Arthritis Care & Research
Vol. 68, No. 12, December 2016, pp 1866–1873
DOI 10.1002/acr.23089

ORIGINAL ARTICLE

Rheumatology Informatics System for Effectiveness: A National Informatics-Enabled Registry for Quality Improvement

JINOOS YAZDANY,[1] NICK BANSBACK,[2] MEGAN CLOWSE,[3] DEBORAH COLLIER,[4] KAREN LAW,[5] KATHERINE P. LIAO,[6] KALEB MICHAUD,[7] ESI M. MORGAN,[8] JAMES C. OATES,[9] CATALINA OROZCO,[10] ANDREAS REIMOLD,[11] JULIA F. SIMARD,[12] RACHEL MYSLINSKI,[13] AND SALAHUDDIN KAZI[14]

Objective. **The Rheumatology Informatics System for Effectiveness (RISE) is a national electronic health record (EHR)–enabled registry. RISE passively collects data from EHRs of participating practices, provides advanced quality measurement and data analytic capacities, and fulfills national quality reporting requirements. Here we report the registry's architecture and initial data, and we demonstrate how RISE is being used to improve the quality of care.**

Methods. **RISE is a certified Centers for Medicare and Medicaid Services Qualified Clinical Data Registry, allowing collection of data without individual patient informed consent. We analyzed data between October 1, 2014 and September 30, 2015 to characterize initial practices and patients captured in RISE. We also analyzed medication use among rheumatoid arthritis (RA) patients and performance on several quality measures.**

Results. **Across 55 sites, 312 clinicians contributed data to RISE; 72% were in group practice, 21% in solo practice, and 7% were part of a larger health system. Sites contributed data on 239,302 individuals. Among the subset with RA, 34.4% of patients were taking a biologic or targeted synthetic disease-modifying antirheumatic drug (DMARD) at their last encounter, and 66.7% were receiving a nonbiologic DMARD. Examples of quality measures include that 55.2% had a disease activity score recorded, 53.6% a functional status score, and 91.0% were taking a DMARD in the last year.**

Conclusion. **RISE provides critical infrastructure for improving the quality of care in rheumatology and is a unique data source to generate new knowledge. Data validation and mapping are ongoing and RISE is available to the research and clinical communities to advance rheumatology.**

INTRODUCTION

Health care in the US is undergoing rapid change, and rheumatologists face significant challenges in adapting to new payment and delivery models, evolving certification requirements, and the rapid implementation of electronic health records (EHRs). As part of a strategic plan to address these challenges, the American College of Rheumatology (ACR) has developed the Rheumatology Informatics System for Effectiveness (RISE). RISE is a novel EHR-enabled registry that passively extracts EHR data from individual practices, aggregates and analyzes these data centrally, and feeds this

The content is solely the responsibility of the authors and does not necessarily represent the official views of the Agency for Healthcare Research and Quality.

Supported by the American College of Rheumatology. Dr. Yazdany's work was supported by the Robert L. Kroc Chair in Rheumatic and Connective Tissue Diseases (I), AHRQ-R01-HS024412, and the Russell/Engleman Medical Research Center for Arthritis.

[1]Jinoos Yazdany, MD, MPH: University of California, San Francisco; [2]Nick Bansback, PhD: School of Population and Public Health, University of British Columbia, Vancouver, British Columbia, Canada; [3]Megan Clowse, MD, MPH: Duke University, Durham, North Carolina; [4]Deborah Collier, MD: Massachusetts General Hospital, Boston; [5]Karen Law, MD: Emory University, Atlanta, Georgia; [6]Katherine P. Liao, MD, MPH: Brigham and Women's Hospital, Boston, Massachusetts; [7]Kaleb Michaud, PhD: University of Nebraska Medical Center, Omaha, and the National Data Bank for Rheumatic Diseases, Wichita, Kansas; [8]Esi M. Morgan, MD, MSCE: James M. Anderson Center for Health Systems Excellence, Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio; [9]James C. Oates, MD: Medical University of South Carolina, Charleston; [10]Catalina Orozco, MD: Rheumatology Associates, Dallas, Texas; [11]Andreas Reimold, MD: Dallas Veterans Affairs Medical Center and University of Texas Southwestern Medical Center, Dallas; [12]Julia F. Simard, ScD: Stanford School of Medicine, Stanford, California; [13]Rachel Myslinski, MBA: American College of Rheumatology, Atlanta, Georgia; [14]Salahuddin Kazi, MD: University of Texas Southwestern Medical Center, Dallas.

Dr. Yazdany has received an independent research award from Pfizer.

Significance & Innovations

- The Rheumatology Informatics System for Effectiveness (RISE) registry is a novel electronic health record (EHR)–enabled registry that passively extracts EHR data from individual practices, aggregates and analyzes these data centrally, and feeds this information back to clinicians as actionable data for quality improvement using a web-based interface.
- RISE's clinical informatics structure was designed to be agnostic to the EHR system used by rheumatologists, and can be adapted to draw data from most certified systems.
- Performance on quality measures across RISE practices presented here provides a useful benchmark for rheumatologists seeking to improve quality in their practices.

information back to clinicians as actionable data using a web-based interface. RISE aims to decrease the burden of data collection on practices, to streamline participation in federal quality programs, and to facilitate local rapid-cycle quality improvement by providing continuous performance feedback and benchmarking.

In 2014, RISE passed a critical milestone and was designated as a federally Qualified Clinical Data Registry (QCDR). The American Taxpayer Relief Act established the QCDR quality reporting option, allowing physicians to submit data for the Physician Quality Reporting System (PQRS) directly through registries (1). Because data collected through QCDRs are meant to improve quality, there is a waiver of individual patient informed consent for registry data capture. All RISE data used for research are de-identified. Moreover, RISE can be used to fulfill a meaningful use objective measure (reporting to a special registry), and is being developed as a tool for maintenance of certification. As the transition to a value-based system of reimbursement advances in the US, RISE will allow rheumatologists to track their performance on measures of quality of care and efficiency. RISE will also serve as an important tool for research in rheumatology.

In this paper, we present the informatics structure of RISE, provide an overview of the type of data currently available to advance rheumatology care and research, report early results on quality measures, and share our vision for the future of the registry.

MATERIALS AND METHODS

RISE informatics structure. RISE is an EHR-enabled registry that automatically extracts data from individual practices' EHRs on a scheduled basis and transfers these data to a central data warehouse. RISE has been constructed to minimize impact on practice workflow. No data entry into a separate database is required; instead, RISE collects data that are entered during the course of routine clinical care into the EHR. This is made possible through technology that uses a lightweight connector, installed locally, to establish a connection between the practice and RISE (Figure 1). RISE can connect to most certified EHR systems in the US; currently, the registry can map to over 30 different EHRs used by rheumatologists. Once an EHR is connected, the RISE data-mapping team works to identify participating clinicians and their patients and creates an initial EHR data extract. Practices then spend 6–10+ hours validating data elements and quality measure performance data before moving into full production. This latter step allows RISE to customize data capture to the particular EHR configuration and workflow within each practice. Once data mapping is complete, further time commitment from practices will only be required if there are data aberrancies or new measures that require mapping.

Data contributed to RISE are cleaned and analyzed centrally and feed a performance dashboard. Rheumatologists can access their practice dashboard through a web-based interface, where they can view national benchmarks for quality measures, performance means across the registry, and practice- and clinician-level performance. Participating practices can also run customized queries on their own patient population and perform basic data analyses. For example, practices can run a query to identify all patients with a specific diagnosis code or who are taking a specific medication. These data can then be used for quality improvement activities or for local research purposes.

Privacy and waiver of informed consent. RISE is a QCDR. The QCDR framework was introduced for the PQRS in 2014 and allows the collection of data without patient informed consent for the purpose of disease tracking and to foster improvement in the quality of care (1). The Centers for Medicare and Medicaid Services (CMS) have the ability to access Medicare patient data in RISE for quality reports through CMS oversight authority. For non-Medicare data, CMS may request the QCDR to mask protected health information (PHI) when aggregate data are requested.

The Western Institutional Review Board (IRB) reviewed RISE and determined that because RISE is a quality improvement registry focused on health care delivery and on measuring and reporting data for clinical, practical, or administrative uses, individual practices do not need IRB approval or patient consent to implement RISE. The RISE data extraction protocol is Health Insurance Portability and Accountability Act (HIPAA) compliant. When a patient's information is uploaded, PHI is stored separately. Any data used by third parties for research are de-identified and aggregated. However, participating practices can access their own PHI data and use these data for their clinical and quality improvement needs and for reporting quality measures to CMS.

Quality measures and reporting. As a QCDR, RISE helps practices report clinical quality data to the PQRS program.

Address correspondence to Jinoos Yazdany, MD, MPH, Division of Rheumatology, University of California, San Francisco, Box 0920, San Francisco, CA 94143-0920. E-mail: jinoos.yazdany@ucsf.edu.

Submitted for publication May 25, 2016; accepted in revised form September 13, 2016.

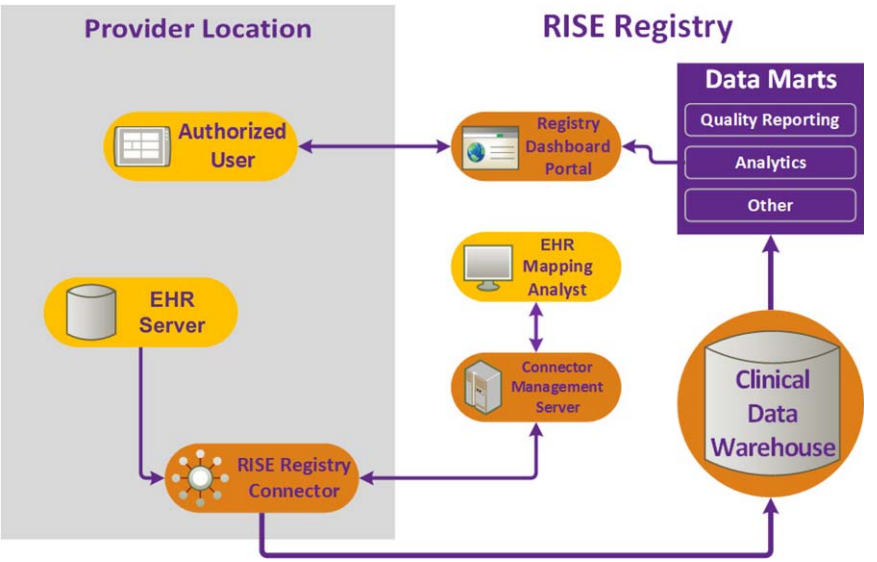

Figure 1. The Rheumatology Informatics System for Effectiveness (RISE) registry data flow for practice improvement and research. The RISE registry uses a lightweight connector to establish a connection between a practice's electronic health record (EHR) server and the centralized registry servers. Local practice data are iteratively mapped by the RISE team to ensure accuracy, and verified extracts enter the RISE clinical data warehouse. Data are then aggregated and analyzed for federal quality reporting, research, and practice-based improvement. Authorized users in a practice can access the RISE data dashboard through a web-based registry portal.

This reporting allows eligible professionals to avoid negative payment adjustments in 2017. In addition, submission of PQRS data through RISE also satisfies an objective of the Meaningful Use program: reporting to a specialized registry. By fulfilling this Meaningful Use objective, RISE helps practices further avoid reporting penalties.

Research data repository. In addition to quality measurement and reporting, RISE serves as a resource for research. Both structured data (laboratories, medications, problem lists) and unstructured data (i.e., text from clinical notes) from the EHR are available for analysis. Research requests undergo formal committee review for feasibility. The ACR has contracted with 3 data analytic centers (University of California, San Francisco, University of Alabama at Birmingham, and Duke University) with special expertise in large data set analyses to execute RISE data requests. These centers will work with de-identified data extracts; any identified data, including text from clinical notes, will remain within the clinical data warehouse and will be analyzed centrally.

Analysis of initial data in RISE. We analyzed data in RISE from October 1, 2014 through September 30, 2015, including the characteristics of participating practices and patients. We examined both sociodemographic characteristics of patients (age, sex, race/ethnicity, insurance status and US region), as well as clinical characteristics (smoking status, blood pressure, billing and problem list diagnoses as defined by the International Classification of Diseases, Ninth Revision [ICD-9] codes, and medications).

All sociodemographic characteristics and clinical data were examined from the most recent clinical encounter. When querying diagnoses, we generated a list of ICD-9 codes for common rheumatic diseases and calculated the frequency of these diagnoses at the last available clinical encounter. We did not require these diagnoses to be mutually exclusive; in other words, patients with 2 diagnoses are represented twice.

Because a key initial focus of the registry is rheumatoid arthritis (RA), we examined clinical data for the subset of patients with this diagnosis in further detail to demonstrate the type of data in RISE. First, we examined active medications at the end of the most recent RA clinical encounter, including all nonbiologic DMARDs (methotrexate, hydroxychloroquine, leflunomide, sulfasalazine, azathioprine, minocycline, cyclosporine, cyclophosphamide, penicillamine, and gold), as well as biologic and targeted synthetic DMARDs (etanercept, adalimumab, infliximab, golimumab, certolizumab, abatacept, anakinra, tocilizumab, rituximab, and tofacitinib). To create these categories, we built algorithms that collated instances where a single drug (e.g., methotrexate) appeared more than once as an active medication. This meant removing duplicate prescriptions and also collapsing instances where 2 formulations of the same drug were listed.

Similarly, we built algorithms to create mutually exclusive categories for the biologic DMARDs. For example, we manually reviewed all records in which patients were listed as taking 2 tumor necrosis factor–inhibiting biologic drugs (1.1% of records). We contacted a sample of practices to understand the workflows leading to these within-class duplicates. Reasons identified included incomplete medication reconciliation or clinicians routinely ordering more than 1 drug at time of initiation while waiting for insurance authorization. In these instances, we either looked into

Table 1. Selected characteristics of patients in the RISE registry*

Characteristics	N = 239,302
Age, mean ± SD years	59 ± 16.1
Sex	
Female	179,069 (74.8)
Male	60,225 (25.2)
Missing	8 (0.003)
Race	
White	145,544 (60.8)
African American	18,335 (7.7)
Asian	3,416 (1.4)
American Indian/Alaskan Native	574 (0.2)
Native Hawaiian/Pacific Islander	116 (0.05)
Other	30,744 (12.9)
Missing	40,573 (17.0)
Health insurance type	
Medicare	70,804 (29.6)
Medicaid	3,914 (1.6)
Commercial	114,259 (47.8)
Other	4,210 (1.8)
Missing	46,115 (19.3)
US region based on patient zip code	
Midwest	29,114 (12.2)
Northeast	32,085 (13.4)
Southeast	91,727 (38.3)
Southwest	50,239 (21.0)
West	11,070 (4.6)
Missing	25,064 (10.5)
Rheumatology encounters, mean ± SD†	2 ± 2.1
Smoking	
Never	142,562 (59.6)
Current	24,913 (10.4)
Former	51,971 (21.7)
Missing	19,856 (10.0)
Blood pressure	
Systolic, mean ± SD mm Hg	125.4 ± 16.1
Diastolic, mean ± SD mm Hg	75.2 ± 9.7
Systolic >140 mm Hg or diastolic >90 mm Hg	34,961 (14.6)
Missing	22,048 (9.2)

* Values are the number (percentage) unless indicated otherwise. All data reflect values at end of last observed clinical encounter. RISE = Rheumatology Informatics System for Effectiveness.
† Number of rheumatology encounters over study period.

future encounters to see which drug persisted and selected only the persistent drug, or randomly sampled one of the drugs.

Among individuals in RISE, we also examined performance on selected quality measures, including those recently endorsed by the National Quality Forum (NQF), such as assessment of disease activity (NQF 2523), functional status assessment (NQF 2524), tuberculosis screening (NQF 2522), and DMARD therapy (NQF 2525), as well as additional measures in the areas of drug safety (use of high-risk medications in the elderly), osteoporosis (screening and treatment), preventive health (tobacco use, obesity, and blood pressure management), gout (monitoring and serum urate), and medication reconciliation. We assessed the number of times the recommended process of care was performed among the eligible denominator population to arrive at the average performance on each measure. A higher average denotes higher quality with the exception of the measures regarding high-risk prescribing in the elderly, in which a lower average denotes higher quality. A complete list of the 2015 RISE measures is included in Supplementary Appendix A (available on the *Arthritis Care & Research* web site at http://onlinelibrary.wiley.com/doi/10.1002/acr.23089/abstract). The measures are evaluated and updated annually.

RESULTS

As of September 30, 2015, there were 312 clinicians and 55 practices participating in RISE. Seventy-two percent of clinicians were in a group practice, 21% were solo practitioners, and 7% were part of a larger health system.

Sociodemographic and clinical characteristics of the 239,302 patients are in Table 1. A majority of patients were women (74.8%), 22.2% were racial/ethnic

Table 2. Selected rheumatologic diagnoses captured in the RISE registry*

Diagnosis at last encounter	ICD-9 codes	No.
Degenerative joint disease		
OA, generalized or localized	715.00, 715.04, 715.09–715.18, 715.20–715.38, 715.80, 715.89	76,381
Inflammatory rheumatic diseases		
RA	714.0, 714.1, 714.2, 714.81	60,102
Polymyalgia rheumatica	725	7,850
Sjögren's syndrome	710.2	15,800
SLE	710.0	13,940
Psoriatic arthritis	696.0	13,550
Spondyloarthritides	720.0–720.2, 720.8, 720.89, 720.9, 729.9	10,265
Vasculitis		
Temporal arteritis	446.5	1,596
Granulomatosis with polyangiitis	446.4	686
Behçet's disease	136.1	301
Henoch Schonlein	287.0	106
Takayasu disease	446.7	85
Goodpasture's syndrome	446.21	4
Scleroderma	710.1	2,754
JIA	714.3, 714.31–714.33	1,342
Dermatomyositis/polymyositis	710.3, 710.4	2,366
Sarcoidosis	135	1,548
Relapsing polychondritis	733.99	886
Crystalline arthropathies		
Gout	274.xx	9,887
CPDD	275.49, 712.1–712.3, 712.8	1,131
Pain syndromes		
Myalgia or myositis (fibromyalgia)	729.1	49,345
Low back pain	724.1	34,768
Infectious arthritis		
Lyme disease	88.81	913
Septic arthritis	711.xx	284

* All data reflect values at end of last observed clinical encounter. Diagnoses are not mutually exclusive across diagnostic categories; for example, a patient may be captured twice in the Table if they have both rheumatoid arthritis (RA) and osteoarthritis (OA). RISE = Rheumatology Informatics System for Effectiveness; ICD-9 = International Classification of Diseases, Ninth Revision; SLE = systemic lupus erythematosus; JIA = juvenile idiopathic arthritis; CPDD = calcium pyrophosphate deposition disease.

minorities, and most had commercial insurance (47.8%). Almost one-third (29.6%) had Medicare health insurance. At their last clinical encounter, 10.4% of patients were smokers, and 14.6% were hypertensive (systolic blood pressure of >140 mm Hg or a diastolic blood pressure of >90 mm Hg).

In Table 2, we list the diagnoses captured in RISE, as defined by ICD-9 codes at the last clinical encounter. Among the diagnoses examined, osteoarthritis was the most prevalent (n = 76,381), followed by RA (n = 60,102). RISE also includes a significant number of individuals with other rheumatologic disorders, such as Sjögren's syndrome (n = 15,800), systemic lupus erythematosus (n = 13,940), dermatomyositis (n = 1,129), and temporal arteritis (n = 1,596). Less common conditions, such as relapsing polychondritis (n = 886), Behçet's syndrome (n = 301), and Takayasu disease (n = 85), are also represented.

For the subset of individuals with ICD-9 codes for RA (n = 60,102), active medications at the last clinical encounter are listed in Table 3. Only 9% were not on DMARD therapy. Thirty-four percent of individuals were using a biologic or targeted synthetic DMARD (n = 20,759), while 67% were using a nonbiologic DMARD (n = 40,272). Twenty-three percent were on biologic DMARD monotherapy. As expected, methotrexate was the most commonly used DMARD (43.5%), followed by hydroxychloroquine (23.3%).

Performance on selected RISE quality measures is listed in Table 4. For example, performance on assessment of disease activity (NQF 2523) was 55.2%. Among those satisfying this measure, the most commonly used outcome measures were Routine Assessment of Patient Index Data 3 (RAPID-3; 56.0%) and Clinical Disease Activity Index (36.9%), with fewer patients having Simplified Disease Activity Index (0.04%), Disease Activity Score in 28 joints (3.8%), or Patient Activity Scale II (3.2%) scores recorded in the EHR. For functional status assessment (NQF 2524), performance was 53.6% and a majority of practices used the RAPID-3/modified Health Assessment Questionnaire (HAQ; 45.2% of scores reported in the EHR) or a version of the HAQ (original HAQ 38.5% or HAQ-II 3.3%). As is reflected in the medication data, 91.0% of patients met the criteria for DMARD therapy (NQF 2525). For tuberculosis

Table 3. Active medications among individuals with rheumatoid arthritis at the last clinical encounter in the RISE registry*

Medication	N = 60,354
Biologic or targeted synthetic DMARDs†	20,759 (34.4)
Anti-TNF	4,924 (8.2)
Etanercept	4,714 (7.8)
Adalimumab	3,419 (5.7)
Infliximab	1,034 (1.7)
Golimumab	847 (1.4)
Other biologic agents	
Abatacept	2,549 (4.2)
Tocilizumab	1,248 (2.1)
Rituximab	988 (1.6)
Anakinra	26 (0.04)
Tofacitinib	1,010 (1.7)
Nonbiologic DMARDs‡	40,272 (66.7)
Methotrexate	26,278 (43.5)
Hydroxychloroquine	14,051 (23.3)
Leflunomide	5,136 (8.5)
Azathioprine	860 (1.4)
Sulfasalazine	3,348 (5.6)
Minocycline	271 (0.5)
Cyclosporine	34 (0.05)
Penicillamine	6 (0.01)
Cyclophosphamide	12 (0.02)
Gold	16 (0.03)
Prednisone	19,073 (31.6)

* Values are the number (percentage). RISE = Rheumatology Informatics System for Effectiveness; DMARD = disease-modifying antirheumatic drug; TNF = tumor necrosis factor.
† Medications in the biologic agent category are mutually exclusive; in other words, algorithms were constructed to ensure patients were only counted once in these categories. In cases where more than 1 medication was listed as active at the last encounter, we constructed algorithms to select 1 drug.
‡ For nonbiologic DMARDs, the overall percentage of 66.7 reflects the patients that were on any nonbiologic drug. The percentages using specific drugs listed below this in the Table are not mutually exclusive; in other words, patients might be represented twice.

screening (NQF 2522), performance was 55.2%. Across all measures in Table 4, performance was highest for a measure regarding medication reconciliation (96.8%) and lowest for serum urate monitoring in gout patients (31.0%).

Some information was missing for all variables, but the proportion of missing data was low for most sociodemographic data, except for insurance status (19.3%). Work is ongoing to understand the accuracy of diagnosis codes and medications in RISE, with initial data suggesting very good specificity for RA and for DMARDs (2). The extent of missingness as well as accuracy is expected to improve as mapping and validation procedures for RISE continue in the coming years.

DISCUSSION

Payment reform, a proliferation of new medication options, and the widespread introduction of EHRs are transforming the practice of rheumatology in the US. Given these changes, the ACR launched the RISE registry to help rheumatologists succeed in advancing the triple aim of improving the care experience, improving the health of populations, and reducing the costs of care (3). The enthusiastic participation of US rheumatologists has allowed the registry to grow quickly since its launch in 2014.

RISE represents the first attempt to create a national EHR-enabled rheumatology registry in the US, thereby avoiding separate entry of data by clinicians or office staff. The registry has made headway in addressing some of the challenges of interoperability that have previously made data sharing across health systems difficult. This is because RISE's clinical informatics structure was designed to be agnostic to the EHR system used by rheumatologists, and can be adapted to draw data from most certified systems. Central mapping of data also creates efficiencies for practices that have limited information technology support or data analytic software capabilities. Additionally, automation permits uploading of a clinician's entire population of patients, preventing biases in patient selection. The data in RISE therefore provide a unique and inclusive view of rheumatology practices, because patients with all medical conditions managed by rheumatologists and all types of insurance are included.

Initial data in RISE provide an interesting birds-eye view of the clinical characteristics of patients seen in participating rheumatology practices. Although prevalent rheumatologic conditions (e.g., osteoarthritis and RA) are well-represented in the registry, RISE already includes data on individuals with several less common conditions, such as inflammatory myopathies and vasculitides. As we try to improve the quality of rheumatologic care across these conditions, we anticipate that data on the natural history, treatment patterns, and clinical outcomes on these disorders will make quality improvement efforts increasingly data driven. Moreover, the generalizability of data in RISE is anticipated to improve as the registry grows and better reflects the racial/ethnic and geographic diversity of patients seen by rheumatologists.

In the area of RA, RISE has started to build a foundation for measuring and understanding outcomes, treatment patterns, and also patient safety. Two nationally endorsed RISE electronic clinical quality measures, assessment of disease activity (NQF 2523), and functional status assessment (NQF 2524), are the first examples of EHR-enabled measures that collect outcomes, including patient-reported outcomes, across the registry. We are encouraged by the fact that over one-half of rheumatologists participating in RISE are routinely capturing this information in practice. Measurement of these outcomes using validated tools enables evidence-based care by facilitating a treat-to-target approach in RA, and also allows for tracking of outcomes and benchmarking across rheumatology practices. In addition, the considerable effort made by rheumatologists and their staff to collect this information in routine clinical care has resulted in one of the largest national efforts to collect patient-reported outcomes for a chronic disease via the EHR in the US.

Another quality measure, DMARD therapy (NQF 2525), has created a foundation for ensuring that accurate information about medication utilization is collected across the registry. Not surprisingly, performance on this measure across rheumatology practices participating in RISE is high (91.0%). The data presented in this study

Table 4. Performance on selected quality measures in the RISE registry*

Quality measure	Measure denominator, no.	Measure numerator, no.	Performance, %
RA: assessment of disease activity (NQF 2523): patients age ≥18 years with a diagnosis of RA and ≥50% of total number of outpatient encounters in the measurement year with assessment of disease activity using a standardized measure	58,095	32,087	55.2
RA: functional status assessment (NQF 2524): patients age ≥18 years with a diagnosis of RA for whom a functional status assessment was performed at least once during the measurement period	58,095	31,127	53.6
RA: DMARD therapy (NQF 2525): patients age ≥18 years with a diagnosis of RA who are prescribed DMARD therapy within 12 months	57,893	52,670	91.0
Drug safety: TB screening prior to first biologic agent therapy (NQF 2522): patients age ≥18 years with a diagnosis of RA who have documentation of a TB screening performed within 12 months prior to receiving a first course of therapy using a biologic DMARD	17,341	9,570	55.2
Drug safety: use of high-risk medications in the elderly: patients age ≥66 years who received at least 1 high-risk medication	98,606	3,880	3.9†
Drug safety: patients age ≥66 years who received at least 2 different high-risk medications	98,606	121	0.12†
Osteoporosis: female patients age ≥65 years who have a central DXA measurement ordered or performed at least once since age 60 years or pharmacologic therapy prescribed within 12 months	77,900	45,472	58.4
Osteoporosis: patients age ≥18 years with 1 of the following conditions or therapies: receiving oral glucocorticoid therapy for greater than 3 months OR hypogonadism OR fracture history OR transplant history OR obesity surgery OR malabsorption disease OR receiving aromatase therapy for breast cancer who had a central DXA ordered or performed or pharmacologic therapy prescribed within 12 months	52,966	32,388	61.2
Osteoporosis: patients age ≥50 years with fracture of the hip, spine, or distal radius who had a central DXA measurement ordered or performed or pharmacologic therapy prescribed	7,496	3,840	51.2
Low back pain: patients with a primary diagnosis of low back pain who did not have an imaging study (plain radiograph, MRI, CT scan) within 28 days of the diagnosis	16,239	11,389	70.1
Preventive care and screening: patients age ≥18 years who were screened for tobacco use ≥1 time within 24 months AND who received cessation counseling intervention if identified as a tobacco user	260,384	213,646	82.1
Preventive care and screening: patients age ≥18 years with a BMI documented during the current encounter or during the previous 6 months AND with a BMI outside of normal parameters, a followup plan is documented during the encounter or during the previous 6 months of the current encounter	259,787	109,093	42.0
Preventive care and screening: patients ages 18–85 years who had a diagnosis of hypertension and whose blood pressure was adequately controlled (<140/90 mm Hg) during the measurement period	26,364	16,258	61.7
Gout: serum urate monitoring: patients age ≥18 years with a diagnosis of gout who were either started on ULT or whose dose of ULT was changed in the year prior to the measurement period, and who had their serum urate level measured within 6 months	5,205	1,614	31.0
Gout: serum urate target: patients age ≥18 years with a diagnosis of gout treated with ULT for at least 12 months, whose most recent serum urate result is <6.8 mg/dl	1,250	786	62.9
Medication documentation: visits for patients age ≥18 years for which the eligible professional attests to documenting a list of current medications using all immediate resources available on the date of the encounter. This list must include all known prescriptions, over-the-counters, herbals, and vitamin/mineral/dietary (nutritional) supplements AND must contain the medications' name, dosage, frequency, and route of administration.	718,292	695,430	96.8

* RISE = Rheumatology Informatics System for Effectiveness; RA = rheumatoid arthritis; NQF = National Quality Forum; DMARD = disease-modifying antirheumatic drug; TB = tuberculosis; DXA = dual x-ray absorptiometry; MRI = magnetic resonance imaging; CT = computed tomography; BMI = body mass index; ULT = urate-lowering therapy.
† Lower percentage indicates high performance.

demonstrate that RISE is capturing the full spectrum of medications used in RA. Work is ongoing to further refine and validate medication information, including initiation and discontinuation dates and ensuring that medications that may not be as reliably recorded in the EHR, such as infusible biologic DMARDs, are captured. In addition, tuberculosis screening (NQF 2522) is an example of a patient safety measure. Our experience validating this measure suggests that lower performance on this measure indicates both a gap in quality and the fact that reliably capturing TB screening in practice requires further work to ensure accurate data capture (2). Efforts are ongoing to improve mapping and further validate all quality measures in RISE.

For clinicians, RISE provides new opportunities to participate in efforts to improve the quality of care in rheumatology. Locally, the RISE user interface allows rheumatologists to track their performance on quality measures in conditions such as RA, gout, and osteoporosis. RISE allows rheumatologists to not only participate in national quality reporting programs such as PQRS, but also provides critical data analytic capacity to facilitate rapid-cycle quality improvement. Clinicians participating in RISE can run reports to view their performance on quality measures, and compare these data to others in their practice as well as against both the registry mean and national benchmarks. This marks a shift away from previous approaches to quality measurement, which have largely relied on administrative claims data or chart review. Limitations of claims data have included the lack of detailed clinical data and the sometimes significant delay in aggregating results; similarly, chart reviews required a significant time investment which impeded rapid-cycle quality improvement. By aggregating up-to-date EHR data and passively collecting more detailed clinical data, RISE is attempting to address some of these previous limitations.

In addition, as payers, particularly Medicare, increasingly tie payments to value assessments, there is an urgent need to develop measures to define "value" in rheumatology. The Medicare Access and CHIP (Children's Health Insurance Program) Reauthorization Act of 2015 has put into place an aggressive timeline for a merit-based incentive payment system and for alternative payment models. For rheumatologists to be successful under these payment reforms, it will be critical to generate both the measures and tools to capture the value of rheumatologic care in a meaningful way. Being able to develop, test, and rapidly implement novel measures in RISE that define quality and efficiency will be critical. Understanding the scientific validity, feasibility, usefulness, and both intended and unintended consequences of these measures are important strategic goals of RISE.

For researchers, RISE aims to generate data that can advance our understanding of the natural history, outcomes, and treatment of rheumatologic disorders. Aggregated population-wide EHR data are a relatively new data source in the US, and both management and analyses of these data will require rapid innovation in research methods and practices. First, RISE will include new types of data, including the text of clinical notes. Extracting information from this unstructured data will require developing new algorithms to identify variables of interest, using techniques such as text mining, natural language processing, and machine learning. Second, although RISE's privacy and security framework is HIPAA compliant and research procedures have been approved by a national IRB, addressing future threats to data security will require continuous vigilance and innovation. Third, data in RISE are observational in nature, and will accumulate rapidly. Analysis of "big data" will require new methods, including approaches to deal with missingness, censoring, nonuniform variables across a population, and evolving computational methods to recognize patterns in data such as machine learning. Moreover, changes in health data standards (e.g., implementation of ICD-10) will require ongoing data integration and validation. Fourth, we anticipate that there will be interest in integrating RISE with other data sources and platforms, such as patient-powered networks, clinical trials networks, administrative claims data, or disease-specific registries. Building the scientific and privacy frameworks to facilitate such integrations will also require significant collaboration, funding, and innovation. In the near term, we hope that RISE will facilitate creating learning networks to share best practices and close gaps in quality of care.

In summary, the ACR has developed RISE to help rheumatologists leverage the new wave of big data from EHRs. By aggregating, analyzing, and continuously feeding data back to rheumatology practices, RISE aims to advance our shared goals of improving knowledge about rheumatologic conditions, refining treatment strategies and outcomes, and improving the quality and safety of care.

AUTHOR CONTRIBUTIONS

All authors were involved in drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be submitted for publication. Dr. Yazdany had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study conception and design. Yazdany, Bansback, Clowse, Collier, Law, Liao, Michaud, Morgan, Oates, Orozco, Reimold, Simard, Myslinski, Kazi.

Analysis and interpretation of data. Yazdany.

REFERENCES

1. Centers for Medicare and Medicaid Services. Qualified clinical data registry reporting. 2016. URL: http://www.cms.gov/medicare/quality-initiatives-patient-assessment-instruments/pqrs/qualified-clinical-data-registry-reporting.html.
2. Yazdany J, Robbins M, Schmajuk G, Desai S, Lacaille D, Neogi T, et al. Development of the American College of Rheumatology's rheumatoid arthritis electronic clinical quality measures. Arthritis Care Res (Hoboken) 2016;68:1579–90.
3. Berwick DM, Nolan TW, Whittington J. The triple aim: care, health, and cost. Health Affairs (Project Hope) 2008;27:759–69.