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Mobile apps, wearables and the future of technology in rheumatic disease care

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Mobile technology is all around and is a disruptive innovation.

Anyone at EULAR 2018 may have noticed the electronic tags on their name badges. They may have been less aware that when they registered for the conference they signed an agreement for these GPS enabled devices to monitor which sessions they attended and when. The use of wearable technology to unobtrusively collect data about people's movements, location, sleep patterns and activity levels is a rapidly advancing field of research and clinical interest. Combine data from body-worn or smartphone sensors with apps to log self-reported symptom experiences or life events, and we suddenly have insight into individuals' daily lives like never before.

A recent systematic review identified 17 apps available on Android or iOS, suitable for RA symptom monitoring, incorporating a range of validated and non-validated symptom tracking measures [1]. The smart-textile, smart-glasses, and wearable electronics sector advancing, with an estimated growth from \$20 billion in 2015 to \$70 billion by 2025 [2]. With large-scale European funding calls for more digital technology research, and an increasing emphasis on private-public partnerships to meet the growing demand for innovation [3], we may all need to begin to think about how to integrate technology into our research plans and clinical practice.

There are several obvious benefits for patients and care providers of incorporating technology into symptom measurement and management. Rheumatological conditions often involve a range of physical and psychological symptoms, challenging to capture in infrequent, time-limited outpatient appointments. Blood test results are often linked with patient-reported outcomes based on recollections from the previous ± 6 months, which may be subject to recall bias. Remote symptom measurement, through apps or wearables, allows cost-effective collection of a wide range of patient-reported outcomes, allowing insight into symptoms experienced over time, in between

clinic visits [4]. Mobile technology may also facilitate monitoring of symptoms prioritised by patients, but often neglected during appointments due to a lack of time or resources. Depression, for example, is known to be prevalent [5] and is associated with a range of adverse outcomes [6]. Traditional models of care can often struggle to find useful ways of measuring variability the wider symptom spectrum. With the aid of well-designed and integrated remote symptom measurement systems, we can move towards more personalized care, with patients selecting the outcomes which are most important to them, changing and adapting their symptom monitoring as their disease progresses and their treatments change.

However, for technology to be meaningfully integrated into clinical care, the added value of new possibilities needs to be evaluated against the potential risks. Systematic review evidence has highlighted some of the barriers of engagement with technology for managing health, emphasizing several essential challenges faced by users when implementing digital innovation into daily routines [7]. Fluctuations in symptom severity were identified as a key barrier to long-term engagement; wearable technology needs to be robust in the face of symptom flare. Systems need to be flexible and compatible with existing routines, with timely notifications improving response rates, particularly in the early days of incorporating technology into daily habits [8]. Might accessing more information about one's own health and symptoms, particularly in those with co-morbid depression or anxiety, increase health anxiety and promote unnecessary help-seeking behaviour? Arguably the most important criterion for successful development and implementation of wearable technologies into routine management is the user's perceived utility of the system: are the risks worth the benefits? Can the technology provide something of intrinsic value to the individual, to improve self-awareness, health behaviours, and a sense of empowerment over an otherwise unpredictable disease course?

Extensive research is needed to start answering these questions, and progress is already being made. The international research consortium, Remote Assessment of Disease and Relapse – Central Nervous System (RADAR-CNS; [9]) is already examining the utility of these technologies in major depressive disorder, multiple sclerosis and epilepsy. The REmote MOnitoring of Rheumatoid Arthritis (REMORA) project, led by the Professor of Digital Epidemiology at Manchester University, has already made great headway in developing and testing a symptom measurement app specific to Rheumatoid Arthritis (RA) [10]. There is little doubt that the age of wearable technology represents a paradigm shift in how long-term conditions are measured and managed. It is, however, a disruptive innovation, displacing current systems and practices, requiring careful and ongoing monitoring and evaluation.

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