South American Publishing

SAP Multidisciplinary Open. 2025; 3:58
doi: 10.62486/mo202558

BRIEF COMMUNICATION

The use of beta blockers in septic shock

El uso de betabloqueantes en el shock séptico

Nathalia Dornellas Sant'Anna[1], Anibal Danilo Farias[1]

[1]Facultad de Medicina y Ciencias de la Salud, Universidad Abierta Interamericana. Argentina.

Cite as
Dornellas Sant'Anna N, Danilo Farias A. The use of beta blockers in septic shock. SAP Multidisciplinary Open. 2025; 3:58. https://doi.org/10.62486/mo202558

Publication History
Submitted: 19-03-2024
Revised: 11-06-2024
Accepted: 01-10-2024
Published: 01-01-2025

Corresponding Author
Nathalia Dornellas Sant'Anna

ABSTRACT

Introduction: the mortality rate in septic patients or septic shock is still very high. Beta-blockers can reduce an overstimulation of adrenergic receptors in septic patients or in septic shock treated in ICU.
Objective: to analyze the usefulness of the use of beta-blockers in septic shock.
Method: a synthesis of available materials on the use of beta-blockers in septic patients and septic shock was performed for a review of the literature. Available articles reporting cases of treatment of this entity were included. For this purpose, information was searched using keywords.
Results: septic shock is a clinical entity that requires rapid action by health teams. It triggers effects at all levels of the economy; however, the management of the cardiovascular system is essential for the reestablishment of the normal functioning of the organism, hence drugs with an effect on the cardiovascular system are highly analyzed.
Conclusions: the literature suggests that the use of beta-blockers in patients with septic shock may be useful; however, it is necessary to study the available scientific evidence from a systematic approach, as well as to carry out clinical trials.

Keywords: Beta-blockers; Sepsis; Septic Shock.

RESUMEN

Introducción: el índice de mortalidad en pacientes sépticos o Shock séptico todavía es muy alto. Los betabloqueantes pueden reducir un sobre estimulo en receptores adrenérgicos de los pacientes sépticos o en shock séptico tratados en UTI.
Objetivo: analizar la utilidad del uso de betabloqueantes en el shock séptico.
Método: se realizó una síntesis de materiales disponibles a cerca del uso de betabloqueantes en pacientes sépticos y shock séptico para una revisión de la literatura. Se incluyeron artículos disponibles que reportaron casos de tratamiento de esta entidad. Para esto se realizaron búsquedas de información mediante el empleo de palabras clave.
Resultados: el shock séptico es una entidad clínica, que necesita de una rápida acción por parte de los equipos de salud. Esta desencadena efectos en todos los niveles de la economía, sin embargo, el manejo del sistema cardiovascular es esencial para el restablecimiento del normal funcionamiento del organismo, de ahí que los fármacos con efecto en el sistema cardiovascular sean altamente analizados.
Conclusiones: la literatura sugiere que el uso de betabloqueadores en el paciente con shock séptico puede ser de utilidad, sin embargo, se hace necesario el estudio de la evidencia científica disponible desde un enfoque sistemático, así como de la realización de ensayos clínicos.

Palabras clave: Betabloqueantes; Sepsis; Shock Séptico.

© 2025; The Authors. This Open access article is distributed under the Creative Commons Attribution 4.0 license (https://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Despite the reduction in mortality of septic and septic shock patients in the last 50 years, there is still a high number of deaths among patients in this state.[1] Septic shock is characterized by circulatory collapse and decreased tissue perfusion, leading to organ dysfunction under conditions of systemic infection. In antiquity, sepsis and shock were associated with organ putrefaction.[2]

Sepsis is characterized by cardiovascular dysfunction, such as hypotension and hyporesponsiveness to vasoconstrictors. Laboratory data demonstrate that impaired vascular reactivity is related to decreased density of adrenergic receptors.[1,2,3]

Beta-blockers reduce myocardial oxygen consumption and sympathetic overstimulation of beta-adrenergic receptors, which produces a catecholamine mediator production response in a sepsis setting. This also involves cytokine production and modulation of the immune system, which is deleterious.[2,3]

The paradoxical study of previous beta-blocker use focuses mainly on short-acting beta-blockers (esmolol or landiolol). The findings suggest that receptor blockade restores vascular reactivity.[4]

This study analyzed the usefulness of beta-blockers in septic shock.

METHOD

For this work, a search for information was performed using the MEDLINE (PubMed), Epistemonikos, and Google Scholar databases. The filters used were related to sepsis, septic shock, treatment in patients with sepsis or septic shock in the ICU, and the use of beta-blockers in these patients.

The search terms were "beta blockers in sepsis", "beta blockers in sepsis", and "septic shock". Abstracts were reviewed to identify research with contributions to the object of study.

DEVELOPMENT

Sepsis is defined as life-threatening organ dysfunction due to a dysregulated immune response to infection. However, there was a differentiation in this concept to improve treatment, being defined as Systemic Inflammatory Response Syndrome (SIRS), which is a set of clinical manifestations in response to aggression in the absence of infection, presenting two or more of the following symptoms:[1,5,6]

- Temperature >38,3°C or <36°C
- Heart rate >90 bpm
- Respiratory rate >20 rpm or PaCO2 <32 mmHg or need for mechanical ventilation
- Leukocytes >12 000 or <4 000, or presence of young cells >10 %.
- Hypoperfusion
- Hypotension
- Hypoxemia
- Lactic acidosis
- Oliguria
- Acute alteration of mental status

Septic shock[2,3,7]

In acute circulatory failure, arterial hypotension persists with a systolic pressure <90 mmHg and diastolic <40 mmHg or mean arterial pressure <60 mmHg, requiring blood volume replacement and vasopressors.

Sequential Organ Failure Assessment (SOFA) is required. The table below quantifies abnormalities according to clinical and laboratory findings and therapeutic interventions and is used to assess the degree of severity.

Vascular system in sepsis[3]

Sepsis can cause acute circulatory failure, considered the most important dysfunction in this condition. The aorta and its primary branches are the main parts of the vascular system.

Blood is ejected with each heartbeat from the left ventricle into the aorta and flows rapidly through the arterial conduction system to the organs. Arteries are efferent vessels about the heart, which decrease in calibre as they branch distally and end in arterioles, where gas and nutrient exchange occurs.

The control of blood pressure is determined by several mechanisms, including vascular tone, which is the contractility of the smooth muscles of the vascular wall due to increased intracellular calcium. This can be induced by neural ligands or hormonal agents such as noradrenaline or angiotensin II through specific membrane receptors or by changes in the membrane potential of these cells. When depolarization occurs, voltage-dependent calcium channels Open, allowing the influx of extracellular calcium into the cell.

Relaxation of the smooth muscle cells of the vessels occurs by the decrease in cytoplasmic calcium, which can be expelled from the intracellular medium to the extracellular medium or recaptured by the sarcoplasmic reticulum. Mediators such as nitric oxide, acetylcholine, serotonin and histamine activate guanylate cyclase and adenylate cyclase, increasing cGMP and cAMP levels. Patients in shock have elevated levels of nitrite/nitrate, stable compounds generated from NO.

Escala SOFA (*Sepsis related Organ Failure Assessment*)					
CRITERIOS	0	1	2	3	4
SNC Escala de Glasgow	15	13-14	10-12	6-9	< 6
Renal Creatinina (mg/dl) Diuresis (ml/dia)	< 1,2	1,2-1,9	2-3,4	3,5-4,9 ou < 500	> 5 ou < 200
Hepático Bilirrubina (mg/dl)	< 1,2	1,2-1,9	2-5,9	6-11,9	> 12
Coagulación Plaquetas $10^3/mm^3$	≥ 150	< 150	< 100	< 50	< 20
Respiratorio PaO_2/FiO_2 (mmHg)	≥ 400	< 400	< 300	< 200 y soporte ventilatorio	< 100 y soporte ventilatorio
Cardiovascular TAM (mmHg) Drogas vasoactivas (µg/kg/min)	≥ 70	< 70	Dopamina a < 5 o dobutamina a cualquier dosis	Dopamina 5-15 Noradrenalina o adrenalina ≤ 0,1	Dopamina > 15 Noradrenalina o adrenalina > 0,1

SNC: sistema nervioso central; PaO_2: presión arterial de oxígeno; FiO_2: fracción de oxígeno inspirado; TAM: tensión arterial media.

Figure 1. SOFA Scale

This excess NO production, induced by a calcium-independent NOS isoform (iNOS), is primarily responsible for the vascular hyporeactivity observed in sepsis. The large amount of NO is a key mediator of cardiovascular dysfunction during sepsis and septic shock, associated with decreased vascular tone, being an important factor in the pathophysiology of this disease.

Beta-blockers

Landiolol is an ultra-short-acting beta-blocker, similar to esmolol in its action, but with greater potency, cardioselectivity, and less impact on blood pressure, making it possible to reduce heart rate without significantly affecting blood pressure. It is 8-12 times more potent than esmolol. It is administered IV in 10-40 mcg/kg/min doses, with a perfusion rate adjusted in ml/h.[7]

Esmolol is a beta-1-adrenergic cardio-selective that does not have sympathomimetic or membrane-stabilizing action. It is indicated for supraventricular tachycardia, uncompensated sinus tachycardia, ventricular rhythm control in patients with atrial fibrillation or flutter in perioperative and postoperative periods, sinus tachycardia, treatment of tachycardia and hypertension during induction of anaesthesia and intubation. It is administered in 10 mg/ml IV doses as a bolus.[8]

Effects of beta-blockers in sepsis and septic shock.

The benefits of beta-blockers in septic and septic shock patients are wide-ranging, from improving cardiac function and microcirculation to anti-inflammatory and anticoagulant effects, improving patient survival.[2,3,4,5,9,10]

The literature reviewed[1,2,3,3,4,5,5,6,9,10] suggests that using beta-blockers in septic patients and patients with septic shock may reduce adrenergic overstimulation. Patients who received this treatment showed better short-term outcomes than those not treated with beta-blockers. Those who started treatment and discontinued it had a higher mortality rate. Patients who did not receive beta-blockers had a higher mortality.

CONCLUSIONS

The literature suggests that the use of beta-blockers in patients with septic shock may be useful; however, it is necessary to study the available scientific evidence from a systematic approach and carry out clinical trials.

FINANCING

The authors did not receive funding for the development of this research.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR'S CONTRIBUTION

Conceptualization: Nathalia Dornellas Sant'Anna, Anibal Danilo Farias.
Data curation: Nathalia Dornellas Sant'Anna, Anibal Danilo Farias.
Formal analysis: Nathalia Dornellas Sant'Anna, Anibal Danilo Farias.
Research: Nathalia Dornellas Sant'Anna, Anibal Danilo Farias.
Methodology: Nathalia Dornellas Sant'Anna, Anibal Danilo Farias.

Project administration: Nathalia Dornellas Sant'Anna, Anibal Danilo Farias.
Writing - original draft: Nathalia Dornellas Sant'Anna, Anibal Danilo Farias.
Writing - revision and editing: Nathalia Dornellas Sant'Anna, Anibal Danilo Farias.

REFERENCES

1. Vela-Vásquez RS, Grigorov-Tzenkov I, Aguilar JL. Bloqueadores beta en shock séptico: una revisión. Revista Española de Anestesiología y Reanimación. 2015; 62(2). https://doi.org/10.1016/j.redar.2014.07.003.

2. Entropía aproximada de la frecuencia cardíaca para el diagnóstico precoz de sepsis en adultos internados en terapia intensiva. Rev Fac Cien Med Univ Nac Cordoba. 2023;80. https://revistas.unc.edu.ar/index.php/med/article/view/42828

3. Espinoza Villafuerte MV, Martínez Zubieta R, Zaragoza Galván JJ. Relación entre consumo crónico de betabloqueadores y mortalidad en sepsis y choque séptico. Med. crít. (Col. Mex. Med. Crít.). 2017; 31(2): 74-77. http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S2448-89092017000200074&lng=es.

4. Cruz MC, Reis L. Betabloqueadores no choque séptico: já chegamos lá?. Rev bras ter intensiva. 2017; 29(1):1–3. https://doi.org/10.5935/0103-507X.20170001

5. Efeito paradoxal do antagonismo alfa-1 adrenérgico na disfunção vascular da sepse. Disponible en: https://repositorio.ufsc.br/handle/123 456789/193209

6. Hasegawa D, Sato R, Prasitlumkum N, Nishida K, Takahashi K, Yatabe T, Nishida O. Effect of Ultrashort-Acting β-Blockers on Mortality in Patients With Sepsis With Persistent Tachycardia Despite Initial Resuscitation: A Systematic Review and Meta-analysis of Randomized Controlled Trials. Chest. 2021; 159(6):2289-2300. doi: 10.1016/j.chest.2021.01.009

7. Landiolol: pharmacology and its use for rate control in atrial fibrillation in an emergency setting. Disponible en: https://cima.aemps.es/cima/dochtml/ft/89271/FT_89271.html

8. Vadmecum Esmolol. Disponible en: https://www.vademecum.es/principiosactivos-esmolol-c07ab09-us

9. Reed EB, Tarver H. The influence of diet on the lipogenic response to thyroxine in rat liver. Life Sci. 1975 Dec 15;17(12):1785-97. https://pubmed.ncbi.nlm.nih.gov/3705 6709/

10. Sanfilippo F, Santonocito C, Morelli A, Foex P. Beta-blocker use in severe sepsis and septic shock: a systematic review. Curr Med Res Opin. 2015;31(10):1817-25. doi: 10.1185/03007995.2015.1062357.