



Review: Chat GPT: General applications and uses in Dentistry

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Abstract

The release and rapid diffusion of ChatGPT have caught the attention of many health providers worldwide. The release of ChatGPT generated a great deal of excitement and trepidation as to its possible effects on various applications it can be implied. Artificial Intelligence (AI) is the latest buzzword as the world revolves around generative AI, which could be defined as a set of consecutive actions performed to execute any intended task. Generative Pre-trained Transformer (GPT)-based tools are advanced AI-based tools that behave like advanced natural language processing (NLP) models that use DL to generate multi-language texts that resemble human communication. This article narrates the History, Mechanism, tasks and various general applications and use of ChatGPT in dentistry.

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Introduction

Artificial Intelligence (AI) is the latest buzzword as the world revolves around generative AI, which could be defined as a set of consecutive actions performed to execute any intended task. Well-equipped to mimic human intelligence, which is also AI's fundamental goal, its applications have permeated various domains, including medicine and dentistry thereby enabling the use of data mining, medical image analysis, natural language processing, and many more. Machine Learning (ML), a subtype of AI, is the process of extracting the necessary information from the data pool by identifying relevant patterns in the data.^[1] Deep Learning (DL) is a type of machine learning based on artificial neural networks, which uses raw input data, thereby outperforming ML in fulfilling complex tasks.^[2]

A concept born in the mid-twentieth century, AI has now outgrown itself as it is in the nascent stage of creating novice forms of intelligence that can solve problems beyond human cognition.^[3] Presently, mankind can even take 3D scans using smartphones that help in AI diagnostics and therapy of oral problems in patients. The post-pandemic situation necessitates the incorporation of virtual technologies in every field, including dental education.^[4]

Generative Pre-trained Transformer (GPT)-based tools are advanced AI-based tools that behave like advanced natural language processing (NLP) models that use DL to generate multi-language texts that resemble human communication.^[5] Such content guarantees good accuracy and better communication in different fields such as education, transportation, and above all, healthcare where deep-learning methods could redefine treatment planning, diagnostics, telemedicine enabling, and patient management.^[4, 6, 7] The latest GPT-based platform made available to the public for free is the magnificent Chat GPT, a user-friendly chatbot developed and released by Open AI.^[5] The objective of this paper was to categorize the applications of Chat GPT in Dentistry

History

In November 2022, the AI-based chatbot, Chat GPT captured the entire attention of the world with its superb technology and profound usability. Available for free on OpenAI's website, the spectacular rise of this DL-based AI technique is commendable. So, what exactly is Chat GPT, and how does it work? Chat GPT is an AI-based computer program that's rigorously trained on humongous heaps of data to come up with human-like responses specific to the inputs given.^[2] Based on the Generative Pretrained Transformer 3 (GPT-3) architecture^[4], ChatGPT makes use of supervised and semi-supervised ML methods^[8] and DL techniques to provide answers to natural language queries, thereby making it a very large language model.^[2]

Deep Learning is AI's most famous and favourite technology, where algorithms train on big datasets, including picture and voice recognition, language translation, voice recordings, emails, social media information, extended text forms, and structured data to respond to various fields of life.^[7] Chat GPT has the amazing ability to answer any queries posted, and there is no denying that it has captured the global audience by acquiring more than one million subscribers within the first five days of its launch.^[3]

Mechanism

The letter 'G' in GPT stands for **Generative**, and this shows the tool's potential to generate results, 'P' refers to **Pre-training** and involves the deployment of a model from one ML to another, and finally, the 'T' in GPT means **Transformers** that look into total connectivity between data series components.^[7] ChatGPT is built with the Transformer architecture as its foundation.^[7]

ChatGPT is not Open AI's first GPT series but the fifth version (GPT-4) after GPT-1, GPT-2, GPT-3, and GPT-3.5 with GPT-3.5's architecture being the foundation for ChatGPT^[8]. [Table 1]

GPT 1 (2018)	GPT 2(2019)	GPT 3 (2020)	GPT 3.5 (2022)	CHAT GPT (2023)
The first version of GPT programming language based on Transformer Neural Network Architecture trained exclusively to anticipate the next word in a string of text.	Featuring 1.5 billion parameters, GPT-2 was trained to generate more cohesive text content.	A much bigger model with 175 billion parameters, GPT-3 was trained using a language modeling job to prove versatility in handling numerous NLP tasks, enables multi-task learning, and few-shot learning due to which this language model is put to use for chatbots, language translation, and content Generation.	Basic architecture for ChatGPT and an improved version of GPT-3 with fewer variables.	Has human-level performance on a wide arena of topics though proficiency levels aren't equivalent to humans for everyday situations. There is scope for Improvement.

For the first ChatGPT model, human AI trainers were the middlemen between the user and the AI helper, and the model was rigorously trained through fine-tuning—

the trainers had sample written recommendations as ready reckoners to spontaneously help with answers. [7] ChatGPT follows a 4-step procedure to come up with the response:

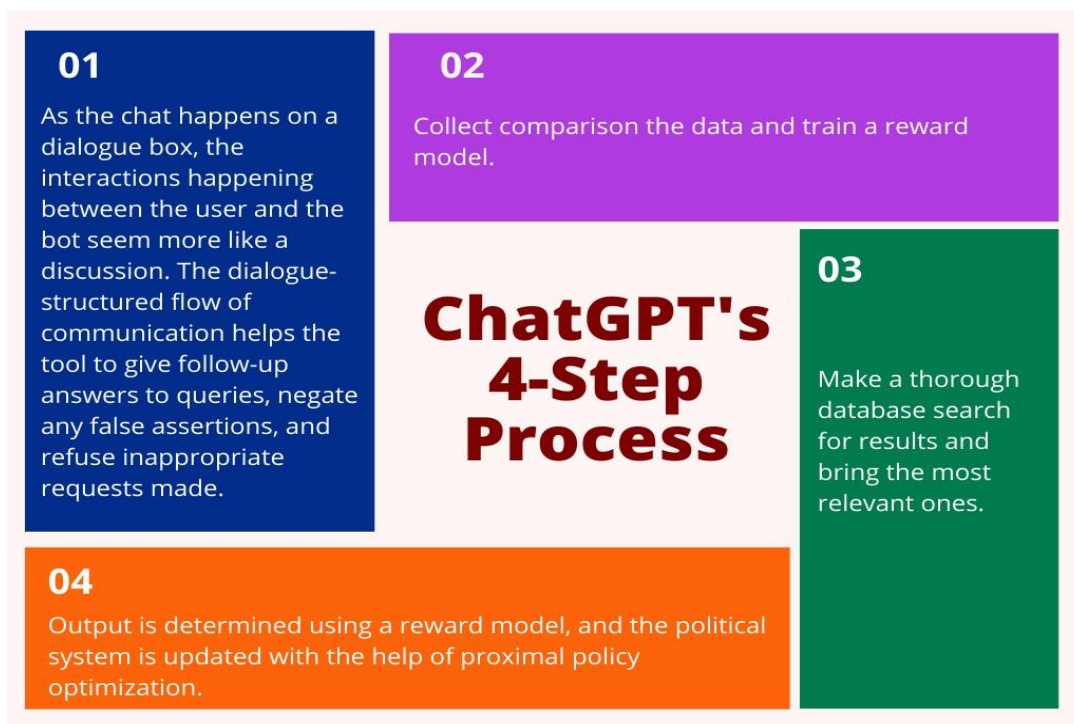


Figure 1: Taken from “An Era of ChatGPT as a Significant Futuristic Support Tool” [7]

Tasks & Functions of ChatGPT:

The sophisticated and accurate design of ChatGPT makes it a wonderful go-to tool for various NLP tasks including [8]:

1. **Language Generation:** The cohesive nature to generate texts and its high proficiency skills makes ChatGPT a prominent tool for spawning error-free, accurate, and logical content.
2. **Multi-tasking Abilities:** ChatGPT’s mastery across various disciplines makes it useful for different applications, which is not limited to but includes programming specialized applications, coaching, interpretation, document generation, literature reviews, and summaries.
3. **Scalability:** Being scalable in terms of both, processing resources and turnaround times, ChatGPT is useful for assignments both small and big, anything from individualistic needs to enterprise-wide programs.
4. **Multi-language Possibility:** ChatGPT’s understanding of different languages makes it a global choice for translating documents retaining the original meaning and context, yielding material in numerous languages, and analyzing the emotions of the individual using the tool.
5. **No-chance or short-chance training:** The tool is capable answering queries that it has never encountered with no-chance training and is smart enough to quickly learn new tasks with a couple of scenarios using short-chance training, thereby minimizing the need f

Wide Applications of ChatGPT:

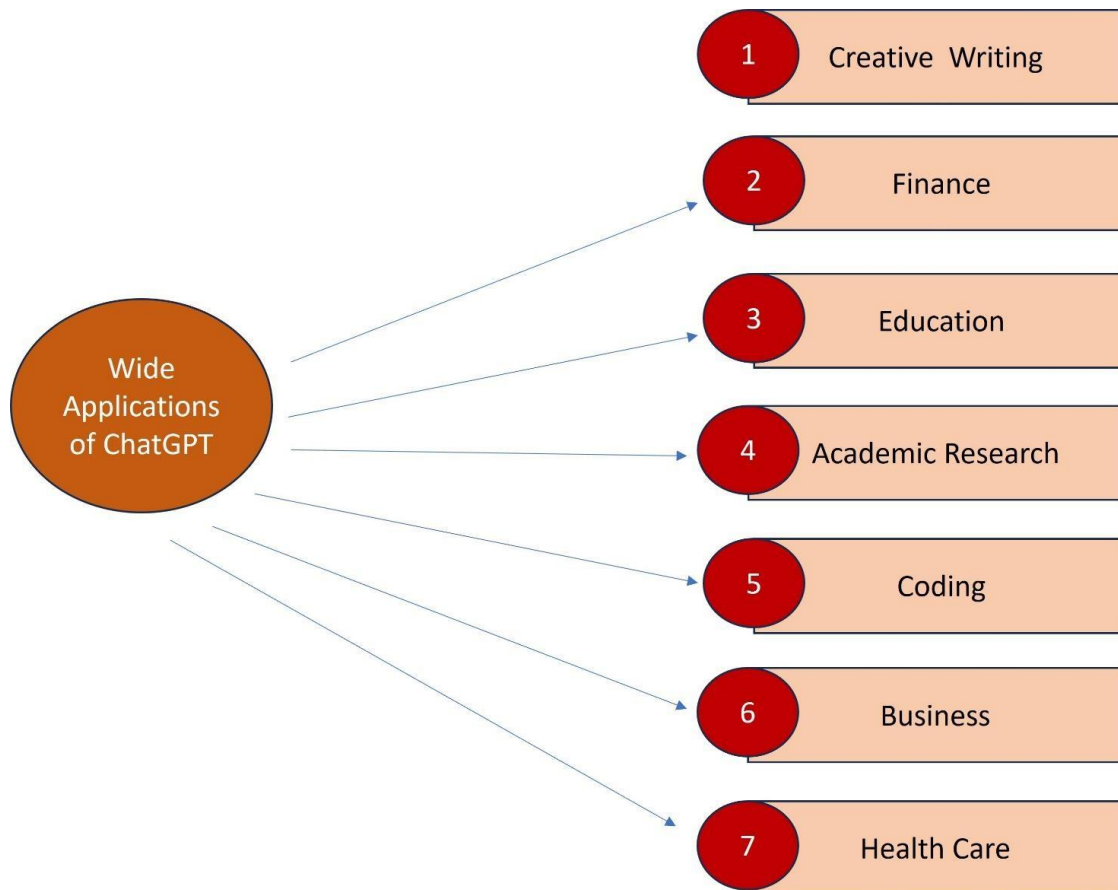


Figure 2: Wide applications of Chat GPT

Soon after its launch, ChatGPT was tried and tested by the human population globally on different aspects, including writing essays, software code, program generation, foreign language translation, and even jokes and recommendations for starting a new business. The tool's versatility, flexibility, and finesse make it a recommended choice for applications besides academic purpose. Given below is the widespread use of ChatGPT, which could revolutionize the future world with its out-of-the-box ideas, business proposals, and healthcare recommendations.

Creative Writing

Just ask for an essay giving the required number of words on any topic and ChatGPT comes up with a complete answer in less than a couple of minutes. We could use ChatGPT for creating content, editing, essay writing, and producing write-ups.^[8] Maybe, the author's block could become a thing of the past with ChatGPT's helpful pointers and initiates. Those involved in small-scale businesses and wanting to promote their work on social media can use ChatGPT for Facebook, Twitter, and Instagram posts based on required parameters—this way, it negates the need for content writers/digital marketers to a large extent.^[7, 8] Such strong content and attractive phrases elevate marketing strategies distinctly.^[7] Students can improve their writing skills and knowledge base using this AI platform that not only provides content but also pinpoints feedback on their essays.

Finance

How about considering ChatGPT as a personal wealth advisor? With its potent ability to proffer highly individualized financial recommendations based on the person's goal, risk ability, and other pointers, this tool acts as a smart reckoner for making investment decisions and procuring better financial results.^[9] Organizations dealing with money laundering and fraud can minimize or avoid losses by identifying fraudulent patterns and behavior. Companies can develop anti-fraud and anti-money laundering systems, make smart investment moves, and invest profits securely with ChatGPT's data analyzing aptitude.^[8] Data analysis and prediction, portfolio management, market research, risk management, and debt management are some financial spheres receiving a thundering response from ChatGPT.^[9] Finally, consumers can rely upon software built using ChatGPT for their savings, expenses, and debt-related issues.^[8]

Education

Small kids to old adults are in awe of ChatGPT which can define the simplest words and weave the most complex sentences under any given topic. For students, it's a boon that could completely change their learning structure and knowledge acquisition methodology by customizing results based on the user's strengths, weaknesses, and learning preferences. Such an approach eliminates the knowledge gap and provides every learner with a mighty tool that supports them in STEM (Science, Technology, Engineering, and Mathematics) field.^[8] The days are not far away when this AI system would take over search engines such as Google, as individuals prefer conversational inputs.^[7] Besides academics, the future would surely witness an overall improvement in the classroom teaching experience as down the line, instructors can teach the fundamentals of a subject and leave the students with a forum to discuss and resolve all queries.^[7, 8]

Academic Research

Scientific studies and academic research use monumental databases. ChatGPT can enhance productivity and shed light on unknown discoveries that were not known earlier by improving the researcher's interaction and interpretation of data. ChatGPT's potential to extract relevant data for academic publications, identify matching trends in statistics, and merge data from different data sources helps researchers understand trends and interconnections between datasets, comprehend complex datasets, and highlight recurring results.^[8]

Coding

Get the needed functionality and code excerpts and optimize program functionality using ChatGPT.^[8] Solving troubleshooting issues by helping in debugging and fixing errors tactically improves the overall code efficiency and program reliability.

Business

Interested in starting a new business, want tips on choosing the right business domain, or require inputs on marketing campaigns for your newly launched business? ChatGPT has the answer to all of these! Those already in commercial operations needing lead creation can use this tool for client retention as well as lead generation, as ChatGPT analyses all the available information on every customer's action and wishes.^[8]

Make use of chatbots to give answers to customer queries, talk more about product recommendations, and offer

personalized suggestions in a realistic and interesting tone that is very close to natural language.^[11,12] Fulfill marketing objectives, engage with the client while exercising privacy and caution to abstain from revealing personal information, and respond to inquiries using ChatGPT.^[7]

1. Healthcare

The applications of ChatGPT aren't limited to the above-mentioned areas but can extend to the healthcare domain, a field in which human touch is indispensable. In the future, this tool has the potential to revolutionize the medical and healthcare field, including dentistry by enhancing diagnostics, minimizing paperwork, detecting medical errors, summarizing the patient history, inputting details dictated by the physician, and supporting clinical decision-making.^[13]

Since COVID-19, online consultations, telemedicine, and virtual diagnosis has been increasingly happening, and ChatGPT could help in healthcare management via virtual assistants who could help patients with their treatments, supervise and manage health history, and book appointments. Mankind could use this tool as a supplement for a diverse range of fields such as radiology, urology, cardiology, dentistry, and more.^[14] Some diversified and indispensable uses of ChatGPT in healthcare include:

- Translate medical and technical jargon accurately for patients to understand their diagnosis and treatment options using its unique language processing skills^[15] ChatGPT makes the prescription language easier to understand, thereby reducing chances of miscommunications.
- Reform practices by analyzing the risk and consequences of diseases and aid in drug development and biomedical research^[2]
- Minimize documentation work by preparing discharge summaries, record patient history and maintain accuracy in record-keeping^[2,15] and streamline admin-related tasks, including insurance claims, staff swapping, and appointment scheduling^[16]
- Identify patients for clinical trials and help connect physicians with potential patients for the trials.^[15]
- Identify patients for clinical trials and help connect physicians with potential patients for the trials.^[15]
- Pave way for straightaway access to medical information for both students and professionals, help academicians with research and publication, and help medical students improve their understanding capabilities with virtual training environments and AI-powered simulation tools^[4,15]

Ability to perform surgery and rehabilitation^[17], analyze patient data like brain-tumor segmentation^[18], and even make epidemiological predictions which can help in clinical decisions.^[19]

- In the field of scientific writing and data analysis where ChatGPT comes of use^[20], it would be favorable for medical researchers and scientists—researching for literature and summarizing data, coming up with an appropriate title, providing a basic draft, giving references and the needed structure, and writing on a required topic are all possible^[17] Still, we need human regulation for such generated articles fearing ethical concerns.^[21] There are some scientific journals that include ChatGPT as an author.^[17]
- Breast cancer is one of the most common cancers in women, and ChatGPT is enabled to perform screening for this disease with moderate accuracy, assess pain levels, and identify the imaging steps needed.^[2]
- Gupta et al. suggest the use of ChatGPT by plastic surgeons not only for research-related data but also in mainstream healthcare for patient consultation, marketing, and support^[2]
- Prada et al. have done research using this tool even for psychiatry^[2]
- Custom-tailored therapy proposals, far better patient outcomes, and disease identification and diagnosis are feasible^[22]

ChatGPT's unchallenged data-processing speed makes it the befitting choice for decision-making processes that are based on data and reducing error percentage in the healthcare sector, a field where errors and mistakes are unacceptable. Also, better communication means better patient-physician bonds, that's the cornerstone for improving various conditions in patients right from obesity^[23] to mental health^[24] and cancer^[25]. Besides general communication, in fields such as psychotherapy and speech impairment treatments, physicians could develop personalized medical care using language models. Neurodegenerative disease patients can enhance vocabulary and coherence in sentence formation and improve comprehensive skills using ChatGPT's personalized algorithms. All these said and done, most healthcare-based applications are not totally ready for full-fledged use. There is limited success, way lower than physicians, in using them as diagnostic tools presently^[26], and we need comprehensive evaluation and training of such language models in clinical settings. The tool's efficiency in writing clinical letters surprisingly found optimal correctness and human-like writing structure still, human regulation to negate any misinterpretation by patients is indispensable for safe patient care.^[27, 28] It's time for physicians to shift their focus from computers to AI-based tools for better efficiency instead of relying upon AI-based algorithms to enable medical diagnoses or read CT scans.^[2]

Applications in Dentistry

Artificial Intelligence & Dentistry

Constant improvements in AI technology provide a ray of hope in the healthcare sector, including dentistry. We already have AI-based dental and maxillofacial abnormalities detection, including root caries, periodontal diseases, facial abnormalities, and bony lesions. [1,2] Neural networks help in restorative dentistry by detecting tooth decay or restorations, detecting caries and picking the right caries excavation method, suggesting post-extraction problems, strategizing dental implant treatments, and prevailing as an automated diagnostic tool. [2] Dental care depends upon face-to-face communication and hands-on procedures, which makes ChatGPT take a backseat. [1] Dentists, their assistants, and hygienists thrive as the forerunners in dentistry. But, from the admin side, education front, research division, and telemedicine perspective, ChatGPT could have a significant impact. [29] It can be applied as Admin-related tasks, Education and Dental information, Dentistry, and other applications.

Admin-related Tasks

On the admin side, in educating the patients, assisting the dentist, aiding with teledentistry, or stabilizing outcomes, the use of ChatGPT in dentistry is evident. [16] A TikTok video by a rheumatologist, Dr. Clifford Stermer, shows the advantage of using ChatGPT for preauthorized requests to deal with insurance companies. [29]

Dentistry

There have been positive results with AI applications in the field of endodontics, but it is inevitable to confirm their degree of trustworthiness, cost-friendliness, and practical applicability in dental settings. [1, 2] It includes orthodontic treatment progress and surgical aspects. A study by Strunga et al. Analyzed the efficiency of advanced AI in orthodontics, which includes consistent monitoring of outcome stability, following up on the treatment progress, and CBCT diagnosis and evaluation. Results were positive, with the researchers concluding that ChatGPT would have tremendous potential in improving patient care and treatment outcomes. With the tool's potential for translation, multi-language communication with patients worldwide becomes easier. But, for all this, the orthodontist must be well-trained and adept in using this tool correctly. [29] A Research by Balel et al. in the field of oral and maxillofacial surgery shows

promising responses in supplying patient information in the field of oral and maxillofacial surgery. [30] In cleft patients, ChatGPT is well-equipped to predict rhinoplasty results and the need for any orthognathic surgery in the future. Orthognathic surgery planning, detecting the risks of complications post-extraction, dental implant treatment planning, and detecting bone lesions are some ways in which ChatGPT can help in dental surgery. [31] Vinayahalingam et al. automated segmentation tools using AI performed consistent segmentation of mandibular condyles and glenoid fossae. The radiographic imaging would significantly affect the progress of AI. [32] In Endodontics Studies confirm their accuracy in diagnosing and predicting outcomes in this field. Using AI in endodontics for diagnosing periapical pathologies, and root fractures, figuring out working lengths, understanding root morphology, tracing apical foramen, and predicting diseases are very common and extremely beneficial. [31]

ChatGPT is heavily reliable in the field of data prediction. For example, intensive research is done for predicting neck and head cancer using AI-based imaging methods, and once this happens, their success rate will be far beyond human judgment. Above all, DL methods such as ChatGPT are more accurate and effective than clinicians with diagnostic procedures in dental radiology, which means no worries regarding overtreatment, excess time spent on any particular task, or missing out on findings. [1, 2, 31]

Education & Dental Information

Using ChatGPT in the field of education is both beneficial and disadvantageous, especially for higher education. Presently dental schools are more inclined toward oral tests, MCQs, supervised patient treatments, and practical applications, but we need to incorporate written assignments in the dental curriculum. [29] Its even better to include educating students about AI, as this would help them get a deeper understanding of AI-based dental applications. [29] Using ChatGPT in dentistry would equip students with better learning potential as they are exposed to a sea of dental information, can choose to delve into their choice of topic for increased comprehension, and even make use of various research materials to analyze dental practices. On the education front, Ali et al. scrutinized the performance of ChatGPT on undergraduate dental education and found that barring its current limitations, this tool is potent to transform virtual learning given that all precautions are taken to avoid unethical use by the learner. [33] Sourced with a

humongous database, ChatGPT is a data mine for oral health and hygiene-related information that's useful for patients, assists students and professionals in acquiring information, and even assists dentists in planning treatments, customizing personal care, billing and appointment scheduling requirements, diagnosing, and monitoring patient health, and gives regular reminders for follow-ups. [34]

Other Applications

It's now possible to detect and classify maxillofacial fractures using convolutional neural networks, excluding very minute fracture details that might not be evident under CT scan resolutions. [35] There is ongoing research for dental age detection using ChatGPT and topological methods with third molar maturity index (I3M) analysis from 456 mandibular radiographs. [35] In the field of periodontology and implantology, AI still needs to be explored and analyzed, but its capability in diagnosis aid, intricate regression, data analysis, and diagnosis proves this tool's worthiness and capabilities. [35] Taking dental care a step higher, yet another study has proposed a better comprehensive AI model that can identify alveolar and teeth bones using dental cone-beam CT (CBCT). [35] On the scientific writing front, ChatGPT's use is inevitable as researchers can now communicate their results and discoveries effectively and with more clarity. Scientific research would see greater leaps as language clarity, immediate response, and the availability of the latest information from newly released publications through ChatGPT helps in sharing of scientific research. [2] The combination of AI and telemedicine together has produced a new tool called the Dental Monitoring (DM) software and White Teeth. Using DM patients can access various dental practices with a click on their smartphone app, thereby helping them understand and monitor every phase of dental treatment. [12] Focussing on robotics, ML, and AI predominantly in this present era called Dentronics, all of which are capable of elevating accuracy, reliability, efficiency, and reproducibility in the dental field. [1] Dentronics can help in better comprehension of disease pathogenesis and improve strategies for assessing risk, disease prediction, diagnosis, and better treatment outcomes. [2] tools for revamping clinical applications, research, planning treatment alternatives, and diagnosis in the field of dentistry. [31] On the healthcare administration front, ChatGPT could automate a big chunk of the jobs done but automating the jobs of physicians and surgeons is almost negligible. [36] There is no denying that the

hype around fully autonomous robotic devices exists, but practically a surgeon's job delves deeper than Operations—it includes being compassionate and motivating, a trait special only in humans, and taking care of the patient beyond the theoretical medical records. [36, 37] Hence, AI penetration in healthcare can only elevate the physician's efficiency by refining performance and reducing workload but can never replace physicians.

Limitations

Exploiting the opportunities with ChatGPT to improve patient care and assist dentists is exhilarating, but the limitations and risks concerning its use must be well understood and acted upon: [37-41]

- Data accuracy and admin support are commendable but emotional assistance, physical treatment, and personalized touch are impossible from this tool.
- Treat ChatGPT as a supplementary tool rather than a replacement tool for patient care and human touch.
- Privacy is a big question mark as patient data is stored and medical history is read using personal information from the database disrupting confidentiality.
- Providing essays and writings seem to be filled with flaws and plagiarism sometimes while using ChatGPT which impacts dental education, ruins students from using their creative ability, and makes it harder for teachers to detect whether a write-up is copied or creative.
- Empathy, sympathy, and feelings—factors indispensable in a healthcare setting lack in this tool. So, using it for counselling or therapy is impossible.
- Research by Vishwanathaiah et al. showed that ChatGPT can never replace pediatric dentists but only assist or complement other dental needs.

Lack of ability to correctly understand the situation and make concrete decisions and too much reliance by doctors without considering its limitations could risk the life of patients.

Conclusion

AI is here to stay, and ignoring its effect is imbecile. ChatGPT is both a boon and a bane! While the tool can ease life by minimizing the performance of mundane and repetitive chores and paperwork, we should execute extra caution while implementing it in specific sectors like healthcare, where privacy is a top-most priority. In dentistry, ChatGPT has displayed tremendous potential in transforming the dental system with its wide outreach, but caution must be executed, and human experience, involvement, and approval are mandatory to avoid hazardous results. Streamlining tasks and revolutionizing industries is great, but we can only wait and watch about the tool's impact on human. Labor and the job sector. [34] In

healthcare specifically, ChatGPT should be used only in the presence of healthcare experts to ensure no compromise on treatment quality, privacy breach, risk, and patient care.

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