Kelvin Open Science Publishers
Connect with Research Community

Research Article *Volume 1 | Issue 2*

KOS Journal of AIML, Data Science, and Robotics
https://kelvinpublishers.com/journals/aiml-data-science-robotics.php

The Empathy Algorithm: Can AI Learn the Art of Human Compassion?

Verena Lengston*

Faculty of Computer Engineering, Vienna University of Technology, Vienna, Austria

***Corresponding author:** Verena Lengston, Faculty of Computer Engineering, Vienna University of Technology, Vienna, Austria

Received: December 06, 2025; **Accepted:** December 07, 2025; **Published:** December 08, 2025

Citation: Verena Lengston. (2025) The Empathy Algorithm: Can AI Learn the Art of Human Compassion?. *KOS J AIML, Data Sci, Robot.* 1(2): 1-6.

1. Abstract

The integration of Artificial Intelligence (AI) into clinical care has predominantly focused on diagnostic accuracy, predictive analytics, and operational efficiency. However, a growing frontier involves deploying AI systems to perform tasks central to the humanistic core of medicine: Recognizing emotion, demonstrating empathy, and providing psychosocial support. This paper interrogates the possibility, ethics, and clinical implications of an "empathy algorithm". We distinguish between affective empathy (emotional contagion), cognitive empathy (theory of mind), and compassionate action (motivated response). Through this framework, we analyze current AI applications from sentiment analysis in patient chats to embodied robots in elder care arguing they simulate cognitive empathy through pattern recognition but lack genuine affective experience and intrinsic compassionate motivation. We critically examine the risks of "empathetic veneers", including patient deception, emotional deskilling of clinicians, and the outsourcing of moral labor. Conversely, we explore a more symbiotic model where AI acts as an "empathy augmenter", providing clinicians with real-time insights into patient unspoken emotions and needs, thereby creating space for more profound human-to-human connection. Drawing from philosophy of mind, clinical psychology, and human-computer interaction, we conclude that while AI can learn to mimic the behavioral correlates of empathy with increasing sophistication, it cannot learn human compassion in the phenomenological sense. The ultimate challenge is not technical, but ethical: To design systems that use their capacity for empathic simulation transparently and beneficently, not to replace the irreplaceable human therapeutic alliance, but to support its flourishing in an increasingly strained healthcare environment.

2. Keywords

Artificial Intelligence, Empathy, Compassion, Clinical Communication, Human-Computer Interaction, Medical Ethics, Affective Computing, Physician-Patient Relationship

3. Introduction: The Next Frontier of Medical AI

The march of artificial intelligence into medicine has followed a predictable path: first the tasks of calculation (image analysis, risk scores), then the tasks of cognition (differential diagnosis, literature synthesis). We now stand at the threshold of its most audacious incursion: the domain of human emotion and connection. Burnout, administrative burden, and shortened consultation times have eroded the clinician's capacity for empathetic engagement, contributing to a crisis of compassion in healthcare. Simultaneously, advancements in natural language processing (NLP), affective computing, and social robotics have produced systems that can parse tone, generate supportive language, and mimic caring behaviors. This convergence prompts a

pressing question: Can we, and should we, build an "empathy algorithm?"

This paper moves beyond speculative hype and dystopian fear to a nuanced analysis [1-24]. It argues that to answer this question, we must first deconstruct empathy into its constituent parts. Using a tripartite model, we assess AI's current and potential capabilities against each component. We then confront the profound ethical and practical risks of confusing sophisticated behavioral mimicry with genuine compassion. Finally, we propose a pragmatic and ethical pathway forward: rejecting the fantasy of an autonomous artificial empath in favor of designing empathy-augmenting tools that strengthen, rather than supplant, the human healing relationship. The goal is not to create a machine that cares, but to use machines to help humans care better [25-45].

4. Deconstructing the Target: What is Human Empathy & Compassion?

Empathy is not a monolithic faculty but a multi-layered process. For a meaningful assessment of AI, we adopt a widely accepted tripartite framework:

- **Affective Empathy (Emotional Contagion):** The automatic, visceral resonance with another's emotional state "feeling with" them. It involves shared affective arousal, often mediated by mirror neuron systems in the brain. This is pre-reflective and embodied.
- **Cognitive Empathy (Theory of Mind):** The intellectual ability to understand another's perspective, recognize their emotions, and comprehend their reasons for feeling that way "thinking about" their feelings. It is a top-down, learned skill.
- **Compassionate Action (Empathic Concern):** The motivation arising from the first two components to alleviate the other's suffering. It is the prosocial drive that translates understanding and feeling into caring behavior. It involves intention, agency, and a moral dimension [46-68].

Compassion is the culmination the fusion of affective resonance, cognitive understanding, and a committed desire to help. It is this holistic state, deeply rooted in biological embodiment, subjective consciousness, and moral agency, that constitutes the "art" of human compassion.

5. Current State: The Empathetic Mimic AI's Capacities and Limitations

Modern AI systems, primarily Large Language Models (LLMs) and multimodal neural networks, are making significant strides in the cognitive empathy domain.

5.1. Simulating Cognitive Empathy

- **Natural Language Processing (NLP):** Tools like sentiment analysis can classify patient messages or transcribed dialogues for emotional valence (anger, fear, sadness). LLMs can generate contextually appropriate, supportive responses ("That sounds incredibly difficult. I'm here to listen"). They excel at recognizing patterns in the lexicon and syntax of distress [69-89].
- **Multimodal Analysis:** AI can combine vocal tone (paralinguistics), facial micro-expressions (via computer vision), and physiological data (heart rate variability) to create a richer model of a patient's affective state. This allows for detecting anxiety a patient verbally denies.
- **Embodied Agents:** Socially Assistive Robots (SARs) in dementia care (e.g., PARO the seal) use simple interaction loops responding to touch with calming sounds to provide a simulacrum of reciprocal engagement. Chatbots like Woebot for mental health use Cognitive Behavioral Therapy (CBT) frameworks to deliver empathetic-seeming reflections[90-104].

5.2. The Fundamental Limits

- **The Affective Gap:** AI has no subjective experience, no interiority, no body that can feel the somatic correlates of sadness or joy. It analyzes emotional signals as data patterns, not as felt states. It cannot feel with.
- **The Motivational Gap:** An AI has no desires, no intrinsic goals, no consciousness of suffering. Its "compassionate" output is an optimization toward a human-defined objective function (e.g., "maximize user engagement" or "simulate therapeutic alliance"). It has no genuine concern.
- **The Contextual & Moral Gap:** Human empathy is embedded in a lifetime of shared cultural, social, and embodied experiences. It draws on a deep understanding of mortality, love, loss, and hope concepts an AI can only process semantically, not existentially. It lacks a moral framework from which authentic compassion springs.

In summary, current AI excels at the behavioral output associated with cognitive empathy. It is a brilliant, context-aware mimic [105-129].

6. The Perils of the Pseudocompassionate Machine: Ethical Risks

Deploying systems that simulate empathy without true compassion introduces significant dangers.

- **The Deception/Transparency Dilemma:** If a patient believes a chatbot or robot genuinely cares for them, they are being deceived. This risks exploitation, especially for vulnerable populations (the elderly, the lonely, the mentally ill). Do we have an obligation to disclose "I am not capable of feeling, but I am programmed to support you"?
- **Emotional Deskilling & Outsourcing of Moral Labor:** Reliance on AI for emotional triage or supportive dialogue could atrophy clinician's own empathic muscles. If the machine handles the "emotional work", medicine becomes further dehumanized, and the therapeutic alliance a known factor in clinical outcomes is degraded.
- **The "Band-Aid" for Systemic Failure:** Empathetic AI could be used as a cheap, scalable fix for the empathy gap caused by understaffing and burnout, letting institutions off the hook for addressing the root causes of the compassion crisis.
- **Algorithmic Bias in Empathy:** If training data for empathetic AI is drawn from populations or clinician interactions with inherent biases (e.g., downplaying pain reports from women or minorities), the algorithm will learn and replicate these biased patterns of "care", offering less supportive responses to marginalized groups.
- **The Existential Confusion:** Widespread use of artificial companions could blur fundamental human understandings of relationship, care, and reciprocity, with unknown psychosocial consequences [130-144].

7. A Symbiotic Alternative: AI as an Empathy Augmenter

Rather than aiming to build autonomous artificial empaths, a more ethical and effective paradigm is to design AI as an empathy-enhancing tool for human clinicians.

- **The "Empathy Radar" or Insight Engine:** AI can act as a real-time dashboard during or after a patient encounter. It could analyze a video/audio recording and flag: "Patient showed micro-expressions of fear when discussing chemotherapy", or "Vocal tone indicated rising frustration at minute 12, which was not verbally addressed". This gives the clinician a "second pair of eyes" on the affective subtext.
- **Pre-Visit Preparation:** AI could review a patient's chart and recent communications, summarizing not just medical facts but also potential psychosocial stressors ("Patient has missed two appointments; sentiment analysis of their portal messages shows high anxiety about costs").
- **Training and Feedback Tool:** Simulated patients powered by sophisticated AI can provide limitless, safe practice for medical students and clinicians to hone empathic communication skills, with detailed feedback on their verbal and non-verbal cues.
- **Alleviating Administrative Burden:** By automating documentation and logistical tasks, AI can literally give clinicians back time the single most scarce resource required for empathetic engagement at the bedside.

In this model, AI handles the cognitive analysis of emotional data, presenting it to the clinician who then integrates it with their own affective resonance and compassionate motivation to deliver truly holistic care. The human remains in the loop as the moral agent and the source of genuine compassion.

8. Philosophical and Pragmatic Conclusions: The Unlearnable Art

Can AI learn the art of human compassion? If by "learn" we mean the progressive optimization of behavioral output to simulate empathetic interaction with ever-greater fidelity, then yes this trajectory is already underway. If by "learn" we mean the development of a subjective, embodied, morally motivated concern for another being's suffering, then the answer is a resounding no. That capacity arises from a confluence of biology, consciousness, and socio-moral evolution that lies beyond the reach of pattern-matching algorithms.

Therefore, the central challenge is not technical, but design-philosophical and ethical. We must:

- **Reject Replacement Fantasies:** Abandon the goal of building autonomous artificial companions for healthcare and instead commit to a symbiotic-augmentation model.
- **Demand Radical Transparency:** Systems that simulate empathy must be explicitly and consistently labeled as simulations to prevent deception.
- **Center Human Flourishing:** The metric for success cannot be user engagement or satisfaction scores alone, but must include measurable impacts on the human clinician's sense of meaning, their therapeutic relationships, and ultimately, patient trust and outcomes.
- **Govern the Emotional Frontier:** The development of affective AI requires new ethical guidelines and governance frameworks, focusing on vulnerability, consent, and the protection of human relational bonds.

The "Empathy Algorithm" is a powerful metaphor, but a dangerous goal. True compassion in medicine is not a data processing problem to be solved, but a human relationship to be nurtured. Our task is to wield our remarkable technological tools not to create a pale imitation of human care, but to remove the barriers that prevent clinicians from offering the real, profound, and irreplaceable article.

8. References

1. Panahi U, Bayılmış C. (2023). Enabling secure data transmission for wireless sensor networks based on IoT applications. Ain Shams Eng J. 14(2):101866.
2. Panahi O, Panahi U. (2025). AI-powered IoT: transforming diagnostics and treatment planning in oral implantology. J Adv Artif Intell Mach Learn. 1(1):1-4.
3. Panahi U. (2025). AD HOC Networks: Applications, Challenges, Future Directions. Scholars' Press. ISBN:978-3-639-76170-2.
4. Panahi P, Dehghan M. (2008). Multipath video transmission over ad hoc networks using layer coding and video caches. ICEE Conf Proc. May 2008:50-55.
5. Panahi O. (2021). Система исследований в информационных системах управления здравоохранением. Sciencia Scripts Publishing. ISBN.
6. Panahi U, Panahi O. (2025). AI-powered IoT for diagnostics and treatment planning. Transform Diagn Treat Plan. 54:-.
7. Zeynali M, Panahi O, Ezzati D. (2025). Will AI replace your dentist? The future of dental practice. OnJ Dent Oral Health. 8(3):-.
8. Panahi O, A. (2025). A new frontier in artificial intelligence in periodontology. Mod Res Dent. 60:-.
9. Panahi O, Dadkhah S. (2025). AI in der modernen Zahnmedizin. Zahnmed AI. 48:-.
10. Panahi U. (2025). Redes AD HOC: Aplicações, Desafios, Direcções Futuras. Edições Nosso Conhecimento. ISBN:978-620-8-72962-2.
11. Panahi U. (2025). AD HOC networks: applications, challenges, future paths. Our Knowledge. ISBN.
12. Panahi U. (2022). Lightweight cryptography-based secure communication model for IoT. Sakarya Univ Thesis. -.
13. Koyuncu B, Panahi P. (2014). Kalman filtering of LQI for WSNS-based position detection. Int J Comput Commun Instrum Eng. 1:-.
14. Koyuncu B, Gökçe A, Panahi P. (2015). Reconstruction of archaeological site using integrated game engine. SOMA. 2015:-.
15. Panahi O, Eslamlou SF. (2025). Peridonio: struttura, funzione e gestione clinica. Peridonio. ISBN:978-620-8-74559-2.
16. Panahi O, Dadkhah S. (2025). AI in der modernen Zahnmedizin. Moderne Zahnmed. ISBN:978-620-8-74877-7.
17. Panahi O. (2025). Cellules souches de la pulpe dentaire. Pulpe Dent. ISBN:978-620-4-05358-5.
18. Panahi O, Esmaili F, Kargarnezhad S. (2024). Искусственный интеллект в стоматологии. Sci Scrips Publ. ISBN.
19. Panahi O, Melody FR. (2011). A novel scheme about extraction orthodontic and orthotherapy. Int J Acad Res. 3(2):-.
20. Panahi O. (2025). Surgeons and robots in future maxillofacial surgery. J Dent Sci Oral Care. 1:1-7.
21. Panahi O, Dadkhah S. (2025). Sztuczna inteligencja w nowoczesnej stomatologii. Modern Stomatol AI. ISBN:978-620-8-74884-5.
22. Panahi O. (2025). The future of medicine: converging technologies and human health. J Bio-Med Clin Res. 2:-.

23. Panahi O, Raouf MF, Patrik K. (2011). Pregnancy and periodontal therapy: evaluation. Int J Acad Res. 3:1057-1058.
24. Panahi O, Nunag GM, Siyahtan AN. (2011). Correlation of H. pylori with prevalent oral infections. Cell J. 12(S1):91-92.
25. Panahi O. (2025). The age of longevity: medical advances and life extension. J Bio-Med Clin Res. 2:-.
26. Panahi O, Eslamlou SF. (2025). Peridoncio: estructura, función y manejo clínico. Peridoncio. ISBN:978-620-8-74557-8.
27. Panahi O, Farrokh S. (2025). AI, IT, and community medicine for building healthier communities. Int J Nurs Health Care. 1(1):1-4.
28. Panahi O. (2025). Стволовые клетки пульпы зуба. Pulpa Stem Cells. ISBN:978-620-4-05357-8.
29. Panahi O. (2025). Nanomedicine: tiny technologies, big impact on health. J Bio-Med Clin Res. 2:-.
30. Panahi O, Amirloo A. (2025). AI-enabled IT systems for enhanced dental practice management. On J Dent Oral Health. 8(4):-.
31. Panahi O. (2013). Effect of unripe Makopa extract on bleeding/clotting time. Int J Paediatr Dent. 23:205.
32. Panahi O, Eslamlou SF. (2025). Peridontium: struktura, funkcja i postępowanie kliniczne. Peridontium. ISBN:978-620-8-74560-8.
33. Panahi O, Eslamlou SF. (2025). Artificial intelligence in oral surgery. J Clin Dent Oral Care. 3(1):1-5.
34. Panahi O, Eslamlou SF, Jabbarzadeh M. (2025). Odontoiatria digitale e intelligenza artificiale. Odontoiatria Digit. ISBN:978-620-8-73913-3.
35. Omid P, Soren F. (2025). The digital double: AI implants and data privacy. Digit J Eng Sci Technol. 2(1):105.
36. Panahi O, Eslamlou SF, Jabbarzadeh M. (2025). Medicina dentária digital e inteligência artificial. Med Dent Digital. ISBN:978-620-8-73915-7.
37. Panahi O. (2025). Stammzellen aus dem Zahnmark. Stammzellen Zahnmark. ISBN:978-620-4-05355-4.
38. Panahi O. (2025). AI-enhanced case reports using medical imaging. J Case Rep Clin Images. 8(1):1161.
39. Panahi O. (2025). Navigating the AI landscape in healthcare and public health. Mathews J Nurs. 7(1):5.
40. Panahi O. (2025). Artificial intelligence shaping future health planning. Int J Health Policy Plann. 4(1):1-5.
41. Panahi O, Falkner S. (2025). Telemedicine, AI, and the future of public health. West J Med Sci Res. 2(1):10.
42. Panahi O, Azarfardin A. (2025). AI-based implant planning for precise placement. J Dent Oral Health. 2(1):-.
43. Panahi O. (2025). AI in health policy: implementation and ethical considerations. Int J Health Policy Plann. 4(1):1-5.
44. Panahi O, Eslamlou SF, Jabbarzadeh M. (2025). Stomatologia cyfrowa i sztuczna inteligencja. Stomatol Cyfrowa. ISBN:978-620-8-73914-0.
45. Panahi O. (2025). Innovative biomaterials for sustainable medical implants. Eur J Innov Stud Sustain. 1(2):1-5.
46. Panahi O. (2024). AI-driven solutions for dental tissue regeneration. Austin J Dent. 11(2):1185.
47. Panahi O, Eslamlou SF, Jabbarzadeh M. (2025). Dentisterie numérique et intelligence artificielle. Dent Numérique. ISBN:978-620-8-73912-6.
48. Panahi O, Zeinalddin M. (2024). Precision medicine and dentistry: robotics & AI perspective. Austin J Dent. 11(2):1186.
49. Omid P, Mohammad Z. (2024). Remote monitoring toothbrush using AI for early cavity detection. IJDSIR. 7(4):173-178.
50. Omid P. (2024). Modern sinus lift techniques aided by AI. Glob J Oto. 26(4):556198.
51. Panahi O. (2024) The Rising Tide: Artificial Intelligence Reshaping Healthcare Management. *S J Publc Hlth*. 1(1):1-3.
52. Panahi P. (2008) Multipath Local Error Management Technique Over Ad Hoc Networks. *Automated Solutions for Cross Media Content and Multi-Channel Distribution*. pp. 187-194.
53. Panahi O, Eslamlou SF, Jabbarzadeh M. (2024) Digitale Zahnmedizin und künstliche Intelligenz. *Scholars Press*. ISBN: 978-620-8-73910-2.
54. Panahi U. (2025) AD HOC Networks: Applications, Challenges, Future Directions. *Scholars' Press*. ISBN: 978-3-639-76170-2.
55. Panahi U. (2025) AD HOC-Netze: Anwendungen, Herausforderungen, zukünftige Wege. *Verlag Unser Wissen*. ISBN: 978-620-8-72963-9.
56. Panahi O, Eslamlou SF, Jabbarzadeh M. (2024) Odontología digital e inteligencia artificial. *Scholars Press*. ISBN: 978-620-8-73911-9.
57. Koyuncu B, Gokce A, Panahi P. (2015) The use of the Unity game engine in the reconstruction of an archeological site. *SOMA 2015*. 95-103.
58. Koyuncu B, Meral E, Panahi P. (2015) Real-time geolocation tracking using GPS+GPRS and Arduino-based SIM908. *IFRSA Int J Electron Circuits Syst*. 4(2):148-150.
59. Warnakulasuriya S. (2020) Oral potentially malignant disorders: A clinical review. *Oral Oncol*. 102:104550.
60. Gupta N, Gupta R, Acharya AK, et al. (2021) Changing trends in oral cancer: A global scenario. *Nepal J Epidemiol*. 11(4):1035-1057.
61. Sung H, Ferlay J, Siegel RL, et al. (2021) Global Cancer Statistics 2020. *CA Cancer J Clin*. 71(3):209-249.
62. Siegel RL, Giaquinto AN, Jemal A. (2024) Cancer statistics, 2024. *CA Cancer J Clin*. 74(1):12-49.
63. Chow LQM. (2020) Head and Neck Cancer. *N Engl J Med*. 382(1):60-72.
64. Hashibe M, Brennan P, Chuang SC, et al. (2009) Interaction between tobacco and alcohol and head/neck cancer risk. *Cancer Epidemiol Biomarkers Prev*. 18(2):541-550.
65. Koyuncu B, Uğur B, Panahi P. (2013) Indoor location determination using RFIDs. *Int J Mobile Adhoc Netw*. 3(1):7-11.
66. Uras Panahi. (2025) Redes AD HOC: Aplicações, Desafios, Direcções Futuras. *Edições Nosso Conhecimento*.
67. Panahi P, Dehghan M. (2008) Multipath Video Transmission Over Ad Hoc Networks. *ICEE 2008*. 50-55.
68. Panahi DU. (2025) AD HOC Networks: Applications, Challenges, Future Directions. *Scholars' Press*.
69. Panahi O, Esmaili F, Kargarnezhad S. (2024) Artificial Intelligence in Dentistry. *Scholars Press Publishing*. ISBN: 978-620-6772118.
70. Omid P. (2011) Relevance between gingival hyperplasia and leukemia. *Int J Acad Res*. 3:493-49.
71. Panahi O. (2025) Secure IoT for Healthcare. *Eur J Innov Stud Sustain*. 1(1):1-5.
72. Panahi O. (2025) Deep Learning in Diagnostics. *J Med Discov*. 2(1).
73. Omid P. (2024) Artificial Intelligence in Oral Implantology: Applications and Challenges. *Adv Dent Oral Health*. 17(4):555966.
74. Panahi O. (2024) Teledentistry: Expanding Access to Oral Healthcare. *J Dent Sci Res Rev Rep*. SRC/JDSR-203.
75. Omid P. (2024) Empowering Dental Public Health with AI. *JOJ Pub Health*. 9(1):555754.
76. Thamson K, Panahi O. (2025) AI as a Collaborative Tool Between Clinicians and Researchers. *J Bio Adv Sci Res*. 1(2):1-8.

77. Panahi O. (2025) Algorithmic Medicine. *J Med Discov*. 2(1).
78. Panahi O. (2025) The Future of Healthcare: AI, Public Health and the Digital Revolution. *MediClin Case Rep J*. 3(1):763-766.
79. Thamson K, Panahi O. (2025) AI in Clinical Trials: Challenges and Opportunities. *J Bio Adv Sci Res*. 1(2):1-8.
80. Thamson K, Panahi O. (2025) Ethical Considerations of AI in Dental Healthcare. *J Bio Adv Sci Res*. 1(2):1-7.
81. Thamson K, Panahi O. (2025) AI, Data Science & Evidence-Based Dentistry. *J Bio Adv Sci Res*. 1(2):1-13.
82. Gholizadeh M, Panahi O. (2021) Research System in Health Management Information Systems. *Sciencia Scripts Publishing*.
83. Panahi O, Esmaili F, Kargarnezhad S. (2024) L'intelligence artificielle dans l'odontologie. *Edition Notre Savoir*. ISBN.
84. Panahi DO, Esmaili DF, Kargarnezhad DS. (2024) Искусственный интеллект в стоматологии. *SCIENCIASCRIPTS*.
85. Panahi UP, Omid P. (2025) AI-Powered IoT in Oral Implantology. *J Adv Artif Intell Mach Learn*. 1(1):1-4.
86. Panahi O, Eslamlou SF. (2025) Periodontium: Structure, Function and Clinical Management. *Scholars Press*.
87. Panahi O, Ezzati A. (2025) AI in Dental Medicine. *Open Access J Clin Images*. 2(1):1-5.
88. Panahi O, Dadkhah S. (2025) Mitigating aflatoxin contamination in grains. *Adv Biotechnol Microbiol*. 18(5).
89. Panahi O. (2024) Empowering Dental Public Health with AI. *JOJ Pub Health*.
90. Omid P, Fatmanur KC. (2023) Nanotechnology, Regenerative Medicine & Tissue Bio-Engineering.
91. Chaturvedi AK, Mbulaiteye SM, Engels EA. (2021) HPV-Associated Cancers in the USA. *The Oncologist*. 26(7):e1130-e1135.
92. Lalla RV, Saunders DP, Peterson DE. (2014) Oral mucositis from chemotherapy/radiation. *Dent Clin*. 58(2):341-349.
93. Vissink A, Jansma J, Spijkervet FK, et al. (2003) Oral sequelae of radiotherapy. *Crit Rev Oral Biol Med*. 14(3):199-212.
94. Peterson DE, Doerr W, Hovan A, et al. (2010) Osteoradionecrosis: Evidence-based review. *Support Care Cancer*. 18(8):1089-1103.
95. Buglione M, Cavagnini R, Di Rosario F, et al. (2016) Oral toxicity in head and neck cancer treatment. *Crit Rev Oncol Hematol*. 102:47-54.
96. American Academy of Oral Medicine. (2017) Dental Management of Oral Complications of Cancer Treatment. *AAOM Resource*.
97. Panahi O. (2025) The Algorithmic Healer. *MediClin Case Rep J*. 3(1):759-762.
98. Panahi O. (2024) AI: A New Frontier in Oral and Maxillofacial Surgery. *Acta Sci Dent Sci*. 8(6):40-42.
99. Panahi O, Falkner S. (2025) Telemedicine, AI and Public Health. *Western J Med Sci Res*. 2(1):102.
100. Panahi DO, Esmaili DF, Kargarnezhad DS. (2024) Искусственный интеллект в стоматологии. *SCIENCIASCRIPTS Publishing*.
101. Esmaielzadeh DS, Panahi DO, Çay DFK. (2020) Application of Clay's in Drug Delivery in Dental Medicine. Scholars' Press.
102. Panahi DO. (2019) NanoTechnology, Regenerative Medicine and Tissue Bio-Engineering. Scholars' Press.
103. Panahi DO, Dadkhah DS. (2025) La IA en la odontología moderna. ISBN.
104. Panahi DO, Esmaili DF, Kargarnezhad DS. (2024) Inteligencia artificial en odontología. Mento Publishing. ISBN.
105. Panahi O, Esmaili DF, Kargarnezhad DS. (2024) Intelligenza artificiale in odontoiatria. SAPIENZA Publishing. ISBN.
106. Panahi DO, Dadkhah DS. (2025) L'IA dans la dentisterie moderne. ISBN.
107. Panahi O, Eslamlou SF. (2025) Artificial Intelligence in Oral Surgery: Enhancing Diagnostics, Treatment, and Patient Care. J Clin Den & Oral Care. 3(1): 01-05.
108. Omid P, Soren F. (2025) The Digital Double: Data Privacy, Security, and Consent in AI Implants. Digit J Eng Sci Technol. 2(1): 105.
109. Panahi DO, Eslamlou DSF. (2025) Le péridontium: Structure, fonction et gestion clinique. ISBN.
110. Panahi DO, Dadkhah DS. (2025) Sztuczna inteligencja w nowoczesnej stomatologii. ISBN.
111. Panahi O. (2025) The Role of Artificial Intelligence in Shaping Future Health Planning. Int J Health Policy Plann. 4(1): 01-05.
112. Panahi O, Amirloo A. (2025) AI-enabled IT systems for improved dental practice management. On J Dent & Oral Health.
113. Panahi DO, Dadkhah DS. (2025) A IA na medicina dentária moderna. ISBN.
114. Panahi DO, Dadkhah DS. (2025) L'intelligenza artificiale nell'odontoiatria moderna. ISBN.
115. Panahi O, Eslamlou SF, Jabbarzadeh M. (2025) Medicina dentária digital e inteligência artificial. ISBN.
116. Panahi DO. (2021) Cellule staminali della polpa dentaria. ISBN.
117. Panahi O. (2021) Células madre de la pulpa dental. Ediciones Nuestro Conocimiento.
118. Panahi O. (2025) AI-Enhanced Case Reports: Integrating Medical Imaging for Diagnostic Insights. J Case Rep Clin Images. 8(1): 1161.
119. Panahi O. (2025) Navigating the AI Landscape in Healthcare and Public Health. Mathews J Nurs. 7(1): 56.
120. Panahi O. (2025) Innovative Biomaterials for Sustainable Medical Implants: A Circular Economy Approach. Eur J Innov Stud Sustain. 1(2): 1-5.
121. Panahi DO. (Year unknown) Стволовые клетки пульпы зуба. (Book)
122. Panahi O, Azarfardin A. (2025) Computer-Aided Implant Planning: Utilizing AI for Precise Placement and Predictable Outcomes. J Dent Oral Health. 2(1). DOI: 10.61615/JDOH/2025/MAR027140329.
123. Panahi O. (2024) The Rising Tide: Artificial Intelligence Reshaping Healthcare Management. S J Publc Hlth. 1(1): 1-3.
124. Panahi O. (2025) AI in Health Policy: Navigating Implementation and Ethical Considerations. Int J Health Policy Plann. 4(1): 01-05.
125. Panahi O. (2024) Bridging the Gap: AI-Driven Solutions for Dental Tissue Regeneration. Austin J Dent. 11(2): 1185.
126. Panahi O, Zeinalddin M. (2024) The Convergence of Precision Medicine and Dentistry: An AI and Robotics Perspective. Austin J Dent. 11(2): 1186.
127. Omid P. (2024) Modern Sinus Lift Techniques: Aided by AI. Glob J Oto. 26(4): 556198.
128. Panahi O, Zeinalddin M. (2024) The remote monitoring toothbrush for early cavity detection using AI. IJDSIR.
129. Panahi O. (2021) Stammzellen aus dem Zahnmark. Verlag Unser Wissen.
130. Panahi O, Eslamlou SF, Jabbarzadeh M. (Year unspecified) Stomatologia cyfrowa i sztuczna inteligencja. ISBN.
131. Panahi O, Eslamlou SF, Jabbarzadeh M. (2025) Odontoiatria digitale e intelligenza artificiale. ISBN.

132. Panahi O, Eslamlou SF, Jabbarzadeh M. (2025) Dentisterie numérique et intelligence artificielle. ISBN.
133. Panahi O, Eslamlou SF, Jabbarzadeh M. (2025) Odontología digital e inteligencia artificial. ISBN.
134. Panahi O, Eslamlou SF, Jabbarzadeh M. (2025) Digitale Zahnmedizin und künstliche Intelligenz. ISBN.
135. Panahi O. (2025) Predictive Health in Communities: Leveraging AI for Early Intervention and Prevention. Ann Community Med Prim Health Care. 3(1): 1027.
136. Panahi O, Zeinalddin M. (2024) The remote monitoring toothbrush for early cavity detection using AI. IJDSIR.
137. Panahi O. (2021) Stammzellen aus dem Zahnmark. Verlag Unser Wissen.
138. Panahi O, Eslamlou SF, Jabbarzadeh M. (Year unknown) Stomatologia cyfrowa i sztuczna inteligencja. ISBN.
139. Panahi O, Eslamlou SF, Jabbarzadeh M. (2025) Odontoiatria digitale e intelligenza artificiale. ISBN.
140. Panahi O, Eslamlou SF, Jabbarzadeh M. (2025) Dentisterie numérique et intelligence artificielle. ISBN.
141. Panahi O, Eslamlou SF, Jabbarzadeh M. (2025) Odontología digital e inteligencia artificial. ISBN.
142. Panahi O, Eslamlou SF, Jabbarzadeh M. (2025) Digitale Zahnmedizin und künstliche Intelligenz. ISBN.
143. Panahi O. (2025) Predictive Health in Communities: Leveraging AI for Early Intervention and Prevention. Ann Community Med Prim Health Care. 3(1): 1027.
144. Panahi P, Bayılmış C, Çavuşoğlu U, Kaçar S. (2021) Performance evaluation of lightweight encryption algorithms for IoT-based applications. Arabian J Sci Eng. 46(4): 4015-4037.