BRITISH JOURNAL OF HOSPITAL MEDICINE

EDITORIAL

# The Convergence of Artificial Intelligence and the Internet of Things in Dentistry and Medicine

Enis Veseli[1,*], Dinesh Rokaya[2,3], Betsy Joseph[4,5]

[1]Department of Prosthodontics, Dental School, Faculty of Medicine, University of Prishtina, Prishtina, Kosovo
[2]Clinical Sciences Department, College of Dentistry, Ajman University, Ajman, United Arab Emirates
[3]Center of Medical and Bio-Allied Health Sciences Research, Ajman University, Ajman, United Arab Emirates
[4]Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Chennai, India
[5]Department of Oral and Maxillofacial Diseases, University of Helsinki and Helsinki University Hospital, Helsinki, Finland
*Correspondence: enis.veseli@uni-pr.edu (Enis Veseli)

## Introduction

The integration of artificial intelligence (AI) with the Internet of Things (IoT) represents a new era in healthcare research, offering substantial advancements in dentistry and medicine. These technologies are reshaping clinical practices and optimizing patient outcomes (Adly et al, 2024; Pourhajibagher et al, 2024; Puri et al, 2024; Tiwari and Waoo, 2024).

## The Impact of AI and IoT in Dentistry

AI algorithms, particularly those based on machine learning, deep learning, and computer vision, significantly improve diagnostic accuracy in dentistry. By analyzing vast datasets, AI can detect conditions such as caries, periodontal disease, and oral cancer earlier than traditional methods, improving patient outcomes (Rokaya et al, 2024; Surdu et al, 2024). A recent study demonstrated that AI outperforms human practitioners in identifying dental caries through radiographic analysis with high sensitivity and specificity (Das et al, 2024). This is particularly critical, where early intervention can significantly alter treatment outcomes. In July 2024, an autonomous AI-controlled robot successfully performed a full dental procedure. It completed the procedure eight times faster than a traditional dentist and eliminated the need for X-rays (Veseli, 2025).

IoT is also revolutionizing dental care. Interconnected devices collect and exchange data in real-time, providing valuable insights into oral health. For example, smart toothbrushes equipped with sensors track brushing habits and provide personalized feedback to patients, aiding in improving oral hygiene (Chen et al, 2021). Orthodontists can enhance patient care through smart orthodontic brackets that integrate nanoelectronics with the IoT to improve treatment outcomes. This technology provides finer control over the direction, magnitude, and speed of tooth movement, potentially shortening treatment time and reducing patient discomfort. This, in turn, facilitates remote monitoring, reducing the need for frequent in-person visits and improving access to orthodontic care, particularly for patients in remote areas (Bahrami and Bahrami, 2023).

**How to cite this article:**
Veseli E, Rokaya D, Joseph B. The Convergence of Artificial Intelligence and the Internet of Things in Dentistry and Medicine. Br J Hosp Med. 2025. https://doi.org/10.12968/hmed.2025.0110

Home-based dental care is another promising application. Liu et al (2019) developed a smart dental health-IoT system using intraoral cameras, sensors, deep learning, and mobile technology. This system achieved up to 90% diagnostic accuracy for seven dental diseases, reducing diagnosis time by 37.5% per patient and increasing the number of treated patients by 18.4%. Patients can upload dental images via a mobile app, allowing AI to analyze and identify conditions like caries and periodontal disease, facilitating proactive care, especially for those in remote areas (Liu et al, 2019).

## The Integration of AI and IoT in Medicine

The integration of AI and IoT is revolutionizing healthcare, providing clinicians with actionable diagnostic and therapeutic insights derived from the vast datasets generated by IoT devices. During the Coronavirus Disease 2019 (COVID-19) pandemic, AI and IoT played a crucial role in tracking disease spread and managing vaccine distribution. These technologies have been used to address healthcare concerns, including diagnosis, drug and vaccine development, vaccine distribution, sentiment analysis, and fake news identification regarding COVID-19 reviews (Almars et al, 2022). The lessons learned and technologies developed during this period are now being applied to a wider range of healthcare applications.

Integrating AI with IoT devices and wearable sensors allows real-time and continuous monitoring of patient health metrics such as heart rate, blood pressure, and glucose levels, enabling early detection of anomalies and facilitating timely diagnosis and treatment. Early detection of anomalies, facilitating timely diagnosis and treatment is enabled by continuously updated databases accessible via application or web platforms (LaBoone and Marques, 2024; Siddiqui et al, 2023). For example, continuous glucose monitoring devices connected to a smartphone app can alert patients and doctors to potentially dangerous blood sugar fluctuations before they become serious. To further enhance the quality of life for individuals with diabetes and mitigate the adverse health effects associated with this condition, the "artificial pancreas" has emerged as a significant approach to disease management in recent years (Luo et al, 2024). Moreover, Kovatchev et al (2024) reported that incorporating advanced AI into an artificial pancreas could automatically monitor and regulate blood sugar levels for patients with type 1 diabetes, a concept referred to by the research team as a "Neural-Net Artificial Pancreas".

Beyond diabetes management, AI is also proving valuable in other areas of healthcare, such as risk assessment. The recent study conducted by Lin et al (2024) assessed the efficacy of an AI-enabled electrocardiogram (ECG) in identifying hospitalized patients with a high risk of mortality. This multicentric randomized controlled trial involved 39 physicians and 15,965 patients. The authors reported that the AI-enabled ECG not only effectively identifies hospitalized patients at high risk of mortality but also significantly contributes to a reduction in all-cause mortality within a 90-day period. The study's primary outcome demonstrated a decrease in mortality, from 4.3% in the control group to 3.6% in the intervention group, high-

lighting the potential of AI technologies to enhance patient care and outcomes in clinical settings.

Early disease predictions empower doctors to make timely interventions, and significantly improve patient outcomes. Kishor and Chakraborty (2022) used seven machine-learning classification algorithms to predict various diseases based on patient data collected from IoT sensors. Their model, using the Random Forest classifier, achieved impressive results, including 97.62%, 99.67% sensitivity, 97.81% specificity, and an area under the curve (AUC) of 99.32% across conditions such as heart disease, diabetes, breast cancer, hepatitis, liver disorders, dermatological issues, surgical data, thyroid conditions, and coronary artery disease. This model has the potential to significantly aid doctors in early disease diagnosis. These advancements in the broader medical field are also finding applications in dentistry, as discussed previously.

## Challenges and Ethical Considerations

While the potential benefits are substantial, the integration of AI and IoT in healthcare also presents several challenges that must be addressed. A primary concern is data security. Traditional healthcare frameworks typically assign ownership of medical records to healthcare providers. However, in the rapidly advancing landscape of AI within integrative healthcare, the novel Collaborative Healthcare Data Ownership framework introduces shared ownership, defined access and control, and transparent governance. This approach offers a promising avenue for responsible and collaborative AI integration in integrative healthcare (Liu and Guo, 2024). Nonetheless, the reliance on interconnected devices can expose sensitive health information, including patient medical records, genetic information, and insurance details, to breaches and cyber threats. According to a report by the World Health Organization (2024), healthcare organizations faced various cyber-attacks, particularly during the COVID-19 pandemic, pointing out the urgent need for stronger security protocols and robust cybersecurity infrastructure.

Ethical concerns also arise regarding the opacity of AI decision-making processes, often referred to as the "black box" problem. Many stakeholders emphasize the necessity of transparency in AI algorithms to maintain trust between patients and healthcare providers (Hassija et al, 2024). Furthermore, issues of bias in AI algorithms, patient autonomy, responsibility and liability in case of AI errors, and data privacy must be carefully considered. Developing ethical frameworks that ensure accountability while harnessing the benefits of AI and IoT remains a pressing challenge. This will require collaboration between researchers, policymakers, healthcare professionals, and technology developers to establish clear guidelines and best practices.

Another significant concern is equitable access to these technologies, particularly for patients and healthcare services that lack reliable internet access and the financial resources to invest in necessary hardware and software. This disparity is especially pronounced in low-income communities and rural areas, where infrastructure investments often lag behind those in urban environments. Patients with-

out dependable internet access face barriers to using telehealth services, accessing health information, and utilizing AI-enhanced tools. Moreover, the adoption of IoT and smart health devices often relies on both reliable internet connectivity and the affordability of these devices, which can disadvantage certain populations. Additionally, healthcare providers serving these communities may encounter challenges with data management and patient engagement, hindering their ability to deliver effective care (Yu et al, 2024). As AI and IoT integration in healthcare progresses, ensuring equitable access must remain a priority for an inclusive future that benefits individuals regardless of socioeconomic status.

## Conclusion

The integration of AI and IoT in dentistry and medicine presents a significant opportunity to revolutionize patient care, improve diagnostic accuracy, and enhance operational efficiency. As research continues to evolve and demonstrates the capabilities of these technologies, the dental and medical fields must remain vigilant in addressing ethical considerations while embracing innovation. This requires ongoing research into developing robust security measures, mitigating bias in AI algorithms, establishing clear lines of responsibility, and ensuring patient privacy. Open dialogue and collaboration among all stakeholders are essential to create ethical frameworks and best practices that will guide the responsible development and implementation of AI and IoT in healthcare, ultimately leading to improved patient outcomes and a more equitable healthcare system.

### Key Points

- AI and IoT are poised to revolutionize dentistry and medicine, leading to better patient care, more accurate diagnostic accuracy, and personalized treatments.
- These technologies can significantly impact chronic disease management by enabling earlier diagnosis, reducing hospital readmissions, and improving survival rates for critical illnesses.
- Addressing data security and ensuring ethical AI practices are crucial, but the potential of AI and IoT to transform healthcare is undeniable.

## Availability of Data and Materials

Not applicable.

## Author Contributions

EV, DR and BJ designed the work. EV drafted the initial version. All authors contributed to the important editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

## Ethics Approval and Consent to Participate

Not applicable.

## Acknowledgement

Not applicable.

## Funding

This research received no external funding.

## Conflict of Interest

The authors declare no conflict of interest.

## References

Adly AS, Adly AS, Malthiery E, Shah SA, Estephan E, Adly MS. Enabling Artificial Intelligence on IoT Edge: Smart Approaches and Solutions for Providing Remote Dental and Medical Services. In Pal S, Savaglio C, Minerva R, Delicato FC (eds.) IoT Edge Intelligence (pp. 365–385). Springer Nature Switzerland: Cham. 2024. https://doi.org/10.1007/978-3-031-58388-9_13

Almars AM, Gad I, Atlam ES. Applications of AI and IoT in COVID-19 vaccine and its impact on social life. In Hassanien AE, Bhatnagar R, Snášel V, Yasin Shams M (eds.) Medical Informatics and Bioimaging Using Artificial Intelligence: Challenges, Issues, Innovations and Recent Developments (pp. 115–127). Springer: Cham. 2022. https://doi.org/10.1007/978-3-030-91103-4_7

Bahrami R, Bahrami R. A new model for managing tooth movement: smart orthodontic brackets in the internet of dental things (IoDT). Medical Hypotheses. 2023; 179: 111168. https://doi.org/10.1016/j.mehy.2023.111168

Chen CH, Wang CC, Chen YZ. Intelligent Brushing Monitoring Using a Smart Toothbrush with Recurrent Probabilistic Neural Network. Sensors. 2021; 21: 1238. https://doi.org/10.3390/s21041238

Das M, Shahnawaz K, Raghavendra K, Kavitha R, Nagareddy B, Murugesan S. Evaluating the Accuracy of AI-Based Software vs Human Interpretation in the Diagnosis of Dental Caries Using Intraoral Radiographs: An RCT. Journal of Pharmacy & Bioallied Sciences. 2024; 16: S812–S814. https://doi.org/10.4103/jpbs.jpbs_1029_23

Hassija V, Chamola V, Mahapatra A, Singal A, Goel D, Huang K, et al. Interpreting black-box models: a review on explainable artificial intelligence. Cognitive Computation. 2024; 16: 45–74. https://doi.org/10.1007/s12559-023-10179-8

Kishor A, Chakraborty C. Artificial intelligence and internet of things based healthcare 4.0 monitoring system. Wireless Personal Communications. 2022; 127: 1615–1631. https://doi.org/10.1007/s11277-021-08708-5

Kovatchev B, Castillo A, Pryor E, Kollar LL, Barnett CL, DeBoer MD, et al. Neural-Net Artificial Pancreas: A Randomized Crossover Trial of a First-in-Class Automated Insulin Delivery Algorithm. Diabetes Technology & Therapeutics. 2024; 26: 375–382. https://doi.org/10.1089/dia.2023.0469

LaBoone PA, Marques O. Overview of the future impact of wearables and artificial intelligence in healthcare workflows and technology. International Journal of Information Management Data Insights. 2024; 4: 100294. https://doi.org/10.1016/j.jjimei.2024.100294

Lin CS, Liu WT, Tsai DJ, Lou YS, Chang CH, Lee CC, et al. AI-enabled electrocardiography alert intervention and all-cause mortality: a pragmatic randomized clinical trial. Nature Medicine. 2024; 30: 1461–1470. https://doi.org/10.1038/s41591-024-02961-4

Liu L, Xu J, Huan Y, Zou Z, Yeh SC, Zheng LR. A Smart Dental Health-IoT Platform Based on Intelligent Hardware, Deep Learning, and Mobile Terminal. IEEE Journal of Biomedical and Health Informatics.

2019; 24: 898–906. https://doi.org/10.1109/JBHI.2019.2919916

Liu S, Guo LR. Data Ownership in the AI-Powered Integrative Health Care Landscape. JMIR Medical Informatics. 2024; 12: e57754. https://doi.org/10.2196/57754

Luo X, Xie J, Yang L, Cui Y. An intelligent wearable artificial pancreas patch based on a microtube glucose sensor and an ultrasonic insulin pump. Talanta. 2024; 273: 125879. https://doi.org/10.1016/j.talanta.2024.125879

Pourhajibagher M, Bahrami R, Bahador A. Revolution of artificial intelligence in antimicrobial, anti-biofilm, and anti-inflammatory techniques: Smart photo-sonodynamic appliance in the internet of dental things (IoDT). Medical Hypotheses. 2024; 184: 111270. https://doi.org/10.1016/j.mehy.2024.111270

Puri V, Kataria A, Sharma V. Artificial intelligence-powered decentralized framework for Internet of Things in Healthcare 4.0. Transactions on Emerging Telecommunications Technologies. 2024; 35: e4245. https://doi.org/10.1002/ett.4245

Rokaya D, Jaghsi AA, Jagtap R, Srimaneepong V. Artificial intelligence in dentistry and dental biomaterials. Frontiers in Dental Medicine. 2024; 5: 1525505. https://doi.org/10.3389/fdmed.2024.1525505

Siddiqui SA, Ahmad A, Fatima N. IoT-based disease prediction using machine learning. Computers & Electrical Engineering. 2023; 108: 108675. https://doi.org/10.1016/j.compeleceng.2023.108675

Surdu A, Budala DG, Luchian I, Foia LG, Botnariu GE, Scutariu MM. Using AI in Optimizing Oral and Dental Diagnoses-A Narrative Review. Diagnostics. 2024; 14: 2804. https://doi.org/10.3390/diagnostics14242804

Tiwari M, Waoo AA. Transforming Healthcare: The Synergistic Fusion of AI and IoT for Intelligent, Personalized Well-Being. In Gupta SK, Karras DA, Natarajan R (eds.) Revolutionizing Healthcare: AI Integration with IoT for Enhanced Patient Outcomes (pp. 109–149). Springer Nature Switzerland: Cham. 2024. https://doi.org/10.1007/978-3-031-65022-2_7

Veseli E. The future of dentistry through robotics. British Dental Journal. 2025; 238: 76–77. https://doi.org/10.1038/s41415-025-8345-8

World Health Organization. WHO reports outline responses to cyber attacks on health care and the rise of disinformation in public health emergencies. 2024. Available at: https://www.who.int/news/item/06-02-2024-who-reports-outline-responses-to-cyber-attacks-on-health-care-and-the-rise-of-disinformation-in-public-health-emergencies (Accessed: 20 January 2025).

Yu J, Bekerian DA, Osback C. Navigating the Digital Landscape: Challenges and Barriers to Effective Information Use on the Internet. Encyclopedia. 2024; 4: 1665–1680. https://doi.org/10.3390/encyclopedia4040109