Association of Clinico-demographic Characteristics in the Use of Muscle Relaxant Reversal Agents in a Tertiary Hospital in the Philippines

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ABSTRACT

This retrospective observational study investigated the factors influencing neuromuscular blocking agent (NMBA) reversal agent use at Amang Rodriguez Memorial Medical Center (ARMMC) from June to December 2023. NMBAs facilitate endotracheal intubation, but reversal agents like Sugammadex and Neostigmine are used to prevent complications such as residual neuromuscular blockade. Objectives. This study aimed to determine the prevalence of reversal agent use and identify clinico-demographic characteristics affecting Sugammadex and Neostigmine administration. Data was collected via total enumeration sampling and chart review of 294 patients who underwent general anesthesia. The study examined variables including age, sex, BMI, comorbidities, ASA classification, and the specific muscle relaxant and reversal agent used. Statistical analysis involved descriptive statistics, Chi-square tests, and multivariate logistic regression. Results showed that Sugammadex was used in 69.4% of reversals. Significant associations were found between age and reversal agent choice, with Sugammadex favored in children ($p<0.001$) and Neostigmine in middle-aged and older patients. Obese patients were more likely to receive Neostigmine ($p=0.039$). Patients with ASA II or III classifications and comorbidities were more likely to be reversed with Sugammadex ($p=0.038$). Notably, bronchial asthma was associated with a decreased likelihood of Sugammadex use (OR = 0.12, $p = 0.05$). This study highlights the influence of patient characteristics on reversal agent selection at ARMMC. The findings can inform the development of local guidelines to optimize NMBA reversal practices and improve patient safety.

Keywords: NMBA, Reversal Agents, Sugammadex, Neostigmine

INTRODUCTION

Endotracheal intubation (TI) is performed as a lifesaving procedure in the ICU which utilizes Neuromuscular blocking agents (NMBAs) muscle relaxants. Despite being renowned as a last resort, life-threatening complications may arise from this intervention. When the unstable physiologic state of the critically ill patient comes into play together with under evaluation of the airways and suboptimal response to oxygenation, severe hypoxemia, and cardiovascular collapse may take place.[1] These life-threatening complications from intubation take place all over the world, and this includes our country.

In the Philippines, several complications were observed after the administration of NMBAs for the purpose of intubation. Commonly, patients are seen as lethargic or unarousable at the Post Anesthesia Care Unit (PACU). Apart from this, signs of muscle weakness or hypoxemia, apnea, or bronchospasm were also observed. Sometimes, these complications may lead to oxygen desaturation. Patients therefore become cyanotic. On the other hand, when residual neuromuscular blockade takes place, reintubation is performed which prolongs the patient's stay in the hospital for monitoring purposes.[2]

Reversal agents are any drugs used to reverse anesthetics, narcotics, or potentially toxic agents. In General Endotracheal Anesthesia, pharmacological reversals are performed before extubation following the

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administration of muscle relaxants during the general anesthesia process before endotracheal intubation. Alongside the close monitoring of neuromuscular block, this is done to prevent any adverse events that the muscle relaxant has brought about. This practice serves as part of the standard of care for patients who have undergone the intubation-extubation route. [3]

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue IX September 2025

Administration of reversal agents, however, needs to be carefully performed as well. Since administration of reversal agents might induce further complications, the anesthesiologists must be aware of the patient's history and clinical characteristics. Research suggests that reversal agents have contraindications that need to be looked into before being administered to the patient. This study would look into the clinico-demographic characteristics of the patients who are administered with either Sugammadex and Neostigmine to document the practice of the anesthesiologists here in the institution.

LITERATURE REVIEW

Anesthesia is a state in which patients are induced to lose sensation with or without loss of consciousness to perform a procedure that may cause pain or require little resistance from the patient. This can be classified into two groups; general and local anesthesia. General anesthesia ideally targets neuronal depression to induce loss of sensations, analgesia, and muscle relaxation. [4] Anesthetic agents classified into 5 classes are used namely: inhalational anesthetics, IV anesthesia, IV sedatives, synthetic opioids, and finally, neuromuscular blocking agents (NMBA).[5]Furthermore, NMBAs target the nicotinic cholinergic receptors specifically at the postsynaptic membrane, blocking acetylcholine from binding to the motor end plate resulting in muscle paralysis. These are further classified into either non-depolarizing or competitive, and depolarizing or non-competitive. Competitive NMBAs include atracurium and rocuronium, which are the focus muscle relaxant agents of his study. Even further, atracurium and rocuronium belong to different subclasses of nondepolarizing NMBAs depending on their chemical structure, specifically, benzylisoquinoline and steroidal, respectively. [6]

Muscle Relaxants and Tracheal Intubation

Neuromuscular blocking agents (NMBA) are used in the field of anesthesia to induce muscle relaxation for easier endotracheal intubation (ET).[7] The duration of its effect varies depending on the dose and agent used which is computed using the patient's ideal body weight to prevent prolongation of the paralysis. Both atracurium and rocuronium are intermediate-acting agents and are some of the most commonly used muscle relaxant agents.

One of the widely used agents, atracurium is given via IV bolus or infusion to induce muscle relaxation. It has an onset of 2 minutes when used during intubation. This is 4 times less potent than its isomer cisatracurium. It also causes histamine release while cisatracurium does not have a similar effect. [8] It requires 0.12, 0.18, and 0.21 mg/kg doses to produce a 50%, 90%, and 95% decrease in forced contraction of muscles. The metabolism of atracurium requires Hoffman elimination or non-enzymatic degradation which affects temperature and pH. Due to this criteria, metabolism is affected by acidosis and hypothermia. A metabolite of atracurium, laudanosine, is known to cause hypotension, bradycardia, and seizures due to its ability to cross the blood-brain barrier. Elimination happens hepatically and renally with its metabolite, laudanosine. Less than 5% is washed off into the urine. Due to this, some conditions affect atracurium's plasma clearance and volume of distribution such as cirrhosis, and hepatorenal diseases. [9]

Much like atracurium, rocuronium is used to assist in endotracheal intubation. It is also administered intravenously at a dose range of 0.6 to 1.2 mg/kg, with onset occurring within 1-2 minutes and lasting up to 35 minutes. [10] Found in the nucleus of pancuronium and vecuronium which makes it 6-10 times less potent than vecuronium.[9] It requires 0.147, 0.268, and 0.305 mg/kg dose to produce a 50%, 90%, and 95% decrease in forced contraction of muscles. Unlike atracurium, rocuronium does not cross the blood brain barrier [11] [1]hence manifests lesser adverse effects. It is excreted primarily through the bile, and renal excretion, hence, the volume of distribution and elimination half-life is affected by renal function. Plasma clearance, volume distribution, and elimination half-life, on the other hand, are affected by cirrhosis and hepatorenal disease. [9]

Several studies have documented the use of NMBA to facilitate ET. Although the use of NMBA is practiced widely, some anesthesiologists practice NMBA-free intubation. [12] Nevertheless, a study in 2020 on the 1999 French guidelines on muscle relaxants and reversal in anesthesia included 31 recommendations. This study recommended the use of muscle relaxants in facilitating tracheal intubations.[13] Additionally, several conditions are contraindicated with its use and concerns with its adverse events such as venous thrombosis,

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue IX September 2025

autonomic interactions, myopathy, and residual or prolonged paralysis.[14] The use of reversal agents became a mainstay in preventing these complications.

Factors Influencing NMBA reversal agents

The use of reversal agents depends on several factors. The most documented are the use of NMBA, age, comorbidities, and ASA classifications. Younger patients were found to be reversed with neostigmine (18-40 year olds) more often than those receiving sugammadex (at least 50 year olds) in a study done by Bash and colleagues in 2021.[15] Similar findings were found by Dubuyov, et al. where patients over 80 years old were reversed with sugammadex while <41 year old patients were reversed with neostigmine.[16] However this was not reflected in the recently published REVEAL study, where there is no significant difference in the populations reversed with neostigmine and sugammadex. However, it was noted that the use of sugammadex was more frequent in elderly than neostigmine, but is again not significantly different.[17]

Furthermore, a large multicentered study conducted in the USA documented the use of sugammadex decreases incidence of desaturation and pneumonia post operatively in patients who underwent intrathoracic or intra-abdominal surgery. Making it the recommended reversal agent in these procedures. [18] For other comorbidities, COPD, congestive heart failure, obesity, solid tumor, peripheral vascular diseases were more associated with reversal using sugammadex compared to neostigmine at $p<0.001$.[15] The REVersal of nEuromusculAr bLocking Agents in Patients Undergoing General Anesthesia REVEAL study also documented hypersensitivity, hypotension, and bradycardia, to be indicators not to use sugammadex as reversal agents.[17] Primarily, patients who have more comorbidities, obese, and are under ASA ¾ are reversed with sugammadex than neostigmine, whose population comprises younger, normal weight, and less comorbid patients.[16]

Aside from patient characteristics affecting the utilization of reversal agents. Post-operative complications were also considered.

Complications and Reversal Agents

Endotracheal Intubation can be performed with or without neuromuscular blocking agents (NMBAs). While both routes are viable, a systematic review conducted in 2018 showed that out of 34 trials, 4 trials displayed an increased risk of difficult tracheal intubation when done with no use of NMBAs. This was affirmed when all the trials were included and demonstrated a significant risk of upper airway discomfort or injury when NMBAs were avoided. Non-use of NMBA was also significantly associated with difficult laryngoscopy. [19]

On the other hand, the use of NMBAs might cause adverse effects. One of the complications of muscle relaxants is postoperative residual or prolonged paralysis which can be reversed using agents such as Sugammadex and neostigmine.

A previous study conducted in Australasia reported that Residual neuromuscular blockade (RNMB) is still common, having manifested in 31% of patients despite being administered with intermediate-acting muscle relaxants. In the same study, they found that RNMB in the postanesthetic care unit is associated with shorter intervals between final dose and arrival in the PACU, higher dose of the muscle relaxant, and shorter duration of anesthesia. [20]

One reversal agent commonly used is Sugammadex. This pharmacological agent is a modified gamma-cyclodextrin used to reverse steroidal non-depolarizing neuromuscular blocking drugs rocuronium and vecuronium which increases the speed of neuromuscular blockade reversal which greatly reduces the risk for residual neuromuscular paralysis.[21] When prevalence is of question, a 2020 study in the United States on the utilization patterns of perioperative NMB reversal have revealed that Sugammadex is the reversal agent of choice for 40% of the patients who have been administered with neuromuscular blockade. [22] Sugammadex was used on average in 40.0% (95% CI 39.8%-40.2%) of cases receiving neuromuscular blockade.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue IX September 2025

In a study that compared the effect of following up rocuronium with Sugammadex or succinylcholine, it was observed that reversal of profound high-dose rocuronium-induced neuromuscular block (1.2 mg/kg) with 16 mg/kg Sugammadex was significantly faster than spontaneous recovery from 1 mg/kg succinylcholine. [23]

Another reversal agent in rotation is Neostigmine. Neostigmine is water-soluble and is an ionized compound

that reversibly inhibits the enzyme acetylcholinesterase. Neostigmine inhibits acetylcholinesterase, which is the enzyme that metabolizes acetylcholine into choline and acetic acid. This allows acetylcholine to build up at the neuromuscular junction and overcome the competitive inhibition of nondepolarizing blocking drugs. This accelerates the reversal of nondepolarizing neuromuscular blockade of nicotinic receptors in the neuromuscular junction at the end of surgery.[24]

In a study published in 2020, Neostigmine was described as the only anticholinesterase in routine use in the Western world. In most countries it is cheap, but requires the simultaneous use of an anticholinergic agent prevent its muscarinic effects such as bradycardia, bronchospasm, and increased intestinal motility. Administration of it requires a detectable two twitches of the train-of-four (TOF) response. It is also worth it to note that it takes at least 8 minutes to have a maximum effect and has a ceiling effect, which means increased dose does not necessarily translate to increased efficacy. [25]

In a study conducted in 2022 on forty subjects who underwent thyroidectomy with intraoperative neuromonitoring (IONM) during thyroid surgery, 20 were administered with neostigmine after tracheal intubation while the control group received normal saline. Electromyography amplitudes of the vagus nerve (V1) were recorded before thyroid dissection and the time from the initial V1 signal check to successful V1 stimulation was recorded. The mean time from skin incision to successful V1 stimulation was significantly shorter in Group N than in Group C. This study concluded that neostigmine administration immediately after tracheal intubation can be useful to reverse neuromuscular blockade for successful IONM in thyroid surgeries. [26]

Current Practices

A clear documentation of the usage of reversal agents in the Philippines is yet to be published. In the institution where this study is set, conditions are considered before the administration of NMBAs and consequently, the appropriate reversal agents. Comorbidities, for example, are considerations that are carefully monitored prior to administration of NMBAs. Patients with allergies or asthma are administered with Rocuronium since Atracurium may induce side effects like histamine release. Another consideration would be kidney diseases as this usually entails slow metabolism of drugs. When patients are reported to have kidney ailments, reversal agents are administered since this prevents residual paralysis. Usually, slow metabolism of drugs means that a patient is prone to recurarization. The same goes for patients with pulmonary problems since they are also prone to residual paralysis and desaturation due to poor lung compliance. For pediatric patients, Rocuronium is usually used and reversal always takes place. For patients with no comorbidities, allergies, liver or kidney problems, the preference of the anesthesiologists are followed. Ultimately, the biggest consideration would be the hypersensitivity of a patient to the reversal agent. For patients without any considerations, the reversal agent that would be used would just depend on the muscle relaxant used in the process.

Similar studies

The use of muscle relaxant reversal agents have been documented in other countries.

In 2020, a retroactive study in the United States on Utilization patterns of perioperative neuromuscular blockade revealed that out of 934,798 cases, Sugammadex was used on average in 40.0% (95% CI 39.8%-40.2%) of cases receiving neuromuscular blockade. These results came after the approval of Suggamadex from the Food and Drug Administration. Additionally, this revealed that Sugammadex was used preferentially in cases with higher degrees of neuromuscular blockade prior to reversal in patients with greater burden of comorbidities. [22]

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue IX September 2025

In another part of the globe, a retrospective study was conducted in the Netherlands on patients who have received elective, non-cardiac surgery and general anesthesia with endotracheal intubation between 2016-2020. In an unrestricted clinical environment, it was reported that Rocuronium was the most commonly used muscle relaxant at 88.5% while Sugammadex was the most commonly used reversal agent (99.9% of those pharmacologically reversed). Of those who were administered with rocuronium, 23.1% of which received a reversal with Sugammadex. Odds of reversal increased with age, BMI, ASA class and shorter surgery duration.[2]

When it comes to the factors affecting the choice of using either Sugammadex or Neostigmine, a study published

in 2023 on the REVersal of nEuromusculAr bLocking Agents in Patients Undergoing General Anaesthesia (REVEAL Study) conducted in Milan, Italy from 2016-2019 reported that the factors associated with NMBA reversal use were severe obesity, high ASA score. Among the comorbidities, OSAS, asthma and other respiratory diseases showed the strongest association with NMBA reversal administration. [17]

Synthesis

Anesthesia is a state in which patients are induced to lose sensation with or without loss of consciousness in order to perform a procedure that may cause pain or may require little resistance from the patient. Neuromuscular blocking agents (NMBA) are used to induce muscle relaxation for easier endotracheal intubation (ET). To prevent Residual neuromuscular blockade (RNMB) and its consequent complications, reversal agents such as Suggamadex and Neostigmine are used, however, certain considerations still have to be made before reversal agents are administered. In this study, we study the associations of the clinicodemographic characteristics of patients and the reversal agents to establish which patients should receive Sugammadex or Neostigmine, based on their history, their comorbidities and other characteristics.

OBJECTIVES

General Objective

This study aims to determine the factors that influence the use of neuromuscular blocking agents reversal agents in ARMMC from June to December 2023.

Specific objectives

Specifically, this study aims to achieve the following:

1. Determine the prevalence of use of muscle reversal agents in patients of ARMMC
2. Determine clinico-demographic characteristics influencing the use of Sugammadex
3. Determine the clinico-demographic characteristics influencing the use of Neostigmine

METHODS

Study Design and Setting

This retrospective observational study was conducted at the ‘Amang’ Rodriguez Memorial Medical Center (ARMMC) in Marikina City, Philippines. The investigation spanned six months, from June to December 2023, and was designed to describe and document the use of neuromuscular blocking agent reversal agents through a systematic review of the hospital’s anesthesia census and patient charts. Institutional Review Board approval was obtained before the commencement of the study, and a waiver of informed consent was granted as the study involved only the analysis of pre-existing, de-identified data.

Study Population

A total enumeration sampling approach was employed to include all patients who underwent general

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue IX September 2025

endotracheal anesthesia during the specified study period and met the following criteria:

Inclusion Criteria

- Patients undergoing elective or emergency non-cardiac surgery.
- American Society of Anesthesiologists (ASA) physical status classification of I–III.
- Administration of either atracurium or rocuronium as the neuromuscular blocking agent, with subsequent reversal using either neostigmine or Sugammadex.
- Total Intravenous Anesthesia (TIVA) was used.

Exclusion Criteria

- Cases involving emergency intubation setups in the operating room.
- Patients requiring planned delayed extubation.
- Non-intubated patients.
- Patients with an ASA physical status classification of IV–V.
- Patients with a diagnosis of rare coexisting diseases known to affect neuromuscular function (e.g., myasthenia gravis, Guillain-Barré syndrome, pseudocholinesterase deficiency).
- Cases where neuromuscular blocking agents were not administered due to short surgical duration or a lack of need for top-up doses.
- Use of suxamethonium (succinylcholine) as the neuromuscular blocking agent.

Data Collection and Management

The principal investigator was responsible for all data collection. The daily anesthesia department census was screened to identify eligible participants, and their medical charts were subsequently reviewed to extract the following variables: age, sex, BMI, comorbidities, ASA classification, muscle relaxant used, and reversal agent used. The collected data were organized into appropriate groupings for each variable. The primary outcome was to assess the utilization patterns of Sugammadex versus neostigmine in patients who received either rocuronium or atracurium, respectively. All data were summarized and prepared for statistical analysis using Microsoft Excel. To ensure data privacy, all participants were assigned a unique code, and identifying information was removed. The dataset was stored and managed on a password-protected computer accessible only to the principal investigator and the study statistician.

Statistical Analysis

Descriptive statistics were used to summarize the collected data. Nominal and categorical variables, including sex, BMI, ASA classifications, and comorbidities, were presented as frequencies and percentages. Age was categorized into six groups and similarly summarized. The Chi-square test of Independence was performed to evaluate the association between the clinico-demographic characteristics (age, sex, BMI, and ASA classifications) and the use of specific reversal agents. Furthermore, a multivariate logistic regression analysis was conducted to determine the independent effects of these variables on the choice of neuromuscular blocking agent reversal. Odds ratios (OR), 95% confidence intervals (CI), and p-values were reported for each group. All statistical analyses were performed using Jamovi version 2.3.17, with a two-sided p-value of <0.05 considered statistically significant.

RESULTS

A total of 294 participants were included in the study, majority of which were female adults at 152 (51.7%), ages 25-40 years old (31%). Followed by middle aged adults at 63 participants (21%). Most participants have a normal body mass index at 148 (50%). A great number of the participants included ASA classification of II and III, at 171 (58%) and 103 (35%), respectively. Comorbidities identified were hypertension, neoplasm, lung infections, diabetes mellitus, and bronchial asthma. A third were alcoholic beverage drinkers (30%), and smokers comprised 26% or the population. A small portion at 2.4% were pregnant.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue IX September 2025

Table 1. Sociodemographic Profile

Particulars	n	%
Sex		
Male	142	48.3
Female	152	51.7
Age		
Children (<12)	39	13.3
Teens (13-18)	23	7.8
Young Adults (19-25)	26	8.8
Adults (26-44)	92	31.3
Middle Age (45-60)	63	21.4
Elderly (>60	51	17.3
BMI		
Underweight	73	24.8
Normal	148	50.3
Overweight	48	16.3
Obese I	15	5.1
Obese II	10	3.4
ASA Classification		
ASA I	20	6.8
ASA II	171	58.2
ASA III	103	35

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue IX September 2025

Comorbidities		
Pregnant	7	2.4
Smoker	77	26.2
Alcohol Drinker	89	30.3
Hypertension	51	17.3
Diabetes Mellitus	12	4.1
Bronchial Asthma	12	4.1
Lung Infections	23	7.8
Neoplasm	49	16.78

NMBA agents were matched with the reversal agents used. Out of the 88 (29.9%) patients whom atracurium was used, all of whom were reversed with Atracurium. For the majority of the patients, rocuronium was used, 206 (70.1%). While most patients where rocuronium was used were reversed with Sugammadex, two (2) patients were reversed with Neostigmine. When descriptively compared, no similarities were found between the 2 patients, although one is a 35 male, ASA II class, smoker, and alcohol drinker, while the other is ASA III 58 female with neoplasm.

Table 2. Prevalence of the use of NMB and NMBA from June to December 2023

Muscle relaxant	n	%
Atracurium	88	29.9
Rocuronium	206	70.1
Reversal Agents used		
Neostigmine	90	30.6
Sugammadex	204	69.4
TOTAL	**294**	**100**

When comparing groups several factors were found to be significant. Children were the preferred population to use sugammadex rather than neostigmine, $p < 0.001$. Among those reversed with neostigmine, middle-aged

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue IX September 2025

patients and older is the preferred age group. In terms of body mass index, patients who are obese were reversed most often with neostigmine at 60% of the time, p = 0.039. Patients with noted comorbidities, classified under ASA II and ASA III have higher incidence of getting reversed with Sugammadex rather than neostigmine, at p value = 0.038.

In terms of sex, there was no statistically significant difference (p = 0.905) in the use of either Sugammadex or Neostigmine. Both male and female patients were nearly equally distributed between the two reversal agents. There was also no significant difference in smoking status (p = 0.324) or alcohol intake (p = 0.063), although slightly more non-smokers and alcohol users were given Sugammadex.

Table 3. Distribution of Patients reversed with Sugammadex vs Neostigmine

Particulars	**Sugammadex** **n (%)**	**Neostigmine** **n (%)**	**Total**	**P value**
Sex				
Male	99 (70)	43 (30)	142	0.905
Female	105 (69)	47 (31)	152	
Age				
Children (<12)	39 (100)	0	39	**<0.001**
Teens (13-18)	16 (70)	7 (30)	23	
Young Adults (19-25)	20 (77)	6 (23)	26	
Adults (26-44)	59(64)	33 (36)	92	
Middle Age (45-60)	36 (57)	27 (43)	63	
Elderly (>60)	34 (67)	17 (33)	51	
BMI				
Underweight	56 (77)	17 (23)	73	**0.039**
Normal	106 (72)	42 (28)	148	
Overweight	29 (60)	19 (40)	48	
Obese I	6 (40)	9 (60)	15	
Obese II	7 (70	3 (30)	10	
ASA Classification				

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue IX September 2025

ASA I	19 (95)	1 (5)	20	**0.029**
ASA II	113 (66)	58 (34)	171	
ASA III	72 (70)	31 (30)	103	
Smoking	50 (65)	27 (35)	77	0.324
Alcoholic Intake	55 (62)	34 (38)	89	0.063
Comorbidities				
Pregnant	4 (57)	3 (43)	7	**0.038**
Hypertension	30 (59)	21 (41)	51	
Diabetes Mellitus	9 (75)	3 (25)	12	
Bronchial Asthma	11 (92)	1 (8)	12	
Lung Infections	18 (78)	5 (22)	23	
Neoplasm	29 (59)	20 (41)	49	

The multivariate logistic regression analysis explored the independent influence of various clinico-demographic factors on the likelihood of using Sugammadex versus Neostigmine as a reversal agent. Sex was not a significant predictor, with males showing an odds ratio (OR) of 1.28 (95% CI: 0.69–2.38, p = 0.43) and females 0.78 (95% CI: 0.42–1.46, p = 0.43), indicating no notable association based on gender.

Among age groups, middle-aged patients had a significantly higher likelihood of receiving Sugammadex (OR = 3.24, 95% CI: 1.00–10.45, p = 0.04), suggesting a clinical preference for this reversal agent in this group. Other age groups did not show statistically significant differences.

Regarding BMI, patients classified as Obese I were significantly three times more likely to be given Sugammadex (OR = 3.25, 95% CI: 1.05–10.11, p = 0.04). Other BMI categories, including Obese II (OR = 1.68, p = 0.52), did not show meaningful associations.ASA classification was not significantly associated with reversal agent choice, although trends were noted—ASA I patients had higher odds of receiving Sugammadex (OR = 0.16, p = 0.09), and ASA III patients were more likely to receive Neostigmine (OR = 2.30, p = 0.11).

Neither smoking status (OR = 0.60, p = 0.24) nor alcohol intake (OR = 1.63, p = 0.07) showed significant associations, though alcohol intake approached borderline significance in favor of Sugammadex use.

Among comorbidities, a significant inverse association was found in patients with bronchial asthma, who were 88% less likely to receive Sugammadex (OR = 0.12, 95% CI: 0.01–1.00, p = 0.05). Other comorbidities such as pregnancy (OR = 2.6, p = 0.39), diabetes mellitus (OR = 1.92, p = 0.33), lung infections (OR = 1.5, p = 0.52), and neoplasms (OR = 1.95, p = 0.15) were not significantly associated with the choice of reversal agent.

In summary, the multivariate analysis identified middle age, Obese I BMI, and bronchial asthma as significant predictors of reversal agent use—highlighting that age, weight classification, and certain respiratory conditions may influence clinical decision-making in selecting between Sugammadex and Neostigmine.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue IX September 2025

Table 4. Multivariate Logistic Regression Analysis of the characteristics influencing the use of Sugammadex vs Neostigmine

Particulars	OR	95% CI	p value
Sex			
Male	1.28	0.69-2.38	0.43
Female	0.78	0.42-1.45	0.43
Age			
Children (<12)	1.65E-08	-	0.98
Teens (13-18)	0.97	0.3-3.16	0.96
Young Adults (19-25)	0.49	0.16-1.47	0.2
Adults (26-44)	2.04	0.68-6.09	0.2
Middle Age (45-60)	3.24	1.00-10.45	**0.04**
Elderly (>60)	1.96	0.57-6.7	0.283
BMI			
Underweight	1.36	0.64-2.88	0.42
Normal	0.73	0.35-1.56	0.41
Overweight	1.25	0.58-2.7	0.56
Obese I	3.41	1.05-11.03	**0.04**
Obese II	1.68	0.35-8.06	0.51
ASA Classification			
ASA I	0.16	0.02-1.41	0.09
ASA II	6.4	0.70-57.8	0.09
ASA III	2.3	0.23-22.63	0.5

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue IX September 2025

Smoking	0.46	0.16-1.27	0.13
Alcoholic Intake	1.63	0.59-4.51	0.35
Comorbidities			
Pregnant	2.6	0.46-14.79	0.28
Hypertension	1.32	0.59-2.98	0.5
Diabetes Mellitus	0.67	0.16-2.80	0.58
Bronchial Asthma	0.12	0.02-1.08	**0.05**
Lung Infections	0.87	0.27-2.78	0.81
Neoplasm	1.95	0.83-4.61	0.13

DISCUSSION

This study aimed to determine the factors influencing the use of neuromuscular blocking agent (NMBA) reversal agents at Amang Rodriguez Memorial Medical Center (ARMMC) from June to December 2023. Specifically, it sought to: 1) determine the prevalence of muscle relaxant reversal agent use; 2) identify clinico-demographic characteristics influencing Sugammadex use; and 3) identify clinico-demographic characteristics influencing neostigmine use.

Prevalence of Muscle Relaxant Reversal Agent Use

In this study, we find that there is a 69.4% prevalence of use of Sugammadex as a reversal agent, which was higher than the reported rate of the study of Dubovoy and team in 2020, which found a rate of 40%. [27] This suggests a potential shift in the use of reversal agents, specifically in ARMMC from as a result of different factors. Possible factors include the clinical characteristics of the patients, the known Sugammadex benefits, clinical protocols, and the like.

It is interesting to note why Sugammadex is observed as the preferred reversal agent. Sugammadex directly encapsulates the NMBA Rocuronium, forming a complex that is then excreted. The resulting reduction in concentration of free muscle relaxant leads to a rapid offset of neuromuscular block.[28] This allows for a more rapid reversal of neuromuscular blockade, even during deep blockades where other agents may be less effective. This affirms an earlier study from Jones in 2008, when he and his team looked into the reversal of profound rocuronium-induced blockade with Sugammadex (a randomized comparison with neostigmine). They concluded that recovery from profound rocuronium-induced neuromuscular blockade was significantly faster with Sugammadex versus with neostigmine, suggesting that Sugammadex has a unique ability to rapidly reverse profound rocuronium neuromuscular blockade.[29]

Clinico-demographic characteristics and Reversal Agents

The study identified several clinico-demographic characteristics influencing the choice of reversal agent. Sugammadex was observed to be mostly used on middle aged and obese patients, which aligns with the findings in a 2021 study which has identified age as a factor in reversal agent selection, with Neostigmine as

the agent used on younger patients.[30] Similarly, the association between obesity and Sugammadex use aligns with the findings of Dubovoy et al. (2020), who noted that patients with comorbidities, including obesity, were more likely to receive Sugammadex.[27] These findings suggest that anesthesiologists at ARMMC consider these factors when selecting reversal agents, possibly due to concerns about prolonged paralysis or other complications in these patient populations. For obese patients, prolonged or residual blockade can lead to significant respiratory complications, which practitioners would like to avoid.

This study also found that patients with bronchial asthma were less likely to receive Sugammadex. This interesting finding has not been extensively discussed in other studies, such as the REVEAL study by Greco et al. (2023), which identified respiratory diseases as a factor influencing NMBA reversal, but did not specifically focus on reduced Sugammadex use in asthmatic patients.[31] This is an opportunity for further investigation to determine if this is a localized practice, a potential contraindication, or if there are other factors influencing this result.

In conclusion, this study provides valuable insights into the factors influencing NMBA reversal agent use at ARMMC. It highlights a higher prevalence of Sugammadex use compared to some other settings and confirms the importance of age and BMI in the selection of reversal agents. Additionally, the study raises an interesting question about the relationship between bronchial asthma and Sugammadex use, which requires further research. These findings contribute to the understanding of anesthetic practices and can potentially inform the development of local guidelines and protocols.

CONCLUSION

This study offers insights into the patterns of NMBA reversal agent use within Amang Rodriguez Memorial Medical Center (ARMMC). The research highlights a higher prevalence of Sugammadex use compared to findings in other studies, suggesting a potential shift in practice or institutional preference. The study also affirms the significance of patient-specific factors, particularly age and BMI, in selecting reversal agents by anesthesiologists. These findings underscore the importance of tailoring anesthetic practices to individual patient characteristics to optimize safety and efficacy.

The research also brings to light an intriguing observation regarding the relationship between bronchial asthma and Sugammadex administration. The study found that patients with bronchial asthma were less likely to receive Sugammadex, a result that differs from findings in other major studies. Investigating why could reveal important clinical considerations or potential areas for protocol refinement.

In conclusion, this study contributes to a deeper understanding of anesthetic practices at ARMMC and provides a foundation for enhancing patient care. By identifying key factors that influence reversal agent selection and uncovering areas for further inquiry, this research can inform the development of local guidelines and protocols aimed at optimizing patient safety and improving clinical outcomes.

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