

**Attitudes to Technology supported Rheumatoid Arthritis
Care: Investigating patient and clinician perceived
opportunities and barriers**

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3 **Attitudes to technology supported rheumatoid arthritis care: investigating patient and**
4 **clinician perceived opportunities and barriers**
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Abstract:

Objectives: Globally, demand outstrips capacity in rheumatology services, making Mobile Health (mHealth) attractive, with the potential to improve access, empower patient self-management and save costs. Existing mHealth interventions have poor uptake by end-users. This study was designed to understand existing challenges, and opportunities and barriers for computer technology in the rheumatoid arthritis (RA) care pathway.

Methods: People with RA were recruited from Barts Health NHS-Trust rheumatology clinics to complete paper questionnaires, and clinicians recruited from a variety of centres in the UK to complete an online questionnaire. Data collected included: demographics; current technology use; challenges managing RA; RA medications and monitoring; clinic appointments; opportunities for technology, and barriers to technology.

Results: 109 patient and 41 clinician questionnaires were completed. 83.5% patients and 93.5% clinicians used smartphones daily. However only 25% had ever used an arthritis app and only 5% had persisted with one. Both groups identified managing pain, flares and RA medications as areas of existing need. Access to care, medication support and disease education were mutually agreeable opportunities; however, discrepancies existed between groups with clinicians prioritising education over access, likely due to concerns of data overwhelm (80.6% considered this a barrier).

Conclusion: In spite of high technology usage and willing from both sides, our cohort did not utilise technology to support care, suggesting inadequacies in existing software. Lack of an objective biomarker for RA disease activity; existing challenges in the healthcare system and need for integration with existing technical systems were identified as the greatest barriers.

Trial registration: Registered on CRN registry (IRAS ID – 264690)

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3 **Key words:** Telemedicine, mHealth, Rheumatoid Arthritis, Digital technology in medicine,
4 questionnaire
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8 **Key Messages:**
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- 11 • Both patients and clinicians are amenable to using mHealth, but do not use existing
12 technology.
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 - 14 • Mutually agreed opportunities for mHealth include support with pain, flares, and
15 medication management.
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 - 17 • Lack of a reliable biomarker for RA activity means that remote monitoring solutions
18 must be multi-faceted.
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24 **Lay summary**

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26 ***What does this mean for patients?***
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29 Globally, demand outstrips capacity in rheumatology services, making Mobile
30 Health (mHealth) attractive; however, existing mHealth interventions have poor uptake.
31 This questionnaire study forms part of a mixed methods study aiming to understand the real
32 needs of people with rheumatoid arthritis (RA), as well as those of their clinicians, to ensure
33 future technology provides solutions to the challenges for those living with RA. 109 patients
34 and 41 clinicians completed questionnaires. Whilst the vast majority used smartphones
35 daily, only 25% had ever used an arthritis app, and only 5% had persisted with one. Both
36 groups identified managing pain, flares and RA medications as areas of existing need. Access
37 to care, medication support and disease education were agreed opportunities. Differences
38 existed between groups with clinicians prioritising education over access, due to concerns
39 about managing the large volumes of patient data submitted. In spite of high technology
40 usage and willingness from both sides, our cohort did not use technology to support care,
41 suggesting inadequacies in existing software. Lack of a reliable marker for RA disease
42 activity, existing challenges in the healthcare system and need for integration with existing
43 technical systems were identified as the greatest barriers.
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INTRODUCTION

Rheumatoid arthritis (RA) is a chronic erosive inflammatory arthritis with a prevalence of approximately 1% (1). The advent of advanced therapeutics and a treat-to-target paradigm have significantly improved outcomes. However, this requires intensive monitoring by a rheumatologist (2) and globally, demand outstrips capacity, making mobile health solutions (mHealth) an attractive prospect with the potential to improve access, empower patients to self-manage, and save costs. Global smartphone penetration is estimated to have reached 83.3% in 2022 (3). The potential for mobile technology to transform the delivery of health services globally is well recognised (4), with the COVID-19 pandemic accelerating this need with the rapid deployment of telehealth clinics (5). However, telehealth is limited by the inability to examine the patient, and recent data supports a strong preference for face-to-face (f2f) consultations, by both rheumatology patients and clinicians (6). Some of those gaps may be filled by mHealth: using validated outcome measures (7–10); visualisation of painful/swollen joints on body maps (11,12); innovative data collection using integrated smartphone biosensors (13–15); and asynchronous communication (16,17), enabling more regular input of data on disease activity in between standard f2f reviews (18).

Data suggest that whilst RA patients in European cohorts have high levels of smartphone usage (82.2-91.2%), and are eager to use mHealth, mHealth technologies are used by only 4.1%-8% of patients (19) (20). However, patients reported that an app could help them to self-manage their disease, if it was tailored to their needs, and co-developed with health professionals (21). Physician recommendation has been found to significantly influence patients' decisions to engage with health technologies (22).

Thus, whilst mHealth is a rapidly growing field, uptake by end-users is variable, and factors influencing this not clearly understood. Furthermore, software developers often design without properly understanding the needs of the ultimate users, solving non-existent problems (23). Recently, EULAR published its 'Points to Consider' for remote care in rheumatic and musculoskeletal diseases (RMDs), specifying that remote monitoring interventions *"should be developed in collaboration with all stakeholders including the healthcare team, caregivers and people with RMDs"* (24).

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3 Therefore, the aim of this study was to understand existing challenges for patients and
4 clinicians managing RA, in order to delineate both explicit and implicitly identified
5 opportunities and barriers for technology supported RA care pathways amongst target end-
6 users (i.e., RA patients and clinicians), based upon the principles of user-centred design (23).
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8 Furthermore, this study sought to understand rheumatologists' attitudes to disease activity
9 assessment, in order to design an acceptable and reliable remote monitoring tool.
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15 **METHODS**

16 **Questionnaire design**

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18 The patient questionnaire, focused on technology in RA care, were developed through two
19 consecutive RA patient public involvement (PPI) group discussions (6 patients), in addition to
20 a review of RA literature (25), and researcher's expertise. Researchers included a
21 rheumatologist (AMB) and human-computer interface scientists (PC, HS). Questions were
22 designed to be broad-based, addressing the challenges of managing RA day-to-day, to capture
23 the areas of greatest need for technological support, in addition to addressing patients' and
24 clinicians' explicit concerns about using health technology. Draft questionnaires were shared
25 with members of the PPI group, who gave direct feedback on the structure, relevance and
26 comprehension of the content, suggesting appropriate rephrasing. A clinician from the
27 research team (FH), not directly involved in the questionnaire development, piloted and fed
28 back upon the clinician questionnaire. Questionnaires used a variety of quantitative
29 responses, including tick-box selection, ranking options, and Likert scales, in order to maximise
30 the quality and relevance of data collected. Questions were structured around: demographic
31 information; digital technology usage; understanding living with RA; RA medications and
32 monitoring; clinic appointments; opportunities for-, and barriers to technology. Clinician
33 questionnaires had an additional section addressing disease activity assessment.
34 Questionnaires are available for review in the supplementary material (available at
35 *Rheumatology Advances in Practice* online) or <https://improvinglifewithra.wordpress.com/>.
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54 **Participants**

55 RA patients >18 years old, able to comprehend and consent to questionnaire, were recruited
56 from Barts Arthritis centre, Barts Health NHS trust, whilst awaiting routine rheumatology
57 clinic appointments from October 2019 - March 2020. Paper surveys were completed whilst
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3 waiting or returned by post. Doctors, nurses, or allied health professionals, specialising in
4 rheumatology care for 1 year or more, were recruited via a series of mailing lists from multiple
5 centres across London and South-East England. Clinician questionnaires were completed
6 online via SurveyMonkey from November 2019 - February 2020.
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12 Return of a completed patient or clinician questionnaire was taken as implicit consent to
13 participate in the questionnaire arm of the study. The study was registered (CMPS ID [43816]).
14 Ethical approval was obtained through the Bloomsbury Research and Ethics Committee
15 (19/LO/1345)
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20 21 **Statistical analysis**

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23 Questionnaire data were analysed with descriptive statistics using SPSS v.26. For each
24 variable, descriptive statistics (count, percentage, mean and standard deviation (SD)) were
25 calculated.
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30 31 **RESULTS**

32 33 **Demographics**

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35 **People with RA:** Of 114 questionnaires collected, five were excluded due to insufficient
36 information to verify the participant's identity, leaving 109 suitable for analysis. Mean age
37 was 56.1 (SD 15.1) years, with the majority of participants female (81.6%). 45% of participants
38 were degree-educated but only 36.6% in employment (24.8% not working due to their
39 health). Mean DAS-28 was 3.6 (SD 1.78), although 53.2% of patients had not had a DAS score
40 at their last clinical review. (TABLE 1)
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48 **Clinicians:** 41 clinicians completed the questionnaire study. They were predominately female
49 (65%), aged 35-54 (65.9%). Most participants were doctors, with clinical nurse specialists
50 representing 22.0% of the cohort. 55.9% were involved in an Early Inflammatory Arthritis (EIA)
51 clinic. Routine outpatient department (OPD) was overwhelmingly the most common setting
52 for these encounters, with 93.1% of RA patients seen in this way. (TABLE 1)
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Technology Usage

People with RA: 87.2% used a device daily. 83.5% used a smartphone. 9/109 (8.3%) did not use any technology on a regular basis (Fig. 1A). The mean age of non-daily smartphone users was 70.7 (SD13.3); 14.6 years older than the median age of the overall group. Considering a preferred device for remote monitoring, 57.8% selected smartphone, with desktop or laptop computer the next most popular choice at 14.7% (Fig. 1B).

Regular smartphone users (n=93) were surveyed on use of smartphone functions (Fig. 1C). Instant and text messaging were the most commonly used features, used daily by 83.9% and 77.4%, respectively. Email and social media were used daily by over half of the cohort. Photos were a feature used by all smartphone owners, although less regularly. Notably, arthritis apps were unpopular, with 75.3% having never used one. 19.2% reported they had used, and given up, a health app, and gave free text answers why, which were coded and grouped (Fig. 1D).

Clinicians: All 31 clinicians completing this section used a form of technology daily, with 93.5% using a smartphone. Desktop computers had similarly high usage levels (Fig. 1E). Patterns of smartphone usage were similar to the patient cohort (Fig. 1F). Arthritis apps were infrequently used, with 9.7% of clinicians reporting daily use. 25.8% used them at least monthly. 54.8% clinicians reported using apps in clinical practice. However, only 6.4% recommended rheumatology apps to their patients. Apps used by clinicians were all disease activity calculators or information databases, with no patient-facing features.

Challenges in RA care

Participants with RA

92/109 participants completed this question; 25 with early (<3 years duration), and 67 with established RA. Overall, pain management, lifestyle changes, and flare management were ranked as the top three most important issues, with concordance between early and established patients (Fig. 2A). Considering managing csDMARDs and advanced therapies, the most commonly identified challenges were: interactions (40.7%), obtaining medications (43.8%) and side effects (33%) rated as occurring 'often' or more frequently. Storage issues and self-administration were least challenging, with 69.9% and 61.4% selecting 'never', respectively. When asked about their greatest concern when commencing a new treatment, participants selected side effects (50%) most commonly, followed by 'obtaining medications'

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3 (17.2%), and 'drug interactions' (12.5%) (Fig. 2B). 44/96 (45.8%) respondents reported no
4 issues with drug monitoring. The most commonly encountered issue was knowing how
5 regularly blood monitoring was required (29.2%), followed by difficulty attending for blood
6 tests (27.1%).
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10 11 12 **Clinicians**

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14 Clinicians ranked disease understanding and acceptance as most important for people with
15 early RA, although these were jointly lowest ranked for those with established disease.
16 Medication management was the third ranked issue for both cohorts. Pain management and
17 flares were the highest ranked issues for people with established RA (Fig. 2C). Of issues
18 clinicians were most frequently contacted about between appointments, flares were ranked
19 first by 52.9%, (88.2% ranked them within the top three most common issues) with queries
20 about medication side effects, medication supply, and monitoring tests ranked 2nd, 3rd, and
21 4th, respectively (Fig. 2D).
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31 Considering existing challenges in RA care, resources, e.g., clinic slot availability, emerged as
32 the greatest challenge by a substantial margin (45.2% ranked it first and 80.6% ranked it in
33 the top three). A further cluster of five issues were highly ranked: medication monitoring and
34 support, flares, relationships with primary care, and patient education/empowerment.
35 Clinical and communication issues were ranked the least important on average, including
36 supply of effective medications, eliciting relevant information, and managing co-morbidities
37 (Fig. 2E).
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45 **Clinicians' attitudes to disease activity assessment**

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47 31 clinicians completed this section. Over 90% of clinicians routinely asked the patient their
48 general wellbeing, reviewed blood test results, and performed a general history and
49 examination. DAS-28, and morning stiffness duration were used by 87.1%. Clinic-based
50 ultrasound was used by almost half of surveyed clinicians (48.4%). Other validated disease
51 outcome measures were rarely used (Fig. 3A).
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58 Rating perceptions of reliability of the DAS-28 (Fig. 3B), no clinician rated it 'always
59 representative' of disease activity, 48.4% rated it to be 'usually representative' and 48.4%
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3 rated it neutrally. Chronic pain, and mechanical joint pain, were the most common
4 contributors to non-representative DAS-28 scores (Fig. 3C). Perceived reliability of patient-
5 reported outcome measures, and patient reported swollen and tender joint counts were
6 rated. Patient-reported joint counts (Pt-JC) were perceived to be less reliable than PROMs,
7 with 29% scoring Pt-JC 'rarely' or 'never' representative of true disease activity (Fig. 3B).
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9 Clinicians' strategies when DAS-28 did not align with their clinical assessment were most
10 commonly ultrasound (83.9%), although 25.8% reported repeating the DAS-28 aiming to meet
11 a specific score (Fig. 3D).
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20 **Useful services provided by technology**

21 Considering how useful potential technology services might be (Fig. 4A), 83/109 patients
22 ranked the features most useful to them (24 patients ticked but did not rank features, 7 did
23 not respond). 'A way to communicate with the Rheumatology team' was top ranked by 72.8%
24 with 48.8% ranking in their top three). The second top-ranked feature was 'Support with drug
25 monitoring' with 30.1% ranking this top three, and was selected by 48% of participants as
26 'useful', the fourth ranked most useful feature, alongside 'A trustworthy information source
27 about RA'. A way to flag concerns you wish to discuss with your clinical team prior to you
28 appointment' was the third most selected feature, selected by 52.3% (28.9% ranked top
29 three). 'A way of recording which joints are painful and swollen on a body map' was rated
30 'useful' by 59.8%; but <20% ranked it within their top three. 'Remote check-ups (replacing
31 routine clinical appointments)' was considered useful by only 22.4% of patients. Fewer than
32 30% of patients felt that technology changing their medication based upon their symptoms
33 would be useful.
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47 31 Clinicians rated the same potential technology services. They considered both their use to
48 clinicians, and to their patient group, with congruence of the top five most positively rated
49 features in both groups (Fig. 4B):
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- 51 1. Support with drug monitoring based on recent blood tests (96.8% Extremely/Fairly
52 Useful to clinicians; 96.7% to patients)
 - 53 2. Support with managing drug side effects (93.3% Extremely/Fairly Useful to clinicians;
54 96.7% to patients)
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3. A trustworthy RA information source (87.1% Extremely/Fairly Useful to clinicians; 93.3% to patients)
4. A way for patients to flag concerns they wish to discuss prior to their appointment (87.1% Extremely/Fairly Useful to clinicians; 93.3% to patients)
5. Tailored flare management advice, based on symptom tracking (90.0% Extremely/Fairly Useful to clinicians and patients)

Four features received more negative than positive responses in terms of their use to clinicians:

1. Fatigue warnings, based on symptom tracking input (71% rated limited/no use)
2. Prediction of good and bad days based upon symptom tracking input (64.5% rated limited/no use)
3. Symptom tracking, not shared with clinical care team (54.8% rated limited/no use)
4. Helping patients to organise and make decisions about future daily activity based on their symptoms (51.6% rated limited/no use)

However, there was a greater discrepancy between how clinicians rated what they considered useful to them, and what might be useful to patients. When rating 'useful to patients', no features received a net negative response.

Barriers to the use of technology to support care

Rating preferences for recording and sharing data with a mobile health monitoring tool (Fig. 5A), 53.2% of participants living with RA chose 'monthly'. Only 8.3% selected 'not at all'. 12.8% were willing to provide data daily or more frequently. 74.3% gave positive or neutral responses when rating acceptability of continuous monitoring. When asked about preparedness to track symptoms/activities to receive continuous recommendations, 48.6% selected acceptable or highly acceptable, 28.4% neutral, and 22.9% unacceptable/highly unacceptable. Participants were further asked what information they would be prepared to record and/or share, and with whom (Fig. 5B). For all options, sharing information directly with the clinical team was the most popular, and sharing information with other patients the least. Recording information on a personal device, but not sharing it, was only marginally more acceptable than sharing with other patients. Participants were most willing to share

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3 clinical information, such as pain scores, joint counts, or medication tracking; rather than
4 lifestyle information e.g. physical activity tracking, sleep patterns, or location tracking. 8.7%
5 of patients left all options blank, suggesting they would be unprepared to record or share any
6 of the proposed information.
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12 31 clinicians answered three questions explicitly addressing attitudes towards utilising novel
13 technology within RA care (Fig. 5C). Responses to “How do you Feel about the use of
14 technology to support RA care?” were largely positive with 83.9% selecting ‘Very- “, or
15 ‘Somewhat Open’. Rating whether specific features would make them more likely to engage
16 with a remote monitoring tool, three features received no negative responses, with all
17 clinicians rating these as ‘Very likely’ or ‘Likely’ to encourage them to engage: ‘Clear and
18 simple presentation of data’, direct linkage of data to patients’ EHR, and medication tracking.
19 ‘Provision of continuous monitoring’ was least positively scored (80% answering negatively
20 or indifferently). ‘Novel technologies’ and ‘subjective measures’ were similarly scored (61.3%
21 and 54.8% rating either negatively or neutrally). The greatest barrier to the use of technology
22 to support care identified by clinicians was ‘NHS technical capabilities’ (93.5%). Only “Patient
23 preference” was rated as either ‘not a barrier’ or neutral, with 41.9% scoring ‘not a barrier’.
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36 **DISCUSSION**

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38 This study assessed current technology usage, and attitudes of people with RA and their
39 clinicians towards utilising technology to support care, and the perceived opportunities and
40 barriers to this. It additionally explored the existing challenges of living with, and managing,
41 RA, in order to draw out potential opportunities for technology not explicitly identified by
42 end-users. Our study is consistent with existing published work in European cohorts (19,20)
43 finding that whilst people with RA have high levels of smartphone usage, and are largely eager
44 to use mHealth, uptake of existing technologies is low, with only 13.8% using an arthritis app
45 regularly. Our study extends this finding to clinicians, as whilst over half our cohort reported
46 using apps in clinical practice, these were all disease activity calculators or information
47 resources, with only 2/31 recommending rheumatology apps to patients. This is congruent
48 with a review of existing commercially available apps, which found that RA apps fall into two
49 categories: simple calculators for rheumatologists, and data tracking tools for people with RA
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3 (26). Thus, there is a clear appetite for mHealth solutions, as yet unmet by existing
4 technologies.
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9 We found existing challenges for people living with RA to be pain management, lifestyle
10 changes, medication management, and flares. The substantially higher ranking of 'lifestyle
11 changes', 'pain management' and 'functional impairment' by people with RA suggest
12 clinicians underestimate the impact that RA has on their patients. These areas present an
13 unmet need, and thus an opportunity for mHealth to provide support for people managing
14 day-to-day life with RA, which may help increase engagement beyond simple remote
15 monitoring. People with RA did not rank disease acceptance and understanding nearly so
16 highly as their clinicians, perhaps because these are not conscious processes, but
17 nevertheless, the high ranking by rheumatologists suggest an area of potential growth for
18 mHealth solutions, providing accessible education resources and support solutions tailored
19 to users' demographics. Clinicians primarily focus on aspects of disease which are directly
20 modifiable by them, within the time-limited constraints of face-to-face appointments, such
21 as flares and medications. Insufficient resources are the greatest existing challenge for
22 clinicians, strengthening the need for mHealth to reduce the pressure on f2f follow-up slots.
23 This questionnaire was conducted just prior to the onset of the COVID-19 pandemic, so these
24 challenges will have only deepened with the backlog of patients produced by the pandemic
25 (27).
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41 Challenges in DMARD prescribing is a significant burden to both patients and clinicians, with
42 patients struggling to obtain medications, and concerns about side effects and interactions.
43 Medication queries are the most frequent reasons for contact with clinicians between
44 planned reviews. Improving existing pathways for DMARD prescribing and monitoring, with
45 side-effect support, is thus a clear opportunity for mHealth technology to improve RA care
46 for people with RA and reduce the burden on rheumatology services.
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54 Clinical assessment of RA activity is multi-faceted, due to the lack of a reliable biomarker to
55 track disease activity. Whilst DAS-28 is the most commonly used composite measure, most
56 surveyed clinicians considered it to be a flawed measure with many potential confounders,
57 e.g., fibromyalgia. Any remote monitoring measure will need to be multifaceted in order to
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3 accurately assess disease activity. Over time, data collected from mHealth monitoring,
4 corroborated clinically, may facilitate development of novel disease activity measures, e.g.,
5 in the ActConnect study, where machine learning methods were used to predict flares based
6 on activity tracking in people with RA and Axial Spondyloarthropathies (28). Considering
7 opportunities, people living with RA rated access to their rheumatologist as the most
8 attractive opportunity for technology by a substantial margin, although this was less highly
9 ranked by clinicians, likely due to concerns about the potential for improved accessibility to
10 create an additional workstream, given 80.6% of surveyed clinicians rated 'saturation of
11 information from patients' as a barrier to using technology. A way to flag concerns prior to
12 appointments, support with drug monitoring and side effects and providing trustworthy
13 information were highly rated by both groups.
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25 People with RA are generally willing to share information about their disease with their clinical
26 team, with a general preference for sharing data rather than tracking on their individual
27 device. Clinicians are open to using technology within the care pathway, but consider NHS
28 technical capabilities, need for trial evidence of efficacy, cost, and time as barriers, in addition
29 to concerns regarding mHealth generating data overwhelm.
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36 The strengths of this study are its cross-disciplinary design, with input from both computer
37 scientists and rheumatologists ensuring both clinical and technical aspects were considered
38 throughout the process. Consistent input from RA patient groups ensured the target group
39 were placed first and foremost. Our questionnaire was distributed on paper, eliminating the
40 bias of requiring technology literacy to participate, ensuring a broad spectrum of views.
41 Exploring broader aspects of living with RA and existing challenges in care enabled us to
42 extract information on potential opportunities and barriers beyond those explicitly identified
43 by participants. A possible criticism of this questionnaire study is that many of the issues
44 addressed might be better addressed by qualitative methods. However, our questionnaire
45 forms part of a mixed-methods study, with further results to follow from qualitative analysis
46 of semi-structured interviews with people with RA and clinicians, which explores the themes
47 identified in greater depth, and will allow us to triangulate data from both sides to strengthen
48 drawn conclusions.
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3 A potential limitation of the study is its single-centre design, and convenience sampling
4 method. However, a diverse population of people with RA were surveyed, in terms of
5 ethnicity, age, and disease duration. The clinician arm of the study was multi-centre and
6 demonstrated that similar issues were experienced in a variety of centres across London,
7 although this may generalise less well to non-urban settings. The exclusion of primary care
8 physicians and RA patient carers, as recommended in EULAR's PTC for remote care (24) is a
9 limitation, and an area for further work. Finally, methodological discrepancies between the
10 clinician and patient questionnaires prevented like-for-like comparison of potential
11 technology services.
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22 **CONCLUSIONS**

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25 In spite of good levels of technology literacy and willing from both sides, our cohort did not
26 use technology to support care, suggesting that existing available software is either poorly
27 publicised, or inadequate, either in function or user experience. Access, medication support,
28 and disease education are mutually agreed opportunities for future mHealth technologies.
29 Existing challenges in the healthcare system, e.g., limited resources, and need for integration
30 with existing technical systems were the greatest barriers identified. The qualitative arm of
31 this mixed-methods study, in which people with RA and clinicians completed semi-structured
32 interviews, will explore these findings in more granular depth and detail.
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44 Research Council [grant number EP/P009964/1, to N.F., as part of the "Patient managed
45 decision-support using bayesian networks" (PAMBAYESIAN) study].
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48 **Data Availability Statement:** The data underlying this article will be shared on reasonable
49 request to the corresponding author.
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52 **Conflict of Interest Statement:** The authors have declared no conflict of interest.
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Table 1: Patient and Clinician Demographics

Characteristic	Patient Questionnaire (n=109)	Clinician Questionnaire (n=41)
Age, years n(%)		
18-34	10 (9.2)	10 (24.9)
35-54	38 (34.9)	27 (63.9)
55-74	52 (47.7)	4 (9.6)
>75	9 (8.3)	0 (0)
Mean age, years (SD)	56.1 (15.1)	x
Female n(%)	89 (81.6)	26 (65.0)
Ethnicity		
Asian/Asian British	43 (39.8)	x
Black/Black British	9 (8.3)	x
White British	41 (38)	x
White other	8 (7.4)	x
Other	9 (8.3)	x
Education Level		
Degree/Postgraduate	45 (41.7)	x
A-Level/equivalent	11 (10.2)	x
GCSE/equivalent	24 (22.2)	x
Other qualification	7 (6.5)	x
No qualification	18 (16.7)	x
Employment Status		
Yes	41 (36.6)	x
No/Retired/Other	17 (15.6)/ 42 (38.5)/ 9 (8.3)	x
Not working due to health	27 (24.8)	x
Clinician Role		
Doctor: (Consultant/Registrar)	x	16 (39.1); 16 (39.1)
Clinical Nurse Specialist	x	9 (22.0)
Years Rheumatology Experience		
<5	x	12 (29.3)
6-15y	x	15 (36.6)
16-25y	x	12 (29.3)
>25y	x	2 (4.9)
Involved in EIA clinic n(%)	x	19 (55.9)
Subspecialty interest in RA n(%)		29 (76.3)
Involved in Research n(%)	23 (21.1)	24 (58.5)
No. RA pts/week		
<=10	x	14 (41.2)
11-20	x	16 (47.1)
>20	x	4 (11.8)
Setting patients seen (%)		
Outpatient Department (Routine/Emergency)	x	93, 4
Inpatient	x	6
Patient Disease Characteristics		
Seropositive n(%)	80 (73.4)	x
Disease Duration, years n(%)		x
< 3	29 (26.6)	x
3 – 10	51 (46.8)	x
> 10	29 (26.6)	x

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DAS-28 at last review mean (SD)	3.6 (1.78)	x
No DAS recorded n(%)	58 (53.2)	x
Smoking n(%)	10 (9.2)	x
≥ 1 Comorbidities n(%)	81 (74.3)	x
DMARDs n(%)		
no DMARD	7 (6.4)	x
csDMARD only	61 (56.5)	x
bDMARD total	48 (44.4)	x
2nd line biologic (or more) n(%)	14 (12.8)	x

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Figure legends**Figure 1: People with RA and clinician technology usage, and monitoring device**

preference. A-C: N=109 people with RA; D: N= 20 people with RA; E-F: N=31 clinicians.

Figure 2. Top Five challenges for RA patients and clinicians.

Patients and clinicians ranked top five issues from list. A. Biggest issues for patients with early RA (within 3 years of diagnosis[n=25]) and established RA (>3yrs[n=67]); B. Biggest issues for patients with early and established RA, perceived by clinicians [n=34]; C. Challenges for patients managing RA medications [n=109], rated on 5-point Likert scale from 1=Always to 5=Never; D. Challenges for Clinicians delivering RA care (Ranking top five issues) [n=31]; E. Reasons Clinicians most commonly contacted by patients between clinic appointments (ranking top five issues) [n=33].

Figure 3: Clinicians' attitudes to disease activity assessment.

A. Methods used by clinicians to routinely assess disease activity; B. Clinicians' ratings of reliability of clinician DAS-28; patient DAS-28; and Patient recorded outcome measures (5-point Likert scale rating); C. Clinicians' ratings of frequency for reasons DAS-28 may be inaccurate (5-point Likert scale rating); D. Clinicians' strategies when DAS-28 not in line with clinical assessment.

Figure 4. People with RA (A) and clinicians (B) ratings how useful prospective services

provided by technology would be. A. People with RA's ratings of useful services, ranking top three most useful services and any services they regarded as useful to them [n=109]; B. Clinicians [n=31] rated on 4-point Likert scale how useful they thought each service would be to them (top) and their patients (bottom).

Figure 5: Perceived barriers to technology.

A. Acceptability of using technology to monitor disease to people with RA, [n=109]; B. Types of information people with RA are willing to record and share [n=109]; C. Clinicians' Attitudes to technology & features most likely to promote clinician engagement [n=31]; D. Perceived barriers by Clinicians to using technology in RA care [n=31].

AtTRA questionnaire **Table 1: Patient and Clinician Demographics**

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35-54	38 (34.9)	27 (63.9)
55-74	52 (47.7)	4 (9.6)
>75	9 (8.3)	0 (0)
Mean age, years (SD)	56.1 (15.1)	x
Female n(%)	89 (81.6)	26 (65.0)
Ethnicity		
Asian/Asian British	43 (39.8)	x
Black/Black British	9 (8.3)	x
White British	41 (38)	x
White other	8 (7.4)	x
Other	9 (8.3)	x
Education Level		
Degree/Postgraduate	45 (41.7)	x
A-Level/equivalent	11 (10.2)	x
GCSE/equivalent	24 (22.2)	x
Other qualification	7 (6.5)	x
No qualification	18 (16.7)	x
Employment Status		
Yes	41 (36.6)	x
No/Retired/Other	17 (15.6)/ 42 (38.5)/ 9 (8.3)	x
Not working due to health	27 (24.8)	x
Clinician Role		
Doctor: (Consultant/Registrar)	x	16 (39.1); 16 (39.1)
Clinical Nurse Specialist	x	9 (22.0)
Years Rheumatology Experience		
<5	x	12 (29.3)
6-15y	x	15 (36.6)
16-25y	x	12 (29.3)
>25y	x	2 (4.9)
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Subspecialty interest in RA n(%)		29 (76.3)
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Inpatient	x	6
Patient Disease Characteristics		
Seropositive n(%)	80 (73.4)	x
Disease Duration, years n(%)		x
< 3	29 (26.6)	x
3 – 10	51 (46.8)	x
> 10	29 (26.6)	x
DAS-28 at last review mean (SD)	3.6 (1.78)	x
No DAS recorded n(%)	58 (53.2)	x

AtTRA questionnaire **Table 1: Patient and Clinician Demographics**

Smoking n(%)	10 (9.2)	x
≥ 1 Comorbidities n(%)	81 (74.3)	x
DMARDs n(%)		
no DMARD	7 (6.4)	x
csDMARD only	61 (56.5)	x
bDMARD total	48 (44.4)	x
2nd line biologic (or more) n(%)	14 (12.8)	x

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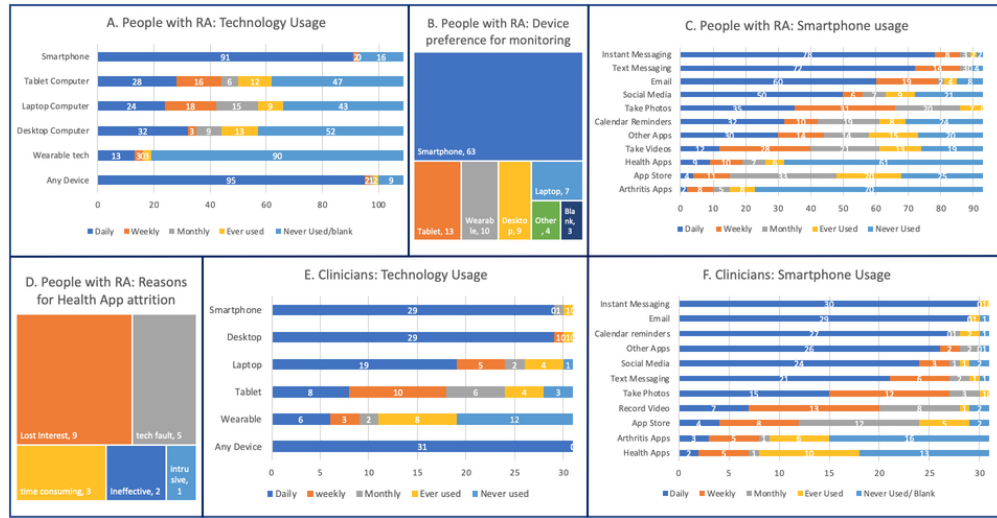


Figure 1: People with RA and clinician technology usage, and monitoring device preference, Fig A-C: N=109 people with RA; Fig D: N= 20 people with RA; Fig E-F: N=31 clinicians

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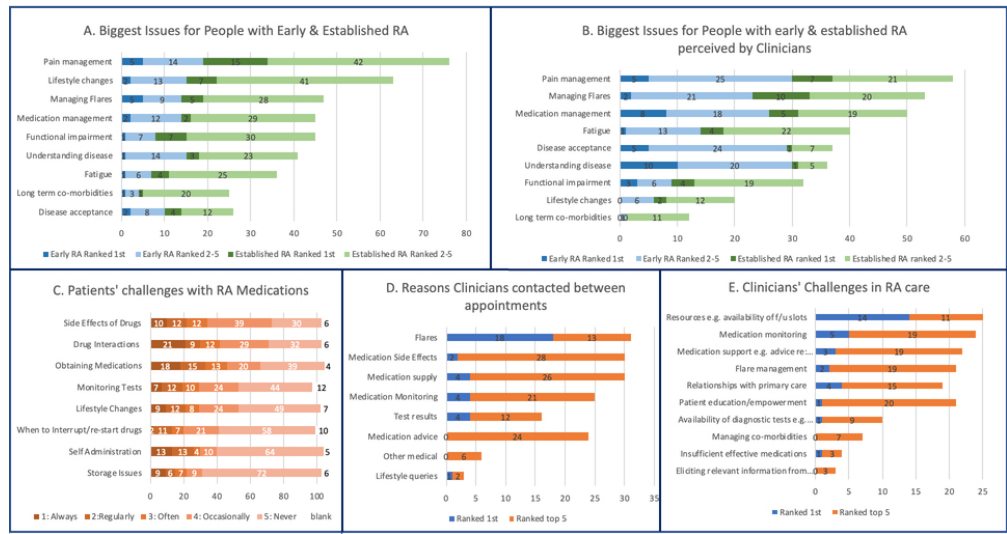


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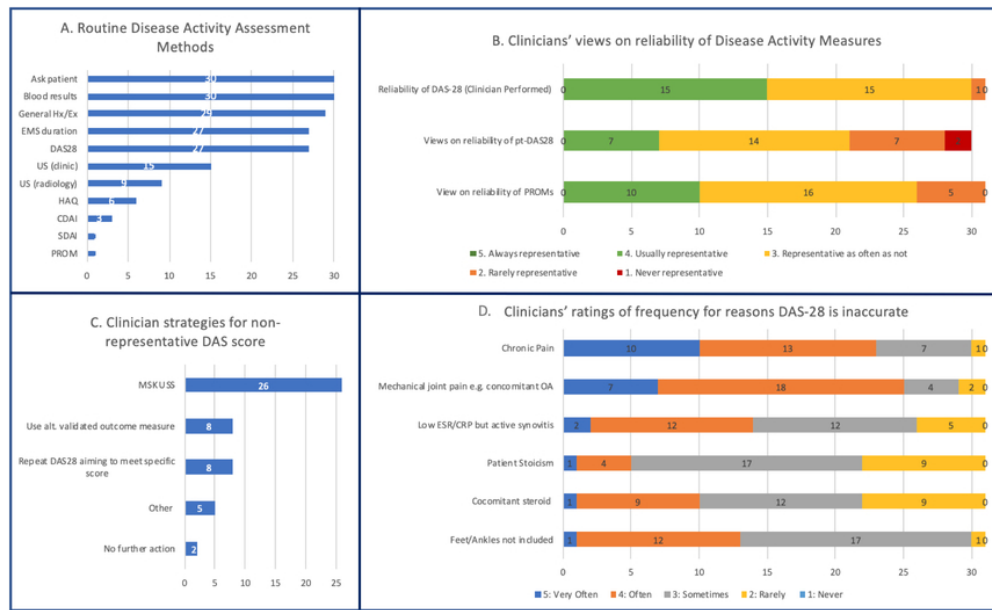


Figure 3: A. Methods used by clinicians to routinely assess disease activity; B. Clinicians' ratings of reliability of clinician DAS-28; patient DAS-28; and Patient recorded outcome measures (5-point Likert scale rating); C. Clinicians' ratings of frequency for reasons DAS-28 may be inaccurate (5-point Likert scale rating); D. Clinicians' strategies when DAS-28 not in line with clinical assessment.

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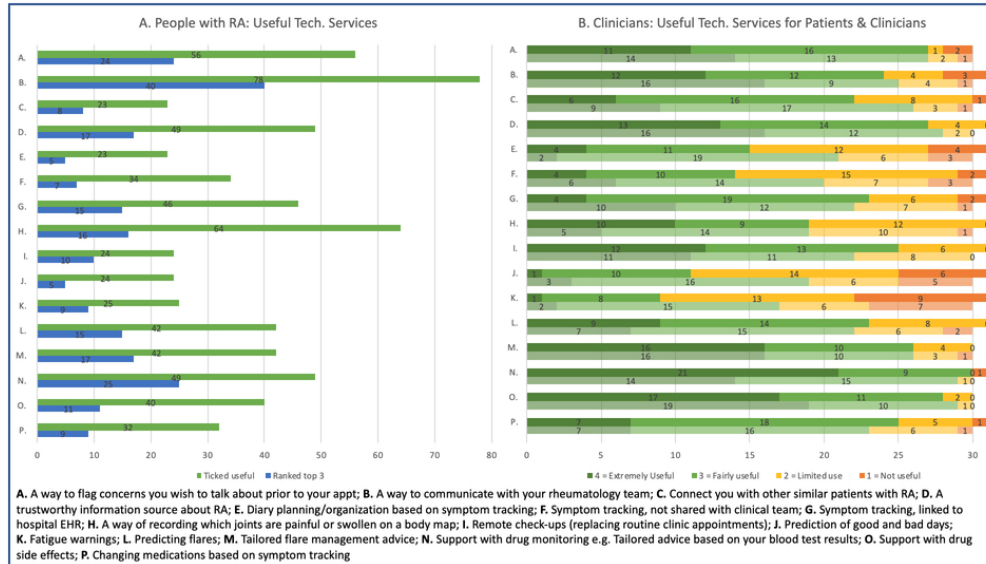


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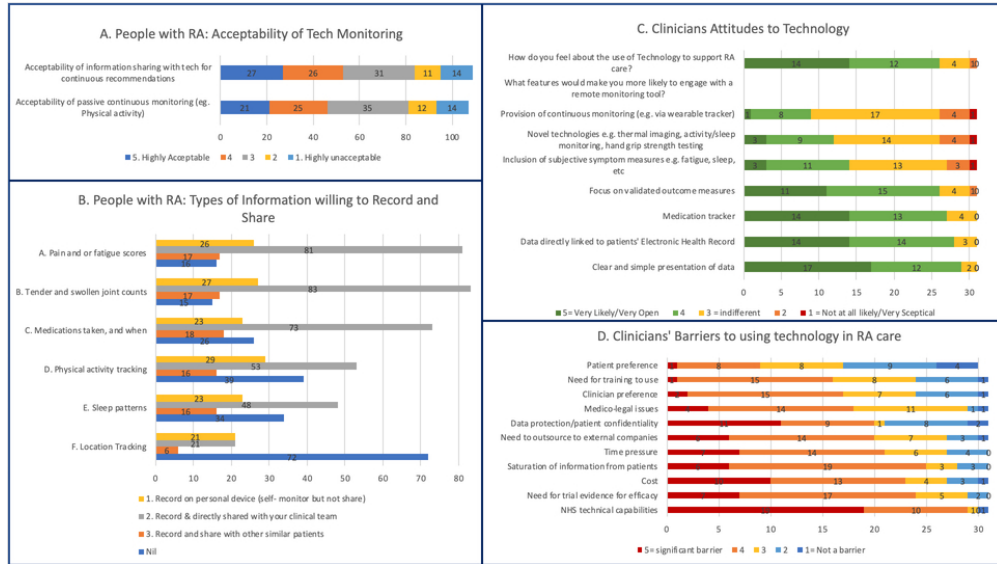


Figure 5: Perceived Barriers to Technology. A. Acceptability of using technology to monitor disease to people with RA, [n=109]; B. Types of information people with RA are willing to record and share [n=109]; C. Clinicians' Attitudes to technology & features most likely to promote clinician engagement [n=31]; D. Perceived barriers by Clinicians to using technology in RA care [n=31]

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