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Commentary

Digital Health Approaches to Transfusion Management in Chronic Anemia

Tibor Zajzon*

Department of Clinical Hematology, University of Pecs, Pecs, Hungary

DESCRIPTION

Chronic anemia remains a persistent clinical challenge across diverse patient populations, including individuals with chronic kidney disease, hematological disorders, malignancies, and inflammatory conditions. Management often involves repeated assessment of hemoglobin levels, clinical symptoms, and physiological indicators to determine the need for transfusion or alternative therapies. Traditional approaches rely on intermittent laboratory testing and clinical evaluation, which may not fully capture day-to-day fluctuations in patient status. As healthcare moves toward individualized care, there is growing interest in integrating continuous monitoring technologies into anemia management. Wearable biosensors, capable of tracking physiological parameters in real time, are emerging as tools that may support more refined transfusion strategies and improve patient outcomes.

In the context of chronic anemia, continuous monitoring through wearable devices may help identify early signs of physiological stress associated with declining hemoglobin levels. For instance, an increase in resting heart rate or reduced exercise tolerance may indicate reduced oxygen-carrying capacity. By detecting such changes, clinicians can intervene earlier, potentially preventing symptom progression and reducing the need for urgent transfusion. Conversely, stable physiological parameters may support deferral of transfusion, minimizing exposure to associated risks. This approach aligns with patient-centered care by considering individual responses rather than relying solely on standardized thresholds.

Integration of wearable biosensor data with clinical information systems represents an important step toward effective implementation. Data collected from devices can be transmitted to secure platforms where they are analyzed and presented to healthcare providers. Decision support tools can incorporate these data alongside laboratory results, medical history, and current treatments to guide transfusion decisions. Such systems may provide alerts when predefined criteria are met, prompting timely clinical review. Ensuring interoperability between devices and healthcare systems is essential to facilitate seamless data exchange and support coordinated care.

Despite the potential advantages, several challenges must be addressed to realize the full value of wearable biosensors in personalized transfusion strategies. Accuracy and reliability of measurements remain key concerns, particularly for parameters such as hemoglobin estimation, which can be influenced by factors including skin pigmentation, perfusion, and environmental conditions. Validation of devices across diverse populations and clinical settings is necessary to ensure consistent performance. Calibration against standard laboratory measurements may be required to maintain accuracy over time.

Data management and privacy considerations are also important. Continuous monitoring generates large volumes of data that must be stored, processed, and protected. Ensuring secure transmission and compliance with data protection regulations is essential to maintain patient confidentiality. At the same time, effective data analysis requires robust algorithms capable of distinguishing clinically meaningful patterns from normal variability. Development of such algorithms involves collaboration between clinicians, engineers, and data scientists.

Another challenge involves integrating wearable technology into existing clinical workflows. Healthcare providers must be able to interpret and act on data without excessive burden. Clear guidelines and protocols are needed to define how biosensor data should influence transfusion decisions. Training for clinicians and support staff is necessary to ensure appropriate use of technology. Without careful implementation, there is a risk of information overload or misinterpretation, which could affect patient care.

Economic considerations also influence the adoption of wearable biosensors. The cost of devices, data infrastructure, and maintenance must be balanced against potential benefits such as reduced hospital visits, improved patient outcomes, and more efficient use of blood products. Health systems may require evidence of cost-effectiveness before widespread implementation. Pilot studies and clinical trials can provide data on the impact of

Correspondence to: Tibor Zajzon, Department of Clinical Hematology, University of Pecs, Pecs, Hungary, E-mail: tibor.zajzon@uni.hu

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wearable technology on transfusion practices and patient quality of life.

Ethical considerations arise in the context of continuous monitoring. While increased data availability can enhance care, it also raises questions about autonomy, consent, and data ownership. Patients must be informed about how their data will be used and have control over participation. Ensuring equitable access to wearable technology is important to avoid disparities in care. Efforts to make devices affordable and accessible across different populations support inclusive healthcare practices.

In summary, the integration of wearable biosensors into chronic anemia management represents a step toward more individualized transfusion strategies. By providing continuous, real-time data on physiological parameters, these devices offer a broader perspective on patient status than intermittent laboratory testing alone. While challenges related to accuracy, data management, workflow integration, and cost must be addressed, ongoing technological and clinical developments support the potential for meaningful impact. As evidence accumulates and systems evolve, wearable biosensors may become an integral component of transfusion medicine, contributing to more responsive and patient-centered care.