Artificial Intelligence (AI) and machine learning are revolutionizing the way we practice dentistry today. AI solutions have been increasingly used to support doctors' decisions in diagnostic suggestions, therapeutic protocols, personalized medicine, patient monitoring, and predicting and tracking epidemiological diseases' expansion. The clinical Decision Support System may effectively provide medical professionals with valuable data, thus improving health outcomes for patients and the general population. Software used in dental practices is constantly getting smarter. AI enables efficient patient scheduling and staffing and can prove lucrative in dentistry's financial aspect by increasing productivity and ensuring evidence-based documentation and essentials for insurance claims. In this review, we have highlighted the current trends and future direction of Smart practices. We are at the dawn of a new era, and AI is undoubtedly the future of dental practice management.

Keywords: Artificial Intelligence, Oral health data, Practice management, Virtual dental assistant.

I. ARTIFICIAL INTELLIGENCE AND DENTAL PRACTICE MANAGEMENT

AI in healthcare is booming, with the traditional dentistry sector evolving and being gradually transformed into digital dentistry. As AI technology rapidly advances every day, we are expected to witness a growing impact of AI in dentistry in the future as it allows enormous benefits for both dental clinics and patients. Furthermore, current research suggests that AI might seriously affect the job markets, as it will replace or repurpose certain professions [1]. The introduction of AI tools in dentistry reduces both human errors and costs.

AI in dentistry functions as a complementary tool that deals with vast amounts of Health Data (HD). Algorithms and IT applications approximate human cognition in analyzing complex data. The main goal is to analyze the arduous task that a human would otherwise be solved exclusively. AI solutions have been increasingly used to support doctors' decisions in diagnostic suggestions, therapeutic protocols, personalized medicine, patient monitoring, and predicting and tracking epidemiological diseases' expansion. The fields of AI application vary from health emergencies, prevention, and treatment techniques to the analytics of patient outcomes.

In this context, AI is expected to provide additional support to practitioners by allowing the transfer of knowledge from basic and clinical research to health professionals and their attempts to search for the best approaches for their patients. The gap between in vitro findings and the straight way into (routine) clinical therapy needs to be overcome to benefit a larger patient population and be made accessible to underdeveloped countries [2]. In addition to this, AI is expected to bridge the gaps between medicine and dentistry to explore and interpret the influence of general disease patterns on oral health.

Apart from generally accelerating the workflows, AI is constantly achieving breakthroughs, thus allowing practitioners to utilize novel and innovative solutions in different aspects of their work. For example, AI-driven custom-designed orthodontic treatments are a recent innovation. However, advanced tools also focus on diagnostic records of virtual IOPAs/RVGs, 3-D scans, and cone-beam computed tomography. The field of restorative and prosthetic medicine has made a step forward by applying computer-aided designs and computer-aided production technology for a precision fit, which can have a vital impact on orofacial and craniofacial prosthetics. From that perspective, AI can have an essential role in all stages of the dental workflow, from endodontics to apex location dentistry. Apart from upgrading dentistry as a field, dental AI will significantly affect implantology for making precise surgical guides and determining cortical bone thickness.

As evidence suggests, AI-based virtual dental assistants can carry out tasks that would sometimes require an entire team of people with different skills and backgrounds. Even though such tasks are various, AI applications perform many tasks with higher precision and efficiency than humans. It primarily refers to operational tasks such as booking or coordinating regular appointments, notification to patients and dentists about check-ups, clinical diagnosis assistance, and treatment agenda. In addition, AI allows patients to participate in the global healthcare system more personally, especially if they willingly provide data on their health habits and conditions (Fig. 1). Patients can also be actively involved in self-monitoring and self-management. As AI has an option to “learn” from the collected data, there are mechanisms to overcome the disadvantages of on-off-medicine (e.g., periodontal disease).
Fig. 1. Role of Artificial Intelligence in Public Health by Tariq in 2021(3).

If there is continuous AI supervision of a patient’s health record, a more comprehensive and accurate understanding of the patient’s health condition is available. With such an approach, both diagnostic and treatment costs can be decreased, thus making healthcare systems less busy and overburdened. From a more global perspective, AI can also help solve the problem of workforce shortages, in that context complying with the World Health Organization (WHO) sustainable development goals.

II. DEVELOPMENT GOALS

Since the 2000s, a global scientific focus has been shifted to different aspects of Artificial intelligence. Even though there is clear evidence that AI systems have brought success to various academic and business fields, much more needs to be done to prevent and promote the population’s health in terms of AI applications. In other words, we need to address how AI solutions can act as a social predictor that would have a more significant impact on the actual outcomes. As AI applications have been reported to match or outperform humans in various domains, it is yet to be seen what essential benefits, on a global scale, AI brings, especially when compared to practical implications stemming from research studies coming from academic communities.

One possible utilization of the artificial intelligence concept in health promotion is analyzing data sets for almost real-time surveillance and oral disease detection, e.g., screening and identifying suspected changed mucosa undergoing premalignant and malignant alterations or diagnosing and treating oral cavity lesions. AI has the potential to showcase images that document the slightest changes, measured in pixels, that would not be possible to notice by the traditional examination technique. When the dental health care professional is unavailable and there is a health emergency, AI can assist by providing E-assistance (Tele assistance). Behavior patterns and risk profiles designed by AI algorithms can be utilized for individually tailored health advice. Recently, there has been an increased interest in computer-aided decision-making in this field, probably due to improved digital literacy in the general population. For instance, it would be useful to alert a dental practitioner about any medical condition or oral habit that might predict genetic oral disease risk in a large population.

It is not an overstatement to say that Artificial Intelligence can significantly increase the efficiency of health services in numerous ways, some of the critical ones being as follows:

1) Using machine learning to detect abnormalities: Clinical Decision Support System may effectively provide medical professionals with valuable data, thus improving health outcomes for dual patients and the general population. Ultimately, AI has proven its usefulness in providing high-precision images in the field of medicine. There is evidence that AI-powered artificial neural networks can detect signs of oral cancer and other conditions with the same accuracy and reliability as human radiologists. In addition, AI provides support to a dentist to spot early signs of disease.

2) The traditional procedures of entering any structured information into the health system appear to be time-consuming work. However, the process has been drastically facilitated by the introduction of voice recognition and the application of AI programs to classify and excerpt information from the scanned paperwork. It should also be stressed that its interactive character allows healthcare professionals to process more data than human assistants would generally, more efficiently and reliably [3].

III. AI AND DENTAL CLINIC MANAGEMENT

The roles of AI as a constative element in the public oral health upgrade and significance are best shown in dental clinics’ management or general operations. Scheduling patient appointments is one of such aspects, and newly appointed assistants can be easily trained to perform such tasks more efficiently and productively. Another aspect of AI smart scheduling appointments is best demonstrated in doctor-patient communication. To arrange an appointment, the system contacts the patient based on their appointment preference and matches the patient with an available position for arranging to schedule proprietary algorithms to identify the ideal patients; the program automates scheduling existing patients with voice, text, or even video. It will also initiate the ideal marketing campaign to convert new patients. Another advanced aspect of AI in scheduling appointments is the possibility to track and optimize patient appointments so that it allows to “proactively schedule unfinished treatment and launch new-patient marketing campaigns based on profit maximization algorithms” [4]. Such optimization is achieved by machine-learning programs that can interface with dental practice software. As far as patients’ general queries are concerned, all simple questions can be easily handled by AI. In contrast, more complex ones can be directed to the PR actioner for further processing. The neural network can also mine data and detect periods of decreased productivity to help determine the most effective marketing campaign. The variety of possibilities within this algorithm allows management officers to see cancellations or supervise the available appointments easily. In contrast, deep learning techniques allow searching patient records for the most profitable patient treatment. In that sense, assistants spend less time dealing with prescriptions post-op and can act more readily before the actual appointment if there is an emergency with a patient to be recognized. In addition to this, and for the more significant benefit of patients, AI can support the dental health care professional in terms of any relevant medical history or allergies that the patient may have. Patients who...
are on tobacco or smoking cessation programs, for example, can utilize AI to set up necessary reminders.

In rare cases when a doctor is not available, AI can serve as a helping hand, as it can store different information related to a patient’s health conditions [5]. Apart from documentation and scientific coding, it can hold and retain databases, help monitor patients’ orders, observe health situations, preventive measures, etc. With the big data, including electronic health records, digital radiographs, and longitudinal follow-up data, it will be possible to establish a reliable source for training the AI system. Predictions will be significantly improved with a better understanding of the patient’s condition drawing upon vast data. This implies that the AI scientific data library will keep itself updated with the current literature knowledge in the field, as it can learn from the scientific database.

Unlike other (traditional) methods of work in dental clinics, AI software allows us to design a comprehensive virtual database for each patient, which can be very easy to use and accessible at the same time [6]. For example, voice recognition and interactive interphases enable the software to help the dentist perform different tasks effortlessly. As the AI software can retrieve all necessary data from the database and present it to the dentist much faster and more efficiently than a human counterpart (e.g., collecting all essential dental records, extraoral photographs, and radiographs necessary for diagnosing any dental condition), any dental intervention becomes more reliable. Because of its unique ability to learn, the AI system can be “trained” to perform many other functions. For instance, it can be integrated with imaging systems like MRI and CBCT to identify slight deviations from normalcy that could have gone unnoticed by the human eye [7].

On the other hand, however, Artificial intelligence is still growing in the dental field. It is not yet that advanced that it could duly replace humans’ skills and competence. If perceived as a complementary technology, AI can assist in numerous dental operations or help raise more awareness of oral and maxillofacial diseases while encouraging patients to schedule early treatment. Even though in its infancy, AI has produced staggering solutions that might drastically change dental procedures in the future. Computer systems with human-level intelligence (or higher) will change the world as we know it, thus affecting our lives. What remains a currently debatable issue is the general concern in what way and to what extent AI could be integrated into practice, as it is a general standpoint that AI cannot act as a complete substitute to a dentist since the clinical trial is not only about diagnoses, but it also includes correlating with clinical findings and imparting personalized patient care. Although AI can be utilized as a handy and quick solution in many ways, some of which have been mentioned in the text, the final decisions need to be made exclusively by dentists, as dentistry is a multidisciplinary approach that needs to consider numerous specific elements related to human health.

IV. AI AND THE FINANCIAL ASPECT OF DENTAL CARE

The financial aspect of dental care is another segment of dentistry in which AI proves to be highly beneficial. Dental AI makes the dental process more transparent for both payer and provider when dealing with the same documentation. In other words, dentists who practice the use of AI in their clinical workflow will be able to understand if there is proper, evidence-based documentation and whether it aligns with the insurer's policies. For example, if there is a need to photograph a broken cusp when it is not apparent in a radiograph, AI systems can make the necessity for a picture.

In that way, misinterpretations of clinical guidelines are minimized, and care providers become pretty aware of the objective measures used by payers. Of course, clinicians reviewing claims need to be consistent when applying standards. If inconsistency in claims review occurs, it is usually due to two factors: inter-clinician variability and sampling of claims for review. As for inter-clinician variability, it is expectable that the more clinicians review the same claim or radiograph, the more potentially different viewpoints we get. Various providers might propose multiple treatment plans for a single patient. Different perspectives of the same situation may occur due to previous skills or training, experience, or even fatigue of the dental provider. As research suggests, AI can help provide reliable and precise measurements that support or recommend each claim without unnecessary subjective estimates, which may vary (i.e., whether the amount of missing tooth structure is 40% or 50%). In such cases, dental consultants will consider outputs from the AI analysis before making the final decision [8].

What can be done to prevent inconsistency in claims review? Indeed, as it can affect provider satisfaction, arouse tensions between payers and providers, and even influence the increase in appeal rates, inconsistency in claims review should be carefully dealt with, with significant AI assistance in that matter. Radiographs can be reviewed with standardized measurements on AI systems, and it can be documented that a tooth needs further intervention according to clinical guidelines.

Recent research suggests that AI-enhanced claims review will ultimately lower costs since every time an appeal is filed or a claim is resubmitted, it increases costs to both parties. Another reason why inconsistency in claims adjudication occurs is the fact that only a small number get processed due to a shortage of dental consultants. In those cases, although two separate benefit claims for the same diagnosis can be submitted, payment will be received for only one share. The reason behind this is that a denial of benefit payment may have been warranted in both cases; however, if the approved claim was not assessed by clinical review and therefore benefited by default. Since this situation can cause a revolt among both providers and patients, AI support can be helpful because it can process all claims that can be reviewed by signaling those that do not meet predefined standards for further processing and claims that can be approved. In both scenarios, the process is conducted consistently and efficiently [9].

This specific application of AI in claims review brings numerous benefits to patients. As the system will bring fewer patient appeals and lessen the number of surprise denials, the system’s transparency will be improved. If used regularly, the AI system will ensure validity and confidence with patients for their prospective dental benefits and treatment plans. Consequently, the improved efficiency in reviewing claims will speed reimbursement and lessen the administrative costs.
from payers. This will reflect the slower growth of premiums for patients and employers.

Another significant benefit of the AI system in dental clinics in terms of financial aspect is instant predetermination, as nowadays, many dental payers offer predeterminations or pre-estimates. In costly procedures, payers prefer predetermination to identify contractual limitations or exclusions that apply to a proposed treatment plan, including certain exclusions or limitations to the proposed plan. Although some plan details can be offered on project player websites, additional time is needed to create and deliver a clinical review, so turnaround times for payers increase to 2 or 3 weeks. Dental AI is expected to transform this process soon.

AI adoption has already commenced for internal claims review and in provider offices. As the main goal for providers and payers is to provide the best experience for patients, and AI potentially brings more clarity and reliability for patients, all parties involved in the process will rely on AI solutions. Finally, the AI paradigm reduces financial uncertainty for patients and helps general dentistry find solutions to resolving delays that can discourage medically necessary treatments.

REFERENCES


