**Augmenting not replacing: preparing the future health workforce for the digital tools revolution in clinical reasoning**

Andrzej A. Kononowicz1\*, Joanna Fąferek2, Ada Frankowska1,   
Anna Kocurek2, Małgorzata Sudacka2, Renata Szydlak1

1Department of Bioinformatics and Telemedicine, Jagiellonian University Medical College,   
Medyczna 7, 30-688 Kraków, Poland  
2Center for Innovative Medical Education, Jagiellonian University Medical College,   
Medyczna 7, 30-688 Kraków, Poland  
{*andrzej.kononowicz, joanna.faferek, ada.frankowska, anna.kocurek, malgorzata.sudacka, renata.szydlak*}@*uj.edu.pl*

\*) on behalf of the D-CREDO project consortium

**Keywords**: clinical reasoning, digital health tools, clinical decision support systems, virtual patients

1. **Introduction**

Clinical reasoning (CR) is the cognitive skill health professionals use in practice to observe, collect, and analyze information in order to diagnose and manage patients, taking into account their specific circumstances and preferences [1]. Poor CR performance directly contributes to medical errors and must continually be improved to ensure a safe and efficient healthcare system. A wide range of digital tools are currently available to enhance CR in practice.

1. **Description of the problem**

Despite the excellent performance of many digital tools in simulated, individual CR tasks, their integration in clinical practice faces significant challenges. For instance, it has been observed that human-machine collaboration does not necessarily lead to improvements in practice and, in some cases, artificial intelligence (AI) alone performs better than when used in collaboration with humans [2]. One explanation is the limited proficiency in using the technology. Consequently, methods are being sought to redesign medical education in order to prepare future health professionals to use emerging technologies efficiently as synergistic partners in CR.

1. **Related work**

Several CR curricula and methods to support the acquisition of this skill are available [3-5]. Researchers have also proposed general approaches to learning CR in alignment with digital tools [1,2]. However, what remains lacking is a comprehensive curriculum with learning resources that explicitly address the use of digital tools in CR.

1. **Solution to the problem**

The D-CREDO project [6], a three-year initiative launched in 2024 and funded by the European Commission, aim to develop a curriculum that teaches both undergraduate health professional students and their teachers how to use digital tools in CR practice. The authors, representing the coordinating institution, work closely with project partners from Austria, Germany, the Netherlands, and Ukraine across several stages of the curriculum development process. The needs analysis comprised 30 semi-structured interviews and 118 survey responses collected across partner institutions. It enabled the selection of digital tool categories considered particularly relevant for the CR process: AI in image analysis, large language models and big data technologies, mHealth applications and wearables, electronic health records with clinical decision support functionality, and telehealth technologies such as videoconferencing and remote monitoring. Building on a systematic rapid review of more than 1500 abstracts from the literature [7] and a Delphi consensus process with associated partners, the consortium has developed a catalogue of 26 learning objectives and produced a white paper outlining selected learning and assessment strategies, both available as deliverables on the project website: <https://d-credo.eu>. At the current stage, the project is finalizing a blueprint of more than ten new learning units that extend the existing DID-ACT curriculum [4]. The curriculum is grounded in theoretical frameworks such as distributed cognition theory, cognitive load theory, and experiential learning theory, and is designed to include a range of self-directed and group learning activities. This activities will cover, e.g. CR-focused prompt engineering techniques, role-played virtual visits, strategic data synthesis of patient information across the electronic health record, and the ethical and legal aspects of CR with digital tools. The learning units will feature virtual patients adapted from the iCoViP repository, illustrating the use of D-CREDO digital tools in CR practice [5].

1. **Conclusions and future work**

During the first year, the D-CREDO project delivered a comprehensive set of source materials, along with an understanding of the needs of the stakeholders involved in CR education. These will be transformed into interactive learning units based on the blueprint during the second year of the project, and then verified and refined in the final year based on eight implementation studies. The associated partner network of the project is open to collaboration with external institutions interested in adopting the learning units or contributing digital tools relevant for CR practice and education. Such tools can be integrated into the curriculum as examples, and thereby learned, tested, and disseminated by a broader community of future health professionals.

**Acknowledgements.** We acknowledge the support of the EU under grant D-CREDO No. 2024-1-PL01-KA220-HED-000247790 (Erasmus+, Cooperation Partnerships in Higher Education). The project partner institutions on behalf of which the abstract is presented are: Bukovinian State Medical University (Ukraine); Erasmus Universitair Medisch Centrum, Rotterdam (the Netherlands); Instruct gGmbH, Munich (Germany); UMIT Tirol, Hall, (Austria).

**References**

1. Pinnock R, McDonald J, Ritchie D, Durning SJ. *Humans and machines: Moving towards a more symbiotic approach to learning clinical reasoning*. Med Teach. 2020 Mar;42(3):246-251.
2. Goh E, Gallo R, Hom J, Strong E, Weng Y, Kerman H, et al. *Large Language Model Influence on Diagnostic Reasoning: A Randomized Clinical Trial*. JAMA Netw Open. 2024 Oct 1;7(10):e2440969.
3. Elvén M, Welin E, Wiegleb Edström D, Petreski T, Szopa M, Durning SJ et al. Clinical Reasoning Curricula in Health Professions Education: A Scoping Review. J Med Educ Curric Dev. 2023 Oct 25;10:23821205231209093.
4. Hege I, Adler M, Donath D, Durning SJ, Edelbring S, Elvén M, et al. *Developing a European longitudinal and interprofessional curriculum for clinical reasoning*. Diagnosis (Berl). 2023 Feb 20;10(3):218-224.
5. Mayer A, Da Silva Domingues V, Hege I, Kononowicz AA, Larrosa M, Martínez-Jarreta B, et al. *Planning a Collection of Virtual Patients to Train Clinical Reasoning: A Blueprint Representative of the European Population*. Int J Environ Res Public Health. 2022 May 19;19(10):6175.
6. D-CREDO - *Digital Health Technologies-augmented Clinical Reasoning Education*, EU Project, Erasmus+, <https://d-credo.eu/>
7. Ammenwerth E, Zwaan L. *Integration of Digital Tools into Clinical Reasoning Education: A Rapid Review*. Stud Health Technol Inform. 2025 Apr 24;324:49-50.