Stimulus Responsive Wireless Sensor Integrated Smart Urine Bag for Early Detection of Catheter-Associated Infections

Wireless catheter bag sensor detecting infection biomarkers in real time to reduce ICU complications.

Researchers at Purdue University have developed a Smart Urinary Bag (SUB) system with an integrated sensor platform designed for real-time monitoring of UTI-associated biomarkers in urine directly within the urinary bag. Urinary catheterization is a routine intervention in intensive care unit (ICU) patients with prolonged immobility. However, extended use of urinary catheters significantly increases the risk of urinary tract infections (UTIs), posing serious healthcare concerns. Early detection of UTIs can effectively prevent disease progression and mitigate additional health complications. Most conventional diagnostic methods rely on periodic urine sample collection and laboratory analysis, which are time-consuming and lack the capacity for continuous, real-time assessment. This SUB platform aims to enhance patient monitoring in ICUs by reducing healthcare provider burden, facilitating early identification of UTI risks, and promoting timely interventions, ultimately reducing antibiotic overuse and addressing the challenge of rising antibiotic-resistant bacterial strains.

Technology Validation:

The embedded sensors and other design elements were optimized using High-Frequency Structure Simulator (HFSS) software to ensure effective wireless readability and sensitivity for practical miniaturization and integration into standard urinary bags. Systematic characterization of the functional coatings confirmed effective compositions that allowed reliable wireless detection of elevated pH (>8) and XOD (>500 U/L) levels in urine, with a response time of less than 3 hours. The sensors maintained stable performance over 14 days under physiologically relevant conditions with high specificity, as verified through tests with both artificial and real urine. As proof of concept, the fully integrated SUB system was tested under simulated patient conditions with varying pH and XOD levels. The platform

Technology ID

2025-RAHI-71064

Category

Digital Health & Medtech/Remote Patient Monitoring & Telehealth
Digital Health & Medtech/Health Informatics

Authors

Sarath Gopalakrishnan
Rahim Rahimi
Muhammad Rana

Further information

Patrick Finnerty
pwfinnerty@prf.org

View online

successfully identified high-risk UTI conditions, enabling timely alerts to healthcare providers for immediate intervention.

Advantages:

-Real-time continuous monitoring of UTI signs

-Enhanced patient monitoring

-Reduced provider workload

-Early identification of UTIs, allowing timely care responses

-Reduced antibiotic overuse

Applications:

-Early detection of catheter-associated urinary tract infections, such as in intensive care unit (ICU) patients and others undergoing prolonged catheterization.

Publications:

M.M. Rana, et al. "Stimulus responsive wireless sensor integrated smart urine bag for early detection of catheter-associated infections." Sensors and Actuators B: Chemical. 426. March 2025. https://doi.org/10.1016/j.snb.2024.136990.

TRL: 4

Intellectual Property:

Provisional-Patent, 2025-04-30, United States

Keywords: Biomedical Engineering, laser processing., smart urine bag, Urinary Tract Infection, urine pH, wireless sensor tag, xanthine oxidase