LEVELS OF CLINICAL INTEGRATION OF ARTIFICIAL INTELLIGENCE IN DENTISTRY

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Introduction. Artificial intelligence (AI) is increasingly applied in dentistry, particularly in diagnostic imaging, treatment planning, digital prosthodontics, and surgical guidance. These technologies are gradually evolving from tools that provide analytical support to systems that participate in clinical decision-making and procedural implementation.

Despite the increasing number of studies in this field, the scientific literature still lacks a unified framework for assessing the degree of clinical integration of AI systems. Most existing studies focus primarily on algorithmic performance metrics, such as accuracy, sensitivity, and specificity, which do not fully reflect the extent to which AI influences clinical workflows and the distribution of professional responsibility.

The novelty of the present study lies in the development of a conceptual model describing different levels of clinical integration of artificial intelligence in dentistry based on the depth of algorithmic involvement in clinical interventions.

Objective. To develop a theoretical and methodological model describing the levels of clinical integration of artificial intelligence in dental practice.

Materials and Methods. This study was conducted as an analytical review of scientific publications published between 2010 and 2024 and indexed in PubMed, Scopus, and Web of Science. The review included studies addressing the use of AI in oral surgery, implantology, digital prosthodontics, and robot-assisted technologies. The analysis focused on the depth of algorithmic involvement in the clinical workflow and the extent to which elements of clinical responsibility are delegated to algorithmic systems.

Results. Based on the analysis, a four-level model of clinical AI integration in dentistry was proposed:

1. Analytical support, where AI systems provide diagnostic or analytical information without influencing clinical decision-making directly.
2. Clinical decision-support, where algorithms contribute to treatment planning and assist clinicians in selecting therapeutic strategies.
3. Navigation-integrated assistance, where AI technologies are incorporated into procedural guidance systems that influence spatial parameters of clinical interventions.
4. Robot-assisted intervention, where AI systems participate in the direct execution of specific stages of a clinical procedure.

The review of existing publications demonstrates that most currently implemented AI applications correspond to the first two levels of integration, while navigation-based and robotic systems remain primarily within experimental or early clinical implementation stages. Increasing levels of AI integration are associated with progressively higher requirements for procedural safety, reproducibility of clinical outcomes, and regulatory oversight.

Conclusions. The degree of clinical integration of artificial intelligence should be assessed not by the level of algorithmic autonomy alone, but by the extent of its influence on the structure of clinical intervention and the redistribution of clinical responsibility between the clinician and the algorithmic system.

The proposed model provides a conceptual framework for classifying AI implementation scenarios in dentistry and may serve as a methodological basis for defining requirements for clinical validation, safety assessment, and regulatory governance of AI-assisted technologies.

Keywords. Artificial intelligence; dentistry; clinical decision support; digital dentistry; robot-assisted dentistry; clinical workflow; AI integration.