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Evaluation of Platelet Indices in Type 2 Diabetes Mellitus

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KEYWORDS

Diabetes mellitus, Mean platelet volume (MPV), Platelet distribution width (PDW), Obesity, Vascular complications

ABSTRACT:

Background: Diabetes mellitus (DM) is a growing global health concern, marked by chronic high blood sugar, leading to complications like cardiovascular and cerebrovascular issues. The disease worsens platelet function, increasing thrombotic risks. Platelet indices such as mean platelet volume (MPV), platelet distribution width (PDW), and platelet large cell ratio (P-LCR) are vital for assessing thrombosis and identifying vascular complications in DM patients.

Aim & Objective:1.To establish a relationship between platelet indices and the early detection of complications in type 2 DM. 2. To compare platelet indices in diabetic and non-diabetic patients, between those with good and poor glycemic control, with the duration of diabetes, and BMI.

Methods: Case control study. **Study setting:** Santosh Medical College and Hospital, Ghaziabad specifically in the Central Clinical Laboratory, Pathology Department

Study duration: From 1 August 2023 to 1 August 2024

Study population: 76 diabetic patients and 76 healthy controls such cases were included in the study

Sample size: 152

Result: No significant finding among age and gender distribution but statistically significant change was seen in MPV (<0.001), PDW (<0.001), and P-LCR (<0.001) values among diabetic than healthy control and more poorly controlled diabetic and patients with high BMI, i.e., obese patients.

Conclusions: This study highlights the increased prevalence of complications in diabetic patients and the higher platelet activation in obese individuals. Platelet indices are easily accessible and useful for detecting potential risks in diabetic patients.

INTRODUCTION

Diabetes mellitus (DM) is an ancient disease that has become a global health crisis. It is characterized by chronic high blood sugar, caused by issues with insulin secretion or action. In 2018, 425 million people worldwide were affected, and projections suggest this number will rise to 642 million by 2040. The World Health Organization (WHO) and the Sustainable Development Goals (SDGs) have set targets to reduce

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the mortality from non-communicable diseases, including diabetes, by 2025 and 2030.[1-3]

The increasing prevalence of DM is linked to a higher risk of both microvascular and macrovascular complications, such as cardiovascular and cerebrovascular issues. Atherosclerotic plaque disruption and thrombosis contribute significantly to vascular problems in diabetes, which are exacerbated by compromised platelet and endothelial function, coagulation, and fibrinolysis. These changes in hemostasis increase the likelihood of clot formation.[4]

DM leads to complications like retinopathy, nephropathy, and neuropathy, and increases the risk of cardiovascular diseases. The global impact of DM is significant, with projections showing its prevalence rising in the coming years.[8] Understanding platelet function, which plays a critical role in maintaining vascular health, is key to managing DM-related complications.[9,10,11]

Platelet indices like mean platelet volume (MPV), platelet distribution width (PDW), and platelet large cell ratio (P-LCR) are crucial for assessing thrombosis. MPV reflects platelet activation, PDW shows platelet variability, and P-LCR identifies larger platelets, which are linked to thrombotic risks. These markers help detect early signs of vascular complications in DM patients.[5,6]

MPV, in particular, is a key parameter in understanding the progression of diabetic vascular complications. Higher MPV levels are associated with poorly controlled diabetes and reflect a higher risk of thrombosis. MPV can be a simple, cost-effective tool for diagnosing and predicting complications in diabetic patients.[7]

AIM AND OBJECTIVES

AIM:

To establish a relationship between platelet indices and the early detection of complications in type 2 DM.

OBJECTIVES:

1. To compare platelet indices in diabetic and non-diabetic patients, between those with good and poor glycemic control, with the duration of diabetes, and BMI.

MATERIAL AND METHODS

Study design: Case Control Study

Study settings: Santosh Medical College and Hospital, Ghaziabad, specifically in the Central Clinical Laboratory, Pathology Department

Study population: 76 diabetic patients and 76 healthy controls such cases were included in the study.

Study period: From 1 August 2023 to 1 August 2024

Sample size: 152

Inclusion criteria:

1. Diagnosed diabetes mellitus according to WHO standards, age and sex matching with the control group.

2. The control group consisted of healthy individuals with normal blood glucose levels, also age and sex-matched to the case group

Exclusion criteria:

1. Male patients with hemoglobin levels below 13 gm/dL, female patients with hemoglobin levels below 11 gm/dL,

2. Non-diabetic patients with coronary artery disease, patients with acute febrile illnesses, malignancies, thrombocytopenia, or thrombotic disorders, those on anti-platelet drugs, and pregnant women.

3. Not willing to participate in the study

Sampling method: Convenient sampling method

Approval for the study:

Written approval from Institutional Ethics committee was obtained beforehand. Written approval of Pathology department and other related department was obtained. After obtaining informed verbal consent from all patients coming to our institute during study period according to exclusion and inclusion criteria such cases were included in the study.

Methods of Data Collection and Questionnaire-

Predesigned and pretested questionnaire was used to record the necessary information. Questionnaires included general information, such as age, sex, Medical history- chief complain, past history, general examination, systemic examination.

Study procedure: The collection of 5ml venous blood in an EDTA vial, under aseptic conditions, from both the

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case and control groups. The samples were analyzed for complete blood count (CBC) and glycosylated hemoglobin (HbA1c). CBC was performed using the Erba-360 Five Parts Auto Analyzer, and HbA1c was estimated using the COBAS-c 311. All clinical history, blood sugar levels, and CBC data were collected, and the data were entered into a master chart for statistical analysis using SPSS Statistics version.

Data Analysis:

The data was coded and entered into Microsoft Excel Worksheet. The categorical data expressed as rates, ratios, and proportions and the continuous data expressed as mean ± standard deviation. The comparison of categorical data performed using Chi-square test and Fisher's exact test and the comparison of continuous data done using independent sample *t*-test. $P \leq 0.05$ at 95% confidence interval will be considered as statistically significant.

RESULT AND OBSERVATION

The present Case control study conducted on all 76 diabetic patients and 76 healthy controls during study period such cases were included in the study.

Table 1: Age and Gender Distribution of Cases and Controls

	Cases vs controls		
Age Range	**Cases**	**Controls**	**Total**
31-35	2	4	6
36-40	14	17	31
41-45	10	17	27
46-50	19	13	32
51-55	13	11	24
56-60	18	14	32
Gender			
Male	46	43	89
Female	30	33	63
Total	76	76	152

Table 1 shows the age distribution between the case group (patients with Type 2 Diabetes Mellitus) and the control group (healthy individuals). The age range of participants spans from 31 to 60 years. The largest groups fall within the 46-50 and 56-60 age ranges, with 32 participants each, followed by 36-40 years (31 participants). The smallest group is the 31-35 age range, with 6 participants. Statistical analysis using the chi-square test yielded a value of 4.56 with a p-value of 0.471, indicating no significant difference in the age distribution between cases and controls. Therefore, the groups are well-matched in terms of age.

Table 1 also presents the gender distribution among the cases (patients with Type 2 Diabetes Mellitus) and controls (healthy individuals). Of the total 152 participants, 89 are male, with 46 in the case group and 43 in the control group. There are 63 females, 30 among the cases and 33 among the controls. The chi-square test result is 0.244, with a p-value of 0.621, indicating no statistically significant difference in gender distribution between the two groups. This suggests that both groups are well-matched for gender, reducing the likelihood of gender-related bias in the analysis.

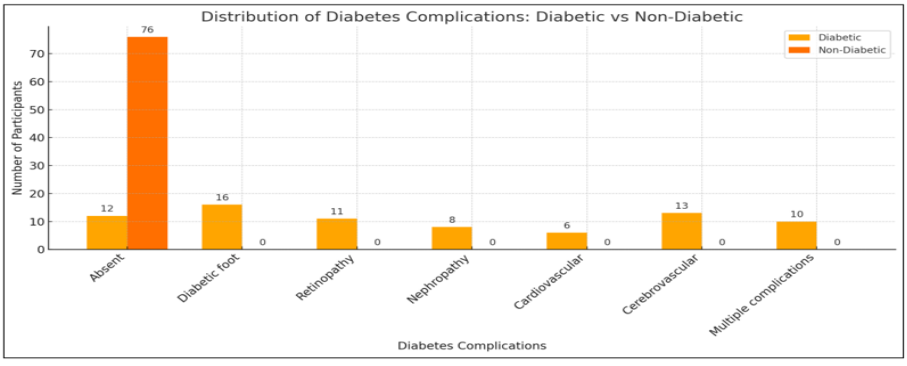

Figure 1: Distribution of Diabetes Complications among Cases and Controls

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Figure 1 presents the distribution of diabetes-related complications between diabetic and non-diabetic participants. Out of the 76 diabetic individuals, 64 (84.2%) reported one or more complications, while 12 (15.8%) did not experience any. The complications observed among diabetic patients include diabetic foot (16 cases), retinopathy (11 cases), nephropathy (8 cases), cardiovascular complications (6 cases), cerebrovascular conditions (13 cases), and multiple complications (10 cases). On the other hand, all 76 non-diabetic participants were free from diabetes-related complications, falling exclusively under the "Absent" category.

The chi-square test resulted in a χ^2 value of 111 with a p-value of <0.001, indicating a statistically significant difference in the occurrence of complications between the two groups. These findings highlight the substantial burden of complications associated with diabetes and emphasize the need for effective clinical management strategies to mitigate these risks among diabetic patients.

Table 2: Comparison of platelet indices between Cases and controls

	Cases vs controls		
Platelet indices	Cases	Controls	P value
MPV (fL)	6.73 ± 1.45	3.42 ± 0.45	<0.001
PDW (fL)	10.4 ± 2.05	5.21 ± 0.57	<0.001
P-LCR (%)	21.7 ± 4.43	10.8 ± 1.35	<0.001
Platelet Count (10^9/L)	257 ± 73.7	232 ± 45.1	0.015

Table 2 presents the comparison of platelet indices between Type 2 Diabetes Mellitus (cases) and healthy controls. The mean platelet volume (MPV) is significantly higher in cases (6.73 ± 1.45 fL) compared to controls (3.42 ± 0.45 fL), with a p-value of <0.001. Platelet distribution width (PDW) is also elevated in cases (10.4 ± 2.05 fL) versus controls (5.21 ± 0.57 fL), with a p-value of <0.001. Similarly, the platelet-large cell ratio (P-LCR) is higher in cases (21.7 ± 4.43%) than in controls (10.8 ± 1.35%), with a p-value of <0.001. The platelet count is slightly elevated in cases (257 ± 73.7) compared to controls (232 ± 45.1), with a statistically significant p-value of 0.015. These findings suggest altered platelet indices in diabetic patients, indicating potential vascular risks.

Table 3: Comparison of platelet indices between diabetics with good control to diabetics with poor control

	Glycemic control status		
Platelet indices	**Poor Control**	**Good Control**	**P value**
MPV (fL)	6.97 ± 1.35	3.55 ± 0.59	<0.001
PDW (fL)	10.8 ± 1.81	5.4 ± 0.81	<0.001
P-LCR (%)	22.4 ± 4.06	11.3 ± 1.85	<0.001
Platelet Count (10^9/L)	256 ± 74.7	236 ± 48.3	0.048

Table 3 compares platelet indices between diabetic patients with poor glycemic control and those with good control. The mean platelet volume (MPV) is significantly higher in poorly controlled diabetics (6.97 ± 1.35 fL) compared to those with good control (3.55 ± 0.59 fL), with a p-value of <0.001. Platelet distribution width (PDW) also shows a significant increase in the poor control group (10.8 ± 1.81 fL) compared to the good control group (5.4 ± 0.81 fL), with a p-value of <0.001.

Similarly, the platelet-large cell ratio (P-LCR) is elevated in the poor control group (22.4 ± 4.06%) compared to the good control group (11.3 ± 1.85%), with a p-value of <0.001. The platelet count is also slightly higher in the poor control group (256 ± 74.7) compared to the good control group (236 ± 48.3), with a p-value of 0.048. These findings suggest that poor glycemic control is associated with altered platelet indices, potentially increasing the risk of vascular complications.

Table 4: Comparison of Platelet indices with duration of DM

	Platelet indices (Mean ± SD)			
Duration of Diabetes (Years)	**MPV (fL)**	**PDW (fL)**	**P-LCR (%)**	**Platelet Count (10^9/L)**
1–5	7.13 ± 1.84	11.0 ± 2.5	22.1 ± 4.19	292 ± 74.2

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5–10	6.68 ± 1.41	10.3 ± 2.0	21.4 ± 4.3	253 ± 69.4
>10	6.67 ± 1.35	10.5 ± 2.03	22.7 ± 5.73	243 ± 95.7
P value (Anova test)	0.657	0.699	0.695	0.259

Table 4 compares platelet indices with the duration of diabetes mellitus (DM) across three groups: 1–5 years, 5–10 years, and >10 years. The mean MPV is highest in the 1–5 years group (7.13 ± 1.84 fL) and slightly lower in the 5–10 years (6.68 ± 1.41 fL) and >10 years (6.67 ± 1.35 fL) groups, with a non-significant p-value of 0.657. PDW and P-LCR values show similar patterns without significant differences (p = 0.699 and 0.695, respectively). The platelet count decreases with the duration of diabetes but remains statistically non-significant (p = 0.259). These findings suggest no significant correlation between platelet indices and the duration of DM in this study population.

Table 5: Comparison of platelet indices with BMI

	Platelet indices (Mean ± SD)			
BMI Category	**MPV (fL)**	**PDW (fL)**	**P-LCR (%)**	**Platelet Count (10^9/L)**
Normal	4.92 ± 1.92	7.6 ± 3.05	15.7 ± 6.07	243 ± 62.7
Obese	7.31 ± 1.46	11.3 ± 1.19	24.6 ± 2.81	250 ± 61.6
Overweight	4.99 ± 1.96	7.67 ± 2.9	16 ± 6.34	246 ± 62.3
P value (Anova test)	0.004	0.003	<0.001	0.922

Table 5 compares platelet indices across different BMI categories: Normal, Overweight, and Obese. The mean MPV is significantly higher in obese individuals (7.31 ± 1.46 fL) compared to normal (4.92 ± 1.92 fL) and overweight (4.99 ± 1.96 fL) groups, with a p-value of 0.004. PDW also shows a significant increase in obese participants (11.3 ± 1.19 fL) compared to other groups, with a p-value of 0.003. P-LCR is notably higher in obese individuals (24.6 ± 2.81%) with a p-value of <0.001. However, the platelet count shows no significant difference across BMI categories (p = 0.922). These findings suggest that higher BMI, particularly obesity, is associated with altered platelet indices, potentially increasing the risk of vascular complications.

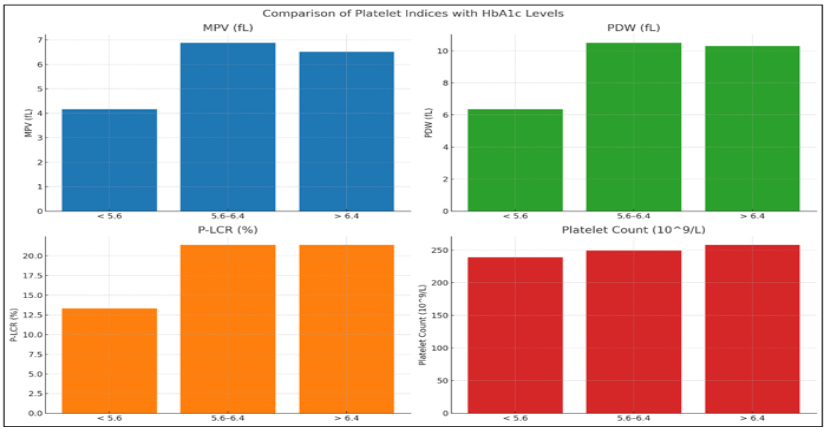

Figure 2 presents the distribution of platelet indices according to HbA1c levels

Figure 2 presents the distribution of platelet indices according to HbA1c levels, categorized as <5.6, 5.6–6.4, and >6.4. The mean MPV increases significantly with higher HbA1c levels, from 4.16 ± 1.62 fL in the <5.6 group to 6.88 ± 1.61 fL in the 5.6–6.4 group (p < 0.001). Similarly, PDW and P-LCR also show significant increases with rising HbA1c levels, with p-values < 0.001. However, the platelet count shows no statistically

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significant difference across the HbA1c categories (p = 0.250). These findings indicate that higher HbA1c levels, reflective of poor glycemic control, are associated with elevated platelet indices, suggesting increased platelet activation and a higher risk of vascular complications in diabetic individuals.

DISCUSSION

The present study found that the distribution of age among Type 2 Diabetes Mellitus (DM) patients (cases) and non-diabetic participants (controls) was comparable. A total of 152 participants were studied, divided equally into 76 cases and 76 controls. Among the diabetic cases, the largest age groups were 46–50 years (19 cases) and 56–60 years (18 cases). Similarly, in the control group, the majority were within the 36–40 years (17 controls) and 41–45 years (17 controls) age ranges.

The present study's findings align with those reported by **Shilpi and Potekar**,[12] who investigated platelet indices in 280 diabetic cases and 280 non-diabetic controls. In their study, participants ranged in age from 45 to 70 years, with the mean age of diabetic cases being 53 ± 5.7 years and the mean age of controls at 54.1 ± 5.2 years. Similarly, **Pujani *et al.*.[13]** studied 30 diabetics with complications and 30 without, reporting a mean age of 50.87 ± 9.75 years for uncomplicated cases and 55.63 ± 7.49 years for those with complications.

The present study found that the gender distribution between Type 2 DM patients (cases) and non-diabetic participants (controls) was comparable. Among the 152 participants, 46 males and 30 females were diabetic, while the non-diabetic controls included 43 males and 33 females. The findings of the present study align with those reported by **Samaddar *et al.*.**,[14] who studied platelet indices in 277 diabetic patients, In their study, the gender distribution within the controlled group was nearly balanced, with 98 males (50.78%) and 95 females (49.22%).

Similarly, the uncontrolled group comprised 41 males (48.8%) and 43 females (51.19%). In contrast, **Dwivedi and Davangeri[15]** reported a different gender distribution in their study, which included 210 diabetic patients attending a tertiary care hospital. They found that 146 (69.2%) of the participants were males and only 64 (30.8%) were females, indicating a male predominance in their cohort. This variation could be attributed to demographic differences or referral patterns to tertiary care centers.

The present study found that 64 out of 76 diabetic patients (84.2%) experienced complications, while all non-diabetic participants had no complications. Among the diabetic patients, the most frequent complications were diabetic foot (16 cases), cerebrovascular complications (13 cases), retinopathy (11 cases), and multiple complications (10 cases). Nephropathy was present in 8 cases, and cardiovascular complications were observed in 6 cases. The findings of the present study align with those of **Dwivedi and Davangeri**,[15] who reported complications in 210 diabetic patients. In their study, 47 (22.38%) had diabetic foot, 94 (44.76%) experienced cardiovascular complications, 5 (2.38%) had retinopathy, and 5 (2.38%) developed nephropathy. The incidence of cerebrovascular events was lower, affecting only 2 (0.95%) patients.

Buch *et al.*.[16] also explored diabetic complications and their relationship with fasting blood sugar (FBS) and HbA1c. They found a significant association between coronary artery disease (55 cases) and higher FBS (188.87 ± 63.4 mg/dL, p = 0.013) as well as elevated HbA1c (9.16 ± 1.75%, p = 0.048). The present study confirms that complications are a significant burden among diabetic patients, with diabetic foot, cerebrovascular issues, and retinopathy being particularly common. These results align with previous research, though variations in complication frequencies highlight the importance of patient-specific factors and the need for early detection and management strategies.

The present study found significant differences in platelet indices between diabetic patients (cases) and non-diabetic participants (controls). Diabetic patients had higher values for mean platelet volume (MPV) at 6.73 ± 1.45 fL, platelet distribution width (PDW) at 10.4 ± 2.05 fL, and platelet large cell ratio (P-LCR) at 21.7 ± 4.43%. In comparison, non-diabetic participants had lower values for MPV (3.42 ± 0.45 fL), PDW (5.21 ± 0.57 fL), and P-LCR (10.8 ± 1.35%), The findings of the present study are consistent with those reported by **Dwivedi and Davangeri**,[15] who studied platelet indices among diabetic patients. Their study found higher values for MPV (8.6 ± 1.24 fL), PDW (17.9 ± 3.75 fL), and P-LCR (35.5 ± 7.88%).

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Similarly, **Taderegew *et al.*.**[19] reported higher MPV (12.3 ± 2.2 fL), PDW (15.5 ± 2.5 fL), and P-LCR (25.4 ± 7.1%) in Ethiopian diabetic patients. Although the absolute values vary across studies, the trend of increased MPV, PDW, and P-LCR in diabetic individuals is consistent, supporting the use of these indices as potential biomarkers for diabetes-related complications.

The present study found that diabetic patients with poor glycemic control exhibited significantly higher platelet indices compared to those with good glycemic control. Increased platelet indices value, i.e., MPV (6.97 ± 1.35 fL), PDW (10.8 ± 1.81 fL), P-LCR (22.4 ± 4.06%) in poorly controlled diabetics versus normal or mild increase count among good controlled diabetics. The present study's findings align with those of **Pujani *et al.*.**,[13] who reported significantly higher MPV ($p = 0.001$) and PDW ($p = 0.003$) in diabetic patients with poor glycemic control (HbA1c >7%) compared to those with good control (HbA1c ≤7%).

Jiskani and Singh[20] also found similar patterns in their study, reporting higher MPV (12.75 fL) and P-LCR (42.58%) in patients with good glycemic control, while patients with poor control exhibited reduced MPV (9.04 fL) and P-LCR (32.18%). These findings underscore the importance of monitoring platelet indices as potential biomarkers to assess glycemic control and predict the risk of diabetic complications.

The present study found no statistically significant variation in platelet indices with the duration of diabetes. The MPV, PDW, P-LCR, and platelet counts did not vary significantly across these duration categories (p-values: 0.657, 0.699, 0.695, and 0.259, respectively). **Kodiatte *et al.*.**[17] found no significant correlation between MPV and the duration of diabetes ($r = -0.036$, $p = 0.585$), which is consistent with the present study's findings.

In contrast, those reported by **Dwivedi and Davangeri**,[15] found significant positive correlations between platelet indices and the duration of diabetes. In their study, MPV ($r = 0.488$, $p < 0.001$), PDW ($r = 0.360$, $p < 0.001$), and P-LCR ($r = 0.415$, $p < 0.001$) were all significantly associated with longer durations of diabetes, indicating increased platelet activation over time. This discrepancy might be due to differences in study populations, sample sizes, or varying levels of glycemic control among participants.

The present study found significant differences in platelet indices across different BMI categories. Obese individuals had the highest MPV (7.31 ± 1.46 fL), PDW (11.3 ± 1.19 fL), and P-LCR (24.6 ± 2.81%), with statistically significant p-values. In contrast, normal-weight participants had lower values for MPV (4.92 ± 1.92 fL) and P-LCR (15.7 ± 6.07%), indicating less platelet activation. Platelet counts did not vary significantly between BMI categories ($p = 0.922$).

The results of the present study differ from the findings of **Biadgo *et al.*.**,[18] who also explored the relationship between hematological indices and anthropometric measures in diabetic patients. Their study, however, found weak and non-significant correlations between platelet indices and BMI. Specifically, they reported r-values of -0.037 ($p = 0.659$) for platelet count, -0.123 ($p = 0.136$) for PDW, and -0.101 ($p = 0.224$) for MPV, suggesting that BMI did not have a strong influence on these parameters in their cohort. This area can be a potential field for further research to establish the relation between platelet variation and body mass index.

CONCLUSION

Diabetes Mellitus is an old-known disease and its epidemiological burden is increasing with every passing year. This well-matched study of 152 participants shows no significant correlation of platelet indices variation with age, gender, and duration of diabetes but we have found a statistical correlation of platelet indices (MPV, PDW, P-LCR) variation with diabetics than non-diabetics, poor glycemic control, diabetic complications, and more variation in obese patients. Therefore, we conclude that assessing platelet indices may provide an early and significant value in evaluating the progression of thrombotic complications and an indication for early management.

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Conflict of interest- none

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