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# A Wearable Solution for Managing POTS: Patient Perspectives on Real-Time Heart Rate Monitoring and Activity Pacing

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**Abstract.** Managing postural tachycardia syndrome (POTS) requires continuous symptom monitoring, yet effective tools for patient self-management are limited. This study assessed patient perspectives on a wearable app designed for POTS management. Participants valued features like real-time heart rate monitoring and symptom tracking, which reduced cognitive strain and fostered confidence. Challenges such as navigation and alert management highlighted the need for improved interface design and customization. These findings demonstrate the app's potential to enhance self-management and foster patient autonomy. Future research should examine long-term outcomes and integrate suggested improvements to optimize patient-centered POTS care.

**Keywords.** Postural tachycardia syndrome, Wearable devices, Long COVID, Remote patient monitoring

## 1. Introduction

Postural tachycardia syndrome (POTS) is a chronic disorder characterized by a rapid increase in heart rate of at least 30 beats per minute when transitioning from a lying to a standing position, without a corresponding drop in blood pressure [1]. This abnormal cardiovascular response, known as orthostatic intolerance, is accompanied by a variety of other challenging symptoms, including mental fogginess ("brain fog"), persistent fatigue, exercise intolerance, and gastrointestinal issues. The impact of POTS on daily life is often profound, with many patients facing difficulties in maintaining regular physical activity, working consistently, and participating fully in everyday tasks [2]. In recent years, the prevalence of POTS and POTS-like symptoms has risen, particularly among individuals recovering from COVID-19. Studies indicate that 2%–14% of COVID-19 survivors develop POTS, with an even greater percentage (9%–61%) experiencing similar symptoms for up to eight months post-infection [3]. The increasing connection between post-COVID-19 symptoms and POTS has highlighted the pressing need for efficient care approaches for this complicated illness. Currently, treatment for

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POTS focuses on symptom management, as no cure is available. Pharmacological treatments target blood volume (e.g., salt supplementation, fludrocortisone) and heart rate reduction (e.g., beta-blockers, ivabradine) [1]. However, nonpharmacological strategies, recommended by the Heart Rhythm Society, are considered first-line treatments and include increased sodium intake, compression garments, and "activity pacing" [4]. Pacing, which balances activity to prevent symptom flare-ups, is challenging due to symptom variability. Wearable technology offers a promising solution, enabling continuous, real-time heart rate monitoring to support pacing and activity adjustments. Devices like smartwatches provide accessible options for tracking fluctuations and receiving real-time feedback, which may enhance symptom management. This study explores patients' perspectives on using wearable devices for heart rate monitoring, aiming to assess their potential to aid in activity pacing and improve symptom control for POTS patients.

## 2. Methods

### *2.1. Study Design*

The current study employed qualitative methods to understand the experience and gather feedback on using a wearable app to support symptom management in patients with POTS. A purposive sampling method was used to recruit individuals with relevant experience in managing POTS symptoms [5]. Recruitment was clinic-based, with healthcare providers at the COVID-19 Long-Hauler Clinic at the University of Utah Health identifying potentially eligible patients. Interested patients were referred to a study coordinator, who provided detailed information about the study, answered questions, and obtained informed consent. Eligible participants were required to be 18 years or older and to have experienced recent POTS-related symptoms, such as increased heart rate with activity, brain fog, lightheadedness, headaches, nausea, vomiting, and chronic fatigue. Exclusion criteria included conditions like unstable angina, uncontrolled hypertension, recent myocardial infarction, pacemaker use, bony metastases, or recent skeletal fractures. Data collection occurred during a single, one-hour in-person session, where participants completed surveys, received an app demonstration, and performed four tasks simulating real-life symptom management. Following this, a 10–15-minute semi-structured qualitative interview was conducted with responses transcribed in de-identified documents in Microsoft Word. Responses were analyzed using inductive content analysis, systematically coding themes and subthemes with a "bottom-up" approach by developing codes directly from the data itself [6,7]. The generated codes, themes, and subthemes were organized into a cohesive narrative that addressed the research objectives and theoretical context.

### *2.2. System Design*

The wearable app for managing POTS symptoms enables continuous heart rate (HR) monitoring and provides real-time clinical suggestions and reminders to help lower HR when needed. The Apple Watch Series 9 was selected for its standalone operation, real-time data capabilities, and seamless cloud integration. Developed using Xcode 10 and Swift for watchOS 10, the app leverages the HealthKit library to read HR data, which clinicians monitor via a secure website. Clinicians access patient data only after

registering the watch's unique MAC address, ensuring privacy. The app displays HR, monitoring duration, and action buttons on its main interface. Real-time alerts, customizable by clinicians, notify patients through vibrations or sounds when HR exceeds thresholds. Data, including HR readings, alerts, and updates, is securely uploaded every 30 readings for continuous monitoring and improved symptom management.

## 3. Results

A total of 12 participants were enrolled and completed the study. The results of the inductive content analysis indicated that the wearable app to support POTS symptom management was well received by participants. The findings of the content analysis revealed five themes: Perceived value and potential impact of the app for symptom management in POTS and related conditions, Building confidence in symptom management through knowledge and real-time support, Pacing and symptom management awareness and strategies, Problems or concerns with app usage, and Suggestions for improvements and additional features.

### *3.1. Theme 1. Perceived value and potential impact of the app for symptom management in POTS and related conditions*

Participants perceived the app as a valuable tool for managing POTS, especially its real-time heart rate monitoring and symptom tracking. They felt these features could reduce cognitive strain by automating symptom awareness, allowing timely adjustments and proactive symptom management. The app's actionable notifications and personalized recommendations were particularly appreciated, as they enabled users to identify critical heart rate thresholds and respond quickly to symptom changes. Many participants expressed interest in future use, noting that the app could benefit those with related conditions, such as Long COVID and ME/CFS, by supporting pacing and symptom regulation.

### *3.2. Theme 2. Building confidence in symptom management through knowledge and real-time support*

Participants indicated that the app could boost confidence in managing POTS by providing real-time symptom insights and adaptive recommendations. Access to real-time data on their physical state, paired with adaptive recommendations based on posture (e.g., standing or sitting), was viewed as empowering, enabling participants to make informed health decisions and provide greater ease in approaching physical activities. The app's potential for improved healthcare communication also fostered confidence, with participants valuing a data-sharing feature to collaborate with providers and track progress. Additionally, positive reinforcement messages and mindful reminders for health interventions enhanced their sense of security.

### *3.3. Theme 3: Pacing and symptom management awareness and strategies*

Participants showed awareness of activity pacing for POTS management, with some demonstrating strong knowledge, but they reported difficulties in consistently applying it due to fluctuating symptoms and symptom-related fatigue. This challenge was compounded by a lack of real-time symptom monitoring, highlighting the potential role of wearable devices in supporting pacing and symptom control. In addition to pacing, participants employed various management strategies, blending lifestyle adjustments, self-monitoring, and medical interventions. Physical strategies included sleeping position adjustments, compression garments, and increased hydration. Self-monitoring of heart rate and other symptoms was common, helping participants tailor their approaches based on symptom patterns. Behavioral methods, such as taking regular breaks and practicing task management, were also key, with some participants using cognitive therapy to address the psychological impact of POTS.

### *3.4. Theme 4: Problems or concerns with app usage*

While most participants reported no major issues with the app, a few noted specific usability and accessibility challenges. Some found it difficult to locate functions like note entry and status feedback, suggesting areas for improved interface navigation. Physical accessibility concerns were also raised, including difficulties reading without glasses and improper fit of the Apple Watch on small wrists, which affected comfort and usability. Concerns about alert management were also expressed. Participants mentioned that receiving health notifications in social settings could feel intrusive, and some worried about "alert fatigue" from excessive notifications. Additionally, concerns about post-exertional malaise underscored the need for customizable alert settings to manage notifications around physical activity and symptom triggers.

### *3.5. Theme 5: Suggestions for improvements and additional features*

Participants provided a range of suggestions to enhance the app's usability, support, and functionality, aiming to make it a more comprehensive tool for managing POTS symptoms. Many recommended expanding health tracking to include vital signs like blood oxygen and blood pressure, alongside heart rate, with visual aids like trend charts to help users recognize symptom patterns and triggers. For a holistic symptom overview, real-time pattern identification and contextual tracking of emotional and environmental aspects were also suggested. To support mental health, participants proposed features to detect anxiety, offering calming reminders. Positive feedback notifications and more visible recommendations, like reminders to lie down, were seen as helpful. Customizable notification controls, such as mute and snooze options, were frequently requested to manage alerts discreetly, particularly in social settings. Interface improvements were also highlighted, including clearer labels, streamlined navigation, and voice-activated commands for accessibility. A patient portal with data visualization and trend tracking was suggested to enhance understanding of health data and facilitate provider communication.

## 4. Discussion

The management of postural tachycardia syndrome (POTS) presents a complex challenge, as patients must constantly monitor and adjust their activities to mitigate symptoms of orthostatic intolerance, fatigue, and cognitive difficulties. The primary strategy for managing POTS is activity pacing, which is based on symptom reduction through lifestyle modifications and medication. However, given the unpredictable nature of POTS symptoms, patients often face difficulties in implementing pacing and symptom management strategies effectively. Although wearable devices, like smartwatches, are gaining attention for their potential to support self-monitoring, limited research explores their practical value in POTS management, particularly for enhancing confidence, understanding, and symptom control.

In this study, we explored participants' perceptions of a wearable app for managing POTS. Participants valued the app's real-time heart rate monitoring and symptom tracking, noting that these features could reduce cognitive strain and facilitate timely intervention. The ability to access real-time symptom insights and adaptive recommendations fostered a sense of control and increased confidence in managing symptoms. However, some usability challenges emerged, including navigation difficulties and alert management issues, underscoring the need for refined interface design and customizable notification settings. Participants also proposed various improvements, such as expanding health metrics to include blood oxygen levels and blood pressure, enhancing mental health support, and offering options for increased personalization.

These findings suggest that wearable devices can play a significant role in advancing POTS management by facilitating symptom monitoring, enhancing patient autonomy, and fostering collaboration with healthcare providers. Real-time symptom monitoring, paired with user-focused interface improvements, could enhance patients' ability to self-manage symptoms more effectively and confidently. Future research should explore long-term outcomes of wearable device use among POTS patients and examine the impact of recommended improvements to optimize patient-centered care and its applicability across diverse patient populations.

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