risk of arterial and venous thrombosis [14,15]. For decades, hemostatic alterations in coagulation factor concentrations and state of hypercoagulation have been identified in HIV-positives—[16,17]. Thus the current study was designed to measure the plasma fibrinogen concentration in Sudanese HIV-infected patients.

The existing study displayed that the mean fibrinogen levels was statistically significantly elevated in HIV patients in comparison to the healthy control group (470.50 ±67.75 vs 214.75±21.25, P-value < 0.001). These in agreement with a cross-sectional study carried out in England by Madden Erin, et al [18], who measured the fibrinogen levels amongst 1131 HIV infected participants and 281 healthy controls, and concluded that the fibrinogen levels were significantly higher in a case group than those the healthy subject. Fibrinogen is an important component of the coagulation system, and increase in its circulating concentrations might predispose to thrombotic illnesses such as venous thromboembolism since higher plasma levels are associated with a nearly 4-fold increase in the risk of thrombosis, inflammation modifies the thrombotic response by increasing pro-coagulants, decreasing anticoagulants, and suppressing fibrinolysis. Tissue damage, whether caused by a virus or an immune response, results in the release of cytokines and cellular products. These circumstances activate the endothelial surface, causing tissue factor expression to increase, endogenous anticoagulant alerts to reduce, and leukocyte infiltration to increase [19,20]. Kuller LH et al [21], investigated the relationship between inflammatory and coagulation biomarkers and mortality in HIV patients. They conclude that most etiological agent of fatality was intimately associated to IL-6 and D-dimer concentrations; through elevating IL-6 and D-dimer levels, and discontinuing antiretroviral therapies (ART) may

raise the chances of mortality even more, in line with a study conducted in Sudan by Himmat et al. in [22].

Likewise, of findings of Tien PC et al. (2010), who demonstrate 1183 HIV- inflamed women and men from different 16 geographically diverse and reported that elevated fibrinogen levels were associated with HIV patients [23]. All studies come consistent with our finding and agreed that the HIV patients had hypercoagulation status, and various coagulation deficiencies in HIV-positive patients have been described, including decreased protein C and S, it occurred as a result of altered protein C synthesis and metabolism, as well as low-grade disseminated intravascular coagulation (DIC) with consumptive coagulopathy in the context of HIV infection with severe immunosuppression, as well as an increased range of von Willebrand factor [24-26]. Infection of megakaryocytes by HIV can result in impaired thrombopoiesis because megakaryocytes contain the HIV receptors CD4 and CXCR4, and different megakaryocyte lines are infectable with HIV, and then impaired in coagulation factor which affect PT, APTT, and elevation in fibrinogen leads to a hypercoagulable state and stimulate the formation of blood thrombi [27,28]. Indeed, many epidemiological studies have reported the occurrence of VTE in HIV-infected patients, with rates ranging from 0.19 to 7.63 percent per year. According to studies 8–20, the overall increase in the risk of VTE in HIV-infected patients was 2–10-fold greater than expected in the general population [29,30].

Our findings revealed that fibrinogen level was significantly increased as disease progress (469.84 ±67.15, 472.74 ±87.75, and 478.47 ±61.92) in stage I, stage II, stage III respectively), P-value≤0.001.

The normal hemostatic system is affected by a variety of conditions, with HIV infection being one of the most frequent causes of hemostatic dysfunction [10]. Our finding agreement with S.

Karpatkin et al, 2002 [31], that it is because HIV infection causes substantial hemostatic complications, especially in the late stages of infection when the immune system is suppressed, and the presence of additional infections or neoplasms aggravates the situation. The coagulation dysfunction observed in HIV patients (thrombocytopenia, endothelial cell dysfunction, and activation of coagulation factors) is due to direct effect of the virus leading to a variety of consequences, due to the capacity of HIV to link to the host cell's receptor, which is situated on the cell's surface. With the guidance of Glycoprotein 120, human cells with the CD4 receptor, co-receptor chemokines ligand 4 (CXCR4), and chemokines receptor 5 (CCR5) communicate with HIV (gp120). This combination lowers nitric oxide expression, resulting in endothelial cell dysfunction and reduced vascular endothelial cell immune function [32, 33].

Concerning HIV stage progression, we revealed that the platelets count, PT, and PTT levels were significantly decreased and prolonged (P-value 0.054, 0.05, 0.041) (Table 2 show 0.000, 0.002 and 0.005 respectively) sustainably upon disease progress, and inversely fibrinogen concentration was significantly increased. Our observation was in agreement with Seyoum M et al, [34] who conclude that the platelets count was significantly lower (0.001) in HAART-naive HIV-infected adults compared to HIV-infected adults who were using HAART. That is because HAART treatment has been noted in studies to lower viral load through increasing CD4 count and platelet production [35]. When compared to HAART-naive individuals, the drop of viral load and immunological reconstitution in HIV-infected people on HAART may lead to elevated platelet count. Furthermore, lowering viral load may help to reduced HIV-related hyper-coagulative conditions, human megakaryocytes contain a CD4 molecule that can bind HIV. Thrombocytopenia is a common complication of HIV1 infection that appears to be caused by a combination of decreased platelet production and impaired platelet production. Platelet count generally improves quickly after reticuloendothelial cell suppression or ablation, indicating an immunologic etiology, or within 1 week of antiHIV1 treatment with azidothymidine (AZT) [36].

## 5. CONCLUSION

HIV-infected patients have significantly increased plasma fibrinogen levels than normal healthy

control and exhibit a hypercoagulation state; this prone likely to increase the risk of thrombosis.

## CONSENT AND ETHICAL APPROVAL

This study was approved by the Faculty of Medical Laboratory Science, Al Neelain University institutional review board. Before samples were gathered all participants gave consent; the information was taken and kept very confidentially.

## ACKNOWLEDGEMENT

This publication was supported by the Deanship of scientific research at Prince Sattam Bin Abdul Aziz University. Authors appreciated to Faculty of Medical Laboratory Sciences, Al Neelain University, Khartoum Sudan.

## DATA AVAILABILITY

All datasets generated or analyzed during this study are included in the manuscript.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Bhardwaj S, Almaeen A, Ahmed Wani F, Thirunavukkarasu A. Hematologic derangements in HIV/AIDS patients and their relationship with the CD4 counts: a cross-sectional study. *Int J Clin Exp Pathol.* 2020;13(4):756-763. Published 2020 Apr 1.
2. Dikshit B, Wanchu A, Sachdeva RK, Sharma A, Das R. Profile of hematological abnormalities of Indian HIV infected individuals. *BMC blood disorders.* 2009;9:5. Available: <https://doi.org/10.1186/1471-2326-9-5>.
3. Hsue PY, Scherzer R, Grunfeld C, et al. HIV infection is associated with decreased thrombin generation. *Clin Infect Dis.* 2012;54(8):1196-1203. DOI:10.1093/cid/cis014
4. Saif MW, Greenberg B. HIV and thrombosis: A review. *AIDS patient care and STDs.* 2001;15(1):15–24. Available: <https://doi.org/10.1089/108729101460065>

5. Comprehensive, up-to-date information on HIV/AIDS treatment and prevention from the University of California San Francisco. HIV Transmission and Prevention in Adolescents. Available:<http://hivinsite.ucsf.edu/InSite?page=kb-04-01-09>. Accessed March 6, 2019.
6. Jong E, Louw S, Meijers JC, de Kruif MD, ten Cate H, Büller HR, Mulder JW, van Gorp EC. The hemostatic balance in HIV-infected patients with and without antiretroviral therapy: partial restoration with antiretroviral therapy. *AIDS Patient Care STDS*. 2009;23(12):1001-7. DOI: 10.1089/apc.2009.0173. PMID: 19929230.
7. Mogadam E, King K, Shriner K, Chu K, Sondergaard A, Young K, Naghavi M, Kloner RA. The association of nadir CD4-T cell count and endothelial dysfunction in a healthy HIV cohort without major cardiovascular risk factors. *SAGE open medicine*. 2020;8:2050312120924892. Available:<https://doi.org/10.1177/2050312120924892>
8. Brenchley JM, Price DA, Schacker TW, Asher TE, Silvestri G, Rao S, Kazzaz Z, Bornstein E, Lambotte O, Altmann D, Blazar BR, Rodriguez B, Teixeira-Johnson L, Landay A, Martin JN, Hecht FM, Picker LJ, Lederman MM, Deeks SG, Douek DC. Microbial translocation is a cause of systemic immune activation in chronic HIV infection. *Nature medicine*. 2006;12(12):1365–1371. Available:<https://doi.org/10.1038/nm1511>
9. Zetterberg E, Neuhaus J, Baker JV, Somboonwit C, Llibre JM, Palfreeman A, Chini M, Lundgren JD, Insight smart study group. Platelet count kinetics following interruption of antiretroviral treatment. *AIDS (London, England)*, 2013;27(1):59–68. Available:<https://doi.org/10.1097/QAD.0b013e32835a104d>
10. Satchell CS, Cotter AG, O'Connor EF, Peace AJ, Tedesco AF, Clare A, Lambert JS, Sheehan GJ, Kenny D, Mallon PW. Platelet function and HIV: a case-control study. *AIDS (London, England)*. 2010;24(5):649–657. Available:<https://doi.org/10.1097/QAD.0b013e328336098c>
11. Jiang J, Fu W, Wang X, Lin PH, Yao Q, Chen C. HIV gp120 induces endothelial dysfunction in tumour necrosis factor-alpha-activated porcine and human endothelial cells. *Cardiovasc Res*. 2010;87(2):366-74. DOI: 10.1093/cvr/cvq013. Epub 2010 Jan 18. PMID: 20083573; PMCID: PMC2895538.
12. Tanko Y, Eze E, Jimoh A, et al. "Haemostatic effect of aqueous extract of mushroom (*Ganoderma lucidum*). *European Journal of Experimental Biology*. 2015;2(6):2015–2018.
13. Youssefian T, Drouin A, Massé JM, Guichard J, Cramer EM. Host defense role of platelets: engulfment of HIV and *Staphylococcus aureus* occurs in a specific subcellular compartment and is enhanced by platelet activation. *Blood*, 2002;99(11):4021–4029. Available:<https://doi.org/10.1182/blood-2001-12-0191>
14. Danesh J, Lewington S, Thompson SG, et al. Plasma fibrinogen level and the risk of major cardiovascular diseases and nonvascular mortality: an individual participant meta-analysis. *Jama*. 2005;294:1799–1809. [PubMed] [Google Scholar]
15. Calmy A, Gayet-Ageron A, Montecucco F, Nguyen A, Mach F, Burger F, Ubolyam S, Carr A, Ruxungtham K, Hirschel B, Ananworanich J; STACCATO Study Group. HIV increases markers of cardiovascular risk: results from a randomized, treatment interruption trial. *AIDS*. 2009 May 15;23(8):929-39. DOI: 10.1097/qad.0b013e32832995fa. PMID: 19425222
16. Konin C, Anzouan-Kacou JB, Essam N'loo A. Arterial thrombosis in patients with human immunodeficiency virus: two-case reports and review of the literature. *Case Rep Vasc Med*. 2011;2011:847241. DOI:10.1155/2011/847241
17. Restrepo CS, Diethelm L, Lemos JA, Velásquez E, Ovella TA, Martinez S, Carrillo J, Lemos DF. Cardiovascular complications of human immunodeficiency virus infection. *Radiographics*. 2006;26(1):213-31. DOI: 10.1148/rg.261055058. PMID: 16418253.
18. Madden E, Lee G, Kotler DP, et al. Association of antiretroviral therapy with fibrinogen levels in HIV-infection. *AIDS*. 2008;22(6):707-715. DOI:10.1097/QAD.0b013e3282f560d9
19. Abdollahi A, Shoar N, Shoar S, Rasoulinejad M. Extrinsic and intrinsic

- coagulation pathway, fibrinogen serum level and platelet count in HIV positive patients. *Acta Med Iran.* 2013;51(7):472-6. PMID: 23945892.
20. de Magalhães MC, Sánchez-Arcila JC, Lyra ACB, et al. Hemostasis in elderly patients with human immunodeficiency virus (HIV) infection-Cross-sectional study [published correction appears in *PLoS One.* 2020;15(3):e0230727]. Published 2020 Feb 12. DOI:10.1371/journal.pone.0227763
  21. Kuller LH, Tracy R, Bellosso W, De Wit S, Drummond F, Lane HC, Ledergerber B, Lundgren J, Neuhaus J, Nixon D, Paton NI, Neaton JD. Insight smart study group. Inflammatory and coagulation biomarkers and mortality in patients with HIV infection. *PLoS Med.* 2008;5(10):e203. DOI: 10.1371/journal.pmed.0050203. PMID: 18942885; PMCID: PMC2570418.
  22. Himmat W, Gaufrri N. Estimation and Assessment of Plasma D-Dimer Levels in HIV Patients. *Journal of Biosciences and Medicines.* 2016;4:1-5. DOI: 10.4236/jbm.2016.410001
  23. Tien PC, Choi AI, Zolopa AR, et al. Inflammation and mortality in HIV-infected adults: analysis of the FRAM study cohort. *J Acquir Immune Defic Syndr.* 2010;55(3):316-322. DOI:10.1097/QAI.0b013e3181e66216.
  24. Kiser KL, Badowski ME. Risk factors for venous thromboembolism in patients with human immunodeficiency virus infection. *Pharmacotherapy.* 2010;30(12):1292-302. CAS PubMed Google Scholar
  25. Lowe GD. Circulating inflammatory markers and risks of cardiovascular and non-cardiovascular disease. *J Thromb Haemost.* 2005;3:1618-27. [PubMed]
  26. Jong E, Louw S, Meijers JC. The hemostatic balance in HIV-infected patients with and without antiretroviral therapy: partial restoration with antiretroviral therapy. *AIDS Patient Care STDS.* 2009;23(12):1001-7.
  27. Reingold J, Wanke C, Kotler D, et al. Association of HIV infection and HIV/HCV coinfection with C-reactive protein levels: the fat redistribution and metabolic change in HIV infection (FRAM) study. *J Acquir Immune Defic Syndr.* 2008;48:142-8. [PMC free article] [PubMed] [Google Scholar]
  28. Khare S, Kushwaha R, Kumar A, Venkatesh V, Reddy HD, Jain M, Yusuf M, Singh US. Prothrombotic state in HIV: A study on protein C, protein S, homocysteine and correlation with CD4 counts. *Indian J Med Microbiol.* 2018;36(2):201-206. DOI: 10.4103/ijmm.IJMM\_15\_414. PMID: 30084411.
  29. Ahonkhai AA, Gebo KA, Streiff MB, Moore RD, Segal JB. Venous thromboembolism in patients with HIV/AIDS: a case-control study. *J Acquir Immune Defic Syndr.* 2008;48(3):310-4. DOI: 10.1097/QAI.0b013e318163bd70. PMID: 18197123; PMCID: PMC2597553.
  30. Malek J, Rogers R, Kufera J, Hirshon JM. Venous thromboembolic disease in the HIV-infected patient. *Am J Emerg Med.* 2011;29(3):278-82. DOI: 10.1016/j.ajem.2009.09.034. Epub 2010 Mar 26. PMID: 20825798.
  31. Karpatkin S, Nardi M, Green D. "Platelet and coagulation defects associated with HIV-1-infection. *Thrombosis and Haemostasis.* 2002;88(3):389-401.
  32. Taremwa IM, Muyindike WR, Muwanguzi E, Boum Y, Natukunda B. Prevalence of HIV-related thrombocytopenia among clients at Mbarara regional referral hospital, Mbarara, Southwestern Uganda. *Journal of Blood Medicine.* 2015;6:109-113.
  33. Jiang J, Fu W, Wang X, Lin PH, Yao Q, Chen C. "HIV gp120 induces endothelial dysfunction in tumour necrosis factor- $\alpha$ -activated porcine and human endothelial cells. *Cardiovascular Research.* 2010;87(2):366-374.
  34. Seyoum M, Enawgaw B, Getaneh Z, Engidaye G, Asrie F, Melku M. Basic Coagulation Parameters among Human Immunodeficiency Virus-Infected Adults in Gondar, Northwest Ethiopia: A Comparative Cross-Sectional Study. *Biomed Res Int.* 2018;2018:5320827. DOI: 10.1155/2018/5320827. PMID: 29888267; PMCID: PMC5977028.
  35. Nascimento FG, Tanaka PY. Thrombocytopenia in HIV-Infected Patients. *Indian J Hematol Blood Transfus.* 2012;28(2):109-111. DOI:10.1007/s12288-011-0124-9.
  36. Marks KM, Clarke RM, Bussel JB, Talal AH, Glesby MJ. Risk factors for thrombocytopenia in HIV-infected persons

in the era of potent antiretroviral therapy. J  
Acquir Immune Defic Syndr. 2009;52  
(5):595-9.

DOI: 10.1097/QAI.0b013e3181b79aff.  
PMID: 19734800;  
PMCID: PMC2787779.

---

© 2021 Ahmed et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

*Peer-review history:*

*The peer review history for this paper can be accessed here:*  
<https://www.sdiarticle5.com/review-history/80182>