Case Series

Evaluating the efficacy of smartwatch-based mobility reminders in pressure sore prevention: a pilot observational study

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ABSTRACT

Wearable technology has gained prominence in healthcare for its ability to enhance patient care, especially for individuals with mobility limitations who are at risk for pressure sores. This pilot study aimed to evaluate the effectiveness of wearable smartwatches in providing mobility reminders to seven patients-three wheelchair-bound and four bedridden-to support regular movement and prevent the development of pressure sores. The study explored the ability of wearable device to deliver real-time notifications for position changes and movement, empowering patients to become more proactive and independent in managing their mobility-related needs. Patients reported enhanced autonomy in maintaining movement routines, with noticeable benefits in pressure sore prevention and a reduced dependency on caregivers. However, the study also identified limitations, such as occasional false-positive alerts, which created minor disruptions, particularly during periods of minimal activity like sleep. Calibration of the devices mitigated some of these challenges, improving the user experience for most patients. Overall, wearable technology showed promise in improving care quality and patient outcomes, with further refinement and personalization required for broader clinical use.

Keywords: Wearable technology, Bed sore, Pressure sores, Smartwatches in healthcare

INTRODUCTION

Wearable technology has emerged as a transformative tool in healthcare, offering not only real-time health monitoring but also fostering patient engagement and promoting a proactive approach to self-care.[1-3] These devices have become integral in addressing various healthcare needs, from monitoring vital signs to tracking movement and activity levels, which are essential for preventive care.[4] In settings with limited healthcare resources, such as India, wearable technology can offer a valuable solution, particularly for patients with restricted mobility.

Among patients who are wheelchair-bound or bedridden, pressure sores represent a major healthcare challenge, often leading to further complications, increased healthcare costs, and a decline in quality of life.[5] Pressure sores, or bedsores, develop from sustained pressure on the skin, leading to tissue damage due to restricted blood flow. These sores are preventable with regular movement and repositioning, yet they require ongoing monitoring and intervention.[6] Traditionally, caregivers or nursing staff play a critical role in assisting patients with necessary position adjustments to prevent sores.[7] However, this dependency on caregivers can limit patient autonomy and create challenges in consistently providing the recommended movement intervals, particularly during busy care shifts.

Wearable smartwatches with mobility reminder functions offer a potential solution to address this need, enabling patients to receive timely alerts for position changes. By prompting patients to move or adjust their position, these

wearables reduce the reliance on caregivers for routine reminders and allow patients to play a more active role in their care.

This study explores the use of wearable smartwatches to remind wheelchair-bound and bedridden patients to move or adjust their positions to prevent bedsores. By analysing patient feedback, this study also seeks to capture the real-world impact of these devices, identifying both the benefits and limitations from a user perspective. Through this approach, the study aims to contribute insights into the potential for wearable technology to enhance mobility care and patient independence in healthcare settings where resources are stretched.

CASE SERIES

This observational pilot study was conducted over a period of six weeks in a clinical setting, involving seven consecutive patients (n=7) without pre-existing pressure sores. Participants were adult patients who were either wheelchair-bound (n=3) or bedridden (n=4) for various conditions such as spinal cord injury or post-surgical immobility. Inclusion criteria were the ability to understand and follow mobility reminders, willingness to participate in the study, and absence of pre-existing pressure sores.

Participants wore commercially available smartwatches equipped with mobility tracking and alert functions. These devices were pre-programmed to provide reminders at intervals optimized for pressure sore prevention, generally ranging from thirty minutes to two hours based on individual needs. The wearable devices included accelerometers and gyroscopic sensors that monitored body position and movement patterns. During the initial setup, alerts were calibrated to each patient's baseline movement level and were adjusted as necessary based on feedback to minimize false positives and maximize effective reminders.

Patients were instructed to follow the smartwatch alerts as closely as possible, with caregivers assisting if needed for bedridden patients. The reminders prompted wheelchair-bound patients to shift weight, stand if possible, or make minor position adjustments. For bedridden patients, reminders encouraged changes in lying position to redistribute pressure and reduce the risk of pressure sore development.

The wearable smartwatch technology positively impacted patient mobility and pressure sore prevention. Among the seven patients, adherence to mobility reminders was high, with an average compliance rate of 85%. Key outcomes included enhanced patient autonomy, reduced reliance on caregivers, and effective prevention of pressure sores over the study period.

All three wheelchair-bound patients reported significant benefits in terms of mobility awareness, stating that the reminders effectively prompted weight-shifting and standing at regular intervals (Figure 1). These reminders contributed to better skin health and a sense of independence. Two of the wheelchair-bound patients experienced occasional false alarms, which occurred primarily during extended periods of seated inactivity. These instances were minimized through device recalibration.

Figure 1 (A and B): Wheelchair bound patient.

For bedridden patients, the reminders effectively facilitated position changes, although three of the four patients required assistance from caregivers for these adjustments (Figure 2). Despite this, bedridden patients expressed satisfaction with the smartwatch reminders as supportive tools. No pressure sores developed, and patients reported improved comfort. However, one patient experienced frequent false alerts during sleep, which was resolved by modifying the alert settings.

Clinically, the study observed no new incidence of pressure sores after 6 weeks, indicating the efficacy of smartwatch reminders in preventing skin breakdown. The table below provides a summary of the primary results:

Figure 2 (A and B): Bedridden patient.

Table 1: Summary of primary results.

Characteristics	N	Percentage (%)
Mobility status		
Wheelchair-bound	3	43
Bedridden	4	57
Compliance with alerts	7	86.1
False alert frequency		
Low	3	43
Moderate	2	29
High	2	29
Caregiver involvement		
Low	2	29
Moderate	2	29
High	3	43
Incidence of pressure sore		
None	7	100
Overall feedback summary		
Positive	5	71
Moderate	2	29

These findings suggest that wearable smartwatch reminders are effective for enhancing mobility in wheelchair-bound and bedridden patients, helping to prevent pressure sores and fostering greater patient autonomy. Adjustments to device sensitivity were necessary for optimal functionality, highlighting the need for customizable algorithms to tailor alerts to each individual's movement patterns.

DISCUSSION

Wearable technology has shown promise in enhancing care for patients with limited mobility.[3,8,9] In this study, wearable smartwatches offered effective and timely reminders for position changes, which significantly contributed to the prevention of pressure sores and encouraged movement among the participants. Patients described a notable increase in autonomy and independence, allowing them to take a more active role in their mobility care and reducing reliance on caregivers. This empowerment was especially significant in environments where healthcare resources may be constrained, as patients were able to manage parts of their care independently. The capacity of wearable technology to deliver such reminders and foster patient engagement

in their care, marks an important advancement in the prevention and management of mobility-related health complications.

Despite these benefits, some limitations of the wearable devices were evident, primarily in the form of false-positive alerts and overly sensitive notifications. These false alarms were generally more frequent during prolonged periods of minimal movement, such as sleep, which indicates the need for devices to better differentiate between actual inactivity and natural low-movement states. Addressing these limitations requires the development of more sophisticated algorithms that can adjust the sensitivity of the alerts to each patient's unique movement patterns. Tailoring the algorithms based on patient-specific needs could significantly reduce false alarms and optimize device accuracy, thus enhancing the user experience and improving adherence. Such adaptations would make wearables more effective in a variety of real-world healthcare environments, especially where patients' mobility patterns may vary widely.

Recent advancements in wearable technology further support the potential for wearables to revolutionize healthcare.[10] Artificial developments in artificial intelligence and machine learning have opened new possibilities for personalizing feedback to individual users.[11] These can help wearables adjust to a patient's habits and patterns over time, reducing the likelihood of false alarms while delivering more accurate, context-sensitive prompts. Moreover, wearable devices are evolving to provide an expanded range of health monitoring capabilities beyond mobility reminders, with the integration of vital sign monitoring, such as heart rate, oxygen saturation, and sleep quality.[3] Such features allow a more holistic assessment of patient health and could provide early indicators of complications. In addition, smart textiles, in which sensors are embedded directly into clothing or bedding, may become a less intrusive option for monitoring and managing patient movements.[12]

The future of wearable technology in healthcare offers several promising pathways for improvement.[13] One critical area is the advancement of personalized algorithms, which would enable wearables to tailor their prompts based on each patient's specific requirements and patterns.[14] These personalized alerts would help minimize false alarms and improve overall device effectiveness. Another significant development would be the integration of wearable technology with electronic health record (EHR) systems, allowing healthcare providers to remotely monitor patient status and intervene if necessary.[15] As telemedicine continues to expand, wearables are expected to play an essential role in remote patient care, providing healthcare professionals with critical insights without requiring in-person visits.

Wearable technology must also become more cost-effective and accessible to be viable in diverse healthcare

settings, particularly in regions with limited resources, such as India. Efforts to make wearables more affordable would ensure that a wider range of patients could benefit from their mobility reminder features and health monitoring capabilities. Lastly, as wearables become increasingly user-friendly, with more customization options, patients are likely to experience improved engagement and adherence. Customizable wearables could enable patients to adjust alert settings, choose features based on their preferences, and ensure that the device meets their comfort and usability requirements.

CONCLUSION

Wearable technology has proven to be an effective tool for improving mobility and preventing pressure sores in patients with limited movement. While there are some limitations, the overall benefits to patient independence and health outcomes are evident. As technology advances, these devices will play an even larger role in healthcare, offering personalized, real-time solutions to improve patient care. With continued innovation, wearable technology will become increasingly accessible, adaptable, and integrated into mainstream healthcare systems.

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