Rheumatologists' guideline adherence in rheumatoid arthritis: a randomised controlled study on electronic decision support, education and feedback

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Abstract

Objective

To assess the effects of education, feedback and a computerised decision support system (CDSS) versus education and feedback alone on rheumatologists' rheumatoid arthritis (RA) guideline adherence.

Methods

A single-centre, randomised controlled pilot study was performed among clinicians (rheumatologists, residents and physician assistants; n=20) working at the study centre, with a 1:1 randomisation of included clinicians. A standardised sum score (SSS) on guideline adherence was used as the primary outcome (patient level). The SSS was calculated from 13 dichotomous indicators on quality of RA monitoring, treatment and follow-up. The randomised controlled design was combined with a before-after design in the control group to assess the effect education and feedback alone.

Results

Twenty clinicians (mean age 44.3±10.9 years; 55% female) and 990 patients (mean age 62 ± 13 years; 69% female; 72% rheumatoid factor and/or anti-CCP positive) were included. Addition of CDSS to education and feedback did not result in significant better quality of RA care than education and feedback alone (SSS difference 0.02; 95%-CI -0.04 to 0.08; p=0.60). However, before/after comparison showed that education and feedback alone resulted in a significant increase in the SSS from 0.58 to 0.64 (difference 0.06; 95%-CI 0.02 to 0.11; p<0.01).

Conclusion

Our results suggest that CDSS did not have added value with regard to guideline adherence, whereas education and feedback can lead to a small but significant improvement of guideline adherence.

Key words

guideline adherence, rheumatoid arthritis, randomised controlled trial, quality of care

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Introduction

Treatment of rheumatoid arthritis (RA) is based on the tight control principle in which disease activity monitoring and treatment changes if a pre-set target is not reached, is essential. Treating patients using a tight control strategy, especially in combination with a specified treatment protocol, results in lower disease activity and less functional damage compared to usual care (1-5). In order to help practicing clinicians using a tight control strategy, many tight control based guidelines are available (6-8). Next to the tight control based treatment guidelines, separate recommendations exist on topics such as shared care or risk management (9, 10).

Unfortunately, adherence to these guidelines is often suboptimal. For example, treatment is not changed on time in case of active disease or patients do not receive appropriate disease-modifying anti-rheumatic drug (DMARD) therapy (11-13). For patients, the lack of adherence to tight control recommendations by rheumatologists can have severe consequences as non-adherence has been associated with more radiographic progression and functional impairment (5).

Despite these observations on suboptimal guideline adherence and its consequences for patients, implementation research in rheumatology is scarce and almost no trials on improving rheumatologist guideline adherence exist (14). However, Cochrane reviews and two RA studies on often performed interventions (educational meetings, audit and feedback, and reminders) conclude that they all can improve care provided to patients (15-17).

Based on the lack of intervention studies within rheumatology and the existence of effective interventions outside rheumatology, we aim to improve RA care by increasing rheumatologists' guideline adherence using education, feedback and Computerized Decision Support System (CDSS).

Methods

Study design and participants

A single centre, randomised controlled pilot study was performed to assess the effects of an extended intervention strategy including education, feedback and CDSS *versus* a standard strategy with education and feedback alone. In addition, the randomised controlled design was combined with a before-after design in the control group to assess the effect of the standard intervention strategy alone (Fig. 1).

The study was conducted at the department of rheumatology at the Sint Maartenskliniek (specialised clinic in rheumatology, orthopaedics and rehabilitation medicine, the Netherlands). All clinicians prescribing rheumatologic medication (rheumatologists, residents and physician assistants (PA)), working at this centre between July 2013 and May 2014 were eligible. Only clinicians that were not willing to sign informed consent were excluded.

Although the interventions were aimed at clinicians, outcomes were measured in patients (provided care in accordance with the guideline 'yes' or 'no'). All adult patients with an ICD-9 code of RA (714.x) with a visit to an included clinician during the pre- or post-intervention period were eligible for inclusion. Participation in a biological DMARD (bDMARD) dose tapering trial, being held at the study centre in the same period, was the only exclusion criterion as this trial could influence treatment decisions made during our study.

A random sample of all eligible patients was drawn both before- and after the intervention. This because approximately 2250 unique RA patients are treated at the study centre and data collection for all those patients was deemed too labour intensive. Thus, patients were identified from two different time periods: July 2013 to December 2013 (pre-intervention) and January 2014 to April 2014 (post- intervention). Balancing precision and feasibility of data collection, we included 30 RA patients per clinician in both time periods. For those patients, only the first visit in the pre- or post-intervention period was used to assess guideline adherence, meaning that in this study the number of visits and patients is equal, and that the before after comparison is done between two unpaired groups.

Randomisation

Included clinicians were randomised in

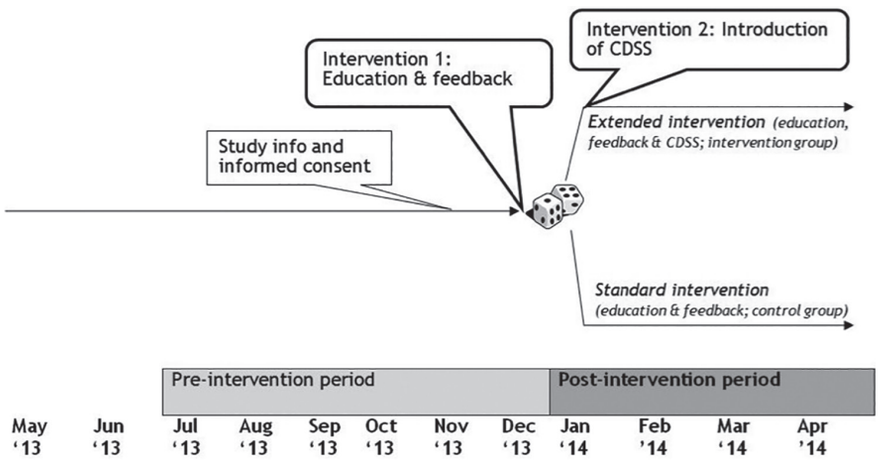

Fig. 1. Study design.

a 1:1 ratio of intervention versus control group using two blocks (block size 10). A research physician allocated clinicians using a computer generated randomisation list. After signing informed consent, the clinician received a sealed opaque envelope that contained the randomly assigned allocation. Due to the nature of the interventions, blinding of participants or researchers was not possible.

Interventions

The standard intervention was provided to all clinicians in the intervention- and control group, and comprised a one-hour group session combining education with feedback. The first part of the session focused on the importance of tight control and guideline adherence in RA patients (education). Next, feedback was given on group level and where possible on individual level (non-anonymous). The whole session was developed and provided by NL (PhD student) and AdB (rheumatologist), both working at the study centre.

In the intervention group, CDSS was added to the previous intervention (extended intervention strategy). The CDSS was linked to the Electronic Health Record (EHR) used at the study centre (EZIS v. 5.2, Chipsoft). The CDSS was incorporated into the Computerized Physician Order Entry system (CPOE) which was already integrated in the EHR and used by all clinicians. The CDSS worked with algorithms, using clinical information from the EHR, to automatically complete CPOE orders and to send reminders to the clinician about routine care. A week before the CDSS became available to the intervention group, they received 1.5 hour training and until the CDSS was released into the EHR, clinicians could practice with the CDSS in a special training version of the EHR. After implementation of the CDSS into the EHR, assistance from the developers was available for additional explanation of the system. The CDSS was designed in such a way that it could be specifically linked to the Chipsoft account of intervention group clinicians, making it impossible for control group clinicians to access the CDSS thereby preventing contamination between groups. The CDSS development was a close collaboration between clinicians (NL and AdB) and the Information Technology department of the study centre.

During the intervention development, we took into account determinants of success as described in relevant reviews on this topic (15, 16, 18-20). A more extensive explanation of both interventions can be found in supplement 1, with the PowerPoint slides used during the educational meeting provided in Supplement 2.

Outcome measures

As no standard indicator set for quality of care in RA is available (21), we had to develop our own indicator set. We chose to base our set on the indicators stated in the Dutch national RA guideline (6) as this guideline most closely matches the situation at the study centre. As mentioned in the introduction, other recommendations besides tight control treatment are available to rheumatologists. Therefore, we chose to incorporate a broader set of indicators than in previous RA guideline adherence studies. This resulted in the selection of 13 indicators on treatment and monitoring, follow-up and shared care, and administration (Table I). In supplement 3 the development process is described in more detail.

Using the 13 indicators as separate primary outcomes would have resulted in multiple testing problems during the analysis. The primary outcome was therefore the mean difference in a standardised guideline adherence sum score (SSS) between the intervention and control group (*i.e.* the primary analysis was conducted on pre-post intervention differences between education alone versus education and CDSS). The 13 separate indicators all had dichotomous outcomes (1 for 'yes' and 0 for 'no'). In this way the SSS could be calculated for every patient by totaling the score of the individual guideline adherence indicators and dividing this by the number of indicators that applied to this patient (score range 0 to 1, higher scores indicating more guideline adherence). Both the adherence percentages of the separate guideline indicators and the mean difference in SSS before and after the standard intervention in the control group are reported as secondary outcomes.

Data collection

As no real time feedback on all indicators was available at the study centre and not all data could be automatically extracted from the EHR, we had to rely on manual EHR review for data collection. For every included patient, data from one visit was collected in either the pre- or post-intervention period. If the patient had visited the clinic more than once during the pre- or post-intervention period, only the first visit in this period was taken into account. Using pre-defined algorithms, the 13 guideline indicators could be calculated from visit data on demographics, disease characteristics, disease activity, functional status and current medication use.

Table I. Guideline adherence indicators and the relation between indicators and interventions.

	Guideline adherence indicator	Topic covered during interventions	
		Education & feedback	CDSS
Treatment and monitoring	DAS28 measurement performed during the outpatient clinic visit	✓	✓
	Radiographs of hands, feet and thorax made at the moment of diagnosis and radiographs of hands and feet repeated 1 and 3 years thereafter	✓	
	Yearly assessment of functional status using the HAQ	✓	✓
	Prescription of conventional and biological DMARDs according to the preferential order[1] when initiating a new DMARD	✓	✓
	Use or prescription of a concomitant conventional DMARD in case of biological use	✓	✓
	Therapy change[2] in case of active disease as measured with the DAS28[3]	✓	
	Dose reduction or interval lengthening (dose optimisation) of biological DMARDs in case of low disease activity and stable biological use for the previous six months	✓	
Follow-up and shared care	Referral of new RA patients to a specialised nurse within the two weeks after diagnosis[4]	✓	✓
	Planned nurse led DAS28 assessment during the next regular outpatient clinic visit [5]	✓	✓
	Referral to a PA[6]	✓	✓
	Correct interval between the visit in the study period and the next planned regular outpatient clinic visit	✓	✓
Administration	A letter to the general practitioner, sent within two weeks after diagnosis in case of a new RA patient (new patient letter)		✓
	A letter to the general practitioner, sent once every 18 months (control patient letter)		✓

Of note, during data collection we mainly relied on the CPOE orders done by included clinicians. For example, in case of indicator 11 (interval to the next visit) we looked at the corresponding CPOE order and noted the interval that the clinician had entered (*i.e.* three months, six months, etc.). In reality this follow-up visit could be planned a few weeks before or after the proposed interval due to organisational issues or patient factors. By using the CPOE orders, we were sure that the clinicians' decision had been noted and not organisational or other issues.

Blinded data collection was not possible as it could be directly seen from the EHR whether the patients' treating clinician used the CDSS (intervention group) or not (control group). However, double data extraction and entry was performed on two different random samples of patients in order to achieve high-quality data collection.

Table II. Clinician and patient characteristics at baseline.

Clinician characteristics	Control group n=10	Intervention group n=10
Age, years (SD)	42.4 (11.1)	46.0 (11.0)
Female sex, n (%)	5 (50)	6 (60)
Rheumatologist, n (%)	9 (90)	6 (60)
Work experience, years (IQR)	5.0 (3.0 to 7.0)	8.0 (8.0 to 14.0)
Patient characteristics	**n=508**	**n=482**
Age, years (SD)	62.1 (12.5)	62.0 (12.6)
Female sex, n (%)	340 (66.9)	346 (71.8)
Disease duration, years (IQR)	8.0 (3.0 to 14.0)	7.0 (2.0 to 12.0)
Rheumatoid factor and/or anti-CCP positivity, n (%)	338 (76.5)	257 (67.5)
Erosive disease, n (%)	225 (47.3)	189 (44.0)

SD: standard deviation, IQR: interquartile range.

Ethical approval

This study was presented to the local ethics committee (CMO; Commissie Mensgebonden Onderzoek region Arnhem-Nijmegen), but according to Dutch Act on Medical Research Involving Human Subjects, the study did not need ethical approval (CMO reference number 2013/529). Written informed consent from all participating clinicians was obtained before study start.

All patient data were collected within the study hospital from the local EHR, after which the data was anonymised. As this data cannot be traced back to an individual patient, no written informed consent was needed from the patients according to Dutch Data Protection Act. The study was registered with the Dutch trial register (www.trialregister.nl, NTR 4449). When reporting this study we followed the CONSORT and SQUIRE guidelines (22, 23).

Data sharing statement

Patient level data, full dataset, technical appendix and statistical code are available at a reasonable request from the corresponding author. Consent from the patients was not obtained but the pre-

Table III. Results on the analyses performed.

Analysis performed	Mean SSS: standard intervention		Mean SSS: extended intervention		Intervention effects (difference; 95% CI (p-value))	
	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Standard vs. extended	Before/after standard
Primary analysis (all clinicians; all indicators)	0.58	0.64	0.55	0.63	0.02; -0.04 to 0.08 (0.60)	**0.06; 0.02 to 0.11 (<0.01)**
Post-hoc sensitivity analysis						
Only CDSS indicators*	0.59	0.67	0.58	0.67	0.01; -0.06 to 0.07 (0.85)	**0.08; 0.03 to 0.13 (<0.01)**
Only rheumatologists	0.53	0.58	0.56	0.63	0.02; -0.05 to 0.08 (0.65)	0.05;-0.002 to 0.10 (0.06)
Only indicators on monitoring and treatment	0.58	0.64	0.59	0.67	0.02;-0.7 to 0.12 (0.62)	0.06; -0.004 to 0.13 (0.07)
Only indicators on follow-up & and referral	0.49	0.55	0.47	0.55	0.02; -0.06 to 0.10 (0.61)	**0.06; 0.002 to 0.12 (0.04)**
Only indicators on administration	0.73	0.75	0.73	0.72	-0.02; -0.14 to 0.08 (0.64)	0.02; -0.06 to 0.09 (0.67)

*SSS calculation from all indicators except indicator 2 (radiographs), 6 (therapy change) and 7 (biological dose optimisation).

sented data are anonymised and risk of identification is low.

Statistical analysis and reporting of results

All analyses were done using STATA v. 13. Depending on the type of variable, descriptive statistics are presented as absolute numbers with the accompanying percentages, as means with standard deviations (SD) or as median with the interquartile range (IQR).

Based on an earlier retrospective study (24) we expected a mean SSS of 0.27±0.13 in both the intervention and control group before the intervention, increasing to 0.45 in the control group and 0.72 in the intervention group (mean SSS difference: 0.27). With one-sided testing (α=0.05, 1–β=0.8) and a randomisation ratio of 1:1, we calculated that 18 subjects would be needed for the before/after controlled design and 8 in the randomised controlled design. Potential clustering of patients within a clinician was already accounted for in the sample size calculation by taking the SSS as the primary outcome measure.

To assess our primary outcome, taking the hierarchical structure of our data into account (clustering of patients within clinicians), multilevel linear regression analysis was performed. In the regression model, the SSS was added as the dependent variable with study period, group allocation and the interaction between group allocation and study period as independent variables. By adding the interaction term we tested whether a baseline to post-treatment change in the dependent variable was greater for the intervention group than for the control group. The effect of the standard intervention alone was assessed with a multilevel linear regression model with study period as the independent variable, only using the data from the control group. Results from both multilevel regression analyses are reported as regression coefficients with the corresponding 95% confidence interval (95% CI) and *p*-value.

Secondary analyses were performed with the thirteen separate guideline indicators using multilevel logistic regression models assessing the added effect of the extended intervention and the separate effect of the standard intervention. Results from these analyses are reported as odds ratios (OR) with the corresponding 95% confidence interval (95% CI) and *p*-value.

As not all 13 guideline adherence indicators could be covered with CDSS (Table I), a post-hoc sensitivity analysis was done in order to see if a SSS excluding the indicators not covered in the CDSS yielded different results than the SSS including all indicators.

A second post-hoc sensitivity analysis was performed to assess if SSS results were different when only rheumatologists were included. This was done because clinician randomisation resulted in more PAs and residents being allocated to the control group.

Finally, the SSS was also calculated and analysed for all three groups of indicators separately (treatment and monitoring, follow-up and shared care, administration) to see whether this made a difference.

Results

Participants

At the start of the study 25 clinicians were assessed for eligibility and 20 fulfilled the inclusion criteria. All eligible clinicians signed informed consent and attended the allocated interventions. No loss to follow-up occurred. Table II shows the baseline clinician and patient characteristics. Altogether, 4648 unique adult patients with an ICD-9 code of RA visited the study clinic during the study period (pre- and post-intervention) and after drawing the random sample, 1102 of those patients were selected for participation. Of those, 60 had to be excluded due to participation in the dose tapering study. In addition, during the EHR review a small proportion of patients turned out not to fulfil the inclusion criteria (n=52). For example, due to rescheduling of visits, no visit in the intervention period was available. This resulted in 990 patients being included in the final analysis (control group n=508 patients; intervention group n=482).

Intervention effects on the standardised sum score

Both the standard and extended intervention resulted in an increase of the SSS, with the mean SSS increasing from 0.58 to 0.64 for the standard intervention and from 0.55 to 0.63 for

Table IV. Guideline adherence to and intervention effects on the separate indicators.

Indicator	Adherence: standard intervention		Adherence: extended intervention		Odds ratio (95% CI)	
	Pre-intervention (n=254)	Post-intervention (n=254)	Pre-intervention (n=241)	Post-intervention (n=241)	Standard *vs.* extended	Before/after standard
1. DAS28 measurement, % (n)	66.8 (144 / 216)	80.3 (183 / 228)	67.5 (139 / 206)	75.6 (164 / 217)	0.7 (0.4 to 1.4)	**2.0 (1.3 to 3.1)**
2. Radiographs, % (n)	48.4 (31 / 64)	13.2 (7 / 53)	35.3 (24 / 68)	23.0 (14 / 61)	3.2 (0.9 to 11.4)	**0.2 (0.1 to 0.4)**
3. Yearly HAQ, % (n)	68.5 (148 / 216)	79.4 (181 / 228)	68.1 (139 / 204)	83.0 (180 / 217)	1.4 (0.7 to 2.8)	**1.8 (1.1 to 2.7)**
4. Correct DMARD prescription, % (n)	50.0 (5 / 10)	46.2 (6 / 13)	78.6 (11 / 14)	65.0 (13 / 20)	1.1 (0.1 to 17.4)	0.4 (0.1 to 4.5)
5. Concomittant DMARD, % (n)	50.7 (36 / 71)	62.6 (62 / 99)	61.3 (49 /80)	59.5 (47 / 79)	0.6 (0.2 to 1.5)	1.6 (0.9 to 3.1)
6. Therapy change in case of active disease, % (n)	63.9 (23 / 36)	56.4 (31 / 55)	47.1 (16 / 34)	52.8 (28 / 53)	1.7 (0.5 to 5.9)	0.7 (0.3 to 1.7)
7. Biological dose optimisation, % (n)	10.5 (4 / 38)	12.0 (6 / 50)	18.8 (6 / 32)	9.7 (3 / 31)	0.5 (0.1 to 4.0)	2.0 (0.2 to 4.2)
8. Referral to a specialised nurse, % (n)	30.8 (8 / 26)	30.8 (4 / 13)	15.8 (3 / 19)	23.1 (3 / 13)	6.2 (0.2 to 221.7)	0.9 (0.2 to 5.6)
9. Planned nurse-led DAS28 at next visit, % (n)	59.8 (143 / 239)	69.6 (156 / 224)	69.7 (156 / 223)	69.8 (148 / 212)	0.8 (0.4 to 1.5)	1.4 (0.9 to 2.1)
10. Referral to a PA, % (n)	22.1 (31 / 140)	39.2 (38 / 97)	14.6 (27 / 185)	34.3 (57 / 166)	1.3 (0.6 to 2.9)	**2.4 (1.3 to 4.4)**
11. Correct visit interval, % (n)	47.8 (108 / 226)	53.7 (116 / 216)	56.9 (119 / 209)	61.5 (126 / 205)	1.0 (0.6 to 1.7)	1.2 (0.8 to 1.8)
12. Timely new patient letter, % (n)	64.0 (16 / 25)	75.0 (9 / 12)	42.1 (8 / 19)	53.9 (7 / 13)	1.0 (0.1 to 7.7)	1.7 (0.4 to 7.9)
13. Timely control patient letter, % (n)	73.2 (169 / 231)	74.9 (182 / 243)	75.7 (168 / 222)	72.4 (168 / 232)	0.8 (0.4 to 1.5)	1.1 (0.7 to 1.6)

Values in bold are significant (p-value <0.05). DAS28: Disease Activity Score in 28 joints; CDSS: Computerized Decision Support; HAQ: Health Assessment Questionnaire; DMARD: disease-modifying anti-rheumatic drug; PA: physician assistant.

the extended intervention (mean SSS difference 0.02; 95%-CI -0.04 to 0.08; p=0.60). In the before/after analysis in the control group, the increase in SSS after the standard intervention was statistically significant (mean difference 0.06; 95%-CI 0.02 to 0.11; p<0.01). All post-hoc sensitivity analyses yielded similar results to the primary analysis (Table III).

Intervention effects on the individual indicators

The secondary analyses on the individual indicators yielded similar results to the primary analysis with no difference between the standard and extended intervention for any of the indicators. In the before/after comparison four out of thirteen indicators changed significantly after the standard intervention (Table IV). Of those four, three improved after the intervention (DAS28 measurements, yearly HAQ assessment and PA referral) and one worsened (radiographs of hands, feet and thorax).

Discussion

To our knowledge this is one of the first randomised controlled trials within rheumatology trying to improve guideline adherence of clinicians. Our results show that CDSS has no added value in this context, whereas education and feedback did lead to a significant improvement in guideline adherence.

The strengths of this study are the use of a randomised design, a broad set of indicators, inclusion of different types of clinicians involved in RA care, inclusion of a large sample of both early and established RA patients reflecting daily clinical practice and the use of two different interventions.

However, this study has some limitations related to the internal validity and generalisability. Firstly, not all desired changes could be implemented in the CDSS. As a result, the SSS included indicators not covered with this intervention (Table I). This concerned indicator 2 (radiographs), 6 (therapy change) and 7 (biological dose optimisation). Nevertheless, sensitivity analyses yielded no different results when excluding these indicators from the SSS calculation. Secondly, after randomisation the control group included more rheumatologists than the intervention group (90% *vs.* 60%), but this did not seem to have influenced our results as sensitivity analyses excluding non-rheumatologists gave similar results as the original analysis. Thirdly, due to our study design we are not able to infer a causal relation between the standard intervention and guideline adherence afterwards as other events in the same time period might have attributed to the observed results. However, we are not aware of any events during the study that could have influenced our results and during the study special attention was paid not to start other quality improvement projects. Fourthly, as this was a single centre study the generalisability may be hampered due to differences on patient-, hospital-, or societal level. However, the RA population treated in the study centre seems to represent a normal RA population, thus not hampering generalisability. Of course, the study centre being a specialised clinic and the study only being performed in the Netherlands might have influenced our results, which stresses the need for replication of our study in other settings. Finally, the use of a broad set of indicators in combination with the sample size can also be seen as a disadvantage as not all patients could be included in all indicators. However, by using this set of indicators for the first time we were able to gain more insight into the broad concept of quality of care in rheumatology. However, future studies, preferably multi-centre, should use a larger sample in order to be able to confirm our results when using multiple indicators.

Being one of the first intervention studies to improve clinicians' RA guideline adherence also has a downside, as we cannot directly compare all of our results with other groups. With regard to our standard intervention we are aware of one other study using education and feedback to improve RA care (Metrix

study). In this randomised controlled trial, rheumatologists receiving education and feedback (n=10) collected more global assessments and HAQs than their colleagues not receiving these interventions (n=10). Furthermore, the researchers could calculate more composite scores in the intervention group (increase from 43% to 57%), whereas the control group did not show any change. Finally, the intervention group did change therapy in 57% of the patients with a high DAS compared to 38% of the rheumatologists in the control group (25). Our results from the standard intervention on comparable topics are similar (therapy change in active disease) or better (HAQ and DAS28 measurement). However, the Metrix study did not measure if composite scores were actually calculated by the rheumatologists themselves and if they were used to guide treatment decisions. This makes our study probably more useful in judging the effect of education and feedback on the use of composite measures such as the DAS28 in daily practice.

With regard to CDSS, parallels can be drawn with other studies within rheumatology but of the four studies we are aware of, only one focuses on RA (26-29). In this study a template, integrating information from different sources (*i.e.* physician itself, patients and/or EHR), was implemented. Following implementation of this system, a strong correlation was found between use of the system by rheumatologists and disease control, and more patients were in a state of low disease activity (28). Although both the intervention and study population are not fully comparable with ours, these results imply that care for patients with rheumatic diseases could benefit from EHR changes.

Outside rheumatology far more studies have been performed on the effect of education and feedback. Two Cochrane reviews on this subject conclude that both educational meetings and feedback can improve clinical practice, although the effects are often small to moderate which resembles the effects found in this study (15, 16, 30). Similarly, different reviews on CDSS have been performed outside rheumatology concluding that CDSS results are not always consistent but can improve practitioner performance. However, patient outcomes such as morbidity and mortality are at best moderately improved (17, 31-34).

Finally, it is interesting to notice that not all indicators did show an improvement after the intervention. For example, the indicators on ordering of radiographs and correct DMARD prescriptions worsened after the intervention in both the standard and extended intervention group. For both observations we do not have a good explanation. However, in the light of these results and the previously mentioned reviews, our results emphasise the need for better understanding why interventions work in one setting and not in another. Several reviews have addressed this issue and many factors could possibly influence successful uptake of the interventions. We have tried to take these factors into account during the development and execution of our interventions, for example by making sure CDSS was integrated into the workflow and the messages were timely and relevant. Also, attendance during the educational meeting was high and feedback was provided by a direct colleague. However, it was not possible to incorporate all the potential factors for success, which might explain the small effects observed. In addition, guideline adherence might be classified as complex behavior due the many, and often interconnected, recommendations that have to be followed. This could have led to the small effect of education and feedback, with our CDSS not being adequate enough to fill in the gap between knowing about the recommendations and actually practicing them.

Despite the small effects observed, we feel that our study has important practical implications, especially within rheumatology. First of all, the results of this study confirm that improving guideline adherence is a challenge. However, the improvement resulting from our standard intervention is a first step in the right direction and again stresses the importance of more attention towards the implementation of guidelines. Secondly, this study probably could have benefited from a more formal barrier analysis before study start, in order to develop an even more targeted intervention. Although a Cochrane review on this subject is not conclusive, future studies should certainly consider such an approach (35). Lastly, our study is an example of implementation research where we tried to bridge the gap between evidence and practice. So far, this type of research is scarce within rheumatology which was recently recognised by Buchbinder *et al*. We agree with these authors that only performing clinical research is not enough to improve care if no attention is given to the implementation of new findings in clinical practice (14). Therefore, we would strongly advocate for more attention towards implementation science within rheumatology in order to let more patients benefit from optimal RA care.

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