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Journal

Arthritis Care & Research, 75(7)

ISSN

2151-464X

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Publication Date

2023-07-01

DOI

10.1002/acr.25009

Peer reviewed

HHS Public Access

Author manuscript

Arthritis Care Res (Hoboken). Author manuscript; available in PMC 2024 July 01.

Published in final edited form as:

Arthritis Care Res (Hoboken). 2023 July ; 75(7): 1544–1552. doi:10.1002/acr.25009.

Monitoring and achievement of target serum urate among gout patients receiving long-term urate lowering therapy in the ACR's RISE Registry

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Abstract

Objective: The American College of Rheumatology's (ACR) 2020 guidelines for the management of gout recommend using a treat-to-target (T2T) approach to lower serum urate (SU). Using the ACR's RISE registry, we examined the use of a T2T approach among gout patients receiving long-term urate lowering therapy and followed longitudinally by rheumatologists.

Methods: Included patients had ≥ 1 ICD9/10 diagnosis for gout in 2018 – 2019 and continuous use of ULT for ≥ 12 months. We assessed the proportions of patients (1) with SU monitoring and (2) among those tested, who achieved SU < 6.0 mg/dL during the measurement year. Multi-level logistic regression adjusting for sociodemographics, comorbidities, region, and healthcare utilization was used to determine factors associated with SU monitoring and achievement of target SU.

Results: 9,560 patients were included: mean (SD) age was 67.2 (12.7) years, 73.5% were male, 32.3% were non-white. 56% of patients had at least one SU recorded during the measurement year; among patients with at least one SU recorded, 74% achieved the SU target. In multivariate analyses, non-white patients were slightly less likely to be tested or achieve a target SU.

Conclusion: Among gout patients receiving long-term ULT followed longitudinally by rheumatologists, more than half had a documented SU and among those tested, three quarters achieved the recommended SU target. Routine monitoring of SU is a first step toward improving quality of care for patients with gout.

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*Dr. Hammam and Ms. Li share the role of first author

Conflict of interests: The authors report no conflicts of interest.

In 2020, the American College of Rheumatology (ACR) issued updated guidelines for the management of gout which recommended using a treat-to-target approach to lower serum urate (SU) to a target level of < 6.0 mg/dL.[1] Patients with SU below this target have fewer gout attacks, fewer tophi, and decreased joint damage compared to those with higher SU.

Despite these recommendations, the treatment of patients with gout in clinical practice remains suboptimal based on several different metrics, including monitoring of SU, use of urate lowering therapies (ULT), and achievement of target SU. One recent analysis of over 1 million patients with gout in the U.S. suggested that more than 30% of patients with chronic gout did not have SU monitoring over a 12-month period.[2] Further, 25-30% of patients with a gout diagnosis were not receiving any ULT. A large meta-analysis that included studies based in countries around the world indicated that SU reached target levels in only one third of gout patients receiving ULT.[3]

However, large U.S. studies reporting on the proportion gout patients who are treated to target are still lacking. Gout is often managed in primary care settings, but patients with severe or refractory disease or multiple comorbidities that complicate management are often referred to rheumatologists. Little is known about the longitudinal management of gout in the rheumatology subspecialty setting, including whether rheumatologists are regularly applying a treat-to-target strategy in this population, or whether an SU target of < 6 mg/dL is routinely achieved in this more difficult to treat group.

In this study we examined patients with gout using the ACR's RISE registry, a national U.S. registry comprised of patients cared for by rheumatologists. Our study objectives were: (1) to examine the frequency of SU monitoring for patients with gout receiving long-term ULT; (2) to determine the proportion of this population who achieved a SU level < 6.0 mg/dL; and (3) to examine factors associated with each of these outcomes.

Patients and methods

Data source and study design

This retrospective observational study used the RISE registry data. RISE is a national electronic health record (EHR)-enabled rheumatology registry and contains data recorded during routine outpatient clinical care in participating rheumatology practices across the U.S.[4] The RISE registry was established in January 2014 and was designed to support practice-based quality improvement and reporting to national pay for performance programs. Participants consist mainly of community-based rheumatology practices from across the U.S. As of June 2020, RISE held validated data from 1235 providers in 234 practices, representing about 30% of the U.S. clinical rheumatology workforce.

Study population and study period

We attempted to define a population of patients with consistent care from a rheumatologist, long-term ULT use, and available labs, according to the specification of the American College of Rheumatology quality measure for gout.[5] The study included patients with at least 1 diagnosis code for gout (ICD-9-CM (274. *) or ICD-10-CM (M10.*, M1A.*)) at any time in the RISE database. Patients were required to have at least 1 visit with their

rheumatologist in each of 2018 and in 2019 (Figure 1), be aged 18 years or older, and have complete information on key covariates including age, sex , and Area Deprivation Index. All patients were seen in practices with labs available in RISE.

Next, we required patients be continuous users of ULT (allopurinol, febuxostat, lesinurad, or probenecid) for at least 12 months prior to the beginning of the measurement year (2019; Figure 2). The RISE registry pulls medication information from 3 sources within the EHRs: 1. patient medication tables, as reported by patients in the medication reconciliation process during a clinical visit; 2. e-prescription tables, which are the electronic medication orders sent from practices to pharmacies; 3. Procedure tables, which include CPT codes for procedures that include medication administration. Medication data from all 3 tables is associated with a start date. Medication stop dates were based on actual stop dates input into the EHR (if available) or calculated as stopping on 90 days after the last observed prescription. We allowed medication possession gaps of no longer than 90 days to define continuous users. If patients stopped using ULT during the measurement year, we only included SU measurements from before their stop date in this study. In order to ensure adequate follow-up time for an SU measurement, we required patients remain on ULT for at least 90 days in the measurement year (i.e., for the 2019 measurement year ULT stop date had to occur on 3/31/2019 or later).

Outcomes

First, we assessed whether or not a patient had a valid SU recorded during the measurement year (“SU monitoring outcome”). We found 257 out of 10,898 SU results that were considered invalid (non-numeric values, negative values, or values > 50 mg/dL) and excluded from the analysis.

Next, we calculated the “treat to target” outcome: At the patient level, we assessed whether individuals with a SU result achieved SU < 6 mg/dL (0.36 mmol/L) during the measurement year (2019; see Figure 2). For patients with more than one SU result recorded during the measurement year, the most recent record was selected. If there was more than one SU result on the same date, the result with the lowest SU level was selected. In the primary analysis, we calculated the proportion of patients with SU at target among those who were monitored (i.e., had at least one SU test recorded during the measurement year).

The outcome measure was also assessed at the practice level, where we defined the denominator as patients with gout on long-term ULT with at least one SU recorded and the numerator as those who achieved the target SU during the measurement year.

Covariates

Patient characteristics included age, gender, race and ethnicity as recorded in the EHR (non-Hispanic white, Hispanic, non-Hispanic African American, non-Hispanic Asian, non-Hispanic multiracial/other, and unknown), geographic region of residence (Northeast, Southwest, West, Southeast, and Midwest), insurance type (private, Medicare, Medicaid, other, and unknown), Area Deprivation Index (ADI; an area-level measure of socioeconomic status (SES) with a range of 1 to 100, with lower scores reflecting higher SES.[6] We extracted information on number of rheumatology visits during the measurement year and

the Charlson comorbidity index (CCI) based on the Deyo protocol.[7] Because chronic kidney disease (CKD) can affect whether patients had SU testing or their treatment with ULT, we also assessed CKD (yes/no, defined as at least 1 ICD code by 12/31/2019: 585.1 - 585.5, 585.9, 586.x, N18.1 – N18.5, N18.9 and N19.x). We also extracted information on allopurinol allergies using an ICD code for allopurinol toxicity (T50.4X5) as well as the patient allergy list.

Practice characteristics

Practice characteristics included practice type (single-specialty group practice, solo practitioner, multi-specialty group practice, and health system), practice size (number of providers; number of eligible patients in each practice).

Statistical analysis

Descriptive statistics were used to examine patient and practice characteristics according to the SU monitoring and SU treat-to-target outcomes. Bivariate analyses were completed by chi-square tests for categorical variables and t-test for continuous variables.

SU monitoring analysis: To examine factors associated with SU monitoring, we constructed a multi-level regression model that included age, gender, race and ethnicity, geographic region, ADI, number of visits during 2019, CKD (yes/no), and CCI > 2 (yes/no), accounting for clustering by practice. Multicollinearity was examined using the variance inflation factor. We performed sensitivity analyses where we repeated this analysis (1) in the subset of patients with at least 1 laboratory test performed during the measurement year (any lab, not necessarily an SU test); (2) using an expanded the measurement window to include SU tests performed in 2018 or 2019; and (3) a complete case analysis excluding patients with unknown race and ethnicity.

Treat-to-target analysis: To assess the association between patient and practice characteristics with achieving target SU, we built a multi-level logistic regression model that included the same variables listed above. As sensitivity analyses, we repeated this analysis (1) among the subset of patients receiving continuous ULT through all of 2019; (2) using an expanded the measurement window to include SU results collected in 2018 or 2019; and (3) a complete case analysis excluding patients with unknown race and ethnicity.

Practice-level performance was reported on the proportion of patients fulfilling the treat to target measure among all those eligible within a given practice using median and interquartile ranges. Practices with fewer than 20 patients were excluded from the practice-level analysis.

For all models, model output parameters were used to produce predicted probabilities and 95% confidence intervals. A p-value < 0.05 was considered statistically significant. Analyses were performed using Stata 16 (StataCorp. 2017. College Station, TX: StataCorp LLC). The Western IRB and UCSF Committee on Human Research approved this study.

Results

9,560 patients were included in this analysis from 188 practices (see Table 1 & Supplementary table 1). 74% were male, and over 50% were 55-74 years old. Most patients were non-Hispanic white (68%), consistent with the overall demographics of patients in the RISE registry. Most patients received allopurinol (75%) or febuxostat (18%) as their ULT; fewer patients received lesinurad (0.1%) or probenecid (1.3%), and 5.6% received more than 1 ULT medication. 3.2% of patients included in the study were noted to have an allopurinol allergy documented in the EHR (see Table 2).

SU monitoring analysis:

Overall we found that 5,332 out of 9,560 (55.8%) of patients had at least one SU test recorded during the measurement year. Among patients with at least one laboratory test (of any kind) recorded (N=8,490), 5,564 (65.5%) of them had an SU test recorded. When we expanded the monitoring window to include both 2018 and 2019, 72.3% (6,914/9,560) of patients had a documented SU. Characteristics of patients with and without monitoring are shown in Table 1. Even after adjustment, there was a strong age gradient in the proportion of patients with SU monitoring, with older patients less likely to receive monitoring ($p<0.05$; Table 3 – SU monitoring analysis). Patients with chronic kidney disease were more likely to receive monitoring (60.7 vs. 57.4%, $p<0.05$). Patients with more visits were also more likely to have SU recorded, as expected ($p<0.05$). Modeling results were similar in the sensitivity analyses among the subsets of patients with at least 1 non-SU lab recorded and when using an expanded measurement window (data not shown). In the complete case analysis (N=8,062), findings were nearly identical, with the addition that male patients were significantly more likely to receive monitoring compared to female patients (Supplementary table 2).

Treat-to-target analysis:

Among patients with at least one SU recorded in 2019, 73.8% (3,933/5,332) of patients achieved the SU target (Table 2). As expected, patients with SU at target (n=3,933) had a mean (SD) SU that was lower than those with a documented SU not at target (n=1,399) (4.6 (0.9) vs. 7.4 (1.5)). In the subset of patients receiving continuous ULT through all of 2019, 74.9% (3,057/4,083) achieved the SU target. When we expanded the measurement window to include tests drawn in 2018, 74.5% (5,148/6,914 patients achieved the SU target. In a model that adjusted sociodemographic and clinical characteristics, we found that Hispanic patients were less likely to achieve the target SU, compared to non-Hispanic white patients (62.1 vs. 74%, $p<0.05$; see Table 3 – Treat-to-target analysis (among patients with SU recorded)). Patients < 55 years old were less likely to be at target compared to older patients. We also found small but statistically significant effects of SES – patients with higher ADI (lower SES) were slightly less likely to be at target. Patients on febuxostat were less likely to be at target than patients on allopurinol (71.5 vs. 75.0%, $p<0.05$); those on other or more than 1 ULT were even less likely to be at target. Modeling results were similar in the sensitivity analyses among the subsets of patients who received ULT for the entire measurement year and when using an expanded measurement window (data not shown). In

the complete case analysis (N=4,437), findings were nearly identical, except that patients on febuxostat were no longer significantly less likely to be at target (Supplementary table 2).

Practice-level analysis:

Finally, we assessed practice-level proportions of patients achieving target SU (among those with SU documented) in the 71 practices with ≥ 20 eligible patients. The median (IQR) practice-level performance on achieving the target SU was 74.4% (66.7 – 81.0%) (see Figure 3).

Discussion

We studied U.S. gout patients receiving long-term ULT who were cared for longitudinally by rheumatologists and examined the frequency of SU monitoring and assessed their achievement of SU < 6.0 mg/dL according to the ACR recommendations. We found more than half of patients with gout on ULT had an SU recorded during the measurement year. Among those with an SU recorded, we found three quarters of patients had achieved the recommended SU target of < 6.0 mg/dL. We found small but statistically significant differences based on race and ethnicity, with Hispanic patients slightly less likely to achieve the SU target.

Our finding that 55% of patients had an SU test recorded is consistent with prior studies reporting on rates of monitoring for patients on ULT. A recent meta-analysis found pooled proportions of patients from U.S. cohorts of 62% (95% CI 46%, 76%).[3] Although it is possible that some patients did not have labs with results recorded in the rheumatologist's EHR, in a sensitivity analysis restricted to patients with at least 1 lab of any type available, the fraction of patients with SU documented only increased modestly, to 66%.

Patients in the RISE registry were considerably more likely to achieve their SU target (74%) compared to other U.S. cohorts, where pooled estimates are closer to 32% (95% CI 23%, 42%).[3] This finding is even more impressive considering that rheumatologists take care of complex gout cases, often including those refractory to initial therapy. There are likely several reasons for this, including possible patient differences across cohorts, as well as provider factors, since other studies were not restricted to patients followed by rheumatologists, who may more closely follow the ACR-endorsed guidelines for gout. At least one other study has shown higher rates of ULT use and SU monitoring among patients under the care of a rheumatologist.[2]

Prior studies addressing treat-to-target in patients with gout have consistently identified male sex, younger age, race and ethnicity, and more comorbid conditions as factors associated with not meeting the SU target.[8,9,10,11] Our findings are similar in that Hispanic patients were less likely to reach a target SU as well as in the age gradient we observed – with younger patients being less likely to achieve the target. Conversely, we did not observe differences in comorbid conditions, although these may be under-coded in this data set. Significant practice variation, even among practices reporting on > 20 patients, suggests that provider-level factors such as education and clinic workflows may also play a significant role.

Moving forward it will be important to reduce missed monitoring for SU, since it is likely that at least at third of patients in this study did not have a SU measured during the measurement year, and for these patients it is not known whether they achieved the SU target or not. Missed monitoring has likely become an even bigger issue during the SARS-Cov-2 pandemic, when many patients switched to video visits and were less likely to get laboratory monitoring.[12] On the other hand, patients without SU monitoring may represent a subgroup with long-standing, stable disease, where frequent lab testing may no longer be required.

This study has some important limitations. It is possible that some patients had labs monitored in other settings, such as a primary care practice that did not have a shared EHR with the rheumatologist, and therefore their lab data may not have been included. However, every practice included in this study had labs available, we only included individuals with longitudinal rheumatology follow-up, and we performed sensitivity analysis including only patients with at least one (non-SU) lab test result available in the rheumatologist's EHR.

Finally, we did not have access to prescription fill information and therefore could not assess medication adherence or the medication possession ratio as other studies have done, although our definition of continuous user of ULT is similar to those in several prior studies.[13,14,15]

In conclusion, more than half of patients with gout on long-term ULT received SU monitoring during a measurement year; among those tested, three quarters achieved a target serum urate of < 6.0 mg/dL. The recent inclusion of gout-related quality measures into national pay for performance programs, including measures addressing whether patients achieve a target SU, will be an important lever for further improving care. Routine monitoring of serum urate will be a first step toward improving quality of care for patients with gout, and efforts will need to be redoubled given the effects of the SARS-Cov2-2 pandemic on in-person care and frequency of laboratory monitoring.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Funding sources:

Drs. Yazdany and Schmajuk are supported by the Russell/Engleman Medical Research Center for Arthritis. Dr. Yazdany is supported by NIH/NIAMS P30 AR070155 and NIH/NIAMS K24AR074534. Data collection was supported by the ACR's RISE Registry. However, the views expressed represent those of the authors, not necessarily those of the ACR. This study protocol was prepared by and the data analysis was executed by the University of California, San Francisco.

REFERENCE

1. FitzGerald JD, Dalbeth N, Mikuls T, Brignardello-Petersen R, Guyatt G, Abeles AM, Gelber AC, Harrold LR, Khanna D, King C, Levy G, Libbey C, Mount D, Pillinger MH, Rosenthal A, Singh JA, Sims JE, Smith BJ, Wenger NS, Bae SS, Danve A, Khanna PP, Kim SC, Lenert A, Poon S, Qasim A, Sehra ST, Sharma TSK, Toprover M, Turgunbaev M, Zeng L, Zhang MA, Turner AS, Neogi T. 2020 American College of Rheumatology Guideline for the Management of Gout. Arthritis Care Res (Hoboken). 2020 Jun;72(6):744–760. doi: 10.1002/acr.24180. Epub 2020 May 11. [PubMed:

32391934] Erratum in: Arthritis Care Res (Hoboken). 2020 Aug;72(8):1187. [PubMed: 32726516] Erratum in: Arthritis Care Res (Hoboken). 2021 Mar;73(3):458. [PubMed: 33630422]

2. Edwards NL, Schlesinger N, Clark S, Arndt T, Lipsky PE. Management of Gout in the United States: A Claims-based Analysis. ACR Open Rheumatol. 2020 Mar;2(3):180–187. doi: 10.1002/acr2.11121. Epub 2020 Mar 1. [PubMed: 32114719]
3. Son CN, et al. Global patterns of treat-to-serum urate target care for gout: Systematic review and meta-analysis. Semin Arthritis Rheum. 2021 Aug;51(4):677–684. doi: 10.1016/j.semarthrit.2021.04.011. Epub 2021 Apr 25. [PubMed: 34139520]
4. Yazdany J, Bansback N, Clowse M, et al. Rheumatology Informatics System for Effectiveness: A National Informatics-Enabled Registry for Quality Improvement. Arthritis Care Res. 2016;68(12):1866–1873. doi:10.1002/acr.23089
5. FitzGerald JD, Mikuls TR, Neogi T, Singh JA, Robbins M, Khanna PP, Turner AS, Myslinski R, Suter LG. Development of the American College of Rheumatology Electronic Clinical Quality Measures for Gout. Arthritis Care Res (Hoboken). 2018 May;70(5):659–671. doi: 10.1002/acr.23500. Epub 2018 Apr 12. [PubMed: 29649348]
6. Kind AJH, Buckingham WR. Making Neighborhood-Disadvantage Metrics Accessible — The Neighborhood Atlas. N Engl J Med. 2018;378(26):2456–2458. doi:10.1056/NEJMp1802313 [PubMed: 29949490]
7. Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. J Clin Epidemiol. 1992;45(6):613–619. doi:10.1016/0895-4356(92)90133-8 [PubMed: 1607900]
8. Hatoum H, Khanna D, Lin SJ, Akhras KS, Shiozawa A, Khanna P. Achieving serum urate goal: a comparative effectiveness study between allopurinol and febuxostat. Postgrad Med 2014;126:65–75. [PubMed: 24685969]
9. Rashid N, Coburn BW, Wu YL, Cheetham TC, Curtis JR, Saag KG, et al. Modifiable factors associated with allopurinol adherence and outcomes among patients with gout in an integrated healthcare system. J Rheumatol 2015;42:504–12. [PubMed: 25512479]
10. Koto R, Nakajima A, Horiuchi H, Yamanaka H. Factors associated with achieving target serum urate level and occurrence of gouty arthritis: A retrospective observational study of Japanese health insurance claims data. Pharmacoepidemiol Drug Saf. 2021 Feb;30(2):157–168. doi: 10.1002/pds.5127. Epub 2020 Sep 16. [PubMed: 32939919]
11. Sheer R, Null KD, Szymanski KA, Sudharshan L, Banovic J, Pasquale MK. Predictors of reaching a serum urate goal in patients with gout and treated with febuxostat. Clinicoecon Outcomes Res. 2017 Oct 10;9:629–639. doi: 10.2147/CEOR.S139939. [PubMed: 29066924]
12. Li J, Ringold S, Curtis JR, Michaud K, Johansson T, Yun H, Yazdany J, Schmajuk G. Effects of the SARS-CoV-2 global pandemic on U.S. rheumatology outpatient care delivery and use of telemedicine: an analysis of data from the RISE registry. Rheumatol Int. 2021 Oct;41(10):1755–1761. doi: 10.1007/s00296-021-04960-x. Epub 2021 Aug 2. [PubMed: 34338816]
13. Chan M, Quinlan TM, Brophy R, Mewar D. Audit of the adherence to BSR guidelines on the management of gout (2007), in two primary care centres within the Merseyside region. Rheumatology (Oxford) 2012;51:iii70.
14. Jackson G, Dalbeth N, Te Karu L, Winnard D, Gerard C, Minko N. Variation in gout care in Aotearoa New Zealand: A national analysis of quality markers. NZ Med J 2014;127:37–47.
15. Singh JA, Hodges JS, Asch SM. Opportunities for improving medication use and monitoring in gout. Ann Rheum Dis 2009;68:1265–70. [PubMed: 18701554]

Significance and Innovation

- This is the first report describing the management of gout and gout outcomes in a large population-based cohort of patients followed longitudinally by rheumatologists from the ACR's RISE registry.
- In this difficult to treat cohort, more than half of patients with gout on urate lowering therapy had a documented SU; and among those tested, three quarters achieved the recommended SU target.

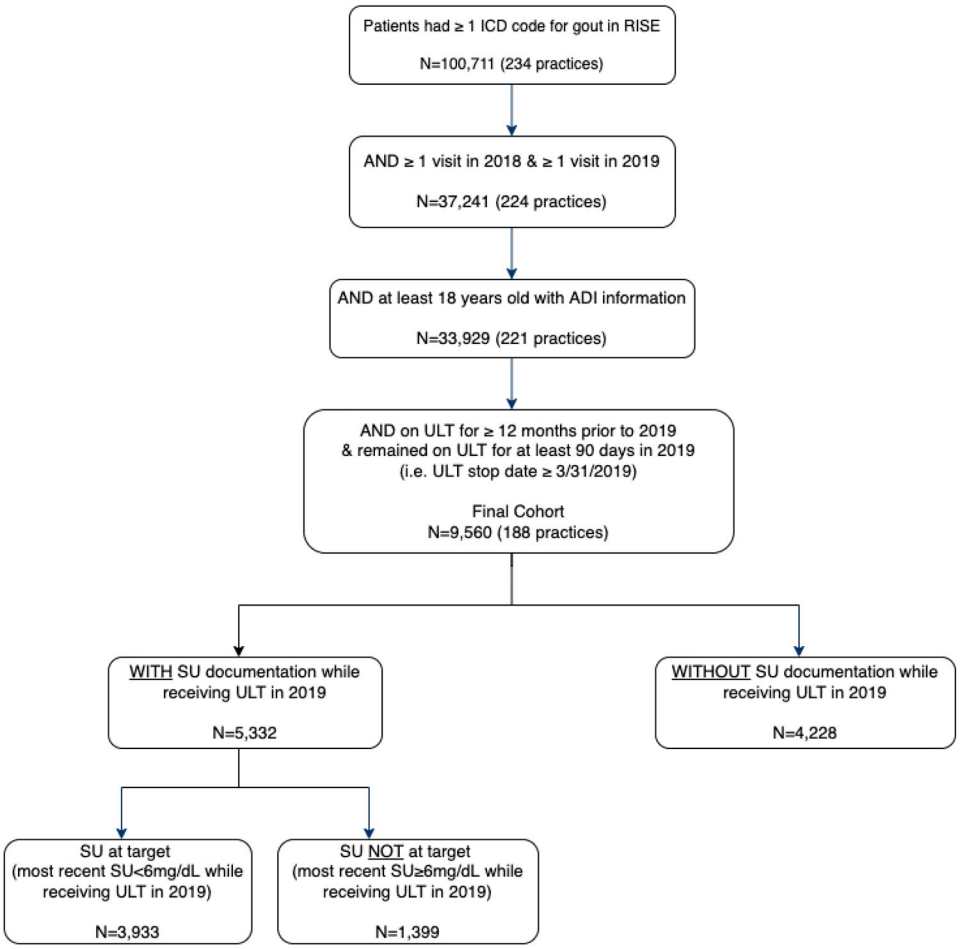

Figure 1.

Study flow chart. ICD: International Classification of Disease, ADI: Area Deprivation Index, SU: serum urate, T2T: treat to target, and ULT: urate lowering therapy.

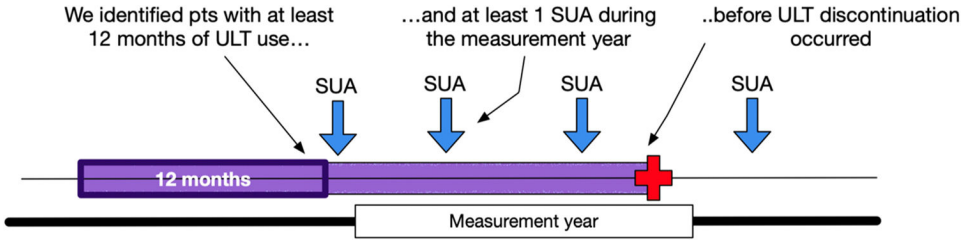

Figure 2.
Illustration of study design. SUA: serum uric acid, and ULT: urate lowering therapy.

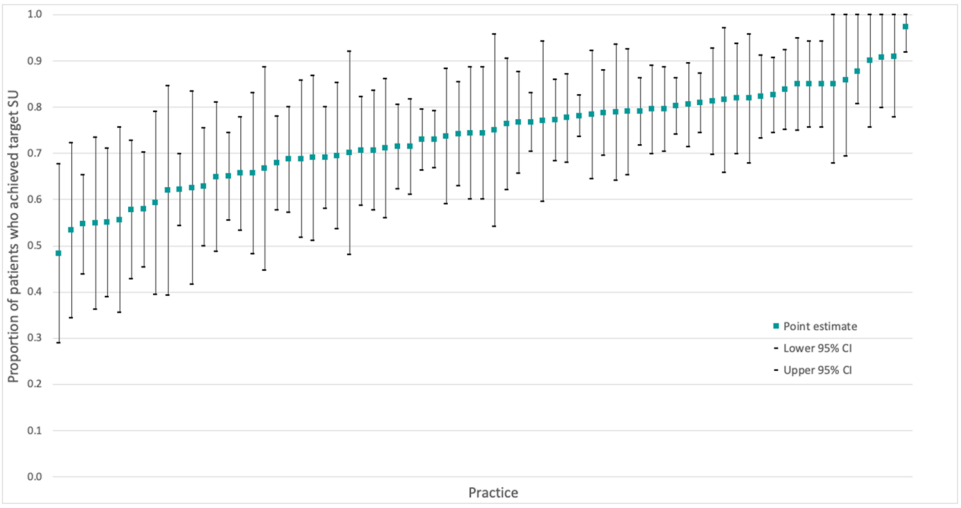

Figure 3.

Practice-level proportion who achieved target serum urate among practices with at least 20 eligible patients (N practices = 71).

Table 1:

Characteristics of patients in the RISE registry with gout receiving long term urate lowering therapy, stratified by whether serum urate testing was performed in 2019.

Characteristics	Total N=9,560 N (column %)	SU monitored N=5,332 N (column %)	SU not monitored N=4,228 N (column %)	p-value*
Age				**<0.001**
<55	1636 (17.1)	1023 (19.2)	613 (14.5)	
55-64	2029 (21.2)	1193 (22.4)	836 (19.8)	
65-74	2976 (31.1)	1635 (30.7)	1341 (31.7)	
75-84	2048 (21.4)	1055 (19.8)	993 (23.5)	
>=85	871 (9.1)	426 (8)	445 (10.5)	
Male	7025 (73.5)	3979 (74.6)	3046 (72)	**0.005**
Race and Ethnicity				**0.017**
White (non-Hispanic)	6475 (67.7)	3579 (67.1)	2896 (68.5)	
African American	901 (9.4)	488 (9.2)	413 (9.8)	
Hispanic	323 (3.4)	181 (3.4)	142 (3.4)	
Asian	314 (3.3)	166 (3.1)	148 (3.5)	
Other†/more than 1 race	49 (0.5)	23 (0.4)	26 (0.6)	
Unknown	1498 (15.7)	895 (16.8)	603 (14.3)	
Insurance				**<0.001**
Medicare	3233 (33.8)	1694 (31.8)	1539 (36.4)	
Private	2487 (26)	1444 (27.1)	1043 (24.7)	
Medicaid	164 (1.7)	78 (1.5)	86 (2)	
Other§	318 (3.3)	167 (3.1)	151 (3.6)	
Unknown	3358 (35.1)	1949 (36.6)	1409 (33.3)	
ADI, median (interquartile range)	36 (17 - 62)	37 (18 - 61)	35.5 (15 - 64)	0.56
Region				**<0.001**
Midwest	1450 (15.2)	997 (18.7)	453 (10.7)	
Northeast	1293 (13.5)	752 (14.1)	541 (12.8)	
South	5672 (59.3)	2899 (54.4)	2773 (65.6)	
West	1145 (12)	684 (12.8)	461 (10.9)	
Healthcare utilization				
Number of visits with rheumatologists in RISE in 2019, mean (SD)	2.8 (2.6)	2.8 (2.6)	2.7 (2.5)	**0.007**
≥2 visits with rheumatologists in RISE in 2019	6532 (68.3)	3845 (72.1)	2687 (63.6)	
Selected clinical characteristics				
Charlson score > 2	1362 (14.2)	693 (13)	669 (15.8)	**<0.001**
Chronic Kidney Disease	1701 (17.8)	910 (17.1)	791 (18.7)	**0.037**
Gout-related medications				
Urate Lowering Therapy (ULT)				**<0.001**
allopurinol	7159 (74.9)	3918 (73.5)	3241 (76.7)	
febuxostat	1732 (18.1)	975 (18.3)	757 (17.9)	

Characteristics	Total N=9,560 N (column %)	SU monitored N=5,332 N (column %)	SU not monitored N=4,228 N (column %)	p-value*
probenecid	128 (1.3)	80 (1.5)	48 (1.1)	
lesinurad	5 (0.1)	2 (0)	3 (0.1)	
more than 1 ULT	536 (5.6)	357 (6.7)	179 (4.2)	
Other				
Pegloticase	37 (0.4)	26 (0.5)	11 (0.3)	0.075

*p-values were tested by t-test for continuous variable and chi-square for categorical variables.

†Other race included American Indian, Alaska, and native Hawaiian.

§Other insurance included Veteran Affairs and no insurance or self-pay.

Table 2:

Characteristics of patients in the RISE registry with gout receiving long term urate lowering therapy with a serum urate documented, stratified by whether most recent serum urate in 2019 was < or ≥ 6.0 mg/dL.

Characteristics	Total SU monitored N=5,332 N (column %)	SU at target N=3,933 N (column %)	SU not at target N=1,399 N (column %)	p-value*
Age				**<0.001**
<55	1023 (19.2)	638 (16.2)	385 (27.5)	
55-64	1193 (22.4)	866 (22)	327 (23.4)	
65-74	1635 (30.7)	1279 (32.5)	356 (25.4)	
75-84	1055 (19.8)	831 (21.1)	224 (16)	
>=85	426 (8)	319 (8.1)	107 (7.6)	
Male	3979 (74.6)	2912 (74)	1067 (76.3)	0.1
Race and Ethnicity				**<0.001**
White (non-Hispanic)	3579 (67.1)	2689 (68.4)	890 (63.6)	
African American	488 (9.2)	339 (8.6)	149 (10.7)	
Hispanic	166 (3.1)	120 (3.1)	46 (3.3)	
Asian	181 (3.4)	104 (2.6)	77 (5.5)	
Other†/more than 1 race	23 (0.4)	16 (0.4)	7 (0.5)	
Unknown	895 (16.8)	665 (16.9)	230 (16.4)	
Insurance				**<0.001**
Medicare	1694 (31.8)	1316 (33.5)	378 (27.0)	
Private	1444 (27.1)	1005 (25.6)	439 (31.4)	
Medicaid	78 (1.5)	47 (1.2)	31 (2.2)	
Other§	167 (3.1)	128 (3.3)	39 (2.8)	
Unknown	1949 (36.6)	1437 (36.5)	512 (36.6)	
ADI, median (interquartile range)	37 (18 - 61)	36 (17 - 60)	39 (19 - 64)	**<0.001**
Region				0.29
Midwest	997 (18.7)	747 (19)	250 (17.9)	
Northeast	752 (14.1)	561 (14.3)	191 (13.7)	
South	2899 (54.4)	2108 (53.6)	791 (56.5)	
West	684 (12.8)	517 (13.1)	167 (11.9)	
Healthcare utilization				
Number of visits with rheumatologists in RISE in 2019, mean (SD)	2.8 (2.6)	2.8 (2.7)	2.9 (2.5)	0.4
≥2 visits with rheumatologists in RISE in 2019				
Number of SU labs in 2019, mean (SD)	1.9 (1.7)	1.8 (1.4)	2.1 (2.4)	**<0.001**
Selected clinical characteristics				
Charlson score > 2	664 (12.5)	487 (12.4)	177 (12.7)	0.79
Chronic Kidney Disease	910 (17.1)	658 (16.7)	252 (18)	0.27
Allopurinol allergy documented	181 (3.4)	132 (3.4)	49 (3.5)	0.8
Most recent serum urate in 2019				**<0.001**
mean (SD)	5.3 (1.6)	4.6 (0.9)	7.4 (1.5)	

Characteristics	Total SU monitored N=5,332 N (column %)	SU at target N=3,933 N (column %)	SU not at target N=1,399 N (column %)	p-value*
range	0.1 - 30.4	0.1 - 5.9	6 - 30.4	
median (IQR)	5.1 (4.3 - 6)	4.7 (4 - 5.3)	6.9 (6.3 - 8)	
Gout-related medications				
Urate Lowering Therapy (ULT)				**<0.001**
allopurinol	3918 (73.5)	2976 (75.7)	942 (67.3)	
febuxostat	975 (18.3)	699 (17.8)	276 (19.7)	
probenecid	80 (1.5)	46 (1.2)	34 (2.4)	
lesinurad	2 (0)	1 (0)	1 (0.1)	
more than 1 ULT	357 (6.7)	211 (5.4)	146 (10.4)	
Other				
Pegloticase	26 (0.5)	13 (0.3)	13 (0.9)	**0.006**

*p-values were tested by t-test for continuous variable and chi-square for categorical variables.

†Other race included American Indian, Alaska, and native Hawaiian.

§Other insurance included Veteran Affairs and no insurance or self-pay.

Table 3:

Predicted margins from multivariate models for patients in the RISE registry with gout on long-term urate lowering therapy for serum urate monitoring outcome and treat-to-target outcome.

Characteristics	SU Monitoring analysis*	Treat-to-target analysis (among patients with SU recorded)**
	Predicted margin (95% CI)	Predicted margin (95% CI)
N	9,560	5,332
Overall - unadjusted	55.8 (54.8 - 56.8)	73.8 (72.6 - 74.9)
Age		
<55 - ref	66 (60.8 - 71.1)	61.7 (58.3 - 65.1)
55-64	**60.8 (56.2 - 65.5)**	**72.2 (69.3 – 75.0)**
65-74	**56.8 (52.6 - 61)**	**77.5 (75.2 - 79.8)**
75-84	**53.4 (48.7 - 58)**	**78 (75.3 - 80.8)**
>=85	**51.3 (45.8 - 56.7)**	**74.1 (70 - 78.2)**
Gender		
Female - ref	56.3 (52.1 - 60.6)	73.2 (70.2 - 76.2)
Male	58.6 (54.3 - 62.9)	73.1 (71.2 - 74.9)
Race and Ethnicity		
non-Hispanic White - ref	57.5 (53.3 - 61.6)	74.0 (72.0 – 76.0)
African American	60.1 (54.8 - 65.3)	70.4 (66 - 74.7)
Asian	56.6 (49.2 - 64.1)	74.4 (66.6 - 82.2)
Hispanic	57.8 (51.7 - 63.9)	**62.1 (55.5 - 68.8)**
Other/more than 1 race	45.8 (32.4 - 59.2)	70.4 (53.5 - 87.3)
unknown	59.7 (54.5 - 64.9)	73.3 (69.4 - 77.2)
ADI		
25th percentile, ADI=17	58.5 (54.4 - 63.2)	**74.8 (72.8 - 76.8)**
50th percentile, ADI=36	58.1 (54.0 - 62.2)	**73.5 (71.7 - 75.3)**
75th percentile, ADI=62	57.2 (52.9 - 61.5)	**71.6 (69.3 - 73.8)**
Region		
Midwest - ref	60.8 (51.8 - 69.8)	73.3 (68.9 - 77.7)
Northeast	56.1 (45.8 - 66.3)	71.1 (66.2 - 76)
South	58.1 (52.3 - 63.9)	73.1 (70.7 - 75.5)
West	56 (47.4 - 64.6)	74.9 (69 - 80.9)
Number of visits with rheumatologists in RISE in 2019		
25th percentile, number of visit=1	**56.1 (51.6 - 60.6)**	73.5 (71.5 - 75.5)
50th percentile, number of visit=2	**57.2 (53.0 - 61.4)**	73.3 (71.4 - 75.1)
75th percentile, number of visit=3	**58.2 (54.1 - 62.4)**	73.1 (71.3 - 74.9)
Charlson score > 2		
No -ref	58.4 (54.3 - 62.6)	73.1 (71.1 - 75)

Characteristics	SU Monitoring analysis*	Treat-to-target analysis (among patients with SU recorded)**
Yes	55.1 (50.1 - 60.1)	73.4 (68.9 - 77.9)
Chronic kidney disease		
No - ref	57.4 (53.2 - 61.5)	73.6 (71.7 - 75.5)
Yes	**60.7 (55.9 - 65.6)**	70.6 (66.2 - 75)
Urate Lowering Therapy (ULT)		
Allopurinol - ref	NA	75 (73 - 76.9)
Febuxostat	NA	**71.5 (68.3 - 74.8)**
Other	NA	**60.6 (56.5 - 64.7)**

*SU monitoring analysis: outcome was whether patients had SU test documented during the measurement year. Every eligible patient was included.

**Treat-to-target analysis (among patients with SU recorded): outcome was whether patients achieved SU < 6.0 mg/dL during the measurement year. Only patients with a SU test documented were included.

Both models adjusted for all variables shown in the table.