Original Article

Airway Assessment and Predicting Difficult Airway in Diabetic Patients Versus Non-Diabetic Patients

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Abstract

Background: Diabetes mellitus is associated with non-enzymatic glycosylation of connective tissue proteins, resulting in limited joint mobility and reduced cervical spine movement, which may increase the risk of difficult airway management during anesthesia. The aim is to assess airway parameters and predict difficult airway in diabetic versus non-diabetic patients undergoing elective surgery under general anesthesia. **Material and Methods:** This prospective observational study was conducted in the Department of Anaesthesia and Critical Care, VIMSAR, Burla, Odisha, from January 2024 to December 2025. A total of 150 patients aged 40–70 years were enrolled, including 75 diabetic and 75 non-diabetic patients. Airway assessment was performed using Modified Mallampati Grade, Thyromental Distance (TMD), Palm Print Sign, Degree of Head Extension (DHE), Prayer Sign, and Cormack–Lehane grading. Hemodynamic parameters including heart rate, blood pressure, and oxygen saturation were also recorded. Statistical analysis was performed using appropriate tests, and $p<0.05$ was considered significant. **Results:** Baseline demographic characteristics were comparable between the groups. Diabetic patients had significantly higher fasting blood sugar, post-prandial blood sugar, and HbA1c levels ($p<0.001$). Restricted head extension was significantly more common among diabetic patients (16.0% vs. 2.7%; $p=0.036$), with an odds ratio of 6.95 (95% CI: 1.45–32.25; $p=0.009$). Abnormal palm print grading was also significantly higher in diabetics (42.7% vs. 25.3%; $p=0.007$), with an odds ratio of 2.19 (95% CI: 1.10–4.39; $p=0.038$). Other airway parameters showed no statistically significant differences. No individual airway assessment test demonstrated high diagnostic accuracy for predicting difficult laryngoscopy. **Conclusion:** Diabetic patients exhibit a higher prevalence of airway abnormalities, particularly restricted head extension and abnormal palm print sign. Combined airway assessment incorporating joint mobility evaluation may improve identification of potentially difficult airways in diabetic patients.

Keywords: Diabetes mellitus, Difficult airway, Airway assessment, Mallampati grade, Palm print sign, Prayer sign, Head extension, Difficult laryngoscopy, Thyromental distance, General anesthesia.

Received: 03 May 2026 **Revised: 19 May 2026** **Accepted: 11 June 2026** **Published: 17 June 2026**

Introduction

Maintenance of an adequate airway is one of the most important duties of the anesthesiologist because failure to maintain an adequate airway could lead to high morbidity and mortality. Therefore, correct pre-operative assessment of airway is crucial to identify those patients who may have a difficult laryngoscopy, difficult intubation or difficult mask ventilation. Numerous bedside screening tests, including Mallampati, thyromental distance, sternomental distance, upper lip bite test, inter-incisor gap measurement and assessment of neck mobility, are routinely used to predict airway difficulty. While these tests have been widely used, there is no single test which has proved to be completely reliable, requiring a comprehensive evaluation using multiple predictors to increase the diagnostic accuracy.[1,2]

Diabetes mellitus is a chronic metabolic disease, with its hallmark of hyperglycaemia and various microvascular and macrovascular complications, which involve several organ systems. Diabetes is a very common condition, which has seen a lot of upsurge in the world and hence diabetic patients form a common population in anesthetic practice. Chronic hyperglycaemia causes non-enzymatic glycosylation of collagen and proteins in connective tissues, causing decreased mobility of joints, stiffness of tissues and limited flexibility of tissues such as the cervical spine and the TMJ. Such pathophysiological alterations can markedly affect airway anatomy and make laryngoscopy and/or endotracheal intubation difficult.[3,4]

A very familiar diabetic connective tissue disorder is known as diabetic cheiroarthropathy, or limited joint mobility syndrome. This is associated with a thickened skin, flexion contractures, and

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DOI:
10.21276/amit.2026.v13.i2.749

How to cite this article: Verma P, Choudhury S, Panigrahy LK, Soren DK, Padhi N, Badhei A. Airway Assessment and Predicting Difficult Airway in Diabetic Patients Versus Non-Diabetic Patients. Acta Med Int. 2026;13(2):694-699.

decreased joint motion at the small joints. The same glycosylation-related changes can occur in the joints of the atlanto-occipital and cervical spine, which may result in reduced extension of the neck, an essential factor for a correct alignment of oral, pharyngeal and laryngeal axes in direct laryngoscopy. This means that diabetic patients may have airway problems even if there are no visible external airway abnormalities.[5,6]

The "prayer sign" and "palm print test" have come to be important bedside signs of poor joint mobility in a diabetic person. A few studies have shown that there is a strong correlation between a positive prayer sign and the abnormal palm print grades and difficult laryngoscopy. These simple, non-invasive tests can be used as an independent predictive test, when combined with other routine preoperative airway assessment tests, in the diabetic patient.[7,8] In addition, it has been reported that the duration of diabetes, glycemic control status and diabetic complications are reported to be correlated with the severity of joint stiffness and airway difficulties, indicating that diabetic patients form a unique group that needs special evaluation.[9]

Therefore, it is of great clinical interest to compare airway characteristics in diabetic patients vs. non-diabetic patients. Knowing if diabetes is a standalone risk factor for a difficult airway can help to smooth out the perioperative planning process, help prepare the right equipment, and improve patient safety. Development of reliable predictors specific to diabetic patients can help anesthesiologists to anticipate the difficulties with the airway and prevent failed intubation or airway complications associated with anesthesia.

This study was designed to compare the airway assessment parameters and prediction of difficult airway between diabetics and non-diabetics. The primary objective was to evaluate Modified Mallampati test, thyromental distance, palm print sign, degree of head extension, prayer sign, and Cormack–Lehane grading. The secondary objective was to assess hemodynamic responses, including heart rate, non-invasive blood pressure, and oxygen saturation, during laryngoscopy and endotracheal intubation.

Materials and Methods

Study Design: Prospective observational study.

Study Population: Patients aged 40–70 years of either gender undergoing elective surgical procedures requiring general anesthesia with endotracheal intubation and mechanical ventilation.

Sample Size: A total of 150 patients were included in the study, comprising 75 diabetic and 75 non-diabetic patients. The sample size was calculated using PASS statistical software assuming an area under the curve (AUC) of 80% for the Modified Mallampati Test and 70% for the Palm Print Sign, with a study power of 80% and an alpha error of 0.05.

Study Duration: January 2024 to December 2025.

Study Place: Department of Anaesthesia and Critical Care, Veer Surendra Sai Institute of Medical Sciences and Research (VIMSAR), Burla, Sambalpur, Odisha, India.

Sampling Technique: Progressive consecutive sampling.

Inclusion Criteria:

1. Patients of either gender.
2. Age between 40 and 70 years.
3. American Society of Anesthesiologists (ASA) physical status I or II.
4. Patients posted for elective surgery requiring general anesthesia with tracheal intubation.
5. Patients willing to provide written informed consent.

Exclusion Criteria:

1. Patients unwilling to participate or not providing informed consent.
2. Patients with known facial, neck, or palatal deformities.
3. Patients with head and neck trauma.
4. Patients with coexisting joint disorders such as rheumatoid arthritis, systemic lupus erythematosus, thyroid disorders, chronic liver disease, or chronic kidney disease.
5. Obese patients with body mass index (BMI) >30 kg/m².
6. Pregnant women.

Statistical Analysis: We put the data into Microsoft Excel and then used SPSS software version 27.0 (SPSS Inc., Chicago, IL, USA) and GraphPad Prism version 5 to look at it. Mean ± standard deviation was used to show continuous variables, and frequencies and percentages were used to show categorical variables. The unpaired t-test was utilized to examine continuous variables between independent groups, whereas the paired t-test was employed for comparisons within the same group. The Chi-square test or Fisher's exact test was used to look at categorical variables, depending on which one was better. A p-value of less than 0.05 was seen to be statistically important.

Results

Table 1: Baseline Characteristics of the Study Population (n = 150)

Parameter	Non-Diabetic (n=75)	Diabetic (n=75)	p-value
Male, n (%)	50 (66.7)	53 (70.7)	0.597
Female, n (%)	25 (33.3)	22 (29.3)	
Weight (kg)	73.0 ± 13.1	72.9 ± 13.1	0.961
Height (cm)	168.9 ± 3.9	169.1 ± 4.0	0.758
BMI (kg/m²)	25.6 ± 4.2	25.5 ± 4.6	0.947
Fasting Blood Sugar (mg/dL)	93.6 ± 11.9	171.3 ± 18.2	<0.001
Post-Prandial Blood Sugar (mg/dL)	130.5 ± 28.8	232.9 ± 38.6	<0.001
HbA1c (%)	5.5 ± 0.7	8.7 ± 0.9	<0.001
Systolic BP (mmHg)	131.3 ± 15.0	128.9 ± 14.5	0.322
Diastolic BP (mmHg)	82.9 ± 4.8	82.8 ± 5.0	0.908
Heart Rate (bpm)	89.3 ± 12.1	89.6 ± 12.7	0.875
SpO_2 (%)	96.6 ± 1.7	96.5 ± 1.8	0.606

Table 2: Comparison of Airway Assessment Indices Between Groups

Parameter	Non-Diabetic (n=75)	Diabetic (n=75)	p-value
Mallampati Grade III–IV, n (%)	5 (6.7)	12 (16.0)	0.281
Thyromental Distance <6 cm, n (%)	2 (2.7)	5 (6.7)	0.246
Mean Thyromental Distance (cm)	7.3 ± 0.8	7.2 ± 0.9	0.557
Head Extension Class II–IV, n (%)	2 (2.7)	12 (16.0)	0.036
Palm Print Grade 1–3, n (%)	19 (25.3)	32 (42.7)	0.007
Cormack-Lehane Grade III–IV, n (%)	19 (25.3)	20 (26.7)	0.851
Prayer Sign Present, n (%)	8 (10.7)	12 (16.0)	0.337

Table 3: Risk of Difficult Airway in Diabetic Patients

Airway Index	Non-Diabetic Difficulty n (%)	Diabetic Difficulty n (%)	OR (95% CI)	p-value
Mallampati Grade III–IV	5 (6.7)	12 (16.0)	2.67 (0.89–7.99)	0.071
Thyromental Distance <6 cm	2 (2.7)	5 (6.7)	2.61 (0.49–13.88)	0.442
Head Extension Class II–IV	2 (2.7)	12 (16.0)	6.95 (1.45–32.25)	0.009
Palm Print Grade 1–3	19 (25.3)	32 (42.7)	2.19 (1.10–4.39)	0.038
Cormack-Lehane Grade III–IV	19 (25.3)	20 (26.7)	1.07 (0.52–2.22)	0.852

Table 4: Diagnostic Performance of Airway Assessment Tests for Predicting Difficult Laryngoscopy

Parameter	Group	AUC	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	p-value
BMI	Non-Diabetic	0.402	63.2	60.7	35.3	82.9	0.236
Mallampati Grade	Non-Diabetic	0.458	57.9	50	28.2	77.8	0.578
Thyromental Distance	Non-Diabetic	0.52	52.6	53.6	27.8	76.9	0.8
Head Extension	Non-Diabetic	0.518	5.3	100	100	75.7	0.82
Palm Print Grade	Non-Diabetic	0.531	89.5	14.3	26.2	80	0.69
BMI	Diabetic	0.527	100	12.7	29.4	100	0.718
Mallampati Grade	Diabetic	0.431	60	50.9	30.8	77.8	0.341
Thyromental Distance	Diabetic	0.475	40	76.4	38.1	77.8	0.762
Head Extension	Diabetic	0.564	25	87.3	41.7	76.2	0.413
Palm Print Grade	Diabetic	0.525	40	74.5	36.4	77.4	0.744

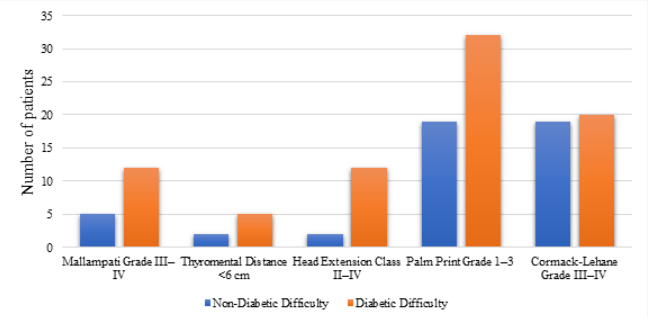

Figure 1: Association of Diabetes Mellitus with Difficult Airway Predictors

A total of 150 patients were enrolled in the study, comprising 75 non-diabetic and 75 diabetic patients. The demographic characteristics were comparable between the two groups. In the non-diabetic group, 50 patients (66.7%) were male and 25 (33.3%) were female, whereas the diabetic group consisted of 53 males (70.7%) and 22 females (29.3%), with no statistically significant difference in sex distribution (p=0.597). The mean body weight was similar between the groups (73.0 ± 13.1 kg in non-diabetics vs. 72.9 ± 13.1 kg in diabetics; p=0.961). Likewise, the mean height was 168.9 ± 3.9 cm in the non-diabetic group and 169.1 ± 4.0 cm in the diabetic group (p=0.758). The mean BMI was also comparable (25.6 ± 4.2 kg/m² vs. 25.5 ± 4.6 kg/m²; p=0.947). As expected, glycemic parameters were significantly higher in diabetic patients. The mean fasting blood sugar level was 171.3 ± 18.2 mg/dL in diabetics compared with 93.6 ± 11.9 mg/dL in non-diabetics (p<0.001). Similarly, post-prandial blood sugar levels were significantly elevated in the diabetic group (232.9 ± 38.6 mg/dL) compared to the non-diabetic group (130.5 ± 28.8 mg/dL) (p<0.001). Mean HbA1c was also markedly higher among diabetic patients (8.7 ± 0.9%) than non-diabetic patients (5.5 ± 0.7%) (p<0.001). Baseline hemodynamic parameters including systolic blood pressure (128.9 ± 14.5 mmHg vs. 131.3 ± 15.0 mmHg; p=0.322), diastolic blood pressure (82.8 ± 5.0 mmHg vs. 82.9 ± 4.8 mmHg; p=0.908), heart rate (89.6 ± 12.7 bpm vs. 89.3 ± 12.1 bpm; p=0.875), and oxygen saturation (96.5 ± 1.8% vs. 96.6 ± 1.7%; p=0.606) did not differ significantly between the two groups.

The comparison of airway assessment parameters revealed a higher prevalence of predictors of difficult airway among diabetic patients. Mallampati Grade III–IV was observed in 12 diabetic patients (16.0%) compared to 5 non-diabetic patients (6.7%), although the difference was not statistically significant (p=0.281). Similarly, a thyromental distance of less than 6 cm was present in 5 diabetic patients (6.7%) and 2 non-diabetic patients (2.7%), without reaching statistical significance (p=0.246). The mean thyromental distance was nearly identical in both groups (7.2 ± 0.9 cm in diabetics versus 7.3 ± 0.8 cm in non-diabetics; p=0.557).

A significant difference was observed in the degree of head extension. Head extension Classes II–IV were present in 12 diabetic patients (16.0%) compared with only 2 non-diabetic patients (2.7%), indicating significantly restricted neck mobility among diabetics (p=0.036). Palm print grades suggestive of limited joint mobility (Grades 1–3) were also significantly more frequent in diabetic patients, occurring in 32 patients (42.7%) compared to 19 patients (25.3%) in the non-diabetic group (p=0.007). Cormack-Lehane Grade III–IV laryngoscopic views were found in 20 diabetic patients (26.7%) and 19 non-diabetic

patients (25.3%), demonstrating no significant difference between groups (p=0.851). Likewise, a positive prayer sign was observed in 12 diabetic patients (16.0%) and 8 non-diabetic patients (10.7%), which was not statistically significant (p=0.337).

The odds ratio analysis demonstrated that diabetic patients had a greater likelihood of exhibiting difficult airway predictors. Patients with diabetes showed a 2.67-fold higher risk of having Mallampati Grade III–IV compared with non-diabetic patients (OR 2.67; 95% CI: 0.89–7.99), although this association did not achieve statistical significance (p=0.071). Similarly, the risk of a thyromental distance less than 6 cm was 2.61 times higher in diabetic patients (OR 2.61; 95% CI: 0.49–13.88), but the result was not significant (p=0.442).

Significant associations were observed for head extension and palm print grading. Diabetic patients had a 6.95-fold increased likelihood of exhibiting restricted head extension (Classes II–IV) compared with non-diabetic patients (OR 6.95; 95% CI: 1.45–32.25; p=0.009). Likewise, the presence of abnormal palm print grades was associated with a 2.19-fold increased risk in diabetic patients (OR 2.19; 95% CI: 1.10–4.39; p=0.038). The occurrence of Cormack-Lehane Grade III–IV views was nearly identical in both groups, with an odds ratio of 1.07 (95% CI: 0.52–2.22; p=0.852), indicating no significant relationship between diabetes status and difficult laryngoscopic view.

Receiver operating characteristic (ROC) analysis was performed to evaluate the predictive performance of different airway assessment tests for difficult laryngoscopy in both groups. Among non-diabetic patients, palm print grade demonstrated the highest sensitivity (89.5%) with an AUC of 0.531, although its specificity was low (14.3%). Head extension assessment showed perfect specificity (100%) and a positive predictive value of 100%, but sensitivity was only 5.3%, resulting in an AUC of 0.518. Mallampati grading and thyromental distance showed limited predictive value, with AUCs of 0.458 and 0.520 respectively. BMI also performed poorly with an AUC of 0.402. None of the tests demonstrated statistically significant predictive accuracy in the non-diabetic group (all p>0.05).

Among diabetic patients, BMI exhibited 100% sensitivity but very low specificity (12.7%), resulting in an AUC of 0.527. Head extension assessment provided the highest overall discriminative ability among the evaluated tests, with an AUC of 0.564, sensitivity of 25.0%, specificity of 87.3%, positive predictive value of 41.7%, and negative predictive value of 76.2%. Thyromental distance demonstrated moderate specificity (76.4%) with an AUC of 0.475, whereas palm print grade showed an AUC of 0.525, sensitivity of 40.0%, and specificity of 74.5%. Mallampati grading yielded an AUC of 0.431 with sensitivity and specificity values of 60.0% and 50.9%, respectively. However, none of the airway assessment tests achieved statistical significance in ROC analysis among diabetic patients (all p>0.05), indicating only modest predictive capability when used individually.

Discussion

The present study evaluated airway assessment parameters and predictors of difficult airway in diabetic and non-diabetic patients undergoing elective surgeries under general anesthesia. Diabetes mellitus is associated with non-enzymatic glycosylation of collagen and connective tissue proteins, leading to limited joint mobility and reduced cervical spine extension, which may contribute to difficult airway management. The findings of the current study demonstrated significant differences in selected airway assessment parameters between diabetic and non-diabetic patients, particularly with respect to head extension and palm print sign.

In the present study, the demographic characteristics including sex distribution, weight, height, BMI, and baseline hemodynamic parameters were comparable between the diabetic and non-diabetic groups. This ensured that differences observed in airway parameters were less likely to be influenced by confounding anthropometric factors. Similar findings were reported by Erden et al,[11] who observed no significant differences in age, sex, or body habitus between diabetic and non-diabetic populations when evaluating predictors of difficult intubation. Similarly, Hashim and Thomas,[12] identified that demographic characteristics between the study groups were similar, so that the changes in the airways could be accurately assessed due to diabetes.

As predicted, diabetic patients of the present study had significantly elevated fasting blood sugar, post prandial blood sugar and HbA1c levels compared to non-diabetic patients. There has been relationship with poor glycemic control and reduced joint mobility with increased connective tissue glycosylation. Vani et al,[13] found that an increase of HbA1c level was associated with an increased prevalence of positive palm print sign and difficult laryngoscopy. Likewise, George and Jacob,[14] reported that hyperglycaemic status of the diabetes, and the duration of diabetes were positively correlated with the occurrence of airway abnormalities, which is similar to the findings in the present study.

Mallampati Grade III–IV occurred more commonly in diabetic patients (16.0%) than in non-diabetic patients (6.7%) but this was not significant. This finding is similar to that of Reissell et al,[15] which showed a greater proportion of unfavorable Mallampati grades in diabetic patients due to poor mobility of oral and pharyngeal structures. They also found that Mallampati classification alone was not having a good predictive value for difficult laryngoscopy. The same was reported by Khan et al,[16] who showed that Mallampati classification was moderately sensitive but insolitary predictor with poor specificity.

Diabetic patients had higher proportions (but not statistically significantly) of patients who had thyromental distances of less than 6 cm. Similar findings were reported by Ramachandran et al,[17] who concluded that thyromental distance was not useful in predicting difficult intubation in diabetic patients. They pointed out that decreased joint mobility, rather than decreased airway dimensions, is a stronger predictor of airway difficulty in diabetics.

The prevalence of restricted head extension was found to be significantly higher in diabetic patients in the present study, which is one of the most important findings of the present study. Head extension, Class II–IV was observed in 16.0% of diabetic as compared to 2.7% of non-diabetic patients. In addition, diabetic patients had almost seven times the odds of having

restricted head extension. The results of this study are consistent with the study conducted by Hogan et al,[18] who found that the atlanto-occipital joint mobility was significantly reduced in diabetic patients because of the stiffening effect of glycosylated periarticular tissues. Likewise, Rosenbloom,[19] showed that decreased cervical spine mobility is an important feature of diabetic cheiroarthropathy and is a significant factor in the likelihood of difficult laryngoscopy.

The difference was also significant with the abnormal palm print grades being 42.7% in the diabetic group and 25.3% in the non-diabetic group as obtained by the palm print grading. Diabetics had over double the risk of having an abnormal palm print sign. The results are similar to the ones reported by Nadal et al,[20] who found that palm print grading was one of the most sensitive parameters associated with difficult laryngoscopy in diabetic patients. Their study showed a good correlation between palm print abnormalities and reduced mobility of the joints, and suggested that this could be employed as a quick bedside screening tool. This has been recorded in a few later studies and reflects the importance of the use of palm print assessment in the evaluation of the airway prior to surgery.

However, the Cormack–Lehane Grade III–IV laryngoscopic view was comparable in diabetic and non-diabetic patients in the current study. This study indicates that diabetic patients have more risk factors related to the airways but that these factors are not necessarily associated with laryngoscopic views that are significantly worse. Reissell et al,[15] reported a similar finding that difficult laryngoscopy was multifactorial and not only related to diabetes. These results may be partly explained by airway management and experience of the operator.

A higher proportion of diabetic patients wore the prayer sign, but this was not statistically significant. Vani et al,[13] and George and Jacob,[14] conducted previous studies with significantly higher incidence of positive prayer sign in diabetics which correlated with difficult intubation. This could be due to the different sample sizes and/or duration of diabetes between participants in the present study.

The diagnostic performance analysis showed moderate AUC values for all the airway assessment tests in both groups. The head extension had the highest discriminative power while the palm print sign had moderate discriminative power in the diabetic patients. The same conclusion was drawn by Khan et al,[16] who found that none of the airway assessment tests used individually had a high enough predictive value. Rather, the use of a combination of several tests is more clinically useful. Similarly, Mallampati grading, palm print sign and cervical mobility assessment has been suggested by Ramachandran et al,[17] to enhance prediction of difficult intubation among diabetic patients.

In general, the present study confirms that the prevalence of limited joint mobility-related abnormalities in the airway is higher in diabetic patients and those that are restricted in head extension and abnormal in palm print sign. The results are consistent with some earlier evidence indicating that evaluation of the joint mobility should be a part of routine preoperative airway evaluation in diabetic patients to ensure an airway diagnosis is made early in the management of a potentially difficult airway.

Conclusion

The results of this study showed that patients with diabetes have a greater prevalence of airway characteristics of difficult airway management than the non-diabetic patients. Restricted head extension and abnormal palm print grading were the procedures with the most significant differences and were significantly more prevalent in the diabetic patients and correlated with increased risk of difficult airway among the various parameters used for airway assessment. Mallampati grading, thyromental distance, prayer sign and Cormack–Lehane grading had high frequencies of abnormal findings in diabetic patients, but these were not statistically significant. Diagnostic performance analysis showed that there was no single airway assessment test that had acceptable predictive accuracy alone. But head extension assessment and palm print sign seemed to be more helpful in relation to difficulty of the airway in diabetic patients. The results highlight the need to include assessment of joint mobility as part of the standard pre-operative airway evaluation of diabetic patients. The early identification of airway related risk factors can aid in optimal preparation, management of the airway and enhance patient safety during the perioperative period.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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