- Wearable devices can be used to monitor personal activity and habits.
- So far, the extent to which this data can be used by clinicians to inform their diagnoses and treatments has remained unclear.
- In a new study, Professor Allan Lawrie at Imperial College London, UK, asks how we can incorporate wearable data with routine clinical data to build an overall picture for individual patients.

Harnessing the power of wearable technology for health

Commercially driven wearable technologies, such as the Apple Watch and Oura Ring, were originally developed to monitor personal health and fitness. But as wearables have become more advanced, they now have the ability to monitor our health, not just our running pace. For example, heart rate monitors are standard on many smartwatches, with some detecting abnormalities such as atrial fibrillation, a major cause of stroke.

As wearable technologies become more sophisticated, their potential to transform healthcare has become apparent. As such, there's been an explosion in the number of studies into the use of wearables in enhancing healthcare – exploring real-time monitoring of various diseases, early disease detection, and improved patient outcomes.

One researcher, however, highlights that it is important to understand the data they collect, the long-term variability of these measurements, and how we use this data (or any potential lack of data) to form 'one piece of the puzzle' in the transition between health and disease. Professor Allan Lawrie of Imperial College London, UK, highlights that before wearable devices can be integrated into current healthcare practice, we need a deeper understanding of the wealth of data they have to offer: what data should be collected, how inter-operable they are between devices/manufacturers, individual users' habits, and therefore, how we interpret their data.

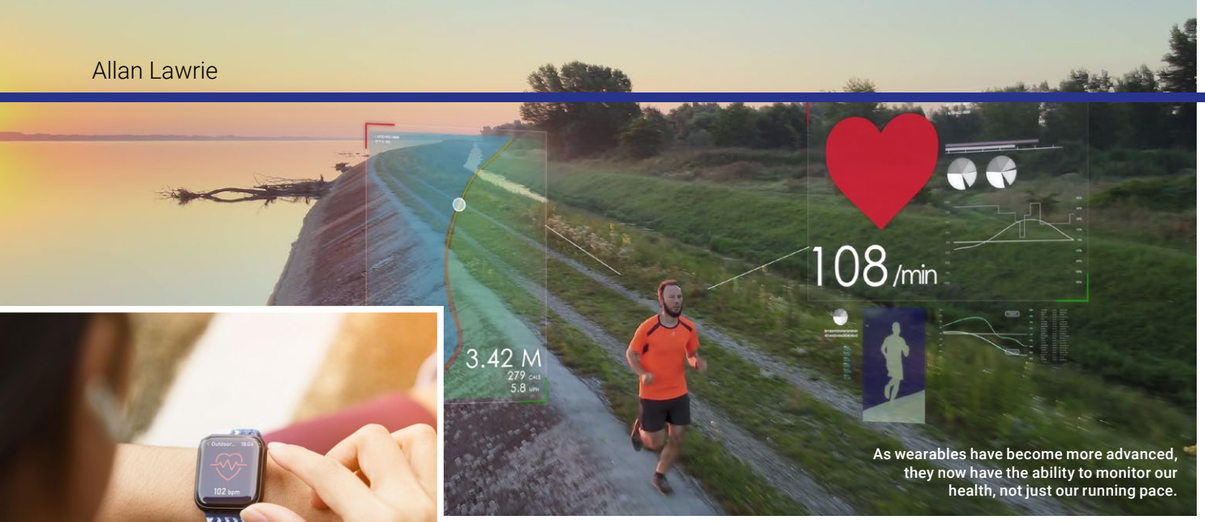
MyHeart Counts app

The MyHeart Counts app study, led by Stanford University in California, launched in March 2015 as a free-to-download smartphone app from the Apple App Store. In this smartphone-based study of cardiovascular health, participants recorded physical activity, filled out health questionnaires, and completed a 6-minute walk test. Over 45,000 participants joined in the first 6 months of the study. In subsequent sub-studies, participants agreed to use MyHeart Counts with the aim of increasing their daily step count. Participants followed specific instructions: some received daily reminders to complete 10,000 steps, others received hourly reminders to stand up after an hour of sitting, a third group was prompted to read the American Heart Association guidelines, and the fourth group was offered online fitness coaching. All four actions helped participants to significantly increase their daily step count, suggesting that such interventions have potential for increasing short-term fitness levels.

The potential of wearable technologies

The addition of a pseudonymised ID field within the MyHeart Counts app allowed the study of specific patient cohorts where the app data can be linked to the individual's health record. One such study by Lawrie using the app explored whether the duration of COVID-19 symptoms is associated with the amount of physical activity the participants undertook. The results showed in a cohort of healthcare workers who were monitored for COVID-19 symptoms who reported mild (non-hospitalised) COVID-19 infection that there was a relationship between physical activity (the healthKit variable distance, walking, or running) and the duration of COVID-19 symptoms. The less active the person, the longer the duration of symptoms. Importantly, although the study focused on the association of symptoms (in this case COVID-19), many of these are also directly relevant to cardiovascular disease, and highlight the use of collecting real-world physical activity data from wearables to track disease symptoms and identify physical activity trends.

> **As wearables become more sophisticated, their potential to transform healthcare has become apparent.**



As wearables have become more advanced, they now have the ability to monitor our health, not just our running pace.

Pulmonary hypertension

Allan Lawrie is Professor of pulmonary vascular diseases in the National Heart and Lung Institute at Imperial College London. A specialist in lung vascular disease, he has spent many years researching pulmonary hypertension (PH), a life-threatening condition caused by high blood pressure of the lung. Lawrie's particular interest lies in the underlying causes and drivers of PH, its complex molecular mechanisms, and the wealth of different biomarkers specific to the disease that can help us to understand and diagnose it. Extrapolating from his work on COVID-19, he proposes that harnessing the power of wearable technology will allow the development of specific algorithms to help earlier diagnosis, and improved patient monitoring, perhaps identifying those who are not responding to treatment.

In an ongoing study by Lawrie and colleagues, wearable technology is used to collect heart rate and personal activity data from patients with pulmonary hypertension. The researchers hypothesise that if used correctly, the routine use of such devices could improve healthcare and advance research.

A future study

Lawrie believes that we need to better understand how to interpret long-term real-world activity data before we integrate them into everyday clinical practice. Building on the success of his previous studies, a new research programme aims to identify how such data can be integrated with other real-world data to become a part of everyday clinical practice and patient monitoring.

The aim is to gain vital insights into how the many different types of data (sleep, activity, heart rate, air quality) from smart devices can be incorporated into a personal 'exposome' signature that can help inform health-disease trajectories. In turn, it could help doctors to optimise their diagnoses and treatments, ultimately saving lives and improving quality of life for millions of people living with cardiovascular-respiratory diseases.

Only when we unpick the intricacies of data from wearables, can we start to really use them as powerful healthcare tools.

Lawrie asks how we can incorporate wearable data with routine clinical data to build an overall picture for individual patients.

What makes patients different?

Harnessing wearable technology and alongside sophisticated laboratory findings, Lawrie aims to further unpick the factors contributing to PH. He will investigate the link between patients' personal activity and their susceptibility to disease progression and living with PH; including their response to treatment.

Drawing from this rich dataset, Lawrie aims to better understand the vast differences between patients – such as variations in socioeconomic group, physical activity, clinical phenotype, and biology. The study will explore how environmental factors such as lifestyle and treatments affect the development and progress of PH (disease trajectories). Wearable devices will collect personal data such as activity levels and heart rate. All this information will be analysed with the help of artificial intelligence and the application of special algorithms to build a 'cardiovascular digital twin', a representative patient avatar. Additionally, Lawrie hopes to understand how different environmental factors affect each patient's disease trajectory. This could help create subgroups of patients each benefiting of different treatments.

Wearing the future

Only when we unpick the intricacies of data from consumer wearables, can we start to really use them as powerful healthcare tools that can be integrated into current clinical practice. Lawrie's study will create a better understanding of how wearable technologies can effectively be used in learning more about cardiovascular disease. He hopes that his results will improve care for PH patients, not only by detecting different types of PH earlier, but also by helping patients receive the most beneficial personalised treatment.

Personal response

What sparked your interest in using wearables for improving health care?

I've always been interested in technology, and how we can use technology to help us. The development and uptake of smartphones and wearables has opened the door for us to use these technologies to understand more about an individual's activity in the 'real world' rather than in an artificial hospital environment. As with all technologies, it is now a matter of finding out what is the most useful data that we can extract.

Can you tell us more about your new research programme?

Clinical decisions are informed by snapshot data collected within an unfamiliar hospital environment that are based on a patient's current state without accounting for their disease trajectory. Treatments are then informed by information gathered from clinical trial populations that rarely match an individual – particularly if they are from underrepresented groups. As such, patients often present with variations of a disease (disease heterogeneity). Our central hypothesis is that heterogeneity is determined by an individual's molecular profile which is (at least in part) determined by their personal exposome – which include lifestyle factors such as activity, sleep, etc. We aim to develop an understanding of environmental and physical factors that define the individual exposome and determine the association with development and progression of pulmonary hypertension.

The long-term aim of this work is to build a holistic view of how all the various aspects of an individual's exposures connect with their underlying biology to influence the development of disease (in this case PH), and affect that individual patient's journey through disease progression. I am currently seeking funding to perform a multi-layered investigation of patients with pulmonary hypertension that integrates data from patients' full healthcare record, in-home and personal monitoring, deep disease phenotyping, and multi-omic profiling. The aim is to investigate the association of the exposome with disease heterogeneity, and the individual's disease trajectory.

How do you expect the results of your study to affect the way clinicians approach screening and choose treatments for their patients?

Remote monitoring data, for example, data from smartphones and smart watches are emerging as a potential solution to collect long-term, real-world data on an individual's activity, but data are unstructured and silloed which limit their integration into clinical systems. We wish to develop an understanding of what the key data are, and how to best integrate them in a meaningful way to form part of the patients' clinical record.

Many of the patients with PH are elderly and might be unfamiliar with modern technologies. How are you hoping to introduce them to wearables and help them comply to the monitoring required?

PH can affect people across the full life-course, from birth to old age. Clearly this technology is not for everyone. In our experience, we have found that most individuals who already have a smartphone cope well with the addition of a wearable. Our aim is to be minimally intrusive/invasive, so we have tried to focus on technologies that require as little, or as much user interaction as the individual is happy to provide. At this stage, our goal is to capture 'normal' activity levels, not necessarily promote any change in this behaviour.

Details

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Collaborators

Use of the MyHeart Counts Application is supported by Professor Euan Ashley at Stanford University, CA, USA

Bio

Allan Lawrie is Professor of Pulmonary Vascular Diseases in the National Heart and Lung Institute at Imperial College London. Lawrie has a track record of leading translational research programmes in understanding the molecular mechanism of pulmonary hypertension, and in the application of AI to real-world data for early disease detection and classification.

Further reading

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Competing interest statement

- Professor Lawrie has received in-kind support from Apple Inc for his research.
- Professor Lawrie is a medical Trustee for Scleroderma and Raynaud's UK Charity, and sits on their Research Committee.
- Professor Lawrie sits on the Clinical Academic Research Partnerships panel of the Medical Research Council, UKRI.