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Hot Topics: Exploring Artificial Intelligence and Inflammatory Memory in the Management of Psoriatic Diseases

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ABSTRACT. The "hot topics" session of the Group for Research and Assessment of Psoriasis and Psoriatic Arthritis (GRAPPA) 2024 annual meeting and trainee symposium explored the integration of artificial intelligence (AI) in managing psoriatic diseases (PsD) and the underlying mechanisms of inflammatory memory that drive recurrence in psoriasis and psoriatic arthritis. Drs. April Armstrong and Denis Poddubnyy discussed the transformative role of AI in enhancing diagnostic accuracy, assessing disease severity, and predicting treatment responses, particularly through deep learning models such as convolutional neural networks. AI systems have shown promise in providing objective, standardized assessments for psoriasis, with applications expanding across dermatology and rheumatology. Dr. Liv Eidsmo presented insights into inflammatory memory, a phenomenon sustained by both immune and nonimmune cells, including tissue-resident memory cells and epigenetically altered keratinocytes. Eidsmo emphasized the importance of understanding the cellular and molecular pathways that contribute to disease persistence. Both AI and inflammatory memory highlight key challenges and opportunities in PsD management; future research is needed to integrate technological advancements, with a deeper understanding of the biological processes affecting treatment outcomes.

Key Indexing Terms: artificial intelligence, deep learning, epigenetics, GRAPPA, psoriasis, psoriatic arthritis, tissue-resident memory cells

Challenges and opportunities of artificial intelligence in psoriatic diseases

The use of artificial intelligence (AI) in the diagnosis, assessment, and management of disease is revolutionizing the field of medicine, including that of psoriatic disease (PsD). Presentations by Drs. April Armstrong and Denis Poddubnyy at the Group for Research and Assessment of Psoriasis and Psoriatic Arthritis (GRAPPA) 2024 annual meeting provided complementary insights on the post-AI future of dermatology and rheumatology. Dr. Liv Eidsmo emphasized the role of underlying biological processes on patient outcomes and therapeutic strategies.

Dermatology perspective: AI in psoriasis

Armstrong's presentation, "Augmented intelligence in dermatology," explored the transformative role of AI in enhancing the diagnosis and treatment of dermatological conditions, with a specific focus on psoriasis (PsO). Training deep learning models—such as convolutional neural networks on dermatological image datasets—enables pattern recognition and predictive diagnostics for the extent of erythema, induration, and scaling, features critical to diagnosing PsO and assessing disease severity. Armstrong emphasized that AI should be seen not as a replacement for clinicians, but as a complementary tool that can augment diagnostic accuracy and efficiency.

Armstrong highlighted a significant advancement in dermatological technology: an AI-based deep learning model designed to estimate the Psoriasis Area and Severity Index (PASI) score, a key clinical metric for evaluating PsO severity. Unlike traditional PASI scoring, which can be subjective and inconsistent, the AI model—trained on a dataset of more than 14,000 images—offers a more standardized and objective approach that can outperform the diagnostic expertise of experienced dermatologists in certain aspects, such as the consistent evaluation of erythema and induration. The development of this diagnostic model into a mobile application enhances its accessibility and practicality, allowing clinicians to quickly analyze patient images for instant PASI scores. This not only streamlines the assessment process but also reduces human error and empowers patients to actively participate in managing their condition by monitoring their progress and sharing data with healthcare providers. These evolutions in AI technology could signal a broader shift in skin disease management with applicability to additional conditions, dermatologic and otherwise.

Despite these advancements, Armstrong also addressed the limitations and challenges associated with AI in dermatology, such as the "black box" nature of AI, wherein the decision-making process of the algorithms remains opaque. This

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lack of transparency can create challenges, particularly when AI-generated diagnoses conflict with a clinician's judgment. There are also concerns regarding algorithm bias, which can arise when AI systems are trained on nondiverse datasets. Further, although generative AI models like ChatGPT (OpenAI) may assist in providing evidence-based responses to clinical queries, Armstrong cautioned that they are not yet reliable for image recognition or for diagnosing rare or complex skin conditions.

In conclusion, Armstrong asserted that although AI holds significant potential for dermatology, particularly in enhancing the assessment and management of PsO, it should be viewed as a tool that complements rather than replaces the expertise of dermatologists. The integration of AI into clinical practice offers exciting possibilities for improving patient care but also necessitates careful consideration of ethical, regulatory, and technical challenges to ensure its effective and equitable application in the field.

Rheumatology perspective: challenges and opportunities of AI in PsD

Poddubnyy's presentation, "Challenges and opportunities of AI in psoriatic diseases," provided a rheumatologist's perspective on the role of AI in managing PsD, including skin and musculoskeletal manifestations such as psoriatic arthritis (PsA). AI models—such as generative pretrained transformers and other machine learning tools—can already provide diagnostic support by analyzing clinical data, including patient history and images, to identify possible diagnoses. Poddubnyy began with a case study of a 45-year-old patient with axial spondyloarthritis with an unclear skin rash that developed during treatment with a tumor necrosis factor inhibitor. This scenario set the stage for discussing AI's potential in aiding diagnosis.

One significant application of AI discussed is the development of prediction models for PsA risk among patients with PsO. A model designed to predict PsA risk trained on Taiwan's National Health Insurance Research Database achieved an area under the receiver-operating characteristic curve (AUROC) of 0.70, with notable sensitivity and specificity levels.[1] Similarly, a retrospective study employing the PredictAI tool on electronic medical records identified undiagnosed patients with PsA with specificity as high as 90% up to 4 years before diagnosis.[2]

AI's ability to handle complex imaging data, including magnetic resonance imaging (MRI), radiography, and computed tomography, could enhance diagnostic accuracy of PsD in clinical settings, particularly with regard to the analysis of these data. In 1 case, a neural networks model, trained on MRI scans to differentiate between conditions such as rheumatoid arthritis and PsA, achieved a high accuracy, with AUROC values ranging from 67% to 92%.[3]

Poddubnyy also highlighted AI's role in predicting treatment responses. AI models can use large datasets from clinical trials to predict patient responses to various treatments, enabling more personalized and effective management of PsD. In 1 instance, AI tools—trained on data from patients treated with secukinumab or guselkumab—identified clusters of patients with different responses to treatment, representing personalized information that could guide therapeutic decisions.[4,5]

However, the challenges in implementing AI in PsD management are similar to those arising from the dermatology perspective. One major concern is the aforementioned transparency of AI algorithms (ie, black box), where the decision-making process is not easily interpretable. This could be problematic when AI recommendations contradict clinical judgment. Additionally, AI models can suffer from biases if trained on nondiverse datasets, limiting their generalizability across different patient populations.

Inflammatory memory in PsD: mechanisms and therapeutic challenges

Eidsmo's presentation, "Inflammatory memory in psoriatic disease: mechanisms and therapeutic challenges," addressed inflammatory memory in the persistence and recurrence of PsO and PsA. Although AI offers promising advancements in the diagnosis, assessment, and management of PsD, understanding the underlying biological mechanisms driving PsD is equally important for treatment discovery. Eidsmo discussed the mechanisms of inflammatory memory in PsD and the associated treatment challenges, emphasizing the tissue-wide inflammatory memory that contributes to the persistent and relapsing nature of PsA and PsO.[6-8]

The cellular players in inflammatory memory include keratinocytes, fibroblasts, and both infiltrating and resident immune cells, particularly T cells and Langerhans cells. Crosstalk between infiltrating and resident immune cells and stroma results in epigenetic changes in keratinocyte stem cells related to a long-lasting state of "trained inflammatory alertness."[9] An environment that perpetuates the disease state is present in resolved lesions and makes recurrence more likely. The reduced threshold for subsequent inflammatory episodes in PsA and PsO suggests that effective therapeutic strategies should encompass both resident and circulating immune cells and the environment that steers their functionality.[8] However, given that tissue-resident memory (TRM) cells are key players in inflammatory memory, which is crucial for maintaining skin health,[6] Eidsmo argued that targeting and eliminating TRM cells is insufficient to prevent disease recurrence. Instead, she highlighted the importance of addressing both TRM cells and the inflammatory signals from tissues already epigenetically primed for inflammation.

Eidsmo also pointed out the need for a deeper understanding of the interplay between joint and skin inflammation in PsD.[7,10] She called for further research into the roles of different cellular and molecular pathways that sustain inflammatory memory, which could ultimately lead to the development of more targeted and effective treatments for PsD.

Conclusion

Overall, the "hot topics" presentations emphasized the tremendous potential AI offers to enhance the diagnosis, assessment, and management of PsD. Dermatology has been focusing on leveraging deep learning models to standardize PsO severity assessments. In parallel, rheumatology is exploring the use of AI to predict PsA, improve diagnosis, and optimize treatment responses—all of which have the potential to substantially

enhance clinical practice. However, the successful integration of AI into health care requires careful consideration of ethical, regulatory, and technical challenges. As AI technology continues to evolve, its capacity to complement clinician expertise could enhance patient care in PsD.

As AI revolutionizes predictive diagnostics, advancing our understanding of the diverse cellular contributors and molecular mechanisms driving inflammatory memory is critical to developing new therapies for PsD. To that end, the hot topics presentations also addressed the role of inflammatory memory in the recurrent nature of PsD. Most notably, therapeutic strategies that address both the skin and joint manifestations of PsD have the potential to transform patient care and outcomes.

Collectively, these insights demonstrate the need for an integrated approach that combines technological advancements with a deeper understanding of disease mechanisms to achieve more precise, personalized, and efficient management strategies in PsD.

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PEER REVIEW

As part of the supplement series GRAPPA 2024, this report was reviewed internally and approved by the Guest Editors for integrity, accuracy, and consistency with scientific and ethical standards.

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