



Shaping Tomorrow's Nephrology: Insight-Driven Kidney Care

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Development of a Preemptive Prediction System for Intradialytic Hypotension Using Sensor Fusion-Based Quantitative Analysis of Vascular Access Physical Indicators

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Objectives : To address the fatal risks of intradialytic hypotension (IDH) in ESKD patients, this study develops a real-time monitoring system using pressure, flow, and vibration sensor fusion. By quantifying physical indicators within the vascular access, the system overcomes the limits of intermittent monitoring to provide preemptive IDH prediction. This robust framework aims to significantly enhance patient safety and clinical efficacy during hemodialysis.

Methods : This study proposes a three-stage sensor fusion system; data acquisition, correlation analysis, and quantitative calculation to collect real-time hemodynamic data via pressure, flow, and vibration sensors at the vascular access. By analyzing subtle patterns linked to rapid plasma volume reduction, the system develops an integrated algorithm to predict precursory signs of intradialytic hypotension (IDH). Currently in the pre-clinical stage, this predictive model aims to overcome the limitations of intermittent monitoring before transitioning into actual clinical practice.

Results : Unlike broad spectrum impulse methods, our active vibration system scans specific frequencies to analyze resonant and damping traits of biological media. Using a custom precision exciter and accelerometer, we tested a healthy control group and identified significant frequency response variations linked to changes in density and elasticity. This enables precise, real-time diagnostic monitoring.

Conclusions : Our sensor fusion system significantly reduces IDH-related risks and mortality. It improves patient safety and quality of life while enabling a data-driven "smart dialysis" environment and efficient resource management.

Figure 1. Schematic Diagram of the Sensor Fusion System for Intradialytic Hypotension (IDH) Monitoring.jpg

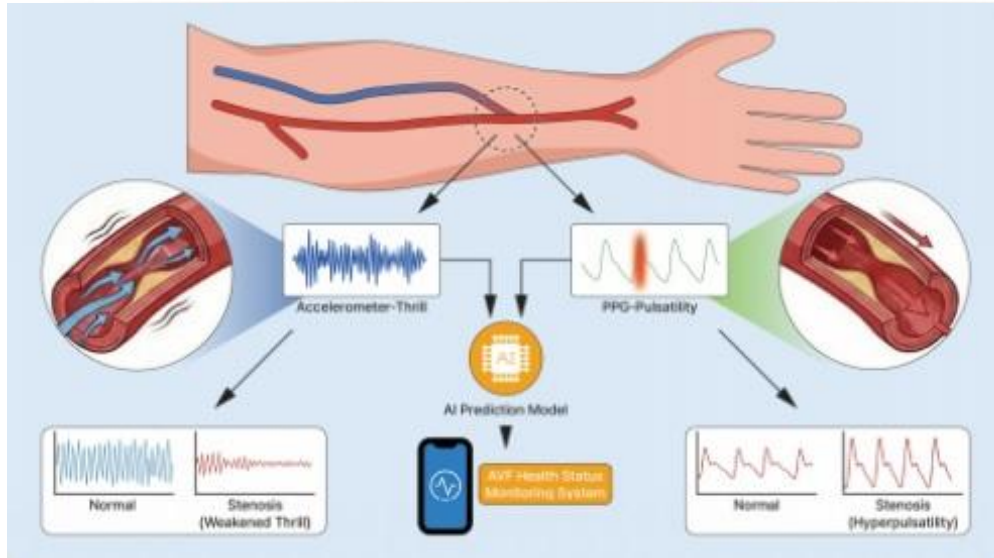


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