

## Original article

# Telemedicine in the management of rheumatoid arthritis: maintaining disease control with less health-care utilization

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## Abstract

**Objectives.** We aimed to evaluate the use of an eHealth platform and a self-management outpatient clinic in patients with RA in a real-world setting. The effects on health-care utilization and disease activity were studied.

**Methods.** Using hospital data of patients with RA between 2014 and 2019, the use of an eHealth platform and participation in a self-management outpatient clinic were studied. An interrupted time series analysis compared the period before and after the introduction of the eHealth platform. The change in trend (relative to the pre-interruption trend) for the number of outpatient clinic visits and the DAS for 28 joints (DAS28) were determined for several scenarios.

**Results.** After implementation of the platform in April 2017, the percentage of patients using it was stable at ~37%. On average, the users of the platform were younger, more highly educated and had better health outcomes than the total RA population. After implementation of the platform, the mean number of quarterly outpatient clinic visits per patient decreased by 0.027 per quarter (95% CI: –0.045, –0.08,  $P=0.007$ ). This was accompanied by a significant decrease in DAS28 of 0.056 per quarter (95% CI: –0.086, –0.025,  $P=0.001$ ). On average, this resulted in 0.955 fewer visits per patient per year and a reduction of 0.503 in the DAS28.

**Conclusion.** The implementation of remote patient monitoring has a positive effect on health-care utilization, while maintaining low disease activity. This should encourage the use of this type of telemedicine in the management of RA, especially while many routine outpatient clinic visits are cancelled owing to COVID-19.

**Key words:** rheumatology, self-management, telemedicine, remote monitoring, eHealth, disease activity, health-care utilization

## Key messages

- Real-world implementation of remote monitoring can reduce the number of hospital visits, while maintaining disease control.
- Mainly younger and more highly educated patients, with lower disease activity, participate in telemedicine.
- The combination of self-management and telemedicine has the potential to replace labour-intensive outpatient clinic visits.

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## Introduction

The World Health Organization estimates that by 2030 there will be a shortage of 18 million health workers, owing to further increase in health-care utilization [1]. In Western countries, the increasing prevalence of chronic diseases is a growing burden to an already overextended health-care system [2]. For rheumatic services, the demand is exceeding supply, as reflected

by long waiting lists in many countries [3]. The expectation is that this demand will continue to increase over the coming years [4]. Simultaneously, the workforce is declining because of an ageing population, while developments in labour productivity in health care are lagging [5, 6]. Therefore, structural changes are needed to deliver an increasing amount of care with the same capacity of people and resources [7]. According to the Dutch Health Authority, a more rapid introduction of digitalization in health care is needed [8]. Digitalization can help to optimize health care by improving the lagging productivity [6]. Both the potential and importance of digitalization have become even clearer in recent months, because it was impossible to deliver care as usual owing to the arrival of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [9].

For instance, telemedicine (i.e. delivery of health-care services through the use of information and communication technologies in a situation where the actors are in different locations: remote monitoring [10]) can be used to replace, in part, outpatient visits and other labour-intensive care [7, 8]. The management of RA lends itself for the use of remote monitoring. RA is a chronic disease that often requires lifelong hospital visits. Owing to the routine character (every 3–6 months) of these hospital visits and the variable disease course of RA, patients are often doing well at the time of consultation, and little action is needed [11]. At the same time, routine outpatient visits are unable to support patients if they experience a flare of their disease in between visits [12]. By supporting self-management and providing education about the disease in general, patients will gain more insight into the individual course of their disease. This will help patients to manage their disease better, which, in turn, will improve their health outcome [13].

The first studies evaluating remote monitoring for the treatment of rheumatic diseases are promising, with high patient satisfaction and equal or higher effectiveness compared with the face-to-face approach [14, 15]. The use of patient-reported outcome measures (PROMs) to assess disease activity and patient-initiated visits makes it possible to achieve similar disease control with fewer outpatient clinic visits [16, 17]. However, research settings the patients participating in these remote monitoring programmes are often a selective group. This group consists of patients who are younger or less sick [15], often with a higher level of education [18]. This selection reflects that there is still a large group who feels reluctant to participate in remote monitoring programmes and telemedicine [19].

However, telemedicine is not merely a change in organization and coordination of care; it is a different way of thinking about care as a system, and the position of patients in it [20]. A prerequisite for telemedicine to be successful is that the patient becomes a partner in care [7].

Therefore, to support patients in their self-management behaviour and improve patient engagement, the eHealth

platform Reumanet Bernhoven was introduced in April 2017 [21]. Reumanet Bernhoven is an eHealth platform that helps patients and health professionals to manage rheumatic disease. The aim of this platform is to increase the number of patients who feel adequately equipped to perform self-management and to improve patient engagement at a population level.

At the same time, research shows that successful disease monitoring by the patient helps to replace lifelong physician-initiated visits with patient-initiated visits [15]. This will reduce the number of routine visits of patients with stable disease, creating more time to review patients with an active disease in a timely manner. In order to teach patients the competencies required for successful self-management, the self-management outpatient clinic (SMOC) was started in March 2018 in Bernhoven. In the SMOC, patients are coached by a trained nurse specialist to use their own abilities to self-monitor their disease (facilitated through the eHealth platform). This aims to reduce the number of unnecessary hospital visits, while maintaining disease control.

This study has three aims: to evaluate the use of an eHealth platform and the different levels of participation; to study the influence of introducing an eHealth platform promoting self-management on disease activity and the number of hospital visits in the RA population; and to study the impact of remote monitoring on health-care utilization and the disease activity of patients with RA.

## Methods

### Design

This observational study evaluates the use of an eHealth platform and different levels of participation in the Department of Rheumatology at Bernhoven using a real-world design setting. It studies the effects of implementing an eHealth platform with regard to disease activity and health-care utilization using an interrupted time series design between July 2014 and October 2019. The study also analyses the patients participating in the SMOC and their disease activity and health-care utilization. Data on all patients with a clinical diagnosis of RA according to the 2010 ACR criteria were collected from the Reumanet Bernhoven registry and included in the analysis [22]. All patients had provided written informed consent for the use of their data for scientific purposes at an earlier time point. All procedures were performed in accordance with the ethical standards of the institutional and national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. According to the medical ethical review committee of the region Arnhem-Nijmegen, this study does not require ethical approval, because only data used for daily clinical practice were collected (file number 2020-6729).

## Reumanet Bernhoven

In April 2017, the eHealth platform Reumanet Bernhoven (Philips VitalHealth software, Ede, Netherlands) was launched [21]. The platform includes data on all patients diagnosed with RA under treatment at the Rheumatology Department in Bernhoven and is automatically available for the patient and the rheumatologist. With permission of the patient, other health professionals can also gain access (e.g. the nurse, general practitioner or physiotherapist). The platform provides the patient with disease-specific information in the form of a library, contains eHealth modules and provides insight into personal medical data, such as medication history and laboratory values. Patients can also monitor their disease activity by using PROMs. Reumanet Bernhoven also includes graphical overviews of disease activity and PROMs, lifestyle advice, and a chat function is available to send messages between the patient and health professional. To improve uptake of Reumanet Bernhoven, special attention was given to making the process as inclusive as possible. For example, educational classes on how to log in and use Reumanet Bernhoven were offered to support those who lacked skills, and reminders to fill out questionnaires were sent to patients at patient-specific time points.

## Self-management outpatient clinic

The SMOC was initiated in March 2018. The aim of this outpatient clinic was to provide patients who were in remission or have low disease activity with the opportunity to self-manage their disease and thereby reduce the number of consultations at the Department of Rheumatology. Patients with a clinical diagnosis of RA, either in stable remission or with low disease activity, who were motivated to take part in the self-management programme and able to use Reumanet Bernhoven were invited to participate in the SMOC. After giving informed consent, the patient received information from a trained nurse specialist about the aim of the SMOC, how to use Reumanet Bernhoven, what to expect from the health professionals and how to contact the outpatient clinic in case they had questions. Patients participating in the SMOC were required to have one consultation with the rheumatologist per year and were asked to fill in the rheumatoid arthritis impact of disease (RAID) [23] to track their disease activity. Patients were obliged to undergo laboratory monitoring according to the guidelines of the drugs they were using. The samples could be taken at a location of the patient's choice and were analysed at the laboratory of Bernhoven. The results of these tests were reviewed by the health-care professionals before sending a prescription for medication for the consecutive period. Patients were able to contact a nurse specialist if they felt the need to, for example, because of a self-monitored flare or an adverse event, and could obtain a consultation within a few days if the patient or nurse practitioner deemed this desirable.

## Measures

Baseline characteristics were age, biological sex, educational status, work status, smoking status, alcohol use, disease duration, RF status, anti-CCP status, BMI and medication use. As a measure of health-care utilization, the number of RA-related outpatient clinic visits was used. The DAS28 was used by the rheumatologist as a measure for disease activity (score between 0 and 10, with a higher score indicating higher disease activity) [24]. The following PROMs were filled out: for functional capacity, the HAQ [25] was used (score between 0 and 3, with a higher score indicating worse function and greater disability); the 36-item short form health survey (SF-36) [26] was used to measure health-related quality of life (score between 0 and 100, with a higher score indicating a better health-related quality of life); and to assess the impact of RA from a patient perspective, the RAID was scored (score between 0 and 10, with a higher score indicating worse impact of disease).

The following measurements and questionnaires could be entered by the patient: educational status, working status, smoking status, alcohol use, HAQ, SF36, RAID and visual analog scales for pain and tiredness.

## Evaluation of self-management through use of the eHealth platform

To evaluate the utilization of the eHealth platform, we categorized the RA population based on the level of utilization. First, we divided the population into two groups: patients who had an email address and therefore had the possibility of logging into Reumanet Bernhoven (potential users) and those without the possibility of logging in (non-users). Second, we identified the subgroup of patients who had logged in (active users). Given that Reumanet Bernhoven offers the possibility of filling out yearly questionnaires, a 1-year cut-off was used to identify active users. Third, we identified those patients who regularly performed PROMs as part of follow-up within the SMOC.

## Interrupted time series analyses

To study the effect of the introduction of Reumanet Bernhoven on health-care utilization and disease activity, a single-centre interrupted time series analysis was performed on the total population and on the subgroup of patients who eventually participated in the SMOC. The interruption in the time series (quarterly intervals) was placed in April 2017 (i.e. the introduction of the platform). The interrupted time series design attempted to assess whether the Reumanet Bernhoven intervention had a significant effect on health-care utilization and DAS28 compared with the underlying trend. The pre-intervention trend served as the control [27]. Autocorrelation in the error distribution was tested by the Cumby–Huizinga general test for autocorrelation. Depending on the outcome of this test, one or more lags were added to the model. Statistical analyses were

done in STATA v.15.1 (TX: StataCorp LLC, College Station).

## Results

### Participation in Reumanet Bernhoven and the self-management outpatient clinic

Since the initiation of the eHealth platform and the SMOC, the utilization of these programmes has increased gradually over time (Fig. 1). However, most of the uptake of Reumanet Bernhoven occurred in the quarter immediately after its introduction, and it was difficult to increase this number over time. By November 2019, 1145 patients with RA were treated at the Rheumatology Department of Bernhoven and therefore included in Reumanet Bernhoven. By then, 818 (71% of the RA population) had uploaded their email address and were able to log into Reumanet Bernhoven. Of those, 434 patients (38% of the RA population) had done so in the last year and were considered as active users of Reumanet Bernhoven. Of this group, 110 patients (10% of the RA population) were included in the SMOC (a flow diagram is provided as [Supplementary Fig. S1](#), available at *Rheumatology Advances in Practice* online).

### Patient characteristics of groups based on the usage of Reumanet Bernhoven

Table 1 shows the patient characteristics on 1 January 2019 of the total RA population (split into potential users and active users) and of the patients who participated in the SMOC between November 2017 and November 2019. It is noteworthy that the patients who used Reumanet Bernhoven and participated in the SMOC tended to be younger, more highly educated and have better health outcomes. Moreover, we observed that

they seemed to use more medication, consume more alcohol and be more likely to have stopped smoking.

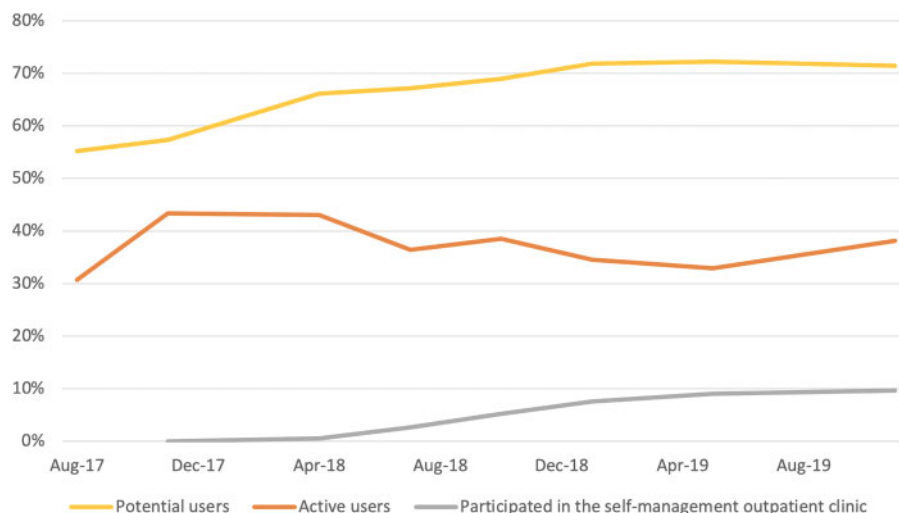
### Interrupted time series analyses of the introduction of Reumanet Bernhoven

The mean number of outpatient clinic visits in the total RA population in July 2014 was estimated at 0.94 visits per patient per quarter (Fig. 2). Before the introduction of the eHealth platforms, there was a non-significant decreasing trend in the number of quarterly visits of  $-0.002$  per quarter (95% CI:  $-0.123$ ,  $0.009$ ,  $P=0.766$ ). After the introduction of the eHealth platform, the mean number of quarterly outpatient clinic visits decreased significantly each quarter by  $0.027$  (relative to the pre-interruption trend; 95% CI:  $-0.045$ ,  $-0.08$ ,  $P=0.007$ ). The decline in quarterly visits was even more prominent in the subgroup who eventually participated in the SMOC (Fig. 3). In July 2014, they had a comparable mean number of outpatient clinic visits of 0.91 per patient per quarter. Before the introduction of the eHealth platform, their mean number of outpatient clinics visits decreased non-significantly by  $0.003$  per quarter (95% CI:  $-0.009$ ,  $0.003$ ,  $P=0.297$ ). After the introduction of the eHealth platform, the trend for the number of quarterly visits decreased significantly by  $0.059$  per quarter (relative to the pre-interruption trend; 95% CI:  $-0.078$ ,  $-0.040$ ,  $P<0.001$ ).

The mean DAS28 of the total RA population in July 2014 was estimated to be 3.19 (Fig. 4). Before the introduction of the eHealth platform, there was a non-significant increase in the DAS28 of  $0.014$  per quarter (95% CI:  $-0.006$ ,  $0.034$ ,  $P=0.164$ ). After the introduction of the eHealth platform, the mean DAS28 decreased significantly (relative to the pre-interruption trend) by  $0.056$  per quarter (95% CI:  $-0.086$ ,  $-0.025$ ,  $P=0.001$ ).

The mean DAS28 of the subgroup of patients who would end up participating in the SMOC was estimated

Fig. 1 Utilization of Reumanet Bernhoven between August 2017 and November 2019

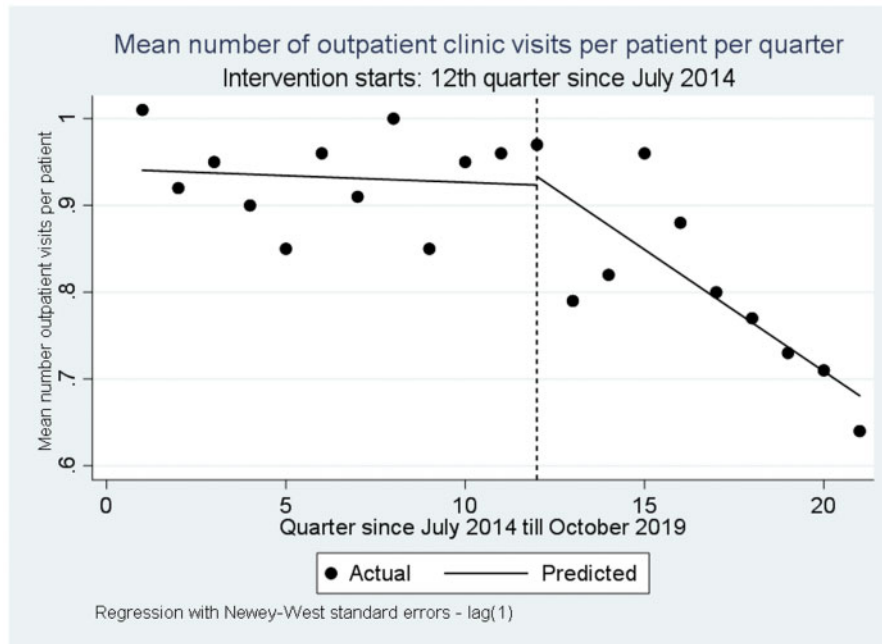


**TABLE 1** Patient characteristics on 1 January 2019 for the total RA population

Patient characteristics	Total population		Potential users		Active users		Self-management clinic	
		<i>n</i> = 1059		<i>n</i> = 761		<i>n</i> = 360		<i>n</i> = 110
Age, years, mean (s.d.)	64 (13)	1059	61 (13)	761	59 (11)	360	57 (11)	110
Female, %	67	705/1059	65	497/761	65	235/360	66	72/110
BMI, kg/m <sup>2</sup> , mean (s.d.)	27 (5.1)	502	27 (5.1)	370	27 (5.3)	174	26 (4.8)	65
Anti-CCP positive, %	56	418/761	53	300/566	56	138/248	64	59/92
RF positive, %	61	443/723	59	308/526	63	147/233	61	54/88
Smoking status								
Current smoker, %	19	61/322	18	33/186	13	20/151	5	3/55
Stopped smoking, %	46	149/322	51	95/186	54	82/151	62	34/55
Never smoked, %	35	112/322	31	58/186	33	49/151	33	18/55
Consumes alcohol, %	62	198/322	70	131/186	70	105/151	76	42/55
Highest education								
High, %	12	38/318	15	28/186	18	27/151	31	17/55
Middle, %	25	79/318	31	58/186	30	45/151	27	15/55
Low, %	63	201/318	54	100/186	52	79/151	42	23/55
Health outcome								
DAS28, median (IQR)	2.6 (2.0–3.4)	863	2.6 (2.0–3.2)	642	2.5 (1.9–3.1)	339	2.1 (1.7–2.7)	109
HAQ, median (IQR)	0.50 (0.12–1.3)	272	0.38 (0–1.0)	182	0.38 (0–0.94)	169	0.32 (0–0.75)	78
SF36 PCS, median (IQR)	43 (35–51)	166	44 (37–52)	133	44 (37–52)	129	48 (40–53)	63
SF36 MCS, median (IQR)	50 (42–58)	166	50 (42–56)	133	51 (42–56)	129	54 (47–60)	63
Medication use								
Biologic users, %	20	214	22	171	24	87	30	33
csDMARD users, %	75	797	75	569	77	277	85	94
No DMARD therapy, %	18	196	19	145	17	61	6	7

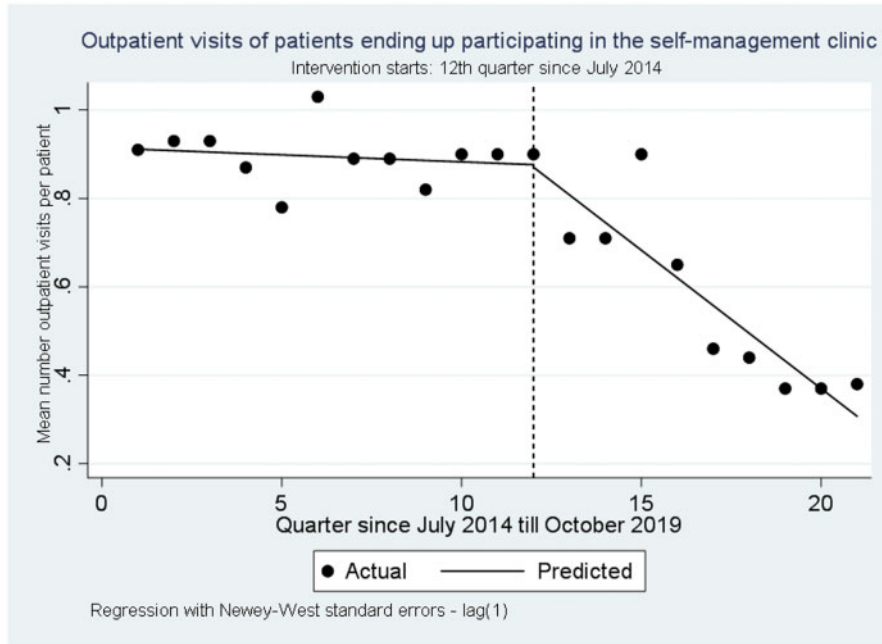
Patient characteristics are split into the potential users, the active users, and the patients who participated in the self-management outpatient clinic between November 2017 and November 2019. csDMARD: conventional synthetic DMARD; DAS28: disease activity score for 28 joints; IQR: interquartile range; SF: short form; PCS: physical component score; MCS: mental component score.

**Fig. 2** Outpatient clinic visits in the total RA population



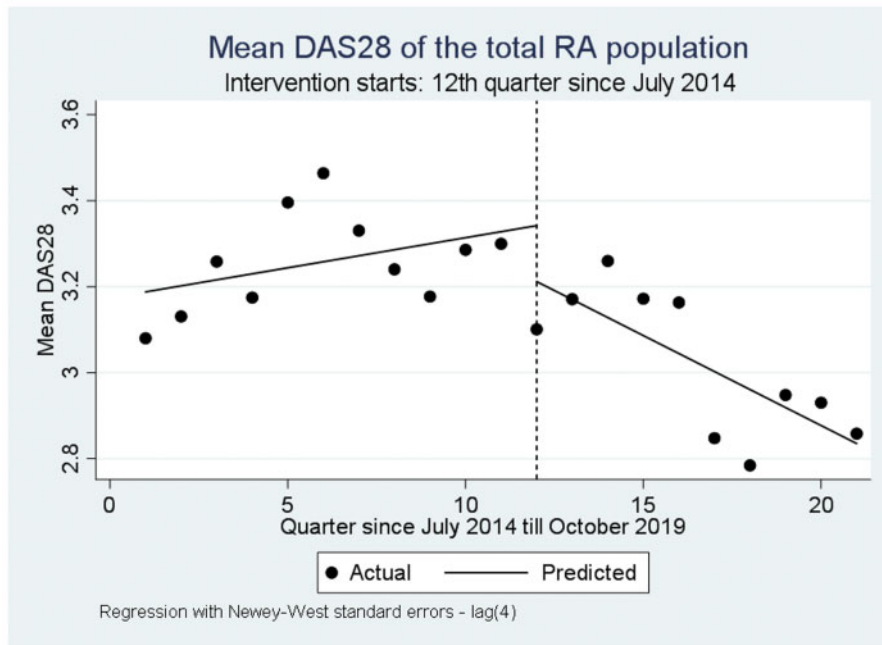
The mean number of outpatient clinic visits per patient per quarter in the total RA population between July 2014 and October 2019.

**Fig. 3** Outpatient clinic visits of the patients who would end up participating in the self-management outpatient clinic



The mean number of outpatient clinic visits per patient per quarter of the patients who would end up participating in the self-management outpatient clinic between July 2014 and October 2019.

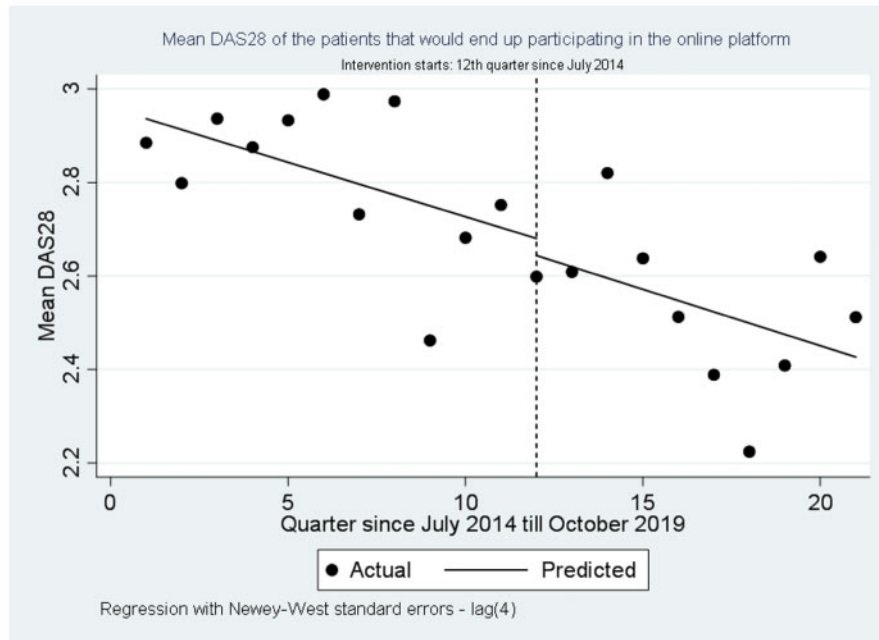
**Fig. 4** DAS28 of the total RA population



The mean DAS for 28 joints (DAS28) of the total RA population between July 2014 and October 2019.

to be 2.94 in July 2014 (Fig. 5). Their mean DAS28 decreased significantly by 0.023 per quarter (95% CI: -0.041, -0.005,  $P=0.015$ ) before the introduction of the eHealth platform. After the introduction of the

eHealth platform, the quarterly post-interruption trend of the DAS28 (relative to the pre-interruption trend) stayed approximately the same (CI: -0.036, 0.047,  $P=0.962$ ).

**Fig. 5** DAS28 of the patients who would end up participating in the self-management outpatient clinic

The mean DAS for 28 joints (DAS28) of the patients who would end up participating in the self-management outpatient clinic between July 2014 and October 2019.

## Discussion

After the implementation of Reumanet Bernhoven, there was a significant decrease in the number of outpatient clinic visits over time, without compromising disease control. Participation in the SMOC reduced the health-care utilization even more, without affecting the pre-existing decreasing trend in DAS28 present in this group. During this period, both the percentage of potential Reumanet Bernhoven users and the percentage of patients participating in the SMOC increased, whereas the percentage of patients regularly using Reumanet Bernhoven did not increase after the initial uptake. On average, the users of Reumanet Bernhoven were younger, more highly educated and had better health outcomes. This difference was even more evident in those who participated in the SMOC.

Our real-world data match positive results from clinical trials investigating self-management supported by eHealth applications and patient-initiated visits for the treatment of rheumatic diseases [14–18]. We found a decrease in health-care utilization after the implementation of telemedicine. This was accompanied by a clinically non-significant improvement in health outcome, showing at least non-inferiority compared with care as usual. This adds to the growing body of evidence concluding that telemedicine methods can be implemented safely in RA. These findings are also relevant in the treatment of other rheumatic diseases and even other chronic diseases. Owing to SARS-CoV-2, many routine

outpatient clinic visits have been cancelled, and the expectation is that it might take years before things get back to normal. Therefore, eHealth applications can be used to support patients in their increased need for self-management, whereas patient-initiated visits can help to select those patients who need to be seen at the outpatient clinic.

The inclusiveness of telemedicine remains an important issue. The goal of Reumanet Bernhoven was to improve patient engagement and to increase the number of patients who feel adequately equipped to perform self-management. To achieve this, particular attention was given to making the process as inclusive as possible during the implementation of Reumanet Bernhoven. These efforts led to an increase in the percentage of patients who were able to log into the eHealth platform (from 55 to 71% of the population). However, most of the active users engaged early on, and the percentage who used the eHealth platform remained stable at ~37%. This illustrates that more efforts are needed in order to motivate more patients to participate in this self-management programme. This low percentage corresponds to other real-world data, where only 34% of the patients engaged in self-management [13]. At the same time, our data show that it is a select group that participates in telemedicine, i.e. the younger, more highly educated patients with low disease activity. This matches findings from systematic reviews assessing the participants of patient-initiated follow-up and eHealth programmes for the treatment of chronic diseases [15,

28]. This selective use of telemedicine, whereby eHealth is least used by the people who need it most, risks widening the gap between those at risk of social health inequalities and the rest of the population [28, 29]. The effects of selective use of telemedicine on inequality and access to care should therefore be monitored.

Different factors influence whether a patient will participate in self-management. For instance, patients with chronic rheumatic diseases perceive different levels of self-management as suitable for themselves and therefore do not always see themselves as partners in care [30]. Lack of information and lack of self-monitoring skills are perceived as barriers to perform self-management [30]. The high number of people with low health literacy and low health skills (29% of the Dutch population) further complicates self-management [31–33]. Therefore, further implementation of telemedicine requires good guidance, offering a tailor-made approach and focusing on those at risk of social health inequalities [29]. Concurrently, we think that it is important to acknowledge that, at least at the moment, not all patients are capable of performing self-management and telemedicine. Adequate selection of which level of self-management can be expected of an individual patient is essential. In our opinion, this task is best performed by a nurse specialist affiliated with the SMOC. They often have more time and skills to explore patients' conditions and needs. In addition, patients often experience a special relationship of trust with their nurse specialist that allows for a tailor-made approach aimed at tackling the aforementioned barriers [25]. Using this relationship of the nurse with the patient can help to increase the participation in self-management and telemedicine.

Interestingly, we have noticed in recent months an increase in patients who have actively enquired regarding the possibilities of performing telemedicine. This increase has coincided with the SARS-CoV-2 pandemic in The Netherlands. Owing to SARS-CoV-2, there has been an increase in Internet use by the elderly, the group currently under-represented in Reumanet Bernhoven users [34]. Simultaneously, the outpatient clinic had to close down somewhat, reducing the possibility for outpatient clinic visits. The fact that Reumanet Bernhoven was still readily available might have helped people to overcome the barriers normally perceived. This change in patients participating in telemedicine should be monitored closely, because changes in the composition of the participating population could influence the effectiveness of telemedicine. Before telemedicine can be applied for the whole population, we should know the effectiveness of telemedicine in the groups currently unlikely to participate.

This study evaluated the use of Reumanet Bernhoven and participation in the SMOC in a real-world setting. A strength of this study is that it offered the opportunity to assess which patients chose to use these programmes in daily clinical practice. Participants in the programme were clearly a self-selected group, which is currently the daily reality [15, 28]. As previously mentioned, efforts will

have to focus on increasing the number of participants of the programme. A limitation of observational data is the difficulty in assessing the causality of interventions. Given that the study period was lengthy, external factors, such as advances in treatment options or changes in treatment guidelines, could potentially influence disease activity and, to a lesser extent, the number of hospital visits. An interrupted time series design is capable of identifying these underlying trends and isolates the effect of the introduction of Reumanet Bernhoven [35]. By using the pre-interruption trend as a control, the observed differences are more likely to be attributable to the studied interventions. This strengthens the confidence that the observed effect can be attributed to the introduction of Reumanet Bernhoven, especially because, as far as we know, during that time period no changes in other factors that could explain the underlying trend for health-care utilization occurred.

In conclusion, the implementation of Reumanet Bernhoven, an eHealth platform aimed at supporting patients in their self-management need, resulted in less health-care utilization, while maintaining disease control. Making use of patient-initiated visits in patients with stable disease activity resulted in an even larger reduction of health-care utilization. Policy-makers should use the momentum telemedicine has gained recently owing to the SARS-CoV-2 pandemic to embed telemedicine firmly into the health-care system, in particular, with the expected cutbacks in mind, required owing to the pandemic. Concomitantly, health-care professionals need to remain vigilant to ensure that those currently unable to participate in telemedicine receive the care they need.

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## Data availability statement

De-identified participant data are available upon reasonable request.

## Supplementary data

Supplementary data are available at *Rheumatology Advances in Practice* online.

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