Understanding Differences in Critical Decisions in the Multiple Myeloma Patient Journey in the Era of Precision Medicine

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Abstract

Empowering patients to make informed decisions about their diagnosis and treatment is critical to advancing precision medicine. How patients perceive key decision points that are germane to their diagnosis and treatment and how these decisions are affected by involvement with third-party patient research and support organizations are important to explore.

A cross-sectional survey collected data from 100 patients (≥25 years) with multiple myeloma affiliated with the Multiple Myeloma Research Foundation (MMRF) and from a comparator group of nonaffiliated patients (n = 77). Patients' experiences with provider choice, insurance coverage, diagnostics, tissue banking, genomics, connecting with other patients, standard of care, clinical trials, and sharing data were assessed. Column proportion tests evaluated differences between MMRF-affiliated and nonaffiliated patients.

MMRF-affiliated patients self-reported being better informed than nonaffiliated patients regarding knowledge of their disease and treatment options, understanding of diagnostic testing and genomics, and provider choice; they were also more willing to share data and bank tissue for research purposes. Critical gaps in understanding the standard of care, precision medicine, genomics, and clinical trials participation were identified among all patients.

Patient knowledge drives appropriate treatment decision-making early and throughout the course of disease. Involvement with a third-party research and support organization (eg, the MMRF) may be a critical success factor in this process. However, a deep knowledge gap persists about the field of genomics and access to genomic testing and tissue banking, thereby identifying educational opportunities to be addressed in support of next-generation precision medicine treatments.

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Introduction

Multiple myeloma (MM), characterized by a malignant proliferation of monoclonal plasma cells,[1-4] comprises clonally diverse subsets of malignant plasma cells exhibiting a vast genetic diversity that contributes to the complex pathogenesis of this disease and underpins its difficulty in treatment.[1-4] It is the second most common hematologic cancer in the United States: approximately 95,688 individuals have MM[5] and 0.7% will be diagnosed during their lifetime.[6] In the United States, it is estimated that 33,330 new cases of MM are diagnosed each year will be diagnosed in 2016,[5] with 86,000 new cases worldwide.[7] Overall, MM is more common in men than in women and twice as likely in African Americans compared with Caucasians.[5]

An MM diagnosis is based on the presence of a bone marrow clonal plasma cell count ≥10% and the presence of a monoclonal or M-protein.[8,9] Recommended diagnostics include a detailed medical history, physical exam, routine laboratory testing, bone marrow biopsy/aspiration for cytogenetic analysis or fluorescence in situ hybridization (FISH), and radiographic imaging. Also recommended to further evaluate symptoms are magnetic resonance imaging (MRI), computed tomography (CT), or positron emission tomography (PET).[8,9]

In 2015, MM resulted in 11,240 deaths in the United States,[10] a number that was projected to increase to 12,650 in 2016.[5] Novel and targeted agents have improved survival, but patients with stable disease still experience symptoms, such as pain and fatigue, and report poor physical functioning.[11] Longitudinal research demonstrated that patients with MM report significantly lower health-related quality of life than age- and gender-matched controls.[12] MM also poses a financial burden on patients via increased work disability rates and high out-of-pocket treatment costs, among other factors.[13]

MM remains, for many patients, incurable.[14] Yet, the survival and complete response rates for patients have improved with available therapies.[15] Recent advances in genetic sequencing, bio-informatics, and clinical trial design have enabled a new era of precision medicine powered by the wider availability of genomic and clinical data.[16-18] Precision medicine is now accelerating the discovery of novel targeted therapeutic agents by providing greater understanding of the genomic basis of cancers,[16-18] including in MM.[19]

Research suggests better health outcomes result when patients are knowledgeable about their respective disease and feel self-empowered to make informed treatment decisions.[20] However, prior research has shown

that a minority of patients with lymphoma and/or MM reported having insufficient information about their disease.[21] Third-party organizations focused on providing knowledge and support systems to patients with MM can potentially serve a meaningful role in filling this unmet need. Yet, the extent to which involvement with such organizations relates to patients' understanding of their disease and to engagement in their diagnosis and treatment has not been investigated (see **Gap Analysis**).

Research Objectives

With the emerging importance of precision medicine, patients must play an active role in the diagnosis, treatment, and management of their disease. The current study assessed how, shortly after diagnosis, patients with MM perceive and understand 10 key decision points pertinent to diagnosis and treatment: provider choice, insurance coverage, diagnostic testing, imaging, tissue banking, genomics, connecting with other patients, standard of care, clinical trials, and sharing data. Additionally, this study examined if involvement with a third-party organization relates both to patients' better awareness of, and engagement in, these critical decisions.

Methods and Materials

Participants

Patients with newly diagnosed MM were recruited by Kantar Health (New York, NY) using Multiple Myeloma Research Foundation (MMRF) 22 resources (n = 100) or from Lightspeed Research and its affiliated online panels (n = 77). Inclusion criteria for all participants were: lives in the United States, ≥25 years, diagnosed with MM in the past 4 to 12 months, self-reported being at least somewhat knowledgeable about MM, and self-reported having at least some input in treatment decisions.

Patient Survey

This study was conducted by Kantar Health and sponsored by the MMRF, with data fielded from April through September 2015. The study protocol was granted an exemption by the Pearl Institutional Review Board (Indianapolis, IN). Potential respondents were e-mailed an invitation to complete a 30-minute online survey. Participants indicated their informed consent by reading the e-mail invitation and then clicking the link to begin the survey.

As part of the survey, patient demographics were collected (**Table 1**). The 10 key decision points developed for the survey were based on results from an initial qualitative study with 26 patients with MM (recruited from Lightspeed Research and affiliate panels) and 6 hematologists/oncologists from a MedQuery online panel (unpublished data). To quantitatively evaluate these decision points, patients in the present study were asked about their experiences with provider choice, insurance coverage, diagnostic testing, imaging, tissue banking, genomics, connecting with other patients, standard of care, clinical trials, and sharing data.

Analyses

Descriptive statistics were calculated. Differences between MMRF-affiliated and nonaffiliated patients were assessed using column proportions tests. Specifically, the proportion of MMRF-affiliated patients, relative to nonaffiliated patients, was compared for each response category for each survey item. Due to low base rates, responses were collapsed across categories for some of these comparisons. There were no missing data, as the survey required responses to all items. Two tailed *P*-values (<.05) were considered statistically significant.

Gap Analysis

Current Practice	Best Practice	Resulting Gap
Among those who did not bank tissue in the current study, the overwhelming majority reported tissue banking was neither offered to them nor did they request this service. For those who underwent genomic testing, fluorescence in situ hybridization was the most commonly reported procedure.	Tissue banking and genomic testing are recommended for characterizing a given patient's multiple myeloma following diagnosis. These testing procedures will likewise play a key role in advancing the identification and subsequent development of precision medicine therapies.	Patients may be insufficiently informed about the potential benefits of tissue banking and genomic tests. When there is limited access to the technology requisite for performing genomic testing, tissue banking will allow future genomic testing to be conducted as it becomes more widely available.
A majority of patients in the current study were not currently enrolled or planning to enroll in a multiple myeloma clinical trial.	Patient participation in clinical trials is key for advancing the development of targeted therapies for multiple myeloma.	Patients may be unaware they qualify to participate in clinical trials or they may hold inaccurate perceptions about the potential risks and benefits of participating.
In this study, multiple patients with myeloma affiliated with a third-party research and support organization were more likely than their unaffiliated counterparts to report being connected with their fellow patients and willing to share their clinical data.	Patient-to-patient communication and having a sense of belonging to a larger community of people facing similar challenges provide important sources of social support and empowerment for those diagnosed with a life-threatening condition such as multiple myeloma.	Third-party patient research and support organizations can play an important role in facilitating community-based communication and data sharing among patients with multiple myeloma.

Table 1. Patient Demographics

Variable	Response Categories	Number of Patients Affiliated with MMRF % (n)	Non-MMRF % (n)	*P*-Value
Sex				
	Male	61.0% (61)	54.5% (42)	.39
	Female	39.0% (39)	45.5% (35)	.39
Race				
	Caucasian	97.0% (97)	74.0% (57)	<.001
	African American	2.0% (2)	16.9% (13)	<.01
	Native American	0.0% (0)	1.3% (1)	.26
	Asian/Pacific Islander	0.0% (0)	3.9% (3)	.05
	Other race	1.0% (1)	3.9% (3)	.20
Hispanic/Latino				
	Yes	5.0% (5)	7.8% (6)	.45
	No	95.0% (95)	92.2% (71)	.45
Age (years)				
	25-25	2.0% (2)	3.9% (3)	.45
	36-45	29.0% (29)	11.7% (9)	.01
	46-55	29.0% (29)	26.0% (20)	.66
	56-65	27.0% (27)	39.0% (30)	.09
	66-75	11.0% (11)	18.2% (14)	.18
	76-85	2.0% (2)	1.3% (1)	.72
	86-100	0.0% (0)	0.0% (0)	.50
Educational attainment				
	High school degree or less	5.0% (5)	16.9% (13)	.01
	Some college	9.0% (9)	26.0% (20)	<.01
	College graduate	36.0% (36)	28.6% (22)	.30
	Postgraduate/graduate degree	40.0% (40)	19.5% (15)	<.01
	Other education	10.0% (10)	9.1% (7)	.84
Employment status				
	Employed (net)	65.0% (65)	46.8% (36)	.02
	Unemployed (net)	30.0% (30)	50.6% (39)	.01
	Prefer not to answer	5.0% (5)	2.6% (2)	.42
Type of primary insurance				
	Private/commercial	50.0% (50)	59.7% (46)	.20
	Medicaid	11.0% (11)	13.0% (10)	.69
	Medicare alone	14.0% (14)	1.3% (1)	<.01
	Medicare plus supplement	20.0% (20)	22.1% (17)	.74
	Veterans Health Administration	5.0% (5)	2.6% (2)	.42
	No insurance	0.0% (0)	0.0% (0)	.50
	Don't know/prefer not to answer	0.0% (0)	1.3% (1)	.26

P-values are 2-sided; values > .05 are statistically significant.

Table 1. Patient Demographics (continued)

Variable	Response Categories	Number of Patients Affiliated with MMRF % (n)	Non-MMRF % (n)	*P*-Value
US born				
	Yes	96.0% (96)	92.2% (71)	.28
	No	4.0% (4)	5.2% (4)	.71
	Prefer not to answer	0.0% (0)	2.6% (2)	.12
Annual household Income				
	Under $50,000	26.0% (26)	39.0% (30)	.07
	$50,000 to $99,999	41.0% (41)	33.8% (26)	.33
	$100,000 or more	26.0% (26)	18.2% (14)	.22
	Prefer not to answer	7.0% (7)	9.1% (7)	.61

MMRF indicates Multiple Myeloma Research Foundation; non-MMRF, patients not affiliated with the Multiple Myeloma Research Foundation. *P*-values are 2-sided; values > .05 are statistically significant.

Results

Participant Characteristics

The study shows that 58% (n = 103) of respondents were male and 87% (n = 154) self-identified as Caucasian. MMRF-affiliated patients were significantly more likely to be Caucasian than nonaffiliated patients, whereas the latter were significantly more likely to self-identify as African American than the former. On average, nonaffiliated patients were older (56.78 years; standard deviation [SD] = 1.22) than MMRF-affiliated patients (52.92 years; SD = 1.09; *P* = .02). MMRF-affiliated patients were significantly more likely to report completing postgraduate work/graduate degree and being employed. Conversely, unaffiliated patients were significantly more likely to report having a high school degree or less or some college and being unemployed. MMRF-affiliated patients were significantly more likely to have Medicare coverage alone than nonaffiliated patients. Patient groups did not differ on the other demographic variables assessed.

Provider Choice

Compared with nonaffiliated patients, a significantly greater proportion of MMRF-affiliated patients reported seeking a second opinion after receiving their initial diagnosis (**Table 2**). When choosing a hematologist/oncologist, MMRF-affiliated patients were more likely to use disease-related criteria, including choosing a physician who is recognized as a clinical expert in the field, is published in this field, has a higher number of patients with MM in his/her practice, and whose practice is in geographic proximity. In contrast, nonaffiliated patients were significantly more likely to select a hematologist/oncologist from a recommendation or referral from another healthcare provider or because this specialist's services were covered by insurance. MMRF-affiliated patients were significantly more likely than nonaffiliated patients to "agree strongly" or "very strongly" agree when asked if they feel comfortable phoning or e-mailing to ask their hematologist/oncologist questions and if they feel comfortable challenging when disagreeing or not understanding something (Table 2).

Insurance Coverage

Across patient groups, a minority reported difficulties gaining access to certain diagnostic tests and treatments due to insurance/reimbursement barriers (Table 2). MMRF-affiliated patients were more likely to report insurance problems than nonaffiliated patients, a difference that was not statistically significant.

Diagnostic Testing

MMRF-affiliated patients were significantly more likely than nonaffiliated patients to report understanding their diagnostic test results "very well" or "extremely well" (Table 2) and were significantly more likely to view themselves as "very well" or "extremely well" informed about their disease compared with nonaffiliated patients. Unaffiliated patients were significantly more likely to be unaware or unsure of their MM and light chain types. A significantly greater proportion of MMRF-affiliated patients reported discussing their risk profile with their hematologist/oncologist (Table 2).

Imaging

Most patients in both groups reported receiving x-rays, although the more sensitive advanced diagnostic imaging, such as MRI, CT scans, or PET scans, were less frequently reported (Table 2). MMRF-affiliated patients were significantly more likely than nonaffiliated patients to have requested a PET scan if they had not received this procedure, whereas a significantly larger percentage of nonaffiliated patients reported they planned to have a PET scan in the near future if they had not already done so. Patients' most frequently cited reasons for not having a PET scan were their doctor had not mentioned it, followed by not understanding the need for this procedure (Table 2).

Tissue Banking

A significantly larger proportion of MMRF-affiliated patients were willing to bank tissue, and to report having actually done so, for research purposes via a bone marrow biopsy compared with nonaffiliated patients (Table 2). Nonetheless, sizeable percentages of patients in both groups have

Table 2. Patient Experiences With Provider Choice, Insurance Coverage, Diagnostic Testing, Imaging, and Tissue Banking

Provider Choice Obtained Second Opinion	Response Categories	Number of Patients Affiliated with MMRF % (n)	Non-MMRF % (n)	*P*-Value
	Yes	56.0% (56)	27.3% (21)	<.001
	No	44.0% (44)	72.7% (56)	<.001
Factors in choice of hem/onc				
	Physician referral	48.0% (48)	71.4% (55)	<.01
	Other patient referral	22.0% (22)	5.2% (4)	<.01
	Close to home	44.0% (44)	26.0% (20)	.02
	Number of patients in practice	13.0% (13)	3.9% (3)	.04
	Expertise in field	28.0% (28)	14.3% (11)	.03
	Has published in field	16.0% (16)	2.6% (2)	<.01
	Covered by insurance	20.0% (20)	41.6% (32)	<.01
Relationship with hem/onc				
	Can phone/e-mail hem/onc with questions	36.0% (36)	16.9% (13)	.01
	Hem/onc encouraged me to learn about my disease	25.0% (25)	13.0% (10)	.05
	Feel comfortable asking hem/onc questions	50.0% (50)	37.7% (29)	.10
	Feel comfortable challenging hem/onc if disagree or don't understand	34.0% (34)	14.3% (11)	<.01
	Hem/onc encouraged me to seek a second opinion	24.0% (24)	7.8% (6)	.01
	Have a close personal relationship with hem/onc	28.0% (28)	18.2% (14)	.13
Insurance Coverage				
Insurance coverage difficulties				
	Yes	21.0% (21)	11.7% (9)	.10
	No	78.0% (7)	81.8% (63)	.53
	Not sure	1.0% (1)	6.5% (5)	.05
Diagnostic Testing				
Understand diagnostic test results				
	Extremely well/very well	48.0% (48)	23.4% (18)	<.01
	Not well at all/not very well	0.0% (0)	1.3% (1)	.26
Informed about disease overall				
	Extremely well/very well	51.0% (51)	23.4% (18)	<.001
	Not at all well/not very well	0.0% (0)	2.6% (2)	.12
Disease awareness				
	Not aware/not sure of multiple myeloma type	16.0% (16)	49.4% (38)	<.001
	Not aware/not sure of light chain type	31.0% (31)	63.6% (49)	<.001
Discussed prognosis with hem/onc				
	Yes	81.0% (81)	84.4% (65)	.56
	No	19.0% (19)	15.6% (12)	.56
Discussed what disease means for me with hem/onc				
	Yes	67.0% (67)	50.6% (39)	.03
	No	19.0% (19)	22.1% (17)	.62

P-values are 2-sided; values > .05 are statistically significant.

Table 2. Patient Experiences With Provider Choice, Insurance Coverage, Diagnostic Testing, Imaging, and Tissue Banking (continued)

Provider Choice Obtained Second Opinion	Response Categories	Number of Patients Affiliated with MMRF % (n)	Non-MMRF % (n)	*P*-Value
Discussed what disease means for me with hem/onc				
	Yes	67.0% (67)	50.6% (39)	.03
	No	19.0% (19)	22.1% (17)	.62
	Not aware/not sure	14.0% (14)	27.3% (21)	.03
Imaging				
Imaging/testing received				
	Genomic testing	68.0% (68)	32.5% (25)	<.001
	X-rays	81.0% (81)	68.8% (53)	.06
	MRI	62.0% (62)	62.3% (48)	.96
	CT/CAT	54.0% (54)	51.9% (40)	.79
	PET	46.0% (46)	46.8% (36)	.92
Requested PET (if no PET)				
	Yes	29.6% (16)	9.8% (4)	.02
	No	68.5% (37)	82.9% (34)	.12
	Not sure	1.9% (1)	7.3% (3)	.19
If no PET, reasons why				
	Plan to have PET soon	1.9% (1)	22.0% (9)	<.01
	Insurance coverage issue	16.7% (9)	12.2% (5)	.55
	Copayment is too high	7.4% (4)	4.9% (2)	.62
	Doctor did not mention a need for PET	59.3% (32)	43.9% (18)	.14
	Do not understand the need for PET	33.3% (18)	22.0% (9)	.23
	Never heard of PET	16.7% (9)	7.3% (3)	.18
	Other	9.3% (5)	4.9% (2)	.42
	Not sure	7.4% (4)	17.1% (7)	.15
Tissue Banking				
Willing to bank tissue				
	Yes	82.0% (82)	46.8% (36)	<.001
	No	2.0% (2)	11.7% (9)	.01
	Not sure	16.0% (16)	41.6% (32)	<.001
Had tissue banked				
	Yes	49.0% (49)	13.0% (10)	<.001
	No	26.0% (26)	54.5% (42)	<.001
	Not sure	25.0% (25)	32.5% (25)	.28
Tissue banking offered or requested (if not banked)				
	Offered	11.5% (3)	7.1% (3)	.54
	Requested	11.5% (3)	7.1% (3)	.54
	Neither offered, nor requested	76.9% (20)	85.7% (36)	.36

CT/CAT indicates computerized tomography or computerized axial tomography; hem/onc, hematologist or oncologist; MRI, magnetic resonance imaging; non-MMRF, patients not affiliated with the Multiple Myeloma Research Foundation; PET, positron emission tomography. *P*-values are 2-sided; values > .05 are statistically significant.

not engaged in this practice. Among those who did not bank tissue, the majority reported that tissue banking was neither offered to them nor did they request this service (Table 2).

Genomics

MMRF-affiliated patients were significantly more likely than MMRF-affiliated patients to have reported undergoing genomic testing **(Table 3)** and were significantly more likely than to report understanding their results "very well" or "extremely well." A minority of patients in each group reported understanding their genomic test results "not very well" or "not well at all." MMRF-affiliated patients were more likely to report fluorescence in situ hybridization (FISH), cytogenetics/karyotyping, and gene expression profiling, whereas the 2 patient groups were comparably likely to report genomic sequencing and that FISH was the most common type of genomic test they underwent. Overall, MMRF-affiliated patients were significantly more likely than nonaffiliated patients to know if they had a genetic abnormality. Of those patients who had not undergone testing, a majority of both groups reported that their physician had not mentioned the need for genomic testing (Table 3). Of relevance to genomic testing, patients were asked if they had heard of "precision medicine," and the majority were unfamiliar with this term.

Connecting with Other Patients

MMRF-affiliated patients were significantly more likely than nonaffiliated patients to report being connected with other patients (Table 3) and through different online venues, including Facebook, e-mail, other social media platforms, or online forums. Conversely, nonaffiliated patients were significantly more likely to report using in-person support groups for this purpose (Table 3).

Standard of Care

For both groups, over half of patients were unaware or unsure of the guideline-recommended standard of care for MM treatment (Table 3). Among those who were aware, MMRF-affiliated patients reported greater awareness than unaffiliated patients, but this difference was statistically nonsignificant. Both MMRF-affiliated and nonaffiliated patients were similarly likely to report being "very involved" or "extremely involved" in their treatment decisions (Table 3).

Clinical Trials

MMRF-affiliated patients were significantly more likely to report either participating in or planning to participate in clinical trials, compared with nonaffiliated patients (Table 3). However, a majority in both groups were not currently planning to enroll in an MM clinical trial. Of these individuals, MMRF-affiliated patients were more likely to report actively looking into clinical trial information than nonaffiliated patients, but this difference was not significant. Conversely, nonaffiliated patients were significantly more likely to report being "very willing" to participate in a clinical trial. The most common reasons cited by patients for nonparticipation were satisfaction with current treatment, more often by MMRF-affiliated patients; not knowing enough about clinical trials; and concerns surrounding the safety and side effects of experimental therapies (Table 3).

Sharing Data

MMRF-affiliated patients were significantly more likely to indicate their willingness to share their health information to advance MM research. Additionally, MMRF-affiliated patients were more likely than nonaffiliated patients to use a mobile app or spreadsheet to track and share their test results (Table 3).

Discussion

Due to the heterogeneity of MM and its complex pathogenesis, drug discovery is now being driven by the development of precision medicine-based molecular targeting strategies.[16-18] The Precision Medicine Initiative is accelerating the discovery of novel targeted therapeutic agents for patients with MM, with the goal of swiftly translating cutting-edge research into available next-generation treatments.[16-18]

When initially receiving an MM diagnosis, patients are challenged with a chaotic influx of information regarding a life-threatening cancer, various diagnostic test results, new encounters with their hematologist/oncologist, and impending treatment decisions. This study assessed how individuals with MM experience key decision points in their patient journey following initial diagnosis through treatment. Involvement with a third-party research and support organization, in this case the MMRF, may facilitate patients' understanding of these issues. However, gaps were also identified regarding knowledge of the standard of care, awareness of precision medicine, understanding of and participation in genomics research, and involvement in clinical trials.

The present research characterized some of the key informational needs specific to patients early in their journey, particularly those impacted by their involvement with a third-party organization. MMRF-affiliated patients, compared with unaffiliated patients, were significantly more informed on their MM disease state and reported a greater understanding of their various diagnostic test results. They were also better prepared for early, critical discussions with their hematologist/oncologist regarding their diagnosis and treatment-related decisions. This is especially notable because many of the initial decisions that a patient makes when undergoing diagnostic testing have considerable downstream ramifications on their prognosis, individualized treatment options, and availability of pretreatment biologic samples. These findings have important implications, as prior research has shown greater health literacy among patients with cancer can be traced to a higher likelihood of receiving treatment.[23]

Patient activation, which occurs when patients have adequate knowledge about their disease and the ability to act upon this information, is linked to better health behaviors and improvements in a variety of health outcomes.[24] Aligned with this prior research, patients in both groups reported comparable levels of engagement in their treatment decisions. However, MMRF-affiliated patients appeared to play a more active role in choosing an appropriate provider, as they were more inclined to use disease-related criteria when choosing their hematologist/oncologist and

were more than twice as likely to obtain a second opinion after initial diagnosis. This suggests these patients were more effectively able to self-advocate regarding their diagnosis and treatment, although further research will be needed to tie these behaviors to actual treatment outcomes.

The current study identified additional opportunities to provide support and information for patients with MM. As the results of a previous study demonstrate, the health-related information preferences of patients with cancer change over the course of their disease,[25] so ongoing efforts are needed to understand the progress of the journey of patients who have MM.

Table 3. Patient Experiences With Genomics, Connecting With Other Patients, Standard of Care, Clinical Trials, and Sharing Data

Provider Choice Obtained Second Opinion	Response Categories	Number of Patients Affiliated with MMRF % (n)	Non-MMRF % (n)	*P*-Value
Genomics				
Understand genomic test results (if had testing)				
	Extremely well/very well	48.5% (33)	8.0% (2)	<.01
	Not well at all/not very well	14.7% (10)	24.0% (6)	.30
Physician recommended genomic testing (if did not have testing)				
	Yes	9.4% (3)	5.8% (3)	.54
	No	81.3% (26)	78.8% (41)	.79
	Not sure	9.4% (3)	15.4% (8)	.43
Has heard of precision medicine				
	Yes	15.0% (15)	24.7% (19)	.12
	No	85.0% (85)	75.3% (58)	.12
Genomic testing type (if received)				
	Cytogenetics/karyotyping	28.0% (28)	2.6% (2)	<.001
	FISH	40.0% (40)	14.3% (11)	<.001
	Gene expression profiling	20.0% (20)	7.8% (6)	.03
	Genomic testing (unsure of type)	21.0% (21)	9.1% (7)	.03
	Genomic sequencing	3.0% (3)	5.2% (4)	.46
	Other	8.0% (8)	11.7% (9)	.41
Has a genetic abnormality				
	Yes	25.0% (25)	11.7% (9)	.03
	No	45.0% (45)	29.9% (23)	.04
	Not sure	30.0% (30)	58.4% (45)	<.001
Connecting with Other Patients				
Connected to other patients				
	Yes	74.0% (74)	33.8% (26)	<.001
	No	26.0% (26)	66.2% (51)	<.001
How connected (if connected to other patients)				
	Facebook	62.2% (46)	19.2% (5)	<.001
	Other social media	23.0% (17)	3.8% (1)	.03
	Online forums	45.9% (34)	15.4% (4)	.01
	E-mail	45.9% (34)	23.1% (6)	.04
	In-person support groups	32.4% (24)	61.5% (16)	.01

BTZ indicates bortezomib; CHOP, cyclophosphamide, doxorubicin, vincristine, and prednisone; DEX, dexamethasone; HSP, heat shock protein; MM, multiple myeloma; PERK, protein kinase R-like ER kinase; R/R, relapsed/refractory; UPR, unfolded protein response; XBP1, X-box binding protein 1.

Table 3. Patient Experiences With Genomics, Connecting With Other Patients, Standard of Care, Clinical Trials, and Sharing Data (continued)

Variable	Response Categories	Number of Patients Affiliated with MMRF % (n)	Non-MMRF % (n)	*P*-Value
Standard of Care				
Aware of standard of care				
	Yes	45.0% (45)	35.1% (27)	.19
	No	24.0% (24)	32.5% (25)	.22
	Not sure	31.0% (31)	32.5% (25)	.84
What is standard of care (if known)				
	Triplet therapies (net)	37.8% (17)	29.6% (8)	.49
	Doublet therapies (net)	20.0% (9)	11.1% (3)	.33
	Chemotherapy (net)	15.6% (7)	18.5% (5)	.75
	Stem cell transplant (if eligible)	26.7% (12)	14.8% (4)	.25
Personally involved in treatment decisions				
	Extremely/very	57.0% (57)	46.8% (36)	.18
	Not at all/not very	1.0% (1)	7.8% (6)	.02
Knowledgeable about available treatments				
	Very/somewhat	95.0% (95)	74.0% (57)	<.001
	Not at all/slightly	5.0% (5)	26.0% (20)	<.001
Clinical trials				
Participation in clinical trials				
	Currently enrolled	15.0% (15)	3.9% (3)	.02
	Plan to enroll	19.0% (19)	6.5% (5)	.02
	Previously participated	6.0% (6)	2.6% (2)	.28
	Have never participated	60.0% (60)	87.0% (67)	<.001
Actively looking for a clinical trial (if not enrolled)				
	Yes	21.2% (14)	10.1% (7)	.08
	No	78.8% (52)	89.9% (62)	.08
Willing to participate in clinical trials (if not enrolled)				
	Very willing	12.1% (8)	27.5% (19)	.03
	Somewhat willing	54.5% (36)	55.1% (38)	.95
	Not willing	33.3% (22)	17.4% (12)	.04
Reasons why less than “very” willing to participate in clinical trials				
	Doing well on current treatment	81.8% (36)	43.9% (25)	<.001
	Need more information	45.5% (20)	42.1% (24)	.74
	Don’t want to be a test subject	18.2% (8)	17.5% (10)	.93
	Afraid to receive placebo	25.00% (11)	35.1% (20)	.28
	Don’t want to travel far	29.5% (13)	19.3% (11)	.24
	Decided against further treatment	2.3% (1)	1.8% (1)	.85
	Hem/onc has not recommended	36.4% (16)	50.9% (29)	.15
	Concerned about risks	40.9% (18)	38.6% (22)	.82

BTZ indicates bortezomib; CHOP, cyclophosphamide, doxorubicin, vincristine, and prednisone; DEX, dexamethasone; HSP, heat shock protein; MM, multiple myeloma; PERK, protein kinase R-like ER kinase; R/R, relapsed/refractory; UPR, unfolded protein response; XBP1, X-box binding protein 1.

Table 3. Patient Experiences With Genomics, Connecting With Other Patients, Standard of Care, Clinical Trials, and Sharing Data (continued)

Variable	Response Categories	Number of Patients Affiliated with MMRF % (n)	Non-MMRF % (n)	*P*-Value
	Concerned about side effects	38.6% (17)	36.8% (21)	.86
	Unsure how to find appropriate trial	9.1% (4)	15.8% (9)	.32
	Other	4.5% (2)	3.5% (2)	.79
Sharing Data				
Willing to share health data for research				
	Yes	93.0% (93)	53.2% (41)	<.001
	No	1.0% (1)	14.3% (11)	<.01
	Not sure	6.0% (6)	32.5% (25)	<.001
Tracking/sharing test results				
	Personal journal/diary	34.0% (34)	40.3% (31)	.39
	Spreadsheet	29.0% (29)	6.5% (5)	<.001
	Mobile app	32.0% (32)	5.2% (4)	<.001
	Print outs/hardcopies	16.0% (16)	7.8% (6)	.10
	Online health portal	5.0% (5)	0.0% (0)	.05
	IMF myeloma manager	0.0% (0)	0.0% (0)	.50
	Something else	1.0% (1)	0.0% (0)	.38
	None of these	22.0% (22)	44.2% (34)	<.01

FISH indicates fluorescence in situ hybridization; hem/onc, hematologist or oncologist; IMF, International Myeloma Foundation; non-MMRF, patients not affiliated with the Multiple Myeloma Research Foundation. *P*-values are 2-sided; values >.05 are statistically significant.

One key knowledge gap was the general lack of awareness regarding the standard of care for MM. Due to significant progress in the approval of effective therapeutic agents in recent years, efforts are needed to effectively inform patients and providers and to offer the requisite tools for them to select optimal treatments. Other important elements include the use of tissue banking and appropriate genomic testing. Overall, these findings underscore the need to close the gap between patients' willingness to bank their tissue and following through with using this service. Continual efforts to improve all patients' awareness of genomic testing are thus warranted, as this initiative is specifically working toward the collection and translation of genomic data into new precision-based therapies for MM.[19]

The availability of individualized information should lead to improved decision making for patients regarding treatments. However, some attention should be given to the existing barriers to care. According to the results of this study, work is still needed to ensure that all patients, regardless of their insurance coverage status or ability to pay, have access to the necessary diagnostic tests and treatments. Additionally, although there do appear to be strong connections within the patient community and a general willingness to share healthcare information for research purposes, only a small percentage of patients in each group were either participating in or planning to participate in clinical trials. With a rare disease like MM, encouraging a sufficient number of patients to enroll in clinical trials will be integral to identifying more precise, efficacious treatments and developing a cure. Adequate outlets for clinical trial enrollment and data sharing need to be provided to patients as they begin to understand the importance of taking an active role in their disease management.

Representing a substantial strength of the current study, the critical decision points assessed in this study were previously identified by patients with MM as both relevant and important through a qualitative research study (unpublished data). Specifically, the decision points examined and the subsequent findings are more likely to have greater external validity and higher fidelity to the unique needs of patients with MM.

Limitations of this study included the following; data were self-reported by patients and no verification of diagnosis, treatments, or diagnostic tests was available. Therefore, recall bias may have affected results. In addition, because participants predominantly self-identified as Caucasian, non-Hispanic, and born in the United States, the survey findings may not represent the experiences of patients outside those patient groups. Lastly, no additional statistical analysis was performed in this study to control for selection bias and for potential confounding due to differences in demographics between the MMRF-affiliated and nonaffiliated groups and their treatment decisions. This is an area of interest for future research.

Conclusion

Being involved with a trusted third-party organization, such as the MMRF, may empower patients to be better informed and more actively engaged in the management of their disease. As the concept of precision medicine advances in the MM research community, it remains critically

important for patients and providers to supply key elements of data that will impact treatment decisions throughout the course of their disease. However, there are knowledge gaps that need to be addressed through patient-centered education and collaborative research initiatives, as these initiatives are intricately linked to developing customized treatment strategies and to accelerating genomic research discoveries. To achieve these bold objectives, third-party organizations appear to play a vital role in keeping patients well-informed from the very start of their journey from diagnosis through treatment.

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References

1. Rollig C, Knop S, Bornhauser M. Multiple myeloma. *Lancet.* 2015;385(9983):2197-2208. doi: 10.1016/S0140-6736(14)60493-1.
2. Palumbo A, Anderson K. Multiple myeloma. *N Engl J Med.* 2011;364(11):1046-1060. doi: 10.1056/NEJMra1011442.
3. Keats JJ, Fonseca R, Chesi M et al. Promiscuous mutations activate the noncanonical NF-kappaB pathway in multiple myeloma. *Cancer Cell.* 2007;12(2):131-144.
4. Bianchi G, Munshi NC. Pathogenesis beyond the cancer clone(s) in multiple myeloma. *Blood* 2015;125(20):3049-3058. doi: 10.1182/blood-2014-11-568881.
5. National Cancer Institute Surveillance,Epidemiology, and End Results Program. Cancer stat facts: myeloma. SEER website. http://seer.cancer.gov/statfacts/html/mulmy.html. Accessed April 7, 2016.
6. American Cancer Society. Multiple myeloma. ACS website. http://www.cancer.org/acs/groups/cid/documents/webcontent/003121-pdf.pdf. Published 2014. Updated January 19, 2016. Accessed April 7, 2016.
7. Becker N. Epidemiology of multiple myeloma. In: Moehler T, Goldschmidt H, eds. *Recent Results in Cancer Research*. 183 edition. Berlin, Germany: Springer-Verlag; 2011:25-35.
8. Dimopoulos M, Kyle R, Fermand JP, et al; International Myeloma Workshop Consensus Panel 3. Consensus recommendations for standard investigative workup: report of the International Myeloma Workshop Consensus Panel 3. *Blood.* 2011;117(18):4701-4705. doi.org/10.1182/blood-2010-10-299529.
9. Rajkumar SV, Dimopoulos MA, Palumbo A, et al. International Myeloma Working Group updated criteria for the diagnosis of multiple myeloma. *Lancet Oncol.* 2014;15(12):e538-e548. doi: 10.1016/S1470-2045(14)70442-5.
10. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2015. *CA Cancer J Clin* 2015;65(1):5-29. doi: 10.3322/caac.21254.
11. Boland E, Eiser C, Ezaydi Y, Greenfield DM, Ahmedzai SH, Snowden JA. Living with advanced but stable multiple myeloma: a study of the symptom burden and cumulative effects of disease and intensive (hematopoietic stem cell transplant-based) treatment on health-related quality of life. *J Pain Symptom Manage.* 2013;46(5):671-680. doi: 10.1016/j.jpainsymman.2012.11.003.
12. Mols F, Oerlemans S, Vos AH et al. Health-related quality of life and disease-specific complaints among multiple myeloma patients up to 10 yr after diagnosis: results from a population-based study using the PROFILES registry. *Eur J Haematol.* 2012;89(4):311-319. doi: 10.1111/j.1600-0609.2012.01831.x.
13. Goodwin JA, Coleman EA, Sullivan E, et al. Personal financial effects of multiple myeloma and its treatment. *Cancer Nurs.* 2013;36(4):301-308. doi: 10.1097/NCC.0b013e3182693522.
14. Kumar SK, Rajkumar SV, Dispenzieri A, et al. Improved survival in multiple myeloma and the impact of novel therapies. *Blood* 2008;111(5):2516-2520.
15. Barlogie B, Mitchell A, van Rhee F, Epstein J, Morgan GJ, Crowley J. Curing myeloma at last: defining criteria and providing the evidence. *Blood.* 2014;124(20):3043-3051. doi: 10.1182/blood-2014-07-552059.

16. Collins FS, Varmus H. A new initiative on precision medicine. *N Engl J Med.* 2015;372(9):793-795. doi: 10.1056/NEJMp1500523.
17. National Institutes of Health. The Precision Medicine Initiative cohort program - building a research foundation for 21st century medicine. NIH website. http://acd.od.nih.gov/reports/DRAFT-PMI-WG-Report-9-11-2015-508.pdf.
18. President Obama's precision medicine initiative [press release]. Washington, DC: The White House Office of the Press Secretary; January 30, 2015. www.whitehouse.gov/the-press-office/2015/01/30/fact-sheet-president-obama-s-precision-medicine-initiative. Accessed April 7, 2016.
19. US National Institutes of Health. Relating clinical outcomes in multiple myeloma to personal assessment of genetic profile (CoMMpass). Clinical Trials website. https://clinicaltrials.gov/ct2/show/NCT01454297?term=NCT01454297&rank=1. Accessed April 7 2016.
20. Schulz PJ, Nakamoto K. Health literacy and patient empowerment in health communication: the importance of separating conjoined twins. *Patient Educ Couns.* 2013;90(1):4-11. doi: 10.1016/j.pec.2012.09.006.
21. Oerlemans S, Husson O, Mols F, et al. Perceived information provision and satisfaction among lymphoma and multiple myeloma survivors--results from a Dutch population-based study. *Ann Hematol.* 2012;91(10):1587-1595. doi: 10.1007/s00277-012-1495-1.
22. Multiple Myeloma Research Foundation. About MMRF. MMRF website. http://www.themmrf.org/about-mmrf/. Accessed April 7, 2016.
23. Busch EL, Martin C, DeWalt DA, Sandler RS. Functional health literacy, chemotherapy decisions, and outcomes among a colorectal cancer cohort. *Cancer Control.* 2015;22(1):95-101.
24. Greene J, Hibbard JH. Why does patient activation matter? an examination of the relationships between patient activation and health-related outcomes. *J Gen Intern Med.* 2012;27(5):520-526. doi: 10.1007/s11606-011-1931-2.
25. Thorne S, Hislop TG, Kim-Sing C, Oglov V, Oliffe JL, Stajduhar KI. Changing communication needs and preferences across the cancer care trajectory: insights from the patient perspective. *Support Care Cancer.* 2014;22(4):1009-1015. doi: 10.1007/s00520-013-2056-4.