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Hospitalizations for Acute Gout: Process Mapping the Inpatient Journey and Identifying Predictors of Admission

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ABSTRACT. ***Objective.*** To identify predictors of admission following emergency department (ED) attendances for gout flares and to describe barriers to optimal inpatient gout care.

Methods. ED attendances and hospital admissions with primary diagnoses of gout were analyzed at 2 UK-based hospitals between January 1, 2017, and December 31, 2020. Demographic and clinical predictors of ED disposition (admission or discharge) and reattendance for gout flares were identified using logistic regression and survival models, respectively. Case note reviews (n = 59), stakeholder meetings, and process mapping were performed to capture detailed information on gout management and to identify strategies to optimize care.

Results. Of 1220 emergency attendances for gout flares, 23.5% required hospitalization (median length of stay: 3.6 days). Recurrent attendances for flares occurred in 10.4% of patients during the study period. In multivariate logistic regression models, significant predictors of admission from ED were older age, overnight ED arrival time, higher serum urate (SU), higher C-reactive protein, and higher total white cell count at presentation. Detailed case note reviews showed that only 22.6% of patients with preexisting gout were receiving urate-lowering therapy (ULT) at presentation. Initial diagnostic uncertainty was common, yet rheumatology input and synovial aspirates were rarely obtained. By 6 months postdischarge, 43.6% were receiving ULT; however, few patients had treat-to-target dose optimization, and only 9.1% achieved SU levels ≤ 360 μmol/L.

Conclusion. We identified multiple predictors of hospitalization for acute gout. Treat-to-target optimization of ULT following hospitalization remains inadequate and must be improved if admissions are to be prevented.

Key Indexing Terms: allopurinol, gout, healthcare costs, hospitalization, hyperuricaemia, patient education

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Gout is the most common form of inflammatory arthritis, affecting 3.2% of UK adults and 3.9% of US adults.[1,2] Hospital admissions for gout flares have increased substantially in recent years, doubling in the US between 1993 and 2011, doubling in Canada between 2000 and 2011, and increasing by 58.4% in England between 2006 and 2017.[3,4,5]

There are likely to be multiple factors driving the growth in hospitalizations for gout flares. This includes an increasing incidence of gout in many countries worldwide, aging populations, and the epidemic of the metabolic syndrome.[1,6] Previous analyses of hospitalized patients with gout in the US have reported predictors of admission following emergency department (ED) attendances for gout flares, including increasing age, higher comorbidity burden, and socioeconomic and insurance provider status.[7,8]

Hospitalizations for gout flares are unpleasant for patients and costly for healthcare services.[5] Many hospitalizations for gout flares could be prevented with more widespread use of existing treatments at effective doses. Urate-lowering therapy (ULT; eg, allopurinol and febuxostat), when titrated to target serum urate

(SU) levels (300–360 μmol/L; 5–6 mg/dL), is highly effective at preventing flares and improving quality of life.[9] Associations between the use of ULT and fewer ED visits and hospitalizations for gout flares have been reported.[10,11] Despite this, previous studies have shown that only a minority of patients hospitalized for gout receive ULT.[12,13] Moreover, postdischarge recommendations to commence ULT are rarely provided by secondary care and/or acted on by primary care.[12,13]

If hospitalizations are to be prevented, we need to understand what barriers exist to optimal inpatient gout care. Only then can strategies be implemented to address these barriers and improve patient outcomes. The objective of this study was to perform detailed analyses of gout care in EDs and inpatient wards at 2 UK-based hospitals over a 4-year period. We sought to identify predictors of admission and utilize process mapping to identify barriers to optimal gout care.

METHODS

Study sample. All ED attendances and hospital admissions at 2 hospitals in London, UK, with primary admission diagnoses of gout between January 1, 2017, and December 31, 2020, were eligible for inclusion. Gout attendances were identified using primary admission diagnostic billing codes (International Classification of Diseases, 10th revision code: M10; SNOMED code: 90560007). Manual case verification was performed to confirm that the final diagnosis made by the treating clinician was a gout flare rather than an alternative diagnosis. The diagnosis of gout flare could be made on clinical grounds alone or through crystal analysis of synovial fluid. Cases were not eligible for inclusion if the primary cause of a patient's joint symptoms was deemed by the treating clinician to be a diagnosis other than a gout flare. There were no other exclusion criteria.

Variables. Coprimary outcomes for the analyses were (1) ED disposition (admission or discharge), and (2) reattendance for gout flares (vs no reattendance) during the study period. Covariates were selected a priori on the basis of what were deemed to be important potential predictors of outcome measures, as follows: age, sex, time of arrival at ED (9 AM to 9 PM vs 9 PM to 9 AM), day of arrival at ED (Saturday/Sunday vs Monday to Friday), C-reactive protein (CRP) (mg/L), SU level (μmol/L), total white cell count ($\times 10^9$/L), and serum creatinine (μmol/L). For laboratory data, the result of the first test performed during the hospital attendance was captured for analysis, where available.

Statistical analyses. Baseline characteristics were tabulated and described without inferential statistics. Logistic regression was used to assess the strength and significance of associations between predictor variables and ED disposition. For patients with multiple ED presentations during the study period, only the first presentation was included in these models. Unadjusted models and models adjusted for all covariates (age, sex, time of arrival at ED, day of arrival at ED, CRP, SU level, total white cell count, and serum creatinine at baseline) were presented with odds ratios and 95% CIs.

Cox proportional hazards models were used to assess associations between predictor variables (age, sex, SU, and serum creatinine at presentation) and the risk of reattendance for gout flares during the study period (single-failure models). Unadjusted models and models adjusted for age, sex, SU, and serum creatinine at baseline were presented with hazard ratios and 95% CIs. Assumptions were tested graphically using Nelson-Aalen plots.

Differences were considered statistically significant if $P < 0.05$. As these were exploratory analyses, correction for multiple hypothesis testing was not performed. Statistical analyses were performed in Stata version 16.1 (StataCorp).

Case note review. To capture detailed information on the processes involved during hospital attendances for gout flares, alongside patient outcomes, we adopted a mixed methodological approach to interrogate the medical records of patients with attendance start dates between October 1, 2020, and December 31, 2020. Information was captured manually from every entry in the clinical records, regardless of who had entered it. Quantitative and qualitative approaches were used to review the data, including transcription of binary outcomes for prespecified variables (see Supplementary Data 1 for further information on captured variables, available with the online version of this article) and identification of common themes arising during patients' ED attendances, inpatient stays, and postdischarge follow-up.

Process mapping. Process mapping was performed to document the process steps and decision points in a typical patient journey, from attendance at ED with symptoms of a gout flare, through to discharge from hospital and subsequent community follow-up. A process flowchart approach based upon Six Sigma methodology was employed,[14] incorporating the findings of the case note reviews and semistructured discussions (n = 32) with multiple stakeholders. Stakeholders from multidisciplinary backgrounds were selected, with and without personal experience of managing hospitalized patients with gout, to ensure a broad range of views were considered (see Supplementary Data 2 for a list of stakeholder groups involved, available with the online version of this article). Sources of delay and/or suboptimal care were highlighted on the process map. Discussions were then held with stakeholders around potential solutions to address the key barriers to optimal hospitalized gout care that had been identified through case note reviews and process mapping. Potential solutions were grouped according to whether they primarily addressed the following barriers: diagnostic delay, inadequate flare treatment, inadequate flare prevention, inadequate follow-up arrangements, and prevention of readmissions.

Study approval. This study was performed as part of a service evaluation project (Preventing Hospital Admissions Attributable to Gout) with the objective of improving care for patients hospitalized for gout flares. Approval to undertake this service evaluation project was obtained from King's College Hospital National Health Service (NHS) Foundation Trust. National research ethical approval was not required under current Health Research Authority guidance.

RESULTS

Characteristics of gout attendances during the study period. Between January 1, 2017, and December 31, 2020, there were 1220 attendances with primary diagnoses of gout in 1065 patients; 287 attendances (23.5%) required admission to hospital from ED (median length of stay: 3.6 days; mean length of stay: 6.8 days); 933 attendances (76.5%) were discharged from ED without an inpatient stay. Inpatient stays for primary admission diagnoses of gout accounted for 1944 hospital bed-days across the study period.

Patient characteristics for gout flare attendances during the study period are summarized in Table 1. The mean age of patients was 59 years; 81.6% were male. 1018 attendances (83.4%) occurred at hospital A (urban location), and 202 attendances (16.6%) at hospital B (suburban location). Three hundred eighty-five attendances (31.6%) had an ED arrival time of between 9 PM and 9 AM. Three hundred twenty attendances (26.2%) began on a Saturday or Sunday. The mean SU level at presentation was 478 μmol/L, mean CRP was 66.1 mg/L, mean white cell count was 9.0×10^9/L, mean neutrophil count was 6.3×10^9/L, mean lymphocyte count was 1.8×10^9/L, and mean serum creatinine level was 127 μmol/L.

Predictors of admission to hospital from ED. In unadjusted and adjusted logistic regression models, there were statistically

Table 1. Characteristics of emergency and inpatient attendances for gout flares at 2 hospitals in London, UK, from January 1, 2017, to December 31, 2020.

	Total N = 1220	ED n = 933	Inpatient n = 287
Age, yrs	59 (17)	55 (16)	71 (16)
Sex			
Female	225 (18.4%)	145 (15.5%)	80 (27.9%)
Male	995 (81.6%)	788 (84.5%)	207 (72.1%)
Location			
Hospital A	1018 (83.4%)	829 (88.9%)	189 (65.9%)
Hospital B	202 (16.6%)	104 (11.1%)	98 (34.1%)
ED arrival time			
9 AM to 9 PM	835 (68.4%)	685 (73.4%)	150 (52.3%)
9 PM to 9 AM	385 (31.6%)	248 (26.6%)	137 (47.7%)
ED arrival day			
Mon–Fri	900 (73.8%)	680 (72.9%)	220 (76.7%)
Sat–Sun	320 (26.2%)	253 (27.1%)	67 (23.3%)
Serum urate, μmol/L	478 (137)	464 (119)	508 (166)
CRP, mg/L	66.1 (78.0)	40.5 (52.9)	109.8 (93.1)
White cell count, × 10^9/L	9.0 (3.0)	8.6 (2.5)	9.9 (3.5)
Neutrophil count, × 10^9/L	6.3 (2.7)	5.8 (2.3)	7.4 (3.2)
Lymphocyte count, × 10^9/L	1.8 (0.8)	2.0 (0.8)	1.6 (0.7)
Serum creatinine, μmol/L	127 (104)	116 (86)	148 (129)

Data for ED-only attendances and attendances requiring inpatient admission are shown in separate columns. For this table, patients could contribute multiple attendances; limiting to just the first attendance made no meaningful difference to patterns. For laboratory data, the result of the first test performed during the attendance was captured for analysis. Data are presented as mean (SD) for continuous measures, and n (%, by column) for categorical measures. ED: emergency department; CRP: C-reactive protein.

significant associations between the following predictor variables and the odds of admission to hospital from ED for gout flares (relative to discharge from ED): older age, overnight ED arrival, higher SU levels, higher CRP, and higher total white cell counts at presentation (Table 2; Supplementary Table 1, available with the online version of this article). Female sex predicted admission from ED in unadjusted models but not in adjusted models. This was due to an interaction between age and sex: the mean age of female patients presenting with gout flares was older than for male patients (66 vs 57 yrs). There was no significant association between the day of arrival at ED (weekend vs weekday) and the odds of admission for gout flares.

Predictors of reattendance. Of 1065 patients with primary admission diagnosis of gout, 111 (10.4%) had > 1 attendance for gout flares at hospitals A or B during the study period: 85 patients had 2 attendances, 14 patients had 3 attendances, 7 patients had 4 attendances, 4 patients had 5 attendances, and 1 patient had 6 attendances. In unadjusted survival models, associations were present between the risk of recurrent attendance for gout flares during the study period (relative to no recurrent attendance) and male sex and higher SU levels; however, following adjustment for other covariates, these associations were not statistically significant (Table 3). There were no statistically significant associations between the risk of recurrent attendance for gout flares and age or serum creatinine level at presentation.

Detailed review of inpatient gout management. To provide an in-depth understanding of current practice during hospital attendances for gout flares, detailed case note reviews were performed for patients with attendances between October 1, 2020, and December 31, 2020. Of 59 attendances, 13 (22.0%) required inpatient stays and 46 (78.0%) were ED-only attendances. Thirty-one patients (52.5%) had preexisting diagnoses of gout, of whom only 7 (22.6%) were on ULT at the time of presentation (all at suboptimal doses).

There was initial diagnostic uncertainty in 29/59 patients (49.2%), with septic arthritis considered in 8 patients (13.6%), 5 of whom received antibiotic cover while diagnostic tests were performed. Despite diagnostic uncertainty being prevalent, rheumatology consultation was sought in ED in only 8 cases (13.6%), whereas joint aspiration was attempted in only 6 patients (10.2%).

Fifty-four patients (91.5%) received antiinflammatory treatment for their flare: NSAIDs (n = 30; 50.8%), colchicine (n = 27; 45.8%), oral corticosteroids (n = 7; 11.9%), or intraarticular steroids (n = 1; 1.7%). Fifteen patients (25.4%) were on diuretic therapy, of whom 1 patient had their diuretics reviewed. Four patients (6.8%) had ULT initiated during their inpatient stay or ED attendance (allopurinol 100 mg once daily in all cases). Documented education on the diagnosis and/or

Table 2. Associations between prespecified predictor variables and the odds of admission to hospital for a gout flare, relative to discharge from ED without admission.

	Unadjusted β	Unadjusted OR	95% CI	*P*	Adjusted β	Adjusted OR	95% CI	*P*
Age (per 10-yr increase)	0.58	1.78	(1.61–1.96)	< 0.001	0.38	1.47	(1.25–1.72)	< 0.001
Female sex	0.65	1.91	(1.37–2.67)	< 0.001	0.48	1.62	(0.86–3.03)	0.13
ED arrival time (9 PM to 9 AM)	0.91	2.48	(1.85–3.33)	< 0.001	0.87	2.39	(1.40–4.08)	0.001
ED arrival day (Sat/Sun)	–0.16	0.85	(0.61–1.19)	0.36	0.20	1.22	(0.70–2.13)	0.49
Serum urate (per 100-μmol/L increase)	0.23	1.25	(1.08–1.45)	0.003	0.23	1.25	(1.05–1.50)	0.01
CRP (per 10-mg/L increase)	0.14	1.15	(1.11–1.18)	< 0.001	0.11	1.12	(1.07–1.16)	< 0.001
Total white cell count (per 1 × 10^9/L increase)	0.16	1.17	(1.11–1.24)	< 0.001	0.13	1.14	(1.04–1.25)	0.007
Serum creatinine (per 10-μmol /L increase)	0.03	1.03	(1.01–1.05)	0.003	0.02	1.02	(0.99–1.04)	0.16

Unadjusted and adjusted associations are shown. Adjustment was performed for: age, sex, ED arrival time, ED arrival day, serum urate, CRP, total white cell count, and serum creatinine at baseline. Outputs are reported with clinically meaningful units (see Supplementary Table 1 for outputs with units as originally reported, available with the online version of this article). ED: emergency department; CRP: C-reactive protein; OR: odds ratio.

Table 3. Cox proportional hazards model outputs demonstrating associations between prespecified predictor variables and the risk of recurrent attendances for gout flares during the study period, relative to no recurrent attendance.

	Unadjusted HR	95% CI	*P*	Adjusted HR	95% CI	*P*
Age (per 10-yr increase)	1.05	(0.94–1.17)	0.37	1.09	(0.93–1.28)	0.30
Male sex	1.81	(1.01–3.22)	0.04	1.29	(0.62 – 2.67)	0.50
Serum urate (per 100-μmol/L increase)	1.19	(1.00–1.42)	0.04	1.19	(0.98–1.43)	0.07
Serum creatinine (per 10-μmol/L increase)	1.01	(0.99–1.03)	0.53	1.00	(0.96–1.03)	0.80

Unadjusted and adjusted associations are shown. Adjustment was performed for age, sex, serum urate, and serum creatinine at baseline. Variables are reported with clinically meaningful units. HR: hazard ratio.

treatment of gout was provided to 19 patients (32.2%); however, specific advice on how to self-manage gout flares was provided to only 1 patient.

Of the 13 patients who required admission, 10 (76.9%) experienced delays in discharge from hospital (ie, beyond that needed for treatment of the gout flare itself), for the following reasons: investigation/treatment of non-gout diagnoses (n = 8); delayed referral for rheumatology consultation (n = 4); input from physiotherapists, occupational therapists, and/or social workers (n = 4); and/or delayed decisions on when to stop antibiotic therapy commenced as cover for septic arthritis (n = 3).

On discharge from hospital, 38 patients (64.4%) were provided with a discharge plan specifying treatment recommendations and/or follow-up for gout: 33 patients (55.9%) had primary care follow-up recommended; 10 patients (16.9%) had rheumatology follow-up recommended; and 16 patients (27.1%) had recommendations to initiate and/or uptitrate ULT after discharge from hospital, 3 of whom had a treat-to-target approach advised.

Of 55 patients with 6-month postdischarge follow-up data available, 19 patients (34.5%) initiated ULT or had their preadmission ULT uptitrated within 6 months of discharge. The median time to initiation or first titration of ULT was 30 days (IQR 17–69). In total, 24 patients (43.6%) were receiving ULT by 6 months postdischarge. Fourteen patients were coprescribed prophylaxis during ULT initiation/titration. Nine patients (16.4%) had evidence of treat-to-target ULT titration during the 6-month postdischarge period; however, only 5 patients (9.1%) achieved a SU level of ≤ 360 μmol/L, while 1 patient (1.8%) achieved a SU level of ≤ 300 μmol/L. Four patients (7.3%) re-presented to hospital for gout flares within 6 months of discharge, with a median time to reattendance of 73 days (IQR 33–139).

Process mapping. Process mapping was performed to describe a typical patient journey, from attendance at ED with symptoms of a gout flare, to discharge from hospital and subsequent community follow-up. The processes, decision steps, and sources of delay are summarized in Figure 1 (see Supplementary Figure 1 for a detailed process map, available with the online version of this article). In consultation with stakeholders, strategies were identified to address key barriers to optimal admitted gout care and readmission prevention (Table 4).

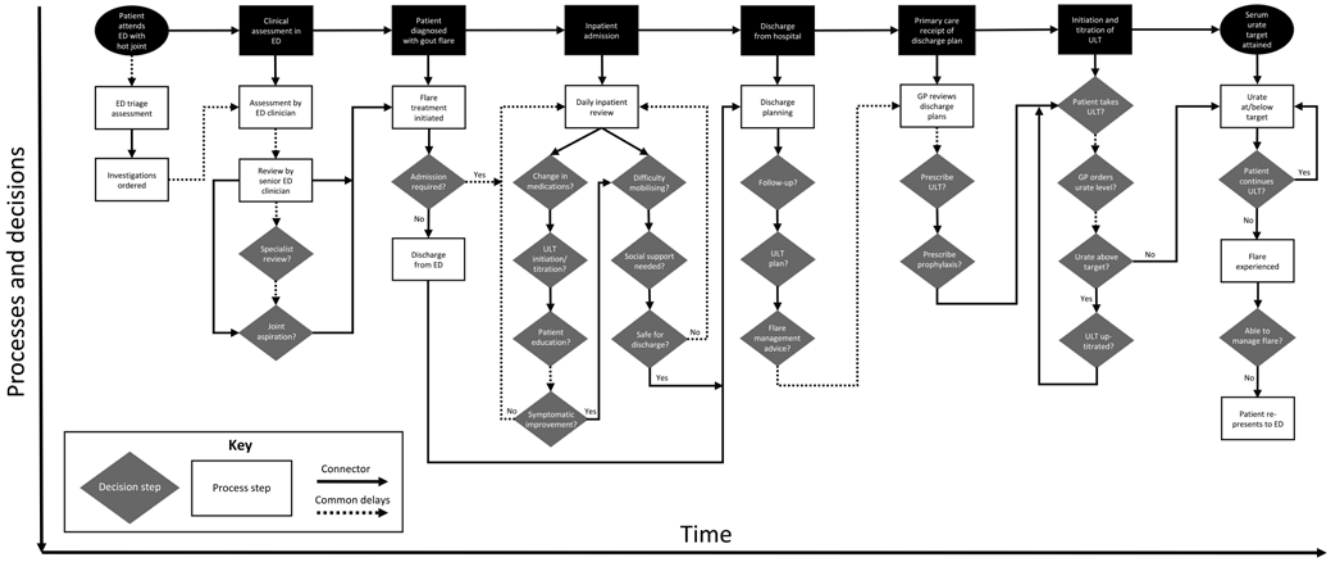

Figure 1. Process map of a typical patient journey during and after an ED attendance for a gout flare. Process steps are shown as rectangles; decision steps are shown as diamonds; ovals represent start/stop points. A high-level process map is shown at the top. Arrows depict flow between processes and decisions steps; dashed arrows highlight common sources of delay. See Supplementary Figure 1 for a detailed process map (available with the online version of this article). ED: emergency department; GP: general/family practitioner; ULT: urate-lowering therapy.

Table 4. Barriers to optimal care of patients attending hospital for gout flares and potential solutions to overcome these barriers.

Problem	Potential Solutions
Diagnostic delay	· Early involvement of rheumatology specialists · Prompt aspiration of joint effusions · Provision of training in point-of-care crystal analysis
Inadequate treatment of flares	· Timely initiation of flare treatments at therapeutic doses · Use of combination therapy for severe and/or polyarticular flares · Therapeutic aspiration of joint effusions to dryness · Use of intraarticular corticosteroids where appropriate
Inadequate flare prevention	· Initiation/titration of ULT during the flare · Education for patients and clinicians on the benefits of ULT · ULT titration using a treat-to-target approach
Inadequate follow-up	· Rheumatology follow-up after discharge · Guidance for primary care clinicians on when to review patients · Use of remote monitoring/consultations (eg, for ULT titration) · Involvement of multidisciplinary professionals (eg, pharmacists)
Readmission for flare	· Education for patients on how to self-manage flares · Rescue packs of antiinflammatory medications for patients · Prescription of flare prophylaxis during ULT initiation/titration · Provision of a helpline for patients to contact in the event of flare · Use of admission avoidance pathways (eg, hot clinics)

Barriers and solutions were identified in consultation with stakeholders, following case note review and process mapping. ULT: urate-lowering therapy.

DISCUSSION

In this study, we described the characteristics and management of patients hospitalized for gout flares in one of the most detailed analyses to date. We identified demographic and clinical predictors of hospitalization from ED, including older age, overnight ED arrival, and higher SU levels. Through detailed case note reviews and process mapping, we highlighted barriers to optimal care and identified strategies to prevent avoidable admissions.

Many of the ED attendances and hospital admissions in our cohort could have been prevented with better use of existing treatments. Over half of the attendances detailed in our case note review involved patients with preexisting gout. However, only 23% of these patients were receiving ULT at the time of presentation, and less than half were prescribed ULT by 6 months postdischarge. In patients receiving ULT, attainment of target SU levels was poor, leaving patients at risk of readmission.

Our findings support previously published reports of suboptimal gout care in other hospitalized cohorts.[12,13] They are consistent with studies reporting inadequate prescription of ULT in primary care and infrequent attainment of target SU levels in rheumatology clinics.[1,15] The reasons behind the inadequate prescription and titration of ULT are manyfold, and include poor understanding of the benefits of ULT, both from a provider and patient perspective.[16] In our cohort, education was provided to only one-third of patients during their hospital attendance. Strategies to both encourage the provision of education and increase the prescription/titration of ULT for hospitalized patients are likely to have a beneficial effect on outcomes. In a randomized controlled trial of primary care patients with gout (n = 517), nurse-delivered patient education and treat-to-target ULT were highly effective at improving attainment of SU targets, reducing flares, and improving quality of life.[9] A similar approach, adapted for implementation during hospitalizations for gout flares, may help prevent avoidable admissions. This should include guidance for patients on how to self-manage flares, prescription of rescue packs to enable prompt flare treatment, and access to admission avoidance pathways for treatment-resistant or severe flares. To reduce the effect of post-discharge recommendations not being acted upon, ULT should be initiated during hospitalizations and ED attendances where possible; this is in line with recently updated American College of Rheumatology guidance, which conditionally recommends initiating ULT during flares, alongside treatment for the flare.[17] Once initiated, patients and primary care clinicians should be provided with clear guidance on ULT titration, to ensure target SU levels are achieved, with rheumatology input as required.

In our cohort, discharge delays were common, and contributed to a mean length of stay of > 6 days; this is in keeping with the mean length of stay observed for gout admissions at a national level.[4] In many cases, delays occurred in the context of the management of non-gout diagnoses and/or a need for allied health professional input, reflective of the older age of patients requiring admission. Delays in referral for rheumatology consultation were not uncommon, and, in the majority of cases, rheumatology input was not sought in the ED, despite initial diagnostic uncertainty in half of patients. Strategies to encourage timely referral for rheumatology input, joint aspiration, and use of intraarticular corticosteroids could reduce diagnostic and treatment delays; this is supported by studies demonstrating associations between inpatient rheumatology consultation and improved outcomes for patients attending hospital for gout flares.[12,13,18,19,20,21]

Our finding that older age predicts inpatient admission following ED attendances for gout flares is supported by previously published studies.[7,8] In our cohort, the risk of admission was also greater in patients presenting to ED overnight, and in patients with higher SU, CRP, and total white cell counts at presentation. Many of these predictors are likely to reflect more general predictors of hospital admission (eg, older age, greater burden of disease, overnight presentation). Validation of these predictors in population-level datasets could facilitate development of admission risk calculators for patients presenting with gout flares. This, in turn, may have utility in directing resources (eg, rheumatology consultation and admission avoidance pathways) toward patients most at risk of admission.

Our study has limitations. Our analyses were restricted to gout attendances at 2 hospitals and, although consistent with the findings of other studies,[1,12,13] our findings cannot be assumed to be generalizable to other locations. Indeed, the primary purpose of this work was to inform local service transformation and quality improvement. However, our quality improvement methodology could be adapted for use at other locations, with the aim of improving inpatient and postdischarge care. The subset of patients for whom we performed detailed case note reviews attended hospital during the COVID-19 (coronavirus disease 2019) pandemic, and, as such, their care may not be fully reflective of other timepoints. Reattendance for gout flare occurred in only 10% of our cohort over the study period; therefore, our analyses of predictors of reattendance lacked statistical power. A number of factors known to affect gout management (eg, medication adherence, comorbidities, diuretic use) were not included within our prediction models. Additionally, our cohort did not include attendances with secondary diagnoses of gout (eg, gout flares occurring during admissions for heart failure) or capture data on readmissions to hospitals outside of South East London (ie, right censorship); thus, our analyses will be an underestimate of the true inpatient burden of gout.

Further analyses using national datasets with linked primary and secondary care data are needed to provide a more complete picture of this avoidable epidemic.

ONLINE SUPPLEMENT

Supplementary material accompanies the online version of this article.

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