Original Article

Evaluation of airway care score as a criterion for extubation in patients admitted in neurosurgery intensive care unit

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Abstract

Background and Aims: Early extubation in neurocritical patients has several potential benefits. Glasgow Coma Scale (GCS) is a crude measure of neurologic function in these patients and a low GCS score does not necessarily mean contraindication for extubation. Data on patients with neurosurgical or neurological pathology undergoing early extubation utilizing the airway score criteria is limited. Hence, this study was conceived to assess the usefulness of modified airway care score (ACS) as a criterion for successful extubation of neurocritical patients whilst comparing various outcomes.
Material and Methods: One hundred and twenty four patient who underwent endotracheal intubation in the neurocritical care unit were enrolled in this prospective observational study over a period of 12 months. Patients were randomly enrolled into either the study group patients (S), who were extubated immediately after a successful spontaneous breathing trial (SBT) and an ACS ≤7 or into the control group (N), wherein patients were extubated/tracheostomized at discretion of the attending neurointensivist. Both groups were observed for comparison of preset outcomes and analyzed statistically.
Results: Patients of study group experienced a statistically significant shorter extubation delay (3.28 h vs 25.41 h) compared to the control group. Successful extubation rate was significantly higher and reintubation rate was significantly lower in study group (6.6% vs 29.3%). Incidence of nosocomial pneumonia, duration of ICU stay and overall duration of mechanical ventilation were significantly lower in the study group. ACS and GCS had a negative correlation at the time of extubation.
Conclusion: ACS can be used as a criterion for successful early extubation of neurocritical patients.

Keywords: Airway care score, extubation, Glasgow coma scale, neurocritical care

Introduction

Neurological causes like ischemic and hemorrhagic stroke, neuro-trauma, subarachnoid hemorrhage, and intracranial hemorrhage make endotracheal intubation and mechanical ventilation necessary for more than 200,000 patients per year.[1-3] Prolonged mechanical ventilation after endotracheal intubation predisposes these patients to an increased incidence of pulmonary complications such as ventilator associated pneumonia (VAP), increased risk of deep vein thrombosis, bed sores, increased hospital stay, and poor clinical outcome. Recent literature suggests that 25–45% of patients mechanically ventilated due to primary neurologic injury develop VAP.[4,5] These patients may experience delayed extubation based solely on lower Glasgow Coma Scale (GCS) scores.

Early extubation in patients admitted for neurocritical care has several benefits, including early detection of postoperative surgical complications,[6] less catecholamine release, reduced

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pulmonary complications,[7,8] and decreased expense of intensive care unit (ICU) admission. However, systemic hypertension in the emergence period is a major disadvantage of early extubation that may cause intracranial complications such as bleeding and brain edema.[9] Hence, definite criteria need to be developed to decrease such complications and enable appropriate selection of suitable patients for early extubation.

Approximately 5–20% of patients undergoing extubation, experience extubation failure (EF).[10] Various clinical studies have analyzed the factors involved in EF in medical and general surgery ICU patients.[11,12] However, these criteria cannot be applied to neurocritical patients due to the different patho-physiology of the disease process. The reasons for failed extubation in brain injured patients with Glasgow coma scores (GCS) of 8 or less are poorly understood. [13,14] A probable cause is reduced conscious level along with large amounts of respiratory secretions, which the patients cannot clear effectively. Recent evidence suggests that low GCS score has not been is linked with EF.[15] King *et al*. suggested that GCS, inability to follow commands and airway reflexes may be independent of each other.[16]

The findings of the landmark observational study by Coplin *et al*.[17] contradicted with prior reports of higher reintubation rates in brain injured patients. On the contrary, no difference with regard to reintubation was observed between extubation delay patients and promptly extubated patients. Another important finding was that a significant number of comatose patients with absent gag/cough reflex, were extubated successfully.

A reluctance to attempt extubation exists mainly due to paucity of respiratory therapy driven weaning protocols in patients with brain injury. Hence, we decided to evaluate the proposed airway care score (ACS) for safe extubation and thus help determine the optimal safe timing for extubation in patients admitted in neurosurgical intensive care unit (NICU).

Material and Methods

After obtaining hospital ethical committee clearance (approval proforma dated 01.05.2012 attached), this prospective randomized study was conducted in NICU at a tertiary care hospital for a period of 1 year (January 2013 to December 2013). Written-informed consent was taken from Legally Authorized Representative (LAR) of patients before involvement in this study.

This study was done on all eligible intubated patients admitted to the NICU. Randomization was done by computerized random number list provided in sealed envelopes.

Inclusion criteria: Neurocritical care patients on mechanical ventilation who had been intubated endotracheally solely because of neurological deterioration and who also fulfilled the following criteria: (a) adequate gas exchange, as indicated by a ratio of the partial pressure of arterial oxygen (PaO_2) to the fraction of inspired oxygen (FiO_2) above 200 with a positive end-expiratory pressure of less than 6 cm of water. (b) Adequate ventilation as indicated by a $PaCO_2$ less than 45 torr. (c) Rapid shallow breathing index (RSBI; spontaneous respiratory rate divided by spontaneous tidal volume) less than 105. (d) Core body temperature less than 38°C and more than 34°C. (e) Hemoglobin more than 8 g/dl. (f) Hemodynamically stable without need for vasopressors.

Exclusion criteria: Age younger than 18 years, lack of informed consent by the LAR, dependence on mechanical ventilation for at least 2 weeks before enrollment, presence of tracheostomy on admission, intubation instituted for therapeutic hyperventilation, concomitant pelvic or long bone fractures, chest trauma patients, abdominal injury and laparotomy, preexisting lung disease, planned surgical or radiological intervention within the next 72 h, anticipated neurological or medically worsening conditions (such as development of cerebral edema or vasospasm), intubation for airway preservation due to airway edema (cervical neck injuries or surgery) as opposed to airway protection, patients with absent brain stem reflexes, hemodynamically unstable patients.

The objectives of the study were (1) to assess the usefulness of modified ACS as a criterion for successful extubation of neurocritical patients [Table 1]. (2) To comparatively assess the outcomes in terms of overall duration of mechanical ventilation, length of stay in ICU, frequency of reintubation, and nosocomial pneumonias, functional status of patient as determined by Modified Glasgow Outcome scale at the time of ICU discharge [Table 2] and correlation of level of GCS with timing of extubation.[17]

To evaluate readiness for extubation, enrolled patients were given a 30 min spontaneous breathing trial (SBT) with

Table 1: Grading for the Airway Care Score

Grading	Cough to suction	Sputum quantity	Sputum character	Sputum viscosity	Suctioning frequency
0	Vigorous	None	Clear	Watery	>3 h
1	Moderate	1 pass	Tan	Frothy	Every 2-3 h
2	Weak	2 passes	Yellow	Thick	Every 1-2 h
3	None	≥3 passes	Green	Tenacious	<Every 1 h

T-piece without continuous positive airway pressure, after discontinuation of sedative medications and stoppage of Ryle tube feed for at least 2 h prior to initiation of SBT. All patients were continuously monitored by the neuro-intensivist and investigator during SBT. The trial was discontinued if any of the following were noted:[18-21] Respiratory rate of more than 35 breaths/min for more than 5 min, arterial saturation below 90% for 2 min, heart rate more than 140 beats/min, sustained changes in heart rate of 20% in either direction, systolic blood pressure higher than 180 mmHg or lower than 90 mmHg, notable increase in agitation or diaphoresis.

Table 2: Modified Glasgow Outcome Score

Score	Description
1	Dead
2	Vegetative
3	Severe disability
4-	Moderate disability
4+	Minimal disability
5	Good recovery

Patients who passed three cycles of T-piece trial each of 30 min were eligible for randomization. They were then randomized using computer-generated random numbers into two groups; into a study group (Group S) who were extubated immediately after they met extubation readiness and ACS criteria and into control group (Group N), wherein patients were extubated at the discretion of the attending neurointensivist.

Patients in Group S were evaluated further using the modified ACS[17] to assess their ability to control their respiratory secretions. The ACS was assessed by an ICU consultant and the principal investigator. ACS assessors were blinded to each other's ACS assessments. If the ACS was more than 7, allocation was delayed and allocation criteria reassessed 12 h later. Patients in this group were extubated immediately after ACS ≤7 and a successful SBT trial. They were monitored closely for a period of 48 h on an hourly basis for first 4 h and thereafter 4 hourly for 48 h. Successful extubation was defined as no need for reintubation for 48 h postextubation.

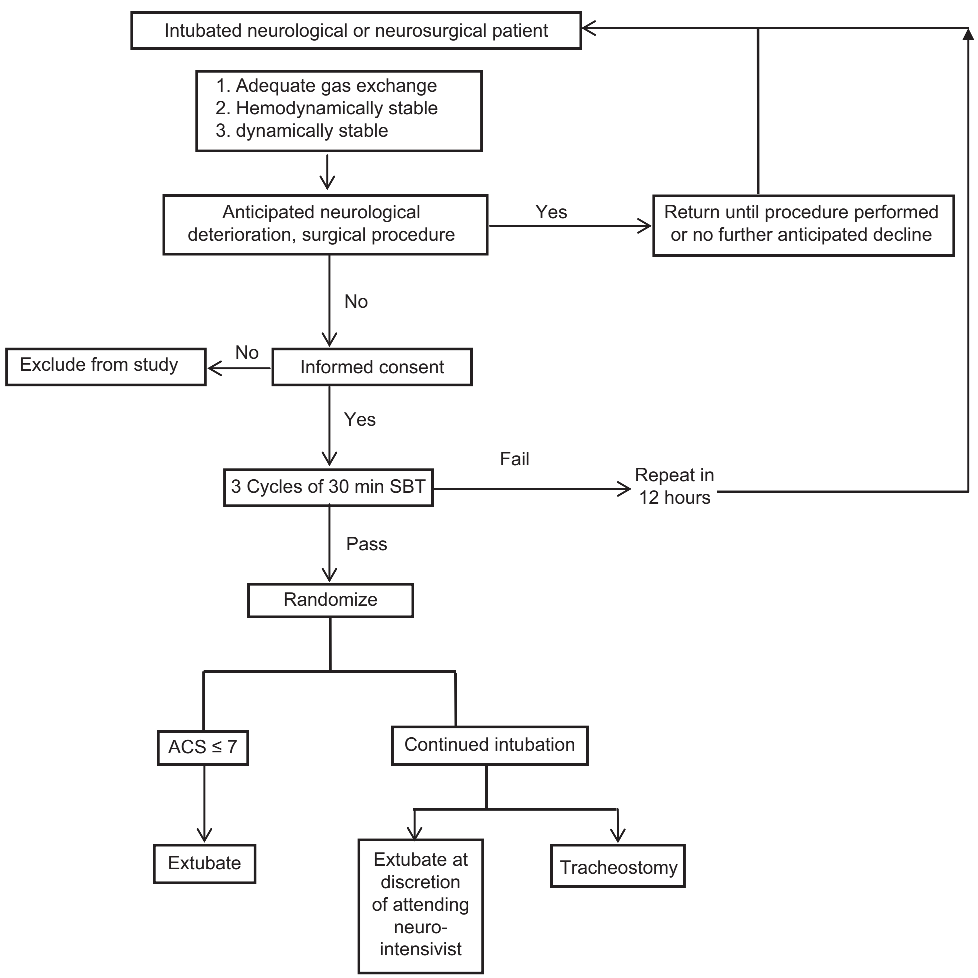

Figure 1: Flow diagram showing methodology

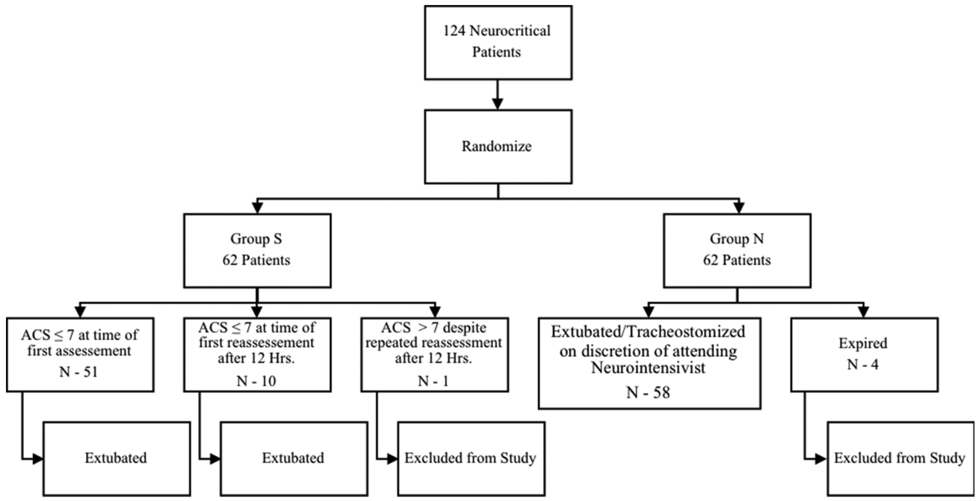

Figure 2: Flow diagram showing study participants

The control group (Group N) was extubated/tracheostomized at the discretion of attending neurointensivist after a prior successful SBT T-piece trial. The neurointensivist observed various objective and subjective criteria like GCS, stable hemodynamics, presence/absence of cough reflex, the associated injuries, and the anticipated course of the patient in ICU before deciding on the extubation. The extubated patients were monitored closely on an hourly basis for the first 4 h and thereafter 4 hourly for 48 h. Successful extubation was defined as no need for reintubation for 48 h postextubation [Figure 1].

Any patient, who was re-intubated, became ineligible for re-enrollment. The following were monitored as criteria for reintubation: Sustained respiratory rate of more than 40 breaths/min accompanied by accessory muscle use or paradoxical breathing pattern, oxygen saturation of less than 90% for 5 min on oxygen supplementation with flow mask with FiO_2 0.5, partial pressure of oxygen (PaO_2) <60 mmHg on an arterial blood gas, partial pressure of carbon dioxide ($PaCO_2$) >60 mmHg, pH <7.3 on arterial blood gas analysis (ABGA), loss of pharyngeal tone noted by loss of gagging to suction catheter or marked stridor. A flow diagram of the study design is given in Figure 2.

Statistical analysis

The continuous data were presented as mean ± SD or median and interquartile range, as appropriate. Normality of quantitative data was checked by Kolmogorov Smirnov test of normality. Mann–Whitney *U*-test was used for statistical analysis of skewed continuous variables. For normally distributed data a *t*-test was applied for comparison of the two groups. Qualitative or categorical variables were described as frequencies and proportions. Proportions were compared using Chi square or Fisher's exact test whichever was applicable. A *P* value of <0.05 was considered to indicate statistical significance. All calculations were performed using SPSS® (Statistical Packages for the Social Sciences, Chicago, IL).

Table 3: Comparison of duration of hours elapsed between passing SBT and extubation

	n	Mean	SD	*P*
Duration of hours elapsed between passing SBT and extubation				
Group S	61	3.3	2.6	<0.001
Group N	58	25.4	20.2	

Results

The study recruited 124 neurocritical care patients on mechanical ventilation who were intubated endotracheally solely because of neurological deterioration and also fulfilled the previously mentioned inclusion criteria. This sample size was in accordance with the findings by Manno *et al*., who concluded that 64–110 patients are required in each arm of the study for it to have a power of 80%.[22]

The ACS scores assigned by the two observers for patients in Group S were not significantly different from each other. The mean of both assigned scores was taken in case of difference in ACS values. Fifty-one patients had an ACS ≤7 during the initial assessment, 10 had ACS ≤7 after 12 h, and one patient could not achieve ACS ≤7 despite repeated reassessments. Hence this patient was excluded from the study. Patients in group N were assessed and extubated/tracheostomized at the discretion of the neurointensivist. The neurointensivists observed various objective and subjective criteria like GCS, stable hemodynamics, presence/absence of cough reflex, the associated injuries, and the anticipated course of patient in ICU before deciding on the extubation. As four patients expired in this group before extubation, they were excluded from study. Finally, data of 61 patients from group S and 58 from group N was subjected to statistical analysis.

Rapid shallow breathing index (RSBI) was calculated for all patients prior to the T piece trial. It was comparable in both groups.

Table 4: Number of reintubated patients in both groups

	Group S *n*=61 (100%)	Group N *n*=58 (100%)
Reintubation		
Yes	4 (6.6%)	17 (29.3%)
No	57 (93.4%)	41 (70.7%)
P	<0.001	

Table 5: Incidence of nosocomial pneumonia and comparison among both groups

	Group S *n*=61 (100%)	Group N *n*=58 (100%)
Nosocomial pneumonia		
Yes	4 (6.6%)	29 (50%)
No	57 (93.4%)	29 (50%)
P	<0.001	

Table 6: Comparison of MGOS between both groups

	n	Mean	SD	*P*
MGOS at start of study				
Groups S	61	2.29	0.405	1.01
Groups N	58	2.19	0.395	
MGOS at extubation				
Groups S	61	3.11	0.519	<0.001

Table 7: Number of patients with Glasgow Coma Score (GCS) ≤/>8 in both groups

	Group S	Group N
GCS at the time of extubation/tracheostomy		
GCS ≤8	10 (16.4%)	38 (65.5%)
GCS >8	51 (83.6%)	20 (34.5%)

Table 8: GCS score done at different points during study and comparison between groups

	n	Mean	SD	*P*
GCS at start of study				
Group S	61	8.59	1.054	<0.001
Group N	58	7.47	1.156	
GCS at extubation/tracheostomy				
Group S	61	9.78	1.086	<0.001
Group N	58	8.33	1.349	
GCS at time of discharge from ICU				
Group S	61	12.72	1.956	<0.001
Group N	58	10.1	1.984	

The demographic profile of both groups in terms of age, height, and weight was comparable. There were 97 males (81.5%) and 22 females (18.5%) in the study. Both the groups were similar in distribution of male and female gender.

Detailed past history was taken and no statistical difference was found among both groups regarding history of past illness and any previous or present neurosurgery. Similarly both groups had no significant difference in regard to concurrent injury.

A statistically significant difference was found in the mean duration of hours elapsed between passing SBT and extubation of patients when comparing both the groups ($P < 0.001$) [Table 3]. Group S had a mean delay of 3.28 h in extubation after SBT whereas group N had a mean delay of 25.41 h.

Of 119 patients enrolled for the study, 99 patients could be extubated. Of these, 21 patients had to be reintubated. Twenty patients in the study were never extubated and were tracheostomized. Of 61 patients in study group S, 4 (6.6%) patients were reintubated and of 58 patients in control group N, 17 (29.3%) patients were reintubated. The data suggested that reintubation rate was significantly higher in group N in comparison to group S (P value < 0.001). Table 4 shows the percentage of reintubated patients within both groups.

33 patients suffered from nosocomial pneumonia; 4 (6.6%) were in group S and 29 (50%) in group N, with a statistically significant difference between both the groups ($P < 0.001$) [Table 5].

Modified Glasgow Outcome Score (MGOS)[23] was calculated in all the patients at three points during the study period, viz., at the start of the study, at the time of extubation, and at the discharge from ICU. Table 6 compares the mean values of the MGOS scores in both groups. MGOS scores

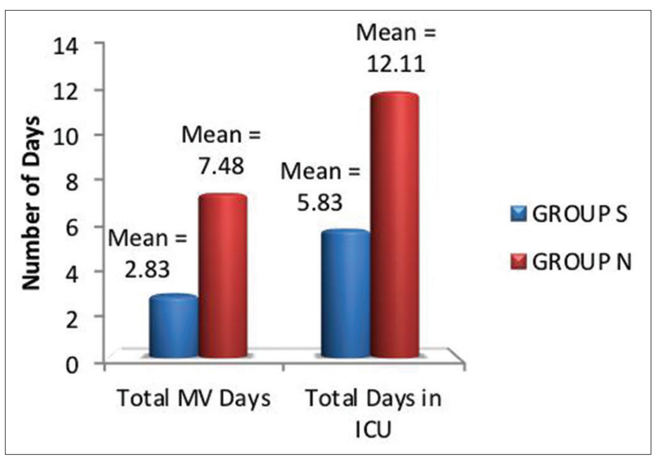

Figure 3: Comparison of total mechanical ventilation (MV) days and total days in ICU between both groups

were statistically insignificant at the time of the start of the study but after that it was significantly more in group S compared to group N at the time of extubation and at the time of discharge from the ICU (P value <0.001).

Table 7 shows the number of patients with GCS scores ≤/>8 at the time of extubation/tracheostomy. Patients of group S had higher GCS at the time of extubation in comparison with group N.

Table 8 compares the mean values of the GCS scores in both groups. It was calculated in all the patients at three points during the study period, viz., at the start of the study, at the time of extubation, and at discharge from the ICU. GCS scores were statistically significantly higher in group S compared to group N at all the three points of observation.

Table 9 shows the distribution and GCS of successfully extubated patients in group S and group N. Group S patients exhibited a statistically significant higher GCS at the time of successful extubation in comparison to group N patients ($P < 0.001$).

Table 10 shows that 25% reintubated patients in group S had GCS ≤8 whereas 70.59% reintubated patients in group N had GCS ≤8.

There was a statistically significant difference of mean among both groups when total days of mechanical ventilation (MV) and total stay in ICU of patient in our study was compared. Patients of group S had mean MV days of 2.83 whereas group N had 7.48 days. Patients of group N also had longer ICU stay than patients of group S [Figure 3].

Discussion

Inclusion of modified ACS as an extubation criterion for successful extubation in neurocritical patients has been evaluated with success by Manno *et al.*[22] In this study, both the groups were well matched in demographic data, history of past illness, concurrent injury, and RSBI. Thus the outcomes of both the groups were comparable without any bias.

Table 9: Distribution of successfully extubated patients in both groups

	n (78)	GCS at extubation	
		≤8	>8
Group S	57	9 (15.79%)	48 (84.21%)
Group N	21	10 (47.62%)	11 (52.38%)
P		<0.001	

Table 10: Distribution of reintubated patients in both groups

	n (21)	GCS at extubation	
		≤8	>8
Group S	4	1 (25%)	3 (75%)
Group N	17	12 (70.59%)	5 (29.41%)

The results suggest a statistically significant difference in the mean duration of hours elapsing between SBT and extubation of patients when comparing both the groups ($P < 0.05$). So early successful extubation was achieved using the modified ACS in a statistically significant number of patients in the group S, thereby reaffirming the usefulness of ACS as a criterion for early successful extubation. The difference in the delay to extubation among both the groups contributed to various secondary outcomes evaluated in the study.

It was found that frequency of reintubation or EF was significantly reduced in patients belonging to the group S. Literature suggests comparable incidence for EF ranging between 5% and 20% of patients undergoing extubation.[11] Good ACS (≤7) contributed to a higher rate of successful extubation thereby resulting in a statistically significantly lower rate of EF in the study group patients.

Patients of group S could be extubated earlier and then shifted out of ICU earlier than group N patients. These results are in consonance with the results of the study by Coplin *et al.*[17]

Incidence of nosocomial pneumonia was also significantly lower in group S. Similar results had been observed by Coplin *et al.*, wherein the rate of nosocomial pneumonia was significantly higher in patients where extubation was delayed (38% vs 21%, $P < 0.05$).[17] According to the national nosocomial infections surveillance system report from January 1992 through June 2004, neurosurgical units have the third highest VAP rate among 10 different ICU subspecialty types, only falling behind trauma and burn ICUs.[24] One of the main causes of VAP in neurocritical patient is a longer ICU stay and delayed extubation. Our analysis showed that VAP rate was significantly reduced in our study group due to early extubation, shorter duration of mechanical ventilation days, and shorter stay in ICU as compared to our control group.

Although improvement of MGOS was statistically significant in both groups, the improvement in MGOS of group S patients was more than in group N patients. This improvement in MGOS of group S can be attributed to early successful extubation, decreased mechanical ventilation days and shorter stay in ICU. These factors have been noted by various studies as independent predictors of improved functional status in neurocritical care patients.[25]

Manno *et al.* in their study used Modified Rankin Score (MRS) and Functional Independence Measure (FIM) for assessment of functional status wherein they could not detect significant differences in functional status between their early and delayed extubation groups. However they ascribe their nonsignificant result to a smaller sample size (16 patients in both the groups).[22]

Our data suggest a negative correlation between ACS and GCS score, that is, a low ACS and high GCS contributed to successful extubation in neurocritical patients. A difference in GCS score in reintubated patients in both groups was also observed but numbers of reintubated patients were statistically fewer in this study and thus the investigators could not elucidate any statistical correlation between ACS and GCS with regard to reintubation rates.

Conclusion

The results indicate that ACS score can be used as a useful criteria for early extubation in neurocritical patients.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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