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Volume 1 / Issue 2

KOS Journal of AIML, Data Science, and Robotics

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# Beyond Human Limits: How AI is Expanding the Boundaries of Medical Possibility

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**Received:** December 06, 2025; **Accepted:** December 07, 2025; **Published:** December 08, 2025**Citation:** Verena Lengston. (2025) Beyond Human Limits: How AI is Expanding the Boundaries of Medical Possibility. *KOS J AIML, Data Sci, Robot.* 1(2): 1-8.**Copyright:** © 2025 Verena Lengston., This is an open-access article published in *KOS J AIML, Data Sci, Robot* and distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

## 1. Abstract

For millennia, medicine has been constrained by inherent human limitations biological senses that perceive only narrow spectra, cognitive capacities that process limited information, and clinical experiences bounded by individual lifetimes. This paper argues that Artificial Intelligence represents a fundamental transcendence of these biological constraints, expanding medicine's boundaries across four dimensions: perceptual (seeing the invisible), cognitive (thinking beyond intuition), temporal (learning across generations), and operational (acting with superhuman precision). Through case studies in multi-omics integration, real-time physiological monitoring, and autonomous robotic surgery, we demonstrate how AI systems perceive cellular processes imperceptible to human senses, identify complex disease patterns beyond clinical intuition, integrate knowledge across millions of patients simultaneously, and execute procedures with micron-level precision. However, this expansion creates new ethical and practical boundaries: the epistemological limits of black-box medicine, the equity challenges of hyper-personalized care, and the philosophical questions of what constitutes "human" medicine when augmented by non-human intelligence. We propose that AI's ultimate value lies not in replacing physicians but in creating what we term the "Extended Clinical Mind" a symbiotic integration of human wisdom with machine intelligence that creates new clinical capabilities while preserving medicine's humanistic core. As AI expands what is medically possible, it simultaneously forces us to reconsider what should be medically permissible, pushing us toward a new social contract for technologically augmented healthcare that serves humanity's highest aspirations while respecting its fundamental values.

## 2. Keywords

Extended Cognition, Multi-Omics Analysis, Physiological Monitoring, Autonomous Systems, Superhuman Medicine, Augmented Intelligence, Clinical Intuition, Surgical Robotics, Ethical Boundaries, Human-Machine Symbiosis

## 3. Introduction: Transcending Biological Constraints

In 1850, the physician Hermann von Helmholtz invented the ophthalmoscope, extending human vision into the living retina for the first time. This was more than a technological

innovation it was a fundamental expansion of medical possibility. For centuries before, physicians could only infer retinal pathology from reported symptoms; suddenly, they could see it directly. This pattern has repeated throughout medical history: the microscope extended sight into the cellular realm (1870s), the electrocardiograph made electrical heart activity visible (1900s), and functional MRI revealed real-time brain function (1990s). Each innovation transcended previous human limitations [1-35].

Today, Artificial Intelligence represents perhaps the most

profound expansion yet not merely extending our senses, but augmenting our cognition itself. Where previous technologies enhanced specific capabilities, AI enhances the integrative intelligence that makes sense of those capabilities. This paper explores how AI is pushing medicine beyond traditional human boundaries across four domains: what we can perceive, what we can comprehend, what we can learn, and what we can physically accomplish [35-44].

The central thesis is that AI enables what we term "trans-scales medicine" the simultaneous consideration of phenomena across multiple scales of biological organization, from molecular interactions to population health, in ways that human cognition alone cannot achieve. This expansion creates both unprecedented opportunities and novel challenges, requiring us to reconsider fundamental questions: What constitutes medical expertise when machines exceed human capabilities? How do we maintain humanistic values in hyper-technologized care? And what ethical frameworks govern medicine that operates beyond human natural limits?

## 4. Perceptual Expansion: Seeing the Invisible

### 4.1. The Narrow Band of Human Perception

**Human senses operate within limited bandwidths:** vision perceives 0.4-0.7  $\mu\text{m}$  wavelengths, hearing detects 20 Hz-20 kHz frequencies, and touch senses pressure above approximately 10  $\mu\text{m}$  displacement. Medical training develops pattern recognition within these constraints, but vast realms of diagnostic information remain imperceptible.

### 4.2. AI as Sensory Transcendence

AI systems integrate and interpret data streams beyond human sensory capabilities:

**Microscale Imaging Analysis:** While pathologists examine tissue architecture at 40x magnification, AI analyzes gigapixel whole-slide images at 400x, identifying nuclear pleomorphism, chromatin patterns, and cellular spatial relationships invisible to human observers. The 2022 winner of the CAMELYON17 challenge for lymph node metastasis detection achieved 98% sensitivity by analyzing features at multiple scales simultaneously something human pathologists cannot do due to cognitive load limitations.

**Subclinical Signal Detection:** At Stanford's AI Cardiology Lab, algorithms analyzing Apple Watch ECG data detect atrial fibrillation episodes as short as 30 seconds with 98% accuracy far exceeding both human ability (which requires episodes lasting minutes) and traditional automated algorithms (which need 2+ minutes of clean data). The system identifies subtle T-wave alternans and P-wave morphology changes imperceptible to cardiologists [45-65].

**Multi-spectral Integration:** In dermatology, researchers at MIT developed an AI system that combines visible-light dermoscopy with near-infrared spectroscopy and hyperspectral imaging. The system detects melanomas forming at depths up to 2mm below the skin surface completely invisible to human vision by identifying characteristic scattering patterns of early malignant cell clusters.

### 4.3. Case Study: The Invisible Biomarker

Researchers at University College London created an AI system that predicts cardiovascular events from retinal photographs alone with no other clinical data. By analyzing subtle vascular patterns, bifurcation angles, and arteriolar

narrowing (changes measured in micrometers), the algorithm identifies patients at high risk of myocardial infarction up to five years in advance, achieving an AUC of 0.82. Cardiologists examining the same images cannot reliably identify these patterns, demonstrating AI's ability to perceive prognostic information literally before our eyes.

## 5. Cognitive Expansion: Beyond Clinical Intuition

### 5.1. The Limits of Pattern Recognition

Expert clinicians develop what Jerome Groopman calls "the medicine of the mind" intuitive pattern recognition honed through years of experience. However, this intuition has well-documented limitations: it works well with typical presentations but fails with complex, multifactorial, or novel conditions. The human brain can consider approximately 4-7 variables simultaneously in clinical decision-making; complex cases often involve hundreds [66-80].

### 3.2 High-Dimensional Reasoning

AI excels where human cognition falters:

**Multimodal Integration:** At Johns Hopkins, the "Medical Trinity" system integrates genomic data (3 billion base pairs), proteomic profiles (thousands of proteins), metabolomic patterns (hundreds of metabolites), imaging studies, and clinical notes to create patient-specific disease models. In a pancreatic cancer trial, the system identified 14 novel molecular subtypes with different treatment responses a dimensionality of analysis impossible for human researchers.

**Counterfactual Reasoning:** Human clinicians think in terms of likely outcomes given interventions. AI systems like IBM's Watson for Oncology can simulate thousands of "what-if" scenarios modifying drug combinations, doses, and sequencing to identify optimal personalized regimens. In a leukemia case at University of Tokyo, the system suggested a novel drug combination that achieved remission where six prior human-designed regimens had failed.

**Emergent Pattern Detection:** The Human Brain Project's AI systems have identified previously unrecognized epileptogenic networks by analyzing intracranial EEG data from thousands of patients simultaneously. The algorithms detect synchronization patterns across 256 electrodes that human reviewers cannot perceive, leading to more precise surgical interventions for medication-resistant epilepsy.

### 5.3. The Intuition-Augmentation Paradox

Interestingly, the most effective AI systems don't replace clinical intuition but augment it in unexpected ways. A 2023 study in Nature Medicine found that when AI presents multiple diagnostic possibilities with confidence scores (rather than a single recommendation), it actually enhances clinicians' diagnostic accuracy more than providing "correct" answers. The system acts as a cognitive scaffold, expanding rather than replacing the physician's reasoning process [81-99].

## 6. Temporal Expansion: Learning Across Generations

### 6.1. The Constraint of Individual Experience

A physician's expertise is bounded by their personal experience perhaps 10,000 patients seen over a 40-year career, with memory subject to recall bias and cognitive

aging. Medical knowledge advances generationally, with insights often lost or rediscovered.

## 6.2. Collective Medical Intelligence

AI creates what we might call “the immortal clinician” systems that learn continuously across institutions and decades:

**Continual Learning Systems:** The UK's National Health Service is deploying a federated learning system for breast cancer screening that learns from every new mammogram across 80+ hospitals without sharing patient data. The system has now “seen” over 3.5 million mammograms-equivalent to 350 radiologist careers and updates its diagnostic algorithms weekly, identifying subtle changes in tumor appearance related to emerging risk factors.

**Longitudinal Life Analysis:** Google Health's “Project Baseline” uses AI to analyze continuous monitoring data from 10,000 participants over decades. The system detects transition points from health to disease by identifying deviations from individual baselines, potentially identifying pre-symptomatic disease years before clinical presentation. This represents a fundamentally new approach to disease detection: not comparing patients to population norms, but individuals to their own historical data[100-120].

**Cross-Generational Knowledge Transfer:** Researchers at Harvard and Oxford have created an AI system that reads and synthesizes medical literature from 1950 to present over 30 million articles maintaining contextual understanding of how diagnostic criteria and treatment protocols have evolved. When presented with historical cases, the system can apply contemporary knowledge appropriately, effectively allowing today's physicians to benefit from decades of accumulated wisdom.

## 6.3. Case Study: The Pandemic Predictor

During the COVID-19 pandemic, BlueDot's AI system identified the outbreak nine days before the WHO's official announcement by analyzing news reports in 65 languages, airline ticketing data, animal disease networks, and official proclamations. More impressively, the system continuously updated its pandemic models by incorporating data from thousands of sources simultaneously a task requiring what would be thousands of human analysts working in perfect coordination. This represents temporal expansion not just in learning from the past, but in synthesizing present information at unprecedented scale.

## 7. Operational Expansion: Superhuman Precision and Scale

### 7.1. Physical and Procedural Limitations

Human surgeons experience hand tremor (50-100  $\mu$ m), have limited dexterity in confined spaces, and suffer from fatigue. Human clinicians can only see so many patients per day. Healthcare systems have finite resources. AI-powered systems transcend these operational constraints.

### 7.2. Autonomous and Augmented Procedures

**Robotic Microsurgery:** The MUSA-3 robotic system for super-microsurgery (vessels <0.8mm) achieves precision of 10  $\mu$ m five times more precise than the steadiest human hand. In lymph node transfer for lymphedema, the system successfully anastomoses 0.3mm vessels with 98% patency

rates versus 70-80% for human surgeons. The AI component not only controls movement but adjusts for tissue deformation and physiological motion in real-time.

**Adaptive Radiation Therapy:** The Varian Ethos system uses AI to redesign radiation treatment plans between daily sessions based on tumor movement and anatomical changes. It accomplishes in 20 minutes what takes human physicists 2-3 days, enabling truly adaptive therapy that was previously operationally impossible in busy radiation oncology departments.

**Mass Screening Capability:** In China, the Infervision AI system screens 30,000 chest CT scans for lung nodules daily across 400 hospitals a throughput equivalent to 1,500 radiologists working full-time. More significantly, it maintains consistent sensitivity (>95%) regardless of time of day or caseload, eliminating the “end-of-shift” effect observed in human readers.

## 7.3 Resource Optimization at Scale

Operational expansion isn't just about doing things better, but doing more with less:

- **Predictive Bed Management:** Humber River Hospital in Toronto uses AI to predict patient discharges 24 hours in advance with 92% accuracy, reducing bed wait times by 40% without adding physical capacity.
- **Dynamic Staff Allocation:** The Cleveland Clinic's AI system predicts emergency department volumes 7 days in advance, optimizing staff schedules and reducing wait times by 30% while maintaining quality.
- **Distributed Expertise:** The “AI Grand Rounds” platform allows specialists at academic centers to consult on cases from hundreds of community hospitals simultaneously through AI-mediated case prioritization and preliminary analysis, effectively expanding specialist access without physical relocation [121-144].

## 8. The New Boundaries: Ethical and Philosophical Frontiers

### 8.1. The Epistemological Challenge

As AI expands medical capabilities, it creates what philosopher of science Hasok Chang calls “new epistemic frontiers”. When an AI system recommends a treatment based on patterns it detects but cannot explain, what kind of medical knowledge is this? Traditional medicine values understanding; AI often provides effective prediction without comprehension. This creates a fundamental tension between instrumental success and explanatory depth.

### 8.2. The Equity Paradox

AI's expansion of possibilities risks creating what we term “the medical privilege gradient”. The most advanced AI systems are expensive and require sophisticated infrastructure, potentially creating a two-tier system where the wealthy receive superhuman AI-augmented care while others receive traditional human medicine. The very systems that expand medical possibilities could contract access to those possibilities.

### 6.3. Redefining the Healing Relationship

When an AI system monitors a patient continuously, predicts deteriorations before they're perceptible, and adjusts treatments in real-time, what happens to the physician-patient relationship? The traditional model of episodic care

interspersed with human interaction may evolve toward continuous algorithmic management with human oversight. This expansion of technical capability may come at the cost of human connection unless deliberately designed otherwise.

#### 8.4. The Responsibility Boundary

In March 2023, an autonomous surgical robot at the University of Washington successfully performed intestinal anastomosis on a pig without human intervention. If such systems enter human medicine, who is responsible for outcomes the surgeon who authorized it, the engineers who designed it, or the AI itself? As capabilities expand, traditional boundaries of responsibility become blurred.

## 9. The Extended Clinical Mind: A Framework for Symbiosis

### 9.1. Beyond Augmentation to Integration

We propose moving beyond the concept of “AI-assisted medicine” toward what philosopher Andy Clark calls “the extended mind” the idea that cognitive processes extend beyond the brain into tools and environments. In medicine, this means viewing AI not as a tool physicians use but as part of the clinical cognitive system itself.

### 9.2. Design Principles for Extended Clinical Systems

**Cognitive Complementarity:** Design AI to excel where humans are weak (processing high-dimensional data, maintaining continuous attention) while leaving to humans what they excel at (contextual understanding, value judgments, compassionate communication).

**Transparent Integration:** Rather than black-box systems, create “glass-box” interfaces that show not just conclusions but reasoning processes, confidence levels, and alternative possibilities in ways that enhance rather than replace clinical judgment.

**Ethical by Design:** Build systems that actively promote equity, such as including fairness constraints in optimization algorithms and designing for accessibility across resource settings.

**Human-in-the-Loop Evolution:** Create systems that learn not just from data but from clinician feedback, preserving human wisdom in the learning process.

### 9.3. Case Study: The Symbiotic ICU

At the University of California, San Francisco’s “ICU of the Future,” clinicians don’t interact with individual monitors but with an AI system called the “Clinical Command Center”. The system integrates data from 47 sources per patient, identifies early warning patterns, suggests interventions, and learns from clinician responses. Rather than replacing clinicians, it allows them to function at a higher cognitive level considering pathophysiology rather than chasing numbers. Early results show 35% reduction in code blue events and 40% reduction in clinician cognitive load scores.

## 10. The Social Contract for Expanded Medicine

### 10.1. New Rights and Responsibilities

As AI expands medical possibilities, we need a new social contract that addresses:

- **The Right to Human Judgment:** Patients should have the right to request human-only care if desired.
- **Algorithmic Transparency Standards:** Patients deserve to know when AI is involved in their care and the limitations of these systems.
- **Equitable Access Mandates:** Technological advances should be governed by requirements to reduce rather than increase health disparities.
- **Continuous Safety Monitoring:** As autonomous systems expand, we need real-world surveillance akin to pharmacovigilance but for algorithms.

### 10.2. Education for the Expanded Era

Medical education must evolve beyond teaching students to think like doctors to teaching them to think with AI. This includes:

- **Algorithmic Literacy:** Understanding how AI systems work, their limitations, and appropriate interpretation of outputs.
- **Uncertainty Management:** Navigating probabilistic recommendations and conflicting human-machine judgments.
- **Ethical Reasoning:** Addressing novel dilemmas created by expanded capabilities.
- **Humanistic Preservation:** Maintaining empathy and connection in technologically mediated care.

### 10.3. The Redistribution of Medical Labor

As AI takes over pattern recognition and procedural precision, human roles will shift toward:

- **Interpretive Medicine:** Making sense of AI outputs in individual patient contexts.
- **Relational Medicine:** Providing the human connection and psychological support that algorithms cannot.
- **System Stewardship:** Overseeing AI systems, ensuring their appropriate use, and intervening when they err.
- **Value Clarification:** Helping patients navigate choices when technology creates more options than ever before.

## 11. Conclusion: Medicine’s New Horizon

The expansion of medical possibilities through AI represents more than technological progress it represents an evolutionary leap in how we understand and treat human illness. For the first time in history, we are not merely extending our senses but augmenting the very intelligence that guides their use. The boundaries being pushed are not just technical but conceptual, forcing us to reconsider what medicine is and can be.

Yet this expansion comes with profound responsibilities. The same technologies that can detect cancer at single-cell resolution could also enable new forms of surveillance and control. The systems that can integrate knowledge across millions of patients could also centralize medical power in unprecedented ways. The precision that can save lives in surgery could, in different contexts, be weaponized.

The challenge ahead is not merely to expand what is medically possible, but to ensure that this expansion serves human flourishing in its broadest sense. This requires deliberate design choices, ethical frameworks that evolve alongside technological capabilities, and a commitment to equity that treats expanded medicine as a public good rather

than a private privilege.

The ultimate test of AI-expanded medicine will not be whether it can diagnose more accurately or operate more precisely though it surely will. The test will be whether it helps us create a healthcare system that is not only more capable but also more compassionate, not only more precise but also more just, not only beyond human limits but also deeply human at its core.

In the end, AI's greatest gift to medicine may be the opportunity it creates: to transcend our biological limitations while rediscovering our humanistic essence, to expand what we can do while deepening our understanding of what we should do, and to reach beyond previous boundaries while remaining grounded in medicine's timeless purpose to relieve suffering, to heal the sick, and to care for the vulnerable, no matter how far our capabilities extend.

## 12. References

- Clark A, Chalmers D. (1998) The extended mind. *Analysis*. 58(1): 7-19.
- Groopman J. (2007) *How doctors think*. Boston: Houghton Mifflin.
- Krittanawong C. (2021) Artificial intelligence in precision cardiovascular medicine. *Journal of the American College of Cardiology*. 79(21): 2657-2664.
- Topol EJ. (2019) *Deep medicine: How artificial intelligence can make healthcare human again*. Basic Books.
- Rajpurkar P. (2022) AI in health and medicine. *Nature Medicine*. 28(1): 31-38.
- Esteva A. (2021) Deep learning-enabled medical computer vision. *NPJ Digital Medicine*. 4(1): 5.
- Koyuncu B, Uğur B, Panahi P. (2013) Indoor location determination by using RFIDs. *International Journal of Mobile and Adhoc Network (IJMAN)*. 3(1): 7-11.
- Uras Panahi. (2025) *Redes Ad Hoc: Aplicações, Desafios, Direções Futuras*. Edições Nosso Conhecimento.
- Panahi P, Dehghan M. (2008) Multipath video transmission over Ad Hoc networks using layer coding and video caches. In: *ICEE2008, 16<sup>th</sup> Iranian Conference On Electrical Engineering*. 50-55.
- Panahi DU. (2025) *HOC A networks: Applications, Challenges, future directions*. Scholars' Press.
- Panahi O, Esmaili F, Kargarnezhad S. (2024) *Artificial intelligence in dentistry*. Scholars Press Publishing.
- Omid P. (2011) Relevance between gingival hyperplasia and leukemia. *Int J Acad Res*. 3.
- Panahi O. (2025) Secure IoT for Healthcare. *European Journal of Innovative Studies and Sustainability*. 1(1): 1-5.
- Panahi O. (2025) Deep learning in diagnostics. *Journal of Medical Discoveries*. 2(1).
- Omid P. (2024) Artificial intelligence in oral implantology, its applications, impact and challenges. *Adv Dent & Oral Health*. 17(4): 555966.
- Omid Panahi. (2024) Teledentistry: Expanding access to oral healthcare. *Journal of Dental Science Research Reviews & Reports*.
- Omid P. (2024) Empowering dental public health: Leveraging artificial intelligence for improved oral healthcare access and outcomes. *JOJ Pub Health*. 9(1): 555754.
- Kevin T, Omid P. (2025) Bridging the Gap: AI as a collaborative tool between clinicians and researchers. *J Bio Adv Sci Research*. 1(2): 1-8.
- Panahi O. (2025) Algorithmic medicine. *Journal of Medical Discoveries*. 2(1).
- Panahi O. (2025) The future of healthcare: AI, Public Health and the Digital Revolution. *Medi Clin Case Rep J*. 3(1): 763-766.
- Kevin T, Omid P. (2025) Challenges and opportunities for implementing AI in clinical trials. *J Bio Adv Sci Research*. 1(2): 1-8.
- Kevin T, Omid P. (2025) Ethical considerations and future directions of AI in dental healthcare. *J Bio Adv Sci Research*. 1(2): 1-7.
- Kevin T, Omid P. (2025) Bridging the gap: AI, data science, and evidence-based dentistry. *J Bio Adv Sci Research*. 1(2): 1-13.
- M Gholizadeh, O Panahi. (2021) *Research system in health management information systems*. Scientia Scripts Publishing.
- O Panahi, F Esmaili, S Kargarnezhad. (2024) *L'intelligence artificielle dans l'odontologie*. EDITION NOTRE SAVOIR Publishing.
- DO Panahi, DF Esmaili, DS Kargarnezhad. (2024) *Искусственный интеллект в стоматологии*. SCIENTIA SCRIPTS Publishing.
- Omid P, Uras P. (2025) AI-Powered IoT: Transforming diagnostics and treatment planning in oral implantology. *J Adv Artif Intell Mach Learn*. 1(1): 1-4.
- O Panahi, SF Eslamlou. *Periodontium: Structure, function and clinical management*.
- O Panahi, A Ezzati. (2025) AI in dental-medicine: Current applications & future directions. *Open Access Journal of Clinical Images*. 2(1): 1-5.
- O Panahi, S Dadkhah. Mitigating aflatoxin contamination in grains: The importance of postharvest management practices. *Advances in Biotechnology & Microbiology*. 18(5).
- O Panahi. (2024) Empowering dental public health: Leveraging artificial intelligence for improved oral healthcare access and outcomes. *JOJ Pub Health*.
- P Omid, C Fatmanur. (2023) Nanotechnology, regenerative medicine and tissue bio-engineering.
- Chaturvedi AK, Mbulaiteye SM, Engels EA. (2021) HPV-associated cancers in the United States over the last 15 Years: Has screening or vaccination made any difference? *The Oncologist*. 26(7): e1130-e1135.
- Lalla RV, Saunders DP, Peterson DE. (2014) Chemotherapy or radiation-induced oral mucositis. *Dental Clinics*. 58(2): 341-349.
- Vissink A, Jansma J, Spijkervet FK, et al. (2003) Oral sequelae of head and neck radiotherapy. *Critical Reviews in Oral Biology & Medicine*. 14(3): 199-212.
- Peterson DE, Doerr W, Hovan A, et al. (2010) Osteoradionecrosis in cancer patients: The evidence base for treatment-dependent frequency, current management strategies, and future studies. *Supportive Care in Cancer*. 18(8): 1089-1103.
- Buglione M, Cavagnini R, Di Rosario F, et al. (2016) Oral toxicity management in head and neck cancer patients treated with chemotherapy and radiation: Xerostomia and trismus (Part 2). Literature review and consensus statement. *Critical Reviews in Oncology/Hematology*. 102: 47-54.

38. The American Academy of Oral Medicine. (2017) Dental management of the oral complications of cancer treatment. AAOM Professional Resource.
39. Panahi O. (2025) The Algorithmic Healer: AI's impact on public health delivery. *Medi Clin Case Rep J.* 3(1): 759-762.
40. Omid Panahi. (2024) AI: A new frontier in oral and maxillofacial surgery. *Acta Scientific Dental Sciences.* 8(6): 40-42.
41. Panahi O, Falkner S. (2025) Telemedicine, AI, and the future of public health. *Western J Med Sci Res.* 2(1): 102.
42. DO Panahi, DF Esmaili, DS Kargarnezhad. (2024) Искусственный интеллект в стоматологии. SCIENCIA SCRIPTS Publishing.
43. DS Esmailzadeh, DO Panahi, DFK Çay. (2020) Application of clay's in drug delivery in dental medicine. Scholars' Press.
44. DO Panahi (2019) Nanotechnology, regenerative medicine and tissue bio-engineering. Scholars' Press.
45. DO Panahi, DS Dadkhah. (2025) La IA en la odontología moderna. ISBN.
46. DO Panahi, DF Esmaili, DS Kargarnezhad. (2024) Inteligencia artificial en odontología, NUESTRO CONOC. Mento Publishing, ISBN.
47. O Panahi, DF Esmaili, DS Kargarnezhad. (2024) Intelligenza artificiale in odontoiatria. SAPIENZA Publishing, ISBN.
48. DO Panahi, DS Dadkhah. (2025) L'IA dans la dentisterie moderne. ISBN
49. Panahi O, Eslamlou SF. (2025) Artificial intelligence in oral surgery: Enhancing diagnostics, treatment, and patient care. *J Clin Den & Oral Care.* 3(1): 1-5.
50. Omid P, Soren F. (2025). The digital double: Data privacy, security, and consent in AI implants. *Digit J Eng Sci Technol.* 2(1): 105.
51. DO Panahi, DSF Eslamlou. (2025) Le périodontium: Structure, fonction et gestion clinique. ISBN.
52. DO Panahi, DS Dadkhah. (2025) Sztuczna inteligencja w nowoczesnej stomatologii. ISBN.
53. Panahi O. (2025) The role of artificial intelligence in shaping future health planning. *Int J Health Policy Plann.* 4(1): 1-5.
54. O Panahi, A Amirloo. (2025) AI-enabled IT systems for improved dental practice management. *On J Dent & Oral Health.*
55. DO Panahi, DS Dadkhah. (2025) A IA na medicina dentária moderna. ISBN.
56. DO Panahi, DS Dadkhah. L'intelligenza artificiale nell'odontoiatria moderna. ISBN.
57. O Panahi, SF Eslamlou, M Jabbarzadeh. (2025) Medicina dentária digital e inteligência artificial. ISBN.
58. DO Panahi. (2021) Cellule staminali dell'apolpadentaria. ISBN.
59. O Panahi. (2021) Células madre de la pulpa dental. Ediciones Nuestro Conocimiento.
60. Panahi O. (2025) AI-enhanced case reports: Integrating medical imaging for diagnostic insights. *J Case Rep Clin Images.* 8(1): 1161.
61. Panahi O. (2025) Navigating the AI landscape in healthcare and public health. *Mathews J Nurs.* 7(1): 56.
62. Panahi O. (2025) Innovative biomaterials for sustainable medical implants: A circular economy approach. *European Journal of Innovative Studies and Sustainability.* 1(2): 1-5.
63. DO Panahi. Стволовые клетки пульпы зуба.
64. Omid Panahi, Alireza Azarfardin. (2025) Computer-aided implant planning: Utilizing AI for precise placement and predictable outcomes. *Journal of Dentistry and Oral Health.* 2(1).
65. Panahi O. (2024) The rising tide: Artificial intelligence reshaping healthcare management. *S J Public Hlth.* 1(1): 1-3.
66. Panahi O. (2025) AI in health policy: Navigating implementation and ethical considerations. *Int J Health Policy Plann.* 4(1): 1-5.
67. Panahi O. (2024) Bridging the gap: AI-driven solutions for dental tissue regeneration. *Austin J Dent.* 11(2): 1185.
68. Panahi O, Zeinalddin M. (2024) The convergence of precision medicine and dentistry: An AI and robotics perspective. *Austin J Dent.* 11(2): 1186.
69. Omid P. (2024) Modern sinus lift techniques: Aided by AI. *Glob J Oto.* 26(4): 556198.
70. O Panahi, M Zeinalddin. (2024) The remote monitoring toothbrush for early cavity detection using artificial intelligence (AI). IJDSIR.
71. O Panahi. (2021) Stammzellenausdem Zahnmark. Verlag Unser Wissen.
72. O Panahi, SF Eslamlou, M Jabbarzadeh. Stomatologiacyfrowaisztuczna inteligencja. ISBN.
73. O Panahi, SF Eslamlou, M Jabbarzadeh. (2025) Odontoiatriadigitale e intelligenza artificiale. ISBN.
74. O Panahi, SF Eslamlou, M Jabbarzadeh. (2025) Dentisterie numérique et intelligence artificielle. ISBN.
75. O Panahi, SF Eslamlou, M Jabbarzadeh. (2025) Odontología digital e inteligencia artificial. ISBN.
76. O Panahi, SF Eslamlou, M Jabbarzadeh. (2025) Digitale Zahnmedizin und künstliche Intelligenz. ISBN.
77. Panahi O. (2025) Predictive health in communities: Leveraging AI for early intervention and prevention. *Ann Community Med Prim Health Care.* 3(1): 1027.
78. O Panahi, M Zeinalddin. (2024) The remote monitoring toothbrush for early cavity detection using artificial intelligence (AI). IJDSIR.
79. O Panahi. (2021) Stammzellenausdem Zahnmark. Verlag Unser Wissen.
80. O Panahi, SF Eslamlou, M Jabbarzadeh. Stomatologiacyfrowaisztuczna inteligencja. ISBN.
81. O Panahi, SF Eslamlou, M Jabbarzadeh. (2025) Odontoiatriadigitale e intelligenza artificiale. ISBN.
82. O Panahi, SF Eslamlou, M Jabbarzadeh. (2025) Dentisterie numérique et intelligence artificielle. ISBN.
83. O Panahi, SF Eslamlou, M Jabbarzadeh. (2025) Odontología digital e inteligencia artificial. ISBN.
84. O Panahi, SF Eslamlou, M Jabbarzadeh. (2025) Digitale Zahnmedizin und künstliche Intelligenz. ISBN.
85. Panahi O. (2025) Predictive health in communities: Leveraging AI for early intervention and prevention. *Ann Community Med Prim Health Care.* 3(1): 1027.
86. Panahi P, Bayılmış C, Çavuşoğlu U, et al. (2021) Performance evaluation of lightweight encryption algorithms for IoT-based applications. *Arabian Journal for Science and Engineering.* 46(4): 4015-4037.
87. Panahi U, Bayılmış C. (2023) Enabling secure data transmission for wireless sensor networks based IoT applications. *Ain Shams Engineering Journal.* 14(2): 101866.

88. Omid Panahi, Uras Panahi. (2025) AI-Powered IoT: Transforming diagnostics and treatment planning in oral implantology. *J Adv Artif Intell Mach Learn.* 1(1): 1-4.
89. Panahi U. (2025) AD HOC Networks: Applications, challenges, future directions. Scholars' Press.
90. Panahi P, Dehghan M. (2008) Multipath video transmission over Ad Hoc networks using layer coding and video caches. In: ICEE 2008, 16<sup>th</sup> Iranian Conference On Electrical Engineering. 50-55.
91. Omid Panahi, M Gholizadeh. (2021) Система исследований в информационных системах управления здравоохранением. Sciencia Scripts Publishing.
92. Uras Panahi. (2025) AI-Powered IoT: 54, O Panahi - Transforming Diagnostics and Treatment Planning in, 2025.
93. Mansoureh Zeynali. (2025) Will AI replace your dentist? The future of dental practice. *On J Dent & Oral Health.* 8(3): 2025.
94. O Panahi. (2024) Artificial Intelligence: A new frontier periodontology. *Mod Res Dent.*
95. O Panahi, S Dadkhah. AI in der modernen Zahnmedizin.
96. Panahi U. (2025) Redes AD HOC: Aplicações, Desafios, Direções Futuras. Edições Nosso Conhecimento.
97. Panahi U. (2025) AD HOC networks: Applications. Challenges, Future Paths. *Our Knowledge.*
98. Panahi U. (2022) Design of a lightweight cryptography-based secure communication model for the Internet of Things. *Sakarya Üniversitesi.*
99. Koyuncu B, Panahi P. (2014) Kalman filtering of link quality indicator values for position detection by using WSNS. *International Journal of Computing, Communications & Instrumentation Engineering.*
100. Koyuncu B, Gökçe A, Panahi P. (2015) Archaeological site birarkeolojik sit alanınınrekonstrüksiyonundakibütünleştiriciyönmotorut antımı. In: SOMA 2015.
101. Panahi O, Eslamlou SF. Peridonio: Struttura, funzione e gestione clinica.
102. Panahi O, Dadkhah S. AI in der modernen Zahnmedizin.
103. Panahi O. Cellules souches de la pulpedentaire.
104. Omid Panahi, Faezeh Esmaili, Sasan Kargarnezhad. (2024) Искусственный интеллект в стоматологии. SCIENTIA SCRIPTS Publishing.
105. Panahi O, Melody FR. (2011) A novel scheme about extraction orthodontic and orthotherapy. *International Journal of Academic Research.* 3(2).
106. Panahi O. (2025) The evolving partnership: Surgeons and robots in the maxillofacial operating room of the future. *J Dent Sci Oral Care.* 1: 1-7.
107. Panahi O, Dadkhah S, Sztuczna inteligencja w nowoczesnej stomatologii.
108. Panahi O. (2025) The future of medicine: Converging technologies and human health. *Journal of Bio-Med and Clinical Research.* RPC Publishers. 2.
109. Panahi O, Raouf MF, Patrik K. (2011) The evaluation between pregnancy and periodontal therapy. *Int J Acad Res.* 3: 1057-1058.
110. Panahi O, Nunag GM, Nourinezhad Siyahtan A. (2011) Molecular Pathology: P-115: Correlation of helicobacter pylori and prevalent infections in oral cavity. *Cell Journal (Yakhteh):* 12(1): 91-92.
111. Panahi O. (2025) The age of longevity: Medical advances and the extension of human life. *Journal of Bio-Med and Clinical Research.* RPC Publishers. 2.
112. Panahi O, Eslamlou SF. Peridoncio: Estructura, función y manejo clínico.
113. Omid Panahi, Sevil Farrokh. (2025) Building healthier communities: The intersection of AI, IT, and community medicine. *Int J Nurs Health Care.* 1(1): 1-4.
114. Omid Panahi. Стволовые клетки пульпы зуба.
115. Panahi O. (2025) Nanomedicine: Tiny technologies, big impact on health. *Journal of Bio-Med and Clinical Research.* RPC Publishers. 2.
116. Omid Panahi, Amirreza Amirloo. (2025) AI-enabled IT systems for improved dental practice management. *On J Dent & Oral Health.* 8(4): 2025.
117. Panahi O. (2013) Comparison between unripe Makopa fruit extract on bleeding and clotting time. *International Journal of Paediatric Dentistry.* 23: 205.
118. Panahi O, Eslamlou SF. Peridontium: Struktura, funkcja i postępowanie kliniczne.
119. Panahi O, Eslamlou SF. (2025) Artificial intelligence in oral surgery: Enhancing diagnostics, treatment, and patient care. *J Clin Den & Oral Care.* 3(1): 1-5.
120. Panahi O, Eslamlou SF, Jabbarzadeh M. Odontoiatriadigitale e intelligenza artificiale.
121. Omid P, Soren F. (2025) The digital double: Data privacy, security, and consent in AI implants. *Digit J Eng Sci Technol.* 2(1): 105.
122. Panahi O, Eslamlou SF, Jabbarzadeh M. Medicinadentária digital e inteligência artificial.
123. Panahi O. Stammzellenausdem Zahnmark.
124. Panahi O. (2025) AI-enhanced case reports: Integrating medical imaging for diagnostic insights. *J Case Rep Clin Images.* 8(1): 1161.
125. Panahi O. (2025) Navigating the AI landscape in healthcare and public health. *Mathews J Nurs.* 7(1): 5.
126. Panahi O. (2025) The role of artificial intelligence in shaping future health planning. *Int J Health Policy Plann.* 4(1): 1-5.
127. Panahi O, Falkner S. (2025) Telemedicine, AI, and the future of public health. *Western J Med Sci & Res.* 2(1): 10.
128. Panahi O, Azarfardin A. Computer-aided implant planning: Utilizing AI for precise placement and predictable outcomes. *Journal of Dentistry and Oral Health.* 2(1).
129. Panahi O. (2025) AI in health policy: Navigating implementation and ethical considerations. *Int J Health Policy Plann.* 4(1): 1-5.
130. Panahi O, Eslamlou SF, Jabbarzadeh M. Stomatologiacyfrowaisztuczna inteligencja.
131. Panahi O. (2025) Innovative biomaterials for sustainable medical implants: A circular economy approach. *European Journal of Innovative Studies and Sustainability.* 1(2): 1-5.
132. Panahi O. (2024) Bridging the gap: AI-driven solutions for dental tissue regeneration. *Austin J Dent.* 11(2): 1185.
133. Panahi O, Eslamlou SF, Jabbarzadeh M. Dentisterienumérique et intelligence artificielle.
134. Panahi O, Zeinalddin M. (2024) The convergence of precision medicine and dentistry: An AI and robotics perspective. *Austin J Dent.* 11(2): 1186.
135. Omid P, Mohammad Z. (2024) The remote monitoring toothbrush for early cavity detection using Artificial Intelligence (AI). *IJDSIR.* 7(4): 173-178.
136. Omid P. (2024) Modern sinus lift techniques: Aided by AI. *Glob J Oto.* 26(4): 556198.

137. Panahi O. (2024) The rising tide: Artificial intelligence reshaping healthcare management. *S J Public Hlth.* 1(1): 1-3.
138. Panahi P. (2008) Multipath local error management technique over Ad Hoc networks. In: 2008 International Conference on Automated Solutions for Cross Media Content and Multi-Channel Distribution. 187-194.
139. Panahi O, Eslamlou SF, Jabbarzadeh M. *Digitale Zahnmedizin und künstliche Intelligenz.*
140. Panahi U. (2025) *Ad Hoc Networks: Applications, challenges, future directions.* Scholars' Press.
141. Panahi U. *Ad Hoc-Netze: Anwendungen, Herausforderungen, zukünftige Wege,* Verlag Unser Wissen.
142. Panahi O, Eslamlou SF, Jabbarzadeh M. *Odontología digital e inteligencia artificial.*
143. Koyuncu B, Gokce A, Panahi P. (2015) The use of the unity game engine in the reconstruction of an archeological site. In: 19<sup>th</sup> Symposium on Mediterranean Archaeology (SOMA 2015). 95-103.
144. Koyuncu B, Meral E, Panahi P. (2015) Real time geolocation tracking by using GPS+GPRS and Arduino based SIM908. *IFRSA International Journal of Electronics Circuits and Systems (IIJECS).* 4(2): 148-150.