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Artificial intelligence in osteoarthritis research: summary of the 2025 OARSI pre-congress workshop

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ABSTRACT

Objective: Artificial intelligence (AI) is transforming musculoskeletal research, offering new approaches to diagnosis, prognosis, and patient management in osteoarthritis (OA). However, implementation and ethical challenges persist. This manuscript summarizes insights from the OARSI 2025 Pre-Congress Workshop on Artificial Intelligence in Osteoarthritis Research, highlighting opportunities and challenges in applying AI across biomechanics, imaging, and clinical research domains.
Design: The workshop, organized by the OARSI Early Career Investigator Committee and co-chaired by Drs. Matthew Harkey and Brooke Patterson, convened experts to discuss the use of AI in real-world biomechanics data collection, radiomics for imaging-based biomarkers, and large language models (LLMs) for clinical and research applications. Emphasis was placed on the need for interdisciplinary collaboration and ethical oversight.
Results: In biomechanics, AI-driven markerless motion capture and wearable sensors enable scalable, ecologically valid data collection, though issues such as class imbalance, data privacy, and model interpretability remain. In imaging, radiomics and deep learning models show promise for early OA detection and progression prediction but face challenges in domain adaptation and external validation. In clinical research, LLMs can streamline documentation and thematic analysis but must address concerns around bias, data security, and transparency. Across domains, transparency, reproducibility, and ethical use of AI were emphasized as critical for maintaining scientific rigor.
Conclusions: Cross-disciplinary collaboration and AI literacy are essential to responsibly advance AI integration in OA research. The workshop's collective insights call for ethical, patient-centered approaches that leverage AI's strengths while preserving research integrity and trust.

1. Introduction

Research is experiencing rapid evolution due to advances in artificial intelligence (AI) technologies. In osteoarthritis (OA) research, machine learning is being used to mine vast archives of scientific literature, imaging data, and clinical records; AI-driven markerless motion-capture systems now enable efficient biomechanics data collection; and large language models (LLMs) can summarize clinical notes, experimental data, and full scientific publications in seconds. Yet despite this progress, widespread implementation of these tools still falls short of their potential and can pose significant ethical challenges.

To explore these opportunities and challenges, the Osteoarthritis Research Society International (OARSI) 2025 Pre-Congress Workshop on AI in OA was held to foster dialogue across disciplines (Table 1). This live workshop was organized by the OARSI Early Career Investigator Committee and developed and co-chaired by Drs. Matthew Harkey and

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Table 1
Overview of Topics and Key Takeaways from the OARSI 2025 Pre-Congress Workshop on Artificial Intelligence in Osteoarthritis Research. The OARSI 2025 Pre-Congress Workshop was organized by the OARSI Early Career Investigator Committee and co-chaired by Dr. Matthew Harkey and Dr. Brooke Patterson. The workshop fostered interdisciplinary dialogue and promoted responsible integration of AI in osteoarthritis research.

Workshop Topic	Presenter(s)	Key Takeaways
AI in biomechanics	Dr. Kerry costello	- Enables large-scale, real-world biomechanics data collection. - Advances predictive modeling for OA risk. - Key challenges: • Class imbalance and data leakage. • Interpretability for clinical use. • Privacy and computational demands.
AI in imaging and radiomics	Dr. Chunyi Wen	- Converts imaging data into quantitative biomarkers. - Improves progression prediction with multi-modal AI models. - Key challenges: • Domain adaptation and validation. • Model explainability.
LLMs in clinical and research applications	Dr. Bella Mehta	- Streamlines clinical documentation and research synthesis. - Reduces errors using retrieval-augmented generation. - Key challenges: • Data privacy and bias management. • Ensuring model transparency.
Ethical and publishing considerations	Dr. Anne-Marie Malfait, Dr. Henning Madry[a]	- Calls for transparency in AI use and disclosure. - Limits AI to language refinement, with human oversight. - Key challenges: • Misinformation and authorship integrity. • Peer review confidentiality.

[a] Drs. Anne-Marie Malfait and Henning Madry contributed their perspectives in their roles as Editors of *Osteoarthritis and Cartilage* and *Osteoarthritis and Cartilage Open*, respectively.

Brooke Patterson. The event featured four invited presentations, each followed by a brief audience Q&A session. The presenters were selected for their expertise in AI-related applications in biomechanics, imaging, LLMs, and scientific publishing. This article offers a structured summary and key insights from the workshop speakers, for those unable to attend and for the wider OA research community. Our aim is to share illustrative ideas and commonly cited challenges (not provide a comprehensive scholarly synthesis) to promote continued interdisciplinary dialogue around the ethical, transparent, and collaborative use of AI in OA research and clinical care.

2. Promises and predictions in key domains

2.1. AI in biomechanics

The following section summarizes broad themes and practical considerations raised during Dr. Kerry Costello's presentation at the OARSI 2025 Pre-Congress Workshop.

2.1.1. Applications

AI provides opportunities to both develop and analyze large OA biomechanics datasets, addressing issues with small samples that have long limited translatability of biomechanics results [1,2]. Traditional gait labs with marker-based systems are labor-intensive and often fail to capture real-world movement patterns. Advances in markerless motion-capture technology now allow joint kinematics to be measured from standard video [3], significantly reducing data collection time and enabling scalable analysis across varied environments. While differences between motion capture systems remain a challenge for pooling data across studies, markerless approaches may help reduce variability by avoiding differences in marker sets and placement across labs, even though variation across hardware and processing software still exists. In parallel, AI-driven predictive models are being developed to estimate joint loading from kinematic data, enhancing the utility of wearable sensors for capturing biomechanics in real-world environments [4]. Importantly, these emerging technologies also create opportunities to build larger, more heterogeneous datasets, which can strengthen signal relative to noise and improve the representativeness of AI models for the broader OA population. Building on this, biomechanics data are also being integrated with other relevant risk factors, such as patient-reported outcome measures, imaging, and clinical history, into AI models to improve predictions of OA progression. These integrative approaches, as described in the workshop, aim not only to identify patients at higher risk but also to inform personalized rehabilitation and prevention strategies.

2.1.2. Challenges

Building AI models with biomechanical data requires careful consideration of model inputs and outcomes. For example, biomechanical data from both limbs of the same individual are not independent and should not be split across training and test sets, as this can lead to data leakage [5]. OA datasets also frequently exhibit class imbalance, with far fewer cases of rapid progression than non-progression. This imbalance necessitates techniques such as data augmentation or cost-sensitive learning to avoid models that skew predictions toward the majority class [5]. Ensuring generalizability across diverse populations and joints is another challenge, especially when training datasets are small or demographically narrow. Clinicians also value interpretability, making it important to balance model performance with transparency. While AI models are highly effective at predicting outcomes, they are typically not designed to identify causal or mechanistic relationships. Thus, caution is warranted when interpreting feature importance scores as targets for intervention without appropriate causal inference methods. Finally, concerns about data privacy, particularly for video and wearable sensor data, and the computational demands of certain AI techniques continue to pose barriers to widespread adoption. These concerns include the potential re-identification of individuals from video data, the need for secure storage and sharing protocols, and the limited accessibility of high-performance computing resources in many research and clinical settings.

2.1.3. Translational examples

Dr. Costello emphasized the importance of letting clinical questions guide AI applications, rather than allowing technology to dictate research directions. The most impactful efforts are likely to be those grounded in real clinical needs, such as identifying which patients may benefit from specific interventions, with AI tools selected accordingly. Thoughtful and appropriate data handling and model selection will further ensure both the validity and clinical relevance of AI biomechanics models. For example, data leakage can be prevented by keeping both legs from a single individual in the same data split, and class imbalance can be addressed through data augmentation (e.g., resampling), model selection (e.g., ensemble methods), or training strategies that adjust misclassification penalties to account for underrepresented groups (e.g., cost-sensitive learning). Developing AI and data science literacy among OA researchers and clinicians was highlighted as a key enabler for effective collaboration with data scientists and for critical evaluation of data pipelines and model outputs. Ultimately, while AI presents promising opportunities for advancing biomechanics research and patient care, its most impactful use may lie in enabling large-scale, real-world data collection that better captures the diversity of individuals living with OA. By integrating biomechanics with imaging, patient-reported outcome measures, and clinical data, AI can support more inclusive, representative, and context-aware models of joint health, as emphasized by the presenter, offering both a path toward more personalized care and opportunities for scalable biomechanics interventions.

2.2. AI in imaging

This section summarizes major themes and current trends presented by Dr. Chunyi Wen during the OARSI 2025 Pre-Congress Workshop.

2.2.1. Applications

Imaging is perhaps the most advanced area for AI applications in OA research [6–8]. Dr. Chunyi Wen highlighted how the field is moving beyond subjective radiographic grading, such as Kellgren-Lawrence (KL) grade, toward continuous, automated radiomic scoring. Radiomics converts standard medical images into rich, quantitative data, enabling extraction of features that capture cartilage texture, bone shape, and other subtle structural changes [9]. These features serve as sensitive imaging biomarkers, capable of detecting early or microscopic joint changes that might elude human observers. When combined with machine learning and deep learning, radiomics has significantly improved OA diagnostic and prognostic models [10]. Multi-view imaging models, integrating data from X-ray, MRI, and longitudinal imaging sequences, have demonstrated high accuracy in predicting OA progression [11]. Advanced AI architectures, such as transformer networks and diffusion models, were highlighted for their role in enhancing imaging analytics, enabling synthetic image generation for data augmentation or resolution enhancement [12].

2.2.2. Challenges

Domain adaptation is critical, as models trained on specific populations or scanner types often struggle to generalize broadly across settings. Many AI models also lack external validation, raising concerns about their generalizability and robustness. Moreover, differentiating early OA from normal aging, particularly between KL grade 1 and 2 knees, remains difficult [13]. High computational demands and the need for large, well-annotated datasets limit accessibility for many research groups. Dr. Wen emphasized the importance of developing explainable AI tools, ensuring that algorithms highlight interpretable features that clinicians can trust and integrate into decision-making.

2.2.3. Translational examples

Dr. Wen presented real-world examples where AI models matched the diagnostic accuracy of senior radiologists in detecting subtle joint changes on radiograph and MRI [14,15]. We acknowledge that domain adaptation remains a significant hurdle in biomedical imaging, particularly when translating algorithms across institutions, imaging modalities, or patient populations. To address this, several approaches (e.g., transfer learning, data augmentation, adversarial training, and federated learning) have shown promise in improving model generalizability and robustness while preserving data privacy. However, real-world implementation remains limited due to technical complexity, evaluation challenges, and the need for curated training datasets. Dr. Wen shared his experience using data from the US, UK, and Hong Kong to develop and validate a generalized patellofemoral radiomics model for predicting progressive knee OA. Rather than relying on advanced domain adaptation methods, the model's performance was strengthened by leveraging shared imaging features across diverse populations, enabling more reliable prediction of OA progression in multicontinental cohorts. Additionally, open-source tools now enable fully automated three dimensional cartilage segmentation, streamlining workflows and supporting large-scale studies [16]. He also described efforts to build “digital twins” of the knee joint, combining AI with quantitative CT and MRI to simulate OA progression and forecast patient-specific outcomes [17]. This approach may support in silico trials [17], helping clinicians to test interventions virtually before recommending them in the clinic. Another emerging application is the combination of low-field, portable MRI with AI-based image enhancement, offering a cost-effective imaging solution that could expand access in under-resourced settings or community screening [18].

2.3. LLMs in clinical and research applications

The following summary captures insights and current use cases and challenges from Dr. Bella Mehta's presentation at the OARSI 2025 Pre-Congress Workshop.

2.3.1. Clinical applications

Generative artificial intelligence, particularly LLMs, such as ChatGPT, are rapidly emerging as powerful tools in both clinical practice and research [19,20]. Dr. Bella Mehta highlighted how LLMs can assist in extracting PROMs and other valuable data from unstructured electronic medical records, turning free-text clinical notes into structured, analyzable data. In clinical settings, LLMs are being explored to support a range of communication and documentation tasks, including patient education, generation of discharge summaries, and administrative workflows, potentially easing clinician workload.

2.3.2. Research applications

In OA research, LLMs are proving useful for mixed-methods studies, assisting with thematic analysis of patient interviews and helping generate survey instruments. For example, an LLM can cluster patient narratives into thematic categories, which researchers can then validate [21]. Dr. Mehta also discussed how retrieval-augmented generation frameworks—combining LLMs with curated databases—are helping to mitigate common issues like AI hallucinations, improving the factual accuracy of AI-generated outputs. She introduced emerging models such as DeepSeek, an open-source large language model developed in China that employs a Mixture-of-Experts architecture and multistage knowledge distillation to improve efficiency and reasoning capabilities. In benchmarking studies, DeepSeek outperformed GPT-4 on a range of medical tasks, including multiple-choice questions and open-ended clinical reasoning, and achieved the highest performance to date on Chinese medical licensing exams [22]. These developments suggest a growing interest in domain-specific LLMs tailored for healthcare applications and multilingual contexts, as discussed by Dr. Mehta. This signals the potential for specialized, domain-tuned models to assist in clinical and research applications in OA.

2.3.3. Challenges

Dr. Mehta cautioned that LLMs are best viewed as augmentative tools, not autonomous agents. Data privacy and security remain paramount, particularly when models interact with sensitive patient information. The interpretability of LLM outputs is also a concern; clinicians must understand the basis of AI-generated recommendations to ensure safe integration into care pathways. Additionally, biases inherent in training data can exacerbate healthcare disparities if not addressed, underscoring the need for careful model validation and monitoring. Over-reliance on LLMs poses risks of factual inaccuracies or misinterpretations, issues that make human oversight and critical appraisal essential at every stage of AI-assisted workflows.

To further address these concerns, Dr. Mehta emphasized several practical strategies. Bias mitigation strategies are essential for the safe and equitable deployment of LLMs in OA care. This includes ensuring training datasets represent diverse patient populations, evaluating model performance across subgroups, and incorporating human oversight throughout the workflow. Protecting patient privacy also requires practical safeguards, such as de-identifying data, implementing secure data-sharing protocols across institutions, and maintaining transparent audit logs. Evaluation of LLMs should go beyond accuracy alone—metrics such as fairness across demographic groups, calibration, and real-world clinical utility must also be assessed. Responsible implementation demands ongoing monitoring, clear documentation of model performance, and adherence to standards that prioritize both patient safety and health equity. As LLM technologies evolve, responsible integration will require transparency, validation in clinical settings, and close collaboration between AI developers, clinicians, and researchers.

2.4. Pitfalls and ethical perspectives for publishing

This final section summarizes closing remarks from Drs. Anne-Marie Malfait and Henning Madry, presented in their respective roles as Co-Editor of Osteoarthritis and Cartilage and Editor of Osteoarthritis and Cartilage Open. Their presentations focused on the ethical, editorial, and policy-related considerations surrounding the use of AI in scientific publishing. The perspectives shared below reflect guidance provided to workshop attendees and are intended to support responsible and transparent AI use in OA research and dissemination. They highlighted the broader ethical landscape and publishing policies surrounding AI use in OA research and reporting. They underscored the critical need for transparency, reproducibility, and human oversight when incorporating AI into scientific work. As outlined in Elsevier's policies [23], generative AI tools may be used to improve the language and readability of a manuscript, but only under human oversight. Drs. Malfait and Madry emphasized that generative AI should not be used to create scientific content or generate novel ideas, although the use of AI as part of the research methods (e.g., model development or analysis) is permitted.

Importantly, the use of AI tools in manuscript preparation must be fully and transparently disclosed. A formal statement detailing the use of AI technologies is required at the time of submission, in accordance with journal policies aimed at preserving transparency and scientific rigor. Consistent with the *Osteoarthritis and Cartilage* and *Osteoarthritis and Cartilage Open* authorship guidelines [24], AI and AI-assisted technologies cannot be credited as authors. Authorship requires substantial contributions to the conception, design, drafting, or critical revision of the manuscript, as well as final approval of the version to be submitted—all of which must be performed by humans. Authors remain solely responsible for the accuracy, integrity, and oversight of any AI-assisted content.

For reviewers and editors, the stakes are equally high. Uploading confidential manuscripts (or scientific grant applications) into public AI tools, such as ChatGPT, is strictly prohibited due to risks of breaching confidentiality and intellectual property rights. The use of AI to manipulate figures is also forbidden unless explicitly part of the research methods, with many journals now employing image forensic tools to detect such alterations. The editors shared cautionary examples, including fabricated manuscripts, hallucinated references, and AI-generated content that passed initial editorial checks, illustrating the risks of over-reliance on AI without proper verification and human oversight. Publishers are collaborating to develop AI-detection tools for both text and images, though no system is yet infallible. For example, a recent study identified a considerable increase in the number of "formulaic research articles" with inappropriate study designs and false discoveries, based on a large public health database [25], highlighting the risk of using AI-assisted workflows that may introduce low-quality literature to the scientific community [26].

Drs. Malfait and Madry concluded by emphasizing that while AI can support research efficiency, it cannot replace the creative and critical thinking, contextual expertise, and the scientific and ethical judgment that human researchers, reviewers, and editors provide. Upholding scientific integrity in the age of AI will require vigilant oversight, transparent reporting, and a shared commitment to responsible use of these evolving tools. If this endeavor fails, the trust in the rigor of scientific findings is at risk to erode over time.

3. Conclusion and call to action

The integration of artificial intelligence into academic research and publishing is rapidly evolving, presenting both opportunities and responsibilities for the OA research community. While much of the focus to date has been on AI's role in data analysis and image processing, the rise of LLMs introduces equally important questions about how we generate, write, review, and disseminate scientific knowledge [27–31]. Concerns around hallucinated content, misattributed authorship, and the use of public AI tools with confidential material are valid and must continue to guide editorial and institutional policies [26]. Yet, a growing body of evidence also highlights the productive, responsible uses of generative AI in academic workflows [29,30]. When applied transparently and under human oversight, AI tools can improve the clarity, accessibility, and efficiency of scholarly writing—particularly benefiting multilingual authors and early-career researchers [28,31].

This manuscript highlights key themes and discussion points raised during the 2025 OARSI Pre-Congress Workshop on AI and is not intended to offer a definitive framework or exhaustive review. Our goal is to encourage ongoing dialogue, identify shared challenges, and foster cross-disciplinary engagement in the ethical adoption of AI in OA research. Moving forward, journals, funders, institutions, and mentors should work together to provide clearer guidance, standardized disclosure practices, and broader AI literacy training. By building space for collaborative conversation and responsible innovation, the research community can ensure that AI enhances—not undermines—the rigor, equity, and trustworthiness of academic work.

Author contributions

Conception and design of the work: All authors.

Drafting of the manuscript: MSH, BP.

Critical revision of the manuscript for important intellectual content: KEC, CW, BM, AMM, HM.

Approval of final version of the manuscript: All authors.

Accountability for all aspects of the work, including accuracy and integrity: All authors.

Declaration of generative AI use

ChatGPT 4o was used to assist with summarization and language refinement during the preparation of this manuscript, based on discussions and presentations from the OARSI 2025 Pre-Congress Workshop. All content was generated under the oversight of the authors, who carefully reviewed and edited the text to ensure its accuracy and integrity.

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Declaration of competing interest

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HM is Editor-in-Chief of Osteoarthritis and Cartilage Open, a Board Member of OARSI, and a member of the Study Section for Orthopaedics and Traumatology of the Deutsche Forschungsgemeinschaft. He has received research support from Deutsche Forschungsgemeinschaft and the European Union's HORIZON program and has served on advisory boards for Thuasne Group and Contura International A/S.

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