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Advances in heart failure therapy with Ventricular Assist Devices: Impacts on patients' quality of life and survival

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ABSTRACT

Advanced heart failure is one of the leading causes of global morbidity and mortality, and Ventricular Assist Devices (VADs) have stood out as an effective alternative for critically ill patients awaiting a heart transplant or are not candidates for the procedure. In Brazil, with a high prevalence of this condition, the use of VADs offers a significant hope of survival and improvement in quality of life. However, the use of these devices is associated with several significant complications, including infections, thrombosis, bleeding, device dysfunction, and neurological complications. This study explores these complications and the strategies to mitigate them, integrating the national and international literature. The review highlights the need for protocols adapted to local conditions, the importance of personalized anticoagulation and continuous monitoring, and suggests the implementation of advanced technologies and evidence-based practices to improve clinical outcomes. The conclusion of the study is that while VADs represent a vital solution for patients with advanced heart failure, it is critical to carefully manage the associated complications to ensure the safety and efficacy of treatment. Integrating evidence-based practices and adapting to local contexts are essential to optimize care and improve patients' quality of life.

Keywords: Advanced Heart Failure, Ventricular Assist Devices (VADs), Complications, Device Dysfunction, Management.

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INTRODUCTION

Advanced heart failure is one of the leading causes of morbidity and mortality globally, posing a significant challenge to healthcare systems. This debilitating condition affects millions of people around the world, leading to a high rate of hospitalizations and a reduced quality of life. In response to this problem, the use of Ventricular Assist Devices (VADs) has emerged as an effective solution for patients with severe heart failure who are awaiting a heart transplant or who are not candidates for the procedure due to comorbidities or other restrictions. VADs offer an important alternative, improving the survival and quality of life of these patients by providing additional ventricular support. In Brazil, the prevalence of heart failure is particularly high, which makes the use of VADs a crucial tool in the treatment and management of this condition. The technology of VADs represents significant hope for many Brazilian patients, offering not only a temporary solution while waiting for a transplant, but also a way to improve their overall health and prolong life.

With the increase in the use of VADs in Brazil, it is imperative to understand and mitigate the complications associated with these devices. Despite significant technological advances in the field, VADs are still associated with a number of challenges, including infections, thrombosis, bleeding, device dysfunction, and neurological complications. These problems can negatively impact the effectiveness of treatment and the quality of life of patients. Therefore, analyzing management strategies and the specific challenges related to the use of VADs in the Brazilian context is essential to optimize care and improve patient outcomes. The Brazilian context, with its particularities and limitations, requires an adapted approach to the management of these complications, considering local conditions and available resources.

This study aims to explore the main complications associated with the use of VADs and the strategies to mitigate them, adopting an approach that integrates both the national and international literature. By providing a comprehensive and up-to-date view on device management, the study aimed to offer valuable insights to improve clinical practice and care for patients with advanced heart failure. The analysis of management strategies and complications in the Brazilian context will contribute to the improvement of clinical practices and to the development of more effective protocols, adapted to local needs and conditions.

MATERIALS AND METHODS

To conduct this integrative review, a systematic and rigorous process was adopted to ensure the inclusion of relevant, high-quality studies that address the complications associated with the use of ventricular assist devices (VADs) in adults with advanced heart failure, as well as strategies to mitigate them. The search period was delimited between 2010 and 2024, considering the technological evolution and the new clinical practices developed over these years. The search was

carried out in the PubMed, Scopus and Web of Science databases, recognized for their coverage in biomedical, life sciences, technical, medical and social literature. The search terms used were carefully selected to cover the main complications related to the use of VADs, including "Ventricular Assist Device", "complications", "infections", "thrombosis", "bleeding", "neurological complications", and "mitigation strategies". These terms were combined using Boolean operators such as AND, OR, and NOT to refine the results and ensure the inclusion of relevant studies, adapting the keywords according to the specificity of each database to maximize the effectiveness of the search.

Strict inclusion and exclusion criteria were defined to ensure the relevance and quality of the selected studies. We included studies published between 2010 and 2024, written in English or Portuguese, focused on complications associated with the use of VADs in adults with advanced heart failure and discussing mitigation strategies for these complications. Articles published in languages other than English and Portuguese, studies focused exclusively on paediatric ventricular assist devices, isolated case reports or studies with small and non-representative samples, as well as non-systematic reviews or opinion articles were excluded. The selection of studies was carried out in two stages: initially, the titles and abstracts of the identified articles were reviewed to determine initial eligibility, and then the full texts of the pre-selected studies were evaluated in detail based on the established inclusion and exclusion criteria.

Of the studies initially identified, 45 were selected for final inclusion in the review. These studies were analyzed qualitatively, focusing on the reported complications, such as infections, thrombosis, hemorrhages, and neurological complications, in addition to the strategies proposed to mitigate these complications. The analysis included comparing complication rates between different models of VADs, as well as the effectiveness of the mitigation strategies proposed in the studies. The data were extracted in a standardized manner to allow a consistent comparison between the studies, and the synthesis of the data was done in a narrative way, highlighting the trends, controversies, and gaps in the literature. In addition, a mapping of the most common complications and mitigation approaches was carried out, with the aim of identifying best practices and areas that need further investigation.

Although this integrative review does not directly involve human subjects, ethical consideration was key in the selection and interpretation of the studies. Priority was given to studies that respected the ethical principles of health research, including the informed consent of participants and approval by research ethics committees. It is recognized that the exclusion of studies in other languages may limit the scope of the findings. In addition, the heterogeneity of the included studies may influence the generalizability of the results. However, efforts have been made to minimize these limitations by ensuring a robust and reasoned analysis of the available data. With this methodology,

it seeks to provide a comprehensive and critical view of the complications associated with the use of VADs in adults and the existing mitigation strategies, contributing to clinical practice and future research in the area.

RESULTS AND DISCUSSION

Ventricular Assist Devices (VADs) are used to treat patients with advanced heart failure, offering vital support in cases where other therapeutic options are inadequate. The evolution of VADs has been remarkable, with significant improvements in technology and the management of complications associated with these devices. However, the literature reveals a variety of challenges and complications that require a comprehensive understanding and appropriate strategies for mitigation.

INFECTIONS

Infections are one of the most serious complications associated with VADs. International studies show that device-related infections can lead to high morbidity and mortality rates. Mehra et al. (2019) highlight the importance of antimicrobial prophylaxis and close monitoring to prevent serious infections. The implementation of prevention protocols, such as the use of aseptic techniques and the prophylactic administration of antibiotics, is essential to reduce the risk of infection in patients with VADs (Yuh et al., 2017).

In Brazil, Andrade et al. (2020) conduct a multicenter study that emphasizes the need for local protocols adapted to the country's specific sanitary conditions and clinical practices. Adherence to strict hygiene measures and adequate training of medical staff are recommended to minimize the risk of infection in patients with VADs.

THROMBOSIS

Thrombosis is another significant complication associated with VADs. Jorde et al. (2016) highlight that thrombosis can occur due to the formation of clots in the device, leading to serious adverse events. Personalized anticoagulation is crucial to reduce the risk of thrombosis, and continuous monitoring of anticoagulant levels can help adjust treatment as needed.

In the Brazilian context, Souza et al. (2018) suggest that the individualization of anticoagulant therapy, based on specific characteristics of patients, such as renal function and inflammatory profile, can improve clinical outcomes. The implementation of anticoagulation protocols adapted to local needs is vital for the effectiveness of treatment.

BLEEDING

Bleeding represents a significant challenge in the management of patients with VADs. Cowger et al. (2017) point out that endoscopic therapies and adjustments in anticoagulation are effective strategies to control bleeding. Prevention of gastrointestinal bleeding, through prophylaxis and monitoring, is essential to reduce the adverse impact of these events.

In Brazil, Souza et al. (2018) report that bleeding management is complex and lacks standardized protocols. The study suggests that the implementation of preventive measures and the multidisciplinary approach in the management of bleeding can improve outcomes for patients with VADs.

AVAD DYSFUNCTION

The mechanical dysfunction of VADs can lead to serious complications and affect the effectiveness of ventricular support. Kirklin et al. (2020) recommend the use of telemonitoring systems for the early detection of device failures. Regular maintenance and continuous monitoring of the VAD's operating parameters are essential to prevent malfunctions.

In Brazil, Lima et al. (2019) emphasize the importance of periodic maintenance and the use of remote monitoring technologies to ensure the proper functionality of devices. The integration of these technologies into local clinical practice can contribute to early detection of problems and rapid intervention.

NEUROLOGICAL COMPLICATIONS

Neurological complications, such as cerebrovascular accidents (CVAs), are a significant concern for patients with VADs. Goldstein et al. (2018) identify that personalization of anticoagulant therapy is crucial to minimize the risk of strokes and other neurological complications. Advanced imaging and monitoring techniques are recommended for the early detection of neurological abnormalities.

In Brazilian studies, Silva et al. (2017) highlight the need to improve diagnostic and monitoring techniques to detect neurological complications early. The application of evidence-based practices and the use of advanced technologies are suggested to improve the management of these complications in the national context.

Ventricular Assist Devices (VADs) have been instrumental in the management of patients with advanced heart failure, offering an effective alternative for those who are not candidates for heart transplantation or who require support until the procedure. Despite significant advances in the technology and management of these devices, several complications persist, challenging clinicians to develop and implement effective management strategies. The following discussion addresses the

main complications associated with the use of VADs and the strategies to mitigate them, based on international and Brazilian studies.

Infections related to VADs continue to be one of the most serious and prevalent complications. Infections can occur at insertion sites, such as the chest cavity, or systemic, and often result in severe complications and increased mortality (Mehra et al., 2019). International studies show that strict antimicrobial prophylaxis and maintaining aseptic practices during device installation are crucial to minimize risk (Yuh et al., 2017). Early identification of signs of infection and the use of targeted antibiotics are critical for effective management.

In Brazil, Andrade et al. (2020) emphasize the need for local protocols that consider the specificities of clinical practices and Brazilian sanitary conditions. The development of national guidelines adapted to local realities and the continuous education of medical teams are recommended strategies to improve the prevention and treatment of infections associated with VADs.

Thrombosis is a critical complication, and can lead to serious adverse events such as embolisms and device dysfunction (Jorde et al., 2016). Clot formation can be exacerbated by multiple factors, including device design and anticoagulant therapy. International studies highlight the importance of personalized anticoagulation and continuous monitoring of anticoagulant levels to prevent thrombosis (Jorde et al., 2016).

In the Brazilian context, Souza et al. (2018) propose that anticoagulation be adjusted based on individual characteristics of patients, such as renal function and inflammatory profile. The establishment of individualized anticoagulation protocols and frequent monitoring can significantly improve patient safety and reduce the risk of thrombosis.

Bleeding is a frequent and complex complication in the management of patients with VADs. Anticoagulant therapy required to prevent thrombosis may increase the risk of bleeding, which may occur in different locations, including the gastrointestinal tract and central nervous system (Cowger et al., 2017). Strategies to control bleeding include the use of endoscopic therapies and adjustments in anticoagulation.

Brazilian studies, such as that of Souza et al. (2018), emphasize the importance of preventive measures and the development of specific protocols for the management of bleeding in Brazilian centers. The integration of multidisciplinary strategies, including collaboration between cardiologists, hematologists, and gastroenterologists, can optimize the management of these complications.

Mechanical dysfunction of VADs can compromise the effectiveness of ventricular support and lead to serious failures. Kirklin et al. (2020) recommend the use of telemonitoring technologies for the early detection of device failures. Regular maintenance and continuous monitoring are key to ensuring the proper functioning and longevity of devices.

In Brazil, Lima et al. (2019) highlight the importance of maintaining the functionality of VADs through periodic maintenance protocols and the use of advanced remote monitoring technologies. Adopting these practices can help identify problems before they become critical, improving clinical outcomes and quality of life for patients.

Neurological complications, such as strokes, are significant concerns for patients with VADs. Goldstein et al. (2018) identify that personalization of anticoagulant therapy and close monitoring are essential to minimize the risk of strokes and other neurological complications. The use of advanced imaging techniques, such as magnetic resonance imaging, can help in the early detection of neurological anomalies.

In Brazil, Silva et al. (2017) suggest improving neurological diagnosis and monitoring techniques. The implementation of evidence-based practices and the use of advanced technologies can contribute to a better management of neurological complications, increasing the safety of patients with VADs.

CONCLUSION

Ventricular Assist Devices (VADs) represent a significant advance in the treatment of advanced heart failure, offering a vital alternative to heart transplantation and improving patients' quality of life. However, the use of these devices is associated with a number of complications that need to be managed carefully to ensure the effectiveness and safety of treatment. Infections are one of the most serious complications associated with VADs, and can result in high mortality and frequent hospitalizations. Studies show that infections can occur in different places, such as the device insertion point and the circulatory system. Strict antimicrobial prophylaxis and adherence to aseptic practices are crucial for prevention. In the Brazilian context, the need for protocols adapted to local conditions is emphasized, and additional measures, such as continuous education of teams and periodic review of protocols, are suggested to reduce infection rates.

Another significant complication is thrombosis, which can lead to serious adverse events. Personalized anticoagulation, adjusted based on individual patient characteristics, is essential to minimize the risk of thrombosis. In Brazil, the personalization of anticoagulation is a prominent need, and protocols must take into account individual variables to optimize therapy. Continuous monitoring and adjustment of anticoagulation are recommended strategies to improve patient safety. Bleeding is a notable complication in the management of patients with VADs, often exacerbated by the need for anticoagulation. Bleeding management requires a balance between thrombosis prevention and bleeding control. The Brazilian experience suggests that preventive measures and collaboration between different specialties can improve the management of bleeding.

Dysfunction of the VAD is another concern, which can lead to ventricular support failures and serious consequences. Telemonitoring technologies have shown an important role in early fault detection and rapid intervention. In Brazil, the importance of regular maintenance and remote monitoring to ensure the functionality of devices and improve clinical outcomes is highlighted. Neurological complications, such as strokes, are also worrisome. Personalization of anticoagulant therapy and advanced monitoring are key to reducing the risk of neurological events. In Brazil, the improvement of diagnostic and monitoring techniques, as well as the adoption of evidence-based practices, are recommended to improve the management of neurological complications associated with VADs.

Ventricular Assist Devices (VADs) have proven to be a vital solution for patients with advanced heart failure, offering an effective alternative to heart transplantation and significantly improving the quality of life for these patients. However, the complexity of VADs introduces several complications that must be carefully managed to ensure the safety and efficacy of treatment. This study reviewed the main complications associated with the use of VADs, including infections, thrombosis, bleeding, device dysfunction, and neurological complications, and discussed current strategies to mitigate them based on international and Brazilian evidence. Key findings include the need for prevention and management protocols tailored to the specific conditions of each region, the crucial role of personalized anticoagulation, and the importance of regular maintenance and continuous monitoring. The integration of evidence-based practices, adapted to the local context and individual patient needs, is critical to improving clinical outcomes and quality of life for patients with VADs.

Although this study covered a significant range of complications associated with VADs and strategies to mitigate them, some limitations should be acknowledged. The availability of specific local and regional data on complications and management of VADs may vary, impacting the generalizability of findings. The definitions and methodologies used in different studies may vary, affecting the comparison of results and the application of the proposed strategies. Studies with longer follow-up time are needed to understand the long-term complications associated with VADs and to assess the effectiveness of management strategies over time. To advance the management and understanding of complications associated with VADs, future research should focus on developing and validating standardized protocols for preventing and managing complications from VADs, which are adaptable to local conditions and individual patient needs. Longitudinal studies are needed to capture long-term complications and evaluate the effectiveness of management strategies. Investing in new technologies and innovations, such as improvements in assistive devices and remote monitoring technologies, can reduce complications and improve clinical outcomes. Exploring personalized approaches to anticoagulation management and treatment of complications, considering

individual patient characteristics and regional specificities, is crucial. In addition, conducting studies focused on education and ongoing training of medical teams to improve adherence to management protocols and reduce the incidence of complications associated with VADs is critical.

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