ORIGINAL RESEARCH

Electronic medical record data to identify variables associated with a fibromyalgia diagnosis: importance of health care resource utilization

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Background: Diagnosis of fibromyalgia (FM) is often challenging. Identifying factors associated with an FM diagnosis may guide health care providers in implementing appropriate diagnostic and management strategies.

Methods: This retrospective study used the de-identified Humedica electronic medical record (EMR) database to identify variables associated with an FM diagnosis. Cases (n=4,296) were subjects ≥18 years old with ≥2 *International Classification of Diseases*, Ninth Revision (ICD-9) codes for FM (729.1) ≥30 days apart during 2012, associated with an integrated delivery network, with ≥1 encounter with a health care provider in 2011 and 2012. Controls without FM (no-FM; n=583,665) did not have the ICD-9 codes for FM. Demographic, clinical, and health care resource utilization variables were extracted from structured EMR data. Univariate analysis identified variables showing significant differences between the cohorts based on odds ratios (ORs).

Results: Consistent with FM epidemiology, FM subjects were predominantly female (78.7% vs 64.5%; $P<0.0001$) and slightly older (mean age 53.3 vs 52.7 years; $P=0.0318$). Relative to the no-FM cohort, the FM cohort was characterized by a higher prevalence of nearly all evaluated comorbidities; the ORs suggested a higher likelihood of an FM diagnosis ($P<0.0001$), especially for musculoskeletal and neuropathic pain conditions (OR 3.1 for each condition). Variables potentially associated with an FM diagnosis included higher levels of use of specific health care resources including emergency-room visits, outpatient visits, hospitalizations, and medications. Units used per subject for emergency-room visits, outpatient visits, hospitalizations, and medications were also significantly higher in the FM cohort ($P<0.0001$), confirming resource utilization as an important variable associated with an FM diagnosis.

Conclusion: Significant differences between the FM and no-FM cohorts were observed for nearly all the demographic, clinical, and health care resource variables, suggesting an association with FM diagnosis. These results also support use of EMR data for identifying variables associated with FM, which may help in the diagnosis and management of this condition.

Keywords: retrospective database analysis, predictors, musculoskeletal pain, observational study, real world data

Background

Widespread pain is the hallmark symptom of fibromyalgia (FM), a chronic, complex musculoskeletal condition that remains undiagnosed in a substantial proportion of patients with this disease.[1] While the pain is generally defined as bilateral both above and below the waist and includes axial skeletal pain,[2] FM is also characterized by a variety of other symptoms and comorbidities, including fatigue, sleep and mood disturbances, cognitive dysfunction, and irritable bowel syndrome.[3] The substantial socioeconomic

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burden of FM is well recognized, resulting from reductions in patient function, productivity, and quality of life, as well as high health care resource utilization.[4–8]

The 1990 American College of Rheumatology (ACR) classification criteria have long provided guidance for the diagnosis of FM based on the primary criteria of widespread pain and a manual tender-point exam for demonstrating the presence of tenderness at a minimum of 11 of 18 specified points. These criteria were updated in 2010 by adding a symptom-severity assessment and eliminating the tender-point exam.[4] Despite the availability of these diagnostic criteria and various screening tools, FM patients still cycle through the health care system for several years before receiving a diagnosis; patients have reported delays of up to 5 years from when they first presented to a physician about their FM symptoms to receiving an actual diagnosis.[1,3]

Identifying variables associated with, or predictive of, developing FM can enhance understanding of the disease and provide a focus for development of appropriate management strategies. Previously, patient-reported registry data demonstrated that the widespread pain that is characteristic of FM was predicted by somatic symptoms, psychosocial and socioeconomic factors, fatigue, sleep problems, and workplace stress.[5] A recent narrative review of biologic markers further highlighted the need for such identification, since while several markers can be considered suggestive of FM, none has unequivocally been shown to be a clinically useful predictor of developing this condition.[6]

Another relevant approach is to identify variables associated with an FM diagnosis, which can be used to inform health care providers of patients in the clinical setting who have a high likelihood of FM, thus reducing the diagnostic delay and facilitating earlier treatment initiation. To identify such variables, it may be necessary to go beyond the demographic and clinical characteristics that have been evaluated based on their ready availability in databases that are frequently used for these types of analyses.

The emergence of electronic medical records (EMR) may provide an opportunity to evaluate a wider range of variables associated with an FM diagnosis in the clinical setting. EMR capture real-world, patient-level data that represent integral components of provider care.[7] These records allow a more complete longitudinal evaluation, including variables that may not necessarily be available from other sources such as claims databases or patient registries. Consequently, results generated using EMR may have greater applicability to clinical practice, and retrospectively evaluating "EMR markers" to characterize the variables associated with an eventual FM diagnosis may provide an opportunity for the earlier identification of FM patients. Therefore, the purpose of the study reported here was to evaluate EMR data with regard to differences in demographic, clinical, and health care resource utilization variables between subjects with a diagnosis of FM and those without FM. Such characterization may provide a first step toward identification of variables predictive of an FM diagnosis to help support the clinical management of FM.

Methods
Data source
This retrospective study was designed to use structured EMR data from the Humedica database to evaluate the characteristics associated with FM diagnosis. The database has broad geographic representation across the USA and captures a range of information longitudinally including demographic, clinical, claims, and medical administrative information.[8] Humedica aggregates de-identified EMR data from providers across the continuum of care. Structured data include demographic information, clinical characteristics, and health care resource utilization. All records are linked through a unique patient identifier and are fully Health Insurance Portability and Accountability Act compliant with regard to patient and provider identification as well as protected health information.

Subjects
All subjects who met inclusion and exclusion criteria were included in the study. Subjects were required to be ≥18 years of age in 2011, and enrolled in an integrated delivery network with at least one encounter with a health care provider recorded in the Humedica database in both 2011 and 2012. Subjects were excluded if they had at least one medical claim anytime during 2011–2012 with an *International Classification of Diseases*, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis code for malignant cancer (except for basal-cell and squamous-cell skin cancers and benign neoplasms) or an *International Classification of Diseases*, Ninth Revision (ICD-9) code for diagnosis or procedure for transplantation. Subjects who were resident in a nursing inpatient facility anytime during 2011–2012 were also excluded, as were subjects with evidence of an FM diagnosis (ICD-9 code 729.1) prior to 2012.

An FM cohort was identified from among subjects who met all inclusion and exclusion criteria, and was defined based on the presence of at least two ICD-9 codes for FM (729.1; myalgia and myositis, unspecified) ≥30 days apart during 2012; this

code is used in database analyses in the absence of a specific ICD-9 code for FM. The no-FM cohort consisted of similar subjects but without the FM ICD-9 codes.

Analyses

The EMR database captures information documented by health care providers at the point of care for patients actively seeking and receiving care. Variables included demographic and clinical characteristics reported by patients and clinicians, general comorbidities defined based on ICD-9 codes documented in the EMR, the Deyo–Charlson Comorbidity Index,[9] and health care resource utilization for the year 2011 (ie, prior to the FM diagnosis) across a variety of categories including inpatient and outpatient encounters, visits in which diagnostic/laboratory testing or imaging was ordered, and medications. Humedica aggregates resource utilization information from health care delivery encounters, and this information was used to estimate resource use by encounter type. These characteristics for the FM and no-FM cohorts were summarized descriptively, with comparisons performed using likelihood ratio chi-square tests for categorical variables and two-sample t-tests for continuous variables. Univariate logistic regression analysis was performed to identify variables showing significant differences between the populations with and without an FM diagnosis based on estimated odds ratios (ORs) and their associated 95% confidence intervals (95% CIs). All analyses were conducted using SAS software (v 9.2; SAS Institute Inc., Cary, NC, USA).

Results

Patient characteristics

From among the individuals in the Humedica de-identified database during 2011 and 2012 (N=9,318,581), a population was identified of 587,961 subjects meeting all inclusion/exclusion criteria and having all required demographic and clinical information (details of population attrition are presented in Table 1). From this population, 4,296 subjects (0.7%) were identified as having FM based on the predefined ICD-9 code criteria (ie, ≥2 FM codes), with 583,665 subjects remaining in the no-FM cohort. During 2012, there were 7,157 subjects (1.2%) who met inclusion and exclusion criteria but had only one FM ICD-9 code, and these subjects were included in the no-FM cohort.

As shown in Table 2, there were significant differences between the cohorts with regard to demographic characteristics, including a higher predominance of females in the FM

Table 1 Sample attrition table

Attrition criterion	N
Total number of de-identified patients in the Humedica database available for this research from January 1, 2011–December 31, 2012	9,318,581
Patients aged ≥18 years in 2011	7,696,733
And enrolled in integrated delivery network	4,192,869
And with ≥1 encounter with a health care provider in 2011 and 2012	720,912
Patients with cancer diagnosis (exclusion)	109,094
Patients with transplantation (exclusion)	5,163
Patients with nursing home (exclusion)	5,099
Patients with FM diagnosis prior to 2012 (exclusion)	20,026
Excluding patients with cancer diagnosis, transplantation, in nursing home, or FM diagnosis prior to 2012	132,574
Patients meeting all inclusion and exclusion criteria	588,338
Missing sex value	377
Total patients in analysis population	587,961
≥2 ICD-9 codes for FM (729.1) at least 30 days apart during 2012	4,296
Number of patients in no-FM cohort	583,665

Abbreviations: FM, fibromyalgia; ICD-9, *International Classification of Diseases, Ninth Revision.*

Table 2 Demographic characteristics of the evaluated cohorts

Variable	Value		P
	FM (n=4,296)	No-FM (n=583,665)	
Female, n (%)	3,379 (78.7)	376,653 (64.5)	<0.0001
Age, years, mean (SD)	53.3 (14.6)	52.7 (16.3)	0.0318
Age distribution, n (%)			<0.0001
18–49 years	1,651 (38.4)	229,910 (39.4)	
50–64 years	1,482 (34.5)	183,414 (31.4)	
≥65 years	1,163 (27.1)	170,341 (29.2)	
Race, n (%)			<0.0001
African American	296 (6.9)	83,727 (14.3)	
Asian	32 (0.7)	11,294 (1.9)	
Caucasian	3,778 (87.9)	429,955 (73.7)	
Other/unknown	190 (4.4)	58,689 (10.1)	
Region, n (%)			
Midwest	2,540 (59.1)	375,872 (64.4)	<0.0001
Northeast	373 (8.7)	118,146 (20.2)	
South	1,125 (26.2)	75,414 (12.9)	
West	5 (0.1)	458 (0.1)	
Other/unknown	253 (5.9)	13,775 (2.4)	
Insurance type, n (%)			<0.0001
Commercial	181 (4.2)	145,425 (24.9)	
Medicaid	7 (0.2)	3,740 (0.6)	
Medicare	88 (2.0)	61,151 (10.5)	
Missing/unknown	4,017 (93.5)	370,332 (63.4)	
Other payer type	0 (0.0)	297 (0.1)	
Uninsured	3 (0.1)	2,720 (0.5)	
Charlson Comorbidity Index, mean (SD)	0.8 (1.3)	0.5 (1.1)	<0.0001

Abbreviations: FM, fibromyalgia; SD, standard deviation.

cohort (78.7% vs 64.5%; *P*<0.0001) and differences in age and race as well as geographic distribution and insurance plans. Subjects in the FM cohort also had a significantly higher score on the Charlson Comorbidity Index (0.8 vs 0.5; *P*<0.0001) (Table 2).

In the year prior to the FM diagnosis, nearly all evaluated general comorbid conditions had a significantly higher prevalence in the FM cohort relative to the no-FM cohort (Table 3).

Univariate analysis showed that nearly all comorbidities were associated with a higher likelihood of an FM

Table 3 General comorbidity prevalence of the evaluated cohorts during 2011 and univariate odds ratios (ORs) for a fibromyalgia (FM) diagnosis

Comorbid condition	Patients, n (%)		OR (95% CI)	*P*
	FM (n=4,296)	No-FM (n=583,665)		
Any musculoskeletal pain condition	2,871 (66.8)	230,549 (39.5)	3.1 (2.9, 3.3)	<0.0001
Lupus	93 (2.2)	2,752 (0.5)	4.7 (3.8, 5.8)	<0.0001
Diffuse diseases of connective tissue	45 (1.0)	1,384 (0.2)	4.5 (3.3, 6.0)	<0.0001
Arthritis/other arthropathies	1,498 (34.9)	103,034 (17.7)	2.5 (2.3, 2.7)	<0.0001
Rheumatoid arthritis	123 (2.9)	5,720 (1.0)	3.0 (2.5, 3.6)	<0.0001
Osteoarthritis	659 (15.3)	47,005 (8.1)	2.1 (1.9, 2.2)	<0.0001
Low-back pain	1,390 (32.4)	73,543 (12.6)	3.3 (3.1, 3.5)	<0.0001
Back, neck pain (excluding low-back pain)	867 (20.2)	38,056 (6.5)	3.6 (3.4, 3.9)	<0.0001
Rheumatism (excluding the back)	1,337 (31.1)	94,477 (16.2)	2.3 (2.2, 2.5)	<0.0001
Other musculoskeletal pain conditions	726 (16.9)	54,963 (9.4)	2.0 (1.8, 2.1)	<0.0001
Any neuropathic pain condition	724 (16.9)	36,225 (6.2)	3.1 (2.8, 3.3)	<0.0001
Postherpetic neuralgia	7 (0.2)	648 (0.1)	1.5 (0.7, 3.1)	0.3417
Carpal-tunnel syndrome	106 (2.5)	6,384 (1.1)	2.3 (1.9, 2.8)	<0.0001
Causalgias	72 (1.7)	2,802 (0.5)	3.5 (2.8, 4.5)	<0.0001
Neuritis radiculitis	79 (1.8)	3,152 (0.5)	3.5 (2.8, 4.3)	<0.0001
Trigeminal neuralgia	15 (0.3)	649 (0.1)	3.1 (1.9, 5.3)	0.0002
Atypical facial pain	7 (0.2)	336 (0.1)	2.8 (1.3, 6.0)	0.0195
Phantom-limb pain	2 (<0.1)	87 (<0.1)	3.1 (0.8, 12.7)	0.1778
Autonomic neuropathies	6 (0.1)	482 (0.1)	1.7 (0.8, 3.8)	0.2384
Mononeuritis of lower limb	47 (1.1)	2,341 (0.4)	2.7 (2.1, 3.7)	<0.0001
Other polyneuropathies	66 (1.5)	3,928 (0.7)	2.3 (1.8, 2.9)	<0.0001
Back, neck pain with neuropathic involvement (excluding low-back pain)	462 (10.8)	21,082 (3.6)	3.2 (2.9, 3.5)	<0.0001
Any sleep disorder	653 (15.2)	29,385 (5.0)	3.4 (3.1, 3.7)	<0.0001
Insomnia/sleep disorder, apnea	593 (13.8)	26,941 (4.6)	3.3 (3.0, 3.6)	<0.0001
Restless-leg syndrome	97 (2.3)	3,403 (0.6)	3.9 (3.2, 4.8)	<0.0001
Any mental disorder	1,305 (30.4)	77,869 (13.3)	2.8 (2.7, 3.0)	<0.0001
Depression	910 (21.2)	49,925 (8.6)	2.9 (2.7, 3.1)	<0.0001
Anxiety/generalized anxiety disorder	683 (15.9)	39,479 (6.8)	2.6 (2.4, 2.8)	<0.0001
Bipolar disorder	67 (1.6)	3,277 (0.6)	2.8 (2.2, 3.6)	<0.0001
Panic disorder	82 (1.9)	3,382 (0.6)	3.3 (2.7, 4.2)	<0.0001
Post-traumatic stress disorder	52 (1.2)	1,606 (0.3)	4.4 (3.4, 5.9)	<0.0001
Fatigue	756 (17.6)	41,872 (7.2)	2.8 (2.6, 3.0)	<0.0001
Headache/migraine	761 (17.7)	37,507 (6.4)	3.1 (2.9, 3.4)	<0.0001
Dyspareunia	22 (0.5)	943 (0.2)	3.2 (2.1, 4.9)	<0.0001
Tinnitus	29 (0.7)	3,443 (0.6)	1.1 (0.8, 1.7)	0.4779
Chest pain	875 (20.4)	57,241 (9.8)	2.4 (2.2, 2.5)	<0.0001
Temporomandibular joint disorder	47 (1.1)	1,478 (0.3)	4.4 (3.3, 5.8)	<0.0001
Memory loss	89 (2.1)	5,113 (0.9)	2.4 (1.9, 3.0)	<0.0001
Abnormal involuntary movements	67 (1.6)	2,628 (0.5)	3.5 (2.7, 4.5)	<0.0001
Obesity	466 (10.8)	36,553 (6.3)	1.8 (1.7, 2.0)	<0.0001
Morbid obesity	177 (4.1)	9,728 (1.7)	2.5 (2.2, 3.0)	<0.0001
Interstitial cystitis	12 (0.3)	613 (0.1)	2.7 (1.5, 4.7)	0.0037
Any gastrointestinal disorder	1,676 (39.0)	114,857 (19.7)	2.6 (2.5, 2.8)	<0.0001
Irritable bowel syndrome	191 (4.4)	7,169 (1.2)	3.7 (3.2, 4.3)	<0.0001
Gastroesophageal reflux disease/gastric/duodenal/other gastrointestinal disorder	1,626 (37.8)	112,098 (19.2)	2.6 (2.4, 2.7)	<0.0001

Abbreviation: CI, confidence interval.

diagnosis (Table 3). The presence of any musculoskeletal condition was associated with an OR of 3.1 (95% CI 2.9, 3.3), as was the presence of any neuropathic pain condition (95% CI 2.8, 3.3). Individual comorbidities with the highest likelihood of an FM diagnosis were lupus (OR 4.7; 95% CI 3.8, 5.8), diffuse diseases of connective tissue (OR 4.5; 95% CI 3.3, 6.0), temporomandibular joint disorder (OR 4.4; 95% CI 3.3, 5.8), post-traumatic stress disorder (OR 4.4; 95% CI 3.4, 5.9), and restless-leg syndrome (OR 3.9; 95% CI 3.2, 4.8). Among the Charlson comorbidities (Table 4), a significantly higher prevalence was observed in the FM cohort for all comorbidities except for myocardial infarction, dementia, liver disease, and hemiplegia/paraplegia; there were no malignancy-related Charlson Comorbidity Index conditions in either cohort as a result of the exclusion criterion of a cancer diagnosis. The presence of any Charlson comorbidity was associated with an almost twofold likelihood of an FM diagnosis (OR 1.9; 95% CI 1.7, 2.0), and the Charlson comorbidity with the highest likelihood for resulting in an FM diagnosis was rheumatologic disease (OR 3.5; 95% CI 2.8, 4.3), followed by peptic ulcer disease (OR 3.4; 95% CI 2.8, 4.3).

Health care resource utilization

Relative to the no-FM cohort, significantly higher proportions of FM patients used each of the health care resource categories ($P<0.0001$) except "Visits in which imaging was ordered" ($P=0.379$) (Table 5). The resource category

with the highest likelihood of an FM diagnosis was "Visits in which diagnostic/laboratory tests were ordered," (OR 5.8; 95% CI, 5.5, 6.3), followed by "Outpatient visits (excluding office visits)", (OR 4.8; 95% CI 4.4, 5.1), and "Opioid prescriptions administered/ordered/written" (OR 4.6; 95% CI 4.3, 4.9). ORs for the other resources ranged from 2.1 (95% CI 2.0, 2.3) for "Hospitalizations" to 3.6 (95% CI 3.4, 3.9) for "Prescriptions administered/ordered".

Similarly, when differences between cohorts were evaluated for the number of units of resource used per patient (Table 6), the FM cohort was associated with significantly ($P<0.0001$) greater utilization of each of the categories except for "Visits in which imaging was ordered". In both cohorts, the highest number of units used per patient was for office visits (defined as an office or clinic visit), with means of 16.8 and 11.1 office visits per patient in the FM and no-FM cohorts, respectively. The greatest difference between cohorts was for "Prescriptions administered/ordered", with 15.1 prescriptions per FM subject and 6.6 prescriptions per no-FM subject, and the greatest proportional difference was for "Opioid prescriptions administered/ordered/written", which was 3.9-fold higher per FM subject (3.5 prescriptions per subject) relative to no-FM (0.9 prescriptions per subject).

Discussion

In contrast to studies that have attempted to identify biologic factors predictive of developing FM, this study used a

Table 4 Charlson comorbidity prevalence of the evaluated cohorts during 2011 and univariate odds ratios (ORs) for a fibromyalgia (FM) diagnosis

Comorbid condition	Patients, n (%)		OR (95% CI)	P
	FM (n=4,296)	No-FM (n=583,665)		
Any Charlson comorbidity	1,758 (40.9)	158,850 (27.2)	1.9 (1.7, 2.0)	<0.0001
Myocardial infarction	103 (2.4)	11,936 (2.0)	1.2 (1.0, 1.4)	0.1133
Congestive heart failure	169 (3.9)	17,804 (3.1)	1.3 (1.1, 1.5)	0.0013
Peripheral vascular disease	141 (3.3)	12,922 (2.2)	1.5 (1.3, 1.8)	<0.0001
Cerebrovascular disease	244 (5.7)	21,416 (3.7)	1.6 (1.4, 1.8)	<0.0001
Dementia	10 (0.2)	2,191 (0.4)	0.6 (0.3, 1.2)	0.1012
Chronic obstructive pulmonary disease	816 (19.0)	52,515 (9.0)	2.4 (2.2, 2.6)	<0.0001
Rheumatologic disease	207 (4.8)	8,326 (1.4)	3.5 (3.0, 4.0)	<0.0001
Peptic ulcer disease	80 (1.9)	3,195 (0.5)	3.4 (2.8, 4.3)	<0.0001
Mild liver disease	28 (0.7)	2,849 (0.5)	1.3 (0.9, 1.9)	0.1449
Diabetes	699 (16.3)	73,420 (12.6)	1.4 (1.2, 1.5)	<0.0001
Diabetes with chronic complications	181 (4.2)	13,559 (2.3)	1.8 (1.6, 2.1)	<0.0001
Hemiplegia or paraplegia	19 (0.4)	1,622 (0.3)	1.6 (1.0, 2.5)	0.0608
Renal disease	204 (4.7)	21,305 (3.7)	1.3 (1.1, 1.5)	0.0003
Malignancy	0 (0.0)	0 (0.0)	–	–
Moderate or severe liver disease	11 (0.3)	1,232 (0.2)	1.2 (0.7, 2.2)	0.5360
Metastatic solid tumor	0 (0.0)	0 (0.0)	–	–
AIDS	Not reported	Not reported	–	–

Abbreviation: CI, confidence interval.

Table 5 Frequency of health care resource use in the evaluated cohorts during 2011

Health care resource	Frequency, n (%)		OR (95% CI)	P
	FM (n=4,296)	No-FM (n=583,665)		
Emergency room visits	1,490 (34.7)	105,762 (18.1)	2.4 (2.3, 2.6)	<0.0001
Hospitalizations	890 (20.7)	63,422 (10.9)	2.1 (2.0, 2.3)	<0.0001
Office visits	4,115 (95.8)	535,551 (91.8)	2.0 (1.8, 2.4)	<0.0001
Outpatient visits (excluding office visits)	3,248 (75.6)	230,376 (39.5)	4.8 (4.4, 5.1)	<0.0001
Prescriptions administered/ordered	2,536 (59.0)	165,614 (28.4)	3.6 (3.4, 3.9)	<0.0001
Prescriptions written	3,802 (88.5)	444,400 (76.1)	2.4 (2.2, 2.6)	<0.0001
Prescription pain medications administered/ordered/ written* (excluding opioids)	3,095 (72.0)	250,181 (42.9)	3.4 (3.2, 3.7)	<0.0001
Opioid prescriptions administered/ordered/written	2,436 (56.7)	129,200 (22.1)	4.6 (4.3, 4.9)	<0.0001
Visits in which diagnostic/laboratory tests were ordered	3,160 (73.6)	188,112 (32.2)	5.8 (5.5, 6.3)	<0.0001
Visits in which imaging was ordered	19 (0.4)	2,090 (0.4)	1.2 (0.8, 1.9)	0.3749

Notes: *Non-opioid pain medications comprised the following classes: simple analgesics, nonsteroidal anti-inflammatory drugs, anticonvulsants, muscle relaxants, benzodiazepines, hypnotics, tricyclic antidepressants, selective serotonin reuptake inhibitors, and serotonin-norepinephrine reuptake inhibitors.
Abbreviations: CI, confidence interval; FM, fibromyalgia; OR, odds ratio.

clinicoepidemiologic approach to evaluate variables associated with a clinical diagnosis based on real-world EMR data. The key findings of this study are the significant association of health care resource utilization with an FM diagnosis and the identification of the more frequently used resource categories that may potentially be useful as predictive variables. Such results are only possible with a large dataset for which there are appropriate codes available for analyses; EMR data reflect what is actually coded, providing a comprehensive selection of variables beyond demographic and clinical characteristics.

Table 6 Units per patient of health care resource use in the evaluated cohorts during 2011

Health care resource	Units per patient, mean (SD)		P
	FM (n=4,296)	No-FM (n=583,665)	
Emergency-room visits	0.9 (2.2)	0.3 (0.9)	<0.0001
Hospitalizations	0.4 (1.0)	0.2 (0.6)	<0.0001
Office visits	16.8 (17.4)	11.1 (13.0)	<0.0001
Outpatient visits (excluding office visits)	4.5 (7.0)	1.6 (4.2)	<0.0001
Prescriptions administered/ ordered	15.1 (32.5)	6.6 (29.1)	<0.0001
Prescriptions written	14.4 (16.4)	7.2 (9.7)	<0.0001
Prescription pain medications administered/ordered/written (excluding opioids)	4.5 (6.7)	1.6 (3.3)	<0.0001
Opioid prescriptions administered/ordered/written	3.5 (6.0)	0.9 (2.8)	<0.0001
Visits in which diagnostic/ laboratory tests were ordered	3.1 (4.4)	1.1 (2.8)	<0.0001
Visits in which imaging was ordered	0.0 (0.3)	0.0 (0.5)	0.6755

Abbreviations: FM, fibromyalgia; SD, standard deviation.

The results of this study also show significant differences between the two cohorts for nearly all the demographic and clinical characteristics. Demographic differences of sex and age have previously been characterized, since the onset of FM is age-related and its prevalence is higher in females.[4]

While a high prevalence of comorbid conditions has also been well recognized in FM,[10,11] the current analysis suggests the magnitude of these differences, both with respect to the types of comorbidities and the likelihood of their prevalence relative to no-FM subjects. With regard to the types of comorbidities, it should be noted that in addition to significant differences in comorbidities that are recognized as being associated with FM, including musculoskeletal and gastrointestinal conditions, several other comorbid conditions were observed to have a significantly higher prevalence in the FM cohort. These other comorbidities included dyspareunia, which had a more than threefold likelihood of being associated with an FM diagnosis relative to no-FM. Dyspareunia may be expected in patients with FM who may have hypersensitivity to touch, although its overall prevalence is low, possibly based on low self-report by patients and minimal questioning of sexual activity by health care providers. Other comorbidities which had a two- to fourfold increased likelihood of an FM diagnosis included chest pain, memory loss, involuntary movements, and obesity/morbid obesity. While non-cardiogenic chest pain, which may be due to pectoralis muscle spasm, can result in increased health care resource utilization,[12] memory loss is a cognitive symptom that represents an important domain and is included in the 2010 ACR criteria for FM.[4] Obesity, particularly morbid obesity, has been associated with decreased functional capacity in FM patients,[13] and, as such, may increase the likelihood of

diagnosis; it is not known if obesity increases the risk for FM. It should be noted that the significant differences observed between FM and no-FM for several of these comorbid conditions (eg, dyspareunia, lupus) was facilitated by both the use of EMR data and a large sample size. However, their low prevalence, even though significantly associated with FM, suggests that they are unlikely to be useful as diagnostic predictors.

A unique and important observation of this analysis is the identification of health care resource utilization categories as variables associated with an FM diagnosis. Previous studies that evaluated health care utilization in FM patients have found substantial utilization of these services.[14,15] Results of the current study not only support the high utilization of health care resources in patients diagnosed with FM, but expand on the previous literature by comparing these patients with a control cohort that did not receive a diagnosis of FM. These results suggest that the statistically significant differences between these two cohorts may be of use to identify those having a higher likelihood of a future FM diagnosis. In particular, in addition to inpatient and outpatient visits and prescriptions, "Visits in which diagnostic/laboratory tests were ordered" was also significantly different between cohorts, with respect to both frequency and number of units. Indeed, "Visits in which diagnostic/laboratory tests were ordered" had the highest OR (5.8) of all the evaluated health care resource categories. This variable may be of special interest as a predictor of an FM diagnosis, since there is often a gap between FM symptom onset and diagnosis that results in high resource use in the years before diagnosis when patients may be searching for the cause of their symptoms.[3,16,17] Recognition of a higher use of diagnostic/laboratory tests may indicate those patients requiring further evaluation using a guideline-based approach for identifying the presence of FM.

Strengths and limitations

Several strengths and limitations of this study should be recognized. The use of "real-world" EMR data from multiple sites across the USA provides external validity and is an important strength of this type of analysis. Furthermore, the dataset contains data collected routinely in clinical practice, some of which are not generally available in claims databases or patient registries. The use of these data thereby enables a more comprehensive approach to identifying objective, and potentially quantifiable variables associated with an FM diagnosis that may have a direct application to clinical practice and care management. As far as we are aware, such

data have not previously been used in univariate analyses to identify variables associated with FM.

On the other hand, a limitation of such database studies is that there is the potential for errors in coding or record keeping at the point of the health care provider. In this regard, as previously noted, ≥ 2 ICD-9 codes were used to improve the accuracy of identifying the FM cohort. However, since 1.2% of the population meeting the inclusion/exclusion criteria had a single ICD-9 code for FM, it is likely that there were patients in the no-FM cohort who were properly diagnosed with FM but were excluded from the FM cohort based on the more conservative ICD-9 inclusion criterion. Furthermore, since these databases are dependent on documentation by individual providers in the course of care delivery, clinical information such as the criteria used by each provider to diagnose FM is not routinely collected. The observational nature of the study is also a limitation, and since causality cannot be determined, all results should be considered inferential.

Conclusion

Consistent with the known epidemiology and patient-reported symptomatology of FM, demographic and clinical variables collected in clinical practice through EMR systems across the USA were identified that may be associated with an FM diagnosis. Significant differences in health care resource utilization across several resource categories were also identified, suggesting these resources are associated with an FM diagnosis. These results suggest that analysis of EMR data can help identify variables associated with FM in a real-world setting, and that further evaluation of health care resource utilization as a metric of FM diagnosis is warranted.

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