Original Article

Comparison of hemodynamic responses to laryngoscopy and intubation using Macintosh or McCoy or C-MAC laryngoscope during uniform depth of anesthesia monitored by entropy

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Abstract

Background and Aims: Laryngoscopy forms an important part of general anesthesia and endotracheal intubation. The aim of the present study was to compare the hemodynamic responses to Laryngoscopy and Intubation using Macintosh or McCoy or C-MAC Laryngoscope with M-Entropy module monitoring to ensure uniform and adequate depth of anesthesia, during and after intubation.

Material and Methods: A prospective, randomised, comparative study was done and patients included were of 18 to 60 years, ASA (American Society of Anesthesiologist) physical status I and II of both sexes undergoing elective surgery under general anesthesia. They were assigned to three groups using simple randomisation, after securing IV (intravenous) access, standard monitoring and Entropy leads were attached. General anesthesia was administered with glycopyrrolate 0.1 mg, fentanyl 2 ug/kg and intravenous thiopentone, 4 mg/kg. Adequate muscle relaxation was achieved with atracurium 0.6 mg/kg IV. By titrating isoflurane concentration, Entropy maintained between 40 and 60, orotracheal intubation done, with Macintosh or McCoy or C-MAC blades according to simple randomisation. Size of laryngoscope blade, time taken for laryngoscopy and intubation were noted. Heart rate, blood pressure, RE (Response Entropy) and SE (State Entropy) were noted before and during induction and laryngoscopy and post intubation up to 5 minutes. Statistical analysis done using NCSS 9 version 9.0.8 statistical software.

Results: Hemodynamic responses during laryngoscopy and intubation using Macintosh or McCoy or C-MAC laryngoscope were statistically insignificant ($p > 0.05$) between the three groups, provided the depth of anesthesia is maintained constant.

Conclusions: It is the depth of anesthesia that decides the magnitude of hemodynamic responses and not the choice of laryngoscope.

Keywords: Anesthesia, awareness, intubation, hemodynamic, laryngoscopy

Introduction

Anesthesiology is the practice of medicine providing total perioperative care to the patients during surgical, obstetric, therapeutic and diagnostic procedures. General anesthesia has become so safe since its introduction just over 150 years ago that the risk associated with it has become almost immeasurably small.[1] Basic elements of general anesthesia include: unconsciousness, amnesia, analgesia, muscle relaxation, diminished motor response to noxious stimuli, reversibility. Muscle relaxation necessitates securing ventilation with endotracheal intubation.[1] Laryngoscopy forms an important part of general anesthesia and endotracheal intubation. To

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ease the process of intubation, laryngoscopes of different shapes and sizes have been designed. The McCoy blade is a modification of the Macintosh blade, with its tip, hinged and C-MAC is video laryngoscope.[2]

Stress response to laryngoscopy and tracheal intubation, has a profound influence on the circulatory parameters. This response manifests as tachycardia, hypertension and can have deleterious effects on neurological and cardiovascular systems.[3,4] Especially in high risk patients, like with coronary artery disease, aortic dissection, elevated ICP (intra cranial pressure) and cerebral aneurysm, tachycardia and hypertension must be blunted, as much as possible, as these transient hemodynamic responses can result in deleterious effects, like left ventricular failure, arrhythmias, myocardial ischemia, rupture of cerebral aneurysm, cerebral hemorrhage and herniation of cerebral contents.[3] Depth of anesthesia has a bearing on awareness and hemodynamic parameters.[4] Clinical end points, in assessing depth of anesthesia during induction, include loss of verbal responsiveness (LVR), loss of eyelash reflex and loss of corneal reflex.[5] Awareness during laryngoscopy and intubation can exaggerate hemodynamic parameters and can have deleterious effects. Awareness during this period, may be monitored with traditional clinical signs, such as movement, tachycardia, hypertension, pupillary responses, lacrimation or by EEG (electro encephalography) based indices.[6]

In the present study, M-Entropy module was used as a guide, to eliminate the risk of awareness during laryngoscopy and intubation, which may otherwise happen if traditional endpoints like loss of verbal response, loss of eyelash reflex are used. It is also used as a guide, to ensure uniform and adequate depth of anesthesia, during and after intubation, by keeping the entropy value, between 40 and 60 in all subjects. We conducted the study to compare the hemodynamic responses, during laryngoscopy and intubation, using Macintosh or McCoy or C-MAC laryngoscope during uniform depth of anesthesia ensured by uniform entropy score in patients of ASA grades I and II, undergoing elective surgery under general anesthesia.

Material and Methods

After Institution Ethics Committee approval, a prospective, randomised, comparative study was conducted during the period between May 2017 and August 2017. The study recruited adult patients, between the age of 18 and 60 years, who were ASA I and ASA II, of both sexes undergoing elective surgery under general anesthesia.

The patients were assigned to one of the following three groups using simple randomisation, according to the computer-generated table of random numbers. Group A -- Macintosh laryngoscope, Group B -- McCoy laryngoscope and Group C – C-MAC laryngoscope was used.

A skilled anesthesiologist in using laryngoscope and ETT was assigned to carry out laryngoscopy and intubation, according to randomisation [Figure 1].

Exclusion Criteria was age <18 or >60 years, patient refusal, morbid obesity, pregnancy, h/o Hypertension and Coronary Artery Disease, h/o Beta blocker therapy, anti-hypertensive therapy, major renal, hepatic, cardiovascular, respiratory ailments and cerebral aneurysms, allergy to any of the drugs used in the study and anticipated difficult airway.

A day prior to the surgery, preoperative visit was made and a detailed history and clinical examination of the patient was done. Airway assessment was done using Modified Mallampati Score (78). All patients were kept nil per oral (NPO) for 8 h prior to the surgery. They were premedicated with tab. ranitidine 150 mg per orally, at bedtime and morning of surgery. In the operation theatre, after connecting the patient to standard monitoring consisting of ECG and SpO2, intravenous access was secured. Entropy leads were attached to forehead for monitoring depth of anesthesia and was connected to Entropy module.

Premedication with glycopyrrolate 0.1 mg IV (intravenous), and fentanyl 2 ug/kg IV prior to induction was done. Glycopyrrolate was given to all the patients included in the study mainly for its anti sialogogue action.

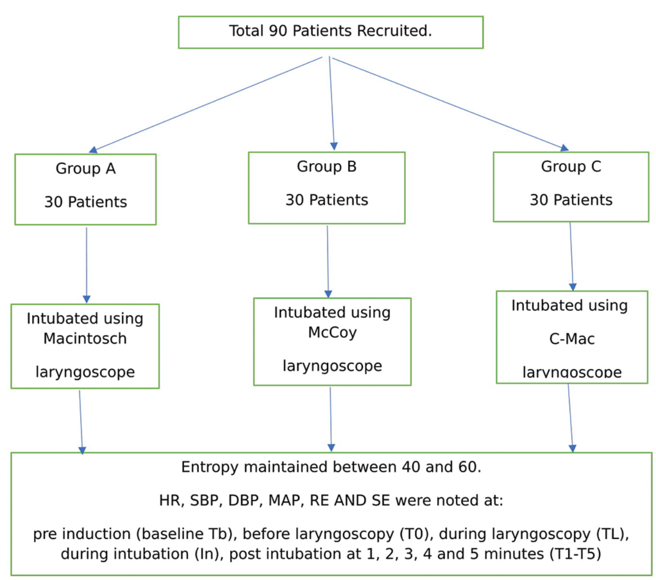

Figure 1: Methodology

All the patients were pre oxygenated for 3 minutes. Induction was done with thiopentone, 4 mg/kg IV titrated to loss of eyelash reflex. After induction, patients were ventilated with (60: 40) N2O & O2 mixture. Anesthesia was maintained with isoflurane (1 MAC), followed by intravenous bolus dose of atracurium 0.6 mg/kg for achieving adequate muscle relaxation for intubation. By altering isoflurane concentration, to attain adequate anesthetic depth, as indicated by Entropy values between 40 and 60, orotracheal intubation was attempted, with Macintosh or McCoy or C-MAC blades according to simple randomisation. Post intubation, uniform depth of anaesthesia (entropy between 40 and 60) maintained with N2O, O2 (60:40) and isoflurane, for five minutes Endotracheal tubes of size 7 or 7.5 mm for female and 8 or 8.5 mm for male patients were used according to formula age/4+4. Size of laryngoscope blade, time taken for laryngoscopy and intubation were noted.

Difficulty of intubation was graded I–IV according to the Cormack- Lehane criteria. Patients requiring more than one attempt at laryngoscopy and intubation; bucking, coughing on intubation were excluded from the study. Surgery or any other manipulations were not allowed to commence, till the study was completed i.e., for five minutes after intubation.

Heart rate, blood pressure (systolic, diastolic and mean arterial pressure), RE and SE were monitored throughout the study and recorded at the following time points: pre induction (baseline Tb), before laryngoscopy (T0), during laryngoscopy (TL), during intubation (In), post intubation at 1, 2, 3, 4, and 5 minutes (T1-T5), Oxygen saturation, EtCo2, and ECG were also monitored throughout the study period. During laryngoscopy, intubation, and post intubation, entropy was maintained between 40 and 60, by altering the concentration of isoflurane. Duration of laryngoscopy was defined as the time from start of laryngoscopy to start of ET tube insertion. Duration of intubation was defined as the time from the start of ET tube insertion, until cuff inflation. Difficulty of intubation was graded according to the Cormack- Lehane criteria.

Statistical analysis

For calculating sample size, taking the power value of 0.9 and alpha of 0.05 and minimum detectable difference of 10 mm Hg in BP and SD of 7 mm Hg, using the multiple comparison test Tukey-Kramer (Pair wise) the power analysis is performed. The total sample size required is 87 (29 Subjects in each group). However, considering the dropouts in the study total 90 subjects were included. All the data was collected, tabulated and checked for correctness and consistency. There were no dropouts during the study. Statistical analysis was carried out using NCSS 9 version 9.0.8 statistical software. Continuous data were represented as mean (SD), both categorical data and ordinal data as frequency and percentages. The pre-requisite assumption for ANOVA test like normality distribution of data was assessed graphically and by Anderson-Darling test. Equality of variance was also assessed, by modified-Levene Equal-Variance test, for all the parameters. Imbalance of baseline parameters, was assessed by Chi-square test and observing the mean values in the three groups.

Both the tests and graphical presentation, confirms normality distribution of the data.

As all the assumptions of ANOVA were accomplished, repeated measure of ANOVA test within the group and between the three groups was done for continuous data, followed by Tukey-Kramer multiple comparison analysis. The Chi-square test and Kruskal-Wallis test were performed for categorical data and ordinal data respectively. P value <0.05 was considered as statistically significant.

Results

A total of 90 patients, who underwent surgery under general anaesthesia, had been studied. The data was collected, tabulated, analysed and the following observations were made.

Demographic data: Demographic data was analysed, by using two sample t test and gender of the patients by Chi-square test. The three groups were comparable in terms of demographic data as there were no significant differences in terms of age, weight, height and sex.

ASA grading and assessment of Airway: The airway assessment and difficulty of intubation scoring system parameters were analysed using Mann-Whitney U Test and it was found to be statistically insignificant ($p > 0.05$) between the three groups [Table 1].

Hemodynamic and Entropy Data: All parameters such as HR, SBP, DBP, MAP, RE and SE at various time intervals were compared within the three groups A, B and C using repeated measures of ANOVA. P value <0.05 was considered to be statistically significant. Later Tukey Kramer multiple comparison test was done within the groups.

Heart Rate: The heart rates on comparison with Tukey Kramer test within the groups was not found to be statistically significant ($p > 0.05$) from the baseline values up to 5 minutes after intubation [Figure 2].

Systolic Blood Pressure (SBP): The SBP on comparison with Tukey Kramer test within group A was found to be statistically significant ($p < 0.05$) from the baseline values at 4 (p 0.00) and 5 (p 0.00) minutes after intubation.

The SBP on comparison with Tukey Kramer test within group B was found to be statistically significant ($p < 0.05$) from the baseline values at 2 minutes (p 0.00055), 4 minutes (p 0.003) and 5 minutes (p 0.003).

The SBP on comparison with Tukey Kramer test within group C was not found to be statistically significant ($p > 0.05$) from the baseline values till 5 minutes after intubation.

Diastolic Blood Pressure (DBP): The DBP on comparison with Tukey Kramer test within the group A was found to be statistically significant ($p < 0.05$) from the baseline values at 4 (p 0.032) and 5 (p 0.0009) minutes after intubation.

The DBP on comparison with Tukey Kramer test within the group B was found to be statistically insignificant ($p > 0.05$) from the baseline values except during laryngoscopy before intubation (p 0.014).

The DBP on comparison with Tukey Kramer test within the group C was found to be statistically insignificant ($p > 0.05$) from the baseline values.

Mean Arterial Blood Pressure (MAP): The MAP on comparison with Tukey Kramer test within the group A was found to be statistically significant ($p < 0.05$) from the baseline values at 4 (p 0.023) and 5 minutes (p 0.003) after intubation [Figure 2].

The MAP on comparison with Tukey Kramer test within the group B was found to be statistically significant ($p < 0.05$) from the baseline values at 2 (p 0.05) and 4 minutes (p 0.001) after intubation [Figure 3].

The MAP on comparison with Tukey Kramer test within the group C was found to be statistically insignificant ($p > 0.05$) from the baseline values [Figure 2].

Response Entropy (RE): The RE on comparison with Tukey Kramer test within the groups was found to be statistically significant ($p < 0.05$) from the baseline values up to 5 minutes after intubation [Figure 4].

State Entropy: The SE on comparison with Tukey Kramer test within the groups was found to be statistically significant ($p < 0.05$) from the baseline values up to 5 minutes after intubation [Figure 5].

Hemodynamic & Entropy Data: Between Group Analysis using repeated measures of ANOVA:

HR, SBP, DBP, MAP, RE and SE were compared between groups A, B and C at various time intervals using repeated measures of ANOVA. RE and SE were found to be statistically significant ($p < 0.05$) between the three groups

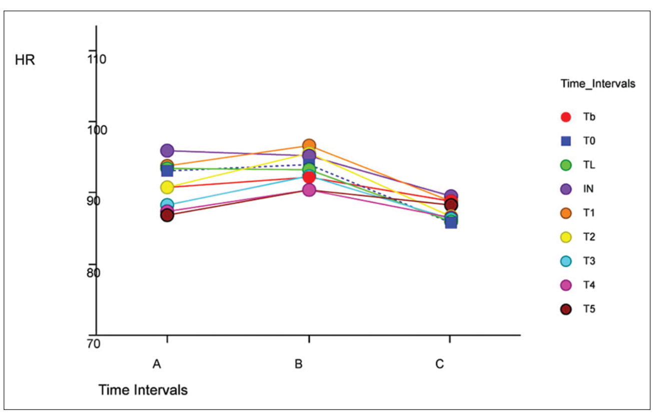

Figure 2: Heart rate changes within Group A, Group B and Group C

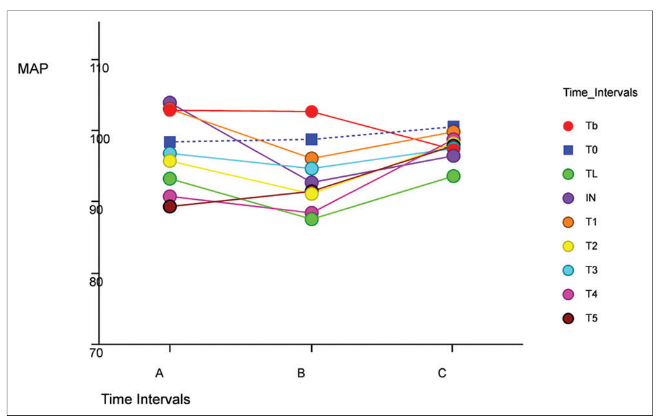

Figure 3: MAP within Group A, Group B and Group C

Table 1: Airway assessment and Intergroup comparison of difficult intubation scoring systems

	Airway assessment			Intergroup comparison of Airway assessment		
Parameter	**Group A (n=30) (Macintosh)**	**Group B (n=30) (McCoy)**	**Group C (n=30) (C-MAC)**	**Groups**	***P* (MPG)**	***P* (CL)**
Modified Mallampatti Score (I/II/III/IV)	10/20/0/0	13/17/0/0	14/16/0/0	A & B	0.71790	0.49632
Cormark and Lehane's score (I/II/III/IV)	13/17/0/0	16/14/0/0	21/9/0/0	A & C	0.55629	1
ASA (I/II/III/IV/V/E)	16/14/0/0/0	15/15/0/0/0	19/11/0/0/0	B & C	0.96352	0.41105

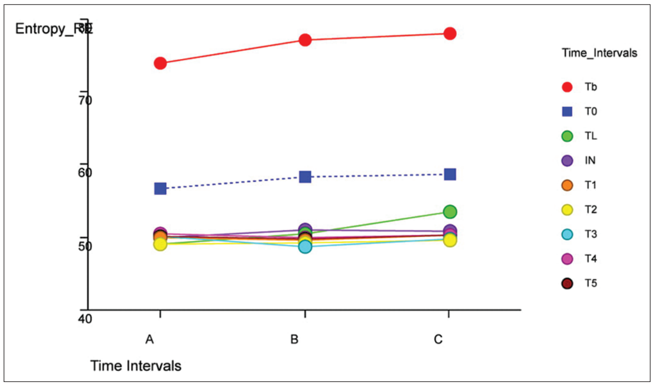

Figure 4: RE within Group A, Group B and Group C

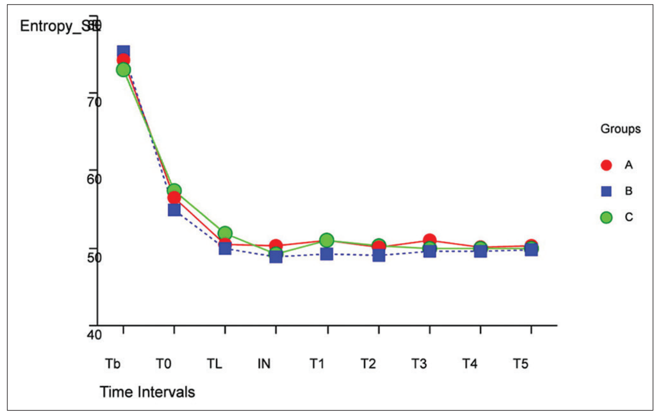

Figure 5: SE between Group A, Group B and Group C

as compared to respective baseline value. HR, SBP, DBP, MAP were found to be statistically insignificant ($p > 0.05$) between the three groups [Table 2].

Table 2: Results of Haemodynamic & Entropy Data Analysis using repeated measures of ANOVA in between the three groups

Parameters	Degrees of freedom (df)	Sum of Squares	Mean square	*F*	*P*
HR	2	4892.032	2446.016	2.55	0.0835
SBP	2	89.67	44.83457	0.03	0.972
DBP	2	2838.007	1419.004	2.46	0.091
MAP	2	2571.69	1285.848	1.99	0.142239
RE	2	244.3556	122.1778	6.84	0.0017*
SE	2	117.2025	58.60123	3.87	0.0245*

Discussion

The stress response to laryngoscopy and intubation, is a well-known centrally mediated, sympathetic reflex associated with a cardiovascular response, of elevated blood pressure, heart rate and dysrhythmias, cough reflexes, increased ICP and increased intraocular pressure.[6-8] If no specific measures are taken to prevent hemodynamic response, the HR can increase from 26% to 66% depending on the method of induction and SBP can increase from 36% to 45%.[9-13]

The response to laryngoscopy and intubation might be of no clinical importance in the healthy, normotensive patients, but might be harmful in patients with intracranial pathologies or other cardiovascular diseases. In such cases, the attenuated response can be achieved, with an adequate depth of anesthesia. Monitoring the adequacy of depth of anaesthesia is of vital importance to prevent arousal, awareness and exaggerated hemodynamic responses during induction, laryngoscopy and intubation. Many anesthesia providers rely on monitoring of patient's hemodynamic responses as a method of awareness assessment, as haemodynamic responses are thought to be indirect indicators of awareness.

Electroencephalography (EEG) monitoring is widely used to monitor depth of anesthesia.[14] Entropy is a new EEG-based technology, to measure the depth of anesthesia. Sufficient adequate depth of anesthesia, for most surgical procedures with low probability of recall, using M- Entropy module is between 40 and 60.[15-17] Several studies, have shown C-MAC and McCoy laryngoscope produce less rise in hemodynamic parameters, as compared to Macintosh laryngoscope, during laryngoscopy and intubation. The McCoy laryngoscope has a hinged tip, controlled by a lever on the handle that allows elevation of epiglottis, while decreasing the overall laryngoscope movements and the force applied. Hence, overall laryngoscopic visualisation is improved and it reduces the stress response. C-MAC is a portable video laryngoscope features standard Macintosh blade designs with a complementary metal oxide semiconductor video chip at the tip of the blade that extends a 60° optical axis in the vertical plane to a video display monitor. Studies have suggested that laryngeal view is improved compared with direct laryngoscopy across various airway scenarios.[18] However, for the experienced provider it is unclear if video laryngoscopy can increase intubation success.

There is no literature about the hemodynamic responses, during laryngoscopy and intubation, by maintaining uniform depth of anesthesia (entropy between 40 and 60). There are a few studies comparing hemodynamic responses due to laryngoscopies using C-MAC with Macintosh and McCoy blades. Therefore, we carried out a prospective, randomised controlled trial to compare hemodynamic responses to laryngoscopy and intubation, between Macintosh, McCoy blades and C-MAC, by ensuring uniform depth of anesthesia.

Our study demonstrated that, hemodynamic responses to laryngoscopy and intubation using Macintosh or McCoy or C-MAC laryngoscope are similar in patients undergoing elective surgeries under general anesthesia provided the depth of anesthesia is maintained constant. The choice of laryngoscope is not the deciding factor; it is the depth of anesthesia that decides the magnitude of hemodynamic responses and is the key factor. This is in contrast to several studies which support that C-MAC, McCoy blade produces less stress response, than the Macintosh blade.[3,18-20] The uniformly maintained depth of anesthesia in all the groups in our study would have contributed to the difference in the outcome, as compared to these studies.

The three groups consisting of 30 participants each, were comparable in terms of age, sex, height, weight, intubation parameters and was found to be statistically insignificant ($p > 0.05$).

There is no significant change in heart rate during laryngoscopy and intubation within each group ($p > 0.05$). The difference of heart rate between the three groups at various time intervals following laryngoscopy and intubation is not statistically significant ($p > 0.05$).

There is no significant change in SBP following laryngoscopy. But the change in SBP is found to be statistically significant ($p < 0.05$) within the groups at 2 minutes, 4 minutes and 5 minutes following intubation. On comparison between the groups A, B and C changes in SBP at various time intervals was statistically insignificant ($p > 0.05$).

The change in DBP with laryngoscopy is not statistically significant within the group. But changes occurring in group A at 4 minutes and 5 minutes following intubation are statistically significant ($p < 0.05$). However, on comparison between the groups A, B and C these changes in DBP at various time intervals was statistically insignificant ($p > 0.05$).

The change in MAP with laryngoscopy is not statistically significant within the group. But changes occurring in group A at 4 minutes and 5 minutes, in group B at 4 minutes following intubation are statistically significant ($p < 0.05$). However, on comparison between the groups A, B and C these changes in MAP at various time intervals was statistically insignificant ($p > 0.05$).

The RE changes were statistically significant ($p < 0.05$) within the groups A, B and C from the baseline values up to 5 minutes after intubation. But on comparison between the groups A, B and C, RE at various time intervals was statistically insignificant ($p > 0.05$). The SE changes were statistically significant ($p < 0.05$) within the groups A, B and C from the baseline values up to 5 minutes after intubation. But on comparison between the groups A, B and C, SE at various time intervals was statistically insignificant ($p > 0.05$). This supports that the depth of anesthesia is uniform in three groups.

Thus, in our study, hemodynamic responses were comparable between the Macintosh, McCoy and C-Mac groups. The rise in hemodynamic values, on comparison, were statistically not significant ($p > 0.05$), when the depth of anesthesia was kept uniform by ensuring uniform entropy score between 40 and 60.

Limitations

Ideally the amount of force applied on the tip of laryngoscope blade should have been measured. To assess adequate muscle relaxation neuro muscular monitoring was not used because of non-availability.

Conclusions

We conclude that, hemodynamic responses during laryngoscopy and intubation using Macintosh or McCoy or C-MAC laryngoscope were similar in patients (MPG 1 or MPG 2) and statistically insignificant ($p > 0.05$) between the three groups, provided the depth of anesthesia is maintained constant. It is the depth of anesthesia that decides the magnitude of hemodynamic responses and not the choice of laryngoscope.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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