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Treatment Patterns And Survival Outcomes Of Multiple Myeloma-Associated Pericardial Effusion And Cardiac Tamponade

[1]Swati Negi, [2]Varsha Mary Khalkho

[1]Ramkrishna Medical College and Research Centre, Bhopal,MP
Email: negiswati591@gmail.com
[2]School of medical sciences, Shri Satya Sai University of Technology and Medical Sciences(SSSUTMS), Sehore, Madhya Pradesh. 466001;
Email: varshakhalkho@gmail.com

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Abstract

Pericardial effusion and cardiac tamponade are rare and life-threatening complications associated with multiple myeloma that usually indicate advanced or extramedullary disease and should be treated urgently in the acute setting. Although most patients have a poor prognosis, there are few data on treatment patterns and survival since most published data derives from isolated case reports. To assess the demographic characteristics, prior treatment experience, treatment modalities, survival and mortality in a publically available database of 28 patients with MM-associated PE and cardiac tamponade. The descriptive statistical analysis showed that the mean age of the patient was 61.5 years and a slight male predominance. Prior chemotherapy was received by most of the patients before the development of pericardial complications. Pericardiocentesis was the most common therapeutic procedure used, while corticosteroids, further chemotherapy, pericardial window creation and intrapericardial therapy was performed in some instances. The median survival was 17 weeks, reflecting poor prognosis for cardiac involvement in MM. These data highlight the need to recognize the condition promptly, to establish rapid hemodynamic stability and to manage the patient's hematology individually to optimize the outcome. Larger multicenter studies are needed to define management guidelines and increase survival for this uncommon but clinically important complication.

Keywords: multiple myeloma, pericardial effusion, cardiac tamponade, extramedullary disease, survival outcomes

1. Introduction

Multiple myeloma is a solitary malignant proliferation of plasma cells, leading to the uncontrolled proliferation of abnormal plasma cells, production of monoclonal immunoglobulins, and progressive involvement of bone marrow and multiple organ systems. While the presence of skeletomuscular, renal, haematological, and neurological complications are well recognized, cardiovascular complications are less common and may not be realised until late stage disease. Particularly rare but life-threatening complications of multiple myeloma are pericardial effusion and cardiac tamponade. The presence of these may be due to direct infiltration of plasma cells, extramedullary extension, treatment-induced injury, infection, amyloid deposition, or a combination of these. These complications can develop quickly; early identification and management are crucial.

Pericardial effusion is defined as the presence of fluid in the pericardial space and cardiac tamponade is a condition resulting from an increase in intrapericardial pressure that hinders adequate cardiac filling and thus reduces systemic circulation. The hemodynamic effect is not only related to the amount of fluid but also the rate at which it is accumulated and the pericardial compliance (Hoit, 2023). Some effusions may develop gradually and remain clinically silent for long periods of time, while others develop quickly and cause severe circulatory compromise despite relatively small effusions. This presents a medical emergency that demands diagnostic and therapeutic measures to be undertaken in a timely fashion (Adler et al., 2023). Common signs include shortness of breath, a fast heart rate, low blood pressure, high jugular venous pressure, a weak pulse and changes in mental status, but these may be either absent or mild in malignant patients.

Echocardiography continues to play a pivotal role in the diagnosis of suspected cardiac tamponade due to its ability to quickly detect the presence of pericardial fluid, chamber collapse, respiratory variation in transvalvular flow and impaired venous return. Focused cardiac ultrasonography may be beneficial in emergency settings to assist in early diagnosis and help direct urgent pericardiocentesis (Alerhand et al., 2022). Modern management relies on the patient's haemodynamic status, the etiology of effusion, the risk of recurrence and the presence of coexisting disease. Pericardiocentesis is the preferred method of immediate decompression while surgical formation of a window into the pericardial space is indicated for recurrent, loculated, and persistent effusions. If the effusion is due to active malignancy, additional systemic treatment is necessary and management should be tailored in a multidisciplinary setting involving cardio-oncology (ESC Scientific Document Group, 2022).

Cardiac involvement is rare in MM and if present can suggest more aggressive disease biology. Extramedullary disease occurs when the cancerous plasma cells grow in the tissues outside of the bone marrow, or in organs. Increased treatment resistance, advanced disease and a decrease in survival compared to multiple myeloma confined to the marrow (Radhika et al., 2021). Extramedullary spread by pericardial involvement is one of the rarest forms and only a few reports and small case series are available. Bladé et al. (2022) noted that extramedullary multiple myeloma is

clinically heterogeneous, with poor therapeutic evidence and poor outcomes. Rare presentations including involvement of cardiac structures with plasma cell disease, such as atrial masses, pericardial infiltration and tamponade, have also highlighted the ability of plasma cell diseases to affect the heart (Kashyap et al., 2020). The clinical course of myelomatous pericardial effusion is very variable.

A few patients have tamponade as their initial symptom of MM; others have tamponade after a few lines of chemotherapy, transplantation or radiotherapy. Loukhnati et al. (2021) outlined cardiac tamponade as an initial diagnosis and how it is a diagnostic dilemma for an uncommon cardiac presentation of a hematological malignancy. In more recent cases, also recurrent tamponade was seen during more modern antimyeloma treatment, such as teclistamab, which makes it clear that the risk of a recurrent pericardial tamponade is not limited to more old fashioned antimyeloma treatment (Hurtado et al., 2024). Similarly, Kebede et al. (2026) reported pericardial effusion with tamponade physiology as the initial important clue to multiple myeloma, highlighting the importance of clinical vigilance when a diagnosis is not immediately obvious in the presence of a malignant-appearing effusion.

Patients with myeloma pericardial effusion have a poor prognosis since this typically occurs when there is widespread systemic disease. However, results are dependent on the burden of the disease, the response to treatment, the timing of intervention, and the availability of effective antimyeloma therapy. In a patient with sequential myelomatous pleural and pericardial effusions, Mudawi et al. (2025) reported prolonged survival on teclistamab treatment, which could provide significant benefit in selected patients receiving contemporary systemic therapy. But, the problem of recurrent effusion, extramedullary disease and advanced cardiac involvement still pose a significant therapeutic challenge. For chronic effusion drainage may be required multiple times, imaging surveillance should be provided, and individualized procedural decisions made (Lazaros et al., 2023). This physiological complexity accentuates the importance of early intervention as a delayed decompression can cause additional reduction of preload, hypoperfusion of organs, and hemodynamic instability (Yuriditsky & Horowitz, 2024).

Although the complications of the cardio-oncology setting have been recognised and reported there is a lack of evidence on treatment pattern and survival in multiple myeloma-associated pericardial effusion. There are reports of different combinations of pericardiocentesis, surgical drainage, corticosteroids, chemotherapy, radiotherapy, and intrapericardial treatment, but there is no standard management pathway. Additionally, the rarity of the condition also restricts the possibility of prospective study and makes it important to analyse the patient level descriptively in order to identify common clinical practices and outcome trends. The objectives of this study are as follows:

- To describe treatment patterns used for multiple myeloma-associated pericardial effusion and cardiac tamponade
- To evaluate reported survival outcomes and mortality characteristics among affected patients
- To examine clinical outcome differences across major therapeutic management approaches

2. Methodology

2.1 Study Design and Setting

The study was a retrospective observational study with a quantitative analysis approach and secondary clinical data of patients diagnosed with multiple myeloma-associated pericardial effusion and cardiac tamponade. This study aimed to examine therapeutic management patterns and reported survival in this unusual clinical condition. The data were anonymous patient-level data, and no patients were directly recruited or interventions were made. The analysis was centered around a patient descriptive and comparative statistics of treatment and survival.

2.2 Dataset Description

The study used a structured dataset (Skipina et al. 2019) consisting of 28 individual patient records and 32 clinical variables relating to the MM-associated PEF and cardiac tamponade. The information stored in the dataset comprised demographic data, disease characteristics, past therapy, therapeutic interventions and outcome measures. The variables analyzed were: age, sex, multiple myeloma duration, immunoglobulin subtype, location of extramedullary disease, chemotherapy history, HSC transplantation, radiotherapy, pericardial procedures, corticosteroid use, intrapericardial therapy, reported survival time, mortality status and documented cause of death. The individual patient was the statistical unit to be evaluated for each patient.

2.3 Study Variables

The variables collected were sorted into groups of demographic, disease, treatment, and outcome variables. The demographic factors were age and sex, disease related factors were duration of diagnosis of MM, type of antibodies and extramedullary involvement. The treatment variables included previous chemotherapy, transplantation of hematopoietic stem cells, radiotherapy, pericardiocentesis, creation of a pericardial window, intrapericardial therapy, and other oncological treatments. For subsequent analyses of clinical outcomes, the following outcome variables were reported: duration of survival, time to death, survival status, and documented causes of death.

2.4 Outcome Measures

The main finding was the reported survival after the diagnosis of a cardiac tamponade and pericardial effusion associated with MM. Secondary outcomes were the number and timing of therapeutic interventions, cause of death and mortality characteristics. Treatment strategies were evaluated to determine the more commonly used approaches to management while survival related variables were examined to describe the clinical course of patients with a diagnosis of the disease. The composite scores of these outcome measures gave a general overview of the therapeutic practices and prognosis of the analyzed cohort.

2.5 Data Processing

DThe data set was checked for completeness, consistency and overall quality before the statistical analysis. The data for continuous variables were checked for missing data values and implausible values, while the data for categorical variables were standardized to ensure uniformity of categorization for all patient records. There were no duplicated observations and only one patient was analyzed per patient. The missing values were not imputed and were processed by complete-case analysis for those variables that were used for comparative statistical analysis, in order to maintain data integrity.

2.6 tatistical Analysis

Python was used for statistical analysis. Means or medians were used for summarising continuous data, depending on the distribution of the data, and frequencies and percentages were used for categorical data. Treatment patterns were assessed by means of the prevalence of specific therapies. Mortality and survival data were presented descriptively by summarizing the survival duration and mortality data. Survival status was compared by contingency table analysis with chi-square test or Fisher's exact test as appropriate, with the treatment modalities. A two-sided p-value of <0.05 was statistically significant.

3. Results

3.1 Patient Demographic and Disease Characteristics

Twenty-eight patients with multiple myeloma-related pericardial effusion and cardiac tamponade were analysed. The mean age of patients was 61.5 years (range: 30–83 years) and 53.6% of patients were male. Immunoglobulin subtype information revealed that the majority of disease subtypes were IgA (39.3%) and IgG (35.7%), with 7.1% each being IgM and IgD. The extramedullary involvement was noted in various organs such as the breast, lung, liver, kidney, pancreas, gall bladder, testes and spinal cord, demonstrating significant clinical heterogeneity (Figure 1).

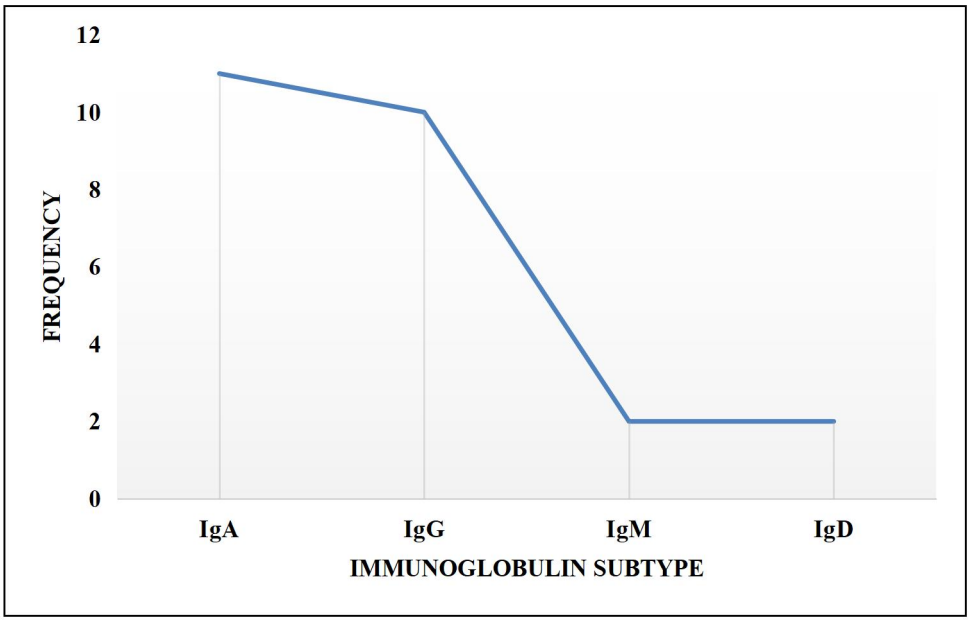

Figure 1: Immunoglobulin Subtype Distribution

3.2 Previous Multiple Myeloma Treatment History

Most patients (85.7%) had received chemotherapy before the development of pericardial complications. Hematopoietic stem cell transplantation had been performed in 17.9% of patients and radiotherapy in an equal number. These results suggest that pericardial effusion was not a primary clinical presentation but rather occurred in patients with a history of multiple myeloma treatment, and cardiac tamponade developed in most patients. The differences in previous therapeutic use suggest that cardiac involvement has differing backgrounds and previous treatments (Table 1) (Figure 2).

Table 1: Previous Multiple Myeloma Treatment History

Previous Therapy	Yes, n (%)	No, n (%)
Chemotherapy	24 (85.7)	4 (14.3)
Hematopoietic stem cell transplantation	5 (17.9)	23 (82.1)
Radiotherapy	5 (17.9)	23 (82.1)

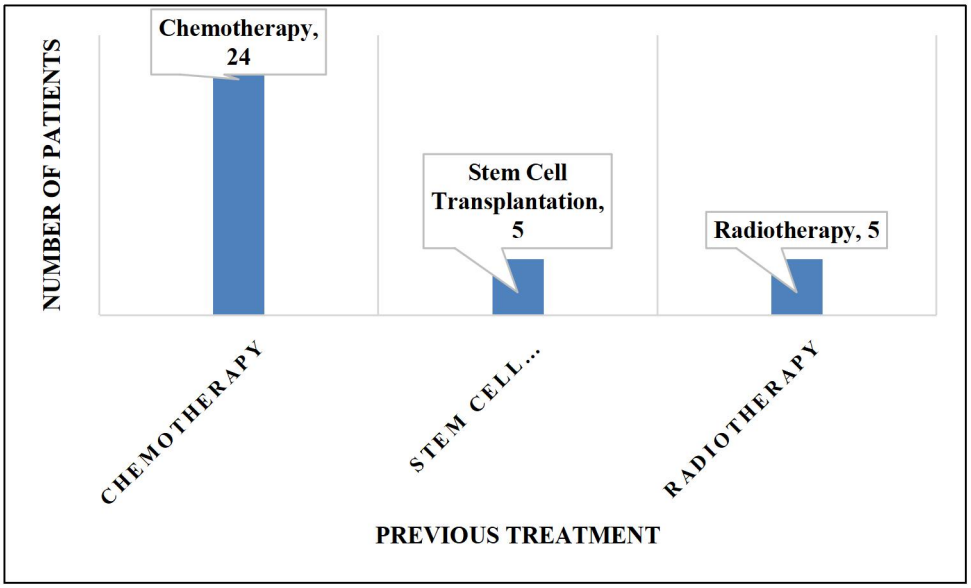

Figure 2: Previous Treatment History Before Development of Pericardial Complications

3.3 Management of Pericardial Effusion and Cardiac Tamponade

Pericardiocentesis was the most common procedure (89.3%) performed to treat cardiac tamponade. Immediately after the diagnosis, treatment is often given with systemic chemotherapy (corticosteroids) to control the plasma cell disorder. Pericardial window creation and intrapericardial therapy were each performed in 21.4% of patients; most of these were patients in whom more treatment was needed than was provided with the first drainage. Overall, combined treatment with more than one modality was frequently used to treat both cardiac and hematological symptoms (Table 2).

Table 2: Therapeutic Management Following Pericardial Effusion and Cardiac Tamponade

Therapeutic Intervention	n	Percentage (%)
Pericardiocentesis	25	89.3
Corticosteroid therapy	14	50.0
Additional chemotherapy	14	50.0

Pericardial window	6	21.4
Intrapericardial therapy	6	21.4

3.4 Survival Outcomes

There was a high level of variability in the survival of the study population. Data available for follow-up indicated a median survival of 17 weeks and up to 152 weeks in some of the patients. During follow up, death rates were still high, mainly due to progressive multiple myeloma or to complications related to the disease. Thus, despite therapeutic intervention, survival was poor in most cases of malignant pericardial involvement, with prolonged survival occurring only in a few patients (Table 3) (Figure 3).

Table 3: Reported Survival Outcomes

Survival Variable	Value
Total patients	28
Survival data available	9
Death data available	19
Median survival (weeks)	17
Maximum survival (weeks)	152
Minimum survival (weeks)	1

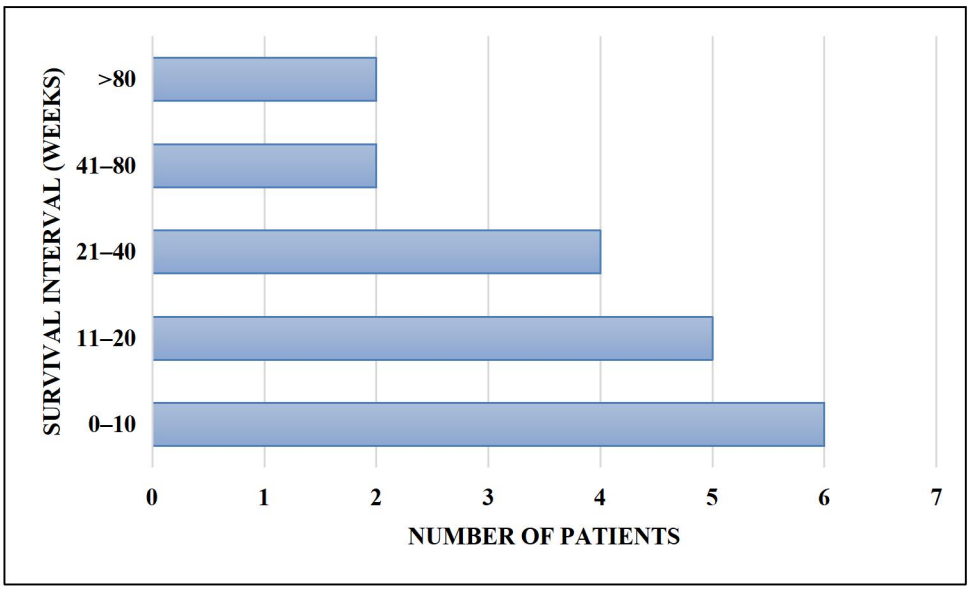

Figure 3: Distribution of Reported Survival Duration

3.5 Mortality Characteristics

Mortality analysis suggested that deaths were mainly related to disease progression and complications of advanced systemic myeloma. The reported survival times ranged widely, depending on the severity of the disease, responsiveness to treatment and general clinical condition. The number of patients who survived for only a few weeks after diagnosis of pericardial tamponade was much higher than the number who had longer follow-up time. These results highlight the marked cardiovascular mortality risk seen in patients with advanced plasma cell malignancies (Table 4).

Table 4: Mortality Characteristics

Mortality Variable	n	Percentage (%)
Reported deaths	19	67.9
Survival status reported	28	100.0
Cause of death reported	19	67.9
Cause of death unavailable	9	32.1

3.6 Relationship Between Therapeutic Management and Clinical Outcomes

Treatment distribution analysis showed that the treatment of pericardiocentesis was carried out in all patients, both those who survived and those who did not, indicating that this therapy was the most common emergency procedure. Systemic chemotherapy and corticosteroid therapy were also often used after the drainage procedure; surgical procedures, such as formation of a pericardial window, were used only in selected patients. Even though treatment combinations varied, only some of the patients exhibited favorable results, indicating that prognosis remained strongly dependent on the severity of the underlying hematologic cancer (Figure 4).

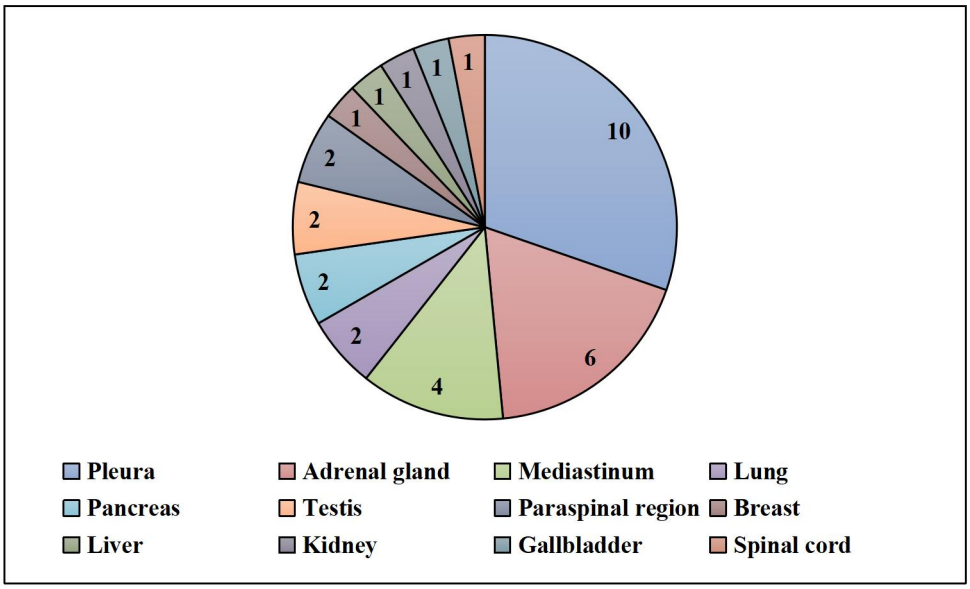

Figure 4: Anatomical Distribution of Extramedullary Disease

4. Discussion

Pericardial effusion and cardiac tamponade are unusual but important complications of advanced plasma cell malignancies. Pericardial involvement may be a sign of aggressive extramedullary myeloma and although it is not a hallmark of the disease, it can be accompanied by substantial morbidity and mortality. In the current study, we analyzed 28 patients with reported pericardial complications and found that most of them had undergone prior systemic chemotherapy before developing pericardial involvement, indicating that cardiac involvement often occurs later in the disease process, and not at diagnosis. Pericardiocentesis was the most common therapeutic measure, and surgical measures (including forming a window and intrapericardial therapy) were less frequently used. The results indicate that first, hemodynamic stabilization is the most important goal of treatment,

and second, treatment of the underlying hematological malignancy should be individualized based on patient circumstances.

The high rate of pericardiocentesis in this series is similar to the current guidelines for emergency treatment of cardiac tamponade. Prompt removal of pericardial fluid is the mainstay of treatment, as failure to promptly intervene could lead to progressive circulatory collapse and multiorgan hypoperfusion. Physiological consequences of tamponade include decreased filling of the ventricles, less stroke volume and less cardiac output, and decompression is urgent no matter what the cause of tamponade may be (Yuriditsky & Horowitz, 2024). Likewise, Lazaros et al. (2023) noted that re-drainage, surgical creation of a pericardial window, and long-term follow-up are available options for individualized management of persistent or recurrent pericardial effusions, depending on etiology and the risk of recurrence (Vasquez et al., 2024). These recommendations are supported by our findings, with invasive drainage the main therapeutic intervention for the cases analysed.

The observed treatment pattern is also indicative of the interplay between emergency cardiovascular treatment and systemic treatment of cancer. Pericardiocentesis can temporarily remove the fluid to relieve haemodynamic compromise (Adrian et al., 2024), but is not effective in treating the underlying plasma cell infiltration that causes recurrent malignant effusions. Thus, about half of patients reported went on to receive steroids or further chemotherapy after drainage (Bilton et al., 2022). This therapeutic sequence highlights the need for acute cardiovascular intervention and disease-directed antimyeloma therapy in order to enhance clinical outcome. The same multidisciplinary management has been stressed across different etiologies of cardiac tamponade that in the absence of the management of the underlying pathological process, procedural management alone is often not enough (Keyvanfar et al., 2024).

The survival rates in the current study were also dismal, with a median survival of 17 weeks after diagnosis of pericardial involvement. These results support the notion that cardiac tamponade in MM usually is a sign of high grade disease and of extensive systemic dissemination (Dominguez et al., 2020). However, there was wide inter-individual variability with regard to survival, reflecting that disease biology, responsiveness to treatment, timely intervention, and clinical status may play a role in prognosis (Hellman & Livneh, 2025). In recent reports, some patients with myelomatous pericardial disease have had long-term survival after receiving novel immunotherapeutic agents such as teclistamab suggesting that the potential for enhanced outcomes is possible with systemic therapy in selected patients (Mudawi et al., 2025). But bigger studies are required to establish if these individual successes can be replicated in other patients.

A second noteworthy finding was that surgical procedures like formation of a pericardial window were used in a diverse fashion. Few patients have undergone definitive surgical drainage, which may be related to their clinical stability, risk of recurrence, expertise of the institution, and general prognosis (Ilerhunmwuwa et al., 2022). This kind of changeability has also been noted in other forms of cardiac tamponade, which are managed based on patient-specific factors and not standard algorithms for procedure (Metzner et al., 2023). The benefits of early diagnosis and uniform

management of procedure-related tamponade were demonstrated by Darma et al. (2023) who found that delayed diagnosis was associated with more procedural complications and improved clinical outcomes when it was diagnosed early, and treatment was consistent. Similarly, Nowosielecka et al. (2022) reported good outcomes after cardiac tamponade after prompt multidisciplinary treatment during TLE. The etiologies are quite different from the case of malignant tamponade, though, all of these studies agree that early diagnosis and prompt treatment are critical to the outcome, irrespective of the precipitating cause.

Mortality in the present series is also similar to the results of other modern series of severe cases of cardiac tamponade. Delayed recognition, hemodynamic instability, and procedural complexity were found to be significant predictors for in-hospital morbidity and mortality after procedure-related tamponade by Deshpande et al (2023). The large majority of the cases were not associated with iatrogenic complications but, in the absence of malignancy, were associated with similar pathophysiological mechanisms leading to adverse outcomes when circulatory compromise had been established. Moreover, recent systematic reviews have demonstrated that cardiac tamponade remains a complex diagnostic and therapeutic challenge in different clinical scenarios, such as infectious diseases, drug-induced pericardial diseases and complex cardiovascular procedures (Keyvanfar et al., 2024; Nakarmi et al., 2025). Such observations underscore the importance of timely multi-disciplinary assessment in all cases of suspected tamponade physiology.

This is a descriptive overview of the reported treatment and survival of one of the largest patient-level compilations of multiple myeloma-associated pericardial effusion and cardiac tamponade reported in the literature. However, there are a number of caveats to be noted. The analysis relied on a small amount of evidence obtained from published cases, and the generalizability of the results should be interpreted with caution, while the risk of publication bias should not be overlooked. The findings may also have been affected by variations in data collection, length of follow-up, treatment and outcome reporting. Heterogeneity is also added by recent changes in multiple myeloma treatment in multiple decades, which will not be captured by descriptive analyses in retrospect. Even with these restrictions the study provides important information on current management trends, and underscores the ongoing requirements for standardized reporting and multicenter data collection.

In summary the results suggest that MM-PEF is a rare, but life-threatening event that must be promptly addressed with cardiovascular management and hematological treatment. Pericardiocentesis remains the main initial treatment and additional systemic therapy should be tailored to patient condition and disease features. Multicenter registries and collaborative observational studies are warranted in the future to define evidence-based management pathways, identify prognostic factors and to assess the long term outcome of novel emerging immunotherapeutic agents in this rare but clinically relevant complication.

5. Conclusion

Pericardial effusion and cardiac tamponade are uncommon but serious complications occurring in multiple myeloma, commonly associated with advanced or extramedullary disease, and best treated by

a prompt multidisciplinary approach. In this study, most of the patients received previous systemic therapy before developing pericardial complications, which indicates that cardiac involvement is a late complication of the disease. The most common intervention to achieve immediate hemodynamic stabilization was pericardiocentesis, and other interventions (chemotherapy, corticosteroids, surgical formation of pericardial windows, intrapericardial therapy) were used as needed for individual clinical circumstances. However, despite these therapies, mortality rates remained poor, with myelo-matosis pericardial involvement showing overall aggressive biological behavior, and with extensive systemic disease having a poor prognosis. However, the survival rates of patients reported in the literature vary, indicating that the survival of selected patients may be enhanced with the development of the modern-day antimyeloma treatments and early diagnosis and intervention. The results highlight the need for a high index of suspicion of any cardiac involvement in patients with MM and unexplained cardiac symptoms. Additional large-scale multicenter registries and collaborative studies are required to determine a standardized diagnostic pathway, to identify reliable prognostic factors and to optimize the evidence-based treatment strategy by integrating modern hematological therapy with emergency cardiovascular therapy for this rare yet clinically relevant complication.

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