Research Article

Open Access Journal of
Biomedical Science
ISSN: 2690-487X

# Relationship Between Neuromuscular Blocking Agents and Mean Blood Pressure in Critical Patients

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## ABSTRACT

**Introduction:** Neuromuscular blockers (NMBs) are initially natural and synthetic substances capable of producing muscle paralysis by acting on the neuromuscular junction. They are widely used during surgeries and are currently an effective modality for the challenges of patients in critical care units.

**Aim:** To conduct a review of the most up-to-date literature on neuromuscular blockers and their effect on mean arterial pressure in critically ill patients.

**Method:** Detailed bibliographic search of the most relevant published information in the pubmed, scielo, medline databases, national and international libraries specialized in the topics covered in this review article.

**Results:** Atracurium and cisatracurium are neuromuscular blocking agents, two studies were included, the first conducted by Vander LA [1] whose sample was 119 patients with 56 patients receiving continuous infusion of atracurium and 63 patients receiving continuous infusion of cisatracurium. Another study conducted by Kosciuczuk [2] carried out a study with the aim of investigating the effects of rocuronium used in intubation doses, 126 patients were included. In all cases there was a decrease in MAP.

**Conclusion:** The use of nondepolarizing neuromuscular beta-blockers such as rocuronium, cisatracurium, atracurio and Mivacurium in critical patients for intubation, in high doses promotes a decrease in mean arterial pressure and with it the appearance of hypotension and hemodynamic instability.

**KEYWORDS:** Blockers; PAM; ICU; Neuromuscular

**ABBREVIATIONS:** NMB: Neuromuscular blockers; ANS: Autonomic Nervous System; MV: Mechanical ventilation

**Quick Response Code:**

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**Received:** March 06, 2023 **Published:** August 09, 2023

**How to cite this article:** Andres FBG, Nataly RB, Laura MMS, Nelson YQL, Hector HBH, et al. Relationship Between Neuromuscular Blocking Agents and Mean Blood Pressure in Critical Patients. 2023- 5(4) OAJBS.ID.000566. **DOI:** 10.38125/OAJBS.000566

## INTRODUCTION

Neuromuscular blockers (NMB) are drugs used to relax striated muscles and are known to be part of the therapeutic arsenal. They are very commonly used in clinical practice to ensure tracheal intubation, ventilation and produce a sufficient surgical plane for the surgeon to adequately perform the surgical procedure [1,2]. The main effect of drugs that block the junction Neuromuscular (NMB) is the interruption of nerve impulse transmission at the motor endplate, through antagonism of the nicotinic acetylcholine (ACh) receptor, as shown in Figure 1; [3].

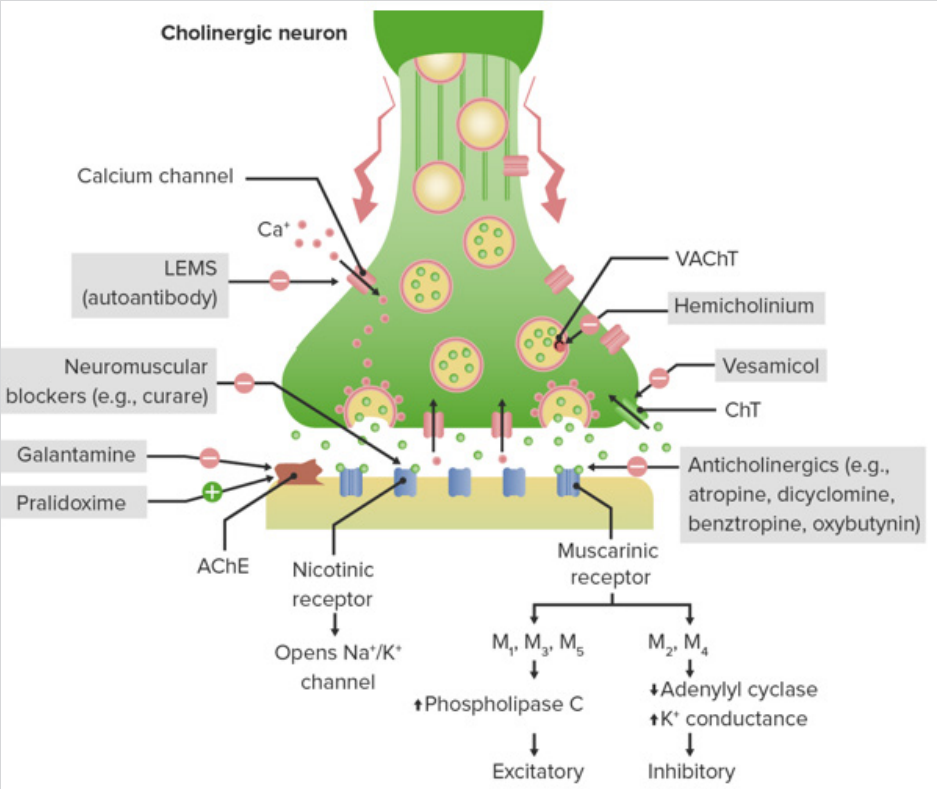


**Figure 1:** Mechanism of action of neuromuscular blockers.

**Table 1:** Characteristics of the most used neuromuscular blockers in clinical practice.

| | Drug | Times of Action and Dose | Indications | Contraindications | Side Effects and Others |
|---|---|---|---|---|---|
| Depolarizing | Succinylcholine | Onset: 10 s Duration: 5-10 m Bolus: 1-2 mg/kg | Intubation but contraindicated | Burns, polytraumatized, crushed, history of malignant hyperthermia, neuroleptic malignant syndrome, myopathies, Guillain-Barré, injuries to the eyeball... | There is no antidote Metabolism: cholinesterase Histamine release and PIO increase |
| Nondepolarizing | Rocuronium | Start: 30-45 s Duration: 45 m Bolus: 0.5-1 mg/kg Infusion: 0.3-0.6 mg/kg/ hour | Intubation and maintenance of relaxation | | Metabolism: hepatic May require refrigerator Antidote: sugammadex |
| | Cisatracurium | Start: 90-150 s Duration 30-60 m Bolus: 0.1-0.3 mg/kg Infusion: 0.05-0.6 mg/kg/h | Intubation and maintenance of relaxation In IH and IR | | Metabolism: cholinesterase No histamine release Good hemodynamic tolerance |
| | Atracurium | Start: 1-4 m Duration: 30-40 m Bolus: 0.3-0.5 mg/kg Infusion: 0.25-1.77 mg/kg/h | Intubation and maintenance of relaxation in myopathies, IH and IR | Bronchial hyperreactivity and hemodynamic instability | Histamine release |
| | Mivacurium | Start: 1.5-2 m Duration: 15- Bolus: 0.1-0.2 mg/kg Infusion: 0.5-0.8 mg/kg/h | Intubation and maintenance of relaxation | | Histamine release |

**Abbreviations:** SRI: Rapid intubation sequence; IH: Liver failure; IR: Renal failure; PIO: intraocular pressure

Two types of neuromuscular blockers can be distinguished according to the mechanism of action, where it is evident that in both cases there is binding to the acetylcholine receptor of the neuromuscular junction, but a situation can be observed where activation occurs until the membrane is exhausted. (depolarizing) or a block to prevent its activation (non-depolarizing). Table 1 shows the drugs most used in clinical practice and their characteristics [4].

The appearance of prospective studies at the beginning of the nineties, have suggested that up to 70% of critically ill patients could manifest muscle weakness after a prolonged administration of certain blockers such as vecuronium and pancuronium, such evidence has led to limit their indications and reduce them to a minimum. the periods and depth of the block are essential [5,6]. For this reason, the use of this pharmacological group has always been controversial in critically ill patients, but, despite everything, it continues to be a common practice, used in between 1% and 20% of hospitalized adult patients. in ICUs and a little more in pediatric patients [7,8]. Its use is of great relevance because assisted ventilation has become a common way of treating very seriously ill patients [9]; (Table 2).

**Table 2:** Indications for the use of neuromuscular blockers.

| | |
|---|---|
| Facilitation of the Management of Mechanical Ventilation (89%) | Endotracheal intubation |
| | Adaptation of the patient to the ventilator |
| Hyperventilation in Cases of Increased Intracranial Pressure (35%) | Abolition of tremor and fasciculations |
| Decreased Oxygen Consumption (25%) | Decreased work of breathing |
| Agitation despite good sedation (23%) | Aspiration of secretions from the airway |
| Facilitation of some therapeutic or diagnostic techniques (15%) | Bronchoscopy, gastroscopy, tomography, Magnetic Nuclear Resonance, etc. |
| Patient Transport | To other services |
| | To other institutions |
| Misc | Tetanus |
| | Status epilepticus |
| | Neuroleptic malignant syndrome |
| | Strychnine and methaqualone poisoning |

Now as mentioned before, neuromuscular paralysis is a necessary fact in most general anesthesia techniques. Clinically significant cardiovascular effects (autonomic and hemodynamic) are present with some of these drugs. Such effects on the cardiovascular system produced by neuromuscular blockers are largely due to stimulation or inhibition at the level of the Autonomic Nervous System (ANS). Histamine release. Changes in serum potassium concentrations. Release of noradrenaline and direct action on contractility, this brings with it alterations in Systemic Vascular Resistance, changes in venous capacitance, alterations in myocardial contraction, in the frequency, heart rhythm and an alteration in mean Arterial Pressure [10].

## MATERIALS AND METHODS

A detailed bibliographic search of the most relevant published information was carried out in the databases PubMed, Scielo, Medline, national and international libraries specialized in the topics covered in this review article. The following descriptors were used: Blockers, PAM, ICU, Neuromuscular. The data obtained oscillate between 5 and 30 records after the use of the different keywords. The search for articles was conducted in Spanish and English, limited by year of publication, and studies published from 2000 to the present were used.

## RESULTS

Neuromuscular blockers are drugs that act on the neuromuscular junction, preventing the transmission of impulses, for this reason, they are widely used during surgeries and currently it is an effective modality for the challenges of patients in critical care units because it facilitates endotracheal intubation. optimize ventilation and reduce oxygen requirements. However, the choice of these drugs will depend on drug interactions and patient comorbidities (hepatic or renal failure) that may cause changes in the pharmacokinetics of NMBs. Therefore, it is essential that clinicians are familiar with the appropriate use of NMB in order to select the appropriate indications for its use and avoid complications [11,12]. Atracurium and cisatracurium are benzylisoquinolinium nondepolarizing neuromuscular blocking (NMB) agents that are inactivated by plasma hydrolysis and Hofmann elimination. As a result, they do not accumulate in patients with hepatic or renal failure, making them useful in critically ill patients [13].

Atracurium is associated with a decrease in mean arterial pressure (MAP) of up to 30 mmHg within 2 minutes of onset, which could lead to hypotension and may be related to histamine release. Vander LA [1] did a study that included 119 patients with 56 patients receiving continuous infusion of atracurium and 63 patients receiving continuous infusion of cisatracurium. The primary outcome was the incidence of hypotension (mean arterial pressure <60 mmHg). Secondary outcomes included: incidence of blood pressure drop of >20% from baseline, time to first hypotensive episode, treatment for hypotension during NMB use, hospital mortality, length of stay in ICU and in hospital the hospital (LOS), duration of mechanical ventilation (MV), and duration of NMB [14].

Furthermore, Kosciuczuk U [2] carried out a study with the aim of investigating the effects of rocuronium used in intubation doses and followed by infusion on hemodynamic parameters during general anesthesia combined with non-cardiac surgery. The parameters of heart rate mean arterial pressure, systolic and diastolic. In said study 126 patients were included resulting in a significant reduction in heart rate, systolic, diastolic and mean blood pressure at the end of rocuronium infusion compared to values before anesthesia, respectively by 8.7%. [15,16].

## DISCUSSION

Mean arterial pressure, defined as the mean of arterial pressure in large-caliber arteries during the cardiac cycle, is one of the most important parameters to assess in critically ill patients. It is estimated that neuromuscular blockers produce an effect on this, among which are mainly Cisatracurium and Mivacurium. In studies carried out, the administration of Cisatracurium does not produce a variability in the values of mean arterial pressure. In turn, Mivacurio increases basal histamine levels by 370% in one minute and by 223% at 3 minutes, which is important since the release of histamine causes peripheral vasodilation, arterial hypotension, tachycardia, and increased blood pressure. coronary perfusion [17]. In studies carried out such as that of Ortiz GJ [18] bradycardia and arterial hypotension are mainly related to high doses and rapid infusion, so that in doses of 0.15 mg/kg the mean arterial pressure is 12 and 16% and with doses from 0.2 mg/kg it goes to 25 and 35% [18].

On the other hand, Carrascosa F [19] and his collaborator state that the changes in mean arterial pressure at doses of up to 0.15 mg.kg-1 are less than 7%, while when mivacurium is administered in 10-15 seconds. at doses of 0.20, 0.25 or 0.30 mg.kg-1 a decrease in mean arterial pressure of 18, 13 and 32% respectively is observed, changes that are transient in healthy patients, however, in those who have heart disease or who are being treated with hypotensive drugs should consider slow administration and doses lower than 0.15 mg.kg [19].

In turn, Herrera [20] in his research work, evaluates the effect of the combination of lidocaine with rocuronium in orotracheal intubation. Based on the hypothesis that lidocaine attenuates the hemodynamic response during intubation and increases the potency of neuromuscular blocking agents, patients operated on at Dos de Mayo Hospital were selected and divided into 2 groups, one in which was administered lidocaine and another that did not, in which it was observed that in the hemodynamic parameters there was a significant difference $p > 0.05$. When comparing the latency time of the group that did not contain lidocaine (x104.19 sec. ± 22.62 SD) and that of the group with lidocaine (x73, 10 sec. ± 16.71 SD), a difference of 31 seconds in favor of the group with lidocaine, which is statistically significant $p < 0.001$, therefore it was concluded that this combination favors the intubation process, decreases the necessary dose of neuromuscular relaxant and in turn allows greater hemodynamic stability of the patient [20].

## CONCLUSION

Beta-blockers are used in critically ill patients to improve intubation techniques; however, it has been observed that these drugs have an adverse effect on receptors present in endothelial smooth muscle, promoting its dilation. This has been observed in critically ill patients who underwent the use of non-depolarizing neuromuscular beta blockers such as rocuronium, cisatracurium, atracurio and mivacurium, where, in high doses, it was possible to observe the decrease in systolic and diastolic blood pressure and with it, the drop in mean arterial pressure with the subsequent appearance of hypotension and hemodynamic instability, generating longer hospitalization time in the ICU and the need for of treatment to regulate blood pressure to normal values.

## REFERENCES


1. Vander Weide LA, Abdel-Rasoul M, Gerlach AT (2017) The incidence of hypotension with continuous infusion atracurium compared to cisatracurium in the intensive care unit. Int J Crit Illn Inj Sci 7(2): 113-118.
2. Kosciuczuk U, Gluszynska P, Diemieszczyk I, Aleksander L, Krzysztof B, et al. (2021) Effect of rocuronium on the heart rate and arterial blood pressure during combined general anesthesia. Disaster and Emergency Medicine Journal 6(3): 104-111.
3. Ortiz GJ (2002) Bloqueantes neuromusculares no despolarizantes en la anestesia total intravenosa: atracurio, cisatracurio, mivacurio, vecuronio y rocuronio. Departamento de Anestesiología, Reanimación, Cuidados Intensivos y Terapia del Dolor. Clínica Universitaria Navarra pp.147-160.
4. Cordero E (2018) Interacción farmacológica de los bloqueadores neuromusculares con fármacos de uso anestesiológico. Revista Cubana de Anestesiología y Reanimación 17(1): 1-11.
5. Rodríguez LV, Carlos ST, Alberte MW (2012) Uso de betabloqueantes. A propósito de un caso. Cadernos de atención primaria 18(4): 306-309.
6. Marcos Oltra AM, López Castilla JD, Brandstrup Azuero KB (2020) Uso de relajantes neuromusculares en UCIP. Protoc diagn ter pediatr 3: 93-102.
7. Michael JM, Heidi D, Erstad B, Anthony G, Judi J, Che Jordan, et al. (2016) Clinical practice guidelines for sustained neuromuscular blockade in the adult critically ill patient. Crit Care Med 44(11): 2079-2103.
8. Roberto CRD, Johan Sebastián JRD (2011) Bloqueantes neuromusculares: en pro del uso adecuado. Colombian Journal of Anestesiology 39(3): 352-357.
9. Carrasco OV (2009) Unidad en cuidados intensivos. Revista Médica La Paz 15(2): 46-57.
10. Pardos P, Cruz C, Fernández R, Garutti I (2005) Betabloqueantes: utilidad perioperatoria en cirugía no cardíaca. Rev Esp Anestesiol Reanim 52(10): 617-626.
11. Telechea, Héctor (2019) Evaluación del uso de sedación y analgesia en niños con asistencia ventilatoria mecánica. Archivos de Pediatría del Uruguay 90(1): 6-11.
12. Laynez C, Jorge M, Morales R, Herbert A, Molina A, et al. (2016) Caracterización clínica y epidemiológica de pacientes en ventilación manual asistida. Rev med interna Guatem 20(3): 12-17.
13. Casacó V, Barrios S, Hernández I, López Q, Escobar IC, et al. (2009) Influencia de los relajantes musculares sobre la presión arterial media, frecuencia y ritmo cardíaco estudio comparado. Rev cuba anestesiol reanim 8(1).
14. Murray MJ, DeBlock H, Erstad B, Gray A, Jacobi J, et al. (2016) Clinical practice guidelines for sustained neuromuscular blockade in the adult critically ill patient. Crit Care Med 44(11): 2079-2103.
15. Stäuble, Cristiane G, Blobner M (2020) The future of neuromuscular blocking agents. Current Opinion in Anaesthesiology 33(4): 490-498.
16. Murray MJ, Deblock H, Erstad B, Gray A, Jacobi J, et al. (2016) Clinical practice guidelines for sustained neuromuscular blockade in the adult critically ill patient. Crit Care Med 44(11): 2079-2103.
17. Robertson EN, Driessen JJ, Booij LH (2005) The use of rocuronium in various clinical situations. Eur J Anaesthesiol 22(1): 4-10.
18. Gomez OJ, Carrascosa F, Mivacurio (2000) Relajantes musculares en anestesia y terapia intensiva. Aran Eds Madrid 59(2): 325-342.
19. Carrascosa F, Ortiz J (1997) Mivacurio. Rev Esp Anestesiol Reanim 44(8): 315-320.
20. Herrera Z, Shane P (2014) Efecto de la lidocaína endovenosa sobre la latencia del rocuronio y la respuesta hemodinámica a la intubación. Tesis de posgrado Lima Peru.