

INTEGRATED BIOSENSING PLATFORM FOR POINT-OF-CARE CREATININE AND GLUCOSE DETECTION FOR HEALTH MANAGEMENT

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ABSTRACT

Effective detection and monitoring of biomarkers like creatinine and glucose are essential for diagnosing and managing various medical conditions. Creatinine reflects renal function, while glucose indicates metabolic health, and accurate measurement of these biomarkers in blood provides crucial insights for timely interventions and personalized treatment strategies. Traditional laboratory methods for biomarker detection are often labour-intensive and inconvenient for patients. Recent advancements in point-of-care devices and biosensors enable rapid, accurate, and minimally invasive detection directly from small blood volumes. Wearable biosensors allow continuous monitoring, empowering individuals to track their health in real-time. This research explores the latest technologies for creatinine and glucose detection, emphasizing their operational principles, performance, and clinical applications. The integration of these biomarkers into unified systems, coupled with cloud technology, facilitates seamless data transmission and remote monitoring, empowering both individuals and healthcare professionals in managing chronic conditions like diabetes and kidney disease. Through these innovations, the aim is to promote precision medicine and proactive healthcare management for improved patient outcomes.

Index Terms: Biomarkers, Creatinine, Glucose, Biosensors, CKD, GFR.

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INTRODUCTION

In the realm of healthcare, effective detection and monitoring of biomarkers hold pivotal importance in diagnosing and managing various medical conditions. Among these, creatinine and glucose stand out as critical indicators of renal function and metabolic health, respectively. The ability to accurately measure these biomarkers in blood provides invaluable insights into an individual's physiological state, enabling timely interventions and personalized treatment strategies[1]. Creatinine, a metabolic byproduct of muscle metabolism, serves as a reliable marker for renal function assessment. Its concentration in blood reflects the glomerular filtration rate (GFR)[2], making it a cornerstone in diagnosing and monitoring renal diseases such as chronic kidney disease (CKD). On the other hand, glucose, a primary energy source for cells, plays a central role in metabolic processes. Deviations from normal glucose levels are indicative of conditions such as diabetes mellitus[3], necessitating precise monitoring for optimal disease management.

Traditional methods for creatinine and glucose detection of-

ten entail laboratory-based assays, which are time-consuming, labour-intensive, and require specialized equipment. Moreover, frequent blood sampling may pose discomfort and inconvenience to patients, hindering adherence to monitoring protocols[4]. Hence, there arises a pressing need for innovative techniques that offer rapid, accurate, and minimally invasive detection of these biomarkers from blood samples.

In recent years, significant strides have been made in the development of point-of-care (POC) devices and biosensors for creatinine and glucose detection[5]. These technologies leverage principles such as electrochemistry[6], spectroscopy[7], and microfluidics to achieve sensitive and selective detection within minutes[8], directly from small volumes of blood. Additionally, advancements in wearable biosensors enable continuous monitoring of biomarker levels, empowering individuals to track their health status in real-time and make informed lifestyle choices.

This research paper aims to explore the latest advancements in creatinine and glucose detection technologies, highlighting their principles of operation, analytical performance, and potential applications in clinical settings. Furthermore, it seeks to

elucidate the impact of these innovations on disease management paradigms[9], emphasizing the role of personalized monitoring in improving patient outcomes and enhancing healthcare delivery.

By elucidating the current landscape and future prospects of creatinine and glucose detection from blood[10], this research endeavours to contribute to the ongoing dialogue surrounding the advancement of diagnostic tools for proactive health management. Through interdisciplinary collaboration and technological innovation, we strive to pave the way towards a future where precision medicine is accessible to all, fostering a paradigm shift from reactive to preventive healthcare approaches.

SIGNIFICANCE IN MONITORING

A. Significance of Glucose Monitoring

1. *Role of Glucose in Diabetes Management:* Glucose, as the primary fuel for the body, plays a central role in diabetes management[11]. The delicate balance of maintaining optimal blood sugar levels is crucial to prevent complications associated with this prevalent metabolic disorder. Monitoring glucose levels becomes not just a measure of glycaemic control but a strategic approach to mitigate the risks of both hypo- and hyperglycaemia[12]. The real-time insights derived from glucose monitoring serve as a guide for individuals and healthcare practitioners in tailoring interventions and treatment strategies for effective diabetes management

2. *Imperative of Real-Time Glucose Monitoring:* The imperative of real-time glucose monitoring lies in its ability to provide timely and actionable data for individuals managing diabetes[13]. Swift detection of fluctuations in blood sugar levels enables immediate responses, fostering proactive healthcare management. By utilizing technologies that offer continuous and instant glucose measurements, individuals gain not only convenience but a heightened sense of control over their health. Real-time monitoring acts as a vigilant guardian, reducing the likelihood of acute complications and contributing to the overall well-being of those with diabetes.

3. *Adverse Outcomes and Health Implications:* The repercussions of inadequately monitored glucose levels reverberate through various aspects of health. Untreated hyperglycaemia can lead to complications such as cardiovascular disease[14], kidney dysfunction, and nerve damage. Conversely, hypoglycemia poses immediate threats, including seizures and unconsciousness. The health implications extend beyond the physical, impacting mental well-being due to

the constant concern and uncertainty. Real-time glucose monitoring becomes a critical tool in averting these adverse outcomes, offering a proactive shield against the multifaceted health risks associated with imbalances in blood sugar levels.

B. Significance of Creatinine Monitoring

A. *Creatinine as a Key Indicator of Kidney Function:* Creatinine emerges as a vital indicator[15], reflecting the efficiency of kidney function. This byproduct of muscle metabolism is consistently produced and eliminated by the kidneys. Its steady levels in the bloodstream make it a reliable marker, with deviations signalling potential issues with renal health. Understanding creatinine as a key indicator allows for a comprehensive evaluation of kidney function, providing insights into the body's filtration system and aiding in the early detection of potential abnormalities.

2. *Early Detection for Mitigating Kidney Dysfunction:* The significance of creatinine monitoring lies in its role as an early detection tool for mitigating kidney dysfunction. As kidneys gradually lose their efficiency, creatinine levels in the blood may elevate, indicating impaired filtration. Early identification of these changes allows for timely intervention and personalized strategies to address the underlying causes. Creatinine monitoring, therefore, becomes a proactive measure in preventing the progression of kidney dysfunction and minimizing the risk of complications associated with renal impairment.

3. *Health Complications Associated with Elevated Creatinine Levels:* Elevated creatinine levels in the bloodstream are indicative of potential health complications, primarily centered around kidney dysfunction. Diseases such as chronic kidney disease (CKD)[16] and acute kidney injury (AKI) are often linked to increased creatinine levels. Monitoring creatinine becomes crucial in identifying and managing these conditions to prevent further deterioration in kidney function. Additionally, the association between elevated creatinine and cardiovascular issues underscores the systemic impact of kidney dysfunction on overall health. By addressing elevated creatinine levels promptly, healthcare professionals can mitigate the risk of associated health complications and enhance overall patient well-being.

C. Importance of Multi-parameter Monitoring

Multiparameter monitoring is crucial in healthcare as

it allows for the continuous observation of various vital signs and medical parameters in real-time[17], enhancing patient safety and improving healthcare efficiency. These monitors, such as multiparameter monitors, consolidate multiple vital signs like heart rate, blood pressure, oxygen saturation and respiratory rate, providing a comprehensive overview of a patient's condition. By offering real-time data, and timely responses to critical vital sign deviations through intelligent alarm systems. Additionally, multiparameter monitoring enhances patient safety by facilitating early detection of deteriorating conditions, preventing adverse events, and stream- lining workflow for healthcare professionals. Overall, the use of multiparameter monitoring is a cost effective solution that revolutionaries patient care by enabling accurate diagnoses, tailored treatment plans and improved healthcare outcomes.

III. RESULTS AND DISCUSSION

A. Synergistic Integration of Glucose and Creatinine

Advancements in sensor technologies and enzymatic reactions have paved the way for seamlessly integrating glucose and creatinine detection within a singular system[18]. Current research is exploring synergistic approaches that enable simultaneous, rapid, and accurate assessment of these critical biomarkers. The focus lies on optimizing sensor architectures to accommodate the unique characteristics of glucose and creatinine, ensuring minimal interference and maximal precision. The integration of glucose and creatinine detection involves a nuanced approach to sensor technologies. Emerging electrochemical sensors, utilizing advanced materials such as graphene and nanomaterials[19], demonstrate heightened sensitivity and selectivity. Additionally, optical sensors, employing principles like surface plasmon resonance[20], contribute to real-time, label-free detection, enhancing the system's capabilities for multiparameter assessment. Enzymatic reactions play a pivotal role in the unified detection of glucose and creatinine. Ongoing research explores novel enzyme immobilization techniques[21], optimizing reaction kinetics for both biomarkers. The challenge lies in achieving a harmonious balance to facilitate swift measurements while maintaining the required specificity. Recent studies highlight innovative approaches, such as enzyme cascades, to enhance the efficiency of the enzymatic reaction process. A comprehensive comparative analysis elucidates the advantages of integrating glucose and creatinine detection within a single system over existing multiparameter approaches. Current multiparameter systems often face

challenges in balancing the specific requirements of diverse biomarkers. The unified system offers a streamlined approach, reducing complexity while maintaining high accuracy. Comparative studies with other biomarkers, such as cholesterol and lactate, showcase the versatility and adaptability of the unified detection system. The integration of glucose and creatinine detection necessitates sophisticated data processing algorithms for real-time monitoring. Ongoing research focuses on machine learning algorithms that can adapt to dynamic physiological conditions, ensuring accurate interpretation of biomarker levels. The continuous evolution of algorithms contributes to the system's ability to provide actionable insights promptly.

B. Cloud-Infused Innovation in Biomarker Monitoring

The integration of a user-friendly interface and cloud technology into biomarker monitoring systems heralds a new era in healthcare diagnostics, particularly in the context of glucose and creatinine multiparameter detection. With cloud integration, the multiparameter detection system offers seamless data transmission from the monitoring device to a centralized cloud platform. This not only ensures the secure storage of sensitive health data but also facilitates real-time accessibility for both individuals and healthcare professionals. The user-friendly interface enables effortless navigation, empowering users to access their biomarker data with ease. Cloud-infused innovation allows for remote monitoring of glucose and creatinine levels[22], transcending geographical constraints. Individuals with diabetes or kidney concerns can share their real-time biomarker data with healthcare professionals, fostering a collaborative approach to health management. Timely interventions, guided by continuous data insights, become a reality, significantly reducing the risks associated with imbalances in glucose and creatinine levels. The cloud infrastructure incorporates robust security measures, ensuring the confidentiality and integrity of biomarker data. Encryption protocols and authentication mechanisms safeguard sensitive health information, addressing concerns related to data privacy. The user-friendly interface emphasizes transparency in data handling, instilling confidence in individuals and healthcare professionals regarding the security of their health-related information. Cloud-infused innovation not only empowers individuals in managing their health but also enhances the capabilities of healthcare professionals in delivering personalized care. The user-friendly interface of the multiparameter detection system allows individuals to actively engage in self-monitoring. Cloud integration enables the generation of personalized insights, offering a deeper understanding of how lifestyle choices impact biomarker levels.

Empowered with this knowledge, individuals can make informed decisions, leading to better glycaemic control and kidney health. Healthcare professionals, armed with real-time biomarker data accessible through the cloud, can engage in collaborative care. The seamless integration of glucose and creatinine monitoring facilitates a comprehensive view of an individual's health status. This not only aids in early disease detection but also allows for the adjustment of treatment plans based on evolving biomarker trends. The user-friendly interface ensures that healthcare professionals can interpret and act upon the data efficiently. Cloud-infused biomarker monitoring opens avenues for data-driven preventive strategies. By analysing trends in glucose and creatinine levels on a population scale, healthcare professionals can implement targeted interventions and public health campaigns. This proactive approach has the potential to reduce the overall incidence of diabetes and kidney diseases by addressing risk factors at both individual and community levels.

C. Glucose-Creatinine Monitoring System

A glucose creatinine monitoring system is a device used to assess kidney function. A working model of a glucose monitoring system was developed using an ESP32 board, the system developed is calibrated to work with test strips. It measures the glucose concentration in the provided blood sample sufficient in a reasonably small time. After the device is powered ON the test strip with the blood sample onto the connector. The blood sample reacts with the enzymes on the test strip electrodes to produce a voltage that is conditioned and amplified to the appropriate levels so that it can be processed by the ESP32. Once the calculations are done, the results are displayed on an OLED module. This module has a clear display without needing extra backlighting, making it easy for users to read their glucose levels quickly and accurately.

At the same time, the processed data is stored securely in a Firebase database. This ensures that users can access their historical glucose readings whenever they need them. It also allows for easy synchronization across different devices, making it convenient for users to keep track of their health data. Additionally, the stored data is accessible through a dedicated website interface. This interface serves as a centralized platform for users and healthcare professionals to monitor and analyse glucose trends over time. By utilizing the internet, the glucometer extends its reach, promoting collaboration and proactive health management. For

non-diabetic adults, blood glucose levels typically fall within the range of 70 to 100 milligrams per deciliter (mg/dL) before meals and rise slightly, usually staying below 140 mg/dL, one to two hours after a meal. In our testing, we observed that the glucose readings for non-diabetic adults consistently fell within these expected ranges both before and after meals.

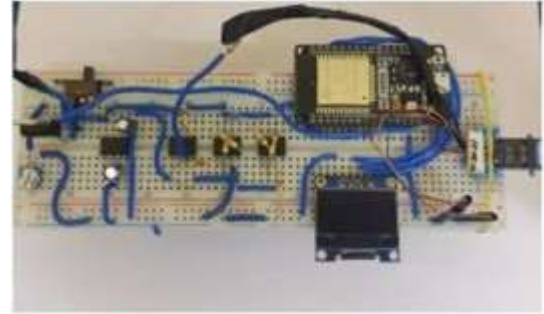


Figure 1. Circuit developed in breadboard.



Figure 2. Readings taken before a meal and 1–2 hours after a meal.

CONCLUSION

The research emphasizes how new technologies for monitoring biomarkers like glucose and creatinine are making healthcare more effective. These innovations, such as portable testing devices and systems that use cloud technology, provide quick and accurate ways to track important health indicators. This helps doctors and patients take proactive steps to manage conditions like diabetes and kidney disease. Overall, these advancements are shaping a future where personalised healthcare is more accessible and leads to better outcomes for everyone.

REFERENCES

- [1] Smith J, Brown A, et al." Clinical Use of Biomarkers for Renal Function and Metabolic Health." *Journal of Nephrology*.2021; 15(2): 123-135.

- [2] Sandrine Lemoine, Anne-Cécile Rouveure, Laurence Dubourg, Solenne Pelletier, Christelle Marolho, Evelyne Decullier, Maurice Laville." Point of care creatinine derived eGFR measurement in capillary blood for identifying patients at risk." *Practical Laboratory Medicine*, 2022.
- [3] Chong Ning, Yuhan Jiao, Jiaqi Wang, Weiwei Li, Jingqiu Zhou, Yi-Chieh Lee, Dik-Lung Ma, Chung-Hang Leung, Ru-gang Zhu, Hui-Min David Wang." Recent advances in the managements of type 2 diabetes mellitus and natural hypo- glycemc substances", *Food Science and Human Wellness*, Volume 11, Issue 5, 2022.
- [4] Hugh Davies, Linda L. Coventry, Alycia Jacob, Lau- rita Stoneman, Elisabeth Jacob,"Blood sampling through pe- ripheral intravenous cannulas: A look at current practice in Australia", *Collegian*, Volume 27, Issue 2, 2020.
- [5] Radhika Babasaheb Jadhav, Tejaswini Patil, Arpita Pandey Tiwari," Trends in sensing of creatinine by elec- trochemical and optical biosensors", *Applied Surface Science Advances*, Volume 19, 2024.
- [6] Alex Lukmanto Suherman, Ziwen Zhao, Alina Sekretareva," From protein film to single-entity protein elec- trochemistry", *Current Opinion in electrochemistry*, 2024.
- [7] Daa Atta, Ahmed Refaat, Adel Ashery, Medhat Ibrahim," Graphene oxide: Synthesis and laser spectroscopy approach", *Optical Materials: X*, Volume 22, 2024.
- [8] Xin Fu, Mei Yang, He Zhang, Qing Wang, Yu Fu, Qiong Liu," Microfluidic bead-based biosensor: Ultrasensitive ctDNA detection based on duplex-functional split-DNAzyme and dendritic enzyme-free signal amplification", *Analytical Biochemistry*, Volume 687, 2024.
- [9] William E. Boden, Mario Marzilli, Filippo Crea, G.B. John Mancini, William S. Weintraub, Viviany R. Taqueti, Carl J. Pepine, Javier Escaned, Rasha Al-Lamee, Luis Henrique W. Gowdak, Colin Berry, Juan Carlos Kaski," Evolving Manage- ment Paradigm for Stable Ischemic Heart Disease Patients: JACC Review Topic of the Week", *Journal of the American College of Cardiology*, Volume 81, Issue 5, 2023.
- [10] Yiquan Liu, Yaping Dong, Miao Hui, Lingyi Xu, Le Ye, Jicheng Lv, Li Yang, Yue Cui," A biosensing array for multiplex clinical evaluation of glucose, creatinine, and uric acid", *Biosensors and Bioelectronics*, Volume 241, 2023.
- [11] Catherine S. Forster, "50 Years Ago in The Journal of Pediatrics: A Study of Blood Glucose and Ketone Bodies and Plasma Free Fatty Acids, Cholesterol, Phospholipids, and Total Lipids in Juvenile Diabetes", *The Journal of Pediatrics*, Volume 166, Issue 2, 2015.
- [12] Alexandra Dumitriu, Ann Lucas, Raffaella Colzani," Real-world evidence study finds no new-onset diabetes or drug-related hyperglycemia in Pompe disease patients treated with avaglucosidase alfa", *Molecular Genetics and Metabolism Reports*, Volume 38, 2024.
- [13] A. Gutie´rrez-Pastor, JA Quesada, MM Soler-Mart´inez, Carratala´ Munuera, FJ Pomares-Go´mez," E ffect of switch from flash glucose monitoring to flash glucose monitoring with real-time alarms on hypoglycaemia in people with type 1 diabetes mellitus", *Primary Care Diabetes*, 2024.
- [14] Lily D. Yan, Rodney Sufrá, Reichling St Sauveur, Marie Christine Jean-Pierre, Alexandra Apollon, Rodolphe Malebranche, Michel The´ard, Gerard Pierre, Jessy De´vieux, Jennifer Lau, Nour Mourra, Nicholas L.S. Roberts, Rehana Rasul, Denis Nash, Altaf M. Pirmohamed, Richard B. Dev- ereux, Myung Hee Lee, Gene F. Kwan, Monika M. Safford, Laure´ Adrien, Jean Patrick Alfred, Marie Deschamps, Patrice Severe, Daniel W. Fitzgerald, Jean W. Pape, Vanessa Rouzier, Margaret L. McNairy, Lily D. Yan, Rodney Sufrá, Reichling St Sauveur, Marie Christine Jean-Pierre, Jean Lookens Pierre, Alexandra Apollon, Rodolphe Malebranche, Michel The´ard, Gerard Pierre, Jessy De´vieux, Jennifer Lau, Nour Mourra, Miranda Metz, Caleigh Smith, Shalom Sabwa, Adrienne Cler- mont, Nicholas L.S. Roberts, Rehana Rasul, Denis Nash, Altaf M. Pirmohamed, Richard B. Devereux, Myung Hee Lee, Gene Kwan, Monika Safford, Laure´ Adrien, Jean Patrick Alfred, Marie Deschamps, Patrice Severe, Daniel W. Fitzgerald, Jean W. Pape, Vanessa Rouzier, Margaret L. McNairy,"Spectrum of prevalent cardiovascular diseases in urban Port- au-Prince, Haiti: a population-based cross-sectional study", *The Lancet Regional Health - Americas*, Volume 33, 2024.

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- [15] Florian Buchkremer, Stephan Seeger, "Body Surface Area, Creatinine Excretion Rate, and Total Body Water: Reference Data for Adults in the United States", *Kidney Medicine*, Volume 3, Issue 2, 2021.
- [16] Cheol Ho Park, Hyung Woo Kim, Young Su Joo, Jung Tak Park, Tae Ik Chang, Tae-Hyun Yoo, Sue Kyung Park, Yeong Hoon Kim, Suah Sung, Young Youl Hyun, Kook-Hwan Oh, Shin-Wook Kang, Seung Hyeok Han, "Findings from the KNOW-CKD Study indicate that higher systolic blood pressure time in target range is associated with a lower risk of chronic kidney disease progression", *Kidney International*, Volume 105, Issue 4, 2024.
- [17] Andrea Zito, Attilio Restivo, Giuseppe Ciliberti, Renzo Laborante, Giuseppe Princi, Giulio Francesco Romiti, Mattia Galli, Daniele Rodolico, Emiliano Bianchini, Luigi Cappanoli, Marika D'Oria, Carlo Trani, Francesco Burzotta, Alfredo Cesario, Gianluigi Savarese, Filippo Crea, Domenico D'Amario, "Heart failure management guided by remote multiparameter monitoring: A meta-analysis", *International Journal of Cardiology*, Volume 388, 2023.
- [18] Shivam Mishra, Ghada A. Khouqeer, B. Aamna, Abdullh Alodhayb, S. Jafar Ali Ibrahim, Manish Hooda, Gaurav Jayaswal, "A review: Recent advancements in sensor technology for non-invasive neonatal health monitoring", *Biosensors and Bioelectronics: X*, Volume 14, 2023.
- [19] Olga Wojciechowska, Adele Costabile, Małgorzata Kujawska, "The gut microbiome meets nanomaterials: exposure and interplay with graphene nanoparticles", *Nanoscale Advances*, Volume 5, Issue 23, 2023.
- [20] Jing Xie, Xian-Deng Li, Mi Li, Hong-Yan Zhu, Yan Cao, Jian Zhang, A-Jing Xu, "Advances in surface plasmon resonance for analyzing active components in traditional Chinese medicine", *Journal of Pharmaceutical Analysis*, 2024.
- [21] Hiroshi Yamaguchi, Masaya Miyazaki, "Enzyme-immobilized microfluidic devices for biomolecule detection", *TrAC Trends in Analytical Chemistry*, Volume 159, 2023.
- [22] Lavanika Roy, Pronamika Buragohain, Vivek Borse, "Strategies for sensitivity enhancement of point-of-care devices", *Biosensors and Bioelectronics: X*, Volume 10, 2022.