Original article

Quality indicators in rheumatoid arthritis: results from the METEOR database

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Abstract

Objective. To test the feasibility of collecting, storing, retrieving and analysing necessary information to fulfil a preliminary set of quality indicators (QIs) that have been proposed by an international task force in a large multinational clinical practice database of patients with RA.

Methods. Data from all 12 487 patients with 46 005 visits in the Measurement of Efficacy of Treatment in the Era of Outcome in Rheumatology database from January 2008 until January 2012 were analysed to test the feasibility of collecting information on 10 QIs: time to diagnosis; frequency of visits; assessment of autoantibodies and radiographs, disease activity and function; disease remission, low disease activity, normal function; time to first DMARD and type of first DMARD. For each QI, two aspects were assessed: information availability and target achievement.

Results. Information was available for <50% of patients regarding the following QIs: time to diagnosis, assessment of ACPAs or radiographs, time to first DMARD and type of first DMARD. Information was available for function assessment in 49% of visits and 67% of patients and for disease activity assessment in 85% of visits and 86% of patients. Information relevant to the QI frequency of visits was available for all patients. Relevant information to calculate the proportion of patients who achieved a defined target could be obtained for all QIs.

Conclusion. Collecting storing, retrieving and analysing the core data necessary to meaningfully assess quality of care is feasible in a multinational, practice-based electronic database.

Key words: rheumatoid arthritis, quality indicator, care.

CLINICAL SCIENCE

Rheumatology key messages

- Assessing quality of care for RA is important but challenging in clinical practice.
- The assessment of compliance of a new set of quality indicators for RA is feasible in clinical practice.
- The METEOR database is useful for collecting, storing, retrieving and analysing data to assess quality of care in RA.

Introduction

RA is a chronic inflammatory disease that has a major impact on physical function and overall health [1, 2].

Assessing the quality of care provided to patients with RA is important not only to patients and physicians, but also to providers and purchasers of health care [3].

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However, it is challenging to define and measure quality of care optimally in RA.

In other chronic diseases, such as diabetes mellitus and hypertension, quality indicators (QIs) are useful to quantify quality of care. For these diseases, the availability of a single measure as the gold standard facilitates measuring the quality of care. However, in RA there appear to be limitations in using gold standards, so it may be that the capacity to analyse quality of care in this disease might be better without a gold standard [4, 5]. QIs are specific and measurable elements of clinical practice that represent minimum standards of care and can be used to assess various aspects of the structure, process or outcome of health care by various stakeholders [3, 6]. The most important attributes of a QI are its validity, its relevance (i.e. diagnosis, prognosis) and the feasibility and reliability of its application to the disease under consideration [7]. Furthermore, the process by which QIs are developed requires careful attention to methodological issues so that the results generated can be used with confidence when making decisions. Once a QI has been defined and the target population has been identified, the next step in this process is to assess the feasibility and its application in clinical practice [8].

For the management of RA, a recent systematic literature review reported that only a limited number of health care QI sets are available, most of these addressing only a small portion of the disease spectrum [9]. Importantly, the process by which these sets of QIs were developed was suboptimal in all cases. The main reason for this suboptimal development was that the QIs were not tested in clinical practice and therefore their feasibility was assessed based only upon expert opinion [10, 11]. This lack of feasibility testing may account, at least in part, for their insufficient integration into clinical practice [12].

Based on both a systematic literature review and expert opinion, an international task force is developing a new set of QIs for use primarily by physicians to improve measurement of the quality of care provided to patients with RA in daily clinical practice. As an integral part of the development process, we tested the feasibility of collecting information on using the proposed QIs in clinical practice. To collect data for this testing, use of a computer application is preferred. Such an application can generate a central database that can be used to monitor patients during routine care or in research studies and may facilitate comparison of quality of care between individual treatment centres or between aggregated patients in different countries [13, 14]. The Measurement of Efficacy of Treatment in the Era of Outcome in Rheumatology (METEOR) database is one such application that provides an excellent source of data to evaluate the feasibility of collecting information on selected QIs from patients with RA [15].

The principal objective of this study was to test the feasibility of collecting, storing, retrieving and analysing the information necessary to fulfil a preliminary set of QIs that have been proposed by an international task force in a large multinational clinical practice database of patients with RA. The secondary objective was to evaluate whether the country in which the patients are followed influences the feasibility of using these QIs.

Patients and methods

Data source and data collection

The METEOR tool and data collection process have previously been described in detail [16, 17]. Briefly, METEOR is an online tool available to rheumatologists worldwide since 2008 with no limitation for the type of practice. Participation in METEOR is entirely voluntary and participants do not receive financial remuneration, nor do they pay for participation. Centres and rheumatologists are invited by country leads, who are often national opinion leaders, but every rheumatologist may participate. METEOR was designed to monitor and record disease activity and function in patients with RA, with the primary objective of improving patient care. Data for all patients with RA visiting a rheumatologist are eligible to be entered into the METEOR database without restrictions on, for example, disease duration or age. This tool allows the following information to be recorded: demographic characteristics, disease activity, function as measured by the HAQ Disability Index (HAQ-DI) [18] and drug treatment. METEOR is password protected and all patient identifiers are encrypted, so it complies with data protection legislation [15]. Data are anonymized, aggregated and stored in a database on a central server. For this study, the dataset lock was January 2012, with 77 hospitals in 32 countries worldwide participating.

Study population

For this study, data recorded in the METEOR database from January 2008 until January 2012 were used. The METEOR Executive Scientific Committee approved this study during its annual meeting on 15 June 2012 and obtained approval to use the data from the participating centres. Because all data were fully anonymized, and this study included data collected during regular health care (not from interventional studies) reviews, approval of the protocol by local ethics committees was not deemed necessary. Data from 14 933 patients with 54 720 visits (including baseline and all follow-up visits) from 62 hospitals in 23 countries in Europe, North America and Asia were included. A total of 2446 (16.4%) patients with 8715 (15.9%) visits had only demographic information entered into the patient characteristics module and were excluded from the final analysis. Furthermore, to evaluate any influence that the country might have on the assessment of QIs, only the nine (39%) countries (France, Great Britain, Italy, Ireland, Japan, the Netherlands, Portugal, Spain and USA) that had entered >100 patients into the database were selected.

QIs and feasibility assessment

The feasibility of collecting information on the QIs proposed by the task force and represented in the

TABLE 1 Preliminary quality indicator set for RA

Quality indicator	Information availability: proportion of patients/visits with registered data	Target achievement: proportion of patients/visits achieving the stated target
Time to diagnosis (QI-1)	✓	RA diagnosed within 6 weeks after onset of symptoms
Antibodies and radiographic assessment (QI-2)	Proportion of patients in whom autoantibody and plain radiography of hands and/or feet have been performed[a]	NA
Frequency of visits (QI-3)	✓	At least one visit per year
Disease activity assessment (QI-4)	✓	Disease activity assessment performed at least once every year by at least one disease activity score
Functional status assessment (QI-5)	✓	Functional assessment performed at least once every year
Remission of disease activity (QI-6)	NA	Clinical remission
Low disease activity (QI-7)	NA	Low disease activity state
Level of functional limitation (QI-8)	NA	Low health assessment questionnaire score $\leqslant 0.25$ for disease duration $\leqslant 2$ years and $\leqslant 0.5$ for disease duration $\geqslant 2$ years
Time to first DMARD (QI-9)	✓	DMARD therapy initiated within 3 months after diagnosis
Type of first DMARD (QI-10)	✓	MTX as first DMARD

[a]In order to assess prognosis and determined by local laboratory using standard procedure. NA: not applicable.

METEOR data modules was assessed. The QIs, with a description for each, are listed in Table 1. All are rate based and disease-specific indicators, of which seven are process and three are outcome indicators. Two aspects of feasibility were assessed for each individual QI: availability of information (presented both as a proportion of visits and patients with registered data for that QI) and target achievement (the proportion of patients and visits for which the target for that QI was reached). The information availability for each QI was categorized based on the proportion of visits or patients for which data were recorded as poor (<50%), acceptable (50–69%), moderate (70–85%) and good (>85%). For each QI, the proportion of visits and patients for which the specific target was attained is presented only in a descriptive manner.

Assessment of disease activity to satisfy QI-4 was defined as the availability of any of the following validated disease activity indices (DAIs) [19]: the DAS with three or four variables (DAS_3v, DAS_4v), the DAS using a 28-joint count with three or four variables (DAS28_3v, DAS28_4v), the simplified DAI (SDAI) or the clinical DAI (CDAI) [20]. Assessment of function to satisfy QI-5 used the HAQ-DI. Remission of disease activity for QI-6 was defined as DAS28 <2.6, CDAI $\leqslant$ 2.8 or SDAI $\leqslant$ 3.3 [21, 22]. Low disease activity for QI-7 was defined as DAS28 <3.2 [21], CDAI $\leqslant$ 10 or SDAI $\leqslant$ 11 [19]. Normal function was defined for QI-8 as HAQ-DI $\leqslant$ 0.25 in patients with early disease (<2 years since the onset of initial symptoms) and HAQ-DI $\leqslant$ 0.5 in patients with established RA (>2 years since the onset of initial symptoms).

Statistical analysis

Dichotomous variables were reported as percentages. Median [interquartile range (IQR)] and/or mean (S.D.) were used for continuous variables. To calculate the median number of visits or assessments per year, only data from patients with more than one visit recorded in the database were analysed. The number of visits in the time interval between the first and last visits was divided by that time interval. For each QI, the proportion of patients for which information about that QI was recorded or for which the QI was achieved were calculated as percentages. All statistical analyses were performed using SPSS version 20.0 (IBM, Armonk, NY, USA).

Results

Patient characteristics

Data from 12 487 patients with RA who had 46 005 visits recorded in the METEOR database from January 2008 until January 2012 were included in the final analysis of this study. Demographic and disease characteristics for the patient population at each patient's first recorded visit are shown in Table 2.

Time to diagnosis (QI-1)

The time to diagnosis was recorded for 5278 (42.3%) patients. Of these, 1248 (23.6%) and 2112 (40.0%) patients were diagnosed within the first 6 and 12 weeks after onset of symptoms, respectively. Median and mean time to

TABLE 2 Demographic and disease characteristics

	Patients	
	Included,[a] n (%)	Frequency, n (%) or median (IQR)
Total number of patients	12 487	
Age, years	11 901 (95.3)	58 (47–67)
Female patients	12 246 (98.1)	9316 (76.1)
Disease duration from onset of symptoms[b]	5470 (43.8)	
Early RA (<2 years)		1652 (30.2)
Established RA (⩾2 years)		3818 (69.8)
RF positive	7757 (62.1)	5529 (71.3)
ACPA positive	4771 (38.2)	3157 (61.2)
Presence of erosion/s	5287 (42.3)	3010 (56.9)
	Visits	
	n (%)	Follow up (months) median (IQR)
Total number of visits	46 005	
Number of patients with		
One visit	4046 (32.4)	—
Two visits	1760 (14.1)	6.1 (3.3–11.5)
Three visits	1537 (12.3)	12.4 (8.1–16.8)
Four visits	1250 (10.0)	17.5 (12.0–23.8)
Five visits or more	3894 (31.2)	32.7 (22.3–56.0)

[a]Number (%) of patients included in the analysis who had no missing data for that variable. [b]Median values were 6.0 (IQR 2.0–13.0) years.

diagnosis were 6.0 months (IQR 2–18) and 20.2 months (s.d. 44) months, respectively, indicating that diagnosis was delayed for many patients. Overall, there was a temporal trend towards a shorter time to diagnosis: the median time to diagnosis was 6.0 months during 2005–09 and 5.0 months during 2010–12.

Assessment of antibodies and radiographs (QI-2)

Information about the presence of disease-specific antibodies was recorded in the database for 7757 (62.1%) patients for RF and for 4771 (38.2%) patients for ACPA. Data regarding the presence of erosions on conventional radiographs were available for 5287 (42.3%) patients.

Frequency of visits (QI-3)

Information to assess QI-3 was available for all patients. By definition, all patients included in this analysis had at least one visit. Among the 7992 (64%) patients who had at least one follow-up visit and the 5994 (48%) patients who had at least two follow-up visits, the initial follow-up visit was performed within a 12 month period in 99.5% of the patients. For these two groups, the median and mean number of visits per year was 2.9 (IQR 2.0–4.3) and 3.7 (s.d. 2.7), respectively. Furthermore, there was a trend towards a higher number of visits per year over time: the median number of visits per year was 2.1 between 2005 and 2009 and 3.2 between 2010 and 2012.

Disease activity (QI-4) and functional status assessment (QI-5)

To satisfy QI-4, disease activity was recorded and assessed using at least one of the DAIs at 38 860 (85%) of the visits for 10 723 (86%) patients (Table 3). The median number of DAI assessments per year was 2.6 (IQR 1.6–4.1), indicating that all patients had at least one and the majority of patients had at least two assessments of disease activity during 12 months of follow-up. The DAS28 was the most frequently performed DAI, whereas the SDAI (which also requires a physician global assessment of disease activity) was the least often used DAI.

To satisfy QI-5, at least one HAQ-DI was recorded at 22 442 (49%) of the visits for 8407 (67%) patients. The median number of HAQ-DI assessments per year was 1.0 (IQR 0.2–2.5), indicating that at least half of the patients had one HAQ-DI assessment during 12 months of follow-up (Table 3).

Remission (QI-6), low disease activity (QI-7) and normal function (QI-8)

The proportion of patients in remission tended to increase, from 12–28% of patients at the first visit recorded in the database to 17–38% at the last recorded visit (Table 4). The proportion of patients who achieved a low disease activity state (including those patients in remission) also tended to increase from the first to the last visit (36–42% at the first visit and 53–56% at the last visit).

Finally, we performed a secondary analysis for QI-6 and QI-7 including data from 1136 (9.1%) patients for whom all

TABLE 3 Proportion of visits and patients with disease activity and function assessment, and number of assessments per year

Measure	Frequency of assessment in all visits (n = 46 005), n (%)	Frequency of assessment in patients (n = 12 487)[a], n (%)	Number of assessments/year[b] (n = 7463), median (IQR)
At least one disease activity index	38 860 (84.5)	10 723 (85.9)	2.6 (1.5–4.1)
SDAI	13 137 (28.6)	3075 (24.6)	0 (0–1.0)
CDAI	17 991 (39.1)	4182 (33.5)	0.5 (0–1.7)
DAS_3v	23 551 (51.2)	6307 (50.5)	1.8 (0–3.2)
DAS_4v	21 780 (47.3)	5907 (47.3)	1.6 (0–3.1)
DAS28_3v	37 630 (81.8)	10 317 (82.6)	2.4 (1.4–3.9)
DAS28_4v	34 176 (74.3)	9405 (82.6)	2.2 (1.3–3.7)
HAQ	22 442 (48.8)	8407 (67.3)	1.0 (0.2–2.5)

[a]Number of patients with at least one assessment in any of all visits of that patient. [b]Patients with only one visit [n = 3269 (29%)], non-reliable values (2%) or with no data to calculate time interval between visits (7%) were excluded. CDAI: clinical disease activity index; DAS_3v: DAS with three variables; DAS_4v: DAS with four variables; DAS28_3v: 28-joint DAS with three variables; DAS_4v: 28-joint DAS with four variables; IQR: interquartile range; SDAI: simplified disease activity index.

three DAIs were recorded (DAS28_4v, SDAI and CDAI), so that results using each of the three DAIs could be compared. As expected [23], a low disease activity state was achieved more frequently when the CDAI or SDAI definitions of low disease activity were used rather than the DAS28 definition; however, remission of disease activity was achieved more frequently when the DAS28 definition was used. To satisfy QI-8, a low HAQ-DI was recorded in 35.5% of patients at the first visit and in 49.8% of patients at the last visit (Table 4).

Treatment QIs: time to first DMARD (QI-9) and type of DMARD (QI-10)

The time interval between diagnosis and prescribing the first DMARD was estimated only in patients with early disease (defined as <2 years since the onset of symptoms) who were treated with a synthetic DMARD (sDMARD). This was done because the information recorded in METEOR about drugs at each visit listed current but not necessarily previous medication. Thus it cannot be assumed that a drug recorded in the database at the first visit was the first medication that the patient had received to treat RA. Data to calculate the time to treatment with the first recorded sDMARD were available for 335 (20.3%) of the 1652 patients with early RA. Among these 335 patients, 247 (73.7%) initiated sDMARD therapy within the first 3 months after diagnosis. The median and mean times to treatment with the first recorded sDMARD were 5 days (IQR 0–162) and 141 days (S.D. 248), respectively. The sDMARD was prescribed as monotherapy in 298 (89%) patients and as part of a combination therapy regimen in 37 (11%) patients.

To address QI-10, MTX was the first sDMARD recorded for 275 (82%) of the 335 patients. Other sDMARDs recorded in the database included HCQ for 50 (15%) patients, SSZ for 37 (11%), LEF for 13 (4%), i.m. gold for 7 (2%), D-Pen for 2 (0.6%), AZA for 1 (0.3%) and CSA for 1 (0.3%). Moreover, 94 (28.1%) patients were also listed as receiving glucocorticoids combined with DMARDs and 31

(9.2%) patients as receiving a biologic therapy [etanercept by 11 (3.3%) patients, adalimumab by 9 (2.7%), infliximab by 9 (2.7%) and abatacept by 2 (0.5%)]. The proportion of patients who satisfied each of the two main aspects (information availability and target achievement) for each QI that was assessed is presented in Fig. 1.

Geographical variation in assessment of QIs

We investigated the influence of the country in which patients resided on the assessment of QIs. There was large variation by country in the number of visits (158–14 532) and patients (103–4897) recorded. Overall, the time to diagnosis after onset of the first symptom also varied widely between countries (median time 2–75 months; mean time 2.3–63.3 months).

Fig. 2 depicts the relative proportions of visits and patients with assessment of disease activity, function, remission, low disease activity and normal function presented for each country. Because most of the patients in this analysis had established RA, normal function was defined as HAQ-DI $\leqslant 0.5$ for all patients. The countries have been made anonymous by replacing individual country names with letters. Disease activity was assessed in the majority of patients in all countries, ranging from 73% to all patients. There was wider geographical variation in assessment of the HAQ-DI, ranging from 46% to 93% of patients. Moreover, the number of assessments per year per patient also varied for each measure, ranging from 1.2 to 8.4 assessments per year for DAIs and from 0 to 6.0 assessments for HAQ-DI. Assessment of low disease activity ranged from 12% to 68% of patients, for remission ranged from 7%- to 53% and for normal function ranged from 13% to 66% across countries.

Discussion

This study evaluates the feasibility of using a new set of QIs that have been proposed to assess quality of care in patients with RA. For most of the 10 QIs we have
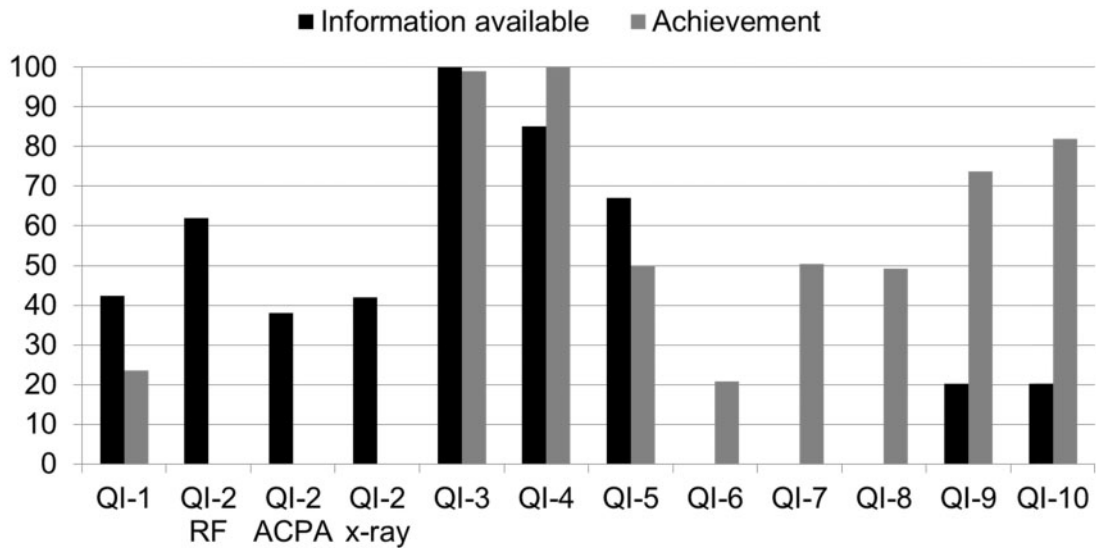
Table 4 Proportion of visits and patients in remission or with low disease activity

| | All data | | | | | Data from patients with all DAIs (DAS28, CDAI, SDAI) assessed | | | | |
| | Data at first recorded DAI[a] | | Data from patients with the same DAI assessed in at least two visits | | | Data from visits with all DAIs assessed in at least two visits | | Data from patients with all DAIs assessed in at least two visits | | |
| | Visits | Patients | | Patients | | Visits | | | Patients | |
	Frequency, n (%)	Frequency, n (%)	Included, n (%)	Frequency (first visit), n (%)	Frequency (last visit), n (%)	Included, n (%)	Frequency, n (%)	Included, n (%)	Frequency (first visit), n (%)	Frequency (last visit), n (%)
Disease activity remission						12 994 (28.2)		1136 (9.1)		
DAS28 (<2.6)	10 921 (32.0)	2699 (29.0)	5364 (57.0)	1521 (28.4)	2054 (38.3)		2785 (21.4)		201 (17.7)	284 (25)
CDAI (≤2.8)	2539 (14.1)	452 (10.3)	1147 (27.4)	212 (12.1)	302 (17.3)		2082 (16.0)		162 (14.3)	216 (19)
SDAI (≤3.3)	2103 (16.0)	366 (11.7)	1150 (36.8)	163 (14.2)	216 (18.8)		2079 (16.0)		159 (14.0)	212 (18.7)
Low disease activity										
DAS28 (<3.2)	16 327 (47.8)	4064 (43.7)	5364 (57.0)	2268 (42.3)	2990 (55.7)		4485 (34.5)		325 (28.6)	468 (41.2)
CDAI (≤10)	8059 (44.8)	1513 (34.5)	1147 (27.4)	629 (36.0)	920 (52.7)		6070 (46.7)		451 (39.7)	632 (55.6)
SDAI (≤11)	5959 (45.4)	1078 (34.5)	1150 (36.8)	438 (38.1)	624 (54.3)		5889 (45.3)		429 (37.8)	615 (54.1)
	Data at first recorded HAQ[a]		Data from patients with HAQ assessed in at least two visits							
HAQ										
HAQ ≤0.25										
All patients	22 442 (48.8)	6291 (28.0)	2341 (18.7)	601 (25.7)	784 (33.5)					
Early RA	2530 (45.6)	1349 (53.3)	332 (20.1)	127 (38.2)	159 (47.9)					
HAQ ≤0.5										
All patients	22 442 (48.8)	8728 (36.9)	2341 (18.7)	824 (35.2)	1040 (44.4)					
Established RA	10 313 (58.8)	3718 (36.1)	916 (24.0)	316 (34.5)	462 (50.4)					

The proportion of patients with low disease activity also includes those patients in remission. [a]The percentage is calculated with the maximum number of assessments for each measure (shown in Table 3) as the denominator. CDAI: clinical disease activity index; DAI: disease activity index; SDAI: simplified disease activity index.

FIG. 1 Proportions of patients with information available or with target achievement per QI

Results are shown in percentage. X-ray: conventional radiograph.

FIG. 2 Assessment and status of disease activity and function per country
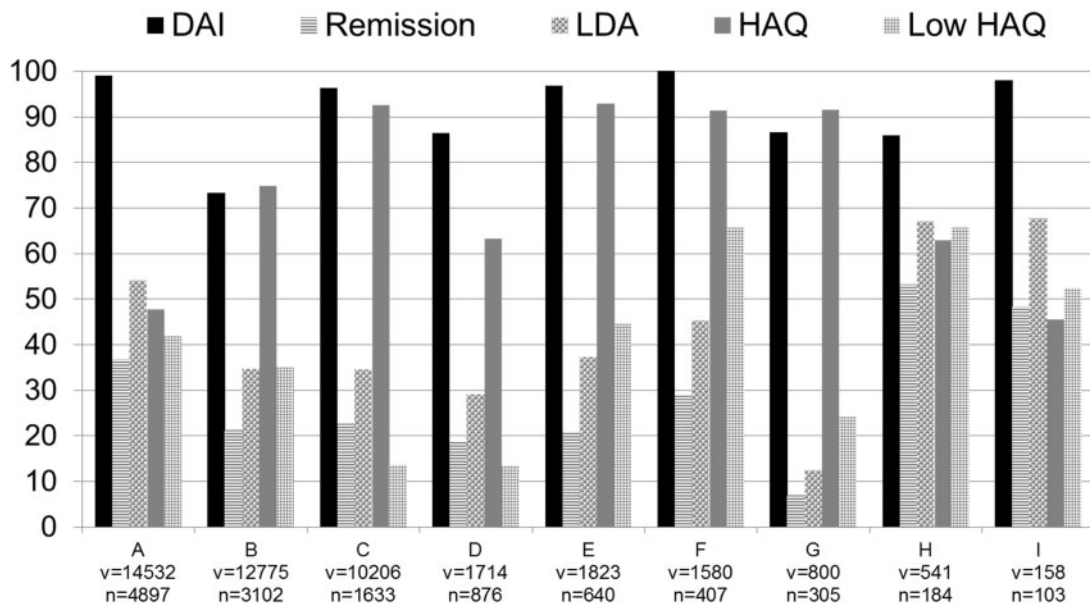
Proportion of visits and patients with assessment of disease activity and function (solid fill) and proportion of patients who were in remission, in a low disease activity state or who had normal function by the HAQ-DI (pattern fill). Remission and low disease activity are defined according to DAS28 definitions. The analysis for normal function by the HAQ-DI includes all patients and applied a cut-off of <0.5 both to patients with early RA and to those with established RA. DAI: disease activity index; DAS28: 28-joint DAS; DI: disability index; LDA: low disease activity; *n*: number of patients; *v*: number of total visits.

demonstrated that it is feasible in clinical practice to collect and record data systematically in an electronic database and to retrieve these data to assess quality of care. However, although we present data from the METEOR database regarding the relative attainment of the thresholds proposed for these QIs by physicians in various countries, assessment of physician compliance with these QIs was beyond the goal of this study.

Our finding that a large amount of information to assess QIs that measure quality of care in RA is available in the METEOR database is similar to that of another study that evaluated a different set of QIs [11]. However, the authors of that study found that the source of the data substantially influenced the ability to fulfil the QIs: information abstracted from paper medical records satisfied fewer QIs about disease activity and function than did information obtained by interviewing patients. We found that assessment of these QIs was feasible using information contained in a database into which information had been entered at clinical encounters. The difference between our findings and those of the previous study could be explained by our use of structured electronic data collection rather than recording data using free text in an unstructured written medical record. An electronic data form provides structured data fields, prompting the user to record all data, whereas a paper medical record usually does not provide the same organization. Had the paper medical records provided clinicians with a framework for structured data collection, the findings of that study might have been similar to ours.

Information to satisfy the QI that assessed time to diagnosis was by far the least available. Two explanations might account for the relative paucity of data to address this QI. Most patients included in the METEOR database have established disease and might have had difficulty recalling the exact date of their symptom onset. Alternatively, with restricted time available during the clinical encounter, clinicians might not have entered this information into the electronic record. In either case, this QI was not satisfied as successfully as others. Furthermore, the low proportion of patients with RF and/or ACPA status recorded may be due to lack of availability of this laboratory test at diagnosis or to the fact that it was not a diagnostic criterion until 2010, or that the tests are available but not added to the database. Lastly, most providers who recorded information about drug therapy into the METEOR database satisfied the QIs regarding initiation of DMARD therapy within 3 months of diagnosis and the use of MTX as the first DMARD. Such data might also be useful to assess compliance with consensus recommendations to treat RA to target [24, 25].

Other studies have evaluated the feasibility of QIs, especially those proposed by the ACR in patients with RA. Our observation that many of these patients are treated with DMARDs early in the course of disease is consistent with previous studies that used data recorded in clinical practice rather than from administrative databases [26, 27]. However, we found that a higher proportion of providers assessed DAIs (82%) in our study compared with that (62%) in the study of Adhikesavan *et al*. [13]. Moreover, the difference found in the proportions of patients classified in the disease activity levels based on the DAI employed has also been observed in other cohorts [23]. While more patients were classified as being in remission using the DAS28 definition, a greater number of patients with low disease activity (LDA) was obtained when employing SDAI or CDAI definitions. Several

reasons may explain this difference. First, the scores have been derived in different ways. Second, it is known that the DAS28 is less stringent and therefore several of the patients in DAS28 remission fell into the LDA category of the CDAI and SDAI. And third, the LDA range of the DAS28 is quite small and therefore patients who are in low moderate disease activity by the DAS28 may fall into the LDA category by the CDAI or SDAI.

A strength of our study is its use of a very large sample of patients with RA from clinical practices in nine countries. The few published studies that have evaluated the feasibility of QIs to measure quality of care in RA have each included patients from only one country [26, 28]. It has not previously been demonstrated that QIs can be transferred directly from the country in which they were developed to other countries without modification to account for geographical variations in clinical practice [29, 30].

Our study has limitations. The most important limitation is that we did not test all of the QIs that were proposed by the international task force. METEOR was developed in 2007, before this set of QIs was created; its primary purpose was to assist in clinical management, not to assess compliance with QIs. Thus the data items to be collected were determined before the development of these QIs and do not contain all of the data necessary to assess compliance with the QIs. In this sense, it also needs to be considered that some of the non-recorded characteristics for centres (e.g. type of insurance) or patients (e.g. socioeconomic status) participating in METEOR may influence the feasibility of QIs as well. Also, the various cut-off points used to define the degrees of feasibility were completely arbitrary. Furthermore, the number of visits and patients recorded varied greatly by country. Thus the number of patients used as the denominator to test the QIs in each country could have influenced the results disproportionally in some countries, thereby limiting the validity of comparing compliance with the QIs across countries. Also, differences in the intended use of the METEOR database in various countries, which might result in the inclusion of more patients with early disease in one country and more patients with established disease in another country, might hinder cross-country comparison. Furthermore, several explanations may tell why 60% of the countries had opened an account in METEOR but included <100 patients. First, METEOR started with only 10 countries and thereafter it was opened up to all countries, so the number of countries participating has constantly increased over time (up to 32 countries in 2014), which means that some countries joined later and therefore did not have enough time to include patients. Second, the fact that a country lead is interested in participation does not necessarily imply that rheumatologists in that country are willing to participate. Third, this could also be due to specific technical requirements related to METEOR. Fourth, it is possible that data were never completed and therefore have led to an overestimation of the feasibility observed in our study. Finally, considering the selection process and the voluntary nature of participation

in the METEOR database, as well as the fact that most countries are from the same continent, extrapolation of the results of this study to all countries and centres may be limited.

Our study using data collected in the METEOR database demonstrates that assessment of compliance with this new set of QIs for RA is feasible in the context of clinical practice. However, as governments and other payers place more emphasis on the fulfilment of QIs to obtain reimbursement for health care delivery, METEOR and other data collection tools may consider the need for revision in order to promote the collection of all relevant data necessary to assess each of the QIs [31].

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