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Backhouse, MR [orcid.org/0000-0003-0056-8467](http://orcid.org/0000-0003-0056-8467), Keenan, A-M [orcid.org/0000-0003-0926-0397](http://orcid.org/0000-0003-0926-0397), Hensor, EMA [orcid.org/0000-0002-5245-4755](http://orcid.org/0000-0002-5245-4755) et al. (8 more authors) (2011) Use of conservative and surgical foot care in an inception cohort of patients with rheumatoid arthritis. *Rheumatology*, 50 (9). pp. 1586-1595. ISSN 1462-0324

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## Original article

## Use of conservative and surgical foot care in an inception cohort of patients with rheumatoid arthritis

Michael R. Backhouse<sup>1,2</sup>, Anne-Maree Keenan<sup>1,2</sup>, Elizabeth M. A. Hensor<sup>1,2</sup>, Adam Young<sup>3</sup>, David James<sup>4</sup>, Josh Dixey<sup>5</sup>, Peter Williams<sup>6</sup>, Peter Prouse<sup>7</sup>, Andrew Gough<sup>1,8</sup>, Philip S. Helliwell<sup>1,2</sup> and Anthony C. Redmond<sup>1,2</sup>

## Abstract

**Objectives.** To describe conservative and surgical foot care in patients with RA in England and explore factors that predict the type of foot care received.

**Methods.** Use of podiatry and type of foot surgery were outcomes recorded in an inception cohort involving nine rheumatology centres that recruited patients with RA between 1986 and 1998 across England. Associations between patient-specific factors and service use were identified using univariate logistic regression analyses. The independence of these associations was then verified through multiple binary logistic regression modelling.

**Results.** Data were collected on 1237 patients with RA [66.9% females, mean (s.d.) age at disease onset = 54.36 (14.18) years, median DAS = 4.09 (1st quartile = 3.04, 3rd quartile = 5.26), median HAQ = 1 (0.50, 1.63)]. Interventions involving the feet in the cohort were low with only 364 (30%) out of 1218 receiving podiatry and 47 (4%) out of 1237 patients having surgery. At baseline, female gender, increasing age at onset, being RF positive and higher DAS scores were each independently associated with increased odds of seeing a podiatrist. Gender, age of onset and baseline DAS were independently associated with the odds of having foot surgery.

**Conclusions.** Despite the known high prevalence of foot pathologies in RA, only one-third of this cohort accessed podiatry. While older females were more likely to access podiatry care and younger patients surgery, the majority of the RA population did not access any foot care.

**Key words:** Rheumatoid arthritis, Foot, Podiatry, Surgery, Orthopaedic surgery, Foot care, Access to service.

## Introduction

The propensity of RA to affect the joints of the hands and feet is familiar to patients and clinicians alike. Foot symptoms account for the initial presentation in ~20% of

patients, increasing with disease duration to eventually affect 90% of patients during the course of their disease [1–3].

Repeated and chronic inflammatory changes of the joints and periarticular tissues result in important and irreversible structural changes [4–6]. The usual forefoot presentation is of retraction and dorsal subluxation of the lesser toes, displacement of the plantar fat pad and particularly hallux valgus, which has been reported in 80% of patients with established disease [7, 8]. Involvement of the mid- and rear-foot is less common initially, but manifests as tibialis posterior tendon dysfunction, flattening of the medial longitudinal arch and valgus deformity of the calcaneus [5, 9].

In addition to physical deformity, patients with RA can endure neurological and vascular deficiency in their feet, which contributes to impaired tissue viability and ulceration [10–13]. Furthermore, there is a growing body of

<sup>1</sup>Section of Musculoskeletal Disease, University of Leeds, <sup>2</sup>NIHR Leeds Musculoskeletal Biomedical Research Unit, Leeds Teaching Hospitals NHS Trust, Leeds, <sup>3</sup>Department of Rheumatology, St Albans City Hospital, St Albans, <sup>4</sup>Department of Rheumatology, Grimsby Hospital, Grimsby, <sup>5</sup>Department of Rheumatology, New Cross Hospital, Wolverhampton, <sup>6</sup>Department of Rheumatology, Medway Maritime Hospital, Gillingham, <sup>7</sup>Department of Rheumatology, North Hampshire Hospital, Basingstoke and <sup>8</sup>Department of Rheumatology, Harrogate District Hospital, Harrogate, UK.

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Correspondence to: Michael R. Backhouse, Section of Musculoskeletal Disease, University of Leeds, 2nd Floor, Chapel Allerton Hospital, Harehills Lane, Leeds LS7 4SA, UK.  
E-mail: m.r.backhouse07@leeds.ac.uk

evidence highlighting that these local changes within the foot have subsequent global impact on physical function, emotional well-being and quality of life in patients with RA [14–16].

Evidence for conservative treatment of foot pathology exists through randomized controlled trials that demonstrate the effectiveness of interventions including foot orthoses and specialist footwear in improving pain and foot-related quality of life in patients with RA [17, 18]. In comparison, however, despite some evidence from observational studies, there is a paucity of quality evidence for the effectiveness of foot surgery in RA [19, 20].

Foot health services, particularly conservative care, may be provided by a variety of health professionals with some overlap between, for example, orthotists and podiatrists in the provision of this care. Despite this diversity, clinicians have expressed concerns as to the generally poor availability of foot health services across rheumatology [21, 22]. National surveys have identified large regional variation in provision of foot care resulting in suboptimal care [22]. In 2006, only one-quarter of rheumatology departments reported having access to a podiatrist and only 18% had foot health services dedicated to rheumatology [22]. This inadequacy of foot health service provision on the NHS has led to as few as 40% of rheumatology patients receiving any foot care, half of whom had to purchase it privately [23].

To date, the only national study looking at foot health provision found large variation between regions [22]. Yet the only study looking at patients' use of foot health services in rheumatology investigates this in a single hospital [23]. To date, no study has investigated the use of foot health services on a national level specifically in RA. The aim of this study was to describe foot care, including foot surgery, in patients with RA from a national perspective and to explore factors that predict the type of foot care received.

## Methods

### Participants

The Early Rheumatoid Arthritis Study (ERAS) is an inception cohort still in follow-up, which recruited patients between 1986 and 1998, from nine hospitals across England. Ethical approval was gained from the East Hertfordshire Ethics Committee. Consecutive assenting patients with RA were enrolled if symptoms had been present for <2 years and before initiation of DMARD therapy. Patients not meeting the 1987 ACR criteria [24] were followed up and subjected to subgroup analysis with patients being excluded if the diagnosis changed—for example, early RA changing to lupus. Further information regarding entry criteria and follow-up details has been described in previous reports [25, 26].

All centres followed the UK published framework guidelines for management of RA in the 1990s, which include early use of sequential monotherapy, step-up combination therapy in patients with severe disease and judicious use of steroids. DMARDs were chosen according to the

physician's preference, with SSZ the most commonly used first DMARD followed by MTX, as previously described. Biological agents were not used during the study period.

### Data collection

Prospective standardized clinical and laboratory assessments were performed by trained metrologists at initial presentation and at an annual appointment. These included two articular indices; the Ritchie articular index (RAI) and a swollen joint count (SJC) of 59 joints, as described previously [26], HAQ, a 100-mm visual analogue scale for pain and presence of extra-articular features and nodules. Disease activity was measured using the original three-variable disease activity score (DAS) based on tender joint count and SJC and acute-phase marker (ESR or CRP) as this was the main tool available at the time [27]. Standardized radiographs of the hands and feet taken at presentation and at 1, 2, 3, 5, 7 and 9 years were digitized, and then scored by one observer as reported previously [28]. Social deprivation was measured using the Carstairs deprivation index with scores derived from results of the 1991 census. Laboratory variables included ESR and presence of RF. Allied health professional (AHP) intervention (podiatrist and orthotist) along with provision of aids and appliances (walking aids) were recorded except where these were issued in the immediate post-operative period. Each inpatient episode was documented along with details of soft tissue, tendon or joint surgery resulting from RA as previously reported [29]. Full details of clinical and laboratory assessments employed in the cohort are described elsewhere [25, 26].

### Statistical analysis

Summary statistics were used to describe clinical features of the cohort along with use of conservative foot health intervention provided by podiatrists and orthotists up to 9 years after diagnosis. Exploratory analysis was performed to identify patient-specific factors associated with use of podiatry and surgery. For podiatry, odds ratios (ORs) were calculated separately for each independent variable using bivariate logistic regression analyses, and then the independence of these associations were verified through multiple binary logistic regression modelling. Wald tests were used to assess the significance of the association between each predictor and the odds of the outcome. Pearson's residuals and leverage values were inspected to identify any potential outliers. Hosmer and Lemeshow tests were used to assess goodness-of-fit and the receiver operating characteristic (ROC) area under the curve was used as an indicator of the discriminatory power of each model. For surgery (where more accurate data were available regarding the timing of the intervention), Cox proportional hazard regression analyses were conducted for variables recorded at entry into the study and at 1 year; variables recorded at any time during follow-up were entered into binary logistic regression models as for podiatry. For Cox regression, the proportional hazards assumption was tested for individual variables

and then for the model as a whole using a likelihood ratio test of nested models, one of which contained a full set of interactions between all of the entered variables and log (time to surgery). Goodness-of-fit was assessed using the Groennesby and Borgan test. Statistical analyses were conducted in PASW 17.0.2 and Stata 11. Full data were not available for all patients, but because the proportion of patients with missing data was low (<6%), we chose to include only patients with data available at each stage of the analysis and did not impute any missing values.

## Results

The sample consisted of 1237 patients, of whom 33.1% ( $n=409$ ) were male and 66.9% ( $n=828$ ) were female. The mean (s.d.) age at onset of symptoms was 54.36 (14.18) years with a range of 17–93 years. The median [interquartile range (IQR)] baseline DAS and HAQ were 4.09 (3.04–5.26) and 1.000 (0.500–1.625), respectively. RF was not available at baseline for 14 patients; 899 (73.5%) out of 1223 were at least weakly RF positive and 770 (62.9%) out of 1223 were moderately or strongly RF positive. Erosions were present in a minority of patients [302 (24.9%) out of 1212] at baseline [feet 122 (10.1%) out of 1212; hands 86 (7.1%) out of 1212; hands and feet 94 (7.8%) out of 1212].

One year after diagnosis, both the median (IQR) DAS and HAQ had reduced to 2.97 (1.85–4.11) and 0.625 (0.125–1.375), respectively. However, the number of patients with any erosions had increased [412 (38%) out of 1075], as did the number with foot erosions [290 (27%) out of 1075]. Data on the Carstairs deprivation index were available for 1231 patients: proportions of patients falling into the five quintiles were 18.2% (lowest quintile), and 21.9, 24.4, 18.0 and 17.1% (highest quintile). Maximum follow-up for conservative care varied, with 57% ( $n=702$ ) followed up for 9 years, 92% ( $n=1142$ ) for 5 years and 100% ( $n=1237$ ) for 3 years. At maximum follow-up, 82% ( $n=1012$ ) had been RF positive at some point of their disease, 79% ( $n=974$ ) had ever had erosions detected on X-ray and 34% ( $n=425$ ) had ever had nodules.

Patients who were lost to follow-up or died before their 9-year follow-up did not differ substantively from those who were followed up in terms of age at onset (mean 56 vs 53 years), gender (both groups 67% females), baseline DAS (mean 4.2 vs 4.3), baseline HAQ (median 1.125 vs 1.000), RF-positive status (72 vs 75%), presence of erosions at baseline (16 vs 19%) or Carstairs deprivation index (lowest or second quintile 38 vs 42%; fourth or highest quintile 36 vs 34%).

Although 827 (68.9%) out of 1201 used assistive appliances during the study period (e.g. wrist splints, kitchen aids, etc.), only 20 patients reported using a walking aid or caliper, and hence this number was too small for meaningful further analysis. However, 190 (15.5%) out of 1225 patients were seen by an orthotist during the follow-up period and associations with use of podiatry and use of surgery were explored.

Data on podiatry input were available for 1218 patients, of whom only 30% ( $n=364$ ) received podiatry care

following inception. The proportion of patients seeing a podiatrist increased with time despite the absolute numbers falling due to incomplete data. At 3 years, 17.4% ( $n=200/1152$ ) had seen a podiatrist; by 5 years the proportion was 26.1% ( $n=266/1021$ ) and had risen to 36.5% ( $n=251/687$ ) by 9 years.

A total of 59 surgical procedures were performed on 47 (4%) patients; the mean (s.d.) age of patients at their first operation was 53.6 (12.8) years. The time to patients having their first operation ranged from 7 to 106 months, with a median (first to third quartile) of 58 (41–79) months. The vast majority of procedures were conducted on the forefoot with 41 MTP joint procedures on 32 patients compared with 4 on the ankle or hindfoot of 4 patients and 14 soft-tissue procedures on 12 patients. Range of movement (ROM) data were dichotomized for each of the available anatomical locations as either reduced or normal. Reduced ROM was seen in 33.0% ( $n=359/1087$ ) of patients at their MTP joints, 37.6% ( $n=426/1133$ ) of patients in their hindfoot and 36.8% ( $n=418/1135$ ) of patient at their ankles.

### Associations of patient-specific factors with use of podiatry and surgery

Results of all bivariate analyses showing associations with use of podiatry and foot surgery are summarized below and presented in Table 1 (supplementary details of the logistic regression analyses are presented in appendix A, available as supplementary data at *Rheumatology Online*).

#### Use of podiatry

Bivariate analyses revealed associations between several demographic factors and use of podiatry (Table 1). The mean (s.d.) age at onset of the group who had ever received podiatry was 59.10 (13.0) years, whereas those who did not receive podiatry were younger with a mean (s.d.) age of 52.21 (14.2) years. Unadjusted odds of receiving podiatry increased with age, and were higher in females than males. No association was identified between social deprivation and use of podiatry.

Markers of disease severity were examined and found to be inconsistently associated with future podiatric care. There were no substantive associations with the presence of nodules or RF at baseline or 1 year. However, the presence of erosions in the hands or feet at either time point increased the odds of accessing podiatry as did higher ESR, DAS and HAQ.

Patients who saw an orthotist at any point during the follow-up period were also more likely to see a podiatrist (OR 4.33). There was some evidence that recording a positive RF at any point during follow-up was associated with higher odds of podiatry (OR 1.32), but this was not statistically significant at the 5% level ( $P=0.093$ ). Patients with reduced ROM in their feet during the follow-up period were more likely to be treated by podiatrists. Reduced hindfoot ROM was most strongly associated with podiatry (OR 2.71,  $P<0.001$ ) closely followed by impairment of the MTP joints (OR 2.68,  $P<0.001$ ) and ankle (OR 2.35,  $P<0.001$ ).

TABLE 1 Results of bivariate logistic and Cox regression analyses

At baseline	<i>n</i>	<i>n</i> (%) had podiatry ever	OR (95% CI)	Significance (P-value)
Gender				
Male	404	75 (18.6)	2.415 (1.809, 3.224)	<0.001
Female	814	289 (35.5)		
Age at onset, per year	1218	-	1.038 (1.028, 1.047)	<0.001
Carstairs deprivation index				
First quintile	221	70 (31.7)	Reference, overall	0.223
Second quintile	267	80 (30.0)	0.923 (0.627, 1.357)	0.683
Third quintile	296	79 (26.7)	0.785 (0.535, 1.152)	0.216
Fourth quintile	217	77 (35.5)	1.186 (0.798, 1.765)	0.399
Fifth quintile	206	56 (27.2)	0.805 (0.530, 1.223)	0.310
RF				
Negative	322	89 (27.6)	1.167 (0.880, 1.549)	0.284
Positive	882	272 (30.8)		
Nodules				
Absent	1123	335 (29.8)	1.034 (0.656, 1.629)	0.887
Present	95	29 (30.5)		
X-ray erosions foot only				
Absent	984	284(28.9)	1.250 (0.910, 1.716)	0.168
Present	211	71 (33.6)		
X-ray erosions hands or feet				
Absent	900	252 (28.0)	1.379 (1.042, 1.825)	0.024
Present	295	103 (34.9)		
ESR, per mm/h	1216	-	1.006 (1.002, 1.010)	0.006
DAS, per unit	1209	-	1.180 (1.094, 1.273)	<0.001
HAQ, per unit	1212	-	1.571 (1.334, 1.850)	<0.001

  

At 1 year	<i>n</i>	<i>n</i> (%) had podiatry ever	OR (95% CI)	Significance (P-value)
Nodules				
Absent	1095	323 (29.5)	1.195 (0.804, 1.777)	0.379
Present	123	41 (33.3)		
X-ray erosions foot only				
Absent	776	207 (26.7)	1.530 (1.147, 2.043)	0.004
Present	288	103 (35.8)		
X-ray erosions hands or feet				
Absent	654	175 (26.8)	1.344 (1.027,1.759)	0.031
Present	410	135 (32.9)		
ESR, per mm/h	1178	-	1.009 (1.005, 1.014)	0.001
DAS, per unit	1170	-	1.226 (1.137,1.323)	<0.001
HAQ, per unit	1182	-	1.742 (1.475, 2.058)	<0.001

  

Ever during follow-up	<i>n</i>	<i>n</i> (%) had podiatry ever	OR (95% CI)	Significance (P-value)
Saw an orthotist				
No	1029	253 (24.6)	4.326 (3.132, 5.974)	<0.001
Yes	188	110 (58.5)		
RF				
Negative	221	56 (25.3)	1.323 (0.950, 1.843)	0.098
Positive	994	308 (31.0)		
Nodules				
Absent	798	228 (28.6)	1.197 (0.927, 1.546)	0.168
Present	420	136 (32.4)		
X-ray erosions hands or feet				
Absent	252	60 (23.8)	1.467 (1.065, 2.020)	0.019
Present	964	303 (31.4)		
Hindfoot ROM				
Normal	694	150 (21.6)	2.713 (2.083, 3.533)	<0.001
Reduced	423	181 (42.8)		
MTP joint ROM				
Normal	717	165 (23.0)	2.683 (2.044, 3.522)	<0.001
Reduced	355	158 (44.5)		
Ankle ROM				
Normal	705	161 (22.8)	2.354 (1.809, 3.063)	<0.001
Reduced	414	170 (41.1)		

(continued)

TABLE 1 Continued

At baseline	<i>n</i>	Mean (95% CI) time to foot surgery	HR (95% CI)	Significance (P-value)
Gender				
Male	409	106.72 (105.80, 107.64)	2.481 (1.159, 5.308)	0.010
Female	828	105.13 (104.19, 106.06)		
Age of onset, per year	1237	-	0.974 (0.954, 0.994)	0.012
Carstairs deprivation index				
First quintile	224	105.81 (104.36, 107.26)	Reference, overall	0.754
Second quintile	270	106.49 (105.28, 107.69)	0.654 (0.243, 1.756)	0.654
Third quintile	300	105.69 (104.28, 107.10)	0.958 (0.397, 2.312)	0.958
Fourth quintile	221	105.83 (104.26, 107.39)	0.915 (0.353, 2.371)	0.854
Fifth quintile	211	104.71 (102.59, 106.43)	1.268 (0.515, 3.120)	0.606
RF				
Negative	222	106.02 (104.73, 107.30)	1.148 (0.584, 2.254)	0.686
Positive	1012	105.51 (104.67, 106.34)		
Nodule				
Absent	812	105.61 (104.88, 106.35)	0.752 (0.233, 2.422)	0.618
Present	425	106.14 (103.96, 108.31)		
X-ray erosions foot only				
Absent	996	106.00 (105.29, 106.71)	1.648 (0.851, 3.190)	0.155
Present	216	104.58 (102.58, 106.59)		
X-ray erosions hands or feet				
Absent	910	106.02 (105.28, 106.76)	1.550 (0.834, 2.880)	0.178
Present	302	104.91 (103.29, 106.52)		
Baseline ESR	1235	-	0.998 (0.988, 1.008)	0.710
Baseline DAS	1227	-	1.229 (1.041, 1.450)	0.015
HAQ, per unit	1231	-	0.893 (0.667, 1.448)	0.932

  

At 1 year	<i>n</i>	Mean (95% CI) time to foot surgery	OR (95% CI),	Significance (P-value)
Nodules				
Absent	1111 <sup>a</sup>	93.83 (93.13, 94.54)	1.252 (0.531, 2.953)	0.608
Present	125	92.94 (90.50, 95.38)		
X-ray erosions foot only				
Absent	784 <sup>a</sup>	94.22 (93.45, 94.98)	1.984 (1.053, 3.736)	0.034
Present	290	92.74 (91.09, 94.39)		
X-ray erosions hands or feet				
Absent	662 <sup>a</sup>	94.04 (93.18, 94.90)	1.375 (0.733, 2.580)	0.322
Present	412	93.41 (92.13-94.68)		
ESR, per mm/h	1194 <sup>a</sup>	-	1.010 (0.999, 1.020)	0.085
DAS, per unit	1186 <sup>a</sup>	-	1.161 (0.979, 1.377)	0.085
HAQ, per unit	1198 <sup>a</sup>	-	0.989 (0.662, 1.477)	0.957

  

Ever during follow-up	<i>n</i>	<i>n</i> (%) had foot surgery	OR (95% CI)	Significance (P-value)
Saw an orthotist				
No	1035	25 (2.4)	5.290 (2.916, 9.599)	<0.001
Yes	190	22 (11.6)		
RF				
Negative	222	7 (3.2)	1.264 (0.559, 2.860)	0.573
Positive	1012	40 (4.0)		
Nodules				
Absent	812	24 (3.0)	1.879 (1.047, 3.370)	0.032
Present	425	23 (5.4)		
X-ray erosions hands or feet				
Absent	261	6 (2.3)	1.868 (0.784, 4.448)	0.152
Present	974	41 (4.2)		
Hindfoot ROM				
Normal	707	23 (3.3)	1.542 (0.843, 2.822)	0.157
Reduced	426	21 (4.9)		
MTP joint ROM				
Normal	728	18 (2.5)	2.952 (1.589, 5.487)	<0.001
Reduced	359	25 (7.0)		
Ankle ROM				
Normal	717	24 (3.3)	1.451 (0.792, 2.660)	0.226
Reduced	418	20 (4.8)		

<sup>a</sup>One patient who had soft-tissue surgery within the first 12 months was excluded from 'any surgery' and 'soft-tissue surgery' 1-year analyses because this would confound the predictive model.



### Foot surgery

The mean (s.d.) age at onset of the group recorded as ever having foot surgery was 48.70 (12.61) years, whereas those who did not have surgery were older with a mean (s.d.) age of onset of 54.58 (14.20) years. Age of onset of RA was associated with having foot surgery with the hazard (risk) of having surgery decreasing by 2.6% per year of age at disease onset ( $P=0.012$ ). As with use of podiatry, females were more than twice as likely to have foot surgery within the given observation period compared with males [hazard ratio (HR) 2.48,  $P=0.010$ ], although the 95% CI (1.16, 5.31) was wider due to the small number of patients having surgery.

Investigation of associations between markers of disease severity and foot surgery revealed that baseline DAS demonstrated a strength of association with any foot surgery similar to that with the use of podiatry (HR 1.23 for each unit increase in DAS,  $P=0.015$ ). In contrast, baseline ESR and HAQ at baseline were not significantly associated with foot surgery. Furthermore, by 1 year, neither ESR, DAS nor HAQ was associated with future foot surgery. Patients having foot surgery were also more likely to receive care from an orthotist (OR 5.29,  $P<0.001$ ). However, out of the 47 patients who had foot surgery, 28 of them had not seen a podiatrist in the first 9 years of their disease, and 18 had seen neither a podiatrist nor an orthotist.

### Predictors of future podiatry and foot surgery

Multivariate logistic and Cox regression models were constructed to predict future use of podiatry and any foot surgery using variables available at inception to the cohort, or at 1 year. Age at onset, gender, Carstairs deprivation index, baseline RF, presence of erosions in the hands or feet (at baseline or 1 year), DAS (at baseline or 1 year) and HAQ (at baseline or 1 year) were entered into the models exploring podiatry. ESR was included in the DAS, and X-ray erosions in the feet and erosion in hands or feet were collinear; therefore, only DAS and erosions in feet were entered into the models. Values for age at onset and baseline DAS and HAQ were centred on the means of their distributions. Data on ROM and whether patients saw an orthotist were not available at baseline or 1 year; because they were likely to change throughout the disease course they were not entered into the models.

Since only a small number of patients had foot surgery, only variables that were individually associated with the outcome at the 20% significance level (sex, age at onset, X-ray erosions in the feet and baseline DAS) were entered into the surgery model. While this approach risks excluding variables that might have emerged as significant contributors to the multivariate model, this was preferable to biasing the results by including too many predictors as this can destabilize the model and/or lead to inaccurate coefficient estimates.

When all of the putative predictors were entered into the podiatry model simultaneously, female gender, increasing age at onset, being RF positive and increasing baseline DAS were each independently associated with increased

odds of seeing a podiatrist. Results for a parsimonious model containing only these significant predictors are presented in Table 2. There was no evidence of interactions between the predictors. This model was a statistically adequate fit to the observed data (Hosmer and Lemeshow goodness-of-fit  $P=0.313$ ), but it did not have substantial discriminatory power [area under the ROC curve (95% CI)=0.70 (0.67, 0.73)]. Adjusting for the duration of follow-up slightly improved the discriminatory power of the model [0.73 (0.70, 0.76)] because those with longer follow-up were more likely to see a podiatrist, but the addition of this term to the model did not substantively alter the ORs for the existing predictors, consequently the ORs presented have not been adjusted for duration of follow-up.

At 1 year, gender, age at onset and DAS remained in the model (Table 2). RF was no longer independently associated with podiatry, but the presence of erosions in the feet at 1 year was associated with an increase in the odds of seeing a podiatrist. HAQ was not found to be associated with the odds of podiatry at baseline, but at 1 year showed evidence of being associated with subsequent podiatry use. The 1-year model did not have substantially greater discriminatory power than the baseline model.

At baseline, female gender, younger age at onset and DAS were each independently associated with the risk of having any sort of foot surgery (Table 3). Full data for this model were available for 1227 patients, 47 of whom had surgery during the follow-up period. There was no evidence of any interactions between the predictors. For this model, the proportional hazards assumption held (all individual variables  $P>0.05$ , overall model  $P=0.902$ ) and the fit statistics were adequate (Groennesby and Borgan goodness-of-fit  $P=0.263$ ), but the C-index did not indicate substantial discriminatory power ( $C=0.67$ ).

At 1 year, female gender and younger age at onset were associated with the risk of having foot surgery, but DAS at 1 year was not associated with subsequent foot surgery (OR 1.099,  $P=0.348$ ). Although the presence of erosions in the feet at baseline was not strongly associated (OR 1.684,  $P=0.112$ ) by 1 year, foot erosions were associated with an increase in the risk of having foot surgery within the follow-up period. Full data for the model containing gender, age and foot erosions at 1 year were available for 1075 patients, 39 of whom had surgery during the follow-up period. For this model, the proportional hazards assumption held (all individual variables  $P>0.05$ , overall model  $P=0.656$ ) and the fit statistics were adequate (Groennesby and Borgan goodness-of-fit  $P=0.871$ ), but the C-index did not indicate substantial discriminatory power ( $C=0.70$ ).

## Discussion

This study is the first to describe on a national level the use of foot care including foot surgery in a multicentre cohort of patients with RA. It has identified low levels of both conservative and surgical foot care over the first 9 years of treatment. This study has also identified

**TABLE 2** Multivariate logistic regression models for baseline and 1 year predictors of podiatry

	<i>B</i>	<i>SE</i>	<i>Wald</i>	<i>P</i> -value	<i>OR</i> 95% <i>CI</i>
<b>Baseline (n = 1196)</b>					
Variable					
Gender: female	1.018	0.155	43.39	<0.001	2.768 (2.045, 3.748)
Age of onset, per unit	0.038	0.005	58.83	<0.001	1.039 (1.029, 1.049)
RF positive	0.258	0.153	2.85	0.091	1.294 (0.960, 1.745)
Baseline DAS, per unit	0.141	0.041	11.78	0.001	1.151 (1.062, 1.247)
Constant	-1.831	0.179	105.12	<0.001	0.160 (NA)
Model performance					
Overall model evaluation: likelihood ratio test			$\chi^2$ , <b>df</b>		
			122.46, 4	<0.001	
Goodness-of-fit test: Hosmer and Lemeshow			9.36, 8	0.313	
Discrimination					
Area under the ROC curve (SE)			0.70 (0.02)	<0.001	
<b>1 year (n = 1168)</b>					
Variable					
Gender: female	0.906	0.169	28.75	<0.001	2.474 (1.776, 3.445)
Age of onset, per unit	0.039	0.006	49.00	<0.001	1.040 (1.028, 1.051)
1 year erosions present in feet	0.472	0.159	8.78	0.003	1.603 (1.173, 2.190)
1 year DAS, per unit	0.105	0.056	3.55	0.059	1.110 (0.996, 1.238)
1 year HAQ, per unit	0.257	0.121	4.54	0.033	1.293 (1.021, 1.638)
Constant	-0.743	0.156	124.11	<0.001	0.175 (NA)
Test					
Overall model evaluation: likelihood ratio test			$\chi^2$ , <b>df</b>		
			127.19, 5	<0.001	
Goodness-of-fit test: Hosmer and Lemeshow			5.37, 8	0.718	
Discrimination					
Area under the ROC curve (SE)			0.72 (0.02)	<0.001	

NA: not applicable.

**TABLE 3** Multivariate Cox proportional hazard regression models for baseline and 1 year predictors of foot surgery

	<i>B</i>	<i>SE</i>	<i>Wald</i>	<i>P</i> -value	<i>HR</i> (95% <i>CI</i> )
<b>Baseline (n = 1227)</b>					
Variable					
Gender: female	0.801	0.391	4.20	0.040	2.228 (1.036, 4.793)
Age of onset, per unit	-0.024	0.010	5.51	0.019	0.976 (0.957, 0.996)
Baseline DAS, per unit	0.213	0.085	6.34	0.012	1.238 (1.048, 1.461)
Model performance					
Overall model evaluation: likelihood ratio test			$\chi^2$ , <b>df</b>		
			17.46, 3	0.001	
Proportional hazards assumption: likelihood ratio test			0.58, 3	0.902	
Goodness-of-fit: Groennesby and Borgan score test			6.48, 5	0.263	
Discrimination					
Harrell's concordance (C)			0.67		
<b>1 year (n = 1074)</b>					
Variable					
Gender: female	1.461	0.530	7.608	0.006	4.311 (1.526, 12.175)
Age of onset, per unit	-0.028	0.011	6.113	0.013	0.973 (0.951, 0.994)
1 year erosions present in feet	0.664	0.323	4.220	0.040	1.943 (1.031, 3.662)
Model performance					
Overall model evaluation: likelihood ratio test			$\chi^2$ , <b>df</b>		
			23.15, 3	<0.001	
Proportional hazards assumption: likelihood ratio test			1.62, 3	0.656	
Goodness-of-fit: Groennesby and Borgan score test			1.83, 5	0.871	
Discrimination					
Harrell's concordance (C)			0.70		

patient-specific factors at disease onset that are then associated with subsequent conservative and surgical foot care and attempts to differentiate between the two.

Patients with higher disease activity at onset were more likely to receive foot surgery or conservative therapy. However, older female patients were more likely to have



conservative foot care whereas younger female patients were more likely to have foot surgery.

The strength of the study is the design: a prospective longitudinal cohort with 9-year follow-up of patients and a wide geographical area suggests that the results are representative of secondary care in true to life settings across England. This highlights the relative lack of podiatry: only 29% of the cohort had ever seen a podiatrist despite previous studies highlighting the widespread nature and high disease burden of foot symptoms in RA [1, 2, 14–16, 30].

Recent data suggest that the prevalence of foot symptoms is similar within the first 2 years of disease with a point prevalence of 61.3% and a disease course prevalence of 90% [30]. This further supports the contention that with only 29% of the cohort ever seeing a podiatrist, there remains a substantial unmet need. It was also notable that, of the 47 patients who had surgery in the first 9 years, 28 of them had never seen a podiatrist. This may suggest a lack of integration between foot care providers, which is consistent with previous studies [22] and raises questions about the timing of both conservative and surgical interventions.

The importance of foot and ankle pathology in RA has gained recognition through the recently introduced ARMA Standards of Care for People with musculoskeletal conditions and the National Institute for Health and Clinical Excellence (NICE) guidelines for people with RA: both recommend that all people with RA and foot problems should have access to a podiatrist [31, 32]. The results of this study do not capture the affect of the introduction of such guidelines nor the recent advances in pharmacological therapy. It does, however, provide important baseline data from which to evaluate the impact of these developments on levels of foot care in patients with RA.

Limitations of the current study are implicit in the design of all prospective observational cohorts with long-term follow-up: clinical practice is likely to evolve during the study period, but data are unlikely to reflect results of changes occurring near the end of the study period. As such the effect of the recently introduced NICE and ARMA guidelines are not captured, nor is the potential impact of improved pharmacological therapy. Similarly secondary analyses, such as this, are limited to investigating variables collected in the original data set. While it is possible that other factors may predict future foot care, we were not able to investigate them in the current study. However, it must be remembered that prospective cohorts provide robust data offering unique insights into the natural history, management and impact of disease [33]. Although this design does have limitations it also accounts for the study's major strengths of prospective, multicentre data in a large inception cohort with 9-year follow-up.

Traditionally, the literature suggests that the lack of attention paid to the feet during routine clinical care is a major contributor to low levels of foot health care. The standard measure of disease activity [28-joint DAS (DAS-28)] does not include any foot joints, and ever since the development of the DAS-28 it has been

argued that in order to improve clinical care the joints of the feet must be examined [34–38]. However, the joint count used in the ERAS cohort did include the feet and yet levels of foot care were still very low. While this is likely to be in part due to poor availability of foot health services, it also suggests that foot examinations should be more complex than merely assessing the number of tender and swollen joints. Clinicians should have the skills required to assess the complex soft-tissue structures in the foot that are frequently affected in RA.

With only 4% of the cohort having foot surgery, it is clear that its use is not widespread in the first 9 years after disease onset. Without evidence-based guidelines of when to escalate individual patients from conservative to surgical care, it is not possible to say whether this number represents adequate access to surgery or otherwise. Nonetheless, this is the first time this information has been reported across such a cohort and sets an important benchmark for future comparison. Over two-thirds of foot operations in the cohort were performed on the MTP joints. This may reflect the extent of forefoot deformity in RA [7, 8] along with the successful results of the forefoot arthroplasty that has previously been shown to be the most widely used forefoot procedure in RA [10].

From the multivariate models, it is clear that global patient factors previously linked with more severe disease [39, 40] such as age, gender and baseline DAS, were found to be independently associated with future conservative and surgical foot care. However, these models showed limited discriminatory ability and it is not clear whether this observed effect is due to the small number of patients receiving foot care or whether there are additional factors affecting the type of foot care received.

While there are clear benefits of knowing which patients are likely to receive conservative or surgical foot care, care must be taken not to confuse this with predicting patients who will need foot care or even benefit from it. Outcomes from conservative and surgical treatment have been shown to vary, particularly so in surgery where the potential for large improvements in pain and quality of life must be weighed against the risk that patients could be worse off [41, 42]. Much work is still needed to guide clinical decision-making and treatment choice in order to bring the era of personalized medicine to foot care: identifying patients with capacity to benefit from treatments would be a conceptually superior approach to both individual case management and broader service planning [43].

In conclusion, we found that fewer than one-third of patients accessed conservative foot care within the first 9 years after onset of their RA and only 4% had foot surgery. Female patients with later onset of disease were more likely to have conservative foot care, whereas female patients with earlier disease onset were more likely to have foot surgery. For the first time, we have identified patient-specific factors associated with subsequent conservative and surgical foot care. Despite the known high prevalence of foot symptoms and the increasing

evidence of their impact on patients, there remains a substantial unmet need for foot care in patients with RA.

#### Rheumatology key messages

- Fewer than one-third of patients had accessed podiatry 9 years after disease onset, representing a large unmet need.
- Older females were more likely to have conservative care, whereas younger females were more likely to have surgery.

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## Supplementary data

Supplementary data are available at *Rheumatology* Online.

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