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Letter to Editor

Artificial Intelligence in Diagnosing Conjunctivitis – A Step towards Smarter Eye Care

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Abbreviations: AI- Artificial Intelligence; VKC- Vernal keratoconjunctivitis; HL- Hamming Loss; CA- Classification accuracy; TEN- Toxic Epidermal Necrolysis; SJS- Stevens-Johnson Syndrome; GPC- Giant papillary conjunctivitis; AKC- Atopic keratoconjunctivitis; AC- Allergic conjunctivitis (AC); CNN- Convolutional Neural Network

To the Editor,

We are writing in reference to a recent article entitled, 'Outbreak of Conjunctivitis in South Asia: A Landscape of Current Situation and Rapid Review of Literature' [1]. We congratulate the authors on their unique narrative review on conjunctivitis, a highly contagious, self-limiting eye infection characterized by conjunctival hyperemia, watery discharge, and follicular reaction. Whilst the article briefly touches upon the clinical diagnostic approaches, we seek to highlight and further elaborate on this topic, particularly on the emerging use of Artificial Intelligence (AI) in the clinical diagnosis of infectious diseases. Given AI's vast influence across different industries and its inevitable impact on the future of modern medicine, we would like to emphasize its potential to bolster the diagnostic accuracy in conjunctivitis.

Type of AI Tools Used for Conjunctivitis Diagnosis

Given the progress in AI technologies, researchers have adopted various techniques for building healthcare diagnostic systems that can correlate symptoms and diagnoses. Examples include automatic image processing-based techniques composed by Joydeep Tamuli et al., which distinguish conjunctivitis-tainted eyes from ordinary eyes and characterize them according to their type, which is either allergic, bacterial, or viral [2]. Additionally, recent breakthroughs in AI have resulted in the development of a highly complex AI-driven chatbot, Google Gemini Advanced, that assists in providing accurate and relevant responses to Vernal Keratoconjunctivitis (VKC)-related queries [3].

Moreover, an innovative automated diagnosing system of adenoviral conjunctivitis used the facial picture built by Melih Gunay et al. to measure the vascularization and intensity of redness in pink eyes after segmenting the sclera regions of eye images to diagnose conjunctivitis with only 30 images (18 healthy and 12 adenoviral conjunctivitis eye images). The average accuracy rate was found to be 96% [4].

In addition to the above-mentioned technologies, one study validates AI-based software named AllergoEye for objectively assessing conjunctival allergic reactions using smartphone imaging and computer analysis, demonstrating 98% sensitivity and 90% specificity. This further highlights its practical applicability in clinics for allergic conjunctivitis evaluation [5].

Table 1 provides insights into the latest AI devices designed for conjunctivitis detection and management.

AI Tools currently in use internationally

The use of AI in diagnosing conjunctivitis is no longer a theoretical concept but a growing reality. Several countries have already initiated AI-based studies and clinical applications, demonstrating AI's potential for early detection, classification, and management of the disease. Some notable instances include the world's first conjunctivitis-related tear biomarker study, which was carried out by Dr. Rohit Shetty at the Narayana Nethralaya Institute in India and used AI to measure the severity of conjunctivitis [6]. Similarly, China developed the EE-Explorer – a multimodal AI system – that used metadata and ocular pictures

Table 1: AI tools designed for conjunctivitis diagnoses and management.

Tool/Model Name	Description	AI Technique	Accuracy
Conjunctive Net [9]	The diagnostic accuracy for conjunctivitis severity stages is increased by a deep learning-based model that uses sophisticated preprocessing techniques and a modified Otsu's method for better image segmentation.	Convolutional Neural Network (CNN) with transfer learning	High accuracy in classifying severity stages
IConDet [10]	An intelligent portable healthcare application designed for the detection of conjunctivitis, utilizing deep learning techniques to analyze eye images captured via mobile devices.	Deep Learning	Achieved 84% accuracy in initial detection
UNet++ Model [11]	A machine learning method that uses camera-based systems to take pictures of the eyes, preprocesses the images, and uses the UNett+ model for image segmentation to diagnose conjunctivitis.	UNet++ for image segmentation	Overall accuracy of 97.07%
AI-based Slit-Lamp Image Analysis [12]	Finds clinical signs of conjunctivitis, such as giant papillary conjunctivitis (GPC), atopic keratoconjunctivitis (AKC), vernal keratoconjunctivitis (VKC), and allergic conjunctivitis (AC), using explainable AI on slit-lamp images of the anterior surface of the eyes.	Explainable AI techniques	Not specified
Eye Condition Detection with Deep Learning [13]	A convolutional neural network designed to detect various eye conditions, such as conjunctivitis, by analyzing images for visual symptoms.	Convolutional Neural Network (CNN)	Not specified

to help with the initial diagnosis and triaging of eye crises. In the first diagnosis, the system showed a Hamming Loss (HL) of 0.011 and a classification accuracy (CA) of 0.860 (7). Furthermore, according to the original article, a study conducted in Japan using 4,942 slit-lamp images showed that Al could identify clinical signs of various types of conjunctivitis, including giant papillary conjunctivitis, vernal keratoconjunctivitis, atopic keratoconjunctivitis, and allergic conjunctivitis [8].

Clinical Implications and Challenges

AI-powered gadgets are becoming increasingly beneficial for the diagnosis and treatment of conjunctivitis.

AI can facilitate remote diagnosis and triage of conjunctivitis cases using teleophthalmology, especially in primary care or disadvantaged areas. However, because conjunctivitis presents differently in separate demographics and geographical areas, there is a lack of generality despite these encouraging developments. Al's incapacity to access subjective symptoms, which are crucial in distinguishing amongst conjunctivitis etiologies, is further reflected in the excessive dependence on picture analysis. Integration into actual clinical practice, lack of extensive clinical validation, and ethical issues continue to be major issues that require attention.

Notwithstanding these drawbacks, AI-driven technology has the potential to improve treatment effectiveness and close gaps in healthcare accessibility. Al can identify potentially fatal conjunctivitis associated with systemic conditions such as sepsis, Kawasaki disease, or Stevens-Johnson Syndrome (SJS)/Toxic Epidermal Necrolysis (TEN), and can ensure that high-risk patients are urgently evaluated by a specialist. Furthermore, risk stratification and predictive analytics in AI models can help prioritize serious illnesses by evaluating patient symptoms, history, and imaging data, which can shorten diagnostic turnaround times and enhance clinical results.

The integration of AI in the diagnosis of conjunctivitis emerges as a promising advancement in ophthalmology. By leveraging image recognition and ML algorithms, AI can assist clinicians in early diagnosis and differentiate between the types of conjunctivitis. Further validation of results through large-scale studies and diverse data sets can help AI to improve diagnostic prediction, streamline patient triage, and improve eye care.

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