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Advancing AI literacy in Canadian orthopedic education: a framework for equitable and inclusive training

Faire progresser la littératie en IA dans la formation orthopédique au Canada : un cadre pour une formation équitable et inclusive

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Introduction

Canadian orthopedic practice is undergoing major change as artificial intelligence (AI) and machine learning (ML) tools enter clinical and training environments. These technologies can enhance surgical planning, decision support, and efficiency while reshaping how trainees learn. AI now influences surgical planning, navigation, and postoperative care, directly affecting orthopedic education. Accordingly, AI literacy and equity-informed algorithmic governance are emerging as competencies that may meaningfully enhance North American orthopedic residency training.

Current and prospective applications of AI in training and care

Several Canadian academic hospitals are piloting AI-integrated tools relevant to orthopedic education. At the Maisonneuve-Rosemont Hospital in Montréal, researchers have implemented preoperative predictive analytics to predict surgical risk,[1] providing residents with learning experiences in data-driven decision-making. In London, Ontario, the Canadian Surgical Technologies and Advanced Robotics (CSTAR) program has developed AI-augmented robotic training platforms for endoscopy, minimally invasive surgery, and tumor localization,[2] offering structured opportunities to practice complex operative tasks. Many academic settings employ AI-powered simulation platforms allowing residents to rehearse procedures and receive data-informed feedback, an experience difficult to replicate in traditional rotations.

Equity and inclusion in AI deployment

AI tools introduced into Canadian training environments do not address gaps in learner understanding. Models trained on urban, resource-rich populations often underperform in rural or Indigenous settings due to a dataset mismatch, and these limitations should be addressed in orthopedic curricula. For example, musculoskeletal MRI segmentation models showed reduced accuracy in underrepresented groups,[3] offering a teaching case for residents learning to evaluate AI reliability. Programs in homogeneous regions with limited imaging infrastructure, like Baie-Saint-Paul, could be heavily affected. Educators should also consider cultural frameworks, such as the Mi'kmaq "Two-Eyed Seeing" approach,[4] which blends Indigenous and Western epistemologies. Incorporating these frameworks into curricula can guide inclusive and representative AI co-development teaching.

Current initiatives to expand care and training

The Orthopaedic Outreach Program in Newfoundland and Labrador has reduced geographic barriers by sending specialists to rural communities like Happy Valley-Goose Bay.5 Integrating AI into these outreach models could further optimize referral triage and expose trainees to decision-support systems in distributed settings. ML-assisted imaging may also augment point-of-care decision-making in clinics without full-time specialists, allowing residents to practice interpreting AI-supported imaging in low-resource contexts. Ontario's Virtual Urgent Care (VUC) pilot, which incorporates pre-clinical algorithmic triage, offers another model for expanding digital consultations.[6] Although not yet AI-driven, such systems could incorporate ML-based triage pathways for acute injuries, creating new educational opportunities in tele-emergency contexts.

The Royal College of Physicians and Surgeons of Canada's Competence by Design (CBD) framework increasingly emphasizes digital health literacy, recommending integration of AI and digital technology competencies into the CanMEDS framework. Institutions such as the University of Toronto and the University of British Columbia (UBC) offer training in clinical data science and health informatics.[7] Strategic partnerships with the Vector Institute (Toronto) and Mila (Montreal) could further advance these efforts by embedding surgical learners within applied ML labs.

Policy recommendations: infrastructure, education, and regulation

Integrating AI and ML into musculoskeletal care in Canada requires alignment with national legal frameworks, particularly the Digital Charter Implementation Act (Bill C-27) and the Artificial Intelligence and Data Act (AIDA). AIDA introduces risk classifications for AI systems, with high-impact systems subject to obligations related to transparency, data provenance, and algorithmic fairness. These regulations will increasingly shape how orthopedic residents employ AI during training.

We believe that the Canadian Institutes of Health Research (CIHR) and provincial agencies should establish dedicated AI funding streams focused on Indigenous health equity, rural learning environments, and surgical education. These programs must align with ethical frameworks such as the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), which mandates community-led co-development in Indigenous health research. We also recommend that the Canadian Orthopaedic Association (COA), the Royal College, and PGME bodies develop a national AI competency curriculum, incorporating formal learning experiences with supervised and unsupervised learning models, clinical validation pipelines, explainable AI, and federated learning strategies. Demographic audit mechanisms aligned with AIDA's bias mitigation requirements can also serve as training tools for evaluating equitable model performance.

Conclusions

AI-ML technologies are transforming surgical innovation, positioning Canada to lead in responsible AI integration for musculoskeletal care and orthopedic training. We see substantial opportunities for enhancing resident education through improved access for remote learning environments, refined surgical precision, and real-time decision-support. However, without alignment with national regulations, Indigenous governance principles, and educational reform, these advances risk deepening gaps in training quality and healthcare delivery. As orthopedic surgery depends on imaging, biomechanics, and improving care before and after surgery, we see it as a key area for AI involvement. By investing in equitable infrastructure, embedding AI literacy in surgical training, and prioritizing co-development with Indigenous communities, we hope that Canada lead in responsible AI adoption in procedural medicine and surgical education.

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