

The Role of Computer Technology in Monitoring and Analysis of Hemodialysis Patient Data: A Review

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Keywords	ABSTRACT:
Hemodialysis, computer technology, monitoring and management and patient data	Hemodialysis is an essential treatment for patients suffering from chronic kidney disease (CKD), particularly those at end-stage renal disease (ESRD). The effective management of these patients requires precise monitoring and thorough analysis of critical clinical parameters, including blood pressure, fluid balance, and biochemical markers. Recent advancements in computer technology have transformed the landscape of hemodialysis care by enabling real-time data acquisition, advanced analytics, and personalized treatment strategies. This review explores the integration of computer systems in the monitoring and management of hemodialysis patient data. Modern hemodialysis machines equipped with sensors and software collect vital metrics, which are seamlessly integrated into electronic health records (EHRs). These systems ensure a comprehensive view of patient health, allowing healthcare providers to make informed decisions. Artificial intelligence (AI) and machine learning (ML) algorithms further enhance the analysis of patient data by predicting complications, optimizing dialysis prescriptions, and identifying trends for better clinical decision-making. Additionally, telemedicine and remote monitoring technologies have expanded access to care by enabling home-based dialysis under professional supervision. Internet of Things (IoT) devices facilitate continuous data transmission, ensuring patient safety and timely interventions. Despite these advancements, challenges such as data security, interoperability, and the need for specialized training persist. The adoption of computer technology in hemodialysis care not only improves clinical outcomes but also streamlines workflows and enhances patient empowerment. This review highlights the transformative potential of digital innovations in advancing hemodialysis management while addressing current challenges and future directions.

Background

Chronic kidney disease (CKD) is a significant global health issue that affects millions of individuals, often leading to end-stage renal disease (ESRD) in severe cases (Trillini et al., 2017; Yang et al., 2020). Hemodialysis, a primary treatment for ESRD, involves a dialysis machine that removes waste products, toxins, and excess fluids from the blood, essentially performing the filtration role of malfunctioning kidneys (Ye et al., 2020; Obi et al., 2024). However, managing hemodialysis patients is complex due to the need for constant monitoring of critical clinical

parameters, including blood pressure, fluid balance, and key biochemical markers (Flythe et al., 2020). Effective management of these parameters is vital for preventing complications and ensuring the overall health of patients undergoing this life-saving treatment (Amir et al., 2025). The integration of computer technology into hemodialysis care has revolutionized how patient data is monitored and analyzed (Mahdavi et al., 2025). Computerized systems enable the real-time acquisition of data during dialysis sessions, providing immediate insights into a patient's condition (Courtney et al., 2025). Predictive analytics and artificial intelligence (AI) tools process this data to identify potential complications, optimize treatment plans, and personalize care based on individual patient needs (Chaparala et al., 2025). By streamlining data management and facilitating early interventions, computer technology has become indispensable in improving patient outcomes and enhancing the efficiency of hemodialysis care delivery.

Role of Computer Technology in Hemodialysis Monitoring

Data Collection and Integration

Modern hemodialysis machines are equipped with advanced sensors and software designed to monitor and record critical patient data during dialysis sessions (Pawuś et al., 2024). Key parameters collected include blood pressure, heart rate, blood flow rates, and ultrafiltration volume (Ramírez-Guerrero et al., 2024). These metrics provide vital insights into a patient's real-time physiological state and the effectiveness of the dialysis process (Canaud et al., 2024). By continuously capturing this data, these systems ensure that potential complications can be identified and addressed promptly (Khatriwada et al., 2024). In addition, the integration of this data into electronic health records (EHRs) plays a pivotal role in enhancing patient care (Igawama et al., 2024). By consolidating information into a single platform, healthcare providers gain a comprehensive view of the patient's status and treatment history (Ştefan et al., 2024). This seamless integration supports better decision-making, allows for trend analysis over time, and facilitates personalized treatment plans tailored to the unique needs of each patient.

Real-Time Monitoring and Alerts

Computerized systems play a critical role in enhancing the safety and effectiveness of hemodialysis sessions through real-time monitoring capabilities (Biswas, 2024; Laurier et al., 2025). These systems continuously collect and analyze patient data during the procedure, such as blood pressure, heart rate, and blood flow (Leth-Olsen et al., 2024; Kumar et al., 2025). Advanced algorithms process this data to identify any abnormalities, such as drops in blood pressure (hypotension) or signs of clotting in the dialysis circuit (Tovey, 2024; Savale et al., 2024). When irregularities are detected, these systems generate immediate alerts to notify clinicians, enabling them to take swift and appropriate action (Pervez et al., 2024). This proactive approach significantly reduces the risk of complications, ensuring that patients receive prompt interventions when needed (Paneru et al., 2024). By improving response times and minimizing delays in addressing critical issues, real-time monitoring systems enhance overall patient safety and contribute to better clinical outcomes in hemodialysis care.

Telemedicine and Remote Monitoring

Telemedicine has revolutionized hemodialysis care by enabling patients to undergo treatment in the comfort of their homes while remaining under the supervision of healthcare professionals (Santosh et al., 2024). These platforms utilize advanced communication technologies to bridge the gap between patients and clinicians, ensuring that care is accessible even for those in remote or underserved areas (Ngwa et al., 2020; George and George, 2023; Holtz et al., 2024). Home-based hemodialysis not only improves convenience and quality of life for patients but also reduces the burden on healthcare facilities (Pungchompoo et al., 2024). Key to this approach is the use of Internet of Things (IoT) devices, which monitor real-time parameters such as blood pressure, fluid levels, and machine performance during dialysis sessions (Liu et al., 2024). These devices transmit data to centralized platforms, where healthcare teams can remotely monitor and evaluate patient

status (Abughazalah et al., 2024). Alerts for any abnormalities allow for timely interventions, ensuring patient safety and continuity of care. Telemedicine and remote monitoring thus represent a significant advancement in delivering personalized and accessible hemodialysis care.

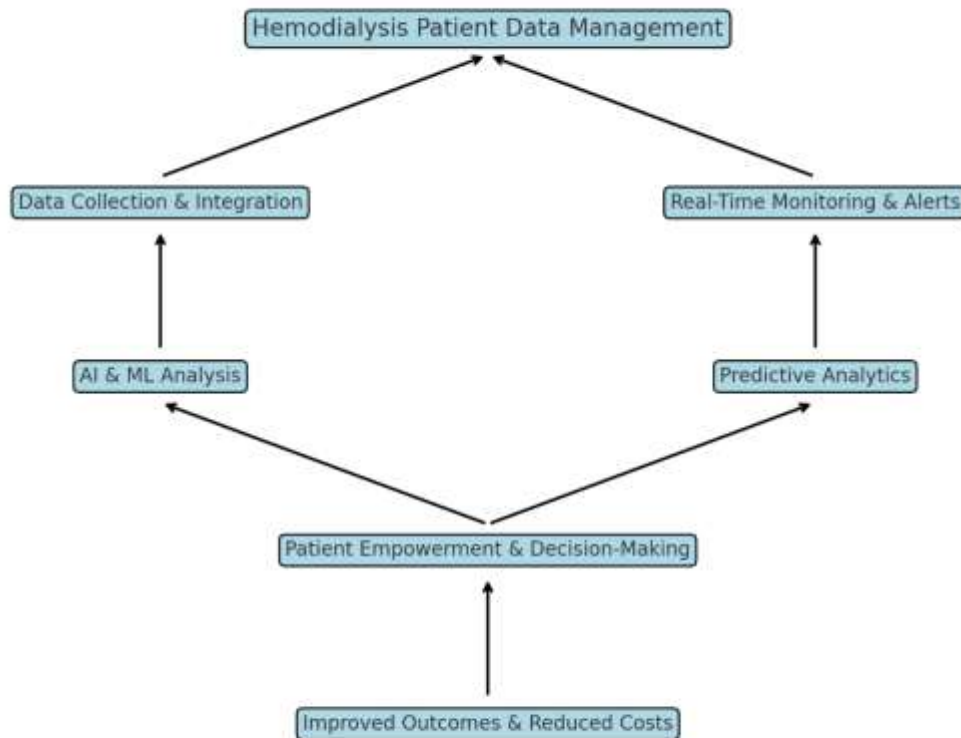


Figure 1: Flowchart representing the management of hemodialysis patient data using computer technology

Advanced Data Analysis Techniques

Artificial Intelligence and Machine Learning

Artificial Intelligence (AI) and Machine Learning (ML) have significantly transformed the management and analysis of hemodialysis patient data (Eskandar, 2024; Aljaafari et al., 2024). One critical application is predicting complications such as intradialytic hypotension, a common and potentially serious event during dialysis (Alqahtani et al., 2024). ML algorithms can detect subtle patterns that precede these events by analyzing real-time data, such as blood pressure, heart rate, and fluid removal rates, enabling early interventions to improve patient safety (Stamate et al., 2024). Similarly, AI-driven models are increasingly being used to customize dialysis prescriptions. Considering an individual's unique physiological responses and historical treatment outcomes, these systems can optimize parameters like fluid removal rates and session durations, ensuring better efficacy and fewer adverse effects (Singh et al., 2025). Another remarkable benefit of AI and ML in hemodialysis is their ability to process and derive insights from large datasets, which are challenging to analyze manually (Lopes et al., 2025). These technologies can identify complex relationships between variables, uncover trends in patient health over time, and highlight areas for clinical improvement (Al-Dmour et al., 2025). By integrating these findings into decision-making processes, clinicians can provide more precise and personalized care, improving overall patient outcomes. As these tools evolve, their integration into hemodialysis care promises more efficient workflows and enhanced patient safety.

Predictive Analytics

Predictive analytics tools leverage historical and real-time data to foresee potential adverse events, significantly improving patient care in hemodialysis (Laurier et al., 2025). By analyzing trends in metrics like blood flow rates, venous pressure, and vascular access usage patterns, these tools can accurately predict the likelihood of complications such as vascular access failure (Roşu et al., 2025). Early identification of these risks allows clinicians to implement preemptive interventions, such as timely imaging, adjustments to dialysis protocols, or vascular surgery, reducing downtime and avoiding more severe complications (Kazi and Mahant, 2025; Anitha et al., 2025). This proactive approach enhances patient outcomes and optimizes resource allocation within healthcare settings. By addressing issues before they become critical, predictive analytics minimizes disruptions in treatment and improves the longevity of vascular access. These advancements demonstrate the potential of data-driven strategies to transform the landscape of hemodialysis care, moving from reactive to preventive healthcare (Figure 2).

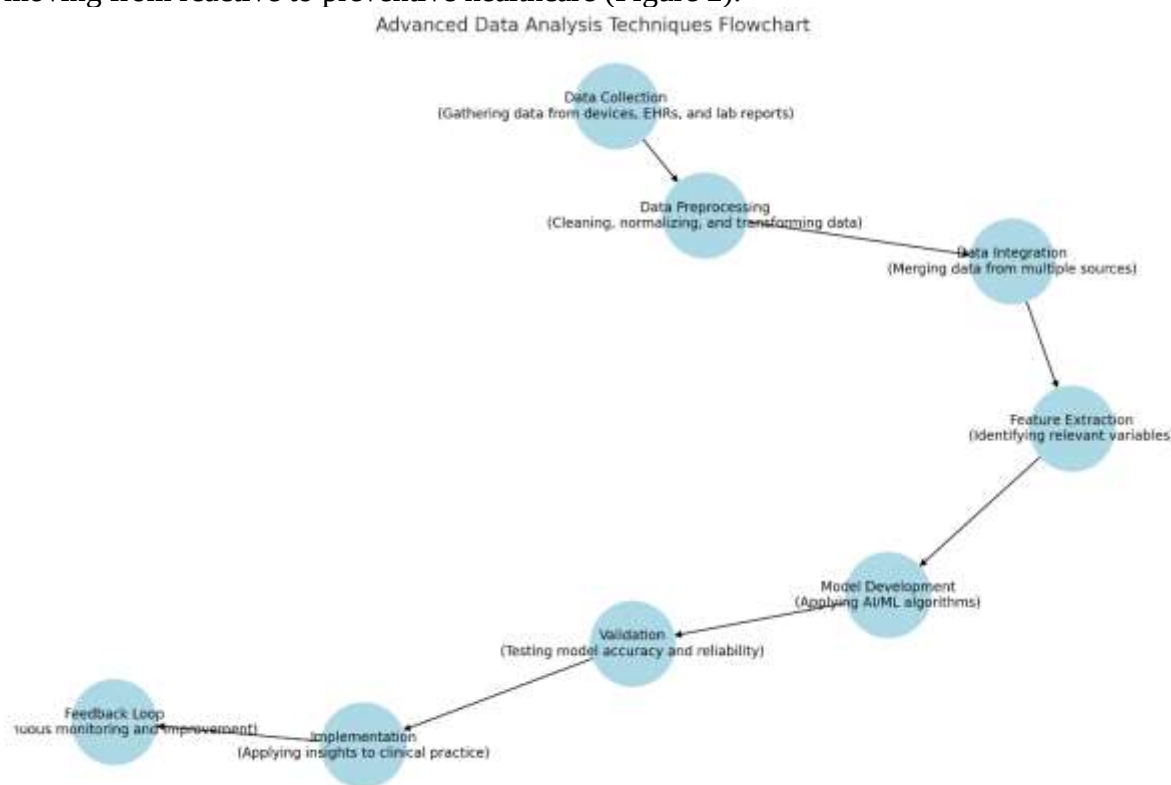


Figure 2: Flowchart depicting the advanced data analysis techniques for hemodialysis care. Each step, from data collection to the feedback loop, represents a critical stage in processing and utilizing patient data effectively.

Big Data Analytics

The immense volume of data generated during hemodialysis sessions, including parameters like fluid removal rates, blood pressure, and biochemical markers, demands robust analytical tools for effective utilization (Abdelhameed and El-Shahat, 2025). Big data platforms play a pivotal role in processing and analyzing this information, enabling healthcare providers to uncover trends and correlations that might otherwise go unnoticed (Zhang, 2025). For example, these tools can reveal patterns linking treatment parameters to patient outcomes, guiding adjustments to dialysis protocols for enhanced safety and effectiveness (Mahdavi et al., 2025). Beyond improving individual patient care, the insights derived from big data analytics contribute significantly to research efforts (Chowdhury, 2024). By integrating and analyzing data from diverse patient populations, these platforms help identify risk factors, validate clinical guidelines, and drive the

development of innovative therapies (Marques et al., 2024). As a result, big data analytics not only supports personalized medicine but also advances the broader understanding of hemodialysis, paving the way for continual improvements in patient outcomes and healthcare efficiency (Table 1).

Table 1. Examples of Software in Hemodialysis Management

Software Name	Functionality	Key Features
Epic Systems	Comprehensive EHR system for integrating patient data.	Customizable dashboards, interoperability, and robust data analytics.
Fresenius Medical Care eCube	Dialysis management software for tracking clinical and operational data.	Real-time reporting, patient management, and regulatory compliance tools.
Baxter RenalSoft	Software for monitoring dialysis sessions and managing patient data.	Data visualization, treatment tracking, and reporting tools.
Nexadia	Remote patient monitoring system for home hemodialysis.	IoT integration, alert systems, and telehealth support.
Dialis	Cloud-based dialysis management solution.	Easy-to-use interface, real-time data access, and patient records.
Meditech	EHR system with modules for nephrology and dialysis care.	Interoperability, reporting, and patient engagement features

Benefits of Computer Technology

Improved Patient Outcomes: The integration of advanced analytics and AI-driven tools in hemodialysis facilitates the timely detection of complications, such as intradialytic hypotension or vascular access failure. This proactive approach not only minimizes the risk of adverse events but also significantly reduces mortality and morbidity rates, ensuring better overall patient health and quality of life (Pawuś et al., 2024; Tognola et al., 2025). **Enhanced Efficiency:** Automation of routine tasks, such as data collection, analysis, and monitoring, allows healthcare providers to focus their efforts on critical decision-making and personalized patient care (Prabhod, 2024; Li et al., 2024). This improved workflow efficiency streamlines operations, reduces errors, and enhances the overall effectiveness of clinical teams.

Cost Reduction: Early detection of complications and optimization of treatment plans minimize the need for hospitalizations, emergency interventions, and costly procedures (Nwosu, 2024). By preventing adverse events and improving resource allocation, healthcare systems can achieve substantial cost savings while maintaining high standards of care (Nwosu et al., 2024). **Patient Empowerment:** The availability of patient-facing applications and tools empowers individuals by providing real-time insights into their treatment progress, lab results, and overall health status (Sargsyan and Muradyan, 2024). These platforms encourage adherence to treatment protocols and foster active participation in care, promoting a sense of ownership and collaboration in managing their health (table 2).

Table 2. Current Applications of Computer Technology in Hemodialysis

Application	Description	Benefits
Electronic Health Records	Integration of patient data from hemodialysis sessions into EHR systems.	Provides a comprehensive view of patient history for better decisions.
AI-Powered Diagnostics	Use of AI to predict complications such as hypotension or vascular failure.	Enables timely interventions and reduces risks during dialysis.
Telemedicine Platforms	Remote monitoring of patients undergoing home-based hemodialysis.	Ensures continuous care and improves accessibility for remote patients.
IoT Devices	Devices that monitor real-time parameters such as blood flow and pressure.	Facilitates proactive management and alerts for abnormal conditions.
Big Data Analytics	Analysis of large datasets from multiple patients for research and trends.	Enhances understanding of CKD and informs evidence-based practices.
Mobile Applications	Patient apps for tracking dialysis schedules, metrics, and education.	Encourages patient engagement and adherence to treatment plans.

Preventing Corruption in Patient Records

Data Security and Integrity in Healthcare: Maintaining the integrity of patient records is critical for ensuring trust and compliance in healthcare (Risawati, 2024). Advanced technologies such as encryption, multi-factor authentication, and blockchain play a vital role in safeguarding patient data from unauthorized access and tampering (Tyagi and Seranmadevi, 2024). Encryption ensures that sensitive information remains unreadable to unauthorized individuals, while multi-factor authentication adds an extra layer of security beyond passwords. Blockchain technology, with its immutable ledger, further enhances data integrity by providing a transparent and tamper-proof method for storing and accessing patient records (Karthikeyan et al., 2025). Ensuring Accountability and Compliance: Transparent data management practices are essential to uphold the security and reliability of healthcare systems (Tariq, 2024). Implementing audit trails that log every access and modification to patient records fosters accountability, enabling organizations to trace actions and identify potential misuse (Ullah et al., 2024). Regular system audits are equally important, allowing healthcare organizations to detect vulnerabilities, address security gaps, and ensure compliance with data protection regulations (Bala et al., 2024). Additionally, fostering a culture of data security through training and awareness programs for healthcare professionals helps reduce human errors and unethical practices, ultimately strengthening the overall protection of patient data.

Challenges in Technology Integration

While computer technology offers transformative benefits in hemodialysis, its integration into clinical practice is not without challenges (Canaud and Davenport, 2024). Data security remains a pressing concern, as the sensitive nature of patient records requires robust measures to prevent breaches and unauthorized access (Wijayanti et al., 2024). Another major hurdle is interoperability, as seamless data exchange between diverse systems and devices is essential for efficient workflows but is often hampered by incompatible standards and protocols (Carlos et al., 2024). Additionally, training healthcare providers to utilize these advanced technologies effectively can be resource-intensive and requires ongoing education to keep pace with technological advancements.

Future Directions

To overcome these challenges, future research and innovation should prioritize several key areas. AI algorithm development must focus on inclusivity, ensuring that predictive models are tailored to account for the diversity in patient populations, including age, ethnicity, and comorbidities. Efforts to enhance interoperability will be crucial, with a focus on standardizing data formats and improving communication between healthcare systems and devices. Furthermore, addressing

ethical concerns related to data usage, patient consent, and the transparency of AI-driven decisions is imperative for maintaining trust in these technologies. Finally, strengthening measures to prevent data corruption through advanced security protocols, blockchain technology, and comprehensive audit systems will ensure the integrity and reliability of patient records.

Conclusion

The integration of computer technology into hemodialysis care has revolutionized the monitoring and analysis of patient data, resulting in improved clinical outcomes and streamlined operations. These advancements empower healthcare providers to deliver more precise, personalized, and efficient care while addressing the unique needs of each patient. As technological innovations continue to progress, their role in hemodialysis will become increasingly indispensable, offering solutions that are both predictive and preventive. Future developments in AI, big data analytics, and telemedicine are poised to further transform the landscape of hemodialysis care. These advancements will not only enhance patient outcomes but also ensure the security and integrity of sensitive health information. By embracing these technologies, the field of hemodialysis will continue to evolve, fostering a more connected, efficient, and patient-centered approach to healthcare.

Author Contributions

Abdillaeva Nazira design the study, collect the data and wrote the manuscript. Shafee Ur Rehman, Ruslan Isaev, Kudaibergen Osmonaliev, and Burul Shambetova edit and improved the final Version.

Conflicts of Interest

The Authors declare that they have No conflict of Interest

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References

- Abdelhameed RM, El-Shahat M. Fabrication of polyacrylonitrile based metal-organic frameworks membranes with super adsorption performance for potential kidney dialysis. *Journal of Molecular Structure*. 2025 Feb 5;1321:139849.
- Abughazalah M, Alsaggaf W, Saifuddin S, Sarhan S. Centralized vs. Decentralized Cloud Computing in Healthcare. *Applied Sciences*. 2024 Sep 3;14(17):7765.
- Al-Dmour R, Al-Dmour H, Basheer Amin E, Al-Dmour A. Impact of AI and big data analytics on healthcare outcomes: An empirical study in Jordanian healthcare institutions. *Digital Health*. 2025 Jan;11:20552076241311051.
- Aljaafari M, Shorouk E, Hany AA, Sorour SE. Integrating Innovation in Healthcare: The Evolution of "CURA's" AI-Driven Virtual Wards for Enhanced Diabetes and Kidney Disease Monitoring. *IEEE Access*. 2024 Aug 28.
- Alqahtani S, Luo S, Alanazi M, Shaukat K, Alsubaie MG, Amer M. Machine Learning for Predicting Intradialytic Hypotension: A Survey Review. *International Journal of Advanced Computer Science & Applications*. 2024 Oct 1;15(10).
- Amir KF, Asyari A, Harun H. Clinical and Demographic Profile of Chronic Kidney Disease Patients Undergoing Kidney Transplantation at a Tertiary Hospital in Indonesia. *Bioscientia Medicina: Journal of Biomedicine and Translational Research*. 2025 Jan 21;9(4):6897-910.
- Anitha V, Reddy CK, Sumalakshmi C, Doss S. Healthcare 6.0 detecting sleeping disorders through intelligent systems. In *Artificial Intelligence for Blockchain and Cybersecurity Powered IoT Applications* 2025 Jan 16 (pp. 245-267). CRC Press.
- Bala I, Pindoo I, Mijwil MM, Abotaleb M, Yundong W. Ensuring security and privacy in Healthcare Systems: a Review Exploring challenges, solutions, Future trends, and the practical applications of Artificial Intelligence. *Jordan Medical Journal*. 2024 Jul 15;58(3).

- Biswas, R., 2024. Innovative Strategies for Remote Patient Management in Peritoneal Dialysis: The Role of Artificial Intelligence.
- Canaud B, Davenport A, Leray-Moragues H, Morena-Carrere M, Cristol JP, Kooman J, Kotanko P. Digital Health Support: Current Status and Future Development for Enhancing Dialysis Patient Care and Empowering Patients. *Toxins*. 2024 Apr 30;16(5):211.
- Carlos Ferreira J, Elvas LB, Correia R, Mascarenhas M. Enhancing EHR Interoperability and Security through Distributed Ledger Technology: A Review. *InHealthcare* 2024 Oct 2 (Vol. 12, No. 19, p. 1967). MDPI.
- Chaparala SP, Pathak KD, Dugyala RR, Thomas J, Varakala SP, Pathak K. Leveraging Artificial Intelligence to Predict and Manage Complications in Patients With Multimorbidity: A Literature Review. *Cureus*. 2025 Jan 21;17(1).
- Chowdhury RH. Big data analytics in the field of multifaceted analyses: A study on “health care management”. *World Journal of Advanced Research and Reviews*. 2024;22(3):2165-72.
- Courtney M, Thompson S, Klarenbach S, Ye F, Zaidi D, Smith TJ, Bello AK. Virtual consultation in kidney care: a mixed-methods study on a model for safe and effective integration into routine clinical care. *BMJ Open*. 2025 Jan 1;15(1):e081651.
- Eskandar K. Artificial intelligence in nephrology: revolutionizing diagnosis, treatment, and patient care. *KIDNEYS*. 2024 Sep 20;13(3):213-9.
- Flythe JE, Chang TI, Gallagher MP, Lindley E, Madero M, Sarafidis PA, Unruh ML, Wang AY, Weiner DE, Cheung M, Jadoul M. Blood pressure and volume management in dialysis: conclusions from a Kidney Disease: Improving Global Outcomes (KDIGO) Controversies Conference. *Kidney international*. 2020 May 1;97(5):861-76.
- George AS, George AH. Telemedicine: A New Way to Provide Healthcare. *Partners Universal International Innovation Journal*. 2023 Jun 25;1(3):98-129.
- Holtz BE, Urban FA, Oesterle J, Blake R, Henry A. The promise of remote patient monitoring. *Telemedicine and e-Health*. 2024 Dec 1;30(12):2776-81.
- Igwama GT, Olaboye JA, Maha CC, Ajegbile MD, Abdul S. Integrating electronic health records systems across borders: Technical challenges and policy solutions. *International Medical Science Research Journal*. 2024;4(7):788-96.
- Karthikeyan V, Kirubakaran G, Gopalakrishnan K, Raj SS. Creative Strategies to Protect Patients’ Health Records and Confidentiality Using Blockchain Technology. *Blockchain-Enabled Solutions for the Pharmaceutical Industry*. 2025 Jan 8:275-318.
- Kazi KS, Mahant MA. Machine Learning-Driven Internet of Things (MLIoT)-Based Healthcare Monitoring System. In *Digitalization and the Transformation of the Healthcare Sector 2025* (pp. 205-236). IGI Global Scientific Publishing.
- Khatriwada P, Yang B, Lin JC, Blobel B. Patient-Generated Health Data (PGHD): Understanding, Requirements, Challenges, and Existing Techniques for Data Security and Privacy. *Journal of Personalized Medicine*. 2024 Mar 3;14(3):282.
- Kumar R, Kumar V, Rich C, Lemmerhirt D, Balendra, Fowlkes JB, Sahani AK. Machine learning models based on FEM simulation of hoop mode vibrations to enable ultrasonic cuffless measurement of blood pressure. *Medical & Biological Engineering & Computing*. 2025 Jan 6:1-4.
- Laurier N, Robert JT, Tom A, McKinnon J, Filteau N, Horowitz L, Vasilevsky M, Weber C, Podymow T, Cybulsky AV, Suri RS. Optimizing use of an electronic medical record system for quality improvement initiatives in hemodialysis: Review of a single center experience. *Hemodialysis International*. 2025.
- Leth-Olsen M, Døhlen G, Torp H, Nyrnes SA. Cerebral blood flow dynamics during cardiac surgery in infants. *Pediatric Research*. 2024 Apr 3:1-9.
- Li YH, Li YL, Wei MY, Li GY. Innovation and challenges of artificial intelligence technology in personalized healthcare. *Scientific reports*. 2024 Aug 16;14(1):18994.

- Liu CL, Lee MH, Hsueh SN, Chung CC, Lin CJ, Chang PH, Luo AC, Weng HC, Lee YH, Dai MJ, Tsai MJ. A bagging approach for improved predictive accuracy of intradialytic hypotension during hemodialysis treatment. *Computers in Biology and Medicine*. 2024 Apr 1;172:108244.
- Lopes MB, Coletti R, Duranton F, Glorieux G, Jaimes Campos MA, Klein J, Ley M, Perco P, Sampri A, Tur-Sinai A. The Omics-Driven Machine Learning Path to Cost-Effective Precision Medicine in Chronic Kidney Disease. *Proteomics*. 2025 Jan 10:e202400108.
- Mahdavi S, Anthony NM, Sikaneta T, Tam PY. Perspective: Multi-omics and Artificial Intelligence for Personalized Nutritional Management of Diabetes in Patients Undergoing Peritoneal Dialysis. *Advances in Nutrition*. 2025 Jan 20:100378.
- Marques L, Costa B, Pereira M, Silva A, Santos J, Saldanha L, Silva I, Magalhães P, Schmidt S, Vale N. Advancing precision medicine: A review of innovative In Silico approaches for drug development, clinical pharmacology and personalized healthcare. *Pharmaceutics*. 2024 Feb 27;16(3):332.
- Ngwa W, Olver I, Schmeler KM. The use of health-related technology to reduce the gap between developed and undeveloped regions around the globe. *American Society of Clinical Oncology Educational Book*. 2020 Mar 31;40:227-36.
- Nwosu NT, Babatunde SO, Ijomah T. Enhancing customer experience and market penetration through advanced data analytics in the health industry. *World Journal of Advanced Research and Reviews*. 2024;22(3):1157-70.
- Nwosu NT. Reducing operational costs in healthcare through advanced BI tools and data integration. *World Journal of Advanced Research and Reviews*. 2024 Jun;22(3):1144-56.
- Obi Y, Raimann JG, Kalantar-Zadeh K, Murea M. Residual Kidney Function in Hemodialysis: Its Importance and Contribution to Improved Patient Outcomes. *Toxins*. 2024 Jun 28;16(7):298.
- Paneru B, Paneru B, Sapkota SC, Poudyal R. Enhancing healthcare with AI: Sustainable AI and IoT-Powered ecosystem for patient aid and interpretability analysis using SHAP. *Measurement: Sensors*. 2024 Dec 1;36:101305.
- Pawuś D, Porażko T, Paszkiel S. Automation and decision support in the area of nephrology using numerical algorithms, artificial intelligence and expert approach-review of the current state of knowledge. *IEEE Access*. 2024 Jun 12.
- Pervez F, Shoukat M, Suresh V, Farooq MU, Sandhu M, Qayyum A, Usama M, Girardi A, Latif S, Qadir J. Medicine's New Rhythm: Harnessing Acoustic Sensing via the Internet of Audio Things for Healthcare. *IEEE Open Journal of the Computer Society*. 2024 Sep 18.
- Prabhod KJ. The Role of Artificial Intelligence in Reducing Healthcare Costs and Improving Operational Efficiency. *Quarterly Journal of Emerging Technologies and Innovations*. 2024 Apr 16;9(2):47-59.
- Pungchompoo W, Parinyachitta S, Pungchompoo S, Udomkhamsuk W, Suwan P. The feasibility of integrating a home telehealth model for older persons living with hemodialysis. *BMC geriatrics*. 2024 Dec;24(1):1-6.
- Ramírez-Guerrero G, Ronco C, Lorenzin A, Brendolan A, Sgarabotto L, Zanella M, Reis T. Development of a new miniaturized system for ultrafiltration. *Heart Failure Reviews*. 2024 Jan 30:1-6.
- Risdawati I. Analysis of Ethical and Legal Aspects in Implementing a Medical Record System in Hospitals on Patient Health Practices. *International Journal of Society and Law*. 2024 May 15;2(1):229-40.
- Roşu CD, Bolintineanu SL, Căpăstraru BF, Iacob R, Stoicescu ER, Petrea CE. Risk Factor Analysis in Vascular Access Complications for Hemodialysis Patients. *Diagnostics*. 2025 Jan 2;15(1):88.
- Santosh R, Mohammed YN, Rahaman Z, Khurana S. The Role of Telemedicine in Enhancing Chronic Kidney Disease (CKD) Management and Dialysis Care. *Cureus*. 2024 Mar;16(3).

- Sargsyan K, Muradyan A. Patient Facing Applications. In *Digitalization of Medicine in Low-and Middle-Income Countries: Paradigm Changes in Healthcare and Biomedical Research* 2024 Aug 31 (pp. 171-175). Cham: Springer International Publishing.
- Savale L, Benazzo A, Corris P, Keshavjee S, Levine DJ, Mercier O, Davis RD, Granton JT. Transplantation, bridging, and support technologies in pulmonary hypertension. *European Respiratory Journal*. 2024 Oct 31;64(4).
- Singh M, Babbarwal A, Pushpakumar S, Tyagi SC. Interoception, cardiac health, and heart failure: The potential for artificial intelligence (AI)—driven diagnosis and treatment. *Physiological Reports*. 2025 Jan;13(1):e70146.
- Stamate E, Piraianu AI, Ciobotaru OR, Crassas R, Duca O, Fulga A, Grigore I, Vintila V, Fulga I, Ciobotaru OC. Revolutionizing Cardiology through Artificial Intelligence—Big Data from Proactive Prevention to Precise Diagnostics and Cutting-Edge Treatment—A Comprehensive Review of the Past 5 Years. *Diagnostics*. 2024 May 26;14(11):1103.
- Ştefan AM, Rusu NR, Ovreiu E, Ciuc M. Empowering Healthcare: A Comprehensive Guide to Implementing a Robust Medical Information System—Components, Benefits, Objectives, Evaluation Criteria, and Seamless Deployment Strategies. *Applied System Innovation*. 2024 Jun 14;7(3):51.
- Tariq MU. Revolutionizing health data management with blockchain technology: Enhancing security and efficiency in a digital era. In *Emerging Technologies for Health Literacy and Medical Practice* 2024 (pp. 153-175). IGI Global.
- Tognola C, Ruzzenenti G, Maloberti A, Varrenti M, Mazzone P, Giannattasio C, Guarracini F. Anderson–Fabry Disease: An Overview of Current Diagnosis, Arrhythmic Risk Stratification, and Therapeutic Strategies. *Diagnostics*. 2025 Jan 9;15(2):139.
- Tovey L. Assessment and Management of Kidney Function. *Critical Care Manual of Clinical Nursing Procedures*. 2024 Oct 30:292.
- Trillini M, Perico N, Remuzzi G. Epidemiology of end-stage renal failure: the burden of kidney diseases to global health. In *Kidney Transplantation, Bioengineering and Regeneration* 2017 Jan 1 (pp. 5-11). Academic Press.
- Tyagi AK, Seranmadevi R. Blockchain for Enhancing Security and Privacy in the Smart Healthcare. *Digital Twin and Blockchain for Smart Cities*. 2024 Oct 15:343-70.
- Ullah F, He J, Zhu N, Wajahat A, Nazir A, Qureshi S, Pathan MS, Dev S. Blockchain-enabled EHR access auditing: Enhancing healthcare data security. *Heliyon*. 2024 Aug 30;10(16).
- Wijayanti D, Ujianto EI, Rianto R. Uncovering Security Vulnerabilities in Electronic Medical Record Systems: A Comprehensive Review of Threats and Recommendations for Enhancement. *Jurnal Ilmiah Teknik Elektro Komputer dan Informatika (JITEKI)*. 2024 Mar;10(1):73-98.
- Yang CW, Harris DC, Luyckx VA, Nangaku M, Hou FF, Garcia GG, Abu-Aisha H, Niang A, Sola L, Bunnag S, Eiam-Ong S. Global case studies for chronic kidney disease/end-stage kidney disease care. *Kidney international supplements*. 2020 Mar 1;10(1):e24-48.
- Ye H, Ding H, Gan W, Wen P, Zhou Y, Cao H, He W. Hemodialysis. *Chronic Kidney Disease: Diagnosis and Treatment*. 2020:209-31.
- Zhang J. From Data to Decisions Exploring the Role of Data Analysis in Big Data. *Journal of Computer, Signal, and System Research*. 2025 Jan 21;2(1):19-27.