






**REVIEW ARTICLE**

# Home-Based Telemedicine in Rheumatology—A Scoping Review

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**Objective.** We performed a scoping review of the relevant literature on home-based telehealth in rheumatology to understand its appropriate application in rheumatology practice.

**Methods.** We searched the Cochrane Library, PubMed, Web of Science, and scientific meeting abstracts to identify articles that specifically addressed telehealth suitability, barriers to telehealth, patient-reported outcomes (PROs) collected in telehealth settings, and telehealth satisfaction. From the initial search of 4,882 studies, 23 reports were included. In addition, 10 abstracts were also eligible for analysis, resulting in a total of 33 articles: 2 randomized clinical trials, 9 prospective cohort studies, and 22 retrospective studies.

**Results.** We found that triage appointments or predictive models could be helpful in selecting patients for telehealth and that telehealth interventions were appropriate for follow-up of patients with systemic lupus erythematosus and inflammatory arthritis, but that conducting new patient visits over telehealth was not ideal. Barriers to telehealth include patient factors (age, technology access) and need for physician/process factors (eg, physical examinations). PROs collected in regular practice can be incorporated into telehealth. Several small, single-center studies suggest that telehealth does not lead to negative outcomes compared with in-person visits, and overall, patients report high patient satisfaction with telehealth. In several scenarios, home-based telehealth was equivalent to in-person visits with regard to patient outcomes and satisfaction.

**Conclusion.** The widespread potential of telehealth to manage and deliver care for people with rheumatic disease is significant. As such, further research in the form of randomized controlled trials can help contribute to growing evidence that shapes telehealth implementation for patients with rheumatic diseases.

## INTRODUCTION

Telehealth is the use of electronic information and telecommunications technologies to support long-distance clinical care, health-related education, public health, and health administration.<sup>1</sup> It has increased gradually in the United States over the last four decades and dramatically during the COVID-19 pandemic, forcing health care providers to rapidly transition to a virtual clinical

care model. There was a 63-fold increase in the deployment of telehealth visits from 2019 to 2020,<sup>2</sup> largely facilitated by supportive policies by payers including Centers for Medicare and Medicaid Services and regulators such as the US Department of Health and Human Services.<sup>3</sup>

Prepandemic, telehealth was typically delivered in a center-based “spoke and hub” model in which the patient and provider were each located in different health care environments.<sup>4</sup> During

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the pandemic, there was a shift to a home-based model, in which the patient was in their home interacting with the health care provider via a personal computer or other electronic device.<sup>5</sup> Because this form of virtual visit continues to be used extensively, we sought to summarize the literature on home-based telehealth for routine rheumatology care to inform day-to-day rheumatology practice about telehealth and identify priorities for additional research. This review is distinct from other scientific reviews of telehealth in rheumatology, which either did not focus on home-based telehealth or did not focus on a broad set of domains that inform day-to-day rheumatology practice.

For the purposes of this review, the terms telemedicine, telerheumatology, telehealth, and virtual visits are synonymous terms that reference home-based telehealth and are used interchangeably. Additionally, in-person face-to-face visits between a patient and their provider are labeled by the acronym F2F.

**MATERIALS AND METHODS**

We developed a protocol for the scoping review and registered it with Center for Open Science OSF portal (<https://osf.io/beh9/>). Given the relatively new practice of home-based telehealth, the breadth of our research objectives and the heterogeneity of the literature, we opted to perform a scoping review instead of a systematic review, which is typically better suited to assess efficacy of an established practice<sup>6</sup> or to summarize the effect of a specific intervention through meta-analysis. We searched the Cochrane Library, PubMed, and Web of Science electronic databases using a predefined search strategy, supported by the Cedars Sinai Medical Center librarian, including records from each database’s inception up to June 2022. The search terms and strategy are in Figure 1. The articles selected were required to address one or more of our four objectives: (1) describe the method(s) by which rheumatology practices screen patients for telemedicine visit eligibility and appropriateness, (2) describe the disease and patient characteristics most

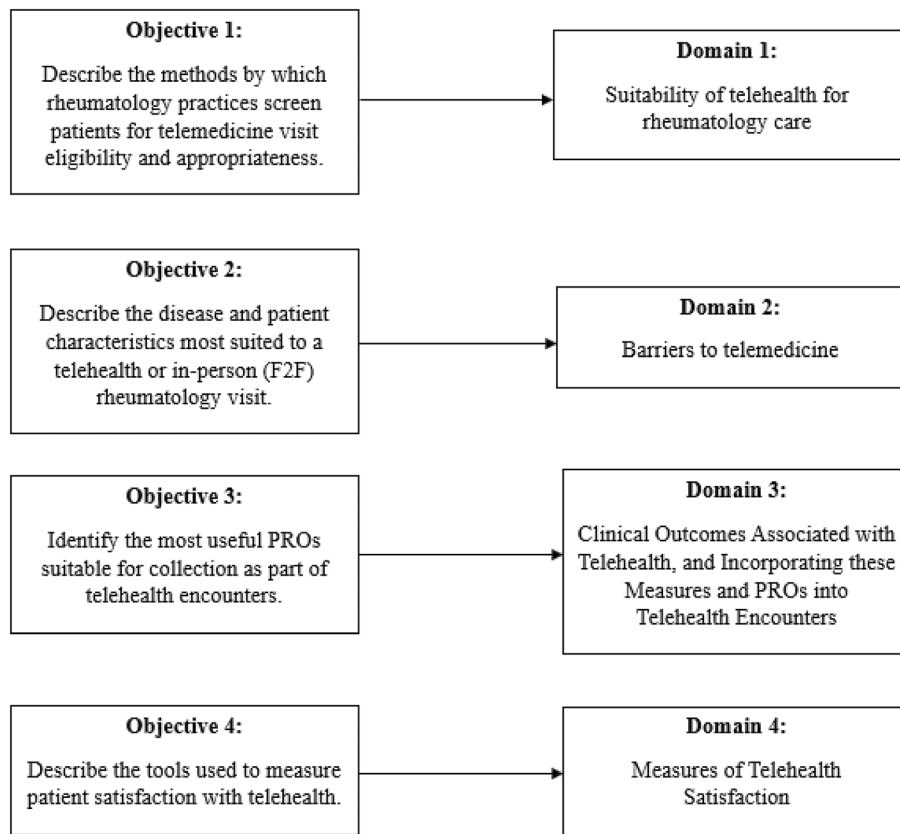
suited to a telehealth or in-person (F2F) rheumatology visit, (3) identify the most useful patient-reported outcomes (PROs) suitable for collection as part of telehealth encounters, and (4) describe the tools used to measure patient satisfaction with telehealth. Our wider research team discussion led to mapping our objectives into four domains (Figure 2). Exclusion criteria were (1) focus on non-home-based telehealth, (2) focus on asynchronous telemedicine (eg, email, portal messages, text messages, voicemail, etc), (3) focus on medical specialties other than rheumatology, and (4) non-English articles. The target literature was published full-length articles and brief reports on primary data that were focused on telerheumatology using a home-based approach. Because this is an emerging field, we also searched the EULAR and American College of Rheumatology annual meeting abstracts from 2020 to 2022 using the search terms found in Figure 1. In addition, we hand-searched the reference lists of other systematic reviews of telemedicine in rheumatology to identify articles that our search might have missed.<sup>7-9</sup> All titles were uploaded into EndNote and duplicate records removed.

After an initial screen of titles and abstracts against inclusion and exclusion criteria by one author (AP), the records that passed through the screen were cited, grouped, and independently reviewed by two authors (AP and ND). Full text was obtained of records meeting the inclusion criteria; the authors (AP and ND) viewed the full text to determine eligibility for final inclusion, and one author (SV) adjudicated any disagreements about inclusion.

We grouped the studies according to the study type: randomized controlled trial (RCT), prospective cohort, and retrospective studies. We then collected and abstracted the data from each study, including the number of patients, type of disease, study duration, outcome measures, and results, into Supplementary Table 1. We elected not to perform a quality appraisal of the data because this is typically not done for scoping reviews.<sup>6</sup> We excluded studies that looked at remote monitoring because this was not in the scope of our definition for home-based telehealth and has been covered by others.<sup>10</sup>

Telehealth Terms [AND]	Rheumatology Terms
telehealth OR telemedicine OR telerheumatology OR video visit OR telephone OR smartphone OR remote consultation OR remote consult OR remote consulting OR econsultation OR econsult OR econsulting OR e Consult OR e consultation OR e consulting OR electronic consult OR electronic consultation OR electronic consulting OR videoconferencing OR remote consult OR remote consultation OR remote consulting OR virtual consult OR virtual consultation OR virtual consulting OR Teleconsultation OR app-based	arthritis OR rheumatic OR rheumatology OR rheumatologic OR joint disease OR rheumatoid arthritis OR RA OR gout OR osteoporosis OR fracture OR lupus OR systemic lupus erythematosus OR SLE OR osteoarthritis OR OA OR vasculitis OR myositis

**Figure 1.** Search term strategy. OA, osteoarthritis; RA, rheumatoid arthritis; SLE, systemic lupus erythematosus.



**Figure 2.** Mapping of objectives to domains. F2F, face to face; PRO, patient-reported outcome measure.

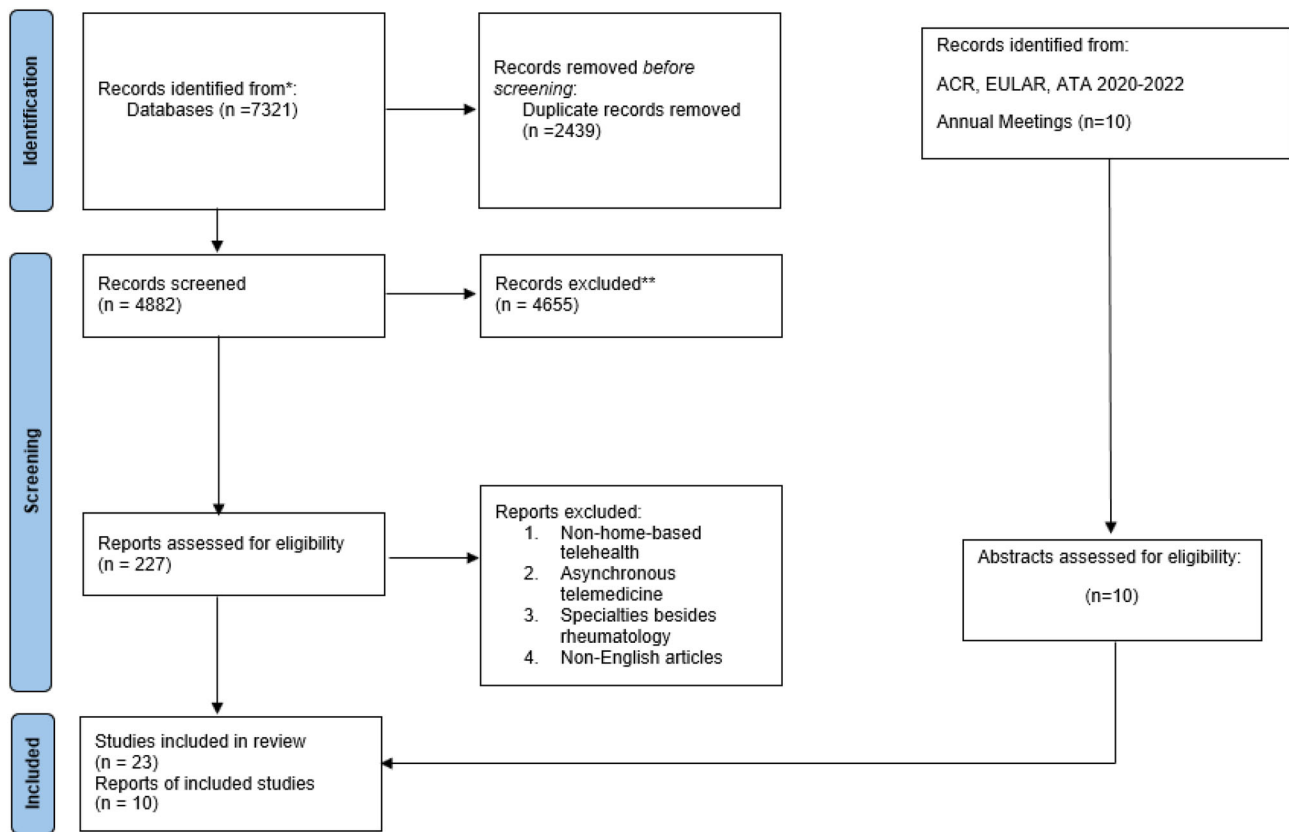
## RESULTS

A total of 4,882 records were selected for title and abstract screening. Of these, 277 potentially met eligibility and underwent full text review, which yielded 23 articles for inclusion. A review of conference abstracts identified 10 additional abstracts that met inclusion criteria (Figure 3).

**Domain 1: suitability of telehealth for rheumatology care.** Seven articles addressed this domain. Two were prospective cohort studies from Italy<sup>11</sup> and the US,<sup>12</sup> and five were retrospective studies from the UK,<sup>13,14</sup> Australia,<sup>15</sup> and the US.<sup>16,17</sup> All were single-center studies conducted after March 2020. The optimal screening method for telehealth visit appropriateness was addressed in two studies. One Italian prospective study found that a triage telehealth appointment before an F2F visit led to a definitive diagnosis after the F2F visit for a higher percentage of patients (79%) versus patients with a single F2F visit (67%). Importantly, telehealth triage also reduced the need for a second follow-up F2F appointment compared with the patients who had a single F2F visit (26% vs 54%,  $P < 0.05$ ), indicating the utility of a triage telehealth appointment in streamlining care.<sup>11</sup> A cohort study from the US included various patient factors such as new versus follow-up, diagnosis and medication

history, and disease activity and provider factors such as same versus new providers to create a predictive model, named the Encounter Appropriateness Score for You (EASY score) to predict suitability for telehealth.<sup>12</sup> The score was derived from a training set of 10,551 encounters that included provider's scores after outpatient rheumatology encounters of the appropriateness of the visit for telehealth or F2F care. EASY scores from visits between January 2021 and December 2021 were calculated to determine the suitability of future visits for telehealth. The validation encounter sets (1,244 encounters from January 2022) assessed model performance in comparison to the test set and reported a similar performance to the training set encounters, with a positive predictive value of 0.80. These studies provide evidence that a triage appointment before a new patient consultation or a predictive model to assess suitability for telehealth could be helpful with patient selection for telehealth visits.

Several retrospective studies aimed to clarify the patient subtypes best suited for telehealth. A study in Ireland of a virtual clinic for fracture risk management resulted in a positive experience for 90% of patients, suggesting that virtual osteoporosis assessments are feasible and well accepted by patients.<sup>13</sup> A retrospective chart review in Australia studied the appropriateness of telehealth for certain populations of patients based on the comparison of electronic records from a historical cohort (April to



**Figure 3.** Flowchart of included studies and abstracts. ACR, American College of Rheumatology; ATA, American Thyroid Association.

May 2019) to a COVID-19 telehealth cohort (April to May 2020). An additional F2F visit was required for 9.4% of patients after telehealth ( $n = 1,444$ ). Predictors of needing an F2F visit after a telehealth visit (suggesting that telehealth was unsuitable) were new patient encounters (odds ratio [OR] = 6.28), patients without a definite rheumatologic diagnosis (OR = 18.43), patients with inflammatory arthritis (IA) (OR = 2.85), and patients with systemic lupus erythematosus (SLE) or other connective tissue disease (CTD) (OR = 3.22).<sup>15</sup> Moreover, providers were less likely to change immunosuppressive therapy during home-based telehealth in 2020 than in 2019 (22.6% vs 27.4%,  $P = 0.004$ ). When surveyed, the physicians reported being comfortable with changing therapy during telemedicine encounters, although the data suggest that therapy de-escalation occurred less frequently.<sup>15</sup> This theme of hesitancy among physicians to change therapy was also reported in several survey studies. Physicians in the UK treating patients with lupus and IA expressed a preference for F2F visits due to concerns of misdiagnosis, diagnostic delay, and barriers to accessing care, indicating a preference for F2F care for patients with SLE and IA.<sup>14</sup> Similarly, a survey reported that most Veterans Affairs providers were comfortable using telehealth for established rheumatology patients, but not new patients, and also reported that providers with higher resilience scores (measured by the Connor–Davidson Resilience Scale) were more comfortable with telehealth.<sup>16</sup>

Although these data suggest concerns for care quality via telehealth for patients with SLE and IA, a retrospective analysis from a large Texas health care system reported that lupus patients with lower socioeconomic status missed fewer telehealth appointments compared with F2F visits, indicating that telehealth options may maintain attendance, an aspect of care quality.<sup>17</sup> Taken together, these studies suggest that telehealth may be less suitable for new patients with possible IA or autoimmune CTD, although it may be suitable to enhance continuity of care during follow-up of patients with IA and SLE and may also be appropriate to provide osteoporosis care.<sup>13,14</sup>

**Domain 2: barriers to telemedicine.** We identified only five articles that discussed accessibility and comfort with telehealth for rheumatology patients in India,<sup>18,19</sup> Japan,<sup>20</sup> the UK,<sup>21</sup> and the Netherlands<sup>22</sup> and identified barriers such as age, lack of technology, and language differences. In one study from India, patients received either a phone call or survey regarding their experience using telemedicine and found that the language of the clinician was a key barrier for a teleconsultation.<sup>18</sup> Another Indian study described a high acceptance rate for telemedicine, but almost 16% of the patients stated that the ease of communication with the doctor during telemedicine was difficult because of their lack of familiarity with new technology and was associated with lower socioeconomic status.<sup>19</sup> A study from Japan reported

that patients who were willing to use telemedicine were on average younger than the patients who were not willing (67.9 vs 73.1 years,  $P = 0.0026$ ).<sup>20</sup> A survey of rheumatology patients in a large UK community hospital indicated younger age as a predictive factor for satisfaction, reporting that 73.9% of patients under 50 years preferred telehealth during the pandemic compared with 57.8% of patients aged 50 to 69 years and 46.8% of patients older than 70 years.<sup>21</sup> One study from the Netherlands reported on physician perspectives on telehealth with a survey and identified three main barriers for telemedicine, including an inability to perform a physical examination, difficulty in estimating the patient's physical condition, and difficulty in reaching the patients.<sup>22</sup> These studies identify patient factors (age, technology access) and physician/process factors (physical examinations) as barriers to telehealth.

**Domain 3: clinical outcomes associated with telehealth and incorporating these measures and PROs into telehealth encounters.** This domain was addressed by two RCTs, four prospective cohort studies, and one retrospective study and included participants with five autoimmune/inflammatory diseases, and 17 different outcome measures were reported (Supplementary Table 1). Two studies included participants with rheumatoid arthritis (RA). An RCT from Norway randomized people with RA to telehealth follow-up ( $n = 108$ ) or F2F follow-up ( $n = 104$ ).<sup>23</sup> There was a significantly higher patient-reported flare rate (13%) for the telehealth group compared with the F2F group (5%). However, physician examination of participants with patient-reported flares (Routine Assessment of Patient Index Data 3 scores  $>6$ ) did not confirm a difference in clinical flares between telehealth and F2F groups, indicating that PRO-based flares may not accurately reflect joint inflammation on examination. Mean satisfaction scores (0–10 visual analog scale) were somewhat lower for telehealth group participants compared with the F2F group (8.8 vs 9.8), which the authors attributed primarily to the problems with their telehealth software application.<sup>23</sup> The second study was a three-month prospective study from Colombia that found comparable disease activity in participants with RA for telemedicine and F2F care using standardized measures such as the Patient Activity Scale, Visual Analogue Scale (VAS), Disease Activity Score with 28 joint counts, and the Health Assessment Questionnaire.<sup>24</sup> Two studies included patients with SLE. One RCT from Hong Kong included 141 patients with lupus nephritis and found similar disease activity between telehealth and F2F care at 1 year using indices such as the SLE Disease Activity Index (SLEDAI) and Quality of Life (QoL) measures, highlighting the potential of telemedicine to provide equivalent lupus nephritis control.<sup>25</sup> A one-year prospective cohort study examined use of immunosuppression, flares at final visit, and current SLEDAI-2k score for patients after telemedicine consults and F2F appointments. Using a multivariable model, the choice of teleconsultation versus F2F consultation did not predict a flare at the next visit

(OR 0.42, 95% confidence interval [95% CI] 0.04–5.04;  $P = 0.49$ ) and did not significantly predict SLEDAI-2k at the next visit (estimate of coefficient [95% CI]  $-0.19$  [ $-0.80$  to  $0.43$ ];  $P = 0.55$ ).<sup>26</sup> These studies suggest that some aspects of care for RA and SLE patients can be adequately managed with telehealth.

There were two studies that reported outcomes of groups of people with IA followed by an F2F visit or telemedicine. A prospective cohort study from Italy included 106 patients with RA, psoriatic arthritis (PsA), or SLE and compared disease activity measures, PROs, and treatment decisions between a video consultation and an F2F consultation two weeks later.<sup>27</sup> The same treatment decision made during telehealth was maintained in 84% of patients after the F2F consult, with the remainder having adjustment of treatment for inadequate disease control (94.1% sensitivity, 96.7% specificity), treatment cessation for adequate disease control (55.6% sensitivity, 93.8% specificity) or need for further investigation (36.4% sensitivity, 95.8% specificity).<sup>27</sup> In addition, the video visits showed excellent sensitivity (94.1%) and specificity (96.7%) in determining treatment adjustments for patients with inadequate disease control.<sup>27</sup> A retrospective study in patients with RA, PsA, and ankylosing spondylitis (AS) with telephone visits or F2F visits from March to May 2020 aimed to determine whether telemedicine could delay an F2F visit; no significant differences were found in VAS and general health measures between telemedicine and face-to-face groups at the next F2F visits.<sup>28</sup>

The final study examined the utility of a self-assessment of myositis activity; the arm lift test for idiopathic inflammatory myopathy (IIM) was a reliable and valid PRO measure with a moderate to strong correlation to standard myositis core set measures and could be feasibly conducted during a telehealth visit.<sup>29</sup> In summary, small studies in single centers with short follow-up periods of three months to one year suggest that telemedicine follow-up does not lead to worse outcomes compared to F2F visits and either improve PROs or provide effective triage of patients with reduced or more efficient health care utilization. Several outcome measures that are used in routine clinical practice can be used while providing telehealth to rheumatology patients (Supplementary Table 1).

**Domain 4: measures of telehealth satisfaction.** We identified 14 studies addressing telemedicine satisfaction, including 2 prospective cohort studies and 12 retrospective studies. These were from the US,<sup>30–35</sup> Australia,<sup>36,37</sup> the UK,<sup>38,39</sup> France,<sup>40</sup> Canada,<sup>41,42</sup> and the Netherlands,<sup>43</sup> with sample sizes from 15 to 819 participants, and included patients with RA, CTD, osteoarthritis, PsA, AS, systemic sclerosis, and SLE. All the studies used bespoke satisfaction instruments or surveys, with only one study using a modified version of the validated Telehealth Satisfaction and Usefulness Survey (TeSS).<sup>36</sup> In the studies without a standardized survey, patients were asked questions



assessing their engagement with telemedicine and comparing that experience with an F2F visit.

In one cohort study, people with SLE, RA, and undifferentiated CTD were asked about their experience with telemedicine in 2020 and again in 2021. Although most rheumatology patients were satisfied with telemedicine, there was a higher satisfaction (94% vs 84%) and a higher desire to use telemedicine in the future (83% vs 77%) among patients in 2021 compared with 2020. In contrast, 82.4% of providers were unsatisfied because of the lack of physical examinations.<sup>30</sup> Another cohort study from Australia, using a modified version of the TeSS, found that older patients with low educational status and health literacy scores were more dissatisfied with telemedicine. The authors advocated for mixed-model clinics, providing optionality between telemedicine and F2F consultations.<sup>36</sup>

Of the 12 retrospective studies, 7 reported patients being comfortable and satisfied with telemedicine visits.<sup>31–33,37–40</sup> In one study, patients preferred to choose between the option of F2F and telemedicine care.<sup>41</sup> Interestingly, a study from Canada reported a higher satisfaction in patients with severe disease as well as those with controlled disease and a lower satisfaction among patients with mild/moderate disease activity, although the reporting of the results in this study is hard to interpret and has incomplete data presentation, thus making this finding unreliable.<sup>42</sup> Another US study reported that, although patients with higher disease activity expressed more difficulties with technology, overall, 88% of patients rated telehealth as satisfactory.<sup>34</sup> In a US study, both patients and providers expressed concerns about the thoroughness of assessments through telemedicine.<sup>35</sup> Another study from the Netherlands highlighted the most important factors influencing patient satisfaction as privacy and technology skills.<sup>43</sup>

Overall, these survey-based studies reported high patient satisfaction with telemedicine use, although, in some studies, not quite as high as F2F visits. The main physician concern expressed was a lack of a physical examination. Additional factors such as increased age, lower educational status, and lower health literacy scores correlated with decreased telemedicine satisfaction. Although one study reported a greater satisfaction with telemedicine for patients with severe disease,<sup>42</sup> the quality of data reporting casts doubts on the results, and other studies reported that patients with severe disease had more difficulties and less satisfaction with telemedicine.<sup>34</sup>

## DISCUSSION

In this scoping review, we summarized the recent literature relevant to home-based telehealth in rheumatology, with included studies that were highly heterogeneous, often conducted in single centers, and mostly retrospective. While noting these limitations, the findings suggest that home-based telemedicine does not lead to an increased rate of poor patient outcomes or lower patient

satisfaction, particularly when conducted in the short term for appropriate patients and encounter types.

There are three recent systematic reviews,<sup>7–9</sup> one scoping review,<sup>44</sup> and one brief report<sup>45</sup> on the use of telemedicine in rheumatology. Two of the three systematic reviews reported that telemedicine may have similar results to F2F care for rheumatic diseases, whereas the third review found limited evidence to suggest telemedicine provided adequate rheumatology care. All three systematic reviews reported difficulties in assessing outcomes of telemedicine due to study design limitations and considerable risk of bias. Our review is the first to focus solely on home-based rheumatology telehealth, restricted to the pandemic or postpandemic era. In addition, the structure of our review allowed the grouping of each study into specific domains. Although the studies we identified show that telemedicine has promise, more RCTs across varied clinical settings using validated outcome measures are needed to determine appropriateness of telemedicine for rheumatic disease care.

Several important themes emerged in our review. In terms of suitability for telehealth, triage appointments<sup>11</sup> or predictive models<sup>12</sup> have the potential to determine suitability for home-based telehealth and optimize health care use. However, these data are preliminary, and the selection criteria of appropriate patients needs refinement. Additionally, physicians were ambivalent about the appropriateness of telehealth for people with IA and active autoimmune conditions, particularly when physical examination is likely to influence management decisions. The lack of a physical examination to assess disease severity was also a concern in the three previous systematic reviews.<sup>7–9</sup> However, in our review, several studies<sup>15,17</sup> indicated that patients with these conditions, even with serious manifestations such as lupus nephritis, may be adequately managed through telehealth in the short term, especially if it improves access to care for patients with transportation limitations or other restrictions. Although additional research on telehealth suitability needs to be conducted, interim measures could include prioritizing telehealth for follow-up visits and conditions such as osteoporosis and perhaps gout, for which biomarker-based decision-making is acceptable.

Several studies identified potential barriers to telemedicine, including lack of technology access and language differences between patients and providers. To further promote telemedicine for those already facing disadvantages, these barriers must be anticipated and mitigated to avoid exacerbating disparities in health care. The involvement of patients in creating research priorities will help to address the concerns regarding health care access and equity.

We reviewed several studies that reported comparable disease activity after telemedicine and F2F care for patients with lupus nephritis, RA, PsA, and SLE.<sup>27</sup> Most of the studies reported using familiar outcome measures, indicating that standard clinical care measures could be used successfully for telehealth. Additionally, a new and reliable PRO measure for IIM was reported.<sup>29</sup>

PROs are an essential part of telehealth, and, as a recent systematic review has shown,<sup>46</sup> they are increasingly used in studies particularly around QoL. As rheumatologists consider the use of outcome measures in telehealth, existing PROs and other outcome measures should be standardized to telemedicine or adapted to be more feasible for telehealth encounters.

In terms of satisfaction, broadly patients reported high satisfaction with telemedicine visits. In general, older patients with lower health literacy scores were less satisfied with telemedicine and the reviewed studies suggested a negative correlation between disease severity and patient satisfaction. Most studies did not use a validated satisfaction instrument, and a small minority of studies reported lower satisfaction scores in the telemedicine group compared with the F2F group,<sup>23</sup> but this may be attributed to the specific technology used. A key implication for practicing rheumatologists is that telehealth should be integrated into existing clinical workflows with adequate staff, technology support, and training on its use to realize positive outcomes.

Telemedicine is suitable for providing cognitive care based on pattern recognition for ambulatory patients who need long term follow-up care and is thus valuable in rheumatology. To increase telehealth's acceptance by rheumatologists, virtual physical examinations, including patient self-examinations, need careful research and validation, and many groups, including ours, are engaging in such efforts. For example, some studies investigated the use of video conferencing to guide patients in performing joint assessments or range of motion measurements.<sup>47</sup> In the era of rapid technological growth, several application-based monitoring systems are available and reimbursable through programs such as Remote Therapeutic Monitoring and Remote Patient Monitoring.<sup>48</sup> Combined with telehealth, and possibly remote patient examinations, these systems could enable rheumatology patients to take ownership of their care, allowing for patient-initiated reporting of symptoms, medication adherence, and disease activity monitoring, leading to timely interventions and improved patient outcomes. An RCT showed that an application-based self-management program allowed adolescents with juvenile idiopathic arthritis to address their pain and functional disability.<sup>49</sup> Another study found high usability and satisfaction rates associated with patients using an application for self-management of RA,<sup>50</sup> though other studies did not show any difference in outcomes for text or application-based monitoring.<sup>51–53</sup> As application-based monitoring becomes more established, further research defining the circumstances in which remote monitoring approaches improve patient outcomes is needed.

Other medical specialties such as endocrinology have looked at telehealth systematically in terms of barriers, outcomes, and remote monitoring, finding improved access with comparable outcomes and high patient satisfaction.<sup>54</sup> Similarly, a meta-analysis of RCTs of telehealth interventions for care in patients with inflammatory bowel disease, although limited by

heterogeneity in study populations, reported overall fewer clinic visits and higher QoL, thereby reducing the access burden through telehealth.<sup>55</sup> These findings are similar to our summary of home-based telehealth in people with rheumatic diseases.

Our study has several limitations. Publication bias likely results in outcomes favoring telehealth being more likely to be reported. We also identified studies that had much heterogeneity in disease, practice settings, technology, geographic location, and socioeconomic status. This limits generalizability to draw firm conclusions without also considering these factors. Additionally, our search strategy did not include non-English articles and abstracts from meetings such as the Asia Pacific League of Associations for Rheumatology or other similar organizations, which could have limited the reporting of global rheumatology telehealth practices during the pandemic.

Given the rise of telehealth's popularity since the pandemic, home-based telehealth can be viable for some people with rheumatic disease. Further research in the form of disease specific RCTs can help confirm the findings in this review, clarifying the reliability of telemedicine visits in place of F2F ones for key patient subgroups. Telehealth-specific PROs should be developed from traditional PROs and/or existing PRO validation in telehealth settings so that physicians can be confident in their use within a telemedicine setting. Regarding accessibility, technological limitations among older adults and people from lower socioeconomic populations need to be addressed in future research.

The lack of a physical examination is a key concern for telehealth-based visits, and further research is needed to develop physical examination surrogates that patients can use consistently and accurately. Additionally, the potential of an application-based monitoring system to enhance telehealth visits is promising and now reimbursable. These programs could improve access to care and improve outcomes through close monitoring of patients between visits, complemented by timely evaluations through telemedicine. Lastly, the advent of artificial intelligence can revolutionize telehealth by automating various portions of telehealth encounters such as patient selection, PRO collection, health care documentation, and further expanded access to care.

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## AUTHOR CONTRIBUTIONS

All authors were involved in drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be published. Dr Venuturupalli had full access to all of the data

in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

**Study conception and design.** Venuturupalli, Peck, Jinka, Fortune, Davuluri, Nowell, Gavigan, Cush, Soares, Grainger, Curtis.

**Acquisition of data.** Venuturupalli, Peck, Davuluri.

**Analysis and interpretation of data.** Venuturupalli, Peck, Jinka.

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