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Editorial

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Wearable Lab-on-Skin Sensors: Real-Time Health Monitoring at the Surface

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Introduction

Advances in biomedical engineering and materials science have led to the development of wearable technologies capable of continuously monitoring physiological signals. Among these innovations, wearable lab-on-skin sensors represent a significant breakthrough. These ultra-thin, flexible devices adhere directly to the skin and function as miniaturized laboratories, capable of analyzing biochemical and biophysical markers in real time. Unlike conventional diagnostic tools that require blood draws or bulky equipment, lab-on-skin sensors offer noninvasive, continuous, and personalized health monitoring [1,2].

Designed to conform seamlessly to the body's contours, these sensors integrate microfluidics, biosensing elements, and wireless communication modules into lightweight platforms. By capturing data directly from sweat, interstitial fluid, or skin temperature, they provide dynamic insights into an individual's health status. As healthcare increasingly shifts toward preventive and personalized models, wearable lab-on-skin sensors are positioned to play a transformative role.

Discussion

A defining feature of wearable lab-on-skin sensors is their mechanical flexibility and biocompatibility. Constructed from stretchable polymers, conductive inks, and soft substrates, these devices can bend, stretch, and move with the skin without compromising performance. This mechanical compatibility reduces discomfort and ensures stable signal acquisition during daily activities [3,4].

Microfluidic channels embedded within the device allow for controlled collection and analysis of small volumes of sweat or other biofluids. Sweat contains valuable biomarkers such as electrolytes, glucose, lactate, cortisol, and pH levels. By incorporating selective chemical sensors or enzymatic detection systems, lab-on-skin platforms can quantify these biomarkers and transmit data wirelessly to smartphones or cloud-based systems for analysis.

Applications of these sensors span multiple domains. In sports medicine, they enable athletes to monitor hydration levels and electrolyte balance in real time, optimizing performance and preventing heat-related illnesses. In chronic disease management, wearable glucose or lactate sensors support individuals with diabetes or metabolic disorders by providing continuous metabolic feedback. Emerging systems also track stress hormones and inflammatory markers, offering insights into mental health and immune responses [5].

Despite their potential, challenges remain in sensor accuracy, long-term stability, and data interpretation. Biofluid composition can vary based on environmental conditions, hydration status, and individual physiology. Ensuring reliable calibration and minimizing interference from external factors are ongoing research priorities. Additionally, issues related to data privacy and secure wireless transmission must be carefully addressed.

Conclusion

Wearable lab-on-skin sensors represent a powerful convergence of microtechnology, materials science, and digital health. By transforming the skin into a real-time diagnostic interface, these devices enable continuous, personalized monitoring without invasive procedures. While technical and regulatory challenges persist, ongoing innovation is steadily improving reliability and functionality. In the future, lab-on-skin technologies are expected to become integral to preventive healthcare, remote patient monitoring, and performance optimization, reshaping how individuals engage with their health on a daily basis.

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