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Wearable Technologies in the Monitoring of Patients with Chronic Kidney Disease

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Mini Review

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Abstract

Chronic kidney disease (CKD) requires repeated assessment of kidney function, cardiovascular status, fluid balance, physical activity, and treatment response. Conventional monitoring relies largely on intermittent clinic visits and laboratory measurements, which may fail to capture physiological changes occurring between assessments. Wearable technologies offer an emerging opportunity for continuous and remote monitoring of patients with CKD. Smartwatches, fitness trackers, wearable patches, and emerging biosensors can measure parameters such as heart rate, physical activity, sleep, oxygen saturation, blood pressure, body composition, and, in experimental systems, biochemical markers relevant to kidney function. Recent advances in flexible sensors and microfluidic platforms have enabled investigation of creatinine, urea, and electrolyte detection in sweat and other peripheral biofluids.

Wearables may be particularly useful for identifying changes in physical activity, fluid status, cardiovascular health, and general well-being in individuals with CKD and kidney failure. Integration with electronic health records, dialysis-machine data, and remote monitoring platforms could support more individualized care. However, current evidence remains limited, and many commercially available wearable measurements have not been sufficiently validated for clinical decision-making in CKD. Challenges include measurement accuracy, data interpretation, patient adherence, privacy, cost, digital inequality, and false-positive alerts. This mini review discusses current applications, emerging opportunities, limitations, and future directions for wearable technologies in CKD monitoring.

Keywords: Chronic Kidney Disease; Wearable Technology; Wearable Sensors; Digital Health; Remote Monitoring; Smartwatches; Biosensors; Dialysis; Precision Nephrology

Introduction

CKD is a major long-term health problem characterized by progressive loss of kidney function and increased risk of cardiovascular disease, hospitalization, and kidney failure. Monitoring patients with CKD traditionally involves periodic assessment of serum creatinine, estimated glomerular filtration rate, albuminuria, blood pressure, electrolytes, and other laboratory parameters. Although these measurements are essential, they provide information at specific time points rather than continuously [1].

The development of wearable technologies has introduced the possibility of collecting physiological

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information outside conventional healthcare settings. Commercial smartwatches and fitness trackers can monitor physical activity, heart rate, sleep, oxygen saturation, and other parameters. In patients with CKD, these measurements may provide additional information about functional status and changes occurring between clinical encounters [2].

More advanced wearable biosensors are being developed to measure biochemical markers. Experimental systems have investigated the detection of creatinine, urea, electrolytes, and other kidney-relevant biomarkers through sweat, interstitial fluid, saliva, tears, and related biofluids. These technologies could eventually complement conventional blood and urine testing.

The purpose of this mini review is to summarize the potential role of wearable technologies in CKD monitoring and discuss their current limitations and future clinical applications.

Wearable Technologies and CKD Monitoring

Wearable technologies used in healthcare can broadly be divided into physiological monitors, activity-monitoring devices, and biochemical biosensors.

Smartwatches and wrist-worn devices can collect information about heart rate, physical activity, sleep, oxygen saturation, and in some devices other cardiovascular parameters. Such information may be relevant because CKD is strongly associated with cardiovascular disease and reduced physical functioning.

Activity monitoring may provide a relatively simple measure of functional status. Reduced physical activity can accompany increasing disease burden, frailty, hospitalization, or declining quality of life. Continuous activity information may therefore complement conventional clinical assessments [3].

Wearable devices can also support remote patient monitoring. Data collected at home may be transmitted to healthcare platforms, allowing clinicians to observe trends rather than relying exclusively on information obtained during scheduled visits.

However, wearable measurements should currently be regarded primarily as supplementary information rather than replacements for established laboratory testing.

Monitoring Fluid and Cardiovascular Status

Fluid balance is an important consideration in advanced CKD and kidney failure. Excess fluid accumulation can contribute to edema, hypertension, shortness of breath, and cardiovascular complications [4].

Wearable technologies may potentially contribute to fluid-status assessment through measurements such as heart rate, activity, body composition, and other physiological signals. Although several approaches are being investigated, reliable non-invasive continuous assessment of volume status remains technically challenging.

In dialysis populations, wearable monitoring could potentially identify changes occurring between treatment sessions. Remote monitoring systems may also help healthcare teams recognize concerning physiological changes earlier.

Recent work on digital health in CKD highlights the potential of combining wearable data with electronic health records and dialysis-machine information to develop more individualized monitoring systems.

Physical Activity and Functional Status

Physical inactivity is common among patients with advanced CKD and dialysis dependence. Reduced exercise capacity may contribute to frailty, cardiovascular risk, and impaired quality of life.

Wearable activity trackers provide an objective method of monitoring daily movement. Step counts, activity duration, sedentary time, and sleep patterns can provide information that may be difficult to obtain through conventional clinical questioning.

These measurements may also support behavioral interventions. Patients can receive feedback regarding activity levels and work with healthcare professionals to establish realistic activity goals.

Importantly, activity data should be interpreted in the context of age, comorbidities, dialysis schedule, symptoms, and baseline functional status.

Sleep and Quality of Life

Sleep disturbances are frequently reported in patients with CKD. Wearable devices capable of monitoring sleep duration and patterns may provide additional information about patients' daily experiences.

Continuous monitoring could help identify changes in sleep behavior that may accompany worsening symptoms or treatment-related problems.

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However, wearable sleep measurements are generally estimates rather than direct clinical assessments. Their findings should therefore be interpreted cautiously and, when necessary, supplemented with validated clinical evaluation.

Wearable Biosensors for Kidney Biomarkers

One of the most promising areas of development is wearable biochemical sensing. Conventional kidney monitoring depends heavily on blood and urine measurements. These methods are clinically established but require intermittent sampling.

Researchers are exploring whether wearable systems can detect kidney-relevant biomarkers from peripheral biofluids. Experimental platforms have investigated creatinine, urea, electrolytes, and related analytes in sweat and interstitial fluid [5].

Flexible materials and microfluidic technologies may allow sweat or interstitial fluid to be transported to integrated sensors. Such systems could potentially provide continuous biochemical information without repeated conventional blood sampling.

Nevertheless, a major challenge is determining how concentrations measured in peripheral biofluids correspond to clinically established blood concentrations. Differences in sweat production, hydration, temperature, skin characteristics, and local physiology may influence measurements.

Therefore, wearable biochemical sensors require extensive validation before they can be used for routine CKD diagnosis or treatment decisions.

Wearables in Dialysis Care

Patients receiving hemodialysis experience substantial fluctuations in fluid balance, blood pressure, physical activity, and symptoms. Wearable technologies may offer opportunities for monitoring these changes between dialysis sessions. Current research has investigated applications involving physical activity, fluid-related parameters, oxygen saturation, and other physiological characteristics. A 2026 systematic review found potential benefits for disease monitoring and self-management among hemodialysis patients, while also emphasizing that available evidence remains limited and heterogeneous.

Wearable and remote monitoring systems may eventually contribute to earlier recognition of clinically important changes and more individualized dialysis care.

However, clinical implementation requires reliable measurements, clear response protocols, and integration with existing dialysis services.

Integration with Artificial Intelligence

The amount of information generated by wearable devices can be substantial. Artificial intelligence and machine learning may help identify patterns within longitudinal datasets. For example, an algorithm could potentially combine changes in activity, heart rate, sleep, blood pressure, symptoms, and laboratory measurements to identify individuals at increased risk of deterioration. Such systems may contribute to precision nephrology by moving from occasional measurements toward dynamic risk assessment. However, predictive accuracy alone is insufficient. AI systems require validation in diverse CKD populations, transparent performance evaluation, and assessment of whether predictions actually improve patient outcomes.

Advantages of Wearable Technologies

Several potential advantages can be identified:

- Continuous or frequent monitoring.
- Home-based data collection.
- Reduced dependence on patient recall.
- Objective measurement of physical activity.
- Potential early identification of physiological changes.
- Improved patient engagement.
- Support for remote consultations.
- Potential integration with electronic health records.
- Opportunities for individualized care.

Challenges and Limitations

Despite their promise, several barriers limit widespread clinical use.

Measurement Accuracy

Consumer-grade devices may not provide measurements equivalent to clinical-grade equipment. Recent reviews emphasize that insufficient validation currently limits the use of many smartwatch measurements for clinical decision-making in CKD.

Biochemical Variability

Concentrations of biomarkers in sweat or interstitial fluid may not directly reflect blood concentrations. This remains a major challenge for wearable kidney biosensors.

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Data Overload

Continuous monitoring can generate large amounts of information. Clinicians need systems that identify clinically meaningful changes rather than simply presenting large volumes of raw data.

False Alerts

Incorrect or nonspecific signals may create unnecessary concern and increase healthcare utilization.

Patient Adherence

Devices must be comfortable, easy to use, affordable, and practical for long-term monitoring.

Privacy

Wearable systems collect personal health information continuously. Appropriate cybersecurity, data governance, and informed consent are therefore essential.

Digital Inequality

Patients without reliable internet access, smartphones, or technological literacy may have limited opportunities to benefit from wearable monitoring.

Future Perspectives

The future of wearable technology in nephrology is likely to involve integration rather than isolated devices. A potential future digital ecosystem could combine wearable measurements, home blood pressure monitoring, laboratory results, medication information, electronic health records, and dialysis-machine data. Advanced biosensors may eventually permit continuous monitoring of kidney-related biochemical markers. Recent research has demonstrated the feasibility of wearable systems designed to detect creatinine, urea, and electrolytes in peripheral biofluids, although substantial clinical validation remains necessary. Artificial intelligence could then analyze these multidimensional data streams and identify individualized patterns. The most important objective should not be simply to monitor more parameters. Instead, wearable technologies should provide actionable information that improves patient outcomes.

Conclusion

Wearable technologies represent an emerging component of digital nephrology with potential applications in CKD, dialysis, and long-term patient monitoring. Current devices can provide useful information regarding physical activity, heart rate, sleep, and other physiological parameters, while experimental biosensors are moving toward continuous measurement of kidney-relevant biochemical markers.

However, wearable technology is not yet a replacement for established laboratory and clinical assessment. Accuracy, validation, data interpretation, privacy, cost, and patient adherence remain important barriers.

Future research should focus on clinically validated sensors, standardized data interpretation, integration with healthcare systems, and patient-centered implementation. If these challenges can be addressed, wearable technologies may contribute to a more continuous, personalized, and proactive model of CKD care.

References

1. Kooman JP, Han M, Josemans SH, Rotmans JI, Usvyat L, et al. (2026) Smartwatches in the digital health ecosystem for health monitoring in patients with chronic kidney disease and kidney failure: opportunities and challenges. Am J Physiol Renal Physiol 331(3): F345-F357.

2. Madhvapathy SR, Cho S, Gessaroli E, Forte E, Xiong Y, et al. (2025) Implantable bioelectronics and wearable sensors for kidney health and disease. Nat Rev Nephrol 21(7): 443-463.

3. Han S, Yamamoto S, Jung CY, Jin DY, Lee T, et al. (2024) Wearable sensors for monitoring chronic kidney disease. Commun Mater 5: 153.

4. Stauss M, Htay H, Kooman JP, Lindsay T, Woywodt A (2023) Wearables in Nephrology: Fanciful Gadgetry or Prêt-à-Porter? Sensors (Basel) 23(3): 1361.

5. Wieringa FP, Broers NJH, Kooman JP, Van Der Sande FM, Van Hoof C (2017) Wearable sensors: can they benefit patients with chronic kidney disease? Expert Rev Med Devices 14(7): 505-519.

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