Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Best Practice & Research Clinical Rheumatology 35 (2021) 101662

Contents lists available at ScienceDirect

Best Practice & Research Clinical Rheumatology

journal homepage: www.elsevierhealth.com/berh

6

Managing patients using telerheumatology: Lessons from a pandemic

James Bateman*, Natasha Cleaton

Royal Wolverhampton NHS Trust, Wednesfield Road, Wolverhampton, WV10 0QP, United Kingdom

Keywords:
Telerheumatology
COVID-19
Rheumatology
Telemedicine
Telehealth
Remote consultation/methods
Health services accessibility
Diagnosis
Rheumatic diseases/diagnosis
Rheumatic diseases/therapy

A B S T R A C T

The coronavirus disease 2019 (COVID-19) pandemic has presented unique challenges to rheumatology provision. Measures to control the pandemic have limited face-to-face contact with rheumatology healthcare professionals. One innovation has been the widespread adoption of telerheumatology to assist in the care of patients with rheumatic and musculoskeletal diseases, building on an existing evidence base in rheumatology. Widespread adoption has only occurred following the COVID-19 pandemic. We discuss the evidence supporting telerheumatology adoption prior to the pandemic, and outline several innovative approaches used to assist in the care of rheumatology patients that have been introduced. Alongside the advantages of these interventions, we discuss the limitations and regulatory challenges. Advances must be balanced, considering wider issues of equity of access, implementation, adoption, and sustainability of telerheumatology post-pandemic. We propose it is not 'if', but 'how' rheumatologists embrace newer telerheumatology technology, outlining practice points and future research agenda.

Introduction

Telemedicine has been increasingly adopted as patients and healthcare professionals have realised the benefits of an inexpensive, convenient, and practical form of healthcare interaction [1]. No single

* Corresponding author.
E-mail address: jamesbateman@nhs.net (J. Bateman).

https://doi.org/10.1016/j.berh.2021.101662
1521-6942/

accepted definition of telemedicine exists, with the World Health Organisation (WHO) adopting the following:

> "*The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities*." [2].

Originally conceived as a way of assisting care delivery in remote communities, it has become increasingly adopted by both primary and secondary care [3]. The coronavirus disease 2019 (COVID-19) pandemic has brought unprecedented changes and requirements of primary and secondary healthcare delivery. Telemedicine has been embraced during the pandemic. Innovations include automated procedures to help transition patients through emergency care settings to outpatient triage, virtual inpatient monitoring, teleconsultations, telecritical care, and clinical decision support [4,5]. Patient facing fully automated web-based decision aids and algorithms have been utilised to track, assess, test, and advise patients regarding COVID-19 symptomatology [6]. The experience has highlighted opportunities for expanding telemedicine longer-term across many areas of healthcare [7]. In rheumatology, clinician and patient-facing advice from the American College of Rheumatology (ACR), European League against Rheumatism (EULAR) and British Society for Rheumatology (BSR) have outlined recommended approaches for treatment initiation, continuation, exposure, corticosteroid use, biologic therapy, and social distancing [8,9]. Telemedicine in rheumatology, 'telerheumatology', was quickly identified as being well placed to deal with a range of challenges associated with the COVID-19 pandemic.

Telemedicine is a rapidly expanding field, with PubMed listing over 15,000 publications between 2015 and 2020, with over 1500 on telemedicine in the COVID-19 era by September 2020. This illustrates the popularity of the topic, and the rapid development of new technologies that support the adoption of telemedicine, particularly smartphone technology. This article will briefly outline the history of telerheumatology, describe current models of delivery, and focus on new areas that are most relevant to rheumatologists. We outline the advantages and problems with telerheumatology and describe the future research and development agenda.

Telerheumatology can be broadly grouped into real-time (synchronous) and store-and-forward (asynchronous) interaction. Asynchronous telerheumatology does not require real-time interaction between patient and rheumatologist or healthcare professional. The different models described for delivering telerheumatology are shown in Table 1.

Telerheumatology before the COVID-19 pandemic

Extensive research had been undertaken in rheumatology, building on earlier speciality experience in areas, such as teledermatology that produced much of the early evidence supporting reductions in patient waiting times, improved care, and patient satisfaction scores [10]. Initially, many studies evaluated the use of video consultations (VCs) in rheumatology. An initial early trial relied on bespoke dedicated video-linked consultations, using a central rheumatology hub to provide consultations to a prison service in the United States [11]. Other telerheumatology applications evolved to cover rural and difficult to reach settings, often with a central hub providing advice, new patient diagnosis, and follow-up [12]. Supporting equipment for telerheumatology included standard telephones, teleconferencing facilities, mobile phone SMS text messages, and web-based services [13–15]. Newer smartphone technology has been used to record self-reported disease activity scores (DAS), such as the DAS-28 and physical wellbeing. This was found to correlate with clinician assessed DAS28 scores [16]. The option of using wearable technology to assess activity, symptom trackers, and more innovative artificial intelligence options to assess symptom severity and scores are in their infancy and have all shown potential [17]. Bespoke devices to assess physical function, so-called 'kinesiotherapy' responses, have been evaluated in systemic sclerosis and rheumatoid arthritis (RA), allowing automated remote monitoring of physical function [18]. Widespread use of asynchronous web-based programmes to support self-management include educational programmes, cognitive behavioural therapy, and self-management

Table 1
Types of Telerheumatology, traditional, and emerging models of synchronous and asynchronous interventions.

Synchronous Telerheumatology Examples		Asynchronous Telerheumatology Examples		
Traditional Doctor Live two-way communication	Emerging models of live communication	Traditional 'Store-and-Forward' interventions	Emerging Models: Remote/Mobile Health Monitoring Systems	Emerging Models: Other Online Information and Mobile Health
Video consultation (VC) Telephone consultation Case conference and MDT between professionals Educational interventions, treatment counselling, for patients and professionals	AI programmes Automated AI* voice services: 'Chatbots'[+] Virtual stethoscopes/ ultrasound imaging techniques Other novel online resources and multimedia	Provider 'Store-and-forward' of images, laboratory results and clinical details for review by a rheumatologist, used for triage, assessment, and treatment	Smartphone symptom trackers. Mobile and wearable smart devices, or assessments for tracking physical activity, sleep Healthcare apps, including symptom diary/PROMS Novel devices for monitoring of physical function, inflammation, medication adherence	Traditional web-based information SMS-based messages/ messaging platforms (e.g. WhatsApp, TikTok) Other social media and patient portals in primary and secondary care.

AI- artificial intelligence; SMS, short message service; PROMS, patient reported outcome measures
[+]Chatbots have AI-assisted computer voice technologies or text interactions that mimic conversation (e.g. Telephone banking, Siri, Alexa, etc.)

guides [19]. VCs evolved to adopt the use of personal smartphones alongside dedicated videoconferencing platforms for both clinicians and patients to conduct telerheumatology [7]. Two systematic reviews have outlined the progress made up to 2017 [20,21].

Adaptations in rheumatology during the pandemic

Many rheumatologists, nursing, and research staff were redeployed at the peak of the pandemic to help support acute and intensive care provision, seeing many outpatient services suspended. These changes led to clinicians and other staff members having to adapt their clinical roles and work more flexibly [22]. Simultaneously, the COVID-19 restrictions imposed on day-to-day life resulted in dramatic reductions in new patient assessments, face-to-face reviews, and access to diagnostic and treatment resources. Prompt national action from European and North American rheumatology academic societies and providers acknowledged the need for a response reliant heavily on telerheumatology, with both clinicians and patients advised to avoid face-to-face contact where possible [23,24]. This was a challenge, for example, in the USA, the majority of states did not regard telemedicine consultations comparable with face-to-face attendance [25], with a similar situation in Europe. Legislators acted quickly, rapidly recognising telerheumatology and appropriately remunerating these interventions in both Europe and North America [26,27].

Video and telephone consultations

Early reports in the pandemic showed new adopters of telerheumatology using VCs to triage and assess patients with inflammatory arthritis. For example, clinicians found that less than 10% of patients required further face-to-face assessment following teleconsultation for psoriatic arthritis [28]. Widespread early adoption of telerheumatology also occurred in areas with less well-resourced healthcare. A large survey found that over 50% of rheumatologists in India had already begun to employ telerheumatology consultations by March 2020, using a variety of methods including personal smartphone devices [29]. The near-universal smartphone use by healthcare professionals has led to this extension into using personal mobile phone devices use for clinical consultations. This is a complex area, with

regulatory challenges discussed later. Clinicians and regulators responded with flexible 'Bring your own device' policies for clinicians [30].

VCs were broadly welcomed by the public and clinicians, becoming the subject of topical debate in the rheumatology community. This included podcasts from individual clinicians and national webinars held by rheumatology societies [31]. Clinicians advocated a range of approaches, such as coaching patients through swollen and tender joint count assessments in an attempt to replace face-to-face clinical examination. Basic assessments of ability to perform simple functions, such as making a fist, already demonstrated to help evaluate clinically suspect arthralgia were adopted [32]. Coupled with standardized patient-reported outcome measures (PROMs), such as the Health Assessment Questionnaire (HAQ) [33], Multidimensional Health Assessment Questionnaire (MDHAQ) and Routine Assessment of Patient Index Data 3 (RAPID3), rheumatologists used evidence-based measurements for remote assessment of disease activity [34]. Fig. 1 shows two separate still images from VCs on a smartphone demonstrating active inflammatory arthritis (1A), and an acute left knee inflammatory arthritis (1B), and the ability of the patient to see the clinician in real-time.

Remote triage, electronic 'Advice and Guidance': asynchronous care during COVID

Many healthcare systems have a pre-consultation exchange before a formal consultation. Traditionally this was by written questionnaire, but preliminary research in this area suggests that large

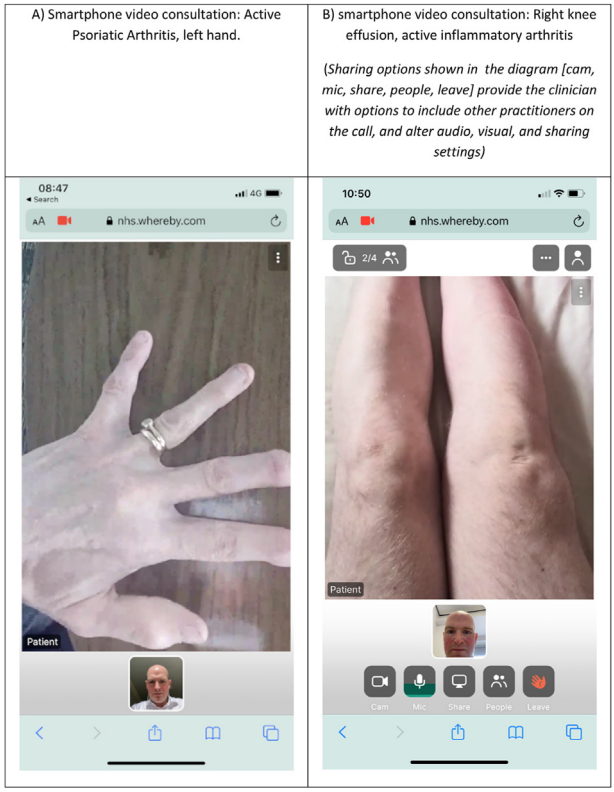

Fig. 1. Example of still images from two remote VCs identifying active disease, and outlining typical controls for the consultation (Images from authors own collection).

numbers of referrals can be triaged without face-to-face or review, with online or telephone dialogue with the referring clinician from another speciality or primary care [35]. These strategies have the potential to reduce rheumatology appointment waiting times, but are limited by the extent to which clinicians can remotely access electronic patient records. This form of telemedicine and triage has been used during the pandemic to facilitate consultations and provide advice to allied professionals caring for patients, however, evidence to support wider uptake is awaited [27].

Patient portal, apps, and remote monitoring

During COVID-19, remote monitoring has been used to identify the risk of certain conditions, population adherence to health policies (e.g. 'social distancing' in the UK) and understanding of arthritis. In the absence of widespread testing early in the pandemic, mobile phone technologies relying on standard smartphone technology were used to evaluate COVID-19 exposure in rheumatology patients in the community. This has provided data on virus exposure, hospitalisation, adherence to national public health advice, treatment adherence, and physical and mental health scores for rheumatology patients [36]. Many hundreds of smartphone applications exist to remotely monitor RA [37]. The challenge is often the integration of patient-reported data from these diverse applications into routine clinical care and electronic records. This requires substantial information technology resource [38]. Numerous commercial bespoke rheumatology remote monitoring systems have been adapted for use in the pandemic [39]. These can collate higher risk patients in line with particular clinical characteristics, for example, screening a large dataset for patients who have particular co-morbidity combinations, such as chronic renal disease, age, combination biologic and DMARD drug therapy, and apply scoring systems based on these metrics [24,40]. Patient-led follow-up, track and trigger systems, and 'virtual disease dashboards' showing, for example, rates of change in symptom scores in RA under therapy are in their infancy and will require substantial investment [41,42].

Prescribing, investigations, and procedures

Electronic prescribing and routine care through the pandemic has also changed. Initially, there was concern that peripheral corticosteroid injections may increase the risk of COVID-19. Many national societies advocated for caution, or complete cessation of corticosteroid injections for a range of indications, following early COVID-19 research advocating against the efficacy of corticosteroids in COVID-19 [27,43]. This was followed by research supporting corticosteroid use in acute serious COVID-19 infection [44]. Concerns were also raised generally about the overuse of analgesics, including opiate analgesic prescription and dependence in all patients in the face of the COVID pandemic [45]. Further data are needed to know if these were justified, however, registry data did not find an increased incidence of hospitalisation in rheumatology patients using a non-steroidal anti-inflammatory drugs [46].

Patient education, risk assessment, and COVID advice

Several strategies were used to communicate guidance for patient-led risk assessments. In the United Kingdom, national risk assessment scores required patients with serious illnesses to strictly socially isolate, known as 'shielding', based on a risk assessment. In response, clinicians adopted SMS-based mobile phone video messages to target rheumatology patients with educational messages and a self-administered COVID risk score [47]. Other initiatives used similar hospital web-based resources and shared information with rheumatology patients via social media and video platforms such as YouTube [48]. Some national schemes provided information to high-risk rheumatology patients about COVID-19 and centrally attempted to aggregate primary and secondary care data based on coding for different conditions [49]. International societies such as the EULAR provided links to these approaches, and in some cases endorsed patient-facing resources from established charity sector organisations [9,50].

Widespread adoption of virtual meetings to support the MDT

Previous face-to-face team meetings have been replaced by the widespread adoption of video-conferencing and electronic multi-disciplinary team (MDT) meetings. This has allowed rheumatology MDT meetings that include clinicians, radiologists, physical therapists, and nurse specialists to take place without additional support [51]. Examples of team meetings being undertaken virtually include education and continuing professional development (CPD), clinical governance, difficult cases, radiology MDT meetings, departmental business meetings, and national rheumatology webinars. In some settings, national procurement of videoconferencing software has enabled smooth, secure working using commercial platforms, such as Microsoft Teams [52].

Novel approaches

Automated 'chatbots' (automatic text or voice-activated conversations) have been used to help provide symptom checkers both in Europe and North America, adding an enhanced service outside of those provided in the third sector and separate from traditional departmental telephone support lines [53]. Anecdotal reports of a tripling of routine calls to services under strain at the start of the pandemic were widely reported. Chatbots have been used by charitable organisations to support COVID care for rheumatology patients, providing an interactive question and answer service [54]. Although international automated helplines in multiple languages coordinated by the WHO have been implemented for more general COVID-19 problems [55], the outcome from its use in rheumatology is awaited.

Advantages of these adaptations

Each of the adaptations provided present advantages to staff and patients in providing care remotely. Numerous reports of positive patient experiences exist from these interventions during COVID-19. Both synchronous and asynchronous telerheumatology interventions during the pandemic have been well received, across Europe, North America, India, and Asia [28,29,47,56,57]. This is in keeping with historically high levels of patient satisfaction with telerheumatology [12]. During the pandemic emergency attendance in US healthcare settings was approximately half of normal levels [58], with synchronous and asynchronous telerheumatology has played a part in advising rheumatology patients. A national survey of rheumatologists has shown high levels of satisfaction with telerheumatology from rheumatologists working in the Department of Veterans Affairs (VA), particularly for follow-up of patients [59]. The use of these tools, a range of PROMs, and patient triggered follow-up systems have all been cited as critical in helping services adapt to the challenges of backlogs of patients and staff pressures, allowing the most in need to be seen most urgently [42]. These have been adopted into routine clinical practice during COVID-19 [57]. These telerheumatology interventions seem to have reached a wide range of follow-up patients. Interestingly older age did not seem to affect patient engagement in a UK urban setting [36]. Previous concerns about the widespread inability to access mobile phone or technology amongst older patients do not seem to be replicated in clinical practice. There are likely to be patients that suffer through social isolation from the pandemic, the use of automated procedures to support mental health alongside physician contact remains a promising area but one requiring further research [60].

Disadvantages of telerheumatology

Despite the progress made, several potential disadvantages exist for the more widespread adoption of telerheumatology.

Equity of access

Concerns have been raised about the possibility of contacting those in the most vulnerable groups when telemedicine strategies are employed. It is estimated that up to 38% of US residents over 65 are

not yet well placed to receive VCs, and 20% of those >65 unsuitable for telephone consults [61]. While digital literacy is reported to be low in some cohorts of patients with rheumatic diseases, the optimal strategy for the assessment of this literacy remains unclear, in this rapidly evolving area [62]. These problems and associated ethnic and language variation, poverty, and mental health concerns all raise questions as to how best to engage these harder to reach groups with telerheumatology [63,64].

Limitations-case complexity, new patients, and training

Telerheumatology has particular challenges in new patient assessments and for follow-up patients where case complexity requires more detailed physical examination. Clinicians expressed high levels of dissatisfaction for the clinical contacts for new patients, and felt it was not useful where a diagnosis has not already been made [59]. For these new patients, and for more complex patients, routine observations, that may be critical to the care of patients with autoimmune rheumatic diseases including urinalysis, temperature, weight, height, oxygen saturation, and blood pressure are not routinely measurable remotely at this point. The lack of physical examination and observations represents a potential reduction in diagnostic accuracy and quality of care [20]. Clinicians, therefore, often favour face-to-face review in patients with higher case complexity such as systemic vasculitis and systemic lupus erythematosus [65], and the clinical impact of less frequent testing is unclear. Patient self-reported PROMS proposed as 'vital signs' for rheumatology, such as the RAPID3 have utility, however, they cannot replace face-to-face review [66]. There have also been concerns raised about the loss of routine physical examination during the COVID-19 pandemic. An example is the loss of the reassurance of negative physical examination findings in the avoidance of therapies such as antibiotics [67]. These concerns have been repeatedly raised in rheumatology which has a significant focus on physical examination in comparison with some other specialities [68]. Self-reported disease activity metrics have limitations. The accurate detection of joint swelling via an audio-visual link for the presence of joint swelling was found to be as low as 15% in a telerheumatology setting [69]. Anecdotally, we have seen increased use of rescue steroid courses for 'flares' in rheumatic illnesses. Finally, the lack of non-face-to-face appointments represents a significant barrier to training both clinical and support staff in outpatient specialities such as rheumatology. Traditional models of trainee development and assessment are challenging and while remote approaches to these issues may be feasible they have yet to be developed [70].

Information governance and risks

With the rapid pace of change, there are risks associated with the adoption of telemedicine, such as data security and personal information, prescription management, hacking and data breaches, and data loss. Although many information governance concerns have been waived by regulators during the pandemic as is the case in the UK, this is the subject of further research [71]. Although several telemedicine platforms have been approved by national regulatory agencies, as clinicians have adapted to the pandemic, reports of consultations utilising popular social media applications, such as WhatsApp and TikTok have emerged [56]. Despite the US outlining 'an unprecedented array of regulatory waivers and new rules', these challenges are likely to re-emerge post-COVID [72].

Regulatory challenges: funding, fraud, and data management

Several concerns have been raised about the cost of telerheumatology. Regulatory regimes in Europe and North America will impact on the use of smartphone devices and commercial applications because of compliance with regulatory requirements, such as the Health Insurance Portability and Accountability Act (HIPPA), which protects patient information in the United States [73]. In the race to adapt to COVID-19, free VC services received regulatory approval in the UK, however, the longer-term funding and cost of these services remain to be determined [74,75]. There are clear cost offsets if less outpatient space and facilities are found to be required with increased online consultation. Regulation and funding in the medium-term remain an ongoing concern [38]. A huge amount of data is generated

by a range of remote monitoring systems, across a variety of applications, smartphone types, wearable technology is a challenge. The interpretation and meaningful assimilation into electronic health records in a useable format represent a challenge for clinicians and IT professionals [76].

Research agenda and future strategic planning

Long-term strategic planning for the future of telemedicine in general, and telerheumatology in particular, appears to be lacking. It is reported four in ten CEOs of US healthcare systems have no digital component to their overall strategic plan, due, in part to significant concerns regarding data protection and privacy [77]. Urgent service evaluation of telemedicine developments is needed to determine how best to deliver, scale, evaluate, and distribute advances in digital health to rheumatology patients [38]. Patient-reported outcomes electronically entered into research registry studies have shown promise and are routinely used for in clinical trials in rheumatology [78]. There is an emerging evidence base that smartphone apps may reduce anxiety, and initiating behaviour change, but there remains limited data specific to autoimmune rheumatic diseases [79]. Given the exponential rise in data, rheumatology practitioners have reported challenges in accommodating patient self-reported symptoms and activity indices derived from smartphone data [37]. It remains to be seen how hospitals and healthcare providers will strategically plan to integrate and respond to the information technology, regulatory, and financial challenges that are presented alongside these advances [77].

Lessons learnt

The opportunity to learn lessons from COVID-19 to reduce unnecessary attendance, investigation, and treatment remains an intriguing possibility for rheumatology [80]. While a ten-fold increase in teleconsultations was reported at the beginning of the pandemic, concerns remain about what may be temporary gains in healthcare systems that have generally been historically slow to adopt telemedicine [72]. We have outlined several advantages and disadvantages of these approaches. Innovation rapidly delivered at the international level [55], needs to be scaled and supported at a national and local level within rheumatology. From a technical aspect, almost anything that can be imagined in telerheumatology might be possible using novel technologies. The future challenges are to develop sustainable methods that are suitable for triage, diagnosis monitoring of patients, and teaching and assessments of trainees.

Summary

Telemedicine is remote clinical care that relies on electronic devices, such as computers and, increasingly, mobile devices using both interactive and non-interactive techniques. Originally conceived to widen access to healthcare for remote communities, COVID-19 saw an exponential increase in the utilization and development of telemedicine applications. The pandemic has been a stimulated the rheumatology community to respond flexibly and has resulted in a large expansion in telerheumatology. Developments have included widespread uptake of VCs, remote triaging and monitoring, electronic prescribing, web-based patient education, virtual MDT conferences, and novel approaches. Clinical need and patient safety have trumped historical regulatory concerns and barriers regarding information governance, funding, legal requirements, and regulatory oversight. Some barriers and concerns still exist, such as equality of patient access and concerns that limited clinical assessment. Despite this, patient experiences of these changes were found to be positive. These approaches have successfully reached vast numbers of patients during the pandemic, including older patients. We have presented data on some successes, highlighted future opportunities and challenges. Moving forward, a key lesson learnt from the response to the COVID-19 pandemic, much like technology applications in other fields, is that it is not ‘if’ but ‘how’ rheumatologists and healthcare organisations should adopt and integrate telerheumatology into their existing practice. While telemedicine uptake has been historically slow, there is a pressing need for longer-term planning of telemedicine and telerheumatology development.

Practice points

1. Telerheumatology may be synchronous (real-time) and asynchronous (store-and-forward) telemedicine interventions.
2. .Coronavirus disease 2019 (COVID-19) has transformed the delivery of standard rheumatology outpatient care, with widespread uptake of telemedicine used to assist referral, assessment, and management.
3. Telerheumatology has been well received with low-cost flexible approaches being positively evaluated by patients, with numerous examples of innovative practice.
4. Legitimate regulatory, data protection, and funding concerns that were relaxed during the COVID-19 pandemic will continue to pose a challenge to longer-term uptake and innovation.
5. Concerns remain for marginalisation patients where age, ethnicity, language barriers, or poverty may limit engagement with digital tools or internet-enabled technology.

Research agenda

1. Determine how to evaluate the patients and clinical scenarios where telerheumatology will provide high-quality, safe, effective care.
2. Determine the optimal functionality, design, interoperability, and data storage for platforms used to video consultations (VCs).
3. Understand how various telerheumatology interventions impact on longer-term outcomes such as behavioural change, disease activity, patient safety and patient experience both during and beyond the coronavirus disease 2019 (COVID-19) pandemic.
4. Standardised outcomes for evaluating new telerheumatology interventions.
5. Establish how patient representatives, rheumatology practitioners, information technology companies and partners, third-sector organisations, and rheumatology societies can best shape the ongoing affordability and sustainability of telerheumatology.

Patient consent statement

Informed patient consent was obtained for the use of the anonymised images in this publication.

Funding

No specific funding was received for this chapter.

Declaration of competing interest

The authors declare no conflict of interest for this publication.

References

[1] Duffy S, Lee TH. In-person health care as option B. N Engl J Med 2018;378:104–6.
[2] WHO. A health telematics policy in support of WHO's Health-For-All strategy for global health development: report of the WHO group consultation on health telematics, 11–16 December, Geneva, 1997: World Heatlh Organisation; 1998.
[3] Telehealth and Telemedicine. n.d. https://www.aafp.org/about/policies/all/telehealth-telemedicine.html. [Accessed 26 August 2020].
[4] Hollander JE, Carr BG. Virtually perfect? Telemedicine for covid-19. N Engl J Med 2020;382:1679–81.
[5] Subramanian S, Pamplin JC, Hravnak M, et al. Tele-critical care. Crit Care Med 2020;48:553–61.
[6] NHS 111 online - about coronavirus (COVID-19). n.d. https://111.nhs.uk/covid-19/. [Accessed 26 August 2020].
[7] Greenhalgh T, Wherton J, Shaw S, et al. Video consultations for covid-19 n.d.
[8] Mikuls TR, Johnson SR, Fraenkel L, et al. American College of rheumatology guidance for the management of rheumatic disease in adult patients during the COVID-19 pandemic: version 2. Arthritis Rheumatol 2020;72:e1–12.

[9] COVID-19 guidance. n.d. https://www.rheumatology.org.uk/practice-quality/covid-19-guidance. [Accessed 26 August 2020].
[10] Finnane A, Dallest K, Janda M, Soyer HP. Teledermatology for the diagnosis and management of skin cancer: a systematic review. JAMA Dermatology 2017;153:319–27.
[11] Chase JL, Lisse JR, Brecht RM. Rheumatology in the 21St-century - telemedicine leading the way. Arthritis Rheum 1995;38:R39.
[12] Poulsen KA, Millen CM, Lakshman UI, et al. Satisfaction with rural rheumatology telemedicine service. Int J Rheum Dis 2015;18:304–14.
[13] Pal B. Following up outpatients by telephone: pilot study. Br Med J 1998;316:1647.
[14] Azevedo ARP, de Sousa HML, Monteiro JAF, Lima ARNP. Future perspectives of Smartphone applications for rheumatic diseases self-management. Rheumatol Int 2015;35:419–31.
[15] McNamara S, O'Neill L, Carey J. Validation of electronic audiovisual media assessments of patients with rheumatic diseases. Ir J Med Sci n.d.;180:S195.
[16] Nishiguchi S, Ito H, Yamada M, et al. Self-assessment tool of disease activity of rheumatoid arthritis by using a smartphone application. Telemed e-Health 2014;20:235–40.
[17] Burmester GR. Rheumatology 4.0: big data, wearables and diagnosis by computer. Ann Rheum Dis 2018;77:963–5.
[18] Pani D, Barabino G, Dessì A, et al. A device for local or remote monitoring of hand rehabilitation sessions for rheumatic patients. IEEE J Transl Eng Heal Med 2014;2.
[19] Liu S, Yang L, Zhang C, et al. Online mental health services in China during the COVID-19 outbreak. The Lancet Psychiatry 2020;7:e17–8.
[20] McDougall JA, Ferucci ED, Glover J, Fraenkel L. Telerheumatology: a systematic review. Arthritis Care Res 2017;69:1546–57.
[21] Piga M, Cangemi I, Mathieu A, Cauli A. Telemedicine for patients with rheumatic diseases: systematic review and proposal for research agenda. Semin Arthritis Rheum 2017;47:121–8.
[22] COVID-19: from rheumatology specialist nurse to 30 ICU patients | British Society for Rheumatology. n.d. https://www.rheumatology.org.uk/News-Policy/Details/COVID-19-Julie-Painter-Wolverhampton-rheumatology-specialist-nurse-30-ICU-patients. [Accessed 4 September 2020].
[23] EULAR | EULAR Guidance for patients COVID-19 outbreak. n.d. https://www.eular.org/eular_guidance_for_patients_covid19_outbreak.cfm. [Accessed 2 August 2020].
[24] Nhs England. Clinical guide for the management of Rheumatology patients during the coronavirus pandemic. n.d. https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/03/clinical-guide-rheumatology-patients-v1-19-march-2020.pdf. [Accessed 29 June 2020].
[25] Lacktman N, Acosta J, com/Telemedicine SL-F, et al. 50-state survey of Telehealth commercial payer statutes n.d.
[26] Medical telemedicine health care provider fact sheet CMS. n.d. https://www.cms.gov/newsroom/fact-sheets/medicare-telemedicine-health-care-provider-fact-sheet. [Accessed 26 August 2020].
[27] Kirby T. Rheumatologists rapidly adjust patient care during COVID-19 pandemic. Lancet Rheumatol 2020;2:e258.
[28] Costa L, Tasso M, Scotti N, et al. Telerheumatology in COVID-19 era: a study from a psoriatic arthritis cohort. Ann Rheum Dis 2020. https://doi.org/10.1136/annrheumdis-2020-217806. Published Online First: 11 June 2020.
[29] Gupta L, Misra DP, Agarwal V, et al. Management of rheumatic diseases in the time of covid-19 pandemic: perspectives of rheumatology practitioners from India. Ann Rheum Dis 2021;80:e1. https://doi.org/10.1136/annrheumdis-2020-217509.
[30] Information governance and technology resources - NHS Digital. n.d, https://digital.nhs.uk/data-and-information/looking-after-information/data-security-and-information-governance/information-governance-alliance-iga/information-governance-resources/information-governance-and-technology-resources. [Accessed 26 August 2020].
[31] Telerheumatology: The new normal? Part 1 - rheumatology advisor. n.d. https://www.rheumatologyadvisor.com/home/multimedia/rheum-advisor-on-air/telehealth-rheumatology-new-normal-podcast-interview-john-botson/. [Accessed 4 September 2020].
[32] Wouters F, Van Der Giesen FJ, Matthijssen XME, et al. Difficulties making a fist in clinically suspect arthralgia: an easy applicable phenomenon predictive for RA that is related to flexor tenosynovitis. Ann Rheum Dis 2019;78:1438–9.
[33] Maska L, Anderson J, Michaud K. Measures of functional status and quality of life in rheumatoid arthritis: health assessment questionnaire disability Index (HAQ), modified health assessment questionnaire (MHAQ), multidimensional health assessment questionnaire (MDHAQ), health assessment questionnaire II (HAQ-II), improved health assessment questionnaire (improved HAQ), and rheumatoid arthritis quality of life (RAQoL). Arthritis Care Res 2011;63:S4–13.
[34] Yazici Y, Bergman M, Pincus T. Time to score quantitative rheumatoid arthritis measures: 28-joint count, disease activity score, health assessment questionnaire (HAQ), multidimensional HAQ (MDHAQ), and routine assessment of patient Index data (RAPID) scores. J Rheumatol 2008;35.
[35] Scheibe MM, Imboden JB, Schmajuk G, et al. Efficiency gains for rheumatology consultation using a novel electronic referral system in a safety net health setting HHS public access. Arthritis Care Res 2015;67:1158–63.
[36] Cleaton N, Raizada S, Barkham N, et al. COVID-19 prevalence and the impact on quality of life from stringent social distancing in a single large UK rheumatology centre. Ann Rheum Dis 2020. https://doi.org/10.1136/annrheumdis-2020-218236. Published Online First: 21 July 2020.
[37] Grainger R, Townsley H, White B, et al. Apps for people with rheumatoid arthritis to monitor their disease activity: a review of apps for best practice and quality. JMIR MHealth UHealth 2017;5:e7.
[38] Keesara S, Jonas A, Schulman K. Covid-19 and health care's digital revolution. N Engl J Med 2020;382:e82.
[39] Dawn Clinical Software. n.d. http://www.4s-dawn.com/. [Accessed 5 September 2020].
[40] Bateman J, Mulherin D, Venkatachalam S, et al. Rapid distribution of complex patient information by SMS-embedded video link during a pandemic: patient uptake, self-risk assessment and feedback. SSRN Electron J 2020. https://doi.org/10.2139/ssrn.3569841.
[41] Whitelaw S, Mamas MA, Topol E, VanSpall HGC. Applications of digital technology in COVID-19 pandemic planning and response. Lancet Digit Heal 2020;2:e435–40.

[42] COVID-19: Patient initiated follow-up | British Society for Rheumatology. n.d. https://www.rheumatology.org.uk/News-Policy/Details/COVID-19-Patient-Initiated-Follow-Up. [Accessed 4 September 2020].
[43] Little CP, Birks ME, Horwitz MD, et al. COVID-19: a rethink of corticosteroid injection? Bone Jt Open 2020;1:253–6.
[44] Horby P, Lim WS, Emberson J, et al. Dexamethasone for COVID-19-preliminary report effect of dexamethasone in hospitalized patients with COVID-19-preliminary report RECOVERY collaborative group*. MedRxiv 2020:2020. 06.22. 20137273.
[45] Alexander GC, Stoller KB, Haffajee RL, Saloner B. An epidemic in the midst of a pandemic: opioid use disorder and COVID-19. Ann Intern Med 2020;173:57–8.
[46] Gianfrancesco M, Hyrich KL, Hyrich KL, et al. Characteristics associated with hospitalisation for COVID-19 in people with rheumatic disease: data from the COVID-19 Global Rheumatology Alliance physician-reported registry. Ann Rheum Dis 2020;79:859–66.
[47] Bateman J, Mulherin D, Hirsch G, et al. Rapid distribution of information by SMS-embedded video link to patients during a pandemic. Lancet Rheumatol 2020;2.
[48] Marzo-Ortega H, Tan AL, Bissell LA, et al. Self-risk assessment for patients with rheumatic disease during the COVID-19 pandemic. Lancet Rheumatol 2020;2:e386–7.
[49] Creating the COVID-19 text service for vulnerable people - NHS Digital. n.d. https://digital.nhs.uk/blog/transformation-blog/2020/creating-a-covid-19-text-service-for-vulnerable-people. [Accessed 26 August 2020].
[50] Coronavirus (COVID-19) and arthritis. n.d. https://www.versusarthritis.org/news/2020/april/coronavirus-covid-19-and-arthritis-where-to-go-for-information/. [Accessed 26 August 2020].
[51] Sidpra J, Chhabda S, Gaier C, et al. Virtual multidisciplinary team meetings in the age of COVID-19: an effective and pragmatic alternative. Quant Imag Med Surg 2020;10:1204–7.
[52] Messaging tool for NHS to support remote working during coronavirus outbreak - NHS Digital. n.d. https://digital.nhs.uk/news-and-events/latest-news/messaging-tool-for-nhs-to-support-remote-working-during-coronavirus-outbreak. [Accessed 4 September 2020].
[53] Miner AS, Laranjo L, Kocaballi AB. Chatbots in the fight against the COVID-19 pandemic. Npj Digit Med 2020;3.
[54] Chat to the arthritis virtual assistant | Versus Arthritis. n.d. https://www.versusarthritis.org/get-help/arthritis-virtual-assistant/. [Accessed 1 September 2020].
[55] WHO Health Alert brings COVID-19 facts to billions via WhatsApp. n.d, https://www.who.int/news-room/feature-stories/detail/who-health-alert-brings-covid-19-facts-to-billions-via-whatsapp. [Accessed 6 September 2020].
[56] Zhang Y, Wang J, Zhao L, et al. Online management of rheumatoid arthritis during COVID-19 pandemic. Ann Rheum Dis 2020; 80:e4. https://doi.org/10.1136/annrheumdis-2020-217548.
[57] Figueroa-Parra G, Gamboa-Alonso CM, Galarza-Delgado DA. Challenges and opportunities in telerheumatology in the COVID-19 era. Response to: online management of rheumatoid arthritis during COVID-19 pandemic' by Zhang et al. Ann Rheum Dis 2020;80:e5. https://doi.org/10.1136/annrheumdis-2020-217631.
[58] Baum A, Schwartz MD. Admissions to Veterans Affairs hospitals for emergency conditions during the COVID-19 pandemic. JAMA, J Am Med Assoc 2020;324:96–9.
[59] Matsumoto RA, England BR, Mastarone G, et al. Rheumatology clinicians' perceptions of telerheumatology within the Veterans health administration: a national survey study. Mil Med 2020;185:e2082–7.
[60] Vaidyam AN, Wisniewski H, Halamka JD, et al. Chatbots and conversational agents in mental health: a review of the psychiatric landscape. Can J Psychiatr 2019;64:456–64.
[61] Lam K, Lu AD, Shi Y, Covinsky KE. Assessing telemedicine unreadiness among older adults in the United States during the COVID-19 pandemic. JAMA Intern Med 2020;180(10):1389–91.
[62] Knitza J, Simon D, Lambrecht A, et al. Mobile health usage, preferences, barriers, and eHealth literacy in rheumatology: patient survey study. JMIR MHealth UHealth 2020;8:e19661.
[63] Drossaert C. SP0132 Measuring digital health literacy, why and how? Ann Rheum Dis 2018;77:35.1. BMJ.
[64] Katz PP, Barton J, Trupin L, et al. Poverty, depression, or lost in translation? Ethnic and language variation in patient-reported outcomes in rheumatoid arthritis. Arthritis Care Res 2016;68:621–8.
[65] Fernando MMA, Isenberg DA. How to monitor SLE in routine clinical practice. Ann Rheum Dis 2005;64:524–7.
[66] Nune A, Iyengar K, Ahmed A, Sapkota H. Challenges in delivering rheumatology care during COVID-19 pandemic. Clin Rheumatol 2020;39:2817–21.
[67] Hyman P. The disappearance of the primary care physical examination—losing touch. JAMA Intern Med 2020;180(11): 1417–8. https://doi.org/10.1001/jamainternmed.2020.3546.
[68] Rothschild B. Telerheumatology: not ready for prime time. Intern Med J 2013;43:468–9.
[69] Graham LE, Mcgimpsey S, Wright S, et al. Could a low-cost audio-visual link be useful in rheumatology? J Telemed Telecare 2000;6:35–7.
[70] Jumreornvong O, Yang E, Race J, Appel J. Telemedicine and medical education in the age of COVID-19. Acad Med 2020; 95(12):1838–43.
[71] Kim DW, Choi JY, Han KH. Risk management-based security evaluation model for telemedicine systems. BMC Med Inf Decis Making 2020;20.
[72] Webster P. Virtual health care in the era of COVID-19. Lancet 2020;395:1180–1.
[73] Ward IM, Schmidt TW, Lappan C, Battafarano DF. How critical is tele-medicine to the rheumatology workforce? Arthritis Care Res 2016;68:1387–9.
[74] Fleming video: information for patients | AccuRx Help Center. n.d. https://support.accurx.com/en/articles/3810780-fleming-video-information-for-patients. [Accessed 26 August 2020].
[75] Information governance - NHSX. n.d. https://www.nhsx.nhs.uk/covid-19-response/data-and-information-governance/information-governance/. [Accessed 26 August 2020].
[76] Dixon WG, Michaud K. Using technology to support clinical care and research in rheumatoid arthritis. Curr Opin Rheumatol 2018;30:276–81.

[77] PwC Health Research Institute. PwC Health Research Institute. Top health industry issues of 2020: will digital start to show an ROI?. https://www.pwc.com/us/en/industries/health-industries/assets/pwc-us-health-top-health-issues.pdf. [Accessed 4 September 2020].
[78] Ibfelt EH, Jensen DV, Hetland ML. The Danish nationwide clinical register for patients with rheumatoid arthritis: danbio. Clin Epidemiol 2016;8:737–42.
[79] Morton K, Dennison L, May C, et al. Using digital interventions for self-management of chronic physical health conditions: a meta-ethnography review of published studies. Patient Educ Counsel 2017;100:616–35.
[80] Moynihan R, Johansson M, Maybee A, et al. Covid-19: an opportunity to reduce unnecessary healthcare. BMJ 2020:370.