

ARTIFICIAL INTELLIGENCE IN PUBLIC HEALTH DENTISTRY

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Abstract: The creation of the relevant technology must be driven by educational demands. Even so, the human factor must always be taken into consideration. Exciting new technology and potent cures will continue to be produced by scientific research. The capacity of a digital computer, computer-controlled robot to carry out actions closely identified with intelligent beings is known as artificial intelligence (AI). The evolution of AI has been clearly accelerating over the past ten years, and dentistry has not been an exception. Dental AI is important for diagnosing patients, storing patient data, and evaluating genetic information to improve patient treatment. This applies particularly to oral medicine and radiography. A good understanding of technology adaption will not only contribute to better and more accurate patient care but will also lighten the workload of the physician. The need for sophisticated software to compute this data has arisen due to the massive growth in documented information as well as patient data. A new age in dentistry has emerged as a result of the convergence of artificial intelligence and digitization, and the field's prospects for the future look quite bright.

Keywords: Artificial Intelligence, Machine Learning, Database, Surveillance

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Conflicts of interest:

The authors declare no conflicts of interest.

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L'INTELLIGENCE ARTIFICIELLE EN SANTÉ PUBLIQUE DENTAIRE

Résumé: La création d'une technologie pertinente doit être motivée par les exigences éducatives. Néanmoins, le facteur humain doit toujours être pris en considération. De passionnantes nouvelles technologies et de puissants remèdes continueront par être produits par la recherche scientifique. La capacité d'un ordinateur numérique, un robot contrôlé par ordinateur, à effectuer des actions étroitement associées à des êtres intelligents est connu sous le nom d'intelligence artificielle (IA). L'évolution de l'IA s'est clairement accélérée au cours des dix dernières années, et la dentisterie n'a pas fait exception. L'IA dentaire est importante pour diagnostiquer les patients, stocker les données des patients et évaluer les informations génétiques afin d'améliorer le traitement des patients. Cela s'applique particulièrement à la médecine buccale et à la radiographie. Une bonne compréhension de l'adaptation technologique contribuera non seulement à prodiguer des soins meilleurs et plus précis aux patients, mais allégera également la charge de travail du médecin. Le besoin de logiciels sophistiqués pour calculer ces données est apparu en raison de la croissance massive des informations documentées ainsi que des données sur les patients. Une nouvelle ère en dentisterie a émergé grâce à la convergence de l'intelligence artificielle et de la numérisation, et les perspectives d'avenir dans ce domaine s'annoncent plutôt prometteuses.

Mots Clés: Intelligence artificielle, apprentissage automatique, base de données, surveillance

Introduction

For as long as recorded history can be traced, researchers and technologists have found the human brain to be one of the most fascinating structures. Exciting new technology and potent cures will continue to be produced by scientific research[1]. The development of newer technology over the years has been founded on theories that attempt to imitate how the human brain works, but even today, an automated system that is capable of thinking like a human is still a pipe dream. This applies particularly to oral medicine and radiography[2]. Aristotle's early attempts to formalize logic and understanding through his syllogisms served as a major inspiration for many modern computing and technology[3].

Artificial intelligence

The invention of a machine that could break down encrypted messages by British mathematician Alan Turing in 1950 could be considered the first major advance in the development of supercomputers. He developed the "Turing Test" to test whether a computer demonstrates intelligence. Similar functionality is currently known as "artificial intelligence"[4]. Intelligence software for its processing has become essential due to the massive rise in patient data that has been documented. Because it can find and diagnose lesions that the human eye might miss, computer-based diagnostics is becoming more popular. Although the standard methodologies have yielded a wealth of information, they have drawbacks[5]. Around the world, artificial intelligence (AI) is being developed to imitate human intelligence and address specific problems. AI can help with the creation of algorithms which can learn from the data presented and create forecasts. Based on data, machine learning develops algorithms. Neural networks were one of the earliest classes of AI algorithms that were

created. Shallow learning neural networks include simple network structures that have just a few layers, whereas neural networks that use deep learning are structures with many levels and large layers[6]. "A field of science and engineering concerned with the computational understanding of what is commonly referred to as intelligent behavior, and with the creation of artefact that exhibit such behavior," is how artificial intelligence (AI) is defined[7]. John McCarthy introduced the idea underlying artificial intelligence (AI) in the year 1956. The ongoing hunt for a model is what gave rise to AI[8]. In the past ten years, technology has also completely transformed the fields of medicine and dentistry. This includes everything from an online appointment book, online check-in at medical facilities, digitization of medical records, requests for additional appointments and dates for child and pregnant patients' immunizations, to drug quantity algorithms and warnings about negative effects when prescription of drug formulations, among other things[9]. AI might be seen as a useful tool to lighten the workload of clinicians and dentists. AI may learn from different sources of information (multi-modal data) to diagnose diseases beyond the capability of humans, in addition to diagnosing disorders using a single information source targeted at a specific ailment. Numerous studies on artificial intelligence (AI) applications in dentistry are in progress or have already been implemented in areas like diagnostics, decision-making, treatment planning, treatment outcome prediction, and illness prognosis[10].

Application of artificial intelligence in dentistry

AI is gradually encroaching into the realm of radiography in dentistry, with a focus on diagnostic records that include IOPAs/RVGs, 3-D and computed tomography with cone beams[1].

Since its inception in the 1980s, the field of automated tutoring has made major advancements. AI is commonly used in the discipline of dental education to create scenarios that mimic performing clinical procedures on patients as well as reduce all the risks associated with training on an actual patient. As a result, the preclinical virtual patient input from the students has significantly increased. Because the interactive inter-phase enables students to assess their work and contrast it with the ideal, it creates high-quality learning settings. Numerous assessments of these systems' effectiveness have shown that they enable students to reach competency-based abilities more quickly than traditional simulator units[11].

Artificial intelligence-powered virtual dental assistants can do a number of tasks in the dental office with greater precision and fewer errors while using less staff as a result. It can help with a range of tasks, including clinical evaluation, planning of therapy, appointment scheduling, insurance and paperwork management, and many more. Knowing health and patient's background and any practises, including drinking and smoking, is very important for the dentist. The patient can choose emergency teleassistance in dental crises, particularly if the doctor isn't there[12].

Artificial intelligence can be applied to identify and treat oral cavity conditions, as well as to identify and categorize suspiciously altered mucosa that has undergone premalignant and malignant modifications. Even minute adjustments at the single-pixel scale that the average human eye could overlook are detected. The genetic predisposition for oral cancer in a broad population may be accurately identified using artificial intelligence. An AI-based machine learning system is a helpful tool for predicting tooth prognosis in light of the dental care plan. A detailed treatment plan must be carefully examined in order to assess a tooth's condition for long-term dental health and functionality[13].

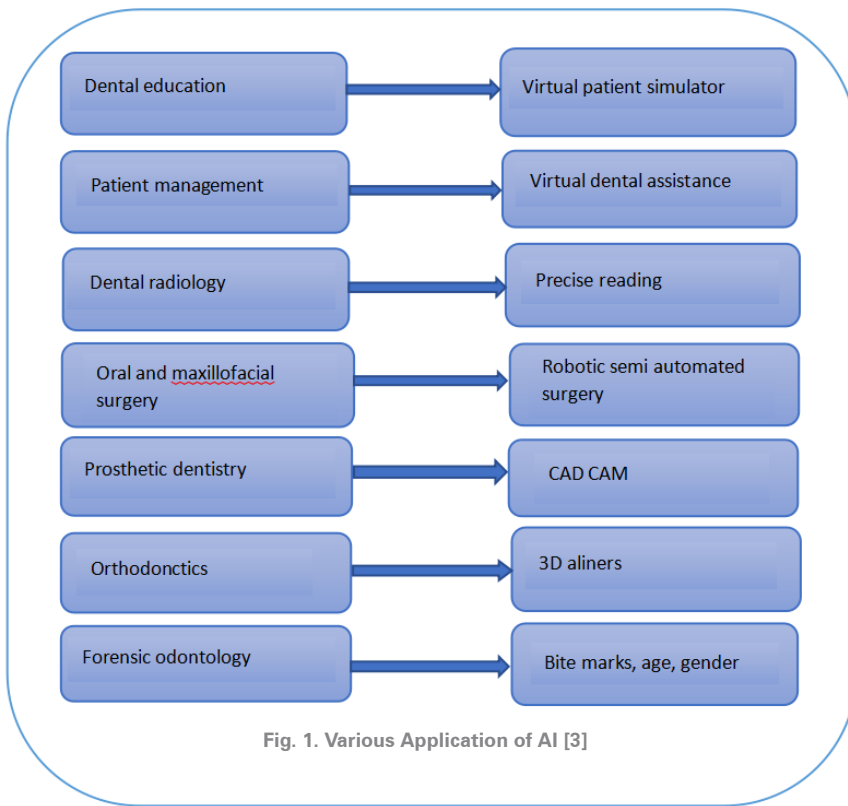


Fig. 1. Various Application of AI [3]

Dentistry in public health: the part of ai

Artificial intelligence-powered virtual dental assistants can carry out a variety of duties more accurately, without as many mistakes, and requiring less work than people. Some of these responsibilities include making sure that patients and dentists have regular appointments, reminding patients as well as dentists to schedule checkups when genetic or lifestyle factors indicate an increased risk of dental diseases, and supporting clinical assessment as well as treatment planning[14]. Additionally, AI holds out the prospect of increasing the role of patients in healthcare, especially if they actively provide their data. Self-management and self-monitoring can empower patients. Utilizing this continuously gathered data can also assist in overcoming the drawbacks of on-off medicine, which sees patients for brief periods of time despite though the ma-

majority of health disorders are often acquired over years and occur intermittently Regular safe behaviour and health monitoring will enable a much deeper comprehension

of the variables influencing each unique process that underlies illness as well as health[15]. Costs associated with diagnosis and treatment can be reduced, relieving the strain on healthcare systems brought on by an ageing population and an increase in the number of complex, chronic illness cases[1].

Health promotion

the use artificial intelligence in the context of medical emergencies Prediction of diseases is the main goal of protection, next comes the detection and scales for disease severity and degree classification. 43.75% of AI types used machine education as well as regression approaches, 25% used machine learning plus deep learning, and 18.75% used solely machine learning[16]. According to one’s risk factors and behaviour patterns, AI provides targeted and individualized health advice. Individual experts have a range of skills depending on their training and work history. This is one of the factors contributing to the rise in interest in using computer-aided decision making. Eg, Informing the dentist about any pertinent medical histo-

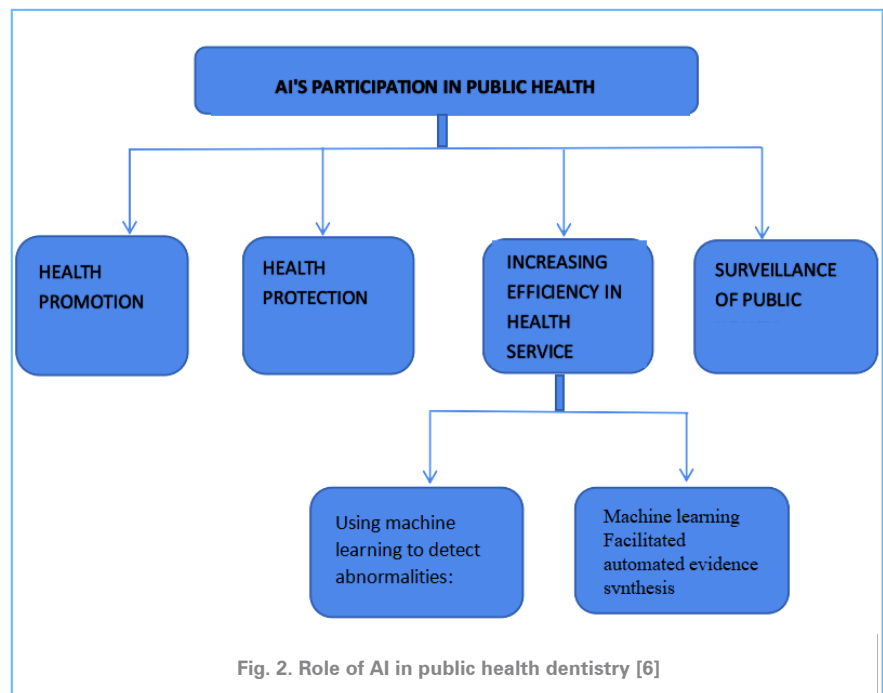


Fig. 2. Role of AI in public health dentistry [6]

ry, for instance, could help properly forecast a genetic tendency for oral disorders in a sizable population.

Health protection

Four problems with associated solutions regarding how AI may tackle them are presented.

a) Cutting back on services at the expense of clinical care. It has been noticed that the absence of uniformity in the Indian health care industry raises the cost of the service. Reducing services while sacrificing clinical care It has been noted that the Indian healthcare sector's lack of standardization drives up service costs. AI shortens the amount of time it takes medical professionals to do those jobs as well as the process of obtaining test results.. As a result, medical professionals can treat a greater number of patients for less money, and standardization is made possible.[17]

b) ensuring the standard of care: AI is crucial in ensuring that the growing number of patients receive high-quality care. Quality and cost will be impacted by artificial intelligence since efficient work lowers time, which in turn reduces the number of employees needed at various locations including reception, diagnosis centers, medical stores, and the like.[18]

c) Data quality and security: Another problem that needs to be resolved is data privacy, which offers protection to patient those involved, service providers, and others. A suitable data structure adheres to standards for collection, storage, completeness, and exchange, ensuring that the data is accurate and in a recognized format. However, due to an inadequate system, one of the problems patients have is that their medical records are not easily accessible. As a result, they are unable to provide the required documents to another doctor, which is problematic in an emergency. Deep learning can be used to solve both problems.[19]

d) Decreasing frauds: Healthcare insurance plans, programme, and schemes, which are primarily run by the government, don't get reliable information from their employees, which encourages fraud across the system. As a result, there are malpractices, providers' persuasive requests, phoney beneficiaries and policyholders, among other things. The Indian government has added an additional layer of security by using AI to track trends and create established protocols to prevent anomalies brought on by excessive invoicing or charging, excessive testing, incorrect beneficiary information, and abuse of referral mechanisms.[20]

Increasing the effectiveness of health services

A) Using artificial intelligence to find anomalies: Machine learning and its related topics, including advanced learning, cognitive computing, processing of natural languages, the field of robotics expert systems, and fuzzy reasoning, are subcategories of artificial intelligence (AI). Ma-

chine learning refers to a branch of artificial intelligence that improves automated learning without being explicitly programmed. Its main objective is to enable automated learning absent human judgement. Using the current set of observations, AI models forecast future events. Figures 2 displays a schematic representation of AI and a model of human intelligence[21].

B) Automatic evidence synthesis aided by machine learning:

The process of entering structured data into the system is the most time-consuming, but with the advent of voice recognition and the possibility for artificial intelligence programme to recognize and extract data from scanned documents, this process has been streamlined. Additionally, there is the interactive inter-phase, which is intended to bridge the gap among the doctor and the patient while enabling the health care professional to absorb a massive amount of information more effectively than human assistance[22].

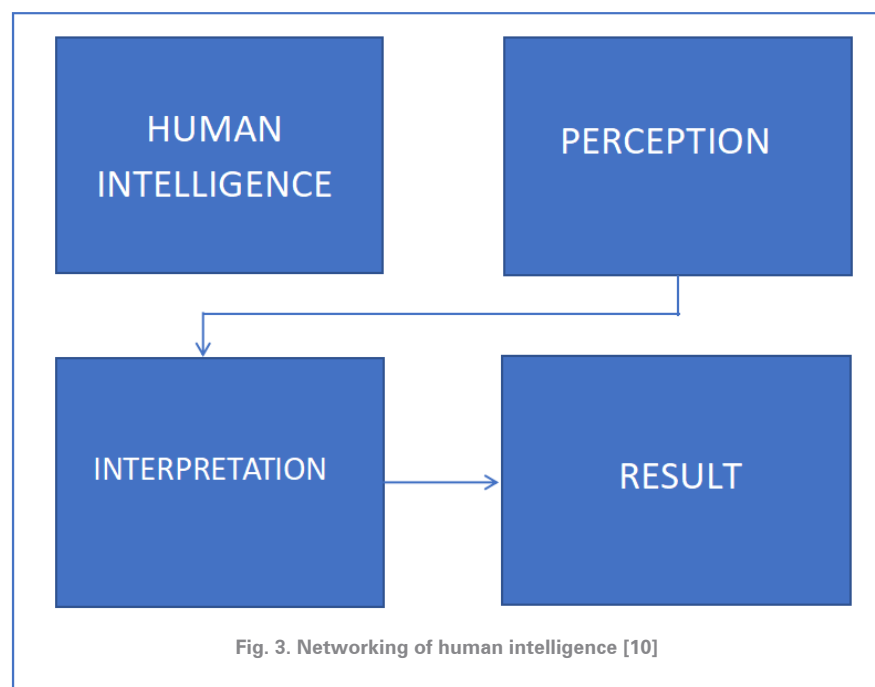


Fig. 3. Networking of human intelligence [10]

Surveillance of public health

AI can support both new and improved public health monitoring and reaction strategies. The underlying difficulties that monitoring for public health and reaction face provide the solution. Data is fundamental to public health surveillance. The primary goal of public health monitoring has traditionally been the identification of early, precise, and accurate markers of health anomalies as well as outbreaks of illness from a variety of data sources. Technically speaking, this presents two distinct challenges: the issue of data sourcing and the challenge of analytics. Finding easily operationalizable streams of data which include meaningful signals is the first data

sourcing difficulty. The examination and forecasting of infectious illness trends through the modeling of spread of infectious diseases pathways as well as the evaluation of responses of public health are additional significant goals for public health surveillance as well as response. Analytically speaking, public health surveillance focuses on quickly and accurately determining the threat of an outbreak, identifying aberrant shifts in the spatial status of a disease, and forecasting the epidemic's trend[23].

Streams of data from public health maintain have long been used to examine trends and threats, machine learning-based AI techniques, in particular, have been used to find patterns, spot anoma-

lies, and recognize patterns in data streams. These data streams must be examined with external financial, social, and ecological information since they frequently have strong temporal and spatial components. Traditional surveillance techniques mainly rely on the application of statistical techniques[24].

Acknowledgement:

I would like to acknowledge my indebtedness and render my warmest thanks to our University (Sharad Pawar Dental College, Datta Meghe Institute of higher Education and Research) who made this work possible.

References

- Tariq SA, Gupta NI, Gupta PR, Sharma AD. Artificial intelligence in public health dentistry. *Int Healthc Res J*. 2021;5(9):1-5.
- Bindushree V, Sameen RJ, Vasudevan V, Shrihari TG, Devaraju D, Mathew NS. Artificial intelligence: In modern dentistry. *Journal of Dental Research and Review*. 2020 Jan 1;7(1):27.
- Khanna SS, Dhaimade PA. Artificial intelligence: transforming dentistry today. *Indian J Basic Appl Med Res*. 2017 Jun;6(3):161-7.
- Ramesh AN, Kambhampati C, Monson JR, Drew PJ. Artificial intelligence in medicine. *Annals of the Royal College of Surgeons of England*. 2004 Sep;86(5):334.
- Sharma S. Artificial intelligence in dentistry: the current concepts and a peek into the future. *Int. J. Contemp. Med. Res*. 2019:5-9.
- Babu A, Onesimu JA, Sagayam KM. Artificial Intelligence in dentistry: Concepts, Applications and Research Challenges. In *E3S Web of Conferences 2021* (Vol. 297, p. 01074). EDP Sciences.
- Turing AM. *Computing machinery and intelligence*. Springer Netherlands; 2009.
- Widmann G. Image-guided surgery and medical robotics in the cranial area. *Biomedical imaging and intervention journal*. 2007 Jan;3(1).
- Buchanan JA. Experience with virtual reality-based technology in teaching restorative dental procedures. *Journal of dental education*. 2004 Dec;68(12):1258-65.
- Ding H, Wu J, Zhao W, Matinlinna JP, Burrow MF, Tsoi JK. Artificial intelligence in dentistry—A review. *Frontiers in Dental Medicine*. 2023;4:9.
- Agrawal P, Nikhade P, Nikhade PP. Artificial intelligence in dentistry: past, present, and future. *Cureus*. 2022 Jul 28;14(7).
- Alexander B, John S. Artificial intelligence in dentistry: Current concepts and a peep into the future. *Int J Adv Res*. 2018;6(12):1105-8.
- Lee SJ, Chung D, Asano A, Sasaki D, Maeno M, Ishida Y, Kobayashi T, Kuwajima Y, Da Silva JD, Nagai S. Diagnosis of tooth prognosis using artificial intelligence. *Diagnostics*. 2022 Jun 9;12(6):1422.
- Kikuchi H, Ikeda M, Araki K. Evaluation of a virtual reality simulation system for porcelain fused to metal crown preparation at Tokyo Medical and Dental University. *Journal of dental education*. 2013 Jun;77(6):782-92.
- Joda T, Waltimo T, Probst-Hensch N, Pauli-Magnus C, Zitzmann NU. Health data in dentistry: an attempt to master the digital challenge. *Public Health Genomics*. 2019;22(1-2):1-7.
- Martinez-Millana A, Saez A, Tornero R, Azzopardi-Muscat N, Traver V, Novillo-Ortiz D. Artificial intelligence and its impact on the domains of universal health coverage, health emergencies and health promotion: An overview of systematic reviews. *International Journal of Medical Informatics*. 2022 Aug 17:104855.
- Rodriguez RV, Sinha S, Tripathi S. Impact of Artificial Intelligence on the health protection scheme in India. *Public Administration and Policy*. 2020 Sep 24;23(3):273-81.
- Angell BJ, Prinja S, Gupt A, Jha V, Jan S. The Ayushman Bharat Pradhan Mantri Jan Arogya Yojana and the path to universal health coverage in India: Overcoming the challenges of stewardship and governance. *PLoS medicine*. 2019 Mar 7;16(3):e1002759.
- Bakshi H, Sharma R, Kumar P. Ayushman bharat initiative (2018): What we stand to gain or lose!. *Indian journal of community medicine: official publication of Indian Association of Preventive & Social Medicine*. 2018 Apr;43(2):63.
- Chandwani RK, Dwivedi YK. Telemedicine in India: current state, challenges and opportunities. *Transforming Government: People, Process and Policy*. 2015 Oct 19;9(4):393-400.
- Ahmed N, Abbasi MS, Zuberi F, Qamar W, Halim MS, Maqsood A, Alam MK. Artificial intelligence techniques: analysis, application, and outcome in dentistry—a systematic review. *BioMed research international*. 2021 Jun 22;2021.
- Zeng D, Cao Z, Neill DB. Artificial intelligence-enabled public health surveillance—from local detection to global epidemic monitoring and control. In *Artificial Intelligence in Medicine 2021* Jan 1 (pp. 437-453). Academic Press.
- Akhtar M, Kraemer MU, Gardner LM. A dynamic neural network model for predicting risk of Zika in real time. *BMC medicine*. 2019 Dec;17(1):1-6.
- Thapen N, Simmie D, Hankin C, Gillard J. DEFENDER: detecting and forecasting epidemics using novel data-analytics for enhanced response. *PLoS one*. 2016 May 18;11(5):e0155417.