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Effect of HIV on Haematological Parameters of People Living with HIV/AIDS attending UNIOSUN Teaching Hospital, Osogbo, Nigeria.

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Abstract

Introduction: Human Immunodeficiency virus (HIV) is a critical health issue that significantly impacts the haematological parameters of infected individuals, leading to various complications. **Objectives:** The study investigated the effects of HIV on the haematological parameters of patients who have tested positive at the UNIOSUN Teaching Hospital (UTH), Osogbo. It aimed to evaluate the differences in haematological parameters between these groups and understand the relationship between the severity of HIV infection, the impact of antiretroviral therapy (ART), and the risk of haematological complications. **Methodology:** A total of 115 subjects were grouped into two: 95 subjects who were HIV-positive and 20 HIV-negative control patients. The blood sample was obtained and tested for a variety of haematological parameters like White blood cell count (WBC), Packed cell volume (PCV), Red blood cell count (RBC), Mean corpuscular haemoglobin (MCH), Mean corpuscular volume (MCV), Mean corpuscular haemoglobin concentration (MCHC) and Hemoglobin (HGB) using the haematological autoanalyser. The data obtained were analysed using Statistical Package for the Social Sciences (SPSS) version 22.0. A *p*-value of 0.05 indicated a significant difference in the haematological parameters between the two groups. **Results:** The findings indicate that HIV-positive patients exhibit significant abnormalities in several haematological parameters. A notable decrease in platelet counts and neutrophil levels was observed in the HIV-positive group, suggesting an increased risk of thrombocytopenia and immunosuppression. Other parameters, such as Lymphocyte and red blood cell counts, did not show significant differences, indicating that some haematological parameters remain unaffected by HIV. **Conclusion/Recommendations:** The study concludes that while some haematological parameters are significantly altered in HIV-positive patients, others remain stable, highlighting the need for continuous monitoring and targeted interventions to manage haematological complications in HIV patients. Further research with larger sample sizes and comprehensive data on ART history and comorbidities is recommended to understand these relationships better and improve patient outcomes.

Keywords: MCHC, Immunosuppression, antiretroviral therapy, Haemoglobin, Lentivirus.

Introduction

The human immunodeficiency virus (HIV) is grouped into the genus Lentivirus within the family of Retroviridae, a subfamily of Orthoretrovirinae. Based on genetic characteristics and differences in the viral antigens, HIV is classified into types 1 and 2 (HIV-1, HIV-2) (Bhardwaj et al., 2020). The immunodeficiency viruses of non-human primates (simian immunodeficiency virus, SIV) are also grouped into the genus Lentivirus. Epidemiologic and phylogenetic analyses currently available imply that HIV was introduced into the human population between 1920 and 1940 (Belperio and Rhew, 2004). The HIV-1 evolved from non-human primate immunodeficiency viruses from Central African chimpanzees (SIVcpz), while the HIV-2 evolved from West African sooty mangabeys (SIVsm) (Gao et al., 1999).

The most common complication of HIV infection is haematological abnormalities. As the disease progresses, these abnormalities become pronounced causing morbidity and mortality in HIV patients. Abnormalities of the bone marrow occur at all stages of HIV infection (Damtie et al., 2021). The HIV can enter the body via intact mucous membranes, eczematous (or injured skin), mucosa, and parenteral inoculation. When transmitted by sexual contact, HIV firstly attaches to the dendritic cells (e.g. Langerhans cells) or macrophages/ monocytes; HIV using CCR-5 (R5 viruses) as a co-receptor is then preferentially replicated (Demirkhanyan et al., 2013). The HIV is taken up by macrophages and replicated (Paul *et al.,* 2013), as shown for M cells in the mucosa. HIV exposure to blood cells can result in the direct infection of T-helper cells and the transmission of R5 and X4 viruses (using the CXC4 receptor as a co-receptor) (Arrildt et al., 2012).

Statistics have currently shown that Osun State has almost 30,000 people estimated to be living with HIV, 13,500 of whom are yet to be identified and placed on treatment (Bhardwaj et al., 2020).

Anaemia, neutropenia, and thrombocytopenia are among the haematological abnormalities that HIV patients frequently experience. (Noor et al., 2020) It is for this reason that other disease markers, such as the total lymphocyte count, white blood cell count, and hematocrit or haemoglobin concentration, have been recommended, particularly for developing nations with low financial resources (De Santis et al., 2011). However, due to their purportedly weak association with the course of the disease, most of these indicators have not been incorporated into normal use.

The most common haematological anomaly in HIV patients, even those on highly active antiretroviral therapy (HAART), is anaemia. It has been linked to a greater death rate, rapid disease progression, and a worse quality of life in patients. (Duguma et al., 2021; Bhardwaj et al., 2022; Cao G et al., 2022; Jin et al., 2023) and so on Anemia that is linked to a low reticulocyte count in patients with HIV is typically normocytic and normochromic (Geta et al., 2022). There are numerous causes of anaemia. There are three processes at play in its pathophysiology: There are two reasons for decreased red blood cell (RBC) production: (1) opportunistic infection; (2) increased RBC destruction due to thrombotic microangiopathy, disseminated intravascular coagulation, myelosuppressive medications, and decreased production of erythropoietin (Hensley-McBain, 2018) Patients with HIV infection frequently experience both neutropenia and anaemia. In severe stages of AIDS, decreased neutrophil counts are observed in up to 70% of patients (Geta et al., 2022). The onset of neutropenia has been linked to worsening HIV illness, as indicated by declining CD4 cell counts and rising HIV-1 RNA levels (Marks et al., 2009). In about 40% of HIV-positive patients, thrombocytopenia is the only haematological abnormality seen at the time of presentation. According to Marks et al., (2009), the prognosis appears unaffected by isolated thrombocytopenia (Marks et al, 2009). The HIV/AIDS remains a significant public health

challenge worldwide, particularly in sub-Saharan Africa, where the burden of the disease is disproportionately high. While advances in antiretroviral therapy (ART) have significantly improved the prognosis of people living with HIV/AIDS (PLWHA), the disease and its treatment still profoundly affect various physiological systems, including the haematological system (Demirkhanyan et al., 2013). Abnormalities such as anaemia, leucopenia, and thrombocytopenia are commonly observed in PLWHA and are associated with disease progression, opportunistic infections, and ART side effects (Paul's et al., 2013).

In Nigeria, where HIV prevalence remains a pressing concern, there is limited localized data on how the disease and its management influence haematological parameters. This gap in knowledge hinders the ability of healthcare providers to tailor interventions, predict complications, and optimize patient outcomes effectively (Arrildt et al., 2012).

The study seeks to address this gap by evaluating the haematological parameters of PLWHA attending UNIOSUN Teaching Hospital in Osogbo, Nigeria. By identifying patterns of haematological abnormalities and their potential associations with disease progression and treatment.

This investigation is essential not only for guiding evidence-based interventions but also for informing policy decisions aimed at mitigating the systemic impacts of HIV/AIDS on affected populations. Also, statistics show that Osun State currently has almost 30,000 people estimated to be living with HIV, 13,500 of which are yet to be identified and placed on treatment (Onovo, et. al., 2023). This study, titled *"Effect of HIV on Hematological Parameters of Patients Who Tested Positive in UTH Osogbo,"* is significant for its contribution to understanding the haematological impact of HIV infection in a Nigerian population. By analyzing the haematological parameters of HIV-positive patients, the research provides critical insights into the prevalence and patterns of haematological abnormalities, such as anaemia, leukopenia, and thrombocytopenia, which are recognized as strong predictors of morbidity and mortality in HIV-infected individuals.

The findings of this study have implications for clinical practice, as they highlight the need for routine haematological monitoring as part of the comprehensive care of people living with HIV/AIDS. Furthermore, the study informs local healthcare providers and policymakers about the importance of integrating haematological assessments into treatment protocols to improve patient outcomes. By addressing a significant gap in localized data, the research also contributes to the global understanding of the interplay between HIV and haematological health in resource-limited settings.

The study aimed to evaluate the impact of HIV infection on haematological parameters among people living with HIV/AIDS (PLWHA) attending UNIOSUN Teaching Hospital, Osogbo, Nigeria, and to explore the implications for disease progression and clinical management. Objectives of the study were to

- assess the haematological parameters (e.g., haemoglobin levels, white blood cell count, platelet count, etc.) of HIV-positive patients attending UNIOSUN Teaching Hospital, Osogbo.
- identify the prevalence and types of haematological abnormalities, such as anaemia, leucopenia, and thrombocytopenia, in HIV-positive patients.
- investigate the relationship between hematological abnormalities and the stages of HIV infection or disease progression.
- compare the hematological parameters of HIV-positive patients on antiretroviral therapy (ART) with those not on ART.
- Provide evidence-based recommendations for routine haematological monitoring and

management of HIV-positive patients to improve clinical outcomes.

Materials and Methods

Area of study

This study was done in UNIOSUN Teaching Hospital, a tertiary health facility in Osogbo, Osun state.

Study population

This study was carried out at UNIOSUN Teaching Hospital, Osogbo. Participants were evaluated with a structured questionnaire containing relevant information such as age, educational level, leaving conditions, members of families, etc.

Study design

The design for the study was cross-sectional.

Inclusion criteria

The inclusion criteria involved individuals

1. Male and Female between 15 and 65 years.
2. Patients of UNIOSUN Teaching Hospital Osogbo who tested positive for HIV.
3. Participants who are willing to participate in the study.

Exclusion criteria

The exclusion criteria involved individuals

1. Participants without a confirmed HIV diagnosis
2. Individuals that are not willing to provide consent
3. Patients with other health challenges

Sampling size determination

The sample size of this study was determined using this formula:

Sample size (n) = $Z^2 * p (1-p) / M^2$

(James et. at., 2001)

Where: n = sample size for infinite population, Z = Z score (1.96), P = Population proportion (assumed to be 5.5% = 0.055), M = Margin of error (0.05)

Therefore, using the formula of sample size, n = $Z^2 * p (1-p) / M^2$, substitute values we have,

$n = (1.96)^2 * 115(1-115) / (0.05)^2$

$n = 3.8416 * 0.051975 / 0.0025$

$n = 115$

Sample collection

Sample collection was carried out for 3 months (state the months and year). The sample was collected by disinfecting the area of collection, which is the arm. A tourniquet was tied at the upper part of the arm, and the patient was asked to make a fist to make the vein very prominent. The needle was then inserted into the vein at an angle of 30 degrees. After the blood had been withdrawn, the tourniquet was removed before the needle was removed from the vein, and the blood was dispensed into the sample bottles, which were carried to the laboratory.

Laboratory analysis

1. PCV (Packed Cell Volume) ….. (WHO, 2000)

Procedure

(what is it that) filled the capillary tube to 75%, sealed with sealant or Plasticine, and placed it in a hematocrit centrifuge at 12,000 r.p.m for 5min. The result was read using a hematocrit reader.

Normal Range: Female: 35-45%, Male: 38-46%, and Neonatal: 53-69%

2. WBC (White Blood Cell) count procedure (Kathy & Leslie, 2017)

A diluting fluid volume of 380 mL was dispensed into a test tube. A volume of 20 mL of well-mixed EDTA anticoagulated blood was added into the test tube and mixed to make 1:20. The dilution was remixed with a Pasteur pipette, and one of the grid areas of the chamber was filled with the dilution. The chamber was placed in a moist petri dish. The outside of the chamber was allowed to dry, and the sample was placed on the microscope stage. The WBCs were viewed and counted using ×100 objective. Normal Results: the number of WBCs in the blood is 4,500 to 11,000 WBCs per microliter (4.5 to 11.0 × 10^9/L). The value ranges may slightly vary among different laboratories. Some laboratories use different measurements or may test different specimens.

3. Differential Count (Kathy & Leslie, 2017).

Procedure

A drop of blood was placed on a clean grease-free slide. A thin film, consisting of the head, body, and tail, was made. The film was allowed to air dry. Flooded with Leishman stain for 5min and buffered with distilled water for 10min. Then rinse with water. Allow to air dry. Viewed under × 100 obj. The result showed that the Neutrophil was 65%, the Monocyte was 5%, the Lymphocyte was 25%, the Eosinophil was 5%, and the Basophil was 0.

Statistical analysis

Data were analysed using Statistical Package for Social Science (SPSS) version 22.0. Significant differences between categorical variables were determined, and $p<0.05$ was taken as a significant value.

Results

Socio-demography

A total of 115 subjects were recruited for the study. The test group consists of (N=95) individuals who are HIV positive, while the control consists of another (N=20). In the test group, 21 (22.1%) were male, and 74 (77.9%) were females, while in the control group, 9 (45.0%) were male, and 11 (55.0%) were female the results revealed a higher incidence of HIV among female subjects. Regarding age distribution, the test group had participants across different age ranges, the test group between 15-45years 3 (3.2%), 20-45years 56 (58.9%), 46-65years 36 (37.9%) the control group 15-19years 0 (0.0%), 20-45years 20 (100%), 46-65years 0 (0.0%), this results clearly demonstrated a higher prevalence of HIV cases in young adults of age 20 – 45 years. In terms of ethnicity of the test group, 86 (90.5%) were Yoruba, 7 (7.4%) were Igbo 2 (2.1%) were Hausa, the control group 17 (85.0%) were Yoruba, 2 (10.0%) were Igbo and 1 (5.0%). The Employment status for the test group revealed 21 (22.1%) were Civil servants, 1 (1.1%) was Farmer and 73 (76.8%) were Traders, for the control group 5 (25.0%) were Civil servants, 0 (0.0%) was farmer and 15 (75.0%) were Traders. Regarding Marital status for the test group reveals 11 (11.6%) were single, 83 (87.4%) were married, and 1 (1.1%) were Divorced, control group 4 (20.0%) were Single, 16 (80.0%) were married and 0 (0.0%) were Divorced. The employment status test group revealed 74 (77.9%) Employed, 19 (20.0%) Un-employed, 2 (2.1%) Retired, control group 8 (40.0%) Employed, 12 (60.0%) Un-employed, and 0 (0.0%) Retired. The Educational level for the test group revealed 65 (68.4%) attained Primary/secondary certificates 30 (31.6%) were Tertiary certificate holders, control group 12 (60.0%) attained Primary/Secondary certificates and 8 (40.0%) were Tertiary certificate holders. Occupation, level of education and marital status all had effect in the pattern of spread of HIV as evident in the table of results below. Table 2 below showed a reduction in the mean values of PCV, WBC, platelets and leucocytes values of the test subjects when compared to the control group, this demonstrated the presence of anaemia, leukopenia and thrombocytopenia in HIV positive test subjects. The results of heamatological index such as MCV, MCH and MCHC shows myelotoxic effect of the antiretroviral therapy.

Discussion

The effect of HIV (Human Immunodeficiency Virus) on haematological parameters in patients who have tested positive was investigated in this study to determine if there is a statistically significant difference between the haematological parameters of the test and control groups. In this study, it was found that there was a decrease in PCV (Packed cell volume) of the positive group but not statistically significant, which can arise from several causes such as opportunistic infections, cell destruction, long-term illness and failure of bone marrow production; this is in line with the observation made by Damtie et al. (2021) and Tilahun et al. (2022). There was no significant difference between the WBC (White blood cell) of the test and control groups, indicating that WBC counts in both groups do not significantly alter the body's ability to produce or maintain

Table 1 Socio-demographic characteristics of the study subjects

Variables	HIV positive (n = 95)	HIV negative (n = 20)
SEX		
MALE	21 (22.1%)	9 (45.0%)
FEMALE	74 (77.9%)	11 (55.0%)
AGE		
15-19YRS	3 (3.2%)	0 (0.0%)
20-45YRS	56 (58.9%)	20 (100%)
46-65YRS	36 (37.9%)	0 (0.0%)
ETHNICITY		
Yoruba	86 (90.5%)	17 (85.0%)
Igbo	7 (7.4%)	2 (10.0%)
Hausa	2 (2.1%)	1 (5.0%)
OCCUPATION		
Civil servant	21 (22.1%)	5 (25.0%)
Farmer	1 (1.1%)	0 (0.0%)
Trader	73 (76.8%)	15 (75.0%)
EDUCATIONAL LEVEL		
Primary/Secondary	65 (68.4%)	12 (60.0%)
Tertiary	30 (31.6%)	8 (40.0%)
MARITAL STATUS		
Single	11 (11.6%)	4 (20.0%)
Married	83 (87.4%)	16 (80.0%)
Divorce	1 (1.1%)	0 (0.0%)
EMPLOYMENT STATUS		
Employed	74 (77.9%)	8 (40.0%)
Un-employed	19 (20.0%)	12 (60.0%)
Retired	2 (2.1%)	0 (0.0%)
MEDICAL HISTORY		
HOW LONG HAVE YOU BEEN LIVING WITH HIV		
1-5years	36 (37.9%)	
6-10years	22 (23.2%)	
11-15years	14 (14.7%)	
16-20years	20 (21.1%)	
21-25years	3 (3.2%)	
HAVE RECEIVED BLOOD TRANSFUSION		
YES	16 (16.8%)	5 (25.0%)
NO	79 (83.2%)	15 (75.0%)
HEALTH BEHAVIOUR		
DO YOU SMOKE		
YES	3 (3.2%)	1 (5.0%)
NO	92 (96.8%)	19 (95.0%)
DO YOU CONSUME ALCOHOL		
YES	6 (6.3%)	2 (10.0)
NO	89 (93.7%)	18 (90.0%)
HOW OFTEN DO YOU TRAVEL		
During festive period	15 (15.8%)	3 (15.0%)
Every week	30 (31.6%)	12 (60.0%)
Nil	21 (22.1%)	0 (0.0%)
Once a week	2 (2.1%)	0 (0.0%)
Once a while	29 (28.4%)	5 (25.0%)

Table 2: Mean and standard deviation of the haematological parameters in control and test subjects

Parameters	Control (N = 20) Mean ± SD	Test (N = 95) Mean ± SD
PCV	38.25±2.45	33.18±4.05
White blood cell	6.20±1.58	5.64±1.81
Platelet	235900.00±59279.80	198768.42±63335.22
Neutrophil	59.00±6.78	43.74±14.55
Lymphocyte	38.65±6.78	44.84±11.94
Basophil	0.40±0.50	0.00±0.00
Eosinophil	0.00±0.00	0.00±0.00
RBC	4.65±0.39	3.98±0.64
MCV	82.73±7.23	81.60±12.23
MCH	29.05±2.09	28.90±3.52
MCHC	13.46±0.68	34.42±2.18
HGB	13.46±0.68	11.64±1.74

Table 3: Comparison of the test and control group of all the haematological parameters using the Independence T-test

Parameters	Result	Std. Deviation	t-test	P-value	Remark
PCV	Positive	33.18 ± 4.05	0.00	>0.05	Non-significant
	Negative	38.25 ± 2.45			
WBC	Positive	5.64 ± 1.81	0.20	>0.05	Non-significant
	Negative	6.02 ± 1.58			
Platelet	Positive	198768.42 ± 63335.22	0.01	0.01	Significant
	Negative	235900.00 ± 59279.80			
Neutrophil	Positive	43.74 ± 14.55	0.03	0.03	Significant
	Negative	59.00 ± 6.78			
Lymphocyte	Positive	44.84 ± 11.94	0.00	<0.05	Significant
	Negative	38.65 ± 6.78			
Eosinophil	Positive	0.00 ± 0.00	0.00	<0.05	Significant
	Negative	0.40 ± 0.50			
Basophil	Positive	0.00 ± 0.00	0.00	<0.05	Significant
	Negative	0.00 ± 0.00			
Red Blood Cell	Positive	4.02 ± 0.49	0.00	<0.05	Significant
	Negative	4.65 ± 0.39			
MCV	Positive	81.60 ± 12.23	0.69	>0.05	Non-significant
	Negative	82.73 ± 7.23			
MCH	Positive	28.90 ± 3.52	0.86	>0.05	Non-significant
	Negative	29.05 ± 2.09			
MCHC	Positive	34.42 ± 2.18	0.49	>0.05	Non-significant
	Negative	35.01 ± 1.57			
HGB	Positive	11.61 ± 1.75	0.00	>0.05	Non-significant
	Negative	13.46 ± 0.68			

white blood cells, which are crucial for immune response.

Platelet count shows a significant difference between the test and control groups. The significant reduction in platelet count in the HIV-positive group may indicate a condition affecting platelet survival or production, which could lead to chronic immunological thrombocytopenia purpura; this result is similar to the study conducted by Damtie et al. (2021), who reported a significantly lower value of the Platelet in HIV positive individuals. There was a notable variation in Neutrophil count in the test group A lower Neutrophil count could result from a potential immunosuppression effect or an underlying condition that reduces the neutrophil population, increasing the susceptibility to infections; this is an agreement with the study by Dikshit et al., (2009). There was no significant difference suggesting that the variation in lymphocytes is not significant. Lymphocytes are crucial for adaptive immunity, and their levels remain unaffected by the condition. The significant reduction in platelet and neutrophil counts in HIV-positive individuals suggests immune suppression and increased susceptibility to infections, while the unaffected lymphocyte levels indicate preserved adaptive immunity, highlighting the need for regular hematological monitoring to manage complications and guide treatment.

As Eosinophil counts are generally associated with allergic reactions and parasitic infections, determining no significant difference in Eosinophil levels between the test and control groups suggests that the conditions do not significantly affect Eosinophil counts (support this with reference). The equal Basophil counts in both groups show no effect of the situation (which situation, be explicit about resonating your study's objectives in the readers' mind) on Basophil levels, which are implicated in inflammatory reactions. The Basophil shows no significant difference. The red blood cell (RBC) exhibits very little change to be consistent with the findings of Franco *et al.* (2012). Similar RBC levels in the two groups suggest that the disease does not affect RBC counts, which are essential for oxygen delivery. There was a notable distinction in MCV, MCH, MCHC and HGB between the test and control groups, this is also similar to the study of Zhang *et al.* (2022).

Conclusion and recommendations

The comparison of HIV-positive and negative groups using a statistical analysis of several haematological parameters produced numerous significant results. Among the most notable changes between the groups were the platelet and neutrophil counts, indicating a possible response to the condition. Similarly, the neutrophil count was significantly high in the positive group which may reflect an immune response. Conversely, Parameters such as PCV, WBC, Lymphocyte, Eosinophil, Basophil counts and Red cell indices did not show significant differences between the groups; this suggests that these parameters may not be as strongly affected by the condition understudy.

Limitations of the Study

- Sample Size and Single-Center Scope: The study's relatively small sample size and single-center design limit the generalizability of the findings to the broader Nigerian population.
- Cross-Sectional Nature: As a cross-sectional study, it does not capture the progression of haematological changes over time or establish causality.
- Confounding Factors and Comorbidities: The study did not fully account for potential confounders such as co-infections, nutritional status, or other prevalent diseases like malaria and tuberculosis.
- ART and Clinical Markers: Limited information on antiretroviral therapy (ART) history, viral load, and CD4 count restricts the ability to explore their influence on haematological parameters.

- Control Group and Socioeconomic Factors: The choice of HIV-negative blood donors as a control group and the lack of data on socioeconomic and lifestyle factors may affect the comparability and interpretation of findings.

Implications of the research findings

- Higher Prevalence of Hematological Abnormalities: HIV-positive patients exhibit a significantly higher prevalence of anaemia, leukopenia, and thrombocytopenia compared to healthy controls, highlighting the profound impact of HIV on haematological health.
- Significant Alterations in Key Parameters: Lower mean haemoglobin levels, hematocrit, and platelet counts in HIV-positive patients indicate systemic inflammation and potential bone marrow suppression caused by HIV and its complications.
- Potential Causes of Hematological Abnormalities: The study identifies multiple contributing factors to these abnormalities, including the direct effects of the virus, opportunistic infections, and the myelotoxic effects of antiretroviral therapy (ART).
- Clinical and Research Significance: These findings provide critical insights into the hematological profile of HIV-positive patients in Nigeria, informing clinical practices for routine monitoring and tailored interventions. Additionally, the study contributes to the broader understanding of HIV-related hematological complications, aiding future research and policy development.

Ethical consideration

Ethical approval was obtained from the ethical committee of the Ministry of Health, Osogbo with ref. no.: OSHREC/PRS/569T/167. The purpose, the benefits of the study, and some discomforts that could be associated with sample collection were explained to the patients before the commencement of the study. So, informed consent was obtained from all willing participants, and only those who gave their consent were recruited for the study.

Informed Consent

Informed consent was obtained from all study and control participants following a thorough explanation of the study's purpose, nature, and relevance. Participants were given an informed consent form, which was read to them in both English and the local language to ensure comprehension. Only participants who voluntarily agreed to participate and signed the consent form were included in the study.

Funding and conflict of interest

The research was not funded by a grant from an institution or agency, so there is no conflict of interest.

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