Large Language Models in Dermatopathology

Subjects: Dermatology

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The potential advantages of Large Language Models (LLMs) include a streamlined generation of pathology reports, the ability to learn and provide up-to-date information, and simplified patient education. Existing instances of LLMs encompass diagnostic support, research acceleration, and trainee education. Challenges involve biases, data privacy and quality, and establishing a balance between AI and dermatopathological expertise. Prospects include the integration of LLMs with other AI technologies to improve diagnostics and the improvement of multimodal LLMs that can handle both text and image input.

Keywords: artificial intelligence ; AI ; LLM ; large language models ; dermatopathology

1. Introduction

The field of dermatopathology has witnessed a remarkable evolution in its diagnostic tools and techniques, reflecting the continued pursuit of precision in understanding and treating skin disorders [1]. From the early days of visual examination to the utilization of advanced microscopy and molecular analyses, dermatologists and dermatopathologists have continually strived to enhance their diagnostic capabilities. In this era of rapid technological advancement [1], Artificial Intelligence (AI) and Large Language Models (LLMs)—a form of AI that is often used to recognize and generate text—are emerging as potent tools for improving diagnostic sensitivity and accuracy. These intelligent systems, trained on data to understand and generate human-like text, are poised to revolutionize dermatopathology by offering insights into the complexities of skin-related conditions [2].

In more recent times, the emergence of LLMs, a form of advanced AI systems capable of processing and generating human-like language based on extensive training on datasets, has propelled NLP to unprecedented heights. In general, LLMs are founded on a neural network architecture that can understand and produce human-like text. These models analyze and generate language, enabling them to perform various language-related tasks.

Dermatopathology, a subspecialty of dermatology and pathology, focuses on diagnosing skin conditions using the histopathologic assessment of skin tissue samples in concert with a holistic appraisal of clinical examination and history. It often involves deciphering pathologic features and patterns within the collected samples [3]. The application of LLMs in dermatopathology may revolutionize the way in which dermatopathologists analyze complex dermatological texts. These language models, if trained and validated on relevant materials, may assist experts, through analyzing the content of textual inputs, in comprehending the nuances of clinical notes, research papers, and pathology reports, aiding in more accurate diagnoses and informed treatment planning [4]. The complexity of dermatopathology cases has been increasing [5], and among 60 surveyed consultants in the UK, almost one-quarter reported complaints or serious incidents related to delayed dermatopathology reporting [6]. LLMs may be able to help improve dermatopathologists' productivity and reduce reporting times.

The dynamic interplay between AI, NLP, and specialized applications like dermatopathology underscores the transformative nature and potential of AI technology in healthcare [7]. It foreshadows an era of data-driven precision and enhanced medical insights. By harnessing the power of NLP and LLMs, dermatopathologists can extract crucial information from pathology reports and other clinical documentation and translate it into actionable knowledge, ultimately leading to improved patient care and outcomes.

2. Advantages of LLMs in Dermatopathology

2.1. Automated Reporting: Revolutionizing the Generation of Pathology Reports

One of the remarkable advancements that the integration of LLMs brings to the field of dermatopathology is the potential for automating the process of generating pathology reports.

Traditionally, dermatopathologists spend a significant amount of time meticulously examining skin tissue samples as slides under a microscope and crafting detailed reports that capture their impressions and findings [8]. This process is not only time-consuming but also demands a high level of specialized expertise.

With the advent of LLMs, the landscape is changing. These language models possess an unparalleled capacity to understand medical jargon, contextual nuances, and technical language. By feeding these models with relevant data and observations from dermatopathological studies, it becomes possible to develop a system that can automatically generate comprehensive and accurate pathology reports.

This automation could significantly reduce the time and effort expended by dermatopathologists on report creation, allowing them to focus more on the critical aspects of analysis and diagnosis [9]. Another potential benefit of AI driven pathology reporting, akin to other benefits of AI in healthcare, includes improving the efficiency of the workforce [10]. Given the nationwide shortage of dermatologists in the US, this technology may alleviate some of this burden through reducing inefficiency and assisting dermatopathologists with writing.

2.2. Continual Learning: Empowering LLMs to Assimilate and Provide Updated Medical Knowledge

The dynamic nature of medical knowledge necessitates that healthcare professionals stay abreast of the latest research, discoveries, and diagnostic methods. In dermatopathology, this requirement is particularly relevant due to the ever-evolving understanding of skin disorders. LLMs, with their capacity for continual learning, offer a transformative solution to this challenge.

LLMs can be designed to continuously assimilate new medical data, research papers, and clinical studies related to dermatopathology [11]. This enables them to stay up-to-date with the latest advancements and refine their understanding of the field over time.

Additionally, users of LLMs like ChatGPT can also create and share custom GPTs to handle specific tasks [12]. If a dermatopathologist desires a GPT that can speak like a dermatopathologist and write notes like a dermatopathologist, it can be realized through instructions and by feeding the LLM with example notes in a desired formatting. The response can include a note template for a particular diagnosis. This custom dermatopathologist GPT can then be shared with all users in the GPT Store.

2.3. Patient Education: Bridging the Gap by Simplifying Complex Dermatopathological Concepts

Effective communication between dermatopathologists and patients is pivotal for successful treatment outcomes [13]. However, conveying intricate dermatopathological concepts to patients who lack medical backgrounds can be challenging. LLMs possess a unique potential to bridge this gap by simplifying complex medical terminology into understandable language [14].

These language models can be leveraged to translate the technical aspects of pathology reports into patient-friendly explanations. A recent cross-sectional study evaluated ChatGPT's ability to reword dermatopathology reports into patient-friendly language. Most of the study subjects—including dermatology residents, dermatology fellows, board-certified dermatologists, and board-certified dermatopathologists—concluded that ChatGPT's reworded reports were mostly complete, accurate, understandable, and unlikely to cause harm to patients [15]. Patient-friendly reports can supplement a physician-guided explanation to help patients comprehend their diagnoses, treatment options, and prognoses more comprehensively [16].

Moreover, LLMs can generate educational materials, such as brochures or online resources, that provide visually engaging and simplified explanations of various skin conditions [17]. By enhancing patient education and understanding, LLMs contribute to informed decision-making and facilitate a more collaborative approach to healthcare.

In conclusion, the incorporation of LLMs into dermatopathology holds transformative potential across various dimensions. From automating report generation to facilitating continuous learning and improving patient education, these language models are poised to reshape how dermatopathology is practiced. As LLMs become more integrated into healthcare workflows, they have the capacity to streamline processes, enhance diagnostic accuracy, and ultimately elevate the standard of care in dermatopathology.

3. Real-World Applications

3.1. Diagnostic Support: How LLMs Can Assist in Identifying Rare or Atypical Presentations

One of the significant challenges in dermatopathology is diagnosing rare or atypical cases. LLMs, with their vast capacity to process and understand medical literature, have emerged as valuable tools in this context. These models can efficiently analyze a wide range of medical texts, providing insights that aid dermatopathologists in identifying and understanding uncommon skin conditions [18]. For instance, LLMs can swiftly review relevant case studies, research papers, and clinical notes to offer comprehensive information, enabling medical professionals to make more accurate diagnoses. Nonetheless, certain rare diseases within the domain of dermatology exhibit an exceedingly low case count, accompanied by an insufficient availability of specimens. This scarcity of data poses a substantial hurdle in furnishing machine learning

algorithms with the requisite training, thereby constituting a significant obstacle for the advancement of AI in the field of dermatology [19]. While current LLMs can attempt to provide a report based on histopathologic imaging, they are limited with respect to accuracy [20]. There is a need for further validation on larger and more diverse datasets.

Multimodal LLMs can improve diagnostic support by drawing multiple sources of data input including clinical images, dermoscopic images, histopathological images, and text. The term multimodal refers to having the ability to engage with multiple modes of input rather than being unimodal, or one mode. One dedicated dermatological, multimodal LLM, SkinGPT-4, can diagnose common skin lesions based on clinical images and text descriptions provided by patients. The authors of the study indicated that several limitations exist, including a potential lack of trust from patients, which may result in an incomplete description provided to the LLM. Physicians can leverage their human connection with patients to facilitate adequate history-taking [21]. Additionally, the LLM does not currently support dermoscopic and histopathological images—meaning diagnoses would not be based on congruence between clinical examination, dermoscopy, and histopathological findings.

3.2. Hypotheses Generation Using LLMs

LLMs offer an innovative solution by quickly comprehending and summarizing extensive medical texts, thus significantly accelerating the initial stages of research [18]. These models can assist researchers in generating hypotheses by analyzing existing data and proposing potential research directions. By leveraging LLMs in this manner, researchers can streamline the initial stages of their projects and focus more on in-depth analysis and experimentation [22].

3.3. Teaching and Training: LLMs as a Tool for Educating Novice Dermatopathologists

Training aspiring dermatopathologists presents a multifaceted challenge, demanding exposure to a diverse array of cases for the cultivation of diagnostic expertise. In this regard, LLMs from the Generative Pre-trained Transformers (GPT) series emerge as invaluable assets within the realm of medical education. These models assume a pivotal role by functioning as interactive educational tools [23][24]. By furnishing contextual information, elucidations, and simulated patient case studies, LLMs enrich the learning journey of budding dermatopathologists, adeptly bridging the gap between theoretical understanding and practical application. For instance, the integration of LLMs can profoundly reshape medical curriculum design, teaching methodologies, tailored study plans, learning resources, and student evaluations, ultimately elevating students' proficiency and knowledge [25]. These models offer innovative resources for students, including interactive learning materials and simulated patient case studies. Additionally, LLMs can contribute to the evolution of assessment methods by providing insights into more effective student evaluations. By reshaping these fundamental aspects of medical education, LLMs play a pivotal role in enhancing students' proficiency and knowledge, fostering a dynamic and comprehensive learning experience [25].

Yet, this transformative potential also prompts a critical examination of the complexities associated with such integration. Addressing concerns like algorithmic biases, undue reliance, plagiarism, dissemination of misinformation, disparities, privacy infringements, and copyright issues in the context of medical education is imperative.

It is important to note that LLMs also suffer from producing some responses that support race-based medicine, which can confound results. One study showed that LLMs such as ChatGPT and Bard indicated that a Black skin is thicker than a White skin and that Black patients may have a higher pain tolerance than white patients [26]. Results such as these may find a way to perpetuate bias in decision-making.

References

1. Dermatology Diagnostic Devices and Therapeutics Market Size, Report By 2032 Precedence Research. Available online: www.precedenceresearch.com/press-release/dermatology-diagnostic-devices-and-therapeutics-market#:~:text=The%20global%20dermatology%20diagnostic%20devices,conditions%2C%20dermatology%20equipment%20is%20req (accessed on 4 August 2023).
2. De, A.; Sarda, A.; Gupta, S.; Das, S. Use of artificial intelligence in dermatology. Indian J. Dermatol. 2020, 65, 352.
3. WedMD Editorial Contributors; Medically Reviewed by Sabrina Felson. What Is a Dermatopathologist? Available online: https://www.webmd.com/a-to-z-guides/what-is-a-dermatopathologist (accessed on 15 July 2023).
4. Wells, A.; Patel, S.; Lee, J.B.; Motaparthi, K. Artificial intelligence in dermatopathology: Diagnosis, education, and research. J. Cutan. Pathol. 2021, 48, 1061–1068.
5. Stagner, A.M.; Tahan, S.R.; Nazarian, R.M. Changing Trends in Dermatopathology Case Complexity: A 9-Year Academic Center Experience. Arch. Pathol. Lab. Med. 2020, 145, 144–1147.
6. Wolfe, C.; Phillips, R.; Laheru, D.; Fisher, R. P30 Declining staff numbers and increasing workload: Is there a solution? Br. J. Dermatol. 2023, 188 (Suppl. S4), ljad113-058.

7. Jartarkar, S.R.; Cockerell, C.J.; Patil, A.; Kassir, M.; Babaei, M.; Weidenthaler–Barth, B.; Grabbe, S.; Goldust, M. Artificial intelligence in Dermatopathology. J. Cosmet. Dermatol. 2023, 22, 1163–1167.
8. Velez, N.; Jukic, D.; Ho, J. Evaluation of 2 whole-slide imaging applications in dermatopathology. Hum. Pathol. 2008, 39, 1341–1349.
9. Locke, S.; Bashall, A.; Al-Adely, S.; Moore, J.; Wilson, A.; Kitchen, G.B. Natural language processing in medicine: A review. Trends Anaesth. Crit. Care 2021, 38, 4–9.
10. Bajwa, J.; Munir, U.; Nori, A.; Williams, B. Artificial intelligence in healthcare: Transforming the practice of medicine. Future Healthcare J. 2021, 8, e188.
11. Karabacak, M.; Margetis, K. Embracing Large Language Models for Medical Applications: Opportunities and Challenges. Cureus 2023, 15, 1–5.
12. Introducing GPTs. Open AI. Available online: https://openai.com/blog/introducing-gpts (accessed on 26 December 2023).
13. Smith, S.D.; Reimann, J.D.; Horn, T.D. Communication between dermatologists and dermatopathologists via the pathology requisition: Opportunities to improve patient care. JAMA Dermatol. 2021, 157, 1033–1034.
14. El Saadawi, G.M.; Tseytlin, E.; Legowski, E.; Jukic, D.; Castine, M.; Fine, J.; Gormley, R.; Crowley, R.S. A natural language intelligent tutoring system for training pathologists: Implementation and evaluation. Adv. Health Sci. Educ. 2008, 13, 709–722.
15. Zhang, Y.; Chen, R.; Nguyen, D.; Choi, S.; Gabel, C.; Leonard, N.; Yim, K.; O'Donnell, P.; Elaba, Z.; Deng, A.; et al. Assessing the ability of an artificial intelligence chatbot to translate dermatopathology reports into patient-friendly language: A cross-sectional study. J. Am. Acad. Dermatol. 2023, 90, 397–399.
16. Elkassem, A.A.; Smith, A.D. Potential use cases for ChatGPT in radiology reporting. Am. J. Roentgenol. 2023, 221, 373–376.
17. Reeves, P.T.; Packett, A.C.; Burklow, C.S.; Echelmeyer, S.; Larson, N.S. Development and assessment of a low-health-literacy, pictographic adrenal insufficiency action plan. J. Pediatr. Endocrinol. Metab. 2022, 35, 205–215.
18. Liopyris, K.; Gregoriou, S.; Dias, J.; Stratigos, A.J. Artificial intelligence in dermatology: Challenges and perspectives. Dermatol. Ther. 2022, 12, 2637–2651.
19. Steele, L.; Velazquez-Pimentel, D.; Thomas, B.R. Do AI models recognise rare, aggressive skin cancers? An assessment of a direct-to-consumer application in the diagnosis of Merkel cell carcinoma and amelanotic melanoma. J. Eur. Acad. Dermatol. Venereol. 2021, 35, e877–e879.
20. ChatGPT. Image Inputs for ChatGPT—FAQ. Available online: https://help.openai.com/en/articles/8400551-image-inputs-for-chatgpt-faq (accessed on 26 December 2023).
21. Zhou, J.; He, X.; Sun, L.; Xu, J.; Chen, X.; Chu, Y.; Zhou, L.; Liao, X.; Zhang, B.; Gao, X. SkinGPT-4: An interactive dermatology diagnostic system with visual large language model. medRxiv 2023.
22. Chan, S.; Reddy, V.; Myers, B.; Thibodeaux, Q.; Brownstone, N.; Liao, W. Machine learning in dermatology: Current applications, opportunities, and limitations. Dermatol. Ther. 2020, 10, 365–386.
23. Khullar, G.; Chandra, M. Virtual dermatopathology: A potential educational tool during COVID-19 pandemic. Dermatologic Therapy 2020, 33, e13755.
24. Matin, R.N.; Linos, E.; Rajan, N. Leveraging large language models in dermatology. Br. J. Dermatol. 2023, 189, 253–254.
25. Abd-Alrazaq, A.; AlSaad, R.; Alhuwail, D.; Ahmed, A.; Healy, P.M.; Latifi, S.; Aziz, S.; Damseh, R.; Alrazak, S.A.; Sheikh, J. Large Language Models in Medical Education: Opportunities, Challenges, and Future Directions. JMIR Med. Educ. 2023, 9, e48291.
26. Omiye, J.A.; Lester, J.C.; Spichak, S.; Rotemberg, V.; Daneshjou, R. Large language models propagate race-based medicine. npj Digit. Med. 2023, 6, 195.

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