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2734 17 Avenue SW,
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Canada
+15878858911
editorial-office@sciformat.ca

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NORADRENALINE OR DOPAMINE IN CARDIOGENIC SHOCK - A LITERATURE REVIEW

Antoni Liebert (Corresponding Author, Email: antoniliebert25@gmail.com)

Medical University of Warsaw, 02-091 Warszawa, Poland

ORCID ID: 0009-0004-8778-1803

Katarzyna Mazurek

Medical University of Warsaw, 02-091 Warszawa, Poland

ORCID ID: 0009-0007-4656-0897

Anna Dominiczak

Medical University of Warsaw, 02-091 Warszawa, Poland

ORCID ID: 0009-0008-5984-2866

Marta Brzęcka

Medical University of Warsaw, 02-091 Warszawa, Poland

ORCID ID: 0009-0007-1853-1415

Stanisław Rogiński

Uniwersytet Medyczny w Poznaniu im. Karola Marcinkowskiego 61-701 Poznań, Poland

ORCID ID: 0009-0007-7867-512X

Karol Krupiniewicz

Wojewódzki Szpital Specjalistyczny im. Janusza Korczaka w Słupsku, Poland

ORCID ID: 0009-0004-4255-4412

Marek Wojciechowicz

Gdański Uniwersytet Medyczny, 80-210 Gdańsk, Poland

ORCID ID: 0009-0000-3963-6805

Miłosz Rogiński

Gdański Uniwersytet Medyczny, 80-210 Gdańsk, Poland

ORCID ID: 0009-0007-1863-1416

Mariusz Suchcicki

Szpital Kliniczny Ministerstwa Spraw Wewnętrznych i Administracji z Warmińsko-Mazurskim Centrum Onkologii w Olsztynie, Poland

ORCID ID: 0009-0008-6988-4664

Łukasz Chojnowski

Szpital Morski im. PCK Gdynia, Poland

ORCID ID: 0009-0005-6077-8636

ABSTRACT

Introduction and purpose: Cardiogenic shock is a clinically specific cause of death that is hard to treat, and choosing the most effective medication remains a major clinical challenge. The aim of this study is to provide key information about this clinical condition and to compare the drugs most frequently used in the treatment of cardiogenic shock: noradrenaline and dopamine.

Materials and methods: A literature search was conducted using the medical database PubMed and Google Scholar. Articles were retrieved using the keywords: „Noradrenaline”, „Dopamine”, „Cardiogenic shock”, „Hypotension” in appropriate configuration.

Results: Four studies were found with relevant topics. One of these studies was excluded due to different vasopressors being compared in one of the trials considered in the meta-analysis. Finally, 3 scientific articles were systematically analyzed in our work.

Conclusions: According to the available medical literature, recommendations, and guidelines, the use of noradrenaline in patients with cardiogenic shock is usually the most appropriate choice. However, the choice of dopamine is also available but it has been linked with a higher risk of complications linked with cardiac arrhythmias.

KEYWORDS

Noradrenaline, Dopamine, Cardiogenic Shock, Hypotension

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1. Introduction

Cardiogenic shock (CS) is a life-threatening clinical syndrome characterized by inadequate tissue perfusion due to primary cardiac dysfunction, resulting in severe hypotension, end-organ hypoperfusion, and high mortality rates.[1] Despite significant advances in cardiovascular care, cardiogenic shock remains one of the most challenging conditions encountered in intensive care units and cardiology departments worldwide.

The most common underlying cause of cardiogenic shock is acute myocardial infarction (AMI), particularly ST-segment elevation myocardial infarction (STEMI). Epidemiological data indicate that cardiogenic shock complicates approximately 5–8% of STEMI cases and 2–3% of non-ST-segment elevation myocardial infarctions (NSTEMI). However, in recent years, the etiological profile of cardiogenic shock has shifted, with an increasing proportion of cases related to acute decompensation of chronic heart failure, severe cardiomyopathies, mechanical complications, and malignant arrhythmias. This changing epidemiology reflects improvements in early revascularization strategies and advances in acute coronary care. [2]

Despite modern therapeutic approaches, cardiogenic shock is associated with persistently high mortality. Contemporary registries report in-hospital mortality rates ranging from 30% to 60%, depending on patient characteristics, comorbidities, and access to advanced therapies such as mechanical circulatory support [3]. The high mortality underscores the urgent need for optimal hemodynamic management and evidence-based pharmacological strategies.

The definition of cardiogenic shock that is being used by the European Society of Cardiology is the presence of clinical signs of tissue hypoperfusion accompanied by a decrease in systolic blood pressure to <90 mmHg for at least 30 minutes, or the need for mechanical and/or pharmacological circulatory support to maintain systolic blood pressure >90 mmHg. A decrease in urine output to <30 mL/h and an increase in blood lactate concentration to >2.0 mmol/L confirm the presence of tissue-level ischemia. [4]

The treatment of cardiogenic shock involves several key components aimed at stabilizing the patient and addressing the underlying illness. The main therapeutic approaches include:

1) cessation of antihypertensive therapy. Especially medications from the group of β -blockers and ACEI must be avoided

2) treatment of the underlying cause of cardiogenic shock. Most often interventional revascularisation is needed or in certain specific cases cardiosurgical intervention is necessary.

3) treatment of symptoms of shock:

- In case of bradycardia Atropine and electrostimulation should be considered and in case of not adequate result continuous infusion of adrenaline;

- In case of documented abnormalities of myocardial contractility noradrenaline and/or dopamine should be considered and in case of inadequate results, Dobutamine in continuous infusion should be used;

- In case of pulmonary congestion or peripheral edema diuretics should be considered and in case of inadequate results, ultrafiltration or hemodialysis should be considered;

- In case of hypoperfusion oxygen therapy should be considered and securing a safe airway by intubation or laryngeal mask. [4] [5]

Hemodynamic stabilization in cardiogenic shock relies on a combination of volume optimization, inotropic support, and vasopressor therapy. Among vasopressors, norepinephrine and dopamine have historically been widely used to restore mean arterial pressure and maintain adequate vital organ perfusion. Norepinephrine primarily acts through α -adrenergic receptor stimulation, leading to vasoconstriction and increased systemic vascular resistance. dopamine exerts dose-dependent effects on dopaminergic, β -adrenergic, and α -adrenergic receptors, providing both inotropic and vasopressor actions. [6]

The optimal choice of vasopressor in cardiogenic shock remains a subject of ongoing debate. dopamine has been associated with an increased risk of tachyarrhythmias and adverse cardiac events, particularly in patients with underlying ischemic heart disease. In contrast, Norepinephrine has demonstrated a more favorable hemodynamic profile and a lower incidence of arrhythmias in several clinical studies, though concerns remain regarding potential increases in afterload and myocardial oxygen demand. [7]

Given the persistent controversy and the clinical importance of vasopressor selection in cardiogenic shock, a comprehensive evaluation of existing evidence was carried out. This literature review aims to compare the efficacy and safety of norepinephrine and dopamine in the management of cardiogenic shock, with particular emphasis on hemodynamic outcomes, mortality, and adverse effects. By analyzing available clinical data, this review seeks to clarify the role of these agents and support evidence-based decision-making in the treatment of cardiogenic shock.

2 Methods

A literature search was conducted using the medical database PubMed, Google Scholar and National library of medicine. Articles were retrieved using the keywords: „Noradrenaline” „Dopamine”, „Cardiogenic shock”, „Hipotension” in appropriate configurations. Four papers were found regarding the comparison of efficacy of dopamine and noradrenaline treatment in patients with cardiogenic shock.

We identified one meta-analysis, one retrospective study and one multicenter randomized trial that collectively analyzed a total of 1310 patients. However, some of the original studies may have been included in the meta-analysis, leading to potential duplications of considered patients.

One of the papers has been excluded from further analysis because it was not completely aligned with the subject of literature review - the authors compared the efficacy of adrenaline against dopamine in place of noradrenaline. [8]

3 Results

Publication	Type of research	Number of patients	Results
Soo Jin et.al 2022[9]	Retrospective study	520	Dopamine more often required to use additional vasopressor No difference in mortality in both groups No difference in % cases of arrhythmias
Rui, Qing et.al 2017 [10]	Meta-analysis of 9 studies	510	Lower death rate with noradrenaline Lower risk of Arrhythmias with noradrenaline Lower risk of gastrointestinal reaction
De Becker et al. 2010 [11]	Multicenter randomized trial sub group	280	Increased death rate in patients with dopamine

The paper by Soo Jin et.al 2022 was a retrospective study which analysed 520 patients who were admitted to cardiac intensive care units in years from 2012 until 2018. In 70% of patients, noradrenaline has been administered, and those patients were in a much more severe clinical condition in comparison to the other 30% which were treated with dopamine. It has been shown that a lower percentage of patients treated with noradrenaline (33.8%) needed additional vasopressor in comparison with dopamine (56.4%) ($p < 0.001$). The study has found no difference in hospital mortality between the two groups treated with vasopressors, with 26.9% for noradrenaline and 31.9% for dopamine ($p = 0.26$). There was also no difference observed in the occurrence of arrhythmias. Atrial fibrillation was noted in 12.2% of patients treated with noradrenaline. In patients treated with dopamine 15.7% of patients experienced atrial fibrillation as a side effect of the treatment??? ($p = 0.30$). Ventricular tachyarrhythmia was observed in 19.9% of patients treated with noradrenaline and in the group treated with dopamine 25.3% of patients had ventricular tachycardia as side effect of the treatment??? ($p = 0.18$). Summarising, the authors have found that the treatment with the use of noradrenaline requires less often an additional vasopressor. This treatment is used more often in cases of greater severity of cardiac shock than treatment with dopamine.

The paper by Rui Qing et.al 2017 reports an analysis of 9 randomized clinical trials involving 510 patients. The authors observed a decrease in mortality of patients treated with noradrenaline in comparison to patients treated with dopamine ($P < .001$) There has been a lower risk of arrhythmic event in the group treated with noradrenaline (RR 3.426 [95% CI 2.120–5.510]; $P < .001$; P heterogeneity = .875) There was also a lower risk of gastrointestinal reaction RR 5.474 [95% CI 2.917–10.273]; $P < .001$; P heterogeneity = 0). Additionally, the authors of the study carried out a subgroup analysis in order to distinguish the mortality based on the cause of the cardiogenic shock. This study showed that treatment with noradrenaline was beneficial with 2 subgroups. The authors concluded that treatment with the use of norepinephrine is associated with a safer profile than the treatment with dopamine in terms of mortality, arrhythmias and gastrointestinal complication regardless of the illness leading to a cardiogenic shock.

The paper by de Becker et.al 2010 reports results of a randomised trial in which all types of shock were considered. There was a defined subgroup of patients with cardiogenic shock and treatment with noradrenaline and dopamine was analyzed. The subgroup of patients with cardiogenic shock contained 280 patients. The authors observed a higher rate of death in patients treated with dopamine then with noradrenaline ($p = 0.03$). They also observed a greater risk of arrhythmic events in the group of patients treated with dopamine than in the group treated with noradrenaline $P < 0.001$. The authors concluded that noradrenaline treatment leads not only to a better survival rate but also has a better safety profile considering arrhythmic events in comparison to dopamine and should be used more often in clinical settings.

4 Discussion

In the present literature review, we compared the efficacy and safety of noradrenaline and dopamine in the treatment of cardiogenic shock. Considering the analyzed publications, noradrenaline appears to be associated with more favorable clinical outcomes, particularly in terms of mortality reduction and a lower incidence of arrhythmic complications, when compared with dopamine.

One of the most important findings across the included studies is the consistently higher risk of arrhythmias associated with dopamine therapy. This observation is clinically significant, as patients with cardiogenic shock frequently have suffered from underlying ischemic heart disease and electrical heart instability. Mortality outcomes also favour noradrenaline in most of the analyzed studies. The meta-analysis by Rui Qing et al. demonstrated a statistically significant reduction in mortality among patients treated with noradrenaline, regardless of the underlying etiology of cardiogenic shock. Similarly, the cardiogenic shock subgroup analysis from the multicenter randomized trial by De Backer et al. reported higher mortality rates in patients receiving dopamine. Although the retrospective study by Soo Jin et al. did not demonstrate a statistically significant difference in mortality, it is notable that patients receiving noradrenaline had more severe shock at baseline and still achieved comparable outcomes, suggesting a potentially stronger hemodynamic efficacy of noradrenaline.

An additional clinically relevant observation is the increased need for adjunctive vasopressor therapy in patients treated with dopamine. Soo Jin et al. reported that dopamine-treated patients more frequently required additional vasopressors to achieve adequate hemodynamic stabilization. This finding suggests that dopamine may be less effective in maintaining sustained arterial pressure in severe cardiogenic shock, potentially leading to more complex pharmacological regimens and increased risk of adverse effects.

Current international guidelines and expert consensus increasingly recommend noradrenaline as the first-line vasopressor in cardiogenic shock, particularly in the presence of hypotension and signs of end-organ hypoperfusion. The findings of the present review are consistent with these recommendations and provide further support for the preferential use of noradrenaline over dopamine in routine clinical practice.

Nevertheless, this review has several limitations. The number of available randomized controlled trials specifically addressing cardiogenic shock remains limited, and some of the included studies differ in patient populations, shock severity, and dosing protocols. Additionally, potential patient overlap between studies included in the meta-analysis may have influenced the results. Finally, retrospective study designs are inherently subject to selection bias and confounding factors, which may affect outcome interpretation.

Despite these limitations, the overall body of evidence suggests that noradrenaline offers a more favourable balance between efficacy and safety compared with dopamine in patients with cardiogenic shock. Future large-scale randomized trials focusing exclusively on cardiogenic shock populations are needed to further refine vasopressor selection and optimize individualized treatment strategies.

5 Conclusions

Cardiogenic shock remains a life-threatening condition with high mortality, and the choice of vasopressor is not easy based on our findings. Available evidence indicates that noradrenaline is associated with better safety and clinical outcomes compared with dopamine, particularly with a lower risk of arrhythmic complications and reduced need for additional vasopressor support. Although dopamine may be used in cases of lack of noradrenaline access, its higher arrhythmogenic potential limits its routine use. Therefore, noradrenaline should be considered the first-line vasopressor in patients with cardiogenic shock.

During the preparation of this work, the author(s) used ChatGPT, an AI language model developed by OpenAI, in order to revise and improve the clarity and fluency of some parts of the English text. After using this tool, the co-author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

Authors contributions:

All authors contributed to the article.

Conceptualization- Liebert A. Krupiniewicz K. Wojciechowicz M., Rogiński M. Brzęcka M. Rogiński S. Suchcicki M. Chojnowski Ł. Mazurek K. Dominiczak A.

Methodology: Liebert A. Dominiczak A. Mazurek K. Brzęcka M. Rogiński M.

Software: Suchcicki M. Rogiński S. Krupiniewicz K. Rogiński M. Wojciechowicz M.

Formal Analysis: Mazurek K. Dominiczak A. Chojnowski Ł. Suchcicki M.

Investigation: Liebert A. Brzęcka M. Rogiński S. Rogiński M. Wojciechowicz M.

Resources: Liebert A. Brzęcka M. Rogiński S. Wojciechowicz M. Rogiński M.

Data Curation: Krupiniewicz K. Chojnowski Ł. Suchcicki M. Rogiński M. Rogiński S.

Writing-rough preparation: Liebert A. Dominiczak A. Mazurek K. Brzęcka M. Chojnowski Ł.

Writing- Review and Editing: Liebert A. Wojciechowicz M. Mazurek K. Krupiniewicz K. Rogiński M. Rogiński S. Suchcicki

Visualisation: Chojnowski Ł. Mazurek K. Dominiczak A. Krupiniewicz K. Rogiński M.

Supervision: Liebert A. Brzęcka M. Rogiński S. Suchcicki M. Chojnowski Ł.

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