

Relationship Between Magnitude of Limitations and Patient Experience During Recovery from Upper-Extremity Fracture

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Background: The relationship between the magnitude of limitations (measured by patient-reported outcome measures, or PROMs) and satisfaction with care providers and hospital services (measured by patient-reported experience measures, or PREMs) over the course of recovery after injury is unclear. The purpose of this study was to assess the relationship between a range of PROMs and 2 PREMs at 3 time points (initial office visit within a week, 2 to 4 weeks, and 6 to 9 months) after shoulder, elbow, and wrist fractures.

Methods: We enrolled 744 adult patients with an isolated shoulder, elbow, or wrist fracture and invited them to complete PROMs (the Patient-Reported Outcomes Measurement Information System Upper Extremity Physical Function computer adaptive test [PROMIS UE], PROMIS Physical Function (PROMIS PF) scale, Quick Disabilities of the Arm, Shoulder and Hand [QuickDASH] questionnaire, EuroQol 5-Dimensions 3-Level Index [EQ-5D-3L], and Oxford Shoulder Score [OSS], Oxford Elbow Score [OES], or Patient-Rated Wrist Evaluation [PRWE]) and PREMs (Numerical Rating Scale [NRS] for satisfaction with care providers [NRS-C] and for satisfaction with hospital services [NRS-S]) at their initial visit at the outpatient surgical practice (maximum, 1 week after the fracture), between 2 and 4 weeks after the injury, and between 6 and 9 months after the injury. Correlational analysis was performed at each time point.

Results: There was moderate correlation between the PROMIS UE and the NRS-C ($r = 0.56$) and NRS-S ($r = 0.59$) at 6 to 9 months after injury, which was stronger than the correlation at the 2 to 4-week mark (NRS-C, $r = 0.34$; NRS-S, $r = 0.36$) and at the evaluation that took place within a week after the injury (NRS-C, $r = 0.18$; NRS-S, $r = 0.16$). These correlational trends were observed with all forms of PROMs. Patients reporting greater limitations after injury were also less satisfied with their care and services.

Conclusions: The increasing alignment of PROMs and PREMs over the course of recovery after an upper-extremity fracture suggests that restored physical function may improve perceptions of satisfaction with care providers and hospital services over time. Future studies should assess factors that could be addressed to improve patient satisfaction and their limitations during recovery after fracture in order to maximize patient outcomes.

Level of Evidence: Therapeutic Level IV. See Instructions for Authors for a complete description of levels of evidence.

The use of patient-reported outcome measures (PROMs) to quantify symptom intensity and the magnitude of limitations is consistent with the biopsychosocial model of health¹⁻⁵. A perception that care was empathic, personal, and well-designed can be measured with patient-reported experience measures (PREMs). Examples of PREMs include a

Numerical Rating Scale for satisfaction with care providers (NRS-C, an 11-point ordinal measure of satisfaction with provider-patient interactions) and a Numerical Rating Scale for satisfaction with hospital services (NRS-S, an 11-point ordinal measure of satisfaction with hospital services with regard to accessibility, safety, cleanliness, and comfort)⁶⁻⁹. PROMs can be

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used to assess general quality of life or regional or disease-specific limitations. It may be instinctive to assume a positive correlation between PROMs and PREMs; however, the relationship between these measures is inconsistent even following procedures with a successful track record for reducing impairment (e.g., total hip and knee arthroplasty)¹⁰⁻¹⁵. Given that a good patient experience is associated with improved adherence to rehabilitation regimens and overall health, a focus on the interplay between PROMs and PREMs may provide important insights for optimizing health outcomes in patients recovering from musculoskeletal injury or surgery^{8,9}.

To the best of our knowledge, the interrelation between limitations faced by patients who sustain common upper-extremity fractures and their levels of satisfaction with their care providers and services experienced in the hospital has not been studied in large populations of patients recovering from these injuries. We performed a prospective, longitudinal cohort study to evaluate the relationship between several widely used PROMs and 2 PREMs at multiple time points during patients' recovery from a shoulder, elbow, or wrist fracture.

Our primary null hypothesis was that the Patient-Reported Outcomes Measurement Information System Upper Extremity Physical Function computer adaptive test (PROMIS UE) does not correlate with satisfaction with care providers (NRS-C) or satisfaction with hospital services (NRS-S) expressed at 6 to 9 months (when recovery is well established) after a proximal humeral, elbow, or distal radial fracture. Secondarily, we assessed this relationship during early recovery within a week after the injury (first visit) and 2 to 4 weeks after the injury. We also tested the correlations of the NRS-C and NRS-S—within a week, at 2 to 4 weeks, and at 6 to 9 months after injury—with a variety of other PROMs, including the PROMIS Physical Function (PROMIS PF) scale, Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) questionnaire, EuroQol 5-Dimensions 3-Level Index (EQ-5D-3L), and Oxford Shoulder Score (OSS), Oxford Elbow Score (OES), or Patient-Rated Wrist Evaluation (PRWE). Finally, to further understand the relationship between PROMs and PREMs, we compared the difference in NRS-C and NRS-S scores between patients scoring in the lower half and those scoring in the upper half of the score range of each PROM.

Materials and Methods

Between January 1, 2016, and August 31, 2016, we approached 775 consecutive, new, adult patients with an isolated proximal humeral, elbow, or distal radial fracture at a U.K. level-I trauma center for possible recruitment into this prospective, research and ethics committee-approved study (Integrated Research Application System [IRAS] Number 16/YH/0017).

Inclusion criteria were fluency in English, an age of 18 years or older, and the ability to provide informed consent. Patients were ineligible if they had sustained a concurrent injury, involving the same arm in which they had sustained the shoulder, elbow, or wrist fracture or in any region (e.g., as part of complex polytrauma); refracture during recovery from a previous injury; fracture-dislocation; or a fracture around a previous fixation or joint replacement.

TABLE 1 Patient Demographics

Demographic	Value
No. of subjects	
≤1 wk after fracture	744
2-4 wk after fracture	744
6-9 mo after fracture	734
Age* (yr)	58.5 ± 20.4 (18-97)
Female†	68% (498)
Charlson Comorbidity Index*	1.9 ± 1.7 (0-6)
Marital status†	
Single	23% (166)
Partner/married	50% (365)
Separated/divorced/widowed	28% (203)
Living situation†	
Alone	21% (153)
Partner/friend(s)/family	70% (514)
Full/part-time care	9% (67)
Education* (yr)	13.7 ± 3 (6-23)
Work status†	
Employed outside home	44% (326)
Homemaker	45% (328)
Retired	6% (46)
Unemployed/Workers' Compensation/litigation	5% (34)
Index of Multiple Deprivation [IMD] factor	70.4 ± 23.6 (0-99.8)
Fracture location†	
Proximal humeral	24% (173)
Elbow	25% (183)
Distal radial	51% (378)
Broad Injury Classification†	
Category 1‡	51% (377)
Category 2§	18% (131)
Category 3#	31% (226)
Dominant side injured†	49% (363)
High-energy injury†	16% (119)
Neurovascular compromise†	5% (38)
Open injury†	2% (13)
Surgery†	16% (118)
Complication†	25% (182)
Prior fracture†	
Dominant arm	19% (137)
Non-dominant arm	11% (79)
Opioid use†	34% (252)
Antidepressant use†	24% (174)

*The values are given as the mean and SD (range). †The values are given as the percentage (number). ‡Proximal humeral fractures of the greater tuberosity, elbow fractures involving the radial head and/or neck, and AO type-A distal radial fractures. §Two-part proximal humeral fractures, extra-articular elbow fractures, and AO type-B distal radial fractures. #More than 2-part proximal humeral fractures, intra-articular elbow fractures, and AO type-C distal radial fractures.

TABLE II Health-Related Outcomes and Patient Experience

	≤1 Wk After Fracture			2-4 Wk After Fracture			6-9 Mo After Fracture		
	No. of Patients	Score		No. of Patients	Score		No. of Patients	Score	
		Mean ± SD	Range		Mean ± SD	Range		Mean ± SD	Range
PROMIS UE	744	24.2 ± 6.2	14.7-56.4	744	29.2 ± 5.9	15.6-45.7	734	43.2 ± 10.7	19.5-56.4
PROMIS PF	744	32.4 ± 6.1	23.5-55.8	744	36.4 ± 8.4	23.5-51.4	734	51.7 ± 12.8	23.5-73.3
QuickDASH	744	70.2 ± 12.1	36.4-93.2	744	63.3 ± 18.5	15.9-90.9	734	24.5 ± 24.5	0-88.6
OSS	177	7.9 ± 5.5	0-24	177	12 ± 7.1	3-34	173	34.8 ± 11.4	14-48
OES	183	16.7 ± 7.8	3-30	183	25.9 ± 9.4	8-41	183	39.8 ± 10.5	11-48
PRWE	384	81.8 ± 6.7	59-94.5	384	70.9 ± 12.3	27-91.5	378	23.7 ± 25	0-82.5
EQ-5D-3L	739	0.274 ± 0.355	-0.594-1	744	0.325 ± 0.407	-0.349-1	734	0.795 ± 0.329	-0.181-1
NRS-C	742	8.2 ± 1.6	1-10	742	8.2 ± 1.7	1-10	737	8.4 ± 2	0-10
NRS-S	742	7.4 ± 2	1-10	742	7.5 ± 2.1	0-10	737	8 ± 2.4	0-10

Of the 775 patients, 31 (4%) declined to participate because of time constraints. The final sample comprised 744 patients (498 women) with a mean age (and standard deviation [SD]) of 58.5 ± 20.4 years (range, 18 to 97 years) (Table I). Four patients died of an unrelated illness before the last measurement interval (6 to 9 months after injury), and 6 patients could not be contacted.

Participants provided demographic details including education level; marital, social, and work status; and arm dominance. Clinical variables included prior arm fractures, including the side of those injuries; neurovascular compromise; whether the fracture was open or closed; surgical procedures; and adverse events gathered from health records.

The PROMs were completed on a secure, encrypted, web-based data collection platform (Assessment Center, Northwestern University)¹⁶. Data were captured at baseline (the initial orthopaedic visit following the emergency department visit, at a maximum of 1 week after the injury), early follow-up (2 to 4 weeks after injury, which is a common initial follow-up time period), and final assessment (6 to 9 months after injury, when a substantial proportion of patients are likely to have recovered from the injury) (Table II). Patients completed assessments in person (70%), by telephone (25%), or via e-mail using an electronic link (5%). We made 3 attempts to contact people by telephone for the 6 to 9-month evaluation.

Injuries were classified by energy (high [e.g., high-speed road traffic accident] or low [e.g., a fall from a standing height]) and by region (i.e., proximal humeral, elbow [radial head, distal humeral, or proximal ulnar], or distal radial fracture). Use of opioid analgesia was defined as regular use of any opiates beyond a 2-week postinjury period; those using opiates prior to injury were counted only if there was an increase in requirements secondary to the fracture. Use of antidepressants included use for a preexisting diagnosis of depression as well as newly diagnosed major depression within the first month following injury.

We selected the most widely used validated PROMs for upper-extremity-specific limitations¹⁷: PROMIS UE (a computer adaptive region-specific measure of physical function)¹⁸, PROMIS PF (a computer adaptive generic measure of physical

function)¹⁸, QuickDASH (a fixed-scale region-specific measure of arm-specific disability)¹⁹⁻²¹, EQ-5D-3L (a fixed-scale measure of general health)^{22,23}, and OSS²⁴, OES²⁵, or PRWE²⁶ (fixed-scale measures of joint-specific disability). The PROMIS UE (version 1.0) assesses arm and hand-specific limitations (e.g., writing and lifting heavy objects). Lower scores indicate greater upper-extremity disability^{18,27}. The PROMIS PF (version 1.0) assesses the ability to accomplish physical activities ranging from low-intensity tasks (e.g., dressing) to strenuous sports. Lower scores indicate greater limitations^{28,29}. The QuickDASH consists of 11 items related to limitations in physical functioning (e.g., daily tasks and social activities) and arm symptoms (e.g., pain) answered on a 5-point Likert scale. Total scores are scaled from 0 to 100, with higher scores representing greater disability²¹. The EQ-5D-3L comprises 5 domains—i.e., mobility, self-care, usual activities, pain/discomfort, and anxiety/depression—each with 3 possible response levels that provide a 5-digit number that can be converted to a total index score. Higher scores represent greater overall health²². The OSS and OES assess the impact of the shoulder and elbow, respectively, on pain, function, and activities of daily life in the previous 4 weeks²⁴. Twelve items, each with 5 response categories, form a total score ranging from 0 to 48, with lower scores representing greater disability^{24,25}. The PRWE is a 15-item scale (including pain, specific activity, and usual activity items) measuring self-reported pain and disability related to the wrist with questions scaled from 1 to 10²⁶. Total scores range from 0 to 100, with higher scores representing greater disability²⁶.

Patients used 11-point ordinal scales to quantify their satisfaction with their care providers (NRS-C) and with hospital services (NRS-S).

Statistical Analyses

Descriptive statistics included frequencies and percentages for discrete variables and the mean, SD, and range for continuous variables. Bivariate analysis included Pearson correlation for continuous variables. The strength of the correlations between PROMs and PREMs was classified as high (≥ 0.7), high-moderate (0.61 to 0.69), moderate (0.4 to 0.6), moderate-weak (0.31 to 0.39), or weak (< 0.31)³⁰.

TABLE III Correlation Matrices of Health Outcome Measures and Satisfaction Ratings *

	PROMIS UE	PROMIS PF	QuickDASH	OSS	OES	PRWE	EQ-5D-3L	NRS-C	NRS-S
≤1 wk after fracture									
PROMIS UE	1.0000								
PROMIS PF	0.6807	1.0000							
QuickDASH	-0.4665	-0.5629	1.0000						
OSS	0.4771	0.4689	-0.7996	1.0000					
OES	0.6410	0.6335	-0.8428	NA	1.0000				
PRWE	-0.1556†	-0.4511	0.4543	NA	NA	1.0000			
EQ-5D-3L	0.1711	0.4371	-0.5936	0.5964	0.7549	-0.5901	1.0000		
NRS-C	0.1797	0.1993	-0.3808	0.2987	0.5613	-0.0321‡	0.2847	1.0000	
NRS-S	0.1644	0.2200	-0.3874	0.2223§	0.5653	-0.0825#	0.2759	0.7196	1.0000
2-4 wk after fracture									
PROMIS UE	1.0000								
PROMIS PF	0.7311	1.0000							
QuickDASH	-0.7763	-0.7530	1.0000						
OSS	0.7758	0.7119	-0.9155	1.0000					
OES	0.6802	0.7643	-0.8360	NA	1.0000				
PRWE	-0.6688	-0.5335	0.6411	NA	NA	1.0000			
EQ-5D-3L	0.6434	0.6539	-0.6559	0.8119	0.7878	-0.4144	1.0000		
NRS-C	0.3438	0.4365	-0.4298	0.3510	0.7071	-0.2508	0.4354	1.0000	
NRS-S	0.3598	0.4325	-0.4491	0.2905**	0.7205	-0.2927	0.4094	0.7545	1.0000
6-9 mo after fracture									
PROMIS UE	1.0000								
PROMIS PF	0.8356	1.0000							
QuickDASH	-0.8326	-0.7796	1.0000						
OSS	0.8703	0.8595	-0.9644	1.0000					
OES	0.8432	0.7498	-0.9402	NA	1.0000				
PRWE	-0.8000	-0.7302	0.9442	NA	NA	1.0000			
EQ-5D-3L	0.6734	0.6077	-0.8196	0.8808	0.9099	-0.8412	1.0000		
NRS-C	0.5575	0.5141	-0.6856	0.6159	0.8277	-0.6348	0.6431	1.0000	
NRS-S	0.5906	0.5203	-0.7398	0.6028	0.8684	-0.7050	0.6795	0.8724	1.0000

*P < 0.001 for all variables unless specified. NA = not applicable. †P = 0.0022. ‡P = 0.5308. §P = 0.0030. #P = 0.1072. **P = 0.0001.

We compared mean NRS-C and NRS-S between patients scoring in the lower half of the PROM scoring ranges and those scoring in the upper half. This analysis was done using the Student t test, after performing a median split for each PROM.

An a priori power analysis indicated that a minimum sample size of 165 patients would provide 90% power to detect a correlation of 0.25 for each diagnosis-specific disability measure, with alpha set at 0.05. All statistical analysis was performed using STATA 14.0 (StataCorp).

Results

The PROMIS UE was moderately correlated with the NRS-C (r = 0.56) and NRS-S (r = 0.59) at 6 to 9 months after

shoulder, elbow, and wrist fractures (p < 0.001) (Table III). The correlation strength was weak at less than a week after injury (NRS-C, r = 0.18; NRS-S, r = 0.16) and moderate-weak at 2 to 4 weeks after injury (NRS-C, r = 0.34; NRS-S, r = 0.36) (p < 0.001) (Table III).

The correlation of other PROMs with both PREMs ranged from weak to moderate at less than a week (e.g., QuickDASH versus NRS-C, r = -0.38, and versus NRS-S, r = -0.39), weak to high at 2 to 4 weeks (e.g., QuickDASH versus NRS-C, r = -0.43, and versus NRS-S, r = -0.45), and moderate to high at 6 to 9 months (e.g., QuickDASH versus NRS-C, r = -0.69, and versus NRS-S, r = -0.74) (p < 0.001, unless specified in Table III footnotes). This sequential increase in

TABLE IV Mean Satisfaction Ratings According to Whether PROM Scores in Lower or Upper Half of Range*

	NRS-C			NRS-S		
	≤1 Wk After Fracture	2-4 Wk After Fracture	6-9 Mo After Fracture	≤1 Wk After Fracture	2-4 Wk After Fracture	6-9 Mo After Fracture
PROMIS UE						
Lower	7.91	7.62	7.71	7.23	6.72	7.07
Upper	8.42	8.79	9.14	7.66	8.21	8.9
PROMIS PF						
Lower	7.89	7.26	7.31	7.05	6.36	6.63
Upper	8.44	8.93	9.28	7.84	8.32	9.02
QuickDASH						
Lower	8.66	8.8	9.16	8.05	8.16	8.85
Upper	7.6	7.53	7.59	6.75	6.68	7.00
OSS						
Lower	7.09	7.16	7.02	6.76	6.51	6.67
Upper	8.11	8.03	8.59	7.46	7.59	8.46
OES						
Lower	7.78	7.2	7.04	6.55	6.21	6.31
Upper	9.1	9.42	9.74	8.71	8.98	9.62
PRWE						
Lower	8.43	8.71	9.26	7.74	8.25	8.97
Upper	8.1	8.19	8.31	7.24	7.12	7.62
EQ-5D-3L						
Lower	7.85	7.58	7.71	7.04	6.75	7.14
Upper	8.48	8.97	9.31	7.84	8.35	9.03

*P < 0.001 for all variables.

correlation strength with each time point was observed for all of the PROMs. The level of correlation between a particular PROM and the NRS-C was similar to the correlation between the same PROM and the NRS-S at every time point.

At each time point, for each PROM, patients with scores in the lower half of the PROM’s score range were less satisfied with their care providers and hospital services (Table IV).

Discussion

Using PROMs and PREMs to quantify a patient’s health and care experience can inform the design of better systems of musculoskeletal trauma care. While we expect PROMs to improve during recovery, we rarely study the relationship between PROMs and PREMs over the course of recovery after upper-extremity fractures.

We found that the strength of correlation between arm-specific physical limitations measured by a computer adaptive test (PROMIS UE) and patient satisfaction with care providers and hospital services (PREMs) was highest at 6 to 9 months after upper-extremity fracture—i.e., that the strength of this correlation gradually increased over time. In other words, patients appear to be more satisfied with their care when they feel better and can do more. The strength of the correlation of each of the

PROMs (which differed by type and by mode of administration) with each of the PREMs used in this study was also relatively consistent. Notably, the correlation strength across different PROMs was variable. This could in part be explained by the differences in measuring one’s limitations on the basis on anatomy (i.e., by joint or region) versus general health. The positive correlation and consistent relationship between PROMs and PREMs were reinforced by assessing the relationship with scores in the upper and lower halves of the PROM scoring range.

Patients with diabetes and cardiovascular disease were found to have better physical function and fewer symptoms of depression when they received care in a practice in which they rated their experiences more highly³¹. Similar positive relationships between PROMs and PREMs were found for patients recovering from open carpal tunnel decompression; in that study, significant correlation was shown between a measure of patient satisfaction and patient-reported outcomes as assessed with the QuickDASH score at 1 year³². Threshold analysis also showed that the postoperative QuickDASH score and the change in QuickDASH scores were predictive of patient satisfaction³². Another study showed that greater preoperative expectations (another facet of patient experience) prior to rotator cuff surgery were correlated with fewer postoperative limitations as measured with

the Simple Shoulder Test, DASH, visual analogue scales of shoulder function and quality of life, and the Short Form-36³³. Another study also showed greater expectations to be significant predictors of fewer limitations at 1 year and greater improvement in ability³⁴. Overall, patients reporting greater limitations were less satisfied with their care and services compared with those with fewer limitations.

While our findings demonstrate an increasing correlation between PROMs and PREMs over time, it is perhaps surprising that these correlations were not stronger—particularly at 6 to 9 months, when recovery is often well-established. This could be explained by other factors related to the complex dynamics between patients and care providers and hospital services. For instance, patients could have variable experiences depending on the personal qualities of the care providers they encounter, irrespective of their outcomes. The level of empathy, communication style, and ability to listen and show respect and understanding could variably impact satisfaction with provider experience. Similarly, multiple aspects of hospital services, including difficulty accessing the hospital departments to levels of cleanliness and comfort on the wards, can influence a patient's experience of those services. Nevertheless, it appears that restoration of capabilities and function after an injury might depend not only on resolution of pathophysiological problems but also on enhancing patients' experiences with their health care. Future work should be done to better the understanding of the dynamic between patients and providers and services and to assess whether optimizing facets of care-provider behavior and hospital services early after injury can decrease future limitations and vice versa. Better health care depends on improvements not only in technical elements and treatments to alleviate physical limitations but also in the delivery of a comfortable experience that allows patients to better engage and navigate health-care systems in pursuing better health³⁵. This is reflected by the expansion of quality improvement initiatives within current health-care organizations in areas such as communication (e.g., telephone contact/messaging systems) and care coordination (e.g., streamlining pathways and discharge) to enhance patient experience³⁶.

Providers should also pay close attention to the relationship between PROMs and PREMs if they are to be used as quality metrics in reimbursement programs. A greater understanding of the relationship between patients' physical limitations and their experience of the care they received (e.g., through determining the sensitivity and specificity of measures as well as threshold analysis) and addressing modifiable factors to augment the correlation could support the substitution of PREMs for PROMs and vice versa in certain clinical settings, with the added benefit of reducing responder burden.

The results of this study should be viewed in light of several limitations. First, because of the scope of the analysis and use of relatively simple PREMs, we could not account for influential factors driving the correlation between PROMs and PREMs. Nor could we ascertain reasons why correlations were not stronger at certain time points or why correlation strengths varied among the PROMs. For instance, it is difficult to determine whether patients with poorer outcomes were managed differently by providers,

thereby leading to poorer experiences, or whether poor experience ratings were influenced by poor life circumstances reflected in poorer outcomes. Future studies might address a range of explanatory variables in a multivariable regression analysis and incorporate PREMs that more comprehensively assess interactions with care providers and services—e.g., quality of communication and access to services. We considered using PREMs such as the Consumer Assessment of Healthcare Providers and Systems (CAHPS) survey^{1,37,38} but chose to use numerical rating scales to decrease patient burden. Second, the findings might apply best to our institution, but given the substantial variation in demographics and deprivation we think that they will be reproduced in other settings. Third, for logistical reasons, patients completed the PROMs with different methods—in person, via telephone, or online. However, this approach is standard and variation based on method has been acceptable³⁹. Fourth, some responders may have found the process burdensome, especially when similarly sounding items were administered sequentially. This could have been minimized by item randomization, but that would have made programming the digital platform impractically complex. Fifth, floor and ceiling effects were assessed in the combined group; subgroup analysis, especially of higher performing individuals, may have yielded different results. Finally, because we analyzed the correlations between PROMs and PREMs at each time point, we cannot fully ascertain the direction of the relationships. Most likely, recovery and satisfaction were working together over time, such that patients who made good recovery were more satisfied and this increased satisfaction further improved recovery.

Patient limitations (PROMs) and their health-care experiences (PREMs) are increasingly aligned over time during recovery from upper-extremity fracture. Future research might address specific factors influencing the strength of the correlation between PROMs and PREMs and whether an improved patient experience can speed recovery. An improved understanding of the relationship between PROMs and PREMs can help inform the design of high-value, patient-centered musculoskeletal trauma care. ■

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