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REVIEW

Burden of Disease, Treatment Patterns, and Healthcare Resource Utilization in Multiple Myeloma in the Middle East and North Africa Region: A Targeted Literature Review

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ABSTRACT

Globally, the multiple myeloma (MM) landscape varies widely, with incidence, treatment patterns, outcomes, and healthcare resource utilization (HCRU) differing across countries and regions. Many factors contribute to these differences, including ethnicity, awareness, and socioeconomic influences. This is the first analysis aiming to explore factors associated with myeloma incidence and patient characteristics in the Middle East and North Africa (MENA) region. A literature search was conducted using PubMed and Embase from 1 January 2015 to 30 May 2025. Articles reporting outcomes of interest in patients with MM in the relevant MENA countries (Egypt, Saudi Arabia, Turkey, and the United Arab Emirates) were identified. Of 1400 articles identified in the search, 94 were included; four articles were added post hoc as gray literature. Most reported findings from retrospective observational studies ($n = 66$); more

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than half were conducted in Turkey. The age-standardized incidence rate in MENA was 1.49 per 100,000 people in 2019; median age at diagnosis was lower in the region (range 43–70 years) than that in global reports (70 years). Nearly half (49.7%) of all patients were treated with a regimen containing bortezomib; the second-most frequently used drug was lenalidomide in newly diagnosed MM and daratumumab in relapsed/refractory MM. Few patients (< 1%) were treated with quadruplet regimens. Overall response rates were generally high (35–90.2%), while survival outcomes varied (median progression-free and overall survival ranged from 2–97.7 months and 4–125.3 months, respectively). Adverse events were inconsistently reported across the studies; hematologic adverse events and peripheral neuropathy were commonly reported. HCRU data in the region were limited. We identified a paucity of comprehensive data on the epidemiology and management of MM in MENA. Improved understanding of treatment patterns and HCRU in the region may provide pathways to advancing access to newer therapies that can alleviate the disease and treatment burden of MM in MENA.

PLAIN LANGUAGE SUMMARY

Multiple myeloma is a cancer affecting plasma cells. While there are many new treatments for multiple myeloma, the disease can become refractory to these treatments and the patient eventually experiences relapse. We aimed to determine the incidence of multiple myeloma in the Middle East and North Africa (MENA) region, what treatments are being used, and how effective the treatments are. We also wanted to know how the disease and the treatments affect the quality of life of patients with multiple myeloma. To address this, we performed a literature search for articles published on multiple myeloma in Egypt, Saudi Arabia, Turkey, and the United Arab Emirates over the past 10 years; 94 articles relevant to our analysis were identified. We found that fewer people in MENA were diagnosed with multiple myeloma, but they tended to be diagnosed at a younger age on average compared with the rest of the world, and more men were affected than women. The most commonly used treatment for multiple myeloma was bortezomib. Even though the most recent treatment guidelines recommend treating multiple myeloma with quadruplet regimens, these were rarely used in MENA. Data on treatment efficacy and safety were not reported in the same way in all the studies, which made it difficult to compare across different treatments. We found limited data on quality of life and healthcare resource utilization. Understanding how multiple myeloma treatments are used in MENA and how well they work will help more patients receive better treatments.

Keywords: Multiple myeloma; Middle East; North Africa; Disease burden; Treatment patterns; Healthcare resource utilization

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Key Summary Points

This literature review aims to understand the epidemiology and burden of disease, treatment patterns and availability, patient and clinical outcomes, and healthcare resource utilization (HCRU) in multiple myeloma (MM) in the Middle East and North Africa (MENA) region.

Incidence of MM in the MENA region is increasing, with a median age at diagnosis younger than the global average.

Many gaps exist in the published literature on treatment sequencing in the region, and in associated patient outcomes and HCRU.

Articles inconsistently reported certain patient characteristics, such as hypercalcemia, renal insufficiency, anemia, and bone lesions (CRAB criteria); cytogenetic abnormalities; and adverse events associated with MM treatments.

INTRODUCTION

Multiple myeloma (MM) is a clonal plasma cell malignancy characterized by an abnormal increase in monoclonal immunoglobulins and bone marrow infiltration, leading to hematopoietic suppression and end-organ damage [1]. Symptomatic disease is defined by the SLiM (clonal bone marrow plasma cell percentage ≥ 60%, involved: uninvolved serum free light chain ratio ≥ 100, > 1 focal lesion on MRI) and CRAB criteria (hypercalcemia, renal insufficiency, anemia, and bone lesions), reflecting the systemic impact of monoclonal plasma cell proliferation [1, 2]. With the availability of novel therapeutic options, MM is generally considered to be a treatable disease, but for the majority of patients, it is not yet curable [3, 4]. The incidence of MM varies greatly across countries and regions [3]. Globally, MM accounts for 1–1.8% of all cancers and approximately 10% of hematological malignancies, and it is the cause of 1.2% of all cancer deaths [3, 5, 6]. In 2022, approximately 187,952 new cases of MM and 121,388 MM-related deaths were recorded worldwide [3]. Of these, 8457 new cases and 6753 deaths were reported in the North Africa and Central and Western Asia regions [3]. The incidence of MM is increasing in the Middle East and North Africa (MENA) region, where some countries have limited resources and the socioeconomic burden of the disease raises significant concerns [7].

The management of MM has advanced significantly over the past two decades with the approval of key drug classes, such as immunomodulatory imide drugs (IMiDs), proteasome inhibitors (PIs), and anti-CD38 monoclonal antibodies, which are now the standard of care in global treatment guidelines [5]. While initial treatment with these drugs has improved outcomes in patients with MM [8–10], the disease often becomes refractory, necessitating new therapies [8, 11, 12]. Recent approvals of novel agents—including antibody–drug conjugates, bispecific T-cell engagers, and chimeric antigen receptor (CAR) T-cell therapy—have broadened treatment options for patients with relapsed and/or refractory MM (RRMM) [11]. However, multidrug combinations, while effective, increase the clinical and economic burden and have a considerable impact on patient quality of life (QOL)—particularly as RRMM typically requires prolonged treatment [13].

The MENA region often faces unique healthcare challenges, including substantial variability in resources and infrastructure. Improved understanding of healthcare resource utilization (HCRU) for MM may aid in optimizing resource allocation to improve the efficient use of limited resources [14–18]. Limited data exist on the availability and uptake of novel therapies, as well as the safety and effectiveness of these treatments in real-world practice in MENA. Obtaining further information on how these treatments are accessed and used is crucial to identifying and helping address specific challenges in the management of MM in the region.

This literature review aims to understand the epidemiology and burden of disease, treatment patterns and availability, patient and clinical outcomes, and HCRU in multiple myeloma in

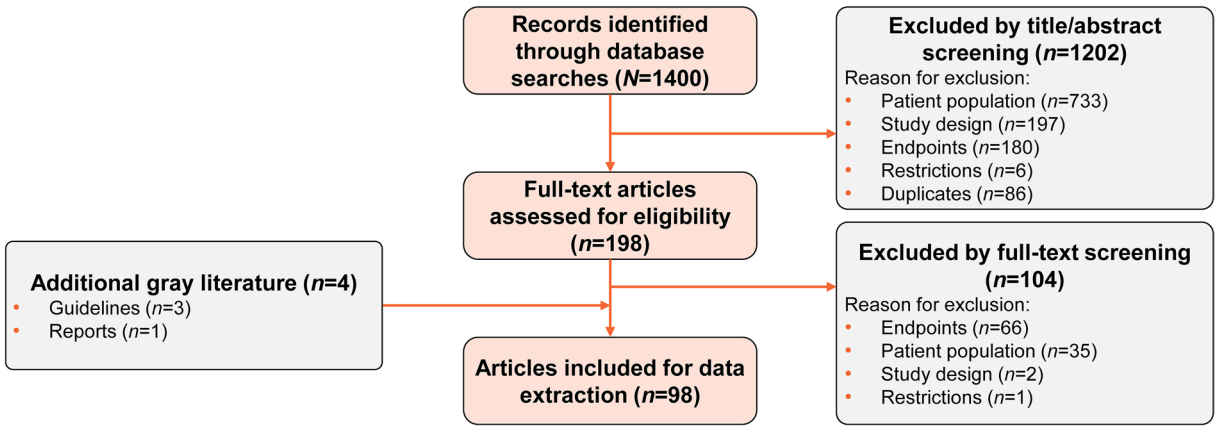


Fig. 1 PRISMA diagram of articles included in this analysis

the MENA countries of Egypt, Saudi Arabia, Turkey, and the United Arab Emirates (UAE).

METHODS

A comprehensive search strategy was developed, encompassing established practices for defining the literature search scope and agreement of search terms. The population, intervention, comparators, and outcomes framework was used to construct the research topics and criteria, and the bibliographical search strategy (Table S1). Broad search strings incorporating "Middle East or North Africa or MENA or Gulf region," individual countries ("Egypt," "Saudi Arabia," "Turkey," and "UAE") and "multiple myeloma [MeSH]" were applied to capture articles and published major congress abstracts of relevance from PubMed and Embase published between 1 January 2015 and 31 May 2025 (Supplementary Table S2).

Article titles were screened initially for relevance, followed by abstracts. Full-text review and data extraction were conducted for included articles. Inclusion and exclusion criteria are presented in Supplementary Table S3. Disease epidemiology, patient characteristics, treatment patterns, clinical and patient-reported outcomes, and HCRU were summarized and analyzed by geography, line of therapy (LOT) and intervention—where data were available.

RESULTS

A total of 1400 articles were identified in the PubMed and Embase databases (Fig. 1). Of these, 1202 were excluded by title/abstract screening, 168 full-text articles and conference abstracts were assessed for eligibility, and 94 (64 full-text publications and 30 conference abstracts) met the eligibility criteria for data extraction (Supplementary Table S4).

Most articles reported findings from retrospective observational studies (66/94; 70.2%). The articles most commonly reported findings from Turkey (52/94; 55.3%), followed by Saudi Arabia (17/94; 18.1%); eight studies reported on MENA as a region (8.5%), and five reported on the Gulf region (5.3%).

An additional four articles were added post hoc from a gray literature search: two Saudi Arabian treatment guidelines published after the literature search date, a treatment guideline from the Turkish Society of Hematology not indexed in PubMed or Embase and one report from the Saudi Cancer Registry.

Epidemiology of MM in the MENA Region

Incidence of MM

Six articles described the epidemiology of MM: four utilizing regional data from the International Agency for Research on Cancer's (IARC)

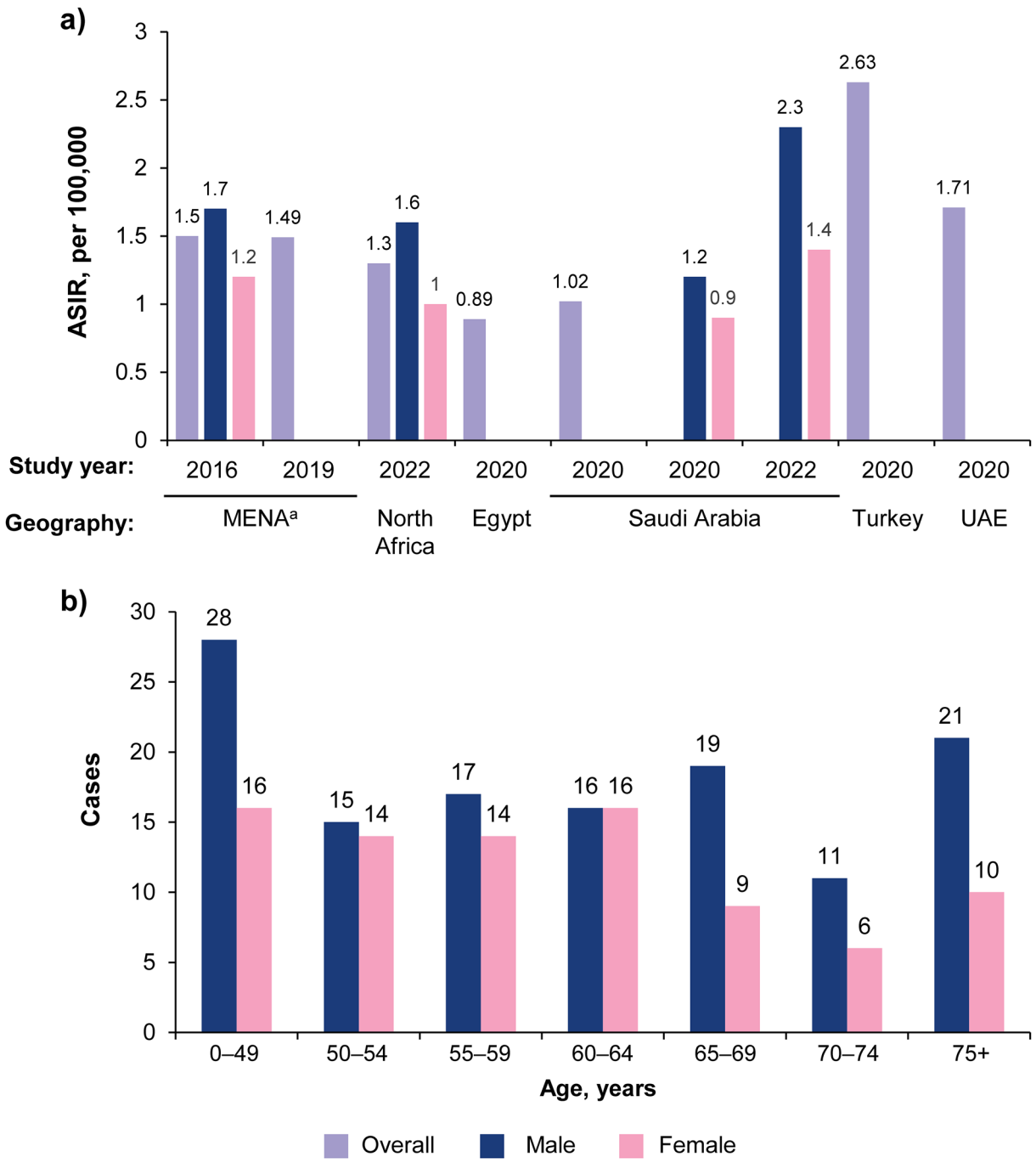
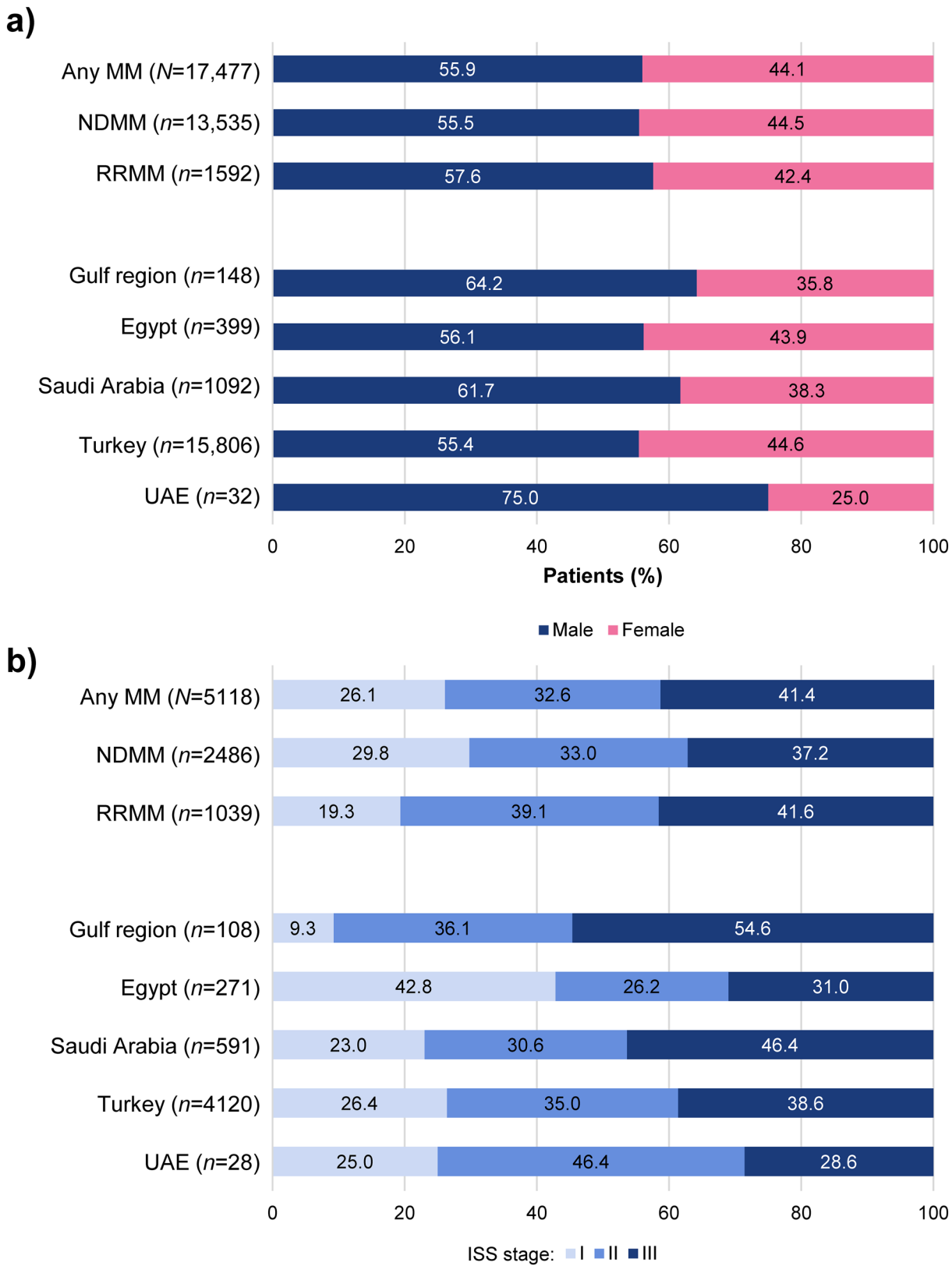


Fig. 2 Incidence of MM in the MENA region. **a** Age-standardized incidence rate reported by geography and sex, where reported [7, 19–23]; **b** age distribution of MM cases in Saudi Arabia reported in 2022 [24]. [a]MENA encompasses the countries of Afghanistan, Algeria, Bahrain, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Sudan, Syrian Arab Republic, Tunisia, Turkey, the UAE, and Yemen. *ASIR* age-standardized incidence rate, *MENA* Middle East and North Africa, *MM* multiple myeloma, *UAE* United Arab Emirates


a)
Any MM (N=17,477)
NDMM (n=13,535)
RRMM (n=1592)
Gulf region (n=148)
Egypt (n=399)
Saudi Arabia (n=1092)
Turkey (n=15,806)
UAE (n=32)
55.9
44.1
55.5
44.5
57.6
42.4
64.2
35.8
56.1
43.9
61.7
38.3
55.4
44.6
75.0
25.0
0
20
40
60
80
100
Patients (%)
Male
Female
b)
Any MM (N=5118)
NDMM (n=2486)
RRMM (n=1039)
Gulf region (n=108)
Egypt (n=271)
Saudi Arabia (n=591)
Turkey (n=4120)
UAE (n=28)
26.1
32.6
41.4
29.8
33.0
37.2
19.3
39.1
41.6
9.3
36.1
54.6
42.8
26.2
31.0
23.0
30.6
46.4
26.4
35.0
38.6
25.0
46.4
28.6
0
20
40
60
80
100
ISS stage:
I
II
III

◂**Fig. 3** Demographics and baseline disease characteristics of patients with MM in MENA. **a** Sex distribution of patients with MM; **b** ISS stage at diagnosis/study entry, where known/reported [23, 25–28, 30–35, 37, 39–42, 50, 51, 53–57, 59–65, 67–70, 72–75, 77–81, 117–128]. *ISS* International Staging System, *MM* multiple myeloma, *NDMM* newly diagnosed multiple myeloma, *RRMM* relapsed and/or refractory multiple myeloma, *UAE* United Arab Emirates

GLOBOCAN database (two reported on the incidence of MM in MENA, one in North Africa, and one on individual countries), one in Turkey, and one in Saudi Arabia (Fig. 2a) [7, 19–23].

In the MENA region, the age-standardized incidence rate (ASIR) was 1.49 per 100,000 population in 2019, with a 14.95% change from 1990 to 2019 [7]. Most incident cases were in patients aged 50–70 years (53.87%), followed by > 70 years (33.00%); 13.14% of cases occurred in patients aged 15–49 years [7].

Data retrieved from the IARC GLOBOCAN database indicated an estimated 2827 incident cases in 2022 in North Africa, accounting for 1.5% of MM diagnoses globally, with an ASIR of 1.3 per 100,000 (1.6 in men, 1.0 in women) [20].

One study analyzed patients with MM who were treated within Turkey's social insurance system (Sosyal Güvenlik Kurumu), and reported an average of 1300 incident cases of MM treated per year between 2011 and 2017, totaling 10,146 cases over this period [23]. The reported incidence of MM in this study was higher in men than in women, with 5655 and 4491 incident cases over this time period, respectively, and a median age at diagnosis between 63.8 and 66.1 years [23]. An analysis of the IARC GLOBOCAN database in 2020 reported an ASIR of 2.63 per 100,000 persons; notably, the incidence of MM in men significantly increased between 2001 and 2019 in Turkey, with an average annual percentage change (AAPC) of 5.63 (95% CI 1.12–10.35; $p = 0.020$); the increase in women was not statistically significant (AAPC: 3.28; 95% CI –0.88 to 7.61; $p = 0.11$) [21].

The ASIR of MM in Saudi Arabia was reported to be 1.02 per 100,000 persons in a study utilizing the GLOBOCAN database in 2020 [21]. This was lower than that reported by the Saudi Cancer Registry in 2022, which reported ASIRs of 2.3 and 1.4 per 100,000 men and women, respectively, among Saudi nationals in 2022 [24]. In 2022, there were 127 and 85 incident cases of MM in men and women, respectively, accounting for 1.5% and 0.8% of all cancer diagnoses in Saudi Arabia. Most cases occurred in people aged ≥ 50 years (0–49 years: 28 and 16 cases in men and women, respectively; 50 + years: 99 and 69 cases in men and women, respectively; Fig. 2b) [24].

Huang and colleagues utilized the IARC database to retrieve data on MM in 2020 for individual countries [21]. From this analysis, the ASIRs for Egypt and UAE were 0.89 and 1.71 per 100,000 persons, respectively [21].

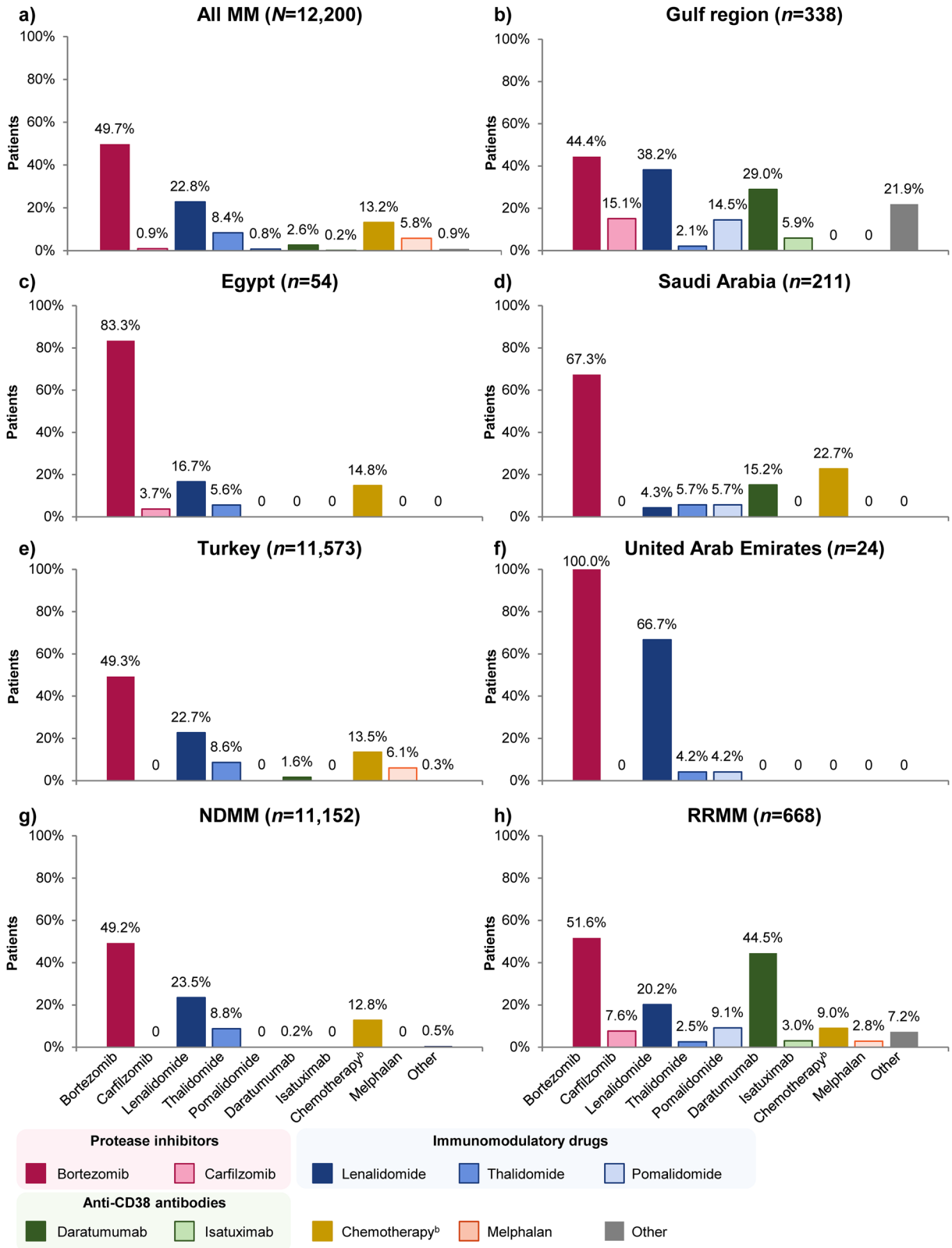
Presenting Symptoms

At presentation or study entry, CRAB criteria were commonly reported across the literature, with bone manifestation as one of the most commonly reported symptoms, occurring in 53.8–96.9% of patients. However, reporting differed across studies; some studies only reported average calcium, creatinine, or hemoglobin levels or glomerular filtration rates without reporting the proportion of patients who fit the definition of each of the CRAB symptoms. The definitions of the other criteria varied across the studies, and these differences in definitions and thresholds limited comparisons.

Patient Characteristics

Of the 69 real-world studies reporting patient age, the median age of study participants ranged from 43 to 70 years (Supplementary Table S4). For patients with newly diagnosed MM (NDMM; $N = 13{,}083$ from 23 studies), the median age of study participants ranged from 45 to 70 years; for patients with RRMM ($N = 1443$ from 18 studies), the median age of study participants ranged from 49.6 to 69.5 years (Supplementary Table S4).

The sex distribution of MM was reported in 62 articles. Of the 17,477 patients included across these studies, 9778 (55.9%) were men; this trend was reflected in each of the individual countries,


a)
All MM (N=12,200)
b)
Gulf region (n=338)
c)
Egypt (n=54)
d)
Saudi Arabia (n=211)
e)
Turkey (n=11,573)
f)
United Arab Emirates (n=24)
g)
NDMM (n=11,152)
h)
RRMM (n=668)
Patients
100%
80%
60%
40%
20%
0%
49.7%
0.9%
22.8%
8.4%
0.8%
2.6%
0.2%
13.2%
5.8%
0.9%
44.4%
15.1%
38.2%
2.1%
14.5%
29.0%
5.9%
0
0
21.9%
83.3%
3.7%
16.7%
5.6%
0
0
0
14.8%
0
0
67.3%
0
4.3%
5.7%
5.7%
15.2%
0
22.7%
0
0
49.3%
0
22.7%
8.6%
0
1.6%
0
13.5%
6.1%
0.3%
100.0%
0
66.7%
4.2%
4.2%
0
0
0
0
0
49.2%
0
23.5%
8.8%
0
0.2%
0
12.8%
0
0.5%
51.6%
7.6%
20.2%
2.5%
9.1%
44.5%
3.0%
9.0%
2.8%
7.2%
Bortezomib
Carfilzomib
Lenalidomide
Thalidomide
Pomalidomide
Daratumumab
Isatuximab
Chemotherapyb
Melphalan
Other
Protease inhibitors
Bortezomib
Carfilzomib
Immunomodulatory drugs
Lenalidomide
Thalidomide
Pomalidomide
Anti-CD38 antibodies
Daratumumab
Isatuximab
Chemotherapyb
Melphalan
Other

◂**Fig. 4** Real-world treatment patterns between 1995 and 2023[a] reported in MENA, in **a** all patients in identified studies with data available; **b** patients with MM in the Gulf region; **c** patients with MM in Egypt; **d** patients with MM in Saudi Arabia; **e** patients with MM in Turkey; **f** patients with MM in the UAE; **g** patients with NDMM; and **h** patients with RRMM [23, 25–42]. [a]Includes three studies with study periods encompassing 1997–2015, 1995–2020, and 2001–2018; the remaining studies report treatment usage from 2010 to 2023. [b]refers to chemotherapy regimens without protease inhibitors, immunomodulatory drugs, nor anti-CD38 antibodies, with or without steroids. *MENA* Middle East and North Africa, *MM* multiple myeloma, *NDMM* newly diagnosed multiple myeloma, *RRMM* relapsed/refractory multiple myeloma, *UAE* United Arab Emirates

with 55.4–75.0% of patients reported to be men (Fig. 3a).

The International Staging System (ISS) stage at study entry or diagnosis was reported in 42 articles. Of the 5118 patients included across these studies, patients most commonly had ISS stage III disease (41.4%; range 7.4–86.8%), followed by stage II (32.6%; range 8.8–61.8%) and stage I (26.1%; range 0–81.5%) (Fig. 3b). Of patients with NDMM, slightly more patients had stage III disease at study entry (37.2%) than stage I (29.8%) or II (33.0%); of patients with RRMM, most patients had stage II or III disease (39.1% and 41.6%, respectively). For individual countries, stage III disease was most common in patients in Saudi Arabia and Turkey (46.4% and 38.6%, respectively), while stage I disease was most common in Egypt (42.8%); one study reported ISS stage in patients in the UAE ($N=32$), where stage II disease was the most common disease stage at study entry (46.4%).

Cytogenetic abnormalities were reported in 25 studies; however, the abnormalities were inconsistently assessed and reported across the studies retrieved. The most commonly reported cytogenetic abnormalities were del(17p), del(13q), and t(4;14), reported in nine, eight, and eight studies, respectively.

Treatment Patterns

A total of 19 articles reported on real-world treatment usage in 12,200 patients with MM, where study entry was not determined by current or prior treatments [23, 25–42]. The study period for most of these articles was after 2010, although one study analyzed patients treated between 1997 and 2015 in Saudi Arabia [25] and another between 1995 and 2020 in Turkey [39].

Overall, bortezomib was the most commonly used drug, with nearly half (49.7%) of all patients receiving a regimen that contained bortezomib. Regimens with lenalidomide (22.8%) and chemotherapy (13.2%) were the second and third most common (Fig. 4a). Treatment patterns were largely similar across the individual countries of interest (Fig. 4b–f), with most patients being treated with a regimen that contained bortezomib (49.3–100%). In Egypt, Turkey, and the UAE, lenalidomide was the second most common drug, with 16.7%, 22.7% and 66.7% of patients treated with a lenalidomide-containing regimen, respectively. In Saudi Arabia, chemotherapy was the second most common treatment (22.7%).

Among patients with NDMM ($n=11,152$) (Fig. 4g), nearly half (49.2%) of all patients were treated with a regimen containing bortezomib; the second most common drug was lenalidomide (23.5%) followed by chemotherapy (12.8%). In a retrospective registry study reporting real-world treatment patterns in patients with MM treated in tertiary-level care centers in the Gulf region who experienced relapse at least once between July 2020 and July 2022 (REPAIR study: $N=148$, from Saudi Arabia, the UAE, Kuwait, and Qatar), first line (1L) induction treatments were generally similar between patients who did and did not receive autologous stem cell transplantation (ASCT), with most patients treated with a regimen containing bortezomib (47% and 42%, respectively) and/or lenalidomide (33% and 36%) (Supplementary Fig. S1) [27]. Thalidomide was the exception to this trend, being mainly used in patients who did not receive ASCT (4.4%) [27].

Of patients with RRMM ($N=668$) (Fig. 4h), treatment regimens containing bortezomib

were the most commonly used (51.6%), closely followed by daratumumab (44.5%), which was rarely used in patients with NDMM. In the REPAIR study, bortezomib was more frequently used in earlier LOTs: 47.3%, 12.5% and 4.3% of patients in 1L, second line (2L), and third line (3L), respectively (Supplementary Fig. S1) [27]. Patients receiving their second to fourth LOT were most commonly treated with daratumumab (24.2%), followed by carfilzomib (15.6%) and pomalidomide (15.0%) [27].

In a cross-sectional study in patients with NDMM within Turkey's social insurance system ($N = 10,146$, mostly treated in the public healthcare system) diagnosed between 2011 and 2017, lenalidomide use showed an increasing longitudinal trend: 235 of the 1168 (20.1%) patients diagnosed in 2011 were treated with lenalidomide compared with 787 of 1378 (57.1%) in 2017 [23]. Notably, in this study, lenalidomide was the most frequently used treatment in 2016 and 2017 [23]. A separate study of real-world treatment patterns in Turkey identified 107 patients with RRMM initiating 2L and 3L treatment, reporting that lenalidomide-containing regimens were used in 41.9% and 63.4% of patients, respectively. Overall, 53.1% of patients were retreated with lenalidomide in a later LOT and 30.8% were refractory to lenalidomide [36].

Of the studies that reported on real-world usage of treatment regimens in patients with MM ($N = 2061$) reporting data from 1995 to 2023, bortezomib + cyclophosphamide + dexamethasone (VCd) was the most commonly used regimen (37.5%) followed by vincristine + doxorubicin + dexamethasone (VAD; 11.6%) (Supplementary Fig. S2). VCd was the most commonly used regimen (48.1%) in patients with NDMM ($N = 1255$), while daratumumab + bortezomib + dexamethasone (DVd; 33.1%) was the most common regimen used in patients with RRMM ($N = 462$). Quadruplet regimens were used in 0.92% of patients with MM (bortezomib + lenalidomide + dexamethasone + cyclophosphamide: 0.58%; daratumumab + lenalidomide + bortezomib + dexamethasone: 0.34%), and were only reported in the REPAIR study in patients with NDMM [27]. Of individual countries, VCd was the most commonly used regimen in Egypt, Saudi Arabia, and Turkey (35.3–59.3%). In the UAE, bortezomib + lenalidomide + dexamethasone (VRd) was the most common regimen (66.7%). According to the REPAIR study, VRd was the most frequently used regimen (27.1%) in the Gulf region in patients with MM [27]. For patients receiving their first, second, third, and fourth LOT, the most frequently used regimens were VRd (50.8%), DVd (17.2%), carfilzomib + pomalidomide + dexamethasone (18.5%), and pomalidomide + bortezomib + dexamethasone (20%), respectively [27].

Treatment Guidelines

Four treatment guidelines were identified within our literature search: two focusing on the management of NDMM and RRMM in the Gulf region [43, 44], and two focusing on apheresis/ASCT in Turkey [45, 46]. Recommendations on the management of RRMM developed by a group of MM experts in the Gulf region were also identified [22]. Treatment guidelines for the management of NDMM and RRMM in Saudi Arabia were published shortly after our literature search cutoff [47, 48]; treatment guidelines from the Turkish Hematology Society were published in 2024 but not indexed in PubMed or Embase [49]. These were included as gray literature and recommendations from the guidelines are summarized in Table 1.

Clinical and Patient-Reported Outcomes

Clinical outcomes were reported in 60 articles, reporting a combination of response rates, progression-free survival (PFS), and overall survival (OS) (Table 2).

Response Rates

The overall response rate (ORR) in patients with NDMM was reported in three articles ($N = 279$) as 60.3% (complete response [CR] not reported) [34] and 80.0% (including CR in 21.1%) [50] in two studies from Turkey and as 83% (≥ CR in 37%) in a study from Saudi Arabia [51].

Table 1 Summary of MENA-specific treatment guidelines

	Gulf region[a] 2025 [43, 44]	Gulf region[a] expert recommendations 2025 [22]	Saudi Arabia Myeloma Working Group 2025 [47, 48]	Turkish Society of Hematology 2024 [49]
NDMM				
Transplant eligible	• Induction with DVRd • Maintenance with lenalidomide, or daratumumab + lenalidomide in select patients (e.g., those who responded well to DVRd and are likely to tolerate continuous daratumumab + lenalidomide)	–	**Standard risk** • Quadruplet induction containing an anti-CD38 mAb (e.g., DVRd or Isa-VRd) followed by upfront ASCT or delaying ASCT until first relapse **High risk** • Anti-CD38 mAb + VRd followed by upfront ASCT **Patients with organ failure/renal disease**[b] • DVCd, with dose adjustment according to renal clearance. Once renal function improves, switching cyclophosphamide to lenalidomide is preferable	**Standard risk (induction)** • Induction with a quadruplet regimen (DVRd, DVTd, or DVCd), DRd, VRd, VTd or VCd followed by ASCT if a ≥ VGPR is achieved, then maintenance therapy for at least 2 years **High risk (induction)** • Induction with a quadruplet regimen (DKRd, DVRd, DVTd, or DVC), D-KRCd, DRd, VRd, or KRd followed by ASCT if a ≥ VGPR is achieved, then maintenance therapy for at least 2 years **After 4–6 cycles of induction therapy** • Proceed to ASCT, followed by maintenance for > 2 years • If a ≥ VGPR/MRD-negativity is not achieved, consider a second consecutive ASCT

Table 1 continued

	Gulf region[a] 2025 [43, 44]	Gulf region[a] expert recommendations 2025 [22]	Saudi Arabia Myeloma Working Group 2025 [47, 48]	Turkish Society of Hematology 2024 [49]
Transplant ineligible	• DRd until disease progression • For fit patients aged 65–70 years, 6–8 cycles of DRd followed by daratumumab + lenalidomide until disease progression. Patients may be able to progress to ASCT and should be considered in specific circumstances	–	**Standard risk** • Fit: DVRd or Isa-VRd followed by lenalidomide maintenance • Frail: DRd until progression or VRd followed by lenalidomide maintenance • Very frail: Vd/Rd or daratumumab + lenalidomide **High risk** • Fit: DVRd or IsaVRd for 9 cycles • Frail: DRd or VRd for 9 cycles	**Initial treatment** • Non-frail: DRd, VRd/VRd-lite, VCd, Rd, VMP/DVMP, Isa-VRd • Frail: Rd, Vd, D-Ixa, MP, thalidomide, cyclophosphamide + dexamethasone **After 2 cycles** • If ≥ PR, continue on the same treatment • If < PR, consider changing treatment; if ≥ VGPR after 6–12 cycles, maintenance for > 2 years or until progression
RRMM				
Early relapse	**Lenalidomide sensitive** • DRd[c] **Lenalidomide refractory** • DKd; if an anti-CD38 mAb is not available/cannot be used, a carfilzomib approach is recommended, with KCd or KPd being the regimens of choice	Guided by prior treatment and refractory status[d] **Lenalidomide refractory** • Anti-CD38 mAb-based, e.g., DPd or IsaKd **Prior anti-CD38 mAb** • Carfilzomib-based combinations, e.g., PomKd **Bortezomib refractory but lenalidomide sensitive** • DRd, KCd, PomKd **Double refractory** • DKd, IsaKd, IsaPd, PomKd, KCd	**First relapse**: consider salvage ASCT in eligible patients who have not had a prior ASCT **Lenalidomide sensitive** • If not refractory to anti-CD38 mAb: DRd or IsaRd • If refractory to/relapse while on anti-CD38 mAb: KRd **Lenalidomide refractory** • If not refractory to anti-CD38 mAb: DKd, IsaKd, or PVd • If refractory to/relapse while on anti-CD38 mAb: PVd or PI + Cd	Guided by prior treatment and refractory status[e]

Table 1 continued

	Gulf region[a] 2025 [43, 44]	Gulf region[a] expert recommendations 2025 [22]	Saudi Arabia Myeloma Working Group 2025 [47, 48]	Turkish Society of Hematology 2024 [49]
Late relapse	• BsAb or CAR T-cell therapy for triple class–exposed patients • Selinexor should only be considered when there is no access to BsAbs or CAR T	**Triple refractory** • CAR T-cell therapy **Where conventional treatments are exhausted** • Elranatamab **Where transplant is not available** • BsAb **Transplant ineligible** • Daratumumab monotherapy • DVRd	**Second or later relapse**[f]: consider clinical trials or salvage ASCT in eligible patients who have not had a prior ASCT • Treatment regimens should be determined based on the patient's previous therapies: if an anti-CD38 mAb has not been used and the patient is eligible, it should be included in the treatment plan • Refer patients for consideration of CAR T-cell therapy if high risk and poor response to quadruplet-based initial therapy	**Lenalidomide/bortezomib refractory** • DKd, IsaPd, EloPd, IsaKd, DPd, Seli-Pd, Ven-Kd **Lenalidomide refractory, PI sensitive** • DKd, EloPd, IsaKd, IsaPd, DPd, DVd, Seli-Vd, Seli-Pd, Ven-Vd, Ven-Kd **Triple refractory** • Clinical trials • Seli-d, belamaf, melflufen-d, Ven, BsAb, CAR T

ASCT autologous stem cell transplant, *belamaf* belantamab mafodotin, *BsAb* bispecific antibody, *CAR* chimeric antigen receptor, *Cd* cyclophosphamide + dexamethasone, *DKd* daratumumab + carfilzomib + dexamethasone, *DPd* daratumumab + pomalidomide + dexamethasone, *DRd* daratumumab + lenalidomide + dexamethasone, *DVCd* daratumumab + bortezomib + cyclophosphamide + dexamethasone, *DVRd* daratumumab + bortezomib + lenalidomide + dexamethasone, *EloPd* elotuzumab + pomalidomide + dexamethasone, *IsaKd* isatuximab + carfilzomib + dexamethasone, *IsaPd* isatuximab + pomalidomide + dexamethasone, *IsaRd* isatuximab + lenalidomide + dexamethasone, *IsaVRd* isatuximab + bortezomib + lenalidomide + dexamethasone, *KCd* carfilzomib + cyclophosphamide + dexamethasone, *KPd* carfilzomib + pomalidomide + dexamethasone, *KRd* carfilzomib + lenalidomide + dexamethasone, *mAb* monocloncal antibody, *MM* multiple myeloma, *PomKd* pomalidomide + carfilzomib + dexamethasone *PI* proteasome inhibitor, *PVd* pomalidomide + bortezomib + dexamethasone, *Seli-d* selinexor + dexamethasone, *Seli-Pd* selinexor + pomalidomide + dexamethasone, *Seli-Vd* selinexor + bortezomib + dexamethasone, *Vd* bortezomib + dexamethasone, *Ven* venetoclax, *Ven-Kd* venetoclax + carfilzomib + dexamethasone, *Ven-Vd* venetoclax + bortezomib + dexamethasone, *Ven-Kd* venetoclax + carfilzomib + dexamethasone

[a]Gulf region refers to Kuwait, Oman, Qatar, and United Arab Emirates

[b]Renal disease related to MM, defined as serum creatinine > 2 mg/dL or creatinine clearance < 40 mL/min

[c]If the patient is young and fit, has an existing source of stem cells, and was in remission for > 4 years, a second ASCT can be considered

[d]A second ASCT may be considered in transplant-eligible patients if they achieved > 36 months of remission after their initial ASCT

[e]For patients treated with 1L VRd and lenalidomide sensitive: KRd, DRd, PVd, DPd, DKd, IsaPd, IsaKd, IxaRd, Seli-Vd, KCd, KPd, PCd, EloRd; lenalidomide refractory: PVd, DPd, DKd, IsaKd, IsaPd, Seli-Vd, KCd, KPd, PCd; bortezomib sensitive: KRd, DPd, DRd, EloRd, PVd, DKd, DVd, IsaKd, IsaPd, Seli-Vd, Ven-Vd, KCd, KPd, PCd; lenalidomide/bortezomib refractory: DKd, DPd, IsaKd, IsaPd, KCd, KPd, PCd. For patients treated with 1L DRd and lenalidomide sensitive: DKd, DPd, IsaKd, IsaPd, KCd, KPd, PCd; lenalidomide refractory: PVd, Kd, Seli-Vd, Seli-Pd, Ven-Vd, Ven-Kd, KCd, KPd, PCd. For patients treated with 1L DVTd or DVMP and bortezomib sensitive: EloRd, KRd, IxaRd, VRd, Seli-Vd, Seli-Pd, Kd, Ven-Vd, Ven-Kd, PVd; bortezomib refractory: EloRd, KCd, KPd, PCd, Seli-Pd, Ven-Kd

[f]For patients without plasma cell leukemia or extramedullary disease

ORR was reported in 13 studies of patients with RRMM ($N=1201$), ranging from 35% to 72.5%, with CR rates of 2.4–28.8% [28, 38, 40, 52–61]. The REPAIR study reported decreasing ORRs and ≥ CR rates with increasing LOTs, with ORRs of 79.0%, 62.2%, 45.7% and 12.4% and ≥ CR rates of 47.9%, 39.1%, 17.8% and 6.2% at 1L, 2L, 3L, and fourth line, respectively [27].

Four studies reported on response rates in patients with RRMM who were treated with daratumumab, with ORRs of 35.9–59.4%, including CR rates of 2.4–28.8% [28, 40, 54, 55]. This included one study that focused on 42 heavily pretreated patients (three or more prior LOTs, including a PI and an IMiD) from 25 centers across Turkey, in which an objective response was reported in 45.2% of patients, including a CR in 2.4% [54].

Six studies reported response rates in patients with RRMM treated with lenalidomide, which ranged from 38.5% to 72.5% with CR rates of 7.7–28.8% [38, 53, 56–58, 60]. Notably, ORRs with lenalidomide decreased with its initiation in later lines of therapy: 62.9%, 16.1% and 6.5% at 2L, 3L and fourth line and beyond, respectively [56].

Four articles reported comparisons of response rates between brand-name lenalidomide (Revlimid®) and generic versions in patients, with most reporting only slight differences in ORRs between the two versions [56–58, 62]. One single-center study in Turkey compared the use of brand-name bortezomib (Velcade®) and a generic version, in combination with cyclophosphamide and dexamethasone, in patients with NDMM; response rates were similar between the two versions [50].

PFS

Median PFS was reported in 24 articles, ranging from 2 to 97.7 months (Table 2). Eight of these were conducted in patients with NDMM ($N=1191$), in which median PFS ranged from 14 to 97.7 months [63–70]. This included six studies reporting data on patients who received ASCT ($N=592$), in which the median PFS ranged from 20 to 97.7 months [64–69]. One single-center study in Turkey compared clinical outcomes in patients with NDMM aged ≤ 65 vs > 65 years, and reported significantly longer median PFS in patients aged ≤ 65 years than in those aged > 65 years (44 vs 30 months; $p=0.02$) [68].

Another single-center study in Turkey compared the efficacy of induction with bortezomib + dexamethasone (Vd) versus VCd in patients with NDMM and reported a median PFS of 67.1 and 97.7 months, respectively, with 5-year PFS rates of 56% and 59%, respectively [65].

Median PFS was reported in 12 studies of patients with RRMM, which ranged from 2 to 38.1 months [28, 38, 40, 41, 53–56, 59–61, 71]; four studies reported 1-year PFS rates of 35.7–76.4% [28, 54, 72, 73]. Median PFS tended to be shorter in patients with a greater number of prior LOTs. In a multicenter retrospective study of patients in Turkey with more than two prior LOTs, those who received elotuzumab and lenalidomide or pomalidomide had a median PFS of 7.5 and 6.5 months, respectively [71]. This compared with 2.9 and 6.5 months in patients with more than three prior LOTs; however, these differences were not statistically significant [71]. Patients in a tertiary care hematology clinic in Turkey initiating lenalidomide at 2L had a median PFS of 29.2 months compared with 26.4 months at 3L [56].

One single-center study in Egypt ($N=25$) compared clinical outcomes in patients with MM with and without high-risk cytogenetic abnormalities (HRCA) and found that patients with t(4;14) had a statistically significantly shorter median time to progression than those without t(4;14) (36.0 versus 88.5 months; $p=0.001$). Similarly, patients with del(17p) had a significantly shorter median PFS than those without (23.3 versus 52.94 months; $p=0.014$) [66]. No significant differences were observed between patients with and without t(11;14) (49.1 versus 41.1 months; $p=0.39$) and del(13q) (20.7 versus 51.0 months; $p=0.282$) [66]. A second single-center Egyptian study compared VAD with Vd induction, followed by ASCT and thalidomide maintenance, in patients with and without t(4;14) and/or del(17p). In patients without these cytogenetic abnormalities, median PFS was significantly longer with Vd than VAD induction (31 versus 26 months; $p=0.018$);

Table 2 Patient and clinical outcomes

Study	Patient population	Intervention/subpopulation	*N*	mPFS, months	PFS rate, %	mOS, months	OS rate, %	ORR, %	CR, %	VGPR, %	PR, %
NDMM											
Kim et al. [74]	NDMM	SCT	32	–	–	–	–	–	71.9 sCR: 15.6	6.3	6.3
		Non-SCT	14	–	–	–	–	–	14.3 sCR: 7.1	14.3	14.3
Alhejazi et al. [27]	NDMM	First LOT	148					79.0	43.2 sCR: 4.7	17.6	13.5
Abdrabou et al. [64]	NDMM	VCd followed by ASCT	87	49	–	–	5-year: 84	–	Pre-ASCT: 31 Post-ASCT: 35.6 sCR: 6.9 (pre-ASCT) 16.1 (post-ASCT)	Pre-ASCT: 41.4 Post-ASCT: 32.2	Pre-ASCT: 1.1 Post-ASCT: 0
Erdogan Yucel et al. [68]	NDMM	Age ≤ 65 years	115	44	–	78	–	–	–	–	–
		Age > 65 years	26	30	–	67	–	–	–	–	–
Kazgı et al. [34]	NDMM	Patients with cytogenetic abnormalities	68	–	–	–	–	60.3	–	–	–

Table 2 continued

Study	Patient population	Intervention/subpopulation	*N*	mPFS, months	PFS rate, %	mOS, months	OS rate, %	ORR, %	CR, %	VGPR, %	PR, %
Kaloyannidis et al. [50]	NDMM		116	–	–	NR	4-year: 67 8-year: 51	83	≥ CR: 37	24	22
Abdrabou et al. [25]	NDMM	Pre-ASCT	–	–	–	–	–	–	38.1 sCR: 11.9	11.3	38.1
		Post-ASCT	–	–	–	–	–	–	57.4 sCR: 20.7	11.8	6.5
Çiftçiler et al. [118]	NDMM	ASCT after induction therapy	153	–	5-year DFS: 46	–	5-year: 75	–	–	–	–
Mersin et al. [50]	NDMM	VCd with Velcade®	42	–	–	–	–	81	23.8	31	26.2
		VCd with generic bortezomib	53	–	–	–	–	79.2	18.9	20.8	39.6
Baysal et al. [29]	NDMM	Overall	159	–	–	50	–	–	–	–	–
		0 HRCA	126	–	–	57	–	–	–	–	–
		1 HRCA	24	–	–	32	–	–	–	–	–
		2 HRCAs	7	–	–	6	–	–	–	–	–
Çiftçiler et al. [65]	NDMM	Vd	36	67.1	5-year: 56	56	5-year: 75	–	–	≥ VGPR Pre-ASCT: 19.4 Post-ASCT: 86.1	–

Table 2 continued

Study	Patient population	Intervention/ subpopulation	*N*	mPFS, months	PFS rate, %	mOS, months	OS rate, %	ORR, %	CR, %	VGPR, %	PR, %
		VCd	67	97.7	5-year: 59	59	5-year: 83	–	–	≥ VGPR Pre-ASCT: 29.9 Post-ASCT: 88.1	–
Denewer et al. [66]	NDMM with FISH available	–	25	t(4;14): 36 Non-t(4;14): 88.5 del(17p): 23.3 Non del(17p): 52.9 t(11;14): 49.1 non-t(11;14): 41.1 del(13q): 20.7 Non del(13q) 51.0	–	t(4;14): 36 Non-t(4;14): 85.0 del(17p): 35.5 Non del(17p): 81.0 t(11;14): 93 non-t(11;14): 48.1 del(13q): 35.0 Non del(13q) 77.8	–	–	–	–	–

Table 2 continued

Study	Patient population	Intervention/subpopulation	*N*	mPFS, months	PFS rate, %	mOS, months	OS rate, %	ORR, %	CR, %	VGPR, %	PR, %
Ciftciler et al. [30]	NDMM	ASCT (patients with CR/VGPR pre-ASCT)	47	–	–	–	–	–	–	≥ VGPR: 95.7	–
		ASCT (patients with ≤ PR pre-ASCT)	157							≥ VGPR: 85.4	
Abdelgawad et al. [63]	NDMM	–	89	mDFS: 12	5-year DFS: 45.7	–	5-year: 72.7	–	–	–	–
Abduljalil et al. [129]	NDMM	–	63	–	95-month rate: 41.1	–	95-month rate: 69.1	–	–	–	–
El-Ghammaz et al. [67]	Standard risk NDMM with no del(17p) and/or t(4;14)	VAD induction followed by high-dose melphalan and ASCT	27	26	At DCO: 77.8	NR	At DCO: 92.6	–	Post-ASCT: 77.8	–	–
		Vd induction followed by high-dose melphalan and ASCT	27	31	At DCO: 85.2	NR	At DCO: 96.3	–	Post-ASCT: 85.2	–	–

Table 2 continued

Study	Patient population	Intervention/ subpopulation	*N*	mPFS, months	PFS rate, %	mOS, months	OS rate, %	ORR, %	CR, %	VGPR, %	PR, %
	High risk NDMM with del(17p) and/or t(4;14)	VAD induction followed by high-dose melphalan and ASCT	13	20	At DCO: 23.1	22	At DCO: 53.8	–	Post-ASCT: 23.1	–	–
		Vd induction followed by high-dose melphalan and ASCT	13	NR	At DCO: 69.2	NR	At DCO: 69.2	–	Post-ASCT: 69.2	–	–
RRMM											
Alhejazi et al. [27]	RRMM	Second LOT	139	–	–	–	–	62.2	33.1 sCR: 2.9	13.0	10.1
		Third LOT	55	–	–	–	–	45.7	16.0 sCR: 1.8	12.9	15.0
		Fourth LOT	16	–	–	–	–	12.7	6.2 sCR: 0	6.2	0
Öztürk et al. [127]	RRMM	Allo-SCT	30	–	–	–	1-year: 45 2-year: 36.3 3-year: 31.7	–	–	–	–
Açar et al. [52]	RRMM (≥ 2 prior LOT)	BPd	11	–	2-year: 71.3	23	2-year: 81.8	54	9.1	45.4	18.2

Table 2 continued

Study	Patient population	Intervention/ subpopulation	*N*	mPFS, months	PFS rate, %	mOS, months	OS rate, %	ORR, %	CR, %	VGPR, %	PR, %
Bakırtaş et al. [53]	RRMM (≥ 2 prior LOTs)	IRd	54	13	–	–	–	38.5	7.7	9.6	21.2
Beksac et al. [56]	RRMM	Revlimid®	74	2L: 22.7 3L: 20.1	–	Mean: 122.3	–	54.1	22.5	55	22.5
		Generic lenalidomide	110	2L: 30.3 3L: 38.1	–	Mean: 123.3	–	60	28.8	50	21.2
Pektas et al. [36]	RRMM	2L/3L therapy	107		–	2L: 10.4 3L: 12.8	–	–	–	–	–
Tekinalp et al. [40]	RRMM	Daratumumab	134	8	–	11.6		55.9	–	≥ VGPR: 35.8	–
Bolaman et al. [57]	RRMM	Revlimid®	55	–	–	–	–	67.7	14.5	45.4	7.2
		Generic lenalidomide	43					60.4	20.9	18.6	20.9
Althomali et al. [28]	RRMM	Daratumumab	32	12	1-year: 50.2	–	1-year: 63	59.4	–	≥ VGPR: 40.7	18.8
Beksac et al. [54]	RRMM (≥ 3 prior LOTs)	Daratumumab monotherapy	42	5.5	18-month: 31.0	NR	18-month: 59.5	45.2	2.4	9.5	33.3
Cengiz et al. [72]	RRMM	Salvage ASCT	22	–	1-year: 43.2	–	2-year: 55.8	–	18.2	54.5	22.7
		Selinexor	10	–	1-year: 37.3	–	2-year: 54.9	–	0	20	40

Table 2 continued

Study	Patient population	Intervention/subpopulation	*N*	mPFS, months	PFS rate, %	mOS, months	OS rate, %	ORR, %	CR, %	VGPR, %	PR, %
Beksac et al. [71]	RRMM	Elotuzumab plus pomalidomide or lenalidomide or bortezomib and dexamethasone	50	5.5 Of pts with > 3 LOTs Len: 2.9 Pom: 6.5	–	Of pts with > 3 LOTs Len: 11.7 Pom: 17	–	Len: 54.9 Pom: 61.4	–	–	–
Bolaman et al. [58]	RRMM	Revlimid®	55	–	–	–	–	60	14.5	45.4	7.2
		Generic lenalidomide	43	–	–	–	–	39.5	20.9	18.6	20.9
Soyer et al. [38]	RRMM	Rd	120	21	–	32	–	72.5	19.2		
Beksac et al. [55]	RRMM	Daratumumab	39	5.5			1-year: 56.9	35.9	5.1	2.6	11
Ozsan et al. [59]	RRMM (heavily pretreated)	Pomalidomide	117	5.6	–	8.4	–	35	–	VGPR + CR: 11	24
Saydam et al. [60]	RRMM	Rd	120	21	–	32	–	72.5	19.2	–	–
Sevindik et al. [61]	RRMM (heavily pretreated)	Carfilzomib	152	6	–	10.4	–	40.8	–	VGPR + CR: 13.2	27.6

Table 2 continued

Study	Patient population	Intervention/subpopulation	*N*	mPFS, months	PFS rate, %	mOS, months	OS rate, %	ORR, %	CR, %	VGPR, %	PR, %
Yalnız et al. [41]	RRMM		19	59 days	–	120 days	–	–	–	–	–
Ozkan et al. [73]	RRMM	Thalidomide	34	–	1-year: 64.7 5-year: 5.9	60.5	1-year: 85.3 5-year: 14.7	–	–	–	–
		Lenalidomide	34	–	1-year: 76.4	44	1-year: 100	–	–	–	–
MM											
Yılmaz et al. [42]	MM	Melphalan 200 mg/m^2 with ASCT	130	33.1	–	125.3	–	–	–	–	–
		Melphalan 140 mg/m^2 with ASCT	26	42.4	–	62.9	–	–	–	–	–
Bostankolu et al. [117]	MM	Melphalan with ASCT	256	–	–	–	–	–	64.9	5.2	15.9
		Melphalan 200 mg/m^2	163	–	–	–	–	–	72.1	5.6	14.9
		Melphalan 140 mg/m^2	93	–	–	–	–	–	52.2	4.5	17.8
Elsergany et al. [119]	MM	ASCT		–	–	–	–	–	–	≥ VGPR: 84	15.4
Ipek et al. [120]	MM	VCd induction	72	–	–	49.4	–	–	12.5	48.6	26.4

Table 2 continued

Study	Patient population	Intervention/subpopulation	*N*	mPFS, months	PFS rate, %	mOS, months	OS rate, %	ORR, %	CR, %	VGPR, %	PR, %
Kassem et al. [33]	MM	VCd	15	DFS: 20	–	37.5	–	–	–	–	–
		VRd	2	DFS: 15	–	25.8	–	–	–	–	–
		VTd	2	DFS: 61.5	–	69.4	–	–	–	–	–
		Endoxan-dexamethasone	4	DFS: 0	–	4.1	–	–	–	–	–
Sulu et al. [39]	MM	Patients who received uHD	70	–	–	30	1-year: 39	–	–	–	–
		Patients who did not receive uHD	70	–	–	84		–	–	–	–
Serin et al. [130]	MM	–	244	42.3	5-year: 42 10-year: 21	–	5-year: 76 10-year: 53	–	–	–	–
Malkan et al. [125]	MM	Single ASCT	211	Mean: 2344 days	–	Mean: 4011 days	–	–	–	≥ VGPR: 49.8	20.9
		Double ASCT	17	Mean: 685 days	–	Mean: 3526 days	–	–	–	≥ VGPR: 29.4	23.5
Şahin et al. [70]	MM	–	310	14	–	41	–	–	–	–	–
Çiftçiler et al. [31]	MM	ASCT	180	–	5-year DFS: 54	–	5-year: 80	–	–	≥ VGPR Pre-ASCT: 16.3 Post-ASCT: 92.9	–

Table 2 continued

Study	Patient population	Intervention/subpopulation	*N*	mPFS, months	PFS rate, %	mOS, months	OS rate, %	ORR, %	CR, %	VGPR, %	PR, %
Kassem et al. [121]	MM	VCd		–	–	20.3	–	–	–	–	–
		VRd	–	–	–	26.4	–	–	–	–	–
		VTd		–	–	44.5					
		Endoxan-dexamethasone		–	–	5.1					
Kirik et al. [69]	MM	Overall	200	43.8	–	–	5-year: 71	–	–	–	–
		VCd induction followed by ASCT	156	55.3	–	–	5-year: 79	–	–	–	–
Umıt et al. [75]	MM	Age ≥ 65 years	80	–	–	17	–	–	–	–	–
Beksac et al. [62]	MM	Lenalidomide	102	–	–	–	–	90.2	26	52	22
		Revlimid®	49	–	–	–	–	73.5	–	–	–
		Generic lenalidomide	53	–	–	–	–	67.9	–	–	–
Gmati et al. [131]	MM	ASCT	60	–	1-year: 84.5 5-year: 43.1	–	1-year: 94.3 5-year: 70.5	–	31 sCR: 47	20	0
Alam et al. [26]	MM	–	32	–	–	–	–	–	–	≥ VGPR: 72	–
Onec et al. [126]	MM	–	66	–	–	39.0	–	–	–	–	–

Table 2 continued

2L second line, *3L* third line, *allo-SCT* allogeneic stem cell transplant, *ASCT* autologous stem cell transplant, *BPd* bendamustine + pomalidomide + dexamethasone, *CR* complete response, *DCO* data cutoff, *DFS* disease-free survival, *FISH* fluorescence in situ hybridization, *HRCA* high-risk cytogenetic abnormality, *IRd* ixazomib + lenalidomide + dexamethasone, *Len* lenalidomide, *LOT* line of therapy, *mDFS* mean disease-free survival, *MM* multiple myeloma, *mOS* median overall survival, *mPFS* median progression-free survival, *NDMM* newly diagnosed multiple myeloma, *NR* not reached, *ORR* overall response rate, *OS* overall survival, *PFS* progression-free survival, *Pom*, pomalidomide, *PR* partial response, *Rd* lenalidomide + dexamethasone, *RRMM* relapsed refractory multiple myeloma, *sCR* stringent complete response, *SCT* stem cell transplant, *uHD* urgent hemodialysis, *VAD* vincristine + adriamycin + dexamethasone, *VCd* bortezomib + cyclophosphamide + dexamethasone, *Vd* bortezomib + dexamethasone, *VGPR* very good partial response, *VRd* bortezomib + lenalidomide + dexamethasone, *VTd* bortezomib + thalidomide + dexamethasone

similarly, median PFS was significantly longer with Vd than VAD induction in patients with t(4;14) and/or del(17p) (not reached [NR] versus 20 months; $p = 0.016$) [67]. With a median follow-up of 17.5 months, for patients treated with VAD and Vd, respectively, the PFS rate was 77.8% and 85.2% in those without t(4;14) or del(17p), and 23.1% and 69.2% in those with t(4;14) and/or del(17p) [67].

Time to Progression

The REPAIR study reported decreasing median time to progression (TTP) with increasing LOTs: 23.9, 10.1, and 5.9 months following the initiation of first, second, and third LOTs, respectively [27]. Among patients with lenalidomide-refractory disease, median TTPs were 16.7, 8.9, and 8.0 months, respectively. In lenalidomide-sensitive disease, median TTPs were 27.3, 38.8, and 10.0 months following the first, second, and third LOTs, respectively [27]. In a Turkish study of patients with RRMM initiating 2L and 3L therapy (approximately half and two-thirds of whom were treated with a lenalidomide-containing regimen), 57.9% and 25.6% experienced disease progression, respectively, although the follow-up duration was not specified [36].

OS

Median OS was reported in 27 articles, ranging from 4 to 125.3 months (Table 2); eight of these reported on patients with NDMM and had a median OS ranging from 22 to 122.2 months [29, 51, 65–68, 70, 74]; 12 articles reported on patients with RRMM, in which median OS ranged from 4 to 60.5 months, with one study reporting a mean OS of 122.3–123.5 months [36, 38, 40, 41, 52, 54, 56, 59–61, 71, 73, 75]. Factors associated with longer median OS reported in two studies included younger age, female sex, and receiving ASCT [23, 68].

In a single-center Turkish study comparing Vd and VCd as induction therapy in patients with NDMM, median OS values were 113.1 and 122.2 months ($p = 0.47$), respectively, with 5-year OS rates of 75% and 83%, respectively [65]. Notably, mortality rate was significantly greater with Vd than VCd (19.4% versus 4.5%;

$p=0.01$) [65]. In a separate single-center Turkish study comparing thalidomide ($N=34$) and lenalidomide ($N=34$) as a second, third, or fourth LOT, median OS values were 65.5 and 44 months with thalidomide and lenalidomide, and 1-year mortality rates were 17.6% and 0%, respectively [73]. In patients with more than three prior LOTs, median OS was not significantly different between those treated with elotuzumab + lenalidomide and those treated with elotuzumab + pomalidomide (11.7 and 17 months, respectively) [71].

A single-center study in Egypt reported that in patients without HRCA, median OS was not reached in those treated with either VAD or Vd induction, and OS rates of 92.6% and 96.3%, respectively, were reported after a median follow-up of 17.5 months [67]. In patients with del(17p) and/or t(4;14) mutations, median OS was 22 months with VAD and not reached with Vd, with OS rates at data cut-off of 53.8% and 69.2%, respectively [67]. In a separate Egyptian study, patients with t(4;14) had a significantly shorter median OS than those without t(4;14) (36.6 versus 85.0 months; $p=0.005$), and patients with del(17p) also had a significantly shorter median OS than those without (35.5 versus 81.0 months; $p=0.008$) [66]. No significant differences were seen between patients with and without t(11;14) (93.0 versus 48.1; $p=0.038$) and del(13q) (35.0 versus 77.8; $p=0.208$) [66]. The presence of more HRCAs was associated with decreasing OS: median OS in patients with zero, one or two HRCAs were 57, 32 and 6 months, respectively [29].

QOL

QOL was reported in four articles [37, 76–78]. In 92 Turkish patients with MM who participated in an online survey, the mean (SD) numeric rating scale (a measure for pain where 0 indicates "no pain" and 10 indicates "the worst pain imaginable" over the past week) was 3.9 (2.6). The mean (SD) Short Form-12 (SF-12) health-related QOL (HRQOL) mental and total physical component scores, respectively, were 45.5 (24.8) and 39.1 (25.4); higher scores indicate greater QOL [76]. The study also utilized the Functional Assessment of Chronic Illness Therapy–Spiritual Well-Being Scale-12 (FACIT-Sp-12, version 4), with a mean (SD) score of 28.1 (9.8) out of a maximum of 48; higher scores represent greater spiritual well-being. In the Meaning, Peace, and Faith subscales, mean (SD) scores were 10.3 (3.5), 8.8 (3.4) and 8.9 (4.6), respectively [76]. Notably, there was a negative correlation between pain scores in the previous week and FACIT-Sp-12 total and subscale scores and in SF-12 physical and mental component scores [76]. The SF-12 physical and mental component scores, respectively, were associated with total FACIT-Sp-12 scores ($r=0.304$ and $r=0.416$), with Meaning ($r=0.345$, $r=0.465$) and Peace ($r=0.481$ and $r=0.579$) subscales, and with pain scores in the previous week ($r=-0.499$ and $r=-0.349$) [76].

Half of the 62 patients with MM and chemotherapy-induced peripheral neuropathy from a single center in Saudi Arabia reported "quite a bit" or "very much" bone aches or pain (50.0%), and pain in the back, hip, arm/shoulder, and chest were reported in 42.6%, 37.7%, 32.8%, and 14.8%, respectively [37]. Notably, 49.1% of patients responded "quite a bit" or "very much" when asked if their pain increased with activity [37].

In a single-center study of 42 patients with fractures due to spinal infiltration in Turkey, statistically significant differences were found between pre- and postoperative visual analog scale (VAS) and Oswestry Disability Index scores, respectively, in patients who underwent kyphoplasty ($p=0.0001$ and $p=0.002$), vertebroplasty ($p=0.0001$ and $p=0.0001$) and both vertebroplasty and kyphoplasty ($p=0.0002$) [77].

In a separate single-center Turkish study of 49 patients with MM and bone lesions, all patients reported moderate to severe pain; the mean (range) duration was 4 (1–9) months [78]. Of the 57 lesions in these patients, 48 were associated with actual or impending pathologic fractures leading to limited motion. Surgical procedures were performed on all 57 lesions, and all patients experienced improvements in pain, extremity motion, and mobility after surgery [78]. Mean (SD) VAS scores decreased from 8.75 (1.2) before surgery to 3.21 (1.56) at discharge after a mean of 6.7 (3.4) days ($p=0.0001$) [78]. Similarly, mean (SD) Musculoskeletal Tumor Society functional scores improved from 9.1% (6.4%) before surgery to 76% (14.9%) at the last follow-up ($p=0.0001$) [78].

Safety and Tolerability of Treatments Received

Adverse events (AEs) were reported in 27 articles. Hematologic AEs—such as anemia, thrombocytopenia, and neutropenia—were commonly reported; common nonhematologic AEs included peripheral neuropathy, diarrhea, and infection (including pneumonia) (Table 3).

Anemia, thrombocytopenia, and neutropenia were frequently reported in studies focusing on daratumumab, with one study of 32 patients with RRMM in Saudi Arabia reporting grade 3/4 events in 46.9%, 43.8%, and 37.5% of patients, respectively [28]; in a second study in 134 patients with RRMM in Turkey, these respective results were 30.9%, 52.8% and 66.2% [40]. Infusion-related reactions were also commonly reported with daratumumab, occurring in 46.9% of patients in one study and in 13.4% of patients in a second study [28, 40]. Notably, the specific AEs counting towards infusion-related reactions were not detailed in either study.

One Turkish study of 152 patients with RRMM treated with carfilzomib reported hematologic AEs in 61.8% of patients and cardiovascular AEs in 26.3%, including heart failure, pulmonary hypertension and systemic hypertension [61]. Cardiac AEs were also reported in 10.6% of patients with RRMM in Turkey treated with ixazomib + lenalidomide + dexamethasone (IxaRd; $N = 54$) [53].

In studies focusing on bortezomib-containing regimens, peripheral neuropathy was reported in 11.3–50% of patients [50, 79–81], with one study reporting dose reductions due to neurotoxicity in 31% of patients treated with intravenous bortezomib [79]. One study compared Velcade® and generic bortezomib and found similar overall AE rates (47.6% versus 41.5%, $p = 0.55$) [50]. While numerically more patients experienced neuropathy with the original drug than the generic version (21.4% versus 11.3%; $p = 0.18$), fewer patients experienced anemia with the original drug (9.5% versus 15.1%; $p = 0.41$); the differences were not statistically significant [50].

Three of the four studies comparing Revlimid® and generic lenalidomide reported no significant differences in the rates of any-grade AEs between the two drugs [56, 58, 62]; however, one study reported a significantly lower rate of pneumonia with Revlimid® (22.6% versus 42.9%; $p = 0.035$) [62], and another reported significantly higher rates of grade ≥ 3 hematologic toxicity with Revlimid® (25.7% versus 13.6%; $p = 0.021$), although this difference disappeared when adjusted for LOT [56]. A separate study reported significantly higher rates of several AEs (nausea, vomiting, fatigue, edema, URTI, pneumonia, back pain, pyrexia, muscle cramps, muscle weakness, skin dry, and skin erythema), with generic lenalidomide than with Revlimid® but a significantly higher incidence of grade 3/4 pyrexia with Revlimid® than with generic lenalidomide (3.6% versus 0%; $p = 0.04$) [57].

One study compared the use of brand-name versus generic melphalan for conditioning prior to ASCT and found similar rates of diarrhea, oral mucositis and fever and similar engraftment kinetics between the treatments [82].

HCRU

Five studies reported on HCRU in the Gulf region, Egypt, Saudi Arabia, and the UAE (Table 4) [83–87]. In a study examining the financial burden of MM in the Gulf region (Saudi Arabia, Kuwait, the UAE, Qatar, and Oman), the weighted average annual direct cost per patient was US $125,000–372,000; patients with RRMM incurred greater individual costs than those with NDMM [85]. In a separate study of patients with NDMM treated in the UAE, annual drug, non-drug medical, and total costs for the first year of treatment were US $7,825,390.33–8,475,601.36, $3,674,228.45–8,954,474.06, and $12,149,829.82–16,779,864.40, respectively; in the fifth year, these costs were US $1,198,759.70–2,079,734.79, $451,416.47–1,924,099.39, and $1,650,176.17–4,003,834.17 [86]. Notably, this study found that changing from intravenous daratumumab to subcutaneous administration resulted in substantial savings in costs associated with premedication, managing AEs, administration, medical staff, and other indirect costs [86].

A study in Saudi Arabia compared costs associated with

Table 3 Adverse events reported in patients treated for MM

Study	Patient population	Intervention/subpopulation	*N*	Overall AEs	Hematologic AEs	Nonhematologic AEs
Proteasome inhibitor						
Kul et al. [81]	NDMM, normal cytogenetics	VCd	68	–	–	Bortezomib-induced peripheral neuropathy: 50%
	NDMM, abnormal cytogenetics	VCd	45	–	–	Bortezomib-induced peripheral neuropathy: 17.8%
Mersin et al. [50]	NDMM	VCd (Velcade®)	42	47.6%	Anemia: 9.5% Neutropenia: 4.8% Thrombocytopenia: 7.1%	Neuropathy: 21.4% URTI: 9.5% Diarrhea: 9.5%
		VCd (generic bortezomib)	53	41.5%	Anemia: 15.1% Neutropenia: 4.8% Thrombocytopenia: 7.5%	Neuropathy: 11.3% URTI: 7.5% Diarrhea: 5.7%
Ciftciler et al. [65]	NDMM	Vd	36	–	Neutropenia: 5.6% Neutropenic fever/infection: 2.7%	–
		VCd	67	–	Neutropenia: 32.8% ($p = 0.002$) Neutropenic fever/infection: 2.9%	–
Sevindik et al. [61]	RRMM	Carfilzomib	152	–	Any: 61.8%	Cardiovascular AEs: 26.3% Renal AEs: 9.2%
Ateşalalu et al. [79]	MM	Bortezomib (SC)	74	–	–	Dose reduction due to neurotoxicity: 19%

Table 3 continued

Study	Patient population	Intervention/subpopulation	*N*	Overall AEs	Hematologic AEs	Nonhematologic AEs
		Bortezomib (IV)	55	–	–	Dose reduction due to neurotoxicity: 31%
IMiD						
Açar et al. [52]	RRMM	BPd	11	–	Neutropenia: 36.4% Anemia: 18.2%	
Beksac et al. [56]	RRMM	Revlimid®	74	–	–	Fatigue: 51.4% Diarrhea: 36.5% Muscle weakness: 33.8% Rash: 35.1% Peripheral neuropathy: 18.9% VTE: 2.7% Pneumonitis: 32.4% Treatment discontinuation due to AE: 31.1%
		Generic lenalidomide	110	–	–	Fatigue: 52.8% Diarrhea: 37.2% Muscle weakness: 32.7% Rash: 39.1% Peripheral neuropathy: 20.9% VTE: 6.4% Pneumonitis: 30.0% Treatment discontinuation due to AE: 29.1%

Table 3 continued

Study	Patient population	Intervention/subpopulation	*N*	Overall AEs	Hematologic AEs	Nonhematologic AEs
Bolaman et al. [57]	RRMM	Revlimid®	55	–	Neutropenia: 61.8% Thrombocytopenia: 38.2% Anemia: 67.3% Febrile neutropenia: 40.0%	–
		Generic lenalidomide	120	–	Neutropenia: 48.8% Thrombocytopenia: 34.9% Anemia: 76.7% Febrile neutropenia: 51.2%	–
Beksac et al. [62]	MM	Revlimid®	49	–	Grade ≥ 3: 37.7%	Fatigue: 58.3% Muscle weakness: 47.4% Diarrhea: 39.6% Rash: 37.7% Peripheral neuropathy: 27% Pneumonia: 22.6%
		Generic lenalidomide	53	–	Grade ≥ 3: 36.7%	Fatigue: 51.3% Muscle weakness: 33.3% Diarrhea: 24.9% Rash: 30.6% Peripheral neuropathy: 19.4% Pneumonia: 42.9%

Table 3 continued

Study	Patient population	Intervention/subpopulation	*N*	Overall AEs	Hematologic AEs	Nonhematologic AEs
Bolaman et al. [58]	RRMM	Revlimid®	55	–	Nausea: 23.6% Vomiting: 18.2% Fatigue: 56.4% Pyrexia: 20.0% URTI: 30.9% Pneumonia: 21.8% Back pain: 23.6% Muscle cramp: 23.6% Muscle weakness: 40.0% Skin dry: 7.3% Skin erythema: 1.8%	–
		Generic lenalidomide	43	–	Nausea: 48.8% Vomiting: 39.5% Fatigue: 41.9% Pyrexia: 46.5% URTI: 65.1% Pneumonia: 55.8% Back pain: 55.8% Muscle cramp: 51.2% Muscle weakness: 58.1% Skin dry: 27.9% Skin erythema: 16.3%	–
Soyer et al. [38]	RRMM	Rd		–	Anemia: 12.5% Thrombocytopenia: 9.2% Neutropenia: 28.3% Pancytopenia: 2.5%	Pneumonia: 15.8% Fatigue: 14.2% Neuropathy: 2.5% Cutaneous reaction: 1.7% Diarrhea: 2.5% Renal failure: 1.7%

Table 3 continued

Study	Patient population	Intervention/subpopulation	*N*	Overall AEs	Hematologic AEs	Nonhematologic AEs
Ozsan et al. [59]	RRMM	Pomalidomide	117	–	Any: 77%	Fatigue: 27.3% Pneumonia: 20.5% Sepsis: 12% Renal: 6%
Saydam et al. [60]	RRMM	Rd	120	–	Anemia: 12.5% Thrombocytopenia: 9.2%	Incidence rate of second primary malignancies: 0.93 per 100 PY Pneumonia: 15.8% Fatigue: 14.2% Herpes infection: 0.8%
Firatli Tuglular et al. [133]	RRMM	Rd	111	Grade 3/4: 36.9%	**Grade 3/4** Neutropenia: 8.1% Pneumonia: 5.4% Anemia: 3.6% Thrombocytopenia: 1.8%	Any grade VTE: 1 (0.9%)
Ozkan et al. [73]	RRMM	Thalidomide	34	–	Cytopenia: 26.5%	Thrombosis: 2.9% Neuropathy: 38.2% Pneumonia: 5.8% Constipation: 47.1% Rash: 8.8%
		Lenalidomide	34	–	Cytopenia: 23.5%	Thrombosis: 0 Neuropathy: 0 Pneumonia: 11.8% Constipation: 0 Rash: 0

Table 3 continued

Study	Patient population	Intervention/subpopulation	*N*	Overall AEs	Hematologic AEs	Nonhematologic AEs
Anti-CD38 mAb						
Bakırtaş et al. [53]	RRMM (≥ 2 prior LOTs)	IRd	54	40.4% had ≥ 1 AE; 19.1% had Grade ≥ 3 AE	Thrombocytopenia: 29.8% Anemia: 31.9% Neutropenia: 27.7%	Infective: 19.1% Constipation: 4.3% Diarrhea: 10.6% Skin rash: 10.6% Hypertension: 8.5% Hepatotoxicity: 6.4%
Tekinalp et al. [40]	RRMM	Daratumumab	134	–	**Any grade/grade 3–4, *n*** Neutropenia: 48/28 Thrombocytopenia: 36 /19 Anemia: 55/17	**Any grade/grade3–4, *n*** Neuropathy: 8/1 Diarrhea: 11/1 Vomiting: 14/0 Pneumonia: 32/9 IRR: 18/1
Althomali et al. [28]	RRMM	Daratumumab	32	–	**Most common grade 3/4 AEs:** Anemia: 46.9% Thrombocytopenia: 43.8% Neutropenia: 37.5%	IRR: 46.9% (G3: 9.4%)
Beksac et al. [54]	RRMM (≥ 3 prior LOTs)	Daratumumab monotherapy	42	76 AEs reported Grade ≥ 3: 43.4%	**Events** Thrombocytopenia: 13 Anemia: 12 Neutropenia: 8	**Events** Neuropathy: 3 Fatigue: 11 URTI: 3 Lower respiratory tract infection: 8 Other infection: 8 IRR: 10
Beksac et al. [55]	RRMM	Daratumumab	39	–	Thrombocytopenia: 28.2% Fatigue: 25.6% Anemia: 25.6%	

Table 3 continued

Study	Patient population	Intervention/ subpopulation	*N*	Overall AEs	Hematologic AEs	Nonhematologic AEs
Melphalan						
Amikishiyev et al. [132]	MM	ASCT with high-dose melphalan conditioning and antimicrobial prophylaxis		–	Median duration of neutropenia: 8 days	Fever requiring antimicrobial treatment: 90.6% Fever of unknown origin: 53% Primary bacteremia: 12.6% Pneumonia: 12.6% Severe skin infection: 5.3% Candidial and/or herpetic stomatitis: 10.6% Invasive fungal infection: 8% No infection-related death during study period
Aypar et al. [80]	MM	High-dose melphalan	114	–	–	**Most frequently reported grade 3/4:** Infection: 64.9% Diarrhea: 25.4% Mucositis: 9.6% Pulmonary toxicity: 9.6% **Grade 1/2:** Mucositis: 33.3% Diarrhea: 53.5% ICU: 2.6% TRM: 1.75%

Table 3 continued

Study	Patient population	Intervention/subpopulation	*N*	Overall AEs	Hematologic AEs	Nonhematologic AEs
		Bortezomib + high-dose melphalan	53	–	–	**Most frequently reported grade ¾:** Infection: 54.7% Diarrhea: 37.7% Mucositis: 13.2% Pulmonary toxicity: 18.9% **Grade ½:** Mucositis: 60.4% Diarrhea: 56.6% ICU: 7.5% TRM: 3.7%
Other/not specified						
Gursoy et al. [32]	NDMM	–	455	–	–	6-month VTE: 7%
Farghaly et al. [85]	MM	–	–	–	Anemia: 54%	Bone pain: 51% Microbial infections: 39%
Cengiz et al. [72]	MM	Salvage ASCT	22		Prolonged isolated thrombocytopenia: 13.6%	Infection: 9.1%
		Selinexor	10	–	Thrombocytopenia: 20%	Fatigue: 30% Nausea: 50% Neuropathy: 10%
Kassem et al. [121]	MM	–	81	–	–	**Hepatic AEs** ALT increase: 1.6% AST increase: 13.6% Bilirubin increase: 15.0%
Umit et al. [75]	RRMM, aged ≥ 60 years	–	80	–	–	Fall risk: 27.5% Autonomous neuropathy: 36.3%

Table 3 continued

Study	Patient population	Intervention/ subpopulation	*N*	Overall AEs	Hematologic AEs	Nonhematologic AEs
Yalnız et al. [41]	RRMM	–	19	–	**Grade 3–4 TRAE:** Anemia: 9% Neutropenia: 55% Thrombocytopenia: 23%	**Grade 3-4 TRAE:** Infection: 9% Nausea: 4%

AE adverse event, *ALT* alanine aminotransferase, *ASCT* autologous stem cell transplant, *AST* aspartate aminotransferase, *BPd* bendamustine + pomalidomide + dexamethasone, *ICU* intensive care unit, *IMiD* immunomodulatory imide, *IRd* isatuximab + lenalidomide + dexamethasone, *IRR* infusion-related reaction, *IV* intravenous, *LOT* line of therapy, *mAb* monoclonal antibody, *MM* multiple myeloma, *NDMM* newly diagnosed multiple myeloma, *Rd* lenalidomide + dexamethasone, *RRMM* relapsed and/or refractory multiple myeloma, *SC* subcutaneous, *TRAE* treatment-related adverse event, *TRM* treatment-related mortality, *URTI* upper respiratory tract infection, *VCd* bortezomib + cyclophosphamide + dexamethasone, *Vd* bortezomib + dexamethasone, *VTE* venous thromboembolism

daratumumab + lenalidomide + dexamethasone (DRd), carfilzomib + lenalidomide + dexamethasone (KRd), elotuzumab + lenalidomide + dexamethasone (EloRd), and ixazomib + lenalidomide + dexamethasone; KRd had the lowest average cost per treatment cycle (US $7299.73), while DRd had the greatest average cost per treatment cycle (US $11,947.20). The cost per ORR was also lowest with KRd (US $345,591.20) and highest with DRd (US $896,541.87) [87].

A study in Egypt modeling a hypothetical health plan estimated that introducing lenalidomide in patients with NDMM and RRMM, respectively, would introduce a cost savings of US $18,457.03 and $23,436.44 in year 1; US $37,783.32 and $71,391.85 in year 2; and US $45,419.91 and $126,301.68 in year 3 [84]. A separate study in Egypt estimated that, over a 20-year time horizon, when compared with Kd, DVd resulted in an increase of 0.43 life-years and 0.34 quality-adjusted life years [83].

DISCUSSION

Epidemiology and Disease Burden

Compared with global rates, the ASIR of MM in MENA is marginally lower: 1.49 per 100,000 individuals compared with a global rate of 1.92 per 100,000 individuals [7]. However, it is unclear whether this reported ASIR accurately reflects the incidence of MM in MENA, or if it is underestimated owing to potential gaps in diagnosis and reporting in the region. In the MENA region, the incidence of MM was higher in men and older individuals (aged > 50 years) than in women or younger individuals—in alignment with global trends [3]. Only two independent studies reported on incidence in Turkey and Saudi Arabia, highlighting a significant data gap in the region [7, 19–23]. Few studies reported on the incidence and prevalence of MM in the MENA region, with data largely sourced from the IARC's GLOBOCAN database. This lack of comprehensive data may hinder effective public health planning and resource allocation for MM in the MENA region.

Similar to global trends, the incidence of MM in MENA has been increasing over time. Notably, the rate of increase appears higher in the MENA region than globally, with an increase of 14.95% in ASIR between 1990 and 2019 in MENA compared with a global rate of 10.99% [7], and an increase in incident cases from 1990 to 2016 of 192% and 126%, respectively [19]. In particular, men in Turkey were reported to have the greatest, statistically significant increases in incidence globally between 2001 and 2019

(AAPC 5.63, 95% CI 1.12–10.35; $p = 0.020$), increasing across all ages; women in Turkey did not experience a significant increase [21]. In Turkey, ASIRs for total cancers and for cancers of various sites increased between 2006 and 2020, and is projected to continue increasing substantially in the future across the MENA region [88, 89]. It remains to be seen whether this represents true changes in cancer incidence or if this is a reflection of progressive improvements in access to healthcare services and enhanced diagnostic capacity leading to increased detection. Although other countries reported higher AAPCs, such as Iceland (AAPC 7.94) and Kuwait (AAPC 7.06), the differences were not considered statistically significant [21]. Notably, the median age of patients with MM identified in the current literature review ranged from 43 to 70 years, which is lower than the global median of 70 years [7]. This wide range of median ages likely reflects the variation in populations and study designs in studies conducted across the region.

In the MENA region, a significant proportion of patients had advanced disease at diagnosis or study entry; 41.4% had stage III disease. Limited awareness of MM symptoms from healthcare provider and patient perspectives can also lead to delayed diagnosis; for example, pain symptoms of MM can be dismissed as musculoskeletal in nature, particularly in community hospitals [22]. Additionally, patients may be reluctant to seek medical attention even when experiencing symptoms, resulting in MM being diagnosed at more advanced stages [22]. Furthermore, availability and access to imaging such as positron emission tomography/computed tomography and magnetic resonance imaging is limited in some parts of the region, representing further barriers to the diagnostic pathway [22]. This is in contrast with studies conducted in Spain and the USA, in which 27.0% and 19.0% of patients had stage III disease at enrollment [90, 91], but aligns with a study of patients in Asia and Latin America in which 40.8% of patients had stage III disease at enrollment [92]. Notably, within MENA there is significant variation across the individual countries: while stage III disease was most common at diagnosis or study entry in Saudi Arabia and Turkey, stage I and II disease were most common in Egypt and the UAE, respectively. Furthermore, < 50% of the articles identified in this literature search reported ISS stage. This may reflect localized differences in early access to diagnostic and prognostic tools such as flow cytometry and cytogenetic testing.

Similar to other diverse geographic and socioeconomic regions, such as Latin America, the reporting of cytogenetic testing in the studies retrieved was inconsistent [93]. Only 25 of the studies identified in our literature search reported on cytogenetic risk factors; furthermore, a significant proportion of patients within these studies did not have cytogenetic information available. The presence of certain cytogenetic abnormalities, such as del(17p), is associated with poor clinical outcomes [29, 66], and detection of these abnormalities can help guide clinical decision-making [48]. Together, this lack of cytogenetic testing and ISS assessment suggests that patients with high-risk disease in the MENA region may be missing out on intensive treatment, leading to inferior outcomes.

Treatment Availability

Although treatment options for MM have evolved over the past decade, access to novel treatments varies between countries in the MENA region, impacted by government reimbursement policies and access to private healthcare. Across the MENA region, and in the individual countries of interest, bortezomib was the most frequently used treatment. Treatment patterns differed between LOTs. Daratumumab was more commonly used in patients with RRMM, while the use of lenalidomide was similar between patients with NDMM and RRMM in the MENA region. This could at least in part be explained by regulatory approvals—in Turkey, daratumumab was only approved for use in patients with NDMM in 2024, resulting in few patients treated with these drugs in the articles included in this review [94]. Few studies reported on treatment patterns in individual countries, and those that did included small sample sizes, with one exception: a Turkish analysis of patients in the Sosyal Güvenlik Kurumu receiving treatment for NDMM between 2011

Table 4 Median/mean healthcare costs per patient (US $, as of 17 November 2025)

Study	Geography	Intervention	All-cause costs	Cancer-related treatment costs	Cost-effectiveness
Farghaly et al. [85]	MENA	–	125–372,000	–	–
Elsisi et al. [83]	Egypt	DVd versus Kd	–	–	DVd resulted in an increase of 0.34 QALY and 0.43 LY over Kd
Elsisi et al. [84]	Egypt	–	–	–	Cost savings with initiation of lenalidomide in NDMM Year 1: 18,457 Year 2: 37,783 Year 3: 45,420 Cost savings with initiation of lenalidomide in RRMM Year 1: 23,436 Year 2: 71,392 Year 3: 126,302
Maroun et al. [87]	Saudi Arabia	KRd	–	Per cycle: 7300 Per ORR: 345,591	–
		DRd	–	Per cycle: 11,947 Per ORR: 896,542	–
		EloRd	–	Per cycle: 10,474 Per ORR: 403,359	–
		IxaRd	–	Per cycle: 9792 Per ORR: 403,840	–
Hamad et al. [86]	UAE	–	Year 1: 12,149,830–16,779,864 Year 5: 1,650,176–4,003,834	Year 1: 7,825,390–8,475,601 Year 5: 1,198,760–2,079,735	–

DRd daratumumab + lenalidomide + dexamethasone, *DVd* daratumumab + bortezomib + dexamethasone, *EloRd* elotuzumab + lenalidomide + dexamethasone, *IxaRd* ixazomib + lenalidomide + dexamethasone, *Kd* carfilzomib + dexamethasone, *KRd* carfilzomib + lenalidomide + dexamethasone, *LY* life-year, *MENA* Middle East and North Africa, *NDMM* newly diagnosed multiple myeloma, *ORR* overall response rate, *QALY* quality-adjusted life year, *RRMM* relapsed/refractory multiple myeloma, *UAE* United Arab Emirates

and 2017, which accounted for the majority of the patients (N=10,146) identified in this review [23]. In this analysis of patients, there was an increasing trend of lenalidomide use over the study period (2011–2017), which mirrors global trends [23, 95, 96] and suggests that a growing number of patients may become refractory to lenalidomide at relapse. Because patients retreated with lenalidomide, particularly those with lenalidomide-refractory disease, tend to have worse clinical outcomes [27, 36], there is an unmet clinical need for new treatment modalities in this growing patient population.

In recent years, CAR T-cell therapies and bispecific T-cell engagers have demonstrated efficacy in the treatment of RRMM, and have been approved for use in the USA and other countries [97–100]; in the MENA region, these therapies are approved in Saudi Arabia, Turkey, and the UAE [101]. However, despite regulatory approvals, access to these novel therapies remains inadequate, primarily owing to a lack of reimbursement and the subsequent financial burden imposed on patients [102]. Furthermore, these treatments with novel mechanisms of action have unique, potentially life-threatening AEs that require specialized monitoring and management, including cytokine release syndrome and immune effector cell-associated neurotoxicity syndrome, adding strain to resource-limited settings [103]. In addition, where the infrastructure exists to support these novel therapies, access to these specialized centers is limited to certain urban centers, presenting a barrier to patients living away from these areas [22].

Nearly all the studies identified in this review were retrospective and observational, suggesting a paucity of clinical trials conducted in the MENA region that presents a hindrance to patients receiving novel treatments. While a number of global clinical trials from the identified articles included study sites in the region, there is a lack of reporting on the MENA patient population. This may have hampered the identification of any potential regional/ethnicity-specific effects of trial medications.

Few localized or regional guidelines exist for the management of MM in MENA, although comprehensive guidelines have recently been published for Saudi Arabia [47, 48], Turkey [49], and the Gulf region [43, 44]; guidelines focusing on ASCT, including in the context of MM, have also been published in Turkey [45, 46]. Similar to the US Mayo Stratification for Myeloma And Risk-adapted Therapy guidelines [104] and the recently updated European Hematology Association guidelines [105], the recent Saudi Myeloma Working Group and Turkish Society of Hematology guidelines recommend an anti-CD38 monoclonal antibody in combination with VRd as 1L treatment for patients with standard-risk NDMM, followed by ASCT in transplant-eligible patients, and bortezomib or lenalidomide maintenance therapy for patients with high-risk disease [48, 49]. According to the real-world studies identified in this literature search, while two-thirds of patients received bortezomib, only 15.2% and 4.3% of patients in Saudi Arabia were treated with daratumumab and lenalidomide, respectively. However, it should be noted that the data on treatment patterns in Saudi Arabia are derived from only three studies totaling 211 patients, and may not represent treatment patterns overall [25, 28, 37]. Overall, < 1% of patients were treated with quadruplet therapy, indicating that current treatment patterns are lagging behind guideline recommendations. Given the inherent delay between changes in clinical practice and the publication of real-world data, it remains to be seen whether practice has changed to follow the updated guidelines.

Clinical and Patient Outcomes

The introduction of IMiDs and PIs has significantly improved clinical and patient outcomes in MM over the last two decades. In line with global literature, survival and response rates were variable in the studies identified in this review [10, 106]. A recently published meta-analysis of efficacy outcomes in Asia, Africa, LATAM, and Eastern Europe found a consistent and significant association of ASCT use with improved PFS, reporting median PFS ranging from 19 to 46 months in patients who received ASCT [107]. In our literature review, median PFS ranged from 20 to 97.7 months in this population. Notably, while some publications specified survival

outcomes in patients who received ASCT, most did not clearly differentiate outcomes between patients who did or did not receive ASCT and no studies reported direct comparisons. Similar to a literature review of MM in LATAM, ORR and CR rates in our review were generally high, particularly in patients with NDMM (60.3–83% in this review and 50.9–94.4% in LATAM) [93]. However, outcomes worsened with increasing LOTs, regardless of the treatment used, particularly in patients with lenalidomide-refractory disease. This finding highlights the need for more effective therapies in earlier LOTs to improve patient outcomes.

Few publications reported survival outcomes and response rates together. Notably, a Turkish publication comparing the efficacy of Vd versus VCd in patients with NDMM reported comparable response rates (≥VGPR: 86.1% versus 88.1%) and median OS (113.1 versus 122.2 months; $p=0.47$), but a significantly higher mortality rate with Vd than VCd (19.4% versus 4.5%; $p=0.01$) [65]. While the follow-up duration for each treatment group was not specified, the differences observed across the outcomes raise questions regarding whether comparisons based on single efficacy endpoints adequately reflect true differences in clinical outcomes.

Globally, patients with MM tend to report poor HRQOL as a result of worsening disease symptoms and AEs associated with treatment [37]. Similarly, studies in MENA identified low QOL scores in patients with MM. In particular, patients frequently reported being in pain [37, 76]; all patients with bone lesions reported experiencing moderate to severe pain, and most patients reported limitations in motion that affected functionality [78]. Surgical procedures provided significant improvements in pain and function, representing an essential part of disease management in patients with MM and bone lesions [77, 78]. Notably, the articles identified in our literature search did not report MM-specific QOL scores, such as those from the European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire–Myeloma Module or Functional Assessment of Cancer Therapy–Multiple Myeloma, highlighting an area that requires further investigation. A systematic literature review of publications reporting on HRQOL in MM found an association of deeper responses and minimal residual disease negativity with improved HRQOL, while disease progression and increasing LOTs were associated with worse HRQOL [108]. This reiterates the need for more effective treatments in earlier LOTs to maintain QOL.

While we identified 60 articles reporting efficacy outcomes, only 31 of them reported safety outcomes. Because these were retrospective, observational studies, most of them did not comprehensively capture AEs owing to the reliance on information captured in databases and clinical practice. Overall, few serious AEs were reported, although most patients experienced at least one AE while on treatment. Cytopenia, especially anemia, is common in patients with MM [1] and can be exacerbated by MM treatments. Anemia, thrombocytopenia, and neutropenia are the most commonly reported hematological AEs. These cytopenias can lead to an increase in the incidence of infections; therefore, prophylactic measures such as prophylactic antibiotics or recombinant granulocyte colony-stimulating factor have been considered for patients with MM [109, 110]. Patients experiencing anemia may also require the use of erythropoietin analogs or transfusions [109].

Of the nonhematological AEs, peripheral neuropathy was frequently reported. Peripheral neuropathy negatively impacts QOL; notably, approximately half of all patients with chemotherapy-induced peripheral neuropathy reported increased pain with activity [37]. While chemotherapy-induced peripheral neuropathy is generally considered reversible, many patients experience long-lasting neuropathy, highlighting the need for close monitoring and immediate dose adjustment in patients experiencing severe symptoms [37, 111]. Additionally, cardiac AEs have been reported in 10.6% of patients treated with IxaRd and in 26.3% of patients treated with carfilzomib [53, 61]. Overall, prospective studies are needed to accurately capture the breadth and frequency of AEs impacting patients with MM in the MENA region.

HCRU

RRMM presents a significant humanistic and economic burden [112–115]. Furthermore, hematologic AEs and infections—both associated with MM treatment—increase morbidity, mortality, and HCRU. Overall, RRMM care is costly, with high expenses from novel therapies—such as CAR T-cell therapy—and indirect costs such as productivity loss due to missed workdays for both patients and their caregivers [102, 113, 115]. Our research shows a significant data gap in understanding HCRU in the MENA region, with only five studies identified from the last 10 years [83–87]. A recent analysis of HCRU and treatment patterns of patients with MM across five European countries identified that patients who were triple-class exposed (i.e., previously treated with at least one PI, one anti-CD38 monoclonal antibody, and one IMiD) experienced higher HCRU than those who were not triple-class exposed, reflected by more inpatient hospitalizations and visits to healthcare professionals in the previous 12 months [116]. From the treatment patterns identified in this review, and the recommendations for early use of quadruplet regimens such as daratumumab + VRd in the recently published Saudi Myeloma Group and Turkish Society of Hematology treatment guidelines [48, 49], it is likely that the number of patients with MM who are triple-class exposed in the MENA region will increase and add further economic strain to payors in the region.

Generic versions of bortezomib and lenalidomide have been approved for MM treatment in MENA. From the studies identified in this review, no clear differences in efficacy or safety were found between the branded and generic versions of these treatments, supporting their use as a more cost-effective alternative to branded products [50, 56, 57, 62]. As health expenditures for MM continue to rise with the increasing development and costs of new treatments, as well as the increasing incidence of MM in the region, the need for cost-effective treatment options also increases. Consequently, the use of generic medications can be an area of cost savings that allows more patients to gain access to treatments [7, 19, 50, 56, 57, 62]. Further studies with standardized designs and outcome assessments are warranted across MENA to elucidate the impact of MM on HCRU and inform appropriate strategies to lessen this impact on patients and healthcare systems.

Limitations

Our literature review had a number of limitations. The majority of the data retrieved were from retrospective studies and therefore susceptible to potential bias. While the countries included in the review were selected to represent the geographic and socioeconomic diversity of the MENA region, many countries in the region were not included. Further, the majority of studies reported data from single institutions and/or have limited patient numbers. Thus, these findings may not be fully representative of each country or the region as a whole. Inconsistencies existed in the reporting of data, particularly safety outcomes, owing to the reliance on real-world, retrospectively analyzed health records. Reporting on the cytogenetic profiles of patients with MM was inconsistent and limited, likely owing to variation in access to cytogenetic testing in the region. The lack of prospective, randomized controlled studies in the MENA region also restricted the degree to which conclusions can be drawn from this analysis.

CONCLUSIONS

Our review of the published literature identified a paucity of comprehensive data on the epidemiology and management of MM in the MENA region, complicating the implementation of fully informed clinical and health policy decisions. Currently, treatment patterns in the region do not reflect the recommendations in the latest international and regional treatment guidelines, highlighting a need to understand the factors behind this disparity. The burden of disease and treatment is particularly high in patients with RRMM, who face increasingly poor clinical outcomes with increasing LOTs.

Improved understanding of the treatment patterns and HCRU in MENA may provide pathways to advancing access to newer therapies that can alleviate the disease and treatment burden of MM in the region.

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Declarations

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Ethical Approval. This article is based on previously conducted studies and does not contain any new studies with human participants or animals performed by any of the authors.

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REFERENCES

1. Cowan AJ, Green DJ, Kwok M, Lee S, Coffey DG, Holmberg LA, et al. Diagnosis and management of multiple myeloma: a review. JAMA.

2022;327(5):464–77. https://doi.org/10.1001/jama.2022.0003.

2. Rajkumar SV, Dimopoulos MA, Palumbo A, Blade J, Merlini G, Mateos M-V, et al. International myeloma working group updated criteria for the diagnosis of multiple myeloma. Lancet Oncol. 2014;15(12):e538–48. https://doi.org/10.1016/S1470-2045(14)70442-5.

3. Ferlay J EM, Lam F, Laversanne M, Colombet M, Mery L, Piñeros M, Znaor A, Soerjomataram I, Bray F. Global Cancer Observatory: cancer today (version 1.1). 2024. https://gco.iarc.who.int/today. Accessed 28 Nov 2024.

4. Nijhof IS, van de Donk N, Zweegman S, Lokhorst HM. Current and new therapeutic strategies for relapsed and refractory multiple myeloma: an update. Drugs. 2018;78(1):19–37. https://doi.org/10.1007/s40265-017-0841-y.

5. Dimopoulos MA, Moreau P, Terpos E, Mateos MV, Zweegman S, Cook G, et al. Multiple myeloma: EHA-ESMO clinical practice guidelines for diagnosis, treatment and follow-up. Ann Oncol. 2021;32(3):309–22. https://doi.org/10.1016/j.annonc.2020.11.014.

6. Moreau P, San Miguel J, Sonneveld P, Mateos MV, Zamagni E, Avet-Loiseau H, et al. Multiple myeloma: ESMO clinical practice guidelines for diagnosis, treatment and follow-up. Ann Oncol. 2017;28(suppl_4):iv52–61. https://doi.org/10.1093/annonc/mdx096.

7. Zhou L, Yu Q, Wei G, Wang L, Huang Y, Hu K, et al. Measuring the global, regional, and national burden of multiple myeloma from 1990 to 2019. BMC Cancer. 2021;21(1):606. https://doi.org/10.1186/s12885-021-08280-y.

8. Bhatt P, Kloock C, Comenzo R. Relapsed/refractory multiple myeloma: a review of available therapies and clinical scenarios encountered in myeloma relapse. Curr Oncol. 2023;30(2):2322–47. https://doi.org/10.3390/curroncol30020179.

9. Kumar S, Baizer L, Callander NS, Giralt SA, Hillengass J, Freidlin B, et al. Gaps and opportunities in the treatment of relapsed-refractory multiple myeloma: consensus recommendations of the NCI Multiple Myeloma Steering Committee. Blood Cancer J. 2022;12(6):98. https://doi.org/10.1038/s41408-022-00695-5.

10. de Moraes Hungria VT, Martínez-Baños DM, Peñafiel CR, Miguel CE, Vela-Ojeda J, Remaggi G, et al. Multiple myeloma treatment patterns and clinical outcomes in the Latin America Haemato-Oncology (HOLA) Observational Study, 2008–2016. Brit J Haematol. 2020;188(3):383–93. https://doi.org/10.1111/bjh.16124.

11. Neri P, Leblay N, Lee H, Gulla A, Bahlis NJ, Anderson KC. Just scratching the surface: novel treatment approaches for multiple myeloma targeting cell membrane proteins. Nat Rev Clin Oncol. 2024;21(8):590–609. https://doi.org/10.1038/s41571-024-00913-y.

12. Yang WC, Lin SF. Mechanisms of drug resistance in relapse and refractory multiple myeloma. Biomed Res Int. 2015;2015:341430. https://doi.org/10.1155/2015/341430.

13. Steinmetz TH, Singh M, Lebioda A, Fink L, Schoehl M, Rieth A, et al. Healthcare resource utilization and costs among patients with relapsed and/or refractory multiple myeloma treated with proteasome inhibitors in real-world clinical practice in Germany. J Med Econ. 2021;24(1):114–22. https://doi.org/10.1080/13696998.2020.1867469.

14. Crusoe E, Ribeiro G, Zanella K, Perobelli L, Filho JCS, Magalhaes R, et al. Multiple myeloma Brazilian register- how about the transplant eligible patients? HemaSphere. 2022;6:3449–50. https://doi.org/10.1097/01.HS9.0000852292.38263.b8.

15. Hungria VTM, Lee JH, Maiolino A, de Queiroz Crusoe E, Martinez G, Bittencourt R, et al. Survival differences in multiple myeloma in Latin America and Asia: a comparison involving 3664 patients from regional registries. Ann Hematol. 2019;98(4):941–9. https://doi.org/10.1007/s00277-019-03602-4.

16. Mela Osorio MJ, Pavlovsky C, Pavlovsky MA. Inequalities in access to treatment in Argentina: differences in management of CLL and multiple myeloma? Semin Hematol. 2023;60(4):209–14. https://doi.org/10.1053/j.seminhematol.2023.07.001.

17. Peña C, Graffigna P, Russo M, Forray E, Bustamante P. Improved overall survival of transplant eligible newly diagnosed multiple myeloma patients in a Chilean public center. How did we achieve it? Hematol Transfus Cell Ther. 2024;46(4):575–6. https://doi.org/10.1016/j.htct.2024.02.024.

18. Samaniego F, Bull L, González N, Araos D, Rojas H, Donoso J, et al. The impact of novel drugs on the survival of patients with multiple myeloma in two Chilean centers. Rev Med Chil. 2022;150(3):331–8. https://doi.org/10.4067/s0034-98872022000300331.

19. Cowan AJ, Allen C, Barac A, Basaleem H, Bensenor I, Curado MP, et al. Global burden of multiple myeloma: a systematic analysis for the global burden of disease study 2016. JAMA Oncol. 2018;4(9):1221–7. https://doi.org/10.1001/jamaoncol.2018.2128.

20. Mafra A, Laversanne M, Marcos-Gragera R, Chaves HVS, Mcshane C, Bray F, et al. The global multiple myeloma incidence and mortality burden in 2022 and predictions for 2045. J Natl Cancer Inst. 2024;117(5):907–14. https://doi.org/10.1093/jnci/djae321.

21. Huang J, Chan SC, Lok V, Zhang L, Lucero-Prisno DE, Xu W, et al. The epidemiological landscape of multiple myeloma: a global cancer registry estimate of disease burden, risk factors, and temporal trends. Lancet Haematol. 2022;9(9):e670–7. https://doi.org/10.1016/S2352-3026(22)00165-X.

22. Alhuraiji A, Lal A, Al Mehairi A, Alam A, Mudawi D, Khan F, et al. Epidemiology and approaches for management of relapsed and refractory multiple myeloma in Gulf Countries: a narrative review and insights from the Gulf multiple myeloma experts. Curr Med Res Opin. 2025;41(4):593–600. https://doi.org/10.1080/03007995.2025.2502125.

23. Dag M, Beksac M. A cross sectional epidemiological and survival analysis of all patients with plasma cell disorders recorded between 2011-2017 in the social insurance system of Turkey. Blood. 2018. https://doi.org/10.1182/blood-2018-99-118185.

24. SHC. Cancer incidence report Saudi Arabia 2022. In: Council SH, editor. 2022.

25. Abdrabou AK, Al Sharif F, El Fakih R, Hashmi S, Khafaga YM, Alhayli S, et al. Outcomes of autologous stem cell transplantation for multiple myeloma in Saudi Arabia. Ann Saudi Med. 2021;41(4):198–205. https://doi.org/10.5144/0256-4947.2021.198.

26. Alam A, Al Qawasmeh K, Aamir M, McCarthy PL. Multiple myeloma therapy in Tawam Hospital. First report from United Arab Emirates (UAE). Blood. 2018. https://doi.org/10.1182/blood-2018-99-110503.

27. Alhejazi A, Alhuraiji A, Nourallah A, Alshehri A, Usman B, ElGohary G, et al. Analysis of pharmacotherapeutic approaches for multiple myeloma and correlated renal and pulmonary impairments: a retrospective real-world registry study in the Greater Gulf Region (REPAIR Study). Front Oncol. 2025;15:1547138.

28. Althomali M, Mutahar E, Al Hashmi H, Alhejazi A, Al Hazmi M, Al Saeed A, et al. Efficacy and safety of daratumumab in the treatment of relapsed/ refractory multiple myeloma, local experience from Saudi Arabia. HemaSphere. 2020;4:945. https://doi.org/10.1097/HS9.0000000000000404.

29. Baysal M, Demirci U, Umit E, Kirkizlar HO, Atli EI, Gurkan H, et al. Concepts of double hit and triple hit disease in multiple myeloma, entity and prognostic significance. Sci Rep. 2020;10(1):5991. https://doi.org/10.1038/s41598-020-62885-0.

30. Ciftciler R, Goker H, Buyukasık Y, Aladag E, Demiroglu H. Impact of pre-transplant and post-transplant remission status of patients on survival in newly diagnosed multiple myeloma. Indian J Hematol Blood Transfus. 2019;35(4):655–61. https://doi.org/10.1007/s12288-019-01108-7.

31. Çiftçiler R, Göker H, Demiroğlu H, Aksu S, Sayınalp N, Haznedaroğlu İC, et al. Evaluation of the survival outcomes of multiple myeloma patients according to their plasmacytoma presentation at diagnosis. Turk J Hematol. 2020;37(4):256–62. https://doi.org/10.4274/tjh.galenos.2019.2019.0061.

32. Gursoy V, Baysal M, Sadri S, Hunutlu FC, Ersal T, Gul OO, et al. Comparative analysis and validation of the IMPEDED VTE, IMPEDE VTE, and SAVED risk models in predicting venous thromboembolism in multiple myeloma patients: a retrospective study in Türkiye. Diagnostics. 2025;15(5):633. https://doi.org/10.3390/diagnostics15050633.

33. Kassem NM, Saadeldin I, Zawam H, Kassem HA. Clinical significance of serum biomarkers: vascular endothelial growth factor-a and chemokine (c-x-c motif) ligand 13 in Egyptian multiple myeloma patients. Acta Med Iran. 2023;61(3):150–60. https://doi.org/10.18502/acta.v61i3.12737.

34. Kazgı MA, Bayram E, Kosecı T, Mete B, Toyran T, Ergin M, et al. Exploring the impact of cytogenetic abnormalities on treatment responses and survival outcomes in multiple myeloma: a single-centre experience of 13 years of follow-up. Biomedicines. 2024. https://doi.org/10.3390/biomedicines12051014.

35. Morad MA, Fahmy O, Marie MA, Samir E, Abdullah REE. Comparison of renal function before and after autologous stem cell transplantation in Egyptian patients with multiple myeloma and renal insufficiency: a retrospective study. Saudi J Kidney Dis Transpl. 2023;34(Suppl 1):S14-s23. https://doi.org/10.4103/sjkdt.sjkdt_333_22.

36. Pektas O, Navaratnam P, Rajput T, Frıedman HS, Demırkır E, Tekle C, et al. Real-world (RW) treatment patterns and outcomes in patients (pts) with relapsed/refractory multiple myeloma (RRMM) with at least one prior therapy in Turkey. Hematol Transfus Cell Ther. 2023;45:S15. https://doi.org/10.1016/j.htct.2023.09.026.

37. Shaheen NA, Alqahtani M, Alawbthani NS, Thomas A, Alaskar A. Chemotherapy-induced peripheral neuropathy and its impact on

health-related quality of life among multiple myeloma patients: a single-center experience. Indian J Palliat Care. 2020;26(4):506–11. https://doi.org/10.4103/ijpc.Ijpc_233_19.

38. Soyer N, Patır P, Uysal A, Duran M, Ünal HD, Durusoy R, et al. Efficacy and safety of lenalidomide and dexamethasone in patients with relapsed/ refractory multiple myeloma: a real-life experience. Turk J Med Sci. 2018;48(4):777–85. https://doi.org/10.3906/sag-1712-160.

39. Sulu C, Yalın SF, Gürer T, Ar MC, Altıparmak MR. Renal recovery after acute kidney injury requiring urgent hemodialysis is not associated with improved survival of the patients with multiple myeloma. Ir J Med Sci. 2023;192(2):757–63. https://doi.org/10.1007/s11845-022-03014-w.

40. Tekinalp A, Gedük A, Akdeniz A, Terzi Demirsoy ET, Gürsoy V, Aslaner Ak MA, et al. Experience of daratumumab in relapsed/refractory multiple myeloma: a multicenter study from Türkiye. Turk J Hematol. 2023;40(4):242–50. https://doi.org/10.4274/tjh.galenos.2023.2023.0029.

41. Yalnız FF, Akkoç N, Salihoğlu A, Ar MC, Öngören Ş, Eşkazan AE, et al. Clinical outcomes related to the use of bendamustine therapy for multiple myeloma patients relapsed/refractory to immunomodulatory drugs and proteasome inhibitors. Turk J Hematol. 2017;34(3):233–8. https://doi.org/10.4274/tjh.2016.0397.

42. Yılmaz U, Erdem Nurcan S, Özmen D, Salihoğlu A, Eşkazan AE, Öngören Ş, et al. Retrospective study to compare outcomes in 159 patients undergoing first autologous stem cell transplantation for myeloma treated with melphalan 140 mg/m^2 or 200 mg/m^2. Ann Transplant. 2025;30:e947186. https://doi.org/10.12659/aot.947186.

43. Alhuraiji A, Al Farsi K, Mheidly K, Elsabah H, Cherif H, Hamad A, et al. Relapsed/refractory multiple myeloma: standard of care management of patients in the Gulf region. Clin Hematol Int. 2025;7(2):20.

44. Marashi M, Al Farsi K, Al Hateeti H, Alhuraiji A, Elsabah H, Cherif H, et al. Frontline management of multiple myeloma patients: optimizing treatment for patients in the Gulf region. Clin Hematol Int. 2025;7(1):14.

45. Tekgündüz E, Arat M, Göker H, Özdoğu H, Kaynar L, Çağırgan S, et al. Autologous hematopoietic progenitor cell mobilization and collection in adult patients presenting with multiple myeloma and lymphoma: a position-statement from the Turkish Society of Apheresis (TSA). Transfus Apher Sci. 2017;56(6):845–9. https://doi.org/10.1016/j.transci.2017.11.025.

46. Tekgündüz E, Demirkan F, Vural F, Göker H, Özdoğu H, Kiki İ, et al. Current practice of autologous hematopoietic progenitor cell mobilization in adult patients with multiple myeloma and lymphoma: the results of a survey from Turkish hematology research and education group (ThREG). Transfus Apher Sci. 2017;56(6):804–8. https://doi.org/10.1016/j.transci.2017.11.010.

47. Alhejazi A, Alotaibi GS, Saleh ASA, Alahmadi M, Motabi I, Alsharif FZ, et al. Guidelines on management of multiple myeloma in the relapsed/refractory setting: the Saudi Myeloma Working Group guideline. Clin Lymphoma Myeloma Leuk. 2025. https://doi.org/10.1016/j.clml.2025.05.005.

48. Alotaibi GS, Saleh ASA, Alhejazi A, Alahmadi M, Motabi I, Alsharif FZ, et al. Definition, diagnosis, risk stratification and management of newly diagnosed multiple myeloma: the Saudi myeloma working group guidelines. Clin Lymphoma Myeloma Leuk. 2025. https://doi.org/10.1016/j.clml.2025.06.005.

49. Beksac M, Salihoğlu A, Seval GC: Multipl Miyelom Tanı ve Tedavi Kılavuzu Güncelleme. 2024. https://www.thd.org.tr/durum/0. Accessed 11 Nov 2025.

50. Mersin S, Gedük A, Mehtap Ö, Tarkun P, Ünal S, Polat MG, et al. Evaluation of a generic bortezomib molecule in newly diagnosed multiple myeloma patients. Turk J Hematol. 2021;38(3):211–7. https://doi.org/10.4274/tjh.galenos.2021.2020.0555.

51. Kaloyannidis P, Abdulla F, Mutahar E, Al Hashim H, Al Harbi S, Estanislao A, et al. Risk assessment for newly diagnosed fit young patients with multiple myeloma in the era of novel treatment modalities: should there be additional factors taken into consideration?? J Blood Med. 2022;13:619–30. https://doi.org/10.2147/jbm.S380133.

52. Açar İH, Güvenç B. Efficacy of bendamustine, pomalidomide, and dexamethasone (BPD) regimen in relapsed/refractory extramedullary myeloma: a retrospective single-centre study, real-life experience. Hematol Rep. 2023;15(3):465–73.

53. Bakırtaş M, Dal MS, Yiğenoğlu TN, Giden AO, Serin I, Başcı S, et al. Real-world data on the effectiveness and safety of ixazomib-lenalidomide-dexamethasone therapy in relapsed/refractory multiple myeloma patients: a multicenter experience in Turkey. J Chemother. 2023;35(6):563–9. https://doi.org/10.1080/1120009x.2023.2208439.

54. Beksac M, Aydin Y, Goker H, Turgut M, Besisik SK, Cagirgan S, et al. Early access program results from Turkey and a literature review on daratumumab monotherapy among heavily pretreated patients with relapsed/refractory myeloma. Clin Lymphoma

Myeloma Leuk. 2020;20(8):e474–84. https://doi.org/10.1016/j.clml.2020.02.017.

55. Beksac M, Aydin Y, Goker H, Turgut M, Besisik SK, Cagirgan S, et al. Multicenter early access program results from Turkey: efficacy and safety of daratumumab among heavily pretreated relapse/refractory multiple myeloma patients. Blood. 2017;130.

56. Beksac M, Seval GC, Koyun D, Topcuoglu P, Yuksel MK, Gurman G, et al. Generic lenalidomide Rivelime versus brand-name Revlimid® in the treatment of relapsed/refractory multiple myeloma: a retrospective single-center experience on efficacy, safety and survival outcome. Clin Lymphoma Myeloma Leuk. 2023;23(3):e164–70. https://doi.org/10.1016/j.clml.2022.12.007.

57. Bolaman AZ, Turgutkaya A, Sahip B, Selim C, Eroğlu Küçükerdiler H, Ertop Ş, et al. Original versus generic lenalidomide in patients with relapsed/refractory multiple myeloma: comparison of efficacy and adverse events. Turk J Hematol. 2021;38(1):41–8. https://doi.org/10.4274/tjh.galenos.2020.2020.0169.

58. Bolaman Z, Ertop S, Turgutkaya A, Cem S, Eroglu Kucukerdiler AH, Sahip B, et al. Original versus generic lenalidomide in patients with relapsed multipl myeloma: comparison of effectivity and adverse events. Blood. 2019;134:5594. https://doi.org/10.1182/blood-2019-131093.

59. Ozsan GH, Sevindik OG, Sadri S, Hacioglu SK, Kaya SY, Geduk A, et al. Real-world data in relapsed refractory myeloma patients treated with pomalidomide, a multicenter Turkish experience. Blood. 2017. https://doi.org/10.1182/blood-2019-131093.

60. Saydam G, Soyer N, Patir P, Uysal A, Duran M, Durusoy R, et al. Efficacy and safety of lenalidomide and dexamethasone in patients with relapsed/refractory multiple myeloma: a real life experience from Turkey. Haematologica. 2017;102:784.

61. Sevindik OG, Pehlivan M, Tuglular TF, Solmaz SM, Dogu MH, Yalniz F, et al. Real-world data in relapsed refractory myeloma patients treated with carfilzomib, a multicenter Turkish experience. Blood. 2017. https://doi.org/10.1182/blood.V130.Suppl_1.5405.5405.

62. Beksac M, Seval GC, Koyun D, Topcuoglu P, Yuksel MK, Gurman G, et al. A retrospective single center experience with the generic of lenalidomide Rivelime® compared with original patented drug Revlimid®. Am J Hematol. 2019;94:S7. https://doi.org/10.1002/ajh.25639.

63. Abdelgawad IA, Radwan NH, Shafik RE, Shokralla HA. Significance of proliferation markers and prognostic factors in Egyptian patients with multiple myeloma. Asian Pac J Cancer Prev. 2016;17(3):1351–5. https://doi.org/10.7314/apjcp.2016.17.3.1351.

64. Abdrabou AK, Al Sharif F, El Fakih R, Zahrani HA, Al Yamany R, Saleh M, et al. Improved long-term survival rate in the responders to bortezomib, cyclophosphamide, dexamethasone induction therapy in a transplant-eligible cohort of predominantly middle-age multiple myeloma patients. Ann Saudi Med. 2024;44(2):93–103. https://doi.org/10.5144/0256-4947.2024.93.

65. Ciftciler R, Goker H, Buyukasik Y, Sayınalp N, Haznedaroglu IC, Aksu S, et al. Comparison of bortezomibcyclophosphamide- dexamethasone versus bortezomib-dexamethasone based regimens in newly diagnosed multiple myeloma patients. Hematol Rep. 2020;12(1):8267. https://doi.org/10.4081/hr.2020.8267.

66. Denewer M, Shamaa S, Samra M, El-Nahass YEN, Azmy E. MM-375: prognostic impact of multiple myeloma cytogenetic abnormalities on outcome of autologous bone marrow transplantation: a single-center experience. Clin Lymphoma Myeloma Leuk. 2020;20:S309. https://doi.org/10.1016/S2152-2650(20)30957-5.

67. El-Ghammaz AM, Abdelwahed E. Bortezomib-based induction improves progression-free survival of myeloma patients harboring 17p deletion and/or t(4;14) and overcomes their adverse prognosis. Ann Hematol. 2016;95(8):1315–21. https://doi.org/10.1007/s00277-016-2692-0.

68. Erdogan Yucel E, Kirmaz AT, Kakci M, Yavuz AF, Sencelikel T, Alacacioglu I, et al. The effect of age on high-dose therapy with autologous stem cell support in multiple myeloma: a single-center experience. J Clin Med. 2024;13(14):4142.

69. Kirik MP, Pehlivan M, Nursal AF, Oyaci Y, Pehlivan S, Serin I. The miRNA 196a2 rs11614913 variant has prognostic impact on Turkish patients with multiple myeloma. BMC Res Notes. 2020;13(1):545. https://doi.org/10.1186/s13104-020-05392-9.

70. Şahin T, Turgutkaya A, Kadıköylü G, Bolaman AZ, Yavaşoğlu İ. Investigation of demographic features, performance, comorbidity status and mortality causes among multiple myeloma patients: real-life data. Expert Rev Hematol. 2021;14(12):1147–53. https://doi.org/10.1080/17474086.2021.1962279.

71. Beksac M, Seval GC, Paydas S, Tuglular TF, Arslan O, Goker H, et al. Elotuzumab plus pomalidomide or lenalidomide is able to achieve durable ≥VGPR responses among immunomodulatory / proteasome inhibitor refractory myeloma patients: a

report on multicenter experience from Turkey. Clin Lymphoma Myeloma Leuk. 2019;19(10):e242–3. https://doi.org/10.1016/j.clml.2019.09.402.

72. Cengiz G, Karakaya B, Yilmaz H, Koyun D, Kircali E, Basboga S, et al. Comparison of salvage autologous hematopoietic cell transplantation with outcomes following selinexor combinations among double/triple refractory myeloma patients. Blood. 2021;138:4904. https://doi.org/10.1182/blood-2021-148835.

73. Ozkan MC, Tombuloglu M, Sahin F, Saydam G. Evaluation of immunomodulatory drugs in multiple myeloma: single center experience. Am J Blood Res. 2015;5(2):95–100.

74. Kim K, Verburgh E, Mitina T, Chen W, Yeh SP, Schutz N, et al. Treatment pathways and clinical outcomes in newly diagnosed multiple myeloma outside Europe and North America: the INTEGRATE study. Int J Hematol. 2025. https://doi.org/10.1007/s12185-025-03972-8.

75. Umıt EG, Baysal M, Bas V, Asker I, Kırkızlar O, Demır AM. Polypharmacy and potentially inappropriate medication use in older patients with multiple myeloma, related to fall risk and autonomous neuropathy. J Oncol Pharm Pract. 2020;26(1):43–50. https://doi.org/10.1177/1078155219835303.

76. Karacan Y, Akkus Y, Bayram R, Budak S, Ünlü AA. Do spiritual well-being and pain intensity predict physical or mental components of health-related quality-of-life scale in patients with multiple myeloma? Pain Manag Nurs. 2024;25(5):e367–74. https://doi.org/10.1016/j.pmn.2024.05.006.

77. Tekin SB, Karslı B, Büyükbebeci O, Demir İH, Gökalp AY, Kılınçoğlu V. How do vertebroplasty and kyphoplasty affect the quality of life of patients with multiple myeloma spinal metastasis? Eur J Orthop Surg Traumatol. 2020;30(8):1447–51. https://doi.org/10.1007/s00590-020-02721-3.

78. Topkar OM, Erol B. Clinical outcomes and complications of surgical interventions for multiple myeloma lesions in the extremities and pelvis: a retrospective clinical study. Acta Orthop Traumatol Turc. 2021;55(2):159–65. https://doi.org/10.5152/j.aott.2021.20130.

79. Ateşaıaılu B, Topc¸uoılu P, Merter M, Sungurlu M, Şener Ö, Beksac¸ M. Subcutaneous bortezomib is as effective and less neurotoxic than intravenous bortezomib: Ankara university experience. Haematologica. 2015;100:740–1.

80. Aypar E, İzzettin FV, Akı ŞZ, Sancar M, Yeğin ZA, Türköz-Sucak G. Comparison of conditioning regimen toxicities among autologous stem cell transplantation eligible multiple myeloma patients: high-dose melphalan versus high-dose melphalan and bortezomib. J Oncol Pharm Pract. 2018;24(4):281–9. https://doi.org/10.1177/1078155217697486.

81. Kul AN, Ipek Y. Investigation of the frequency of bortezomib neuropathy in patients with multiple myeloma diagnosis with normal and abnormal genetic characteristics. J Oncol Pharm Pract. 2023;29(7):1652–60. https://doi.org/10.1177/10781552221132554.

82. Topcuoglu P, Gultay D, Ozturk N, Kilic O, Okay M, Eraslan Karadag Y, et al. Generic (Bioequivalent) melphalan has similar efficacy and toxicity but lower cost in the conditioning regimen for autologous hematopoietic stem cell transplantation. Bone Marrow Transplant. 2015;50:S440. https://doi.org/10.1038/bmt.2015.30.

83. Elsisi G, Elattar M, Eldesouky N. EE260 cost-effectiveness analysis of daratumumab triplet therapy vs carfilzomib duplet therapy in patients with relapsed or refractory multiple myeloma in Egypt from payer perspective. Value Health. 2023;26(12):S101. https://doi.org/10.1016/j.jval.2023.09.527.

84. Elsisi GH, Carapinha JL, Afify R, Elmoty MA, Khalaf M. A budget impact analysis of lenalidomide in multiple myeloma Egyptian patients. J Med Econ. 2020;23(10):1168–75. https://doi.org/10.1080/13696998.2020.1796288.

85. Farghaly M, Fasseeh A, Korra N, Abd-El Aziz A, Al Dallal S, Badr M, et al. EE178 the burden of multiple myeloma in the Gulf Region. Value Health. 2024;27:S88. https://doi.org/10.1016/j.jval.2024.10.462.

86. Hamad A, Elazzazy S, Taha RY, Osman H, Blooshi S, Elkonaissi I, et al. Cost-minimization analysis for subcutaneous daratumumab in the treatment of newly diagnosed multiple myeloma in 3 Gulf countries. J Health Econ Outcome Res. 2024;11(2):9–19. https://doi.org/10.36469/001c.120288.

87. Maroun R, Kilic E, Dokuyucu O, Coggia A. PCN215 cost comparison of lenalidomide based triple combination therapies for the treatment of relapsed/refractory multiple myeloma in the Kingdom of Saudi Arabia. Value Health. 2019;22:S477. https://doi.org/10.1016/j.jval.2019.09.411.

88. Eser S, Örün H, Hamavioğlu E, Lofti F. Cancer incidence, mortality and survival in Türkiye as of 2020. Basic Clin Cancer Res. 2022.

89. Pilleron S, Sarfati D, Janssen-Heijnen M, Vignat J, Ferlay J, Bray F, et al. Global cancer incidence in older adults, 2012 and 2035: a population-based

study. Int J Cancer. 2019;144(1):49–58. https://doi.org/10.1002/ijc.31664.

90. Ocio EM, Montes-Gaisán C, Bustamante G, Garzón S, González E, Pérez E, et al. Clinical and sociodemographic characteristics of patients with relapsed and/or refractory multiple myeloma and their influence on treatment in the real-world setting in Spain: the CharisMMa study. Clin Lymphoma Myeloma Leuk. 2022;22(4):e241–9.

91. Medhekar R, Ran T, Fu AZ, Patel S, Kaila S. Real-world patient characteristics and treatment outcomes among nontransplanted multiple myeloma patients who received Bortezomib in combination with Lenalidomide and Dexamethasone as first line of therapy in the United States. BMC Cancer. 2022;22(1):901.

92. Hungria VT, Lee JH, Maiolino A, de Queiroz Crusoe E, Martinez G, Bittencourt R, et al. Survival differences in multiple myeloma in Latin America and Asia: a comparison involving 3664 patients from regional registries. Ann Hematol. 2019;98(4):941–9.

93. Seehaus CM, Remaggi G, Filho JS, Ochoa P, Bigni R, de Magalhães RJP, et al. Burden of treatment, treatment sequencing and healthcare resource utilization in multiple myeloma in Latin America: a targeted literature review. Oncol Ther. 2025. https://doi.org/10.1007/s40487-025-00400-z.

94. İP: KISA ÜRÜN BİLGİSİ. 2022. https://pdf.ilacprospektusu.com/21355-darzalex-1800-mg-sc-enjeksiyonluk-cozelti-kub.pdf. Accessed 29 Nov 2025.

95. Ribbands A, Boytsov N, Bailey A, Gorsh B, Luke E, Lambert A. Drivers of physician decision-making and patient perspectives across lines of therapy in multiple myeloma in the USA. Future Oncol. 2023;19(22):1549–62.

96. Bruno AS, Willson JL, Opalinska JM, Nelson JJ, Lunacsek OE, Stafkey-Mailey DR, et al. Recent real-world treatment patterns and outcomes in US patients with relapsed/refractory multiple myeloma. Expert Rev Hematol. 2020;13(9):1017–25.

97. Natrajan K, Kaushal M, George B, Kanapuru B, Theoret MR. FDA approval summary: ciltacabtagene autoleucel for relapsed or refractory multiple myeloma. Clin Cancer Res. 2024;30(14):2865–71.

98. Sharma P, Lin X, Xu Z, Kanapuru B, Theoret MR, Sokolic R, et al. FDA approval summary: idecabtagene vicleucel for the treatment of triple-class-exposed, relapsed or refractory multiple myeloma. Clin Cancer Res. 2025;31(16):3362–7. https://doi.org/10.1158/1078-0432.Ccr-24-4181.

99. Baines AC, Kanapuru B, Zhao J, Price LSL, Zheng N, Konicki R, et al. FDA approval summary: teclistamab-a bispecific CD3 T-cell engager for patients with relapsed or refractory multiple myeloma. Clin Cancer Res. 2024;30(24):5515–20. https://doi.org/10.1158/1078-0432.Ccr-24-1872.

100. Firestone R, Lesokhin AM, Usmani SZ. An embarrassment of riches: three FDA-approved bispecific antibodies for relapsed refractory multiple myeloma. Blood Cancer Discov. 2023;4(6):433–6. https://doi.org/10.1158/2643-3230.Bcd-23-0176.

101. Atallah R, Shatnawi Y, Mammadzadeh A, Hashmi SK, Shabeeha R, Mushtaq MU, et al. The GLAMM1 study—global access to myeloma medications: potential barriers to chimeric antigen receptors (CART) and t-cell-engaging bispecific antibodies (TCE) globally. Transplant Cell Ther. 2024;30(2):S373–4. https://doi.org/10.1016/j.jtct.2023.12.523.

102. Hakan G, Engin K, Elifcan KA, Haluk D, Mehmet T, Suman K, et al. CAR-T cell therapy in relapsed or refractory multiple myeloma and access in Turkey. Front Med. 2024. https://doi.org/10.3389/fmed.2024.1413825.

103. Markouli M, Ullah F, Unlu S, Omar N, Lopetegui-Lia N, Duco M, et al. Toxicity profile of chimeric antigen receptor t-cell and bispecific antibody therapies in multiple myeloma: pathogenesis, prevention and management. Curr Oncol. 2023;30(7):6330–52. https://doi.org/10.3390/curroncol30070467.

104. Mayo stratification for myeloma and risk-adapted therapy. Newly diagnosed myeloma. 2024. https://static1.squarespace.com/static/5b44f08ac258b493a25098a3/t/674ddeb4676dad6c868c9c55/1733156532740/mSMART+Newly+Dx+v22+Oct+2024rev3.pdf. Accessed 29 Aug 2025.

105. Dimopoulos MA, Terpos E, Boccadoro M, Moreau P, Mateos M-V, Zweegman S, et al. EHA–EMN evidence-based guidelines for diagnosis, treatment and follow-up of patients with multiple myeloma. Nat Rev Clin Oncol. 2025;22(9):680–700. https://doi.org/10.1038/s41571-025-01041-x.

106. Hungria VT, Maiolino A, Martinez G, Duarte GO, Bittencourt R, Peters L, et al. Observational study of multiple myeloma in Latin America. Ann Hematol. 2017;96(1):65–72. https://doi.org/10.1007/s00277-016-2866-9.

107. Almasri J, Hasan B, Tarakji Z, Naffa FW, Warner L, Mian H, et al. Treatment outcomes of multiple myeloma in developing countries: a systematic review and meta-analysis. Clin Hematol Int. 2025;7(4):1.

108. Fonseca R, Tran D, Laidlaw A, Rosta E, Rai M, Duran J, et al. Impact of disease progression, line of therapy, and response on health-related quality of life

in multiple myeloma: a systematic literature review. Clin Lymphoma Myeloma Leuk. 2023;23(6):426-37.e11. https://doi.org/10.1016/j.clml.2023.03.005.

109. Bird SA, Boyd K. Multiple myeloma: an overview of management. Palliat Care Soc Pract. 2019;13:1178224219868235. https://doi.org/10.1177/1178224219868235.

110. Leleu X, Gay F, Flament A, Allcott K, Delforge M. Incidence of neutropenia and use of granulocyte colony-stimulating factors in multiple myeloma: is current clinical practice adequate? Ann Hematol. 2018;97(3):387–400.

111. de Miranda Drummond PL, Dos Santos RMM, Silveira LP, Malta JS, Moreira Reis AM, Costa NL, et al. Chemotherapy-induced peripheral neuropathy impacts quality of life and activities of daily living of Brazilian multiple myeloma patients. Curr Drug Saf. 2024;19(3):356–67.

112. Yang J, Boytsov N, Carlson JJ, Barthold D. Health care resource utilization and costs among patients with multiple myeloma with exposure to double-class or triple-class multiple myeloma treatments: a retrospective US claims database analysis. J Manag Care Spec Pharm. 2023;29(8):917–26.

113. Bennink C, Brink M, Duijts SF, Scheurer H, Sonneveld P, Blommestein HM. Changes in income and employment after diagnosis among patients with multiple myeloma in The Netherlands. Clin Lymphoma Myeloma Leuk. 2024;24(9):604–10.

114. Kolovos S, Nador G, Kishore B, Streetly M, Rabin NK, Chantry AD, et al. Unplanned admissions for patients with myeloma in the UK: low frequency but high costs. J Bone Oncol. 2019;17:100243.

115. Choon-Quinones M, Zelei T, Barnett M, Keown P, Durie B, Kaló Z, et al. Beyond medicines' barriers: exploring the true cost of multiple myeloma. J Med Econ. 2022;25(1):1167–75.

116. Martínez-Lopez J, Bailey A, Lambert A, Luke E, Ribbands A, Erler-Yates N, et al. Real-world treatment patterns, healthcare resource use and disease burden in patients with multiple myeloma in Europe. Future Oncol. 2023;19(31):2103–21.

117. Bostankolu Değirmenci B, Yegin ZA, Akdemir Ü, Dede A, Gündem GG, Özkurt ZN, et al. Clinical factors associated with autologous stem cell transplantation outcomes in multiple myeloma: upfront transplant with MEL200 remains the standard of care. Ann Hematol. 2024;103(1):269–83. https://doi.org/10.1007/s00277-023-05511-z.

118. Çiftçiler R, Göker H, Demiroğlu H, Haznedaroğlu İC, Sayınalp N, Aksu S, et al. Evaluation of prognostic significance of the international staging system according to glomerular filtration rate in newly diagnosed multiple myeloma patients eligible for autologous stem cell transplantation. Turk J Hematol. 2021;38(1):33–40. https://doi.org/10.4274/tjh.galenos.2020.2020.0115.

119. Elsergany AR, Shamaa S, Awad M, Ibrahim M, Elkhodary T, Abd Elhamid M, et al. MM-095 Safety and efficacy of dexamethasone for prevention of engraftment syndrome in a patient with multiple myeloma undergoing ASCT: a single-center experience. Clin Lymphoma Myeloma Leuk. 2024;24:S535–6. https://doi.org/10.1016/S2152-2650(24)01641-0.

120. Ipek Y, Karademir N, Yilmazer O, Yilmaz G. The effects of second primary malignancies and frailty on overall survival and mortality in geriatric Turkish patients with multiple myeloma. Curr Oncol. 2023;30(6):5615–30. https://doi.org/10.3390/curroncol30060423.

121. Kassem NM, Kassem HA, Ibrahim M, Zawam H, Hamada E. The clinical impact of hepatitis C virus infection in Egyptian multiple myeloma patients. J Egypt Natl Canc Inst. 2020;32(1):43. https://doi.org/10.1186/s43046-020-00054-0.

122. Khojah O, Al-Majed M, Al-Mozain N, Al-Rajeh A, Al-Sharif F, Khalil S. Genetic characteristic of 123 newly diagnosed plasma cell myeloma patients: a 5 years' experience of a single oncology center. J Appl Hematol. 2019;10:S18–9.

123. Khojah O, Al-Rajeh A, Al-Majed M, Ramadan S, Al-Mozain N, Al-Sharif F, et al. Molecular cytogenetic analysis of 103 newly diagnosed plasma cell myeloma patients resulting in a novel biphasic approach. J Appl Hematol. 2016;7:S13–4.

124. Khojah O, Barri S, Ramadan S, Al-Sharif F, Al-Maeen AR, Khalil S. A proposed biphasic approach based on analysis of genetic alteration in newly diagnosed plasma cell myeloma patients. Int J Lab Hematol. 2016;38:53.

125. Malkan UY, Demiroglu H, Buyukasik Y, Karatas A, Aladag E, Goker H. Comparison of single and double autologous stem cell transplantation in multiple myeloma patients. Open Med. 2021;16(1):192–7. https://doi.org/10.1515/med-2021-0216.

126. Onec B, Okutan H, Albayrak M, Can ES, Aslan V, Soyer Kosemehmetoglu O, et al. Comparative evaluation of common comorbidity scores and Freiburger comorbidity index as prognostic variables in a real life multiple myeloma population. Indian J Hematol Blood Transfus. 2016;32(4):424–30. https://doi.org/10.1007/s12288-015-0618-y.

127. Öztürk H, Dikyar A, Yeğin Z, Kaynar L, Can F, Özkurt Z. Allogeneic hematopoietic stem cell

transplantation in relapsed refractory multiple myeloma. Niger J Clin Pract. 2024;27(12):1405–9. https://doi.org/10.4103/njcp.njcp_107_24.

128. Yıkılmaz A, Akinci S, Bakanay ŞM, Dilek İ. VAD chemotherapy versus bortezomib containing regimens as remission induction for ASCT in multiple myeloma: a single center experience. Int J Hematol Oncol Stem Cell Res. 2020;14(4):248–56. https://doi.org/10.18502/ijhoscr.v14i4.4481.

129. Abduljalil OZ, Al Hashmi HH. Retrospective observational study on multiple myeloma cases admitted to King Fahad Specialist Hospital: Dammam between 1st of June 2006 till the end of December 2013. J Appl Hematol. 2016;7:S17–8.

130. Serin I, Oyaci Y, Pehlivan M, Pehlivan S. Role of cytokines in multiple myeloma: IL-1RN and IL-4 VNTR polymorphisms. HemaSphere. 2022;6:3410–1. https://doi.org/10.1097/01.HS9.0000852292.38263.b8.

131. Gmati GE, Damlaj M, Alzaharani M, Altamimi S, Alherz N, Khalid F, et al. Outcome of autologous stem cell transplantation in multiple myeloma; experience from a single center in Saudi Arabia. HemaSphere. 2019;3:973–4.

132. Amikishiyev S, Hindilerden IY, Erdem S, Aktan M, Nalcaci M, Sargin D, et al. Infectious epidemiology in multiple myeloma patients after autologous stem cell transplantation: a single-center analysis from Turkey. Bone Marrow Transplant. 2019;53:566–7. https://doi.org/10.1038/s41409-018-0354-7.

133. Firatli Tuglular AT, Pehlivan M, Sari HI, Ayyildiz MO, Saydam G, Sonmez M, et al. Post-authorization safety of lenalidomide + dexamethasone in patients with relapsed/refractory multiple myeloma: early safety report of Turkish pass study. Haematologica. 2015;100(s1):734.