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Original Research Article

Propensity of use of neuromuscular blocking agents among Indian anaesthesiologists: A questionnaire-based survey

Anil Kumar Jain[1], **Shubha Hodarkar**[2,*]

[1] *Dept. of Anaesthesiology, Pain and Perioperative Medicines, Sir Ganga Ram Hospital, New Delhi, india*
[2] *S L Raheja Hospital – Fortis, Mumbai, Maharashtra, India*

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ABSTRACT

Background: This survey aimed to understand the use of neuromuscular blockers (NMBs) with respect to neuromuscular monitoring, reversal of residual neuromuscular block, and incidence of adverse events among Indian anaesthesiologists.

Materials and Methods: A 40-item questionnaire was sent to 250 anaesthesiologists across India via email and their responses were statistically analysed.

Results: The response rate was 50%. To facilitate tracheal intubation, 81.0% respondents preferred cisatracurium, 72.2% preferred atracurium, 43.7% preferred vecuronium, 58.7% preferred rocuronium, and 70.6% preferred succinylcholine. Safety and recovery time are the most important criteria for an ideal NMB. About 84% respondents expressed concerns about the adverse effects of NMBs, especially recovery of neuromuscular function (31.1%) and hemodynamic effects (26.4%). The train-of-four (TOF) ratio for residual paralysis was not checked by 57% respondents. Reversal agents were used by >2/3rd respondents; however, 86.5% used them after cisatracurium was used. Concerns about adverse effects of anticholinesterase/antimuscarinic agents were expressed by 63.4% respondents, while 85% expressed the need for availability of sugammadex in India. Almost two-thirds opined that conventional nerve stimulators and quantitative TOF monitors should be available in the operating room.

Conclusion: The survey showed that safety and recovery time are the most important parameters in selecting an NMB. Cisatracurium was the most widely used NMB for tracheal intubation because of its safety, duration of action, less anaphylactic reactions, and fewer hemodynamic fluctuations. The use of TOF for monitoring was low. While reversal agents were used by >2/3rd respondents, many respondents used them after cisatracurium was used as an NMB.

1. Introduction

Neuromuscular blockers (NMBs) are regularly used for muscle relaxation during anaesthesia.[1,2] Avoiding NMBs increases the risk of difficult intubation and upper airway injury.[2] However, the residual effects of NMBs can cause adverse postoperative events.[1] Recovery from NMB varies between individuals, and incomplete recovery is potentially associated with postoperative pulmonary and other complications.[3] Nevertheless, residual neuromuscular block is preventable by adequate monitoring of the patient and timing the reversal and extubation procedures.[4]

This survey aimed to understand the use of NMBs among Indian anaesthesiologists, including their choice and dosages of NMBs, neuromuscular monitoring, use of reversal agents for residual neuromuscular block, and incidence of adverse effects.

* *Corresponding author*.
E-mail address: shodarkar@gmail.com (S. Hodarkar).

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2. Materials and Methods

A questionnaire-based online survey was conducted was sent to 250 anaesthesiologists via email. Each anaesthesiologist provided responses based on their observation of 15 patients undergoing surgery and who were administered NMBs in their clinical practice. As this survey did not involve any intervention or direct patient participation, ethical approval by an independent ethics review board was not required. However, informed consent was obtained from all participating physicians, and physician confidentiality and anonymity were maintained throughout the survey conduct.

This survey was conducted between March 2021 and September 2021. The participants were asked to select an answer from the multiple choices provided for each question. The questionnaire had 40 questions and was divided into three sections on the use of 1) NMBs (11 questions), 2) reversal agents (17 questions), and 3) cisatracurium (12 questions) (Table 2).

All statistical analyses were performed using Microsoft Excel and expressed as frequencies and percentage of respondents.

3. Results

Of 250 anaesthesiologists approached, 126 responded to the questionnaire; thus, the response rate was 50.4%.

Common NMBs available in the operating rooms of the respondents were cisatracurium (97.6%), atracurium (96.0%), succinylcholine (83.3%), vecuronium (81.7%), and rocuronium (69.8%). Among the NMBs used to facilitate tracheal intubation, 81.0% respondents preferred cisatracurium, 72.2% preferred atracurium, 43.7% preferred vecuronium, 58.7% preferred rocuronium, and 70.6% preferred succinylcholine. Most anaesthesiologists (81.0%) did not monitor core temperature of patients undergoing surgery regardless of the choice of NMB used.

With regard to preferred characteristics of an ideal NMB, safety was important according to 58.7% respondents, recovery time according to 47.7%, followed by duration of action according to 35.7% respondents. Potency and onset of action ranked the lowest in the order of importance for an ideal NMB (Figure 1). In all, 84.1% of the respondents expressed concerns about the adverse effects of NMBs, with inadequate recovery of neuromuscular function (31.1%) and hemodynamic effects (26.4%) being more frequently observed than others. Nevertheless, 62.0% and 94.4% respondents opined that hemodynamic disturbance and anaphylactic reactions due to NMBs were experienced by <5% of patients in their clinical practice, respectively.

Neuromuscular monitoring to guide intubation timing and to measure depth of muscle relaxation were adopted by 77.0% and 63.5% of respondents, respectively. When a nondepolarizing relaxant has been administered, 71.4% of respondents administered an anticholinesterase at the end of surgery. Among those who did not administer anticholinesterase, 92.2% did not administer a reversal agent in up to 25% of patients. Among the factors that guide the decision of not administering a reversal agent, timing of the last dose of nondepolarizing relaxant was the leading factor (62.2%), followed by no evidence of clinical weakness (46.7%; Figure 2). Overall, 71.4% respondents considered clinical signs such as the ability to sustain a 5-second head lift were reliable indicators of adequacy of neuromuscular recovery, 61.9% thought that post tetanic count >10 excluded the presence of residual curarization, and 88.1% reported the incidence of residual curarization to be <5% in their practice. A majority of the respondents (63.4%) expressed concerns regarding the adverse effects associated with the administration of anticholinesterase/antimuscarinic agents, with inadequate recovery of neuromuscular function being the most common (45.7%; Figure 3).

Time to extubation following administration of neostigmine (an anticholinesterase), was <5 min according to 53.2% respondents and 10-15 min according to 42.9% respondents. Less than half the respondents (46.0%) thought a train of four (TOF) count of 4 could indicate reliable and rapid reversal with neostigmine. Neostigmine was administered at a dose of 0.05 mg/kg by 63.5% respondents, while a dose of 2.5 mg dose was administered by 23.8% respondents.

Majority of the respondents (57.1%) opined that they did not check residual paralysis as defined by a TOF ratio <0.9. In all, 38.1% respondents opined that TOF ratio should be 91%-100% before tracheal extubation, while 21.4% did not consider the TOF ratio to be important to know before tracheal extubation (Figure 4). Nevertheless, 64.3% respondents suggested that quantitative TOF monitors should be available in the operating room, and 45.2% opined that these should be a part of the minimal monitoring standards. Similarly, regarding conventional nerve stimulators, 69.0% responded that they should be available in the operating room, and 42.9% were of the opinion that these should be a part of the minimal monitoring standards.

An overwhelming 84.9% respondents expressed the need for availability of sugammadex in India.

Regarding the factors associated with choice of cisatracurium, 44.4% of respondents preferred it because of its safety, while 16.7% prefer it because of the duration of action (Figure 5). Low incidence of anaphylactic reactions and fewer hemodynamic fluctuations were important factors favouring the choice of cisatracurium according to 92.9% and 92.1% of respondents, respectively Intubating doses of 0.15 and 0.2 mg/kg were preferred by 60.3% and 32.5% respondents, respectively. The average durations of action of 0.15 and 0.2 mg/kg doses were 30-50 min according

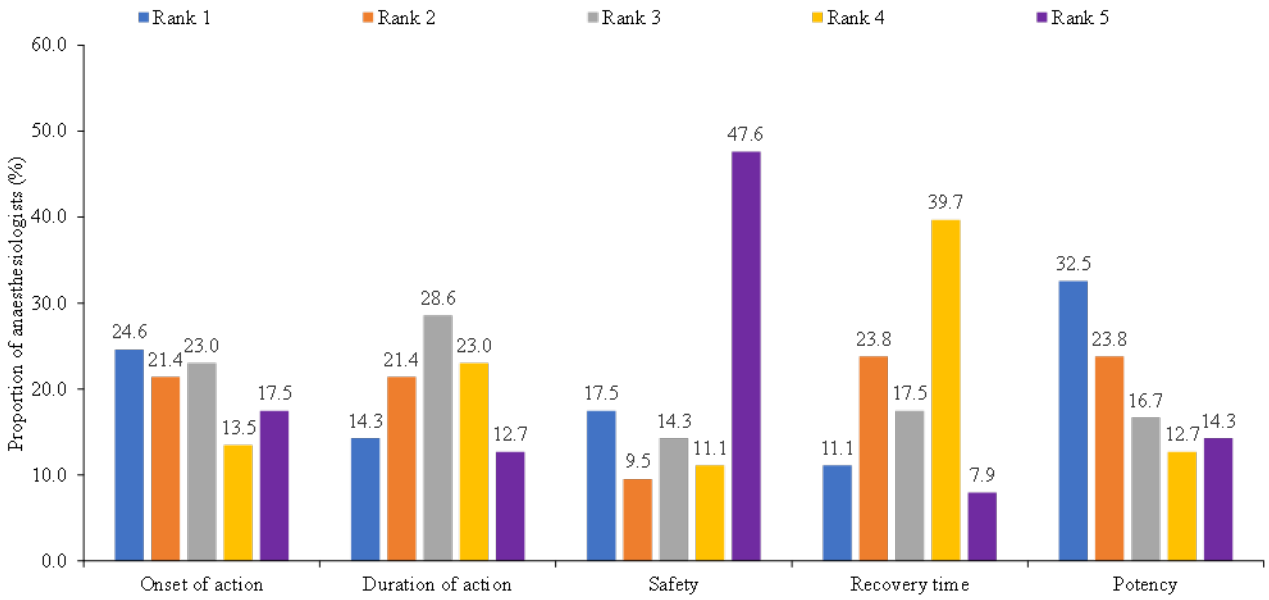

Fig. 1: Preferred characteristics of an ideal neuromuscular blocker Rank 1 corresponds to least preferred characteristic and Rank 5 corresponds to most preferred characteristic

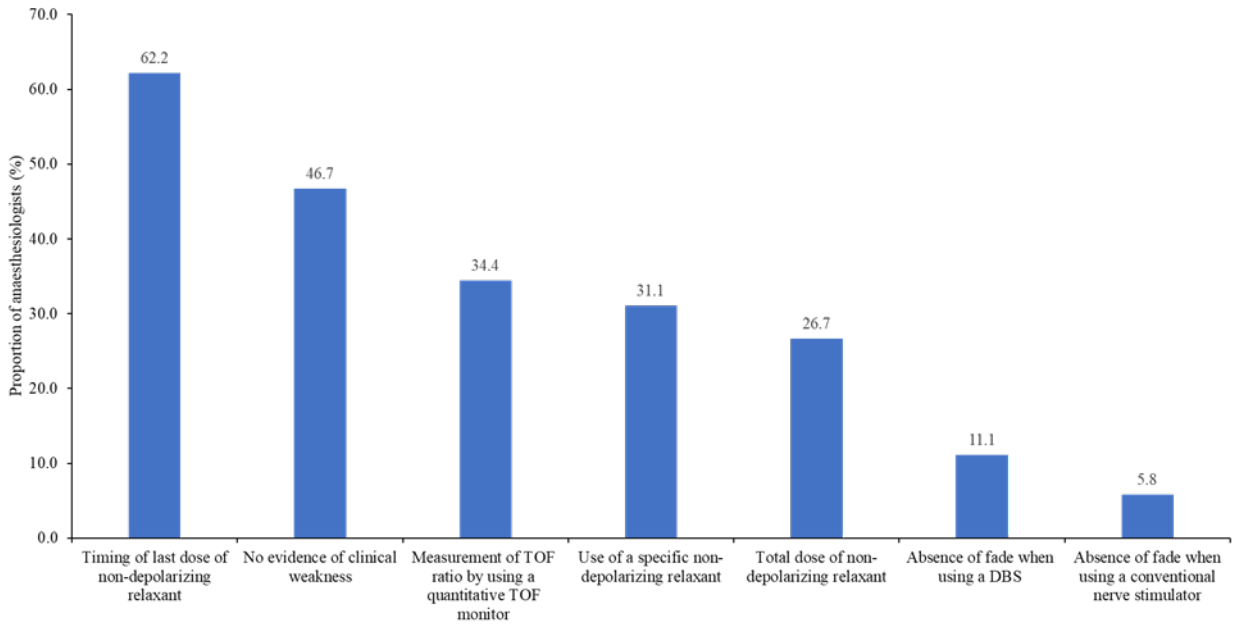

Fig. 2: Factors guiding the decision not to administer a reversal agent at the end of surgery

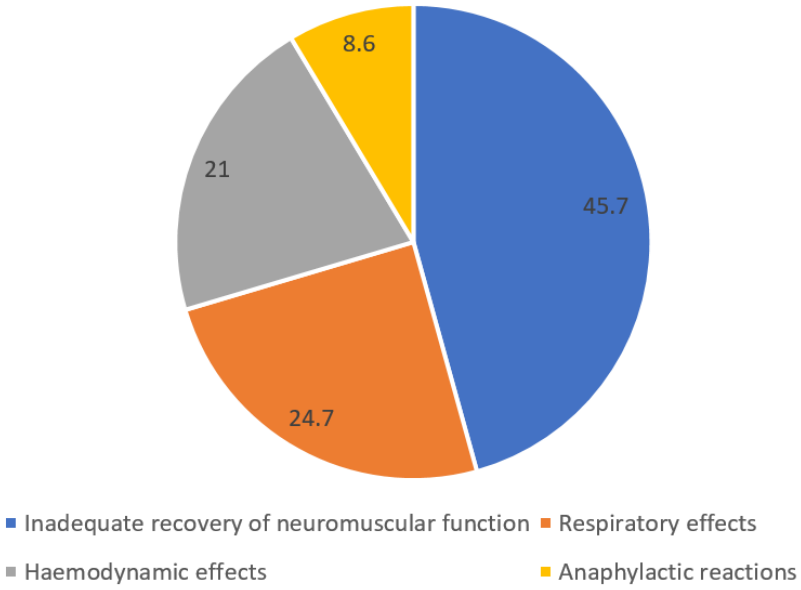

Fig. 3: Commonly observed adverse effects with the administration of anticholinesterase/antimuscarinic agents

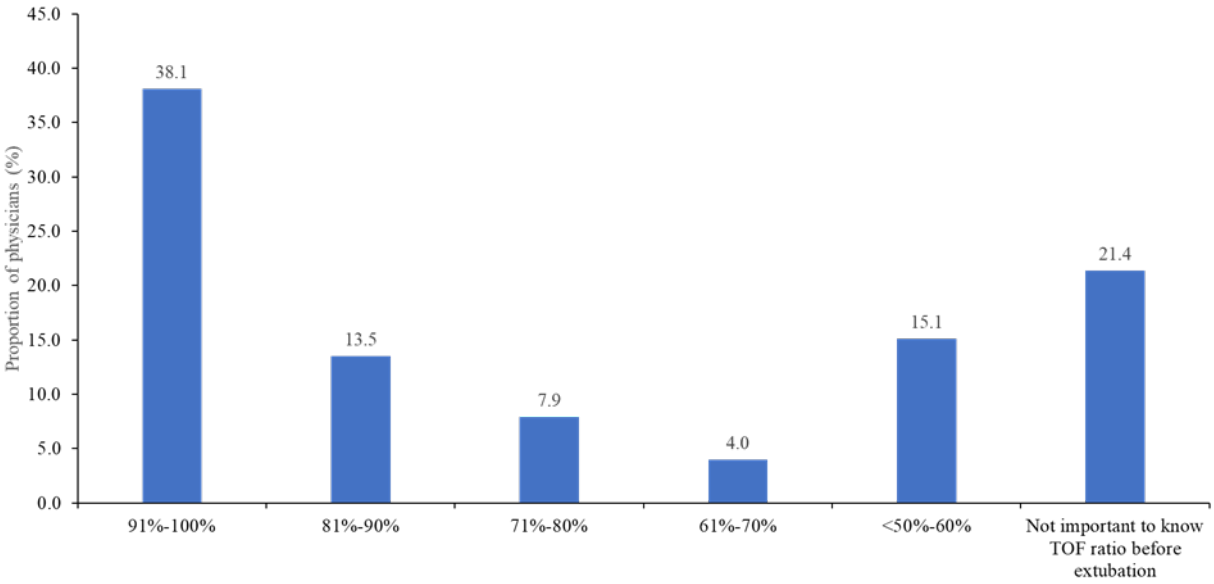

Fig. 4: Desirable TOF ratio before extubation

to 91.3% respondents and 40-60 min according to 68.3% respondents, respectively. For general anaesthesia, 81.7% administered cisatracurium as a bolus dose, while others administered it as a continuous infusion. A maintenance dose of 0.03 mg/kg was used by 55.6% of respondents, while 27.0% used the 0.02 mg/kg dose. In patients on a 0.03 mg/kg maintenance dose, the need for a bolus dose arises after 20-30 min according to 92.1% respondents (Table 1).

Cisatracurium was considered to be ideal for all general anaesthesia (GA) procedures lasting >60-90 min by 52.4% of respondents and for all procedures lasting 30-60 min by 37.3% respondents. Many of the respondents (86.5%) used a reversal agent when cisatracurium was used as an NMB although 45.2% thought that reversal agents are required by 75%-100% of patients after surgery.

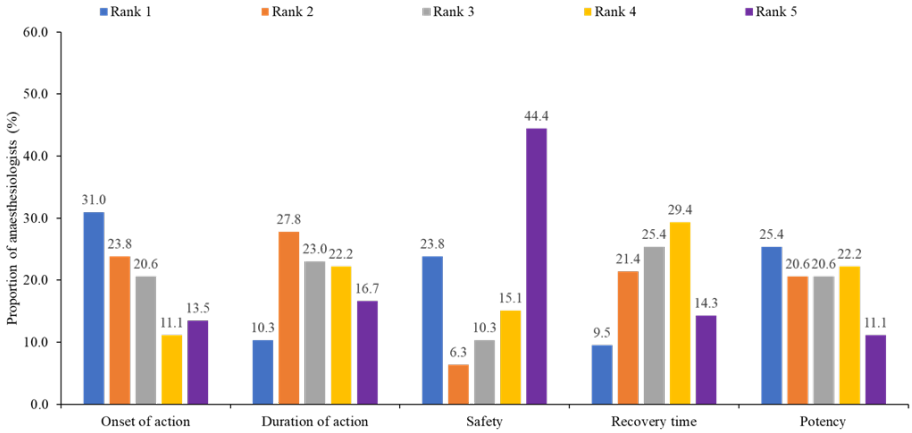

Fig. 5: Preference of characteristics to be considered when choosing cisatracurium for patients undergoing surgery

Table 1: Summary of cisatracurium administration and duration of action as reported by anaesthesiologists

Parameters	Dose (mg/kg)	Duration (min)	% Respondents N = 126
Bolus dose	0.15		60.3
	0.2		32.5
	0.1		4.0
	>0.2		3.2
Duration of action	0.15	30-40	51.6
		40-50	39.7
		50-60	4.8
		60-70	3.2
		70-80	0.8
	0.2	30-40	16.7
		40-50	43.7
		50-60	24.5
		60-70	10.3
		70-80	4.0
		>80	0.8
Mode of administration	Bolus		81.7
	Continuous infusion		18.3
Maintenance dose	0.01		7.1
	0.02		27.0
	0.03		55.6
	0.04		5.6
	0.05		4.8
Duration after which bolus is required at a maintenance dose of 0.03 mg/kg		After 10	1.6
		After 15	6.3
		After 20	31.7
		After 25	14.3
		After 30	46.0

Table 2: Survey questionnaire (Appendix 1)

Section 1: NMBs			
Q1	Which of the following drugs are available in your operating room? (one or more options can be selected)		
	a) Atracurium	b) Cisatracurium	c) Pancuronium
	d) Rocuronium	e) Succinylcholine	f) Vecuronium
Q2	Which of the following NMBs do you use to facilitate tracheal intubation? (one or more options can be selected)		
	a) Atracurium	b) Cisatracurium	c) Pancuronium
	d) Rocuronium	e) Succinylcholine	f) Vecuronium
	g) None		
Q3	What are the characteristics you expect to be in an ideal NMB? Rank them from 1 to 5 as per your preference [1 = least preferred to 5 = most preferred]		
	Parameter	**Rank**	
	Onset of action		
	Duration of action		
	Safety		
	Recovery time		
	Potency		
Q4	Do you have any concerns regarding the adverse effects associated with the administration of NMB drugs?		
	a) Yes	a) Yes	
Q5	If answer to Q5 is yes, choose the most commonly observed adverse effect in your clinical practice?		
	a) Hemodynamic effects	b) Respiratory effects	c) Anaphylactic reactions
	d) Inadequate recovery of neuromuscular function	e) Inadequate effect	
Q6	In your clinical practice, in what percentage of patients do you observe anaphylactic reactions due to NMBs?		
	a) 0%-5%	b) 6%-10%	c) 11%-15%
	d) 16%-20%		
Q7	In your clinical practice, in what percentage of patients do you observe hemodynamic disturbances due to NMBs?		
	a) 0%-5%	b) 6%-10%	c) 11%-15%
	c) 11%-15%		
Q8	In your clinical practice, do you use neuromuscular monitoring to guide time of intubation?		
	a) Yes	b) No	
Q9	In your clinical practice, do you use neuromuscular monitoring to measure depth of muscle relaxation?		
	a) Yes	b) No	
Q10	In your clinical practice, do you monitor core temperature for patients undergoing surgery?		
	a) Yes	b) No	
Section 2: Reversal agents of NMBs			
Q11	When a nondepolarizing relaxant has been given, do you always administer an anticholinesterase at the end of surgery		
	a) Yes	b) No	
Q12	If answer to Q11 was "No," in what percentage of cases do you omit a reversal agent?		
	a) 0%-25%	b) 26%-50%	b) 26%-50%
	d) 76%-100%		
Q13	If you elect not to administer a reversal agent at the end of surgery, which of the following factors helps in making that decision? (one or more options can be selected)		
	a) Total dose of nondepolarizing relaxant	b) Timing of last dose of nondepolarizing relaxant	c) Absence of fade when using a conventional nerve stimulator
	d) Absence of fade when using a DBS	e) Measurement of TOF ratio by using a quantitative TOF monitor	f) No evidence of clinical weakness

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Table 2 continued

Q14	Do you think that the clinical signs (such the ability to sustain a 5 second head lift) are reliable indicators of the adequacy of neuromuscular recovery?		
	a) Yes	b) No	
Q15	Do you think that a post tetanic count above 10 excludes the presence of residual curarization?		
	a) Yes	b) No	
Q16	How much time do you allow from time of administration of neostigmine to extubation?		
	a) <5 mins	b) 10–15 mins	c) >15 min
Q17	In your views, at what TOF count would neostigmine produce reliable and rapid reversal?		
	a) 0	b) 1	c) 2
	c) 2	d) 3	e) 4
	f) Any response to neuromuscular stimulation	g) It depends on the muscle relaxant used	h) Do not use reversal drugs in my practice
Q18	When administering neostigmine, what is the dose you usually administer?		
	a) 2.5-mg dose	b) <0.05 mg/kg	c) 0.05 mg/kg
	d) >0.05 mg/kg	e) Do not use reversal drugs in my practice	
Q19	Do you have any concerns regarding the adverse effects associated with the administration of anticholinesterase/antimuscarinic agents?		
	a) Yes	b) No	
Q20	If answer to Q19 is yes, choose the most commonly observed adverse effect in your clinical practice?		
	a) Hemodynamic effects	b) Respiratory effects	c) Anaphylactic reactions
	d) Inadequate recovery of neuromuscular function		
Q21	Do you think that postoperative residual curarization represents a significant issue in your clinical practice?		
	a) Yes	b) No	
Q22	In your hospital/institution, what is the incidence of residual curarization?		
	a) <5%	b) 5%-15%	c) 15%-30%
	c) 15%-30%		
Q23	Do you measure residual paralysis as defined by TOF ratio <0.9?		
	a) Yes	b) No	
Q24	Prior to tracheal extubation, the TOF ratio should be		
	a) <50%-60%	b) 61%-70%	c) 71%-80%
	d) 81%-90%	e) 91%-100%	f) It is not important to know the TOF ratio before extubation
Q25	What is your opinion on conventional nerve stimulators (one or more options can be selected):		
	a) Should be a part of the minimal monitoring standards	b) Should be available in the operating room	c) Should be regarded as unnecessary
Q26	What is your opinion on quantitative TOF monitors should (one or more options can be selected)		
	a) Should be a part of the minimal monitoring standards	b) Should be available in the operating room	c) Should be regarded as unnecessary
Q27	In your opinion, is there a need for sugammadex in India? (Currently sugammadex is not available in India)		
	a) Yes	b) No	
Section 3: Cisatracurium			
Q28	What are the drug-related factors that you consider while choosing cisatracurium for your patients undergoing surgery? Rank them from 1 to 5 as per your preference [1 = least preferred to 5 = most preferred]		
	Parameter	**Rank**	
	Onset of action		
	Duration of action		
	Safety		
	Recovery time		
	Potency		

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Table 2 continued

Q29	Do you consider less anaphylactic reaction as an important factor for choosing cisatracurium in your patients undergoing surgery?		
	a) Yes	b) No	
Q30	Do you consider hemodynamic parameter as an important factor for choosing cisatracurium in your patients undergoing surgery?		
	a) Yes	b) No	
Q31	In your clinical practice, what cisatracurium intubating dose do you prefer for patients undergoing surgery?		
	a) 0.1 mg/kg	b) 0.15 mg/kg	c) 0.2 mg/kg
	d) >0.2 mg/kg		
Q32	What is the average duration of action you have seen with cisatracurium (0.15 mg/kg intubating dose) in your patients undergoing surgery?		
	a) 30-40 min	b) 40-50 min	c) 50-60 min
	d) 60-70 min	e) 70-80 min	f) >80 min
Q33	What is the average duration of action you have seen with cisatracurium (0.20 mg/kg intubating dose) in your patients undergoing surgery?		
	a) 30-40 min	b) 40-50 min	c) 50-60 min
	d) 60-70 min	e) 70-80 min	f) >80 min
Q34	In your clinical practice, what cisatracurium maintenance dose do you prefer for patients undergoing surgery?		
	a) 0.01 mg/kg	b) 0.02 mg/kg	c) 0.03 mg/kg
	d) 0.04 mg/kg	e) 0.05 mg/kg	
Q35	In patients on cisatracurium maintenance dose (0.03 mg/kg bolus), when does the need arise to give subsequent dose to prolong the duration of surgery?		
	a) After 10 mins	b) After 15 mins	c) After 20 mins
	d) After 25 mins	e) After 30 mins	
Q36	Considering all characteristics, which of the following will be the ideal condition for the use of cisatracurium? (one or more options can be selected)		
	a) All the GA procedures with duration <30 min	b) All the GA procedures with duration 30–60 min	c) All the GA procedures with duration >60–90 min
	d) All the GA procedures with duration >90 min		
Q37	Mention the dosage protocol you follow for cisatracurium for patients undergoing surgery under GA		
	a) Bolus	b) Infusion	
Q38	Do you use any reversal agent after using cisatracurium after the surgery?		
	a) Yes	b) No	
Q39	If answer to Q38 is yes, what percentage of patients need reversal agents after the surgery		
	a) 0%-25%	b) 25%-50%	c) 50%-75%
	d) 75%-100%		

DBS, Double burst stimulus; GA, General anaesthesia; NMBs, Neuromuscular blockers; TOF, Train of four

4. Discussion

The survey showed that cisatracurium is the most widely used NMB for tracheal intubation, followed by atracurium, vecuronium, rocuronium and succinylcholine. Safety and recovery time were believed to be the most important criteria for an ideal NMB. Cisatracurium is known to be three times more potent than atracurium, and its duration of action is slightly longer than that of atracurium. Therefore, a lower dose of cisatracurium is required to achieve an equivalent degree of neuromuscular blockade as atracurium.[5] The elimination of cisatracurium and atracurium is largely through Hoffman elimination; hence, they can be safely administered to patients with hepatic or renal dysfunction.[5,6] Succinylcholine is preferred for rapid-sequence intubation and emergencies where immediate airway management is required as it has a rapid onset and short duration; it can be administered intramuscularly in patients without venous access.[7,8] However, it has several adverse effects like hyperkalaemia, malignant hyperthermia, increased intraocular and intracranial pressures,[7] and high risk of anaphylaxis.[9] Moreover, residual blockade is unpredictable after succinylcholine. Early extubation before succinylcholine has worn off can cause hypoxia, requiring emergency reintubation. Currently, there is no reversal agent that can be administered after succinylcholine.[10] Patients on aminoglycoside antibiotics or cholinesterase inhibitors should not be administered succinylcholine chloride as they can exacerbate paralysis.[8] In cardiac surgeries, haemodynamic stability is very important because of a likely coronary reserve in such patients. Hence, any agent that stimulates the cardiovascular system and increases the myocardial oxygen demand should be avoided.[11] Vecuronium and rocuronium decrease the heart rate and are useful NMBs in patients with high baseline heart rate.[12] A recent study showed that vecuronium had better and more cardiac favourable variables and more cardiovascular stability than rocuronium and atracurium. Rocuronium was more cardio stable than atracurium.[13]

Of all respondents, 84% expressed concerns about the adverse effects of NMBs, the most common being inadequate recovery of neuromuscular function and hemodynamic effects; however, hemodynamic disturbance was seen in <5% of patients. Recent studies reported that the rate of postoperative residual neuromuscular blockade is seen in 40% to 60% of patients;[4,14] these patients leaving the operating room with residual paralysis have a high potential risk for postoperative pulmonary and other complications.[14] Anaphylactic reactions to NMBs were reported to be rare according to the respondents. The estimated incidence of hypersensitivity reactions during anaesthesia varies from 1:1250 to 1:13,000 patients receiving anaesthesia. A prospective study of suspected hypersensitivity reactions in a single hospital over a 2-year period reported a hypersensitivity ratio of 1:3180 anaesthetics.[15]

More than two-thirds of the anaesthesiologists in this survey adopted neuromuscular monitoring for the timing of intubation and depth of muscle relaxation. However, 57% did not measure residual paralysis using the TOF ratio; more than two-thirds considered clinical signs (such the ability to sustain a 5-second head lift) as reliable indicators of adequacy of neuromuscular recovery. Nevertheless, 42.9% of respondents opined that conventional nerve stimulation should be a part of the minimal monitoring standards. However, literature suggests that this method has an inherent limitation because it is a subjective method, and many clinicians might not able to reliably identify the degree of fade (TOF ratio >0.4–0.6).[3] Two-thirds of respondents opined that TOF monitors should be available in the operating room. However, without immobilization of the arm and fingers, the use of preload to the thumb, and calibration of the device, the measurements can be considerably variable.[16] Studies from Singapore and UK have shown that only 10%-13% of anaesthetists routinely use objective neuromuscular monitoring despite its availability because of additional efforts required.[4] A 2017 consensus statement by an international panel of experts recommended that quantitative (objective) NMB monitoring should be used whenever nondepolarizing NMBs are administered. Until conventional nerve stimulation devices are replaced with quantitative monitoring equipment, use of nerve stimulation monitoring should be mandatory.[17] However, key anaesthesia societies like the European Society of Anaesthesiology and the American Society of Anesthesiology have abstained from making statements on the topic.[3]

Though more than two-thirds of those surveyed administered anticholinesterase when a nondepolarizing relaxant was used, most were concerned about the adverse effects associated with anticholinesterase/antimuscarinic agents like neostigmine, especially inadequate recovery of neuromuscular function. Less than half the respondents relied on TOF to decide on the timing of extubation after administering neostigmine with most of them extubating between 5 and 15 min. A 0.05 mg/kg dose of neostigmine was used by 63.5% of respondents, while 23.8% administered a dose of 2.5 mg. It has been reported that due to concern about its muscarinic adverse effects, anaesthesiologists might administer lower doses of neostigmine than necessary, or not use it at all. Even when administered at a dose appropriate for the level of NMB, adequate recovery (TOF ratio >0.9) requires approximately 15 min.[3] If administered too late, neostigmine itself might cause muscle weakness.[18] However, it is reported that administering neostigmine with no objective monitoring does not significantly reduce the incidence of residual block.[19] In fact, it might be associated with increased rates of atelectasis,[20] hypoxemia,[21] and reintubation.[22]

An overwhelming 84.9% respondents expressed the need for availability of sugammadex in India. Sugammadex ensures rapid and safe reversal of the commonly used non-depolarizing NMBAs rocuronium and vecuronium.[23,24] Sugammadex reversal is considerably faster and more intense than that with acetylcholinesterase inhibitors.[25] However, only neuromuscular blockade induced by rocuronium, vecuronium, or pancuronium can be reversed with sugammadex, which potentially may increase the cost of using these NMBs. Hence, acetylcholinesterase inhibitors are the only options for reversal of other NMBs, such as cisatracurium.[1]

Safety, non-organ dependent metabolism short recovery time, low incidence of anaphylactic reactions, and fewer hemodynamic fluctuations were reported by respondents as reasons for preferring cisatracurium. Clinical events due to histamine release after bolus administration of cisatracurium have not been usually observed, even with very high doses of up to 0.4 mg/kg. No cardiovascular adverse effects have also been reported at high doses.[5,26] Most respondents in this survey administered a dose of 0.15 or 0.2 mg/kg with the average duration of action of 30-50 min and 40-60 min, respectively. The maintenance dose used was 0.02 or 0.03 mg/kg. A 2019 study from India reported that 0.15 mg/kg cisatracurium provides excellent intubating conditions with rapid onset of action, longer duration of action, and no significant hemodynamic changes. The authors suggested that 0.15 mg/kg cisatracurium can be used as an ideal non-depolarizing muscle relaxant for intubation.[26] A study among patients undergoing abdominal surgery under GA showed that higher doses of cisatracurium (0.2 and 0.3 mg/kg) provided more effective, rapid neuromuscular blocking with longer duration of action, stable haemodynamic status, and no signs of histamine release.[27] Cisatracurium has an intermediate onset of action. Following an intubating dose of 0.15 mg/kg, the time to onset of action is 2 min and that to achieve a 90% block is 2.6 (range: 1.0-4.4) min. Maximum block is achieved in 3.5 (range: 1.6-6.8) min, and the action lasts for 55 (range: 44-74) min. Following a dose of 0.2 mg/kg, the time to onset of action is 1.5 min and that to achieve a 90% block 2.4 (range: 1.5-4.5) min. Maximum block is achieved in 2.4 (range: 1.5-4.5) min, and the action lasts for 55 (range: 44-74) min.[28]

A comparison of three different doses of cisatracurium (0.075, 0.15, and 0.3 mg/kg) revealed that there was a 2-fold decrease in the onset time between the 0.075 and 0.150 mg/kg doses ($P < 0.05$), but the difference was not significant between the 0.15 and 0.3 mg/kg doses.[29] Cisatracurium is not associated with dose-related histamine release even at bolus doses of ≤8× effective dose 95 (ED95) and has also demonstrated cardiovascular stability in healthy patients and those with coronary artery disease at these doses.[30] More than half the respondents in this survey, considered that cisatracurium was ideal for all procedures performed under GA lasting >60-90 min, and 86.5% used a reversal agent following cisatracurium use.

This survey had certain limitations. First, the response rate to the survey was only 50%. Second, respondents were not asked about the basis on which they decide to use the various NMBs and the methods of neuromuscular monitoring used. Third, it was not evaluated whether practice patterns varied by geography and type of hospital. Nevertheless, the data from this survey provides important insights about the real-world usage patterns of NMBs among anaesthesiologists in India. Further, surveys with larger sample sizes, which also address the above limitations may be useful.

5. Conclusion

These survey results indicate that properties like safety, recovery time, onset and duration of action, dose required, adverse effects, and route of elimination are important factors in selecting an NMB for tracheal intubation, and cisatracurium is considered superior to other agents on these aspects. Due to the lack of TOF or other objective monitoring devices, residual paralysis is measured based on clinical signs, which is not a reliable strategy. While anticholinesterase/antimuscarinic agents like neostigmine are regularly used for reversal of NMB, there might still be residual block due to lack of objective monitoring. Hence, establishing the importance and need for objective monitoring before extubation and emphasizing on the availability of objective monitoring devices for measuring residual paralysis is necessary.

6. Author Contributions

Both authors participated in the survey and contributed to analysis and interpretation of the results. The manuscript has been read and approved by both the authors, the requirements for authorship have been met, and each author believes that the manuscript represents honest work.

7. Source of Funding

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8. Data Availability Statement

Participant-level data will be made available upon reasonable request.

9. Conflicts of Interest

Both authors received research grant from Abbott for participation in the survey.

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Author biography

Anil Kumar Jain, Senior Consultant https://orcid.org/0009-0008-9168-1214

Shubha Hodarkar, Consultant Anaesthesiologist

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