Letter to the Editor

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Seeing the future: Ophthalmology gets "eye-tech" savvy with Internet of Medical Thing

Dear Editor,

As technology rapidly evolves within healthcare, the incorporation of the Internet of Medical Things (IoMT) into ophthalmology represents a pivotal beacon of innovation with transformative potential. IoMT encompasses interconnected devices, sensors, software, and platforms meticulously designed to amplify the diagnosis, treatment, and overall management of ocular conditions. Its integration marks a significant stride in revolutionizing numerous domains within the healthcare sphere.

Here is an Elaboration on How the Internet of Medical Thing Can Transform Ophthalmology

Remote monitoring and teleophthalmology

IoMT can enable remote monitoring of patients with ocular conditions. Devices such as smartphones coupled with specialized attachments can allow patients to capture high-resolution images or videos of their eyes. These can be securely transmitted to ophthalmologists for remote assessment, diagnosis, and management of eye diseases, especially in remote or underserved areas.

OphthoAI IoMT is one the example for this kind of technology, it is a headset which integrates a wearable head-mounted camera with an age-related macular degeneration (AMD)-ResNet deep Convolutional Neural Network application, facilitating the detection of AMD disease severity. Users can capture retinal fundus photographs, which are securely encrypted and transmitted over the Internet to a central, firewall-protected location. This headset supports local inference through embedded artificial intelligence (AI) algorithms or cloud-based inference through AI and data analytics services. User data can be optionally stored locally with encryption or removed postsynchronization with secure storage. A cloud computing framework oversees individual headsets, managing secure image transmission, patient cloud storage, resource monitoring, and AI-driven disease progression prediction. This system is coordinated through an Internet of Things (IoT)-Enabled Healthcare Service Directory and Cloud IoT System Manager. In addition, an ophthalmologist dashboard with a secure, privacy-aware, multi-tenant cloud backend ensures role-based access control to patient data, preventing risks such as data loss, misuse, or privacy violations among users.[1]

Smart devices for home care

The integration of smart intraocular pressure (IOP) monitors and home-based visual field (VF)-testing kits within the IoMT framework holds immense promise in empowering patients while enhancing their involvement in managing ocular conditions such as glaucoma.[2]

a. Several devices have been developed for measuring 24-h IOP, including the integration of IOP sensors into intraocular lenses postcataract extraction surgery, implantable IOP sensors positioned in either the ciliary sulcus or the capsular bag, and contact lens sensors. However, implantable devices have seen limited use in human studies with preliminary results and are currently only accessible to individuals undergoing intraocular surgery. In addition, the IOP readings from contact lens sensors are presented in units rather than millimeters of mercury, with no conversion method available at present
b. In addition, home-based VF-testing kits offer a means for patients to conduct VF assessments conveniently from their homes. These kits typically utilize specialized software and a laptop that allow individuals to perform tests assessing their peripheral vision. Moorfields Motion Displacement Test is one of the computer-based software for community VF tests, runs on standard laptops. It utilizes vertical white lines at 31 spots, spatially aligned with Humphrey field analyser and Swedish Interactive Threshold Algorithm 24-2 test locations by Carl Zeiss Meditec. This technology enables regular monitoring of VFs, aiding in the early detection of any changes or anomalies that could indicate disease progression or treatment inefficacy.

Data analytics and artificial intelligence-assisted diagnostics

IoMT devices generate vast amounts of data, including retinal images, optical coherence tomography scans, patient history, and treatment records. This influx of data serves as a valuable resource for AI-powered algorithms. These algorithms have the potential to analyze intricate patterns within the data, enabling the identification of ocular diseases such as – diabetic retinopathy, AMD, macular pathologies (choroidal

neovascularization, macular edema, drusen, geographic atrophy, epiretinal membrane, vitreomacular traction, macular hole, and central serous chorioretinopathy), retinopathy of prematurity, glaucoma, and anterior segment disorders.[3]

Wearable technology

The smart contact lens (SCL) stands as an innovative ophthalmic device that extends beyond vision correction by integrating electronic components with the widely-used platform of soft contact lenses. By embedding sensors, microprocessors, and wireless communication elements within SCLs, these lenses gain the capability to measure diverse biometric data. This includes monitoring glucose levels in tears, measuring IOP, and detecting various biomarkers associated with different diseases.[4]

Treatment adherence and patient engagement

The integration of the IoMTs stands to revolutionize patient engagement by enabling tailored care plans, medication reminders, and streamlined follow-up appointments through user-friendly apps or wearable devices. This transformative approach not only customizes health-care delivery but also fosters a stronger patient–provider connection. With personalized care plans, patients receive treatment regimens adapted to their specific needs, while timely reminders through apps or wearables ensure adherence to medication schedules. Moreover, the seamless coordination for follow-up appointments enhances convenience and promotes proactive health-care management. By harnessing the capabilities of IoMT, this comprehensive approach strives to significantly enhance patient adherence to treatment regimens, ultimately optimizing health outcomes.[5]

Surgical and procedural advancements

IoMT can play a role in enhancing precision and efficiency in eye surgeries. Although the da Vinci Surgical robot has been globally employed in various surgical fields over the past decade,[6] robotic technology in ophthalmology enhances precision and addresses movement stability challenges. It facilitates complex procedures such as micro-incision cataract surgeries, improving outcomes, and reducing surgeon fatigue. However, challenges include logical processing for effective execution, device flexibility, and high costs. Ongoing research trials will shape the future of robotic surgery in ophthalmology.[7] Information technology can enable a robotic system to autonomously operate and interact in both physical and virtual realms. This system has the potential to assimilate real-world inputs, contextualize the information, and respond based on its programming and newly acquired data. However, while this system offers perception, control, and interaction capabilities, it currently lacks a certain level of sensitivity or nuanced understanding.

Wearable health monitoring devices outperform homecare and hospital environments in terms of scale, efficiency, and ease of use,[8] but there is no established study which could comment on the reliability of these devices in the field of ophthalmology and adding further they promise that in future improvements can be seen with this technology.[4] It is imperative for the scientific community to navigate this transformative landscape collaboratively, leveraging the potential while addressing the intricacies, to pave the way for a future where enhanced patient outcomes and technological advancements coalesce seamlessly.

Data availability statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Conflicts of interest

The author declares that there are no conflicts of interest of this article.

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