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SPECIAL CPD SUPPLEMENT

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Integrating artificial intelligence (AI) in modern dental practice – Practical, Ethical, and Legal considerations.

Antibiotic stewardship in dentistry – review of evidence-based clinical recommendations on appropriate antibiotic prescribing in dental practice: Clinical guidelines and recommendations for antibiotic prescribing in dental practice.

The moral compass of a dental practitioner: A balancing act between ethical principles, moral values, and professionalism

Navigating the bi-directional relationship between oral diseases and mental disorders – Clinical management implications and ethical considerations for dental practitioners.

Duties, responsibilities and obligations to patients, colleagues, society, and self

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Editor, Ethics in Dentistry 2024

Ethics originates from the Greek word 'Ethos' which means 'character' or 'conduct'. It is a branch of philosophy and theology studying systematically what is right or wrong, or what is good or bad with respect to character and conduct.

Dentistry, being one of the healing professions, has an obligation to society that dental professionals will adhere to high ethical standards of conduct and at all times place the patients' best interest first.

In today's society, the ethical issues faced by dentists are increasing and more complicated due to changing patient demands and expectations, changing technological environment and needs of a dental practice, and changing regulatory system and legal obligations related to access to dental care, advertising, consent, disclosure and misrepresentation and financial arrangements.

Ethics is inseparably linked every decision, judgement or choice made by a dentist. In addition, ethics also influence the relationship the dentist has with his patient, public, staff and other professionals. Sometimes decisions on what is right or wrong are very simple and straight forward, and at other times they can be very complicated.

Ethics describes the dentists' duty and moral obligations by asking them to consider their actions, judgements and justifications. A Code of Ethical Conduct defines the moral boundaries and obligations within which professional dental services may be ethically provided. These are based on four fundamental ethical principles of (i) autonomy (right to self-determination and confidentiality, (ii) non-maleficence (do no harm), (iii) beneficence (promoting or doing well), and (iv) justice and veracity (being fair in their dealing with patients).

Ignoring ethics and its fundamental principles, compromises the dentists service, undermines professionalism and the trust that society has placed on the dentist.

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Dr Johan Hartshorne graduated as a dentist at the University of Stellenbosch in 1976 and was awarded the SADA Gold Medal award for exceptional achievement during his study career. He was awarded The Ernest Oppenheimer Study Fellowship in 1977. During a full-time academic career at the University of Stellenbosch between 1984 to May 2004, as specialist and consultant, he obtained his M.Ch.D. (1987), M.P.A (1989) and a PhD (1995). He has been fill-time in private dental practice from 2004 to date.

His scholarly activities amongst others include 86 publications in scientific peer-reviewed Journals and 32 oral and poster presentations at National and International Scientific Meetings. In 1988 he was awarded the Middleton-Shaw Fellowship by the Dental Association of South Africa to study Professional Ethics in Dentistry and Healthcare in the UK and USA, which culminated in the development of Ethics Curricula for Medicine and Dentistry at the University of Stellenbosch. He has also since 2001 to 2023 been involved as Ethics and Dental Editor for eCPD, and has submitted several ethics articles for International Dentistry- African Edition.

In 2008 he was awarded the Fellowship of the Faculty of Public Health of the Royal Colleges of Physicians of the United Kingdom. Dr. Hartshorne was a Visiting professor at the Department of Periodontics and Oral Medicine, School of Dentistry, University of Pretoria in 2014-2015. He was an active member of the International Team for Implantology for 15 years and was actively involved as a team member at the ITI Centre of Excellence at the University of Pretoria in 2014 -2015.

He was also an external examiner and moderator for Dental Assistants at the Peninsula Technicon and Postgraduate Dental students at the University of the Western Cape between 1995 and 2011. He is also an active reviewer for several International Dental Journals.

During the period 2009-2014 he was Chairperson of the Intercare Clinical Governance Committee. He was also a member of Intercare's Vaccine Advisory Committee.

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Integrating artificial intelligence (AI) in modern dental practice – Practical, Ethical, and Legal considerations

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Executive summary
Rationale / Importance
- Artificial Intelligence (AI) holds immense advantage in dental practice, offering innovative solutions to enhance patient care, improve treatment outcomes, and streamline practice management.
- This review explores the role of AI and its current applications and benefits, emerging trends, and the practical, ethical and legal challenges of integrating AI in the dental practice setting, shedding light on both its promise and complexity.

Key points
- Key areas where AI is expected to make significant contributions include diagnostic imaging analysis, treatment planning assistance, patient communication and management, and practice management optimization.
- By embracing AI, dental professionals can deliver higher-quality care, optimize patient outcomes, and streamline practice workflow and management efficiency.
- While the integration of AI is reshaping every aspect of dental practice, it is important to note that human expertise and clinical judgement remain essential elements of everyday clinical practice.

Practice implications
- Integrating AI into dental practice requires careful consideration of logistical, ethical, and legal challenges to facilitate seamless integration into daily workflows without disrupting patient care, and staff training requirements.
- Successful implementation will depend on addressing these challenges and ensuring that the technology is used to complement, rather than replace, the expertise and judgment of dental professionals.
- The biggest hurdle for AI lies not in determining its capabilities but rather in ensuring its acceptance in routine clinical practice.
- With proper training and education, challenges and obstacles can be overcome, paving the way for a more advanced and efficient dental care system.

Background

In recent years, the intersection of AI-technologies and healthcare has ushered in a new era of innovation, a transformative force revolutionizing and reshaping the way we approach how medical and dental services are delivered, diagnostics are made, and treatments are administered.[1-4] The application of AI in dentistry has seen an explosive growth over the past decade [5,6] and has tremendous potential to positively disrupt and transform the current practice of dentistry.[7]

Owing to the rapid development of three cornerstones of AI technology, namely big data coming through digital devices, computational power, and sophistication of AI algorithms in the past two decades, AI applications are rapidly developing to provide convenience to dentists lives in the dental practice setting[5] by enhancing diagnostic accuracy, facilitating personalized treatment planning, optimising practice workflow and efficacy, and enhancing patient experiences and treatment outcomes.[3,8-10]

Embracing AI however, comes with several challenges and complexities.[11] Furthermore, currently, there are no well-defined regulations in place to address the legal and ethical issues that may arise due to the use of artificial intelligence in healthcare settings.[12] For dentists, it remains crucial to understand and address these complexities and challenges, ultimately fostering innovation in modern dental practice, while upholding the highest ethical standards and promoting patient welfare.

AI encompasses a broad spectrum of emerging technologies that continue to influence every aspect of daily life.[11,13,14] It refers to the development of computer systems or machines that can perform tasks such as visual image perception, speech recognition, decision-making, and language translation, that typically require human intelligence to complete.[2,5,15] To perform tasks that simulate intelligent human cognitive functions, AI technologies utilize machine and deep learning techniques, computer algorithms, cognitive computing, computer vision, and natural language processing.[5,15]

Augmented intelligence (AugI), involves using AI as a supplementary tool to assist or enhance human intelligence, rather than replacing it, to improve decision-making, problem-solving, and overall performance of various tasks.[11,15-17] AugI aims to complement human capabilities by leveraging AI algorithms to analyse vast amounts of data, to generate actionable insights, and assist in making more informed decisions, ultimately amplifying human potential and productivity.

Purpose and Methodology

The purpose of this narrative review is to provide an overview of current applications of AI in dentistry, emerging trends and future directions, and the practical, ethical, and legal considerations that dentists have to anticipate when integrating AI-technologies into their practices. This knowledge is aimed at helping dental professionals understand the challenges of using AI as a supplementary tool to assist in their routine work with improved efficiency, whilst highlighting its potential to enhance diagnostic accuracy, personalize treatment planning, streamline workflow, and foster continuous learning and improvement in dental practice.

ChatGPT, an AI language model developed by OpenAI, was used to glean information for structuring and organizing this review into coherent sections, and to contextualize various aspects of AI's impact on dentistry from current applications to future prospects, practical challenges, ethical and legal considerations within the dental practice ecosystem. All ChatGPT derived information was verified for accuracy of content and context by systematically searching and referencing scientific open access databases [i.e., MEDLINE/PubMed Central, Google Scholar, Directory of Open Access Journals (DOAJ), arXiv, PLOS and CORE (COnnecting REpositories)] for appropriate evidence-based and/or supporting literature.

Current applications of AI in dental practice

AI has entered various fields of dentistry, including dental radiology and oral maxillofacial radiology[18,19,] restorative and aesthetic dentistry[20], periodontology [21-24], endodontics[25-30], orthodontics[31-33], implantology[34-40], oral and maxillofacial surgery[41-46,] and practice management.[11,14,17,47,48] Detailed examples of how AI is used in clinical dental practice are described in several recent reviews.[3-5,11,16, 33,44,47,49-55]

The current applications of AI in dentistry can be classified into the following groups:

Image analysis and diagnostic tool

AI has made significant advancements in the field of diagnosis in dentistry, revolutionizing the way anatomy and oral diseases are detected and diagnosed. AI-powered dental imaging software (i.e., Diagnocat™, Pearl™, Denti. AI™) can analyse dental radiographs, CBCT scans, and intra-oral images, in real time to assist dentists in identifying pathologies or detect abnormalities such as dental caries, vertical root fractures, apical lesions, periodontal diseases, salivary gland disease, maxillary sinusitis, alveolar bone loss, and oral tumors in X-rays with more accurately and earlier

than traditional methods.[7,19,42,55-60]

AI models are also in used oral and maxillofacial radiology to provide quantitative and qualitative radiographic assessment, i.e., cephalometric analysis, segmenting anatomic structures, image enhancement and manipulation.[7,61,62] AI can also be used for classifying, detecting, or segmenting oral mucosal lesions on photographs.[63]

One of the primary benefits of AI in dentistry is its ability to improve diagnostic accuracy and early detection of oral diseases. By detecting pathologies at an early stage, dentists can intervene promptly and implement appropriate treatment strategies, leading to better patient care outcomes.[5,16,53,56,60,64,65]

Clinical decision support and personalized treatment planning

AI facilitates personalized treatment planning by synthesizing patient data, clinical guidelines, and evidence-based practices to tailor interventions to individual patient needs. By analysing patient data, AI algorithms can recommend optimal treatment options, predict treatment outcomes, and anticipate potential complications.[8,56,60] AI-driven clinical decision support tools can assist dentists in interpreting diagnostic images, reviewing treatment plans, and documenting patient encounters, saving time and improving productivity.[8] This leads to improved efficiency, reduced wait times, enhanced patient satisfaction, and adherence to treatment regimens.

Examples of AI-driven clinical decision support and treatment planning applications in the dental field include the following:

Orthodontics: AI models can assist in treatment planning for procedures such as predicting need for orthodontic treatments,[20,32] orthodontic extractions and orthognathic surgery[44,48,] automated landmark detection in lateral cephalograms (i.e. WebCeph™, CephX™, AudaxCeph™, IPS Case Planner™), age and gender determination, skeletal growth and maturation assessment, airway volume assessment[48,67] and diagnostic orthodontic work-up, virtual monitoring (Invisalign® Virtual Care AI).[66] In some studies it was found that these systems were even able to outmatch dental specialists in terms of performance and accuracy.[33,56,66,68]

Dental Implantology: AI can assist in treatment planning for guided implant placement surgery [i.e., IconiX™, 3SHAPE™ Implant Studio, CoDiagnostiX 10™ (Straumann)][34-36,38-40] It is suggested that AI-driven software can

recommend optimal treatment options, predict treatment outcomes, and anticipate potential complications, allowing for more effective and customized treatment approaches, leading to better outcomes. (i.e., OraQ™)[8,56,68] AI models for implant type recognition, implant success prediction, and implant design optimization have demonstrated great potential but are still in development.[34,37]

Periodontology: Touchless voice charting AI is used for periodontal charting to determine diagnosis, risk, prognosis as well as treatment choices and clinical notes. (i.e. Bola AI™, Denti.AI™)[21-24,65,69]

Oral Maxillofacial Surgery: AI is used to assist diagnosing and planning treatment with the least possible error such as predicting internal derangements in cases with TMJ disorders[41-43,] the detection of impacted third molar teeth and their relationship to anatomical structures[70,] and orthognathic surgery[46,70,] and virtual guided surgical treatment planning.[45]

Endodontics: AI is used as a diagnostic tool to assess treatment outcomes, detection of apical lesion, root fractures or assessing the quality of existing root canal fillings.[26] Pre-treatment planning including work length determination, root canal system morphology, and prediction of endodontic retreatment outcome (i.e.Diagnocat™). In endodontics, in terms of disease detection, evaluation, and prediction, AI has demonstrated accuracy and precision.[25,26,28,30] AI can aid in the advancement of endodontic diagnosis and therapy, thus enhancing endodontic treatment results.

Prosthodontic: Dental prosthetic use has been a leader in the use of AI with chairside dental design, digital wax-ups and milling CAD/CAM systems.[71] AI holds promise in assisting dentists and technicians with digital restorative design in obtaining morphology templates that closely resemble the original shape of the defective teeth. These customized templates serve as a foundation for enhancing the efficiency and precision of digital restorative and prosthesis design.[36,71-73]

Aesthetic dentistry

AI can assist in treatment planning for procedures such as aesthetic dentistry or digital smile design (i.e., DSD™ and Smilefy™) Digital smile design software software also allows the clinician to educate the patients regarding the improvements that can be done and also helps in collecting

the patient's own preferences and requirements, thereby making the patient feel like he is a part of the decision-making process rather than just being on the receiving end.[74] The DSD workflow begins with digital scanning of the patient's dentition using an intraoral scanner, which is then imported to the respective DSD software. Using the various different shapes and forms available in the digital repository, the dentist can overlap the teeth for a given aesthetic procedure.[74]

Patient risk and treatment risk prediction

AI algorithms can analyse patient data to identify or predict patient-specific risks, such as likelihood of developing dental caries, periodontal disease, oral cancer or endodontic or implant failure.[75-77] By identifying high-risk patients early on, dentists can implement targeted preventive measures and personalized treatment plans to maintain oral health and prevent disease progression and future complications.[8]

Optimize clinical workflow efficiency

The DEXIS™ digital ecosystem [78] is an interconnected, AI-powered platform for digital implant workflow—combining cutting-edge CBCT, intraoral scanning, diagnostics, and treatment planning to optimise clinical workflow efficiency.8. AI-powered eco-systems empowers clinicians to manage each step of the implant case, from diagnosis to delivery, with one, integrated toolset, while preserving complete flexibility to adapt their workflows based on the individual needs of each case.[8] Invisalign® has an AI-powered platform for digital clear aligner workflow, including diagnostic orthodontic work-up and virtual monitoring (Invisalign® Virtual Care AI).[66] and orthodontic treatment outcome simulation (i.e., Invisalign® Outcome Simulator Pro)[66,79]

Opitimise practice management and operational efficiency

AI driven cloud-based technologies (i.e., Adit)[80] and AI-powered chatbots optimize operational efficiency by automating administrative tasks such as appointment scheduling, reminders, and follow-ups, freeing up staff time and administrative burdens. [8] AI-driven scheduling systems minimize wait times, maximize operatory utilization, and enhance the overall patient experience.

Enhanced Patient Communication and Education:

Effective patient education and communication are integral components of quality dental care, contributing to informed decision-making, treatment compliance, and positive clinical outcomes.[81] AI-powered chatbots and virtual assistants improve patient communication by providing instant responses to inquiries, and delivering educational content.[8,81] This enhances patient engagement, satisfaction, and adherence to treatment regimens ultimately leading to better oral health outcomes and improved patient experience.

Augmented reality (AR) or virtual reality (VR) systems (i.e., OraQ AI) can overlay digital information onto the dentist's field of view, offering visual guidance and image overlays during procedures such as digital smile design, dental implant placement, orthodontic treatment planning, and orthognathic surgery.

Limitations of current AI applications

AI is increasing the scope of state-of-the-art models in dentistry but is still under development. Further studies are required to assess the clinical performance of AI techniques in dentistry.[4] Clinical decision support systems incorporate knowledge with patient-specific data to serve clinicians with supportive tools that enhance their clinical decision-making process.[32] However, a limitation of these AI algorithms is that they have not been validated and require caution by clinicians in terms of utilizing the provided predictions as well as monitoring treatments' results.[26,82] Moreover, these technological advancements also require the integration of multi-source data capture, including clinical information and three-dimensional imaging such as CBCT, digital dental models (DDMs), photographs, lateral cephalogram and panoramic x-rays.[84] It is also suggested, before incorporating AI models into routine clinical operations, it is still important to further certify the cost-effectiveness, dependability, and applicability of these models.[85]

Emerging trends and future directions in AI technology

Emerging trends in AI-driven technologies are reshaping the landscape of dental practice, empowering dentists with innovative tools and solutions to deliver higher-quality care, improve patient outcomes, and adapt to the evolving demands of the digital age.[11] The most eminent emerging trends and future directions in AI-driven technologies specifically in dental practice include:

Advanced Diagnostic Imaging

Future advancements may include the development of AI algorithms for early detection of oral cancers and microscopic abnormalities86, quantitative assessment of periodontal disease progression, and automated analysis of 3D imaging data for implant planning and placement.[2] This will enable earlier intervention and improved patient

outcomes. AI's role in dentistry is poised to enhance diagnostic and treatment capabilities while optimizing CBCT scans, ultimately improving patient care.[87] Future aims of AI research in the dentistry sector include not only raising the performance of AI models to expert levels but also detecting early lesions that are invisible to the human eye.[2,87]

Personalized treatment planning

AI-driven approaches will enable dentists to develop more personalized and precise treatment plans tailored to individual patient needs and preferences. Future directions may include the integration of genomic and biomarker data, microbiomic, immunological and lifestyle factors into AI algorithms for predicting treatment response, optimizing treatment outcomes, and reducing the risk of adverse events or complications.[2]

Conversational agents, Tele-Dentistry and Remote Monitoring

Tele-dentistry, facilitated by AI technologies, has emerged as a valuable tool for remote consultations and monitoring.[89] Patients can receive advice and follow-up care without the need for physical visits to the dental office.[90]

Conversational agents (CAs) are AI programs that engage in a dialogue with users by interpreting their questions or concerns and replying to them in a text message, image, or voice format.[89,91] CA's typically imitate human conversation by applying natural language processing and machine learning and stand in contrast to text-based engagement platforms that accept discretely formatted human inputs and reply with preset messages.[91]

Future developments may include AI-powered tele-dentistry platforms for real-time analysis of intraoral images, remote patient education and coaching, and integration with wearable devices for continuous remote monitoring of oral health parameters.

AI-driven tele-dentistry platforms and remote monitoring solutions will enable dentists to remotely assess patient oral health, provide virtual consultations, and monitor treatment progress.[2,89] These technologies will improve access to dental care, particularly in underserved areas, and enhance patient engagement and compliance with treatment plans.[2,89]

Virtual Treatment Planning and Simulation

Augmented Reality (AR) overlays digital information onto the real-world environment, enhancing perception and interaction with physical objects. In dental practice, AR can be used for patient education and treatment planning by overlaying digital models of teeth, gums, and dental prosthetics onto the patient's oral cavity in real-time.[2,81] AI-driven software will enable virtual treatment planning and simulation for dental procedures, including orthodontic treatment, implant placement, and restorative dentistry. Dentists and patients can use AR headsets or mobile devices to visualize treatment outcomes, simulate dental procedures, and communicate treatment plans with patients more effectively, leading to improved treatment outcomes and patient satisfaction.[81]

Interactive patient engagement and education

Virtual assistants and Chatbots powered by AI are streamlining patient communication, making informed decisionmaking more convenient, and providing patients with information about oral hygiene practices and dental procedures.[90] Chatbots such as ChatGPT facilitates virtual consultations, educates patients, and serve as a real-time surgical assistant during procedures.[92] These tools can provide patients with immediate answers to their queries, help with pre-visit preparations, and offer post-treatment care advice, enhancing patient engagement and satisfaction.

AI driven software will provide interactive educational tools and applications for patients, using animations, simulations, and virtual models to explain and help patients better understand their oral health condition, treatment options, and preventive measures more effectively.[81] Augmented reality (AR) and virtual reality (VR) technology can assist dentists in explaining various dental procedures to their patients, using interactive methods.[81] With 3D models showing patients' teeth, gums, and oral cavities, dentists can make out a diagnosis, set a treatment plan, and visually present expected results in an understandable way. Patients can also study several treatment options to make an informed decision about their oral health.[81] This will improve patient engagement, compliance, and overall satisfaction with dental care.

Virtual Training and Simulation:

AI-powered simulation tools can provide dental professionals with realistic practice scenarios, improving their skills and reducing the risk of errors during actual procedures. Virtual (VR) and Augmented (AR) Reality creates immersive, computer-generated environments that users can interact with and explore using specialized headsets or devices. In dentistry, a VR training simulator can be used for dental education and training, allowing students and dentists to practice simulated

dental procedures in a realistic virtual environment without the need for physical models or patients. This method can be especially useful for complex procedures requiring careful planning and high precision, like oral surgery or implant installation. VR-based simulations can help develop clinical skills, improve hand-eye coordination, and gain confidence in performing complex dental procedures in a risk-free, controlled setting. One of the main advantages of using VR and AR for training is the ability to practice anywhere, even at home. Besides, you can conduct joint training with people who are in different places. It helps to share experiences and set up the most effective communication between specialists.

Overall, AR, VR, and MR technologies and ChatGPT applications can offer innovative solutions for dental education, training, treatment planning, and patient communication.[1, 2,93,94,95,96] By leveraging these immersive technologies, dental professionals can enhance clinical outcomes, improve patient experiences, and advance the practice of dentistry in the digital age. AI can help tailor continuing education programs to the specific needs of dental professionals, ensuring they stay updated with the latest advancements and techniques.

Predictive Analytics and Preventive Care
AI will play a critical role in advancing predictive analytics and preventive care initiatives in dentistry by identifying at-risk patients, predicting disease progression, and recommending targeted interventions to maintain oral health. Future directions may include the development of AI-driven risk assessment tools for early identification of individuals at high risk of developing oral diseases, implant prognosis, personalized preventive care plans, and remote monitoring strategies for proactive disease management, and reduce the need for invasive treatments. [97]

Practice Management Solutions:
Virtual assistants powered by AI are streamlining administrative tasks, making appointment scheduling, sending reminders, and follow-ups automated and more convenient and efficient, reducing no-show rates and improving patient adherence to treatment plans.[90] Chatbots such as ChatGPT facilitates virtual consultations, educates patients, and serves as a real-time surgical assistant during procedures.[92]

AI-powered practice management solutions automate administrative tasks, such as billing, insurance claims processing, and inventory management, allowing dental staff to focus more on patient care, optimize scheduling, and improve workflow efficiency in dental practices, reducing

the administrative burden on dental practices, and allow dentists to focus more on patient care.[2] Practices will be able to utilize AI to forecast trends in patient flow, optimize resource allocation, and manage workforce scheduling more effectively.

Robotics-assisted and guided surgery
The future application of AI-driven robotics in guided surgery holds immense promise for revolutionizing dental practice. By combining artificial intelligence with robotic technology, guided surgery systems can enhance precision, accuracy, and efficiency in dental procedures such as implant placement and oral surgeries, reduce the risk of complications, improving patient outcomes and reduce the physical demand of dental work.[2,11,45,90,98,99]

AI algorithms analyze patient data, diagnostic images, and treatment plans to generate precise surgical paths and optimize implant positioning in real-time. Robotic systems execute these plans with submillimeter accuracy, reducing the risk of complications and improving treatment outcomes. Additionally, AI-driven robotics enable real-time feedback and adaptive control during surgery, allowing for adjustments to be made based on intraoperative conditions. This convergence of AI and robotics in guided surgery heralds a new era of precision dentistry, where advanced technologies work synergistically to deliver optimal results and improve patient care.[98] The future of implant dentistry lies in harnessing the potential of robotics and AI while upholding the highest standards of patient care and ethical practice.[11]

Research, innovation and development
AI also plays a crucial role in the research and development of dental treatments. By facilitating the analysis of vast datasets, AI contributes to the discovery of new materials and drugs for restorative dentistry.[90] AI systems have the capability to continuously learn and improve over time by analysing feedback from users, refining algorithms, and adapting to changing clinical contexts. By leveraging techniques such as reinforcement learning and deep learning, AI algorithms can evolve to become increasingly accurate, reliable, and clinically relevant. AI will accelerate research in dentistry by analysing large datasets of patient records, clinical trials, and scientific literature.[2] AI-driven approaches will also facilitate drug discovery for oral diseases, advancements in materials science for dental prosthetics and implants, and the development of predictive models for treatment outcomes and disease progression. AI-driven research in dentistry holds the promise of accelerating advancements in diagnostic

techniques, treatment modalities, and preventive strategies. By analysing large datasets and identifying patterns in patient outcomes, AI contributes to evidence-based practice and drives innovation in dental care, ultimately leading to better outcomes for patients and practitioners alike.[2]

Challenges and obstacles with adopting AI-technologies in dentistry practice

Although AI-driven technologies offer numerous benefits for transforming dentistry and improving patient care, dentists may face several challenges and obstacles in adopting AI technologies and applications to realize its full potential.[2] While the integration of AI in dental practice holds promise for improving diagnostics, treatment planning, and patient outcomes, it also requires careful consideration of practical, logistical, ethical, and legal challenges to ensure that AI technologies are deployed responsibly and ethically.[65]

Dentists and AI developers must navigate these logistical, ethical, and legal challenges thoughtfully, ensuring that AI technologies are deployed responsibly, ethically, and in accordance with applicable laws and regulations, while prioritizing patient safety, autonomy, and well-being. Collaboration between stakeholders, including dental professionals, AI developers, regulators, policymakers, and ethicists, is essential to address these issues and foster a culture of ethical and responsible innovation in dentistry that will ultimately maximise the potential benefits of AI in dentistry while mitigating potential risks.

Logistical Challenges

Integrating AI into dental practice faces logistical hurdles such as costs associated with purchasing and maintaining AI-enabled equipment and software, compatibility with existing digital systems, integration with electronic health records, and training requirements. Ensuring seamless integration into daily workflows without disrupting patient care is crucial. Additionally, maintaining and updating AI systems to keep pace with evolving technology adds another layer of logistical complexity.

Dentists and dental staff may require extensive training and education to effectively utilize AI technologies. Additionally, there may be concerns about the accuracy and reliability of AI algorithms, as well as the need for robust validation and testing procedures to ensure optimal performance.

Adoption and Acceptance

Despite the potential benefits of AI in dentistry, widespread adoption and acceptance by dental professionals may be hindered by factors such as cost, accessibility, and resistance to change and the learning curve. Dentists may be hesitant to adopt AI technologies due to concerns about reliability, usability, and perceived threats to professional autonomy. The biggest hurdle for AI lies not in determining its capabilities but rather in ensuring its acceptance in routine clinical practice.[22] Overcoming barriers to adoption will require effective education, training, and demonstration of the value proposition of AI in improving clinical outcomes and practice efficiency.[98]

Cost

Implementing AI systems often requires significant initial set-up investment associated with purchasing and maintaining AI-enabled equipment and software, training, and integration with existing systems, which may be prohibitive for smaller dental practices.[100]

Compatibility and integration with existing systems

Dental practices often use a variety of digital systems and software solutions for managing patient electronic health records, imaging data, and treatment plans. Ensuring seamless interoperability and integration between these systems to enable data exchange and workflow automation presents a significant challenge. Without standardized data formats and interoperability standards, integrating AI technologies into existing dental workflows may be cumbersome and inefficient.[68,100] Integrating AI technologies with existing dental practice management systems and workflows can be complex and time-consuming, requiring careful planning and customization.

Data quality and quantity

AI algorithms rely heavily on access to high-quality, well-curated datasets for training and validation of AI algorithms. Currently, a major limitation for further deployment of AI in dentistry is the lack of sufficient and accurate data. Therefore, it is currently the responsibility of dentists to focus on collecting and entering valid data into their database so that it can be fully used for AI in dentistry in the future.[11] In dentistry, access to large, diverse datasets with annotated clinical data can be limited, leading to challenges in developing robust AI models. Challenges may arise from the fragmentation and variability of dental data sources, data privacy regulations, and concerns about data security. Additionally, data privacy regulations and concerns about patient confidentiality may restrict the sharing and aggregation of dental data, further complicating efforts to build AI systems. Dentists and AI developers must address these challenges by establishing

data sharing agreements, implementing data governance frameworks, and ensuring compliance with regulatory requirements.[9]

Continual updating of AI-systems

Additionally, maintaining and updating AI systems to keep pace with evolving technology adds another layer of logistical complexity.

AI systems must continually learn and adapt to new data, emerging trends, and evolving clinical practices to remain effective and relevant over time. Dentistry is a dynamic field with constant advancements in technology, materials, and treatment modalities. AI algorithms must be capable of adapting to changes in dental practice guidelines, diagnostic criteria, and treatment protocols to maintain accuracy and efficacy. Implementing mechanisms for ongoing model validation, calibration, and updating will be essential to ensure the long-term performance of AI systems in dentistry.[11,26]

Training and Education

Dentists and dental staff need adequate training and education to understand how to use AI technologies effectively and interpret their outputs accurately. Dental education will need to accompany the introduction of clinical AI solutions by fostering digital literacy in the future dental workforce.[111] Continuous training may be necessary to keep up with advancements and updates in AI.[2] In order to use the advantages of AI correctly, it is important to use these tools with intelligence, objectivity and common sense, with an appropriate learning curve.[101] The road to successful integration of AI into dentistry will necessitate training in dental and continuing education, a challenge that most institutions are not currently prepared for.[17]

Interdisciplinary Collaboration

Successful integration of AI into dental practice will require interdisciplinary collaboration among dentists, computer scientists, engineers, and other healthcare professionals.[11] It has been suggested that an innovative inter-professional coordination among clinicians, researchers, and engineers will be the key to AI development in the field of dentistry.[13] Challenges may arise from differences in terminology, expertise, and priorities among stakeholders. Dentists may lack the technical expertise to develop and deploy AI systems independently, necessitating collaboration with experts in machine learning, data science, and software engineering. Establishing collaborative networks and partnerships between dental schools, research institutions, and technology companies will be crucial for advancing the field of AI in dentistry and translating research into clinical practice.

Ethical Considerations

Among the great challenges posed to democracy today is the use of technology, data, and automated systems in ways that threaten the rights of people.[102,103] It is suggested that there is a lack of regulatory oversight, especially with the use of facial images, and a urgent need to establish licensing protocols, and the imperative to investigate the moral quality of new norms set with the implementation of AI applications in medico-dental diagnostics.[104]

Conscientious and ethical AI use in dentistry has to consider: (i) when to apply AI and (ii) how to use AI appropriately and responsibly. Patients should be notified about how their data is used, also about the involvement of AI-based decision-making, especially if there is a lack of regulatory policy if AI is utilized to diminish costs rather than improve the health of patients, or if the dentist has a conflict of interest. As many dentists are speeding in the direction of integrating AI systems into diagnostics, prognostics, dental treatment, and practice management, the legal and ethical questions are becoming even more pertinent.[14,65,81,103,105-108]

Patient Privacy and Data Security

AI systems in dentistry often rely on access to sensitive patient data, including medical records, facial images, diagnostic images, and treatment histories. Ensuring the privacy and security of patient information is paramount to maintaining patient trust and compliance with ethical principles.[11,14,65,102,104,106,108] Dentists and AI developers must implement robust data encryption, access controls, and data anonymization techniques to protect patient confidentiality and prevent unauthorized access or disclosure of personal health information.[102,103,105]

Informed Consent and Patient Autonomy

Patients have the right to be informed about the use of AI technologies in their dental care and to provide informed consent for their participation.[14,65,102,104,106,108] Dentists must educate or disclose to patients the capabilities, limitations, and potential risks of AI systems, allowing them to make informed decisions about their treatment options. Respecting patient autonomy and preferences is essential to maintaining trust and transparency in the dentist-patient relationship.[65]

Algorithm Bias and Fairness

AI algorithms may exhibit biases or limitations in their ability to generalize findings across diverse patient populations, dental conditions, and clinical settings, leading to disparities in diagnosis and treatment recommendations.[2,14,48] Accordingly, biases may arise from imbalanced training data, algorithmic assumptions, or inherent limitations of the machine learning models.[9,48,65,109]

As a result, AI systems may perform differently across diverse patient demographics or fail to generalize to new cases not encountered during training, leading to potential disparities in diagnosis and treatment recommendations. Dentists and AI developers must mitigate algorithmic biases by ensuring representative and inclusive training datasets, evaluating model performance across diverse demographic groups, and implementing mechanisms for fairness and accountability in algorithmic decision-making.[102]

Professional judgment, oversight and responsibility

While AI technologies can augment clinical decision-making and assist dentists in diagnosis and treatment planning, they should not replace human judgment or override professional expertise. Dentists remain ultimately responsible (accountable) for the care and well-being of their patients, and must exercise clinical judgment and oversight when using AI systems.[65,106,108] Implementing safeguards such as peer review, quality assurance protocols, and second opinions can help mitigate risks associated with over-reliance on AI. Dentists have a professional responsibility to ensure that AI technologies are used ethically and responsibly in patient care.[14,65,103,106,108] This includes ongoing monitoring and evaluation of AI systems, transparency about their limitations and capabilities, and a commitment to providing high-quality, patient-centered care.[106] Furthermore, dentists have a clear responsibility for AI-generated decisions and outcomes, especially in cases where errors or biases may occur.

Ethical AI Design and Governance

As AI technologies become more pervasive in dentistry, ensuring ethical design, deployment, and governance of these systems will be paramount.[102] Dentists and AI developers must prioritize ethical principles such as beneficence, non-maleficence, autonomy, and justice in the design and implementation of AI algorithms. Transparent and accountable AI systems that prioritize patient safety, privacy, and equity will be essential for building trust among patients, practitioners, and regulatory authorities.[102] The complexity

and unpredictability of AI algorithms call for cautious implementation and regular manual validation. Continuous AI learning, proper governance, and addressing privacy and ethical concerns are crucial for successful integration into dental practice.[33,65,103,106,107]

Addressing these ethical considerations is crucial for the responsible and ethical integration of AI into dental practice, ultimately aiming to enhance patient care while upholding ethical standards and principles. Implementing transparent and accountable AI systems, promoting patient-centered decision-making, and maintaining open communication with patients will be essential to address ethical concerns and build trust in AI-driven dental practice.

Legal Considerations

From a legal standpoint, there are questions about liability and accountability in cases where AI systems make errors or fail to provide accurate diagnoses or recommendations. Dentists may need to navigate regulatory frameworks related to medical devices and data protection laws, ensuring compliance with relevant regulations. Liability issues may arise if AI systems make errors or if their recommendations are not followed. Additionally, dentists must navigate intellectual property rights when using AI software developed by third parties. Clear contracts and agreements should outline responsibilities and liabilities.

Regulatory Compliance:

The use of AI in dentistry raises complex regulatory and ethical questions related to patient privacy, informed consent, liability, and professional responsibility.[2,65,104,106,] Regulatory bodies such as the Health Professions Council of South Africa (HPCSA) and professional organizations such as the Dental Association of South Africa (DASA) may need to develop guidelines and standards for the ethical use of AI in dentistry, addressing issues such as data privacy, algorithm transparency, accountability, and patient autonomy. Dentists and AI developers must navigate these legal and ethical considerations to ensure compliance with existing regulations and uphold the highest standards of patient care.

The use of AI in dentistry is subject to regulatory requirements and standards governing medical devices, data privacy, and professional practice. Dentists and AI developers must ensure compliance with relevant regulations such as the South African Protection of Personal Information Act (POPIA), the data protection law of South Africa that safeguards the integrity and sensitivity of private information. It defines what personal data is and prescribes

duties for controllers and processors, and medical device regulations enforced by regulatory agencies such as the Medical Devices Unit of The South African Health Products regulatory Authority (SAHPRA) regulates the licencing of medical device establishments and the registration of medical devices in South Africa to ensure the availability of medical devices that comply with an acceptable level of safety and quality. Dentists and AI developers must navigate these legal and ethical considerations to ensure compliance with existing regulations and uphold the highest standards of patient care.[9] Failure to comply with regulatory requirements may result in legal sanctions, fines, or penalties.

Liability and Malpractice:
Dentists may face legal liability for errors, omissions, or negligence in the use of AI technologies in patient care. While AI systems can enhance diagnostic accuracy and treatment planning, they are not infallible and may produce false positives or false negatives. The question raised here is would a detrimental treatment based on an incorrect prediction of an AI-software be charged for medical malpractice (i.e., the dentist) or product liability (i.e., the company)?[65,104] Dentists must exercise due diligence in the selection, validation, and use of AI systems. Dentists may be held accountable for the consequences of AI-driven decisions and interventions.

Intellectual Property Rights:
AI technologies in dentistry may involve the development and deployment of proprietary algorithms, software, and data analytics platforms. The question however, is: who owns the data of a continuously evolving AI software? And may the owner dispose of the data freely?[104] Dentists and AI developers must be mindful of intellectual property rights, including patents, copyrights, and trade secrets, when creating, licensing, or distributing AI systems. Protecting intellectual property assets can safeguard against unauthorized use, reproduction, or distribution of AI technologies by competitors or third parties.

Standard of Care:
The integration of AI into dental practice may also raise questions about the appropriate standard of care and professional competence expected of dentists.[110] Dentists must stay abreast of developments in AI technologies, undergo training and education on their use, and adhere to professional standards and guidelines established by dental associations and regulatory bodies. Failure to meet the standard of care in the use of AI may result in allegations of professional misconduct, negligence, or malpractice.

Conclusion
AI is poised to revolutionize dental practice, offering innovative solutions to enhance patient care and communications, optimize treatment outcomes, streamline practice management, enhance the overall patient experience and promote professional training and education. However, the impact of technological transformation due to the integration of AI over the next decade is perceived by dental professionals, corporate, and health care administrators with a mixture of optimism and cautious anticipation.

The integration of AI in dental practice has seen significant advancements with a range of applications currently being utilized in various aspects of dental care, including AI-powered diagnostic imaging tools that assist in the early detection of oral diseases, personalized treatment planning based on patient data, and virtual simulations for procedure planning and training. However, applications that have reached full clinical maturity and regulatory approval are still very limited.

Key emerging trends and future directions include the development of AI-driven clinical decision support systems, predictive analytics for oral health outcomes, tele-dentistry and remote monitoring, robotics for guided precision procedures, and AI-enabled patient and dental professional education through virtual reality engagement platforms. By leveraging AI technologies, dental professionals will be empowered to unlock new opportunities for precision dentistry, personalized treatment planning, clinical decision support systems, proactive patient engagement and communication, improving practice management to enhancing workflow efficiency and productivity and continuing education.

Thus, while the integration of AI in dental practice holds great promise for improving patient care and outcomes, it also poses various logistical, ethical, and legal challenges and complexities that need to be carefully addressed.

From a practical and logistical point of view, there are concerns about the accuracy and reliability of AI algorithms, as well as the need for extensive training and education for dental professionals to effectively utilize AI technologies, issues related to data management, compatibility of AI systems with existing dental software, and the costs associated with implementing and maintaining AI solutions in dental practices. There will be a learning curve for dental practices to integrate AI technologies into their existing

workflows. Adequate training and change management will also be crucial to adapt to AI driven technological transformations.

Ethically, there are considerations regarding patient privacy and consent, as well as the potential for bias in AI algorithms that could disproportionately affect certain patient populations. Because AI systems handle sensitive patient data, ensuring robust data security and privacy measures will be paramount to maintain patient trust and comply with regulations. Additionally, there are concerns about the role of AI in decision-making and whether it may replace human judgment or autonomy in dental care. From a legal standpoint, there are questions about liability and accountability in cases where AI systems make errors or fail to provide accurate diagnoses or recommendations.

Overall, while there is significant enthusiasm about the potential of AI to revolutionize dental practice, successful implementation will depend on addressing these challenges and ensuring that the technology is used to complement, rather than replace, the expertise and judgment of dental professionals. The initial investment in AI technologies might be substantial, posing a barrier for smaller practices. Ensuring these innovations are accessible to all practice sizes will be important for widespread adoption.

Although the application of AI has numerous advantages, facilitations and optimizations in the dental practice setting, it also has some potential disadvantages including concerns related to job displacement, privacy and security of patient data, lack of transparency and accountability, dependence on technology for clinical decision making, lack of human contact, and that AI systems may have limited understanding of context and have difficulty understanding nuances and subtleties of human language and behaviour.

Continued research, collaboration, and regulation are essential to continue validating the reliability and practicality of AI for possible widespread integration into daily clinical practice, and to ensure that AI technologies are ethically deployed, effectively utilized, and seamlessly integrated into dental workflows while upholding patient safety, privacy, and autonomy. The use of artificial intelligence in dental practice holds immense promise for advancing precision dentistry, driving innovation, and shaping the future of oral healthcare.

Limitations concerning the practical clinical use of AI needs to be addressed in future studies. It is of high importance to continue validating the reliability and practicality of AI for possible widespread integration into daily clinical practice. Further studies are needed to explore specific applications

and real-world scenarios before confidently integrating these models into dental practice.

However, the road to successful integration of AI into dentistry will necessitate training in dental and continuing education, a challenge that most institutions are not currently prepared for.

Post script – Recommendations for Use of AI-assisted technologies (language models) in Dental Scholarly Publishing

According to a new announcement from the International Committee of Medical Journal Editors (CMJE), researchers may use AI language models (ChatGPT and BingChat) to write and revise scientific manuscripts.

Chatbots (such as ChatGPT) should not be listed as authors because they cannot be responsible for the accuracy, integrity, and originality of the work, and these responsibilities are required for authorship (see Section II.A.1).

Authors should not list AI and AI-assisted technologies as an author or co-author, nor cite AI as an author."

Artificial intelligence and AI-assisted technologies must not be cited as a reference or other primary source or as an author of a reference.

Authors should carefully review and edit the result because AI can generate authoritative-sounding output that can be incorrect, incomplete, or biased.

Authors should disclose any use of artificial intelligence (AI)–assisted technologies (e.g., large language models, chatbots, image creators) in any aspect of the creation of the submitted work, in the methodology, or Acknowledgement section of the manuscript.

Researchers/ Authors of publication must denote how AI-assisted technologies were used.

Authors who use such technology should describe, in both the cover letter and the submitted work in the appropriate section if applicable, how they used it. For example, if AI was used for writing assistance, describe this in the acknowledgment section (see Section II.A.3). If AI was used for data collection, analysis, or figure generation, authors should describe this use in the methods (see Section IV.A.3.d).

Authors must be able to assert that there is no plagiarism in the article, including in text and images produced by AI-assisted technologies, and must ensure appropriate attribution of all material, including full citations where appropriate.

Human authors are responsible for any submitted material that includes the use of AI-assisted technologies, including its correctness, completeness and accuracy.

Even if AI-assisted technologies are used in a manner in which manuscript confidentiality can be guaranteed, peer reviewers who choose to use such technologies to facilitate their review must disclose their use and its nature to Editors and are responsible for ensuring that any AI-generated content incorporated into reviews is correct, complete and unbiased.

Reference

International Committee of Medical Journal Editors (ICMJE). Recommendations for the conduct, reporting, editing, and publication of scholarly work in medical journals. International Committee of Medical Journal Editors; updated May 2023. Available: https://www.icmje.org/recommendations/ (accessed 29 March 2024).

References

The full list of References 1-111 is available in the separate References file.

Antibiotic stewardship in dentistry – review of evidence-based clinical recommendations on appropriate antibiotic prescribing in dental practice: Clinical guidelines and recommendations for antibiotic prescribing in dental practice

Johan Hartshorne[1]

Executive summary

Rational

- Antibiotic stewardship efforts in dental practice are an opportunity to improve antibiotic prescribing practices and to curb antibiotic resistance.

Key Points

- Antibiotic prophylaxis is used routinely in high-risk groups of patients to reduce bacteraemia and the risk of developing infective endocarditis.
- Endocarditis prophylaxis is required in all dental procedures that involve manipulation of gingival tissue, the periapical region of teeth, or perforation of the oral mucosa
- In general, for patients with prosthetic joint implants, prophylactic antibiotics are NOT recommended prior to dental procedures to prevent prosthetic joint infection. In cases where antibiotics are deemed necessary, it is appropriate that the orthopaedic surgeon recommend the antibiotic regimen and when reasonable write the prescription.
- A single dose 2gm of amoxicillin given orally 1 hour preoperatively is effective and efficacious and significantly reduce failures of dental implants placed in ordinary conditions.
- There is no conclusive evidence to suggest the routine use of antibiotic as prophylaxis for third molar extraction surgery in healthy young adults.
- The primary care for odontogenic infections is by local intervention through drainage and or removal of the cause of infection by means of endodontic or surgical therapy.
- In patients with clearly established oral and dental infections, antibiotic therapy

should be reserved for those patients who have regional or systemic body manifestations.

- Patients with infection spreading to the eye (orbital cellulitis) or throat (Ludwig's angina) or presenting with life threatening symptoms should be referred to an Oral Maxillo-Facial Surgeon for immediate intravenous antibiotics and appropriate surgical intervention.
- Prescribe narrow-spectrum antibiotics for the shortest duration possible until the clinical cure of the patient is obtained. This will also minimize disturbance of the normal gut flora.
- Amoxicillin is the preferred first line antibiotic because it is more effective against various Gram-negative anaerobes and has a lower incidence of gastro-intestinal adverse effects.
- A review point two to three days after drainage of an acute dental infection is a key element of the guidance. Those patients whose infections have resolved, and body temperature returned to normal, should be instructed to stop taking the antibiotics.
- Antibiotics may be used in conjunction with, but not as an alternative to other appropriate interventions, such as endodontic therapy, periodontal debridement, or surgical extraction of a tooth.
- Dentists should curb the use of Clindamycin due to high frequency of side effects, and specifically because it increases the risk of Clostridiosis (formerly Clostridum) difficile pseudomembranous colitis 4 x
- Any antibiotic prescribing recommendations should be integrated with the practitioner's professional judgement in consultation with the patients' physician, and the patient's needs and preferences.
- The benefits of giving an antibiotic should always outweigh the risks of antibiotic-related allergy, toxicity, super infection and the development of drug-resistant strains.

Practical implications

- Local intervention (endodontic therapy, periodontal debridement, extraction and surgical drainage) are always first line primary care, with antibiotics serving as adjunctive therapy in indicated cases.
- First line antibiotics used in dentistry are penicillin's, amoxicillin, clindamycin and azithromycin. The use of Clindamycin should be reviewed and used with caution.
- Topical or local administration of 10% Doxycycline as an adjunctive to deep scaling and root planing (SRP) for

treatment of periodontitis, can reduce or avoid the need for systemic therapy and subsequent gut microbiome exposure.

- Amoxicillin is the most commonly recommended antibiotic for children, with metronidazole or azithromycin being the alternative antibiotic in penicillin-sensitive patients.
- Safety and product cost should always be taken in consideration when selecting an appropriate antibiotic.

Introduction

Avoiding unnecessarily and inappropriate prescribing of antibiotics is the key to reducing the number of adverse drug reactions and curbing antibiotic resistance.

Various international (World Health Organization), Governmental Organizations (Centers for Disease Control and Health Prevention, USA, Department of Health and Human Services, USA, National Health Service, UK, British National Formulary, UK), Health Related Associations (American Heart Association, American Dental Association, Faculty of General Dental Practitioners, UK), Research Organizations (Cochrane Database) and Independent research collaborative efforts, publish and regularly update evidence-based clinical guidelines, recommendations and systematic reviews and meta-analysis for prescribing antibiotics. These clinical recommendations and guidelines are a key element of antibiotic stewardship and therefore fundamental for appropriate antibiotics prescribing in the dental setting.

Infective endocarditis prophylaxis recommendations[1]
Indications

Antibiotic prophylaxis is used routinely in high-risk groups of patients to reduce bacteraemia, and the risk of developing infective endocarditis.[2] Patients at increased risk of developing infective carditis (IE) are:

- Prosthetic cardiac valves, including trans catheter-implanted prostheses and homographs
- Prosthetic material used for cardiac valve repair, such as annuloplasty rings and cords
- Previous IE
- Unrepaired cyanotic congenital heart disease or repaired congenital heart disease, with residual shunts or valvular regurgitation at the site of or adjacent to the site of a prosthetic patch or prosthetic device.
- Cardiac transplant with valve regurgitation due to structurally abnormal valve.

Endocarditis prophylaxis is required in all dental procedures

Table 1: Prophylactic regimen to prevent infective endocarditis [1]

Situation	Regimen: Single dose 30-60 minutes before procedure		
	Antibiotic	Adults	Children
Oral	Amoxicillin	2g	50mg/kg
Unable to take oral medication	Ampicillin or Cefazolin or Cefttriaxone	2g IM or IV 1g IM or IV	50mg/kg IM or IV 50mg IM or IV
Allergic to penicillin or ampicillin – oral	Cephalexin OR Clindamycin OR Azithromycin or clarithromycin	2g 600mg 500mg	50mg/kg 20mg/kg 15mg/kg
Allergic to penicillin or ampicillin and unable to take oral medication	Cefazolin or Ceftriaxone OR Clindamycin	1g IM or IV 600mg IM or IV	50mg/kg IM or IV 20mg/kg IM or IV

that involve manipulation of gingival tissue, the periapical region of teeth, or perforation of the oral mucosa, including prophylactic cleaning, dental extractions, periodontal procedures, endodontic instrumentation, placement of orthodontic bands, placement of implants or any oral surgical procedure.

Antibiotic regimen
The AHA guidelines state that an antibiotic for prophylaxis should be administered in a single dose 1 hour before the procedure[3,4] (Table 1)

However, in the event that the dosage of antibiotic is inadvertently not administered before the procedure, it may be administered up to two hours after the procedure.

For patients already receiving an antibiotic that is also recommended for IE prophylaxis, then a drug should be selected from a different class; for example, a patient already taking oral penicillin for other purposes may likely have in their oral cavity Streptococcus viridans that are relatively resistant to beta-lactams. In these situations, clindamycin, azithromycin or clarithromycin would be recommended for antibiotic prophylaxis.[3,4] Alternatively if possible, treatment should be delayed until at least 10 days after completion of the antibiotic to allow reestablishment of usual oral flora.

A recent systematic review 2 made the following recommendations based of the available evidence-based-literature:

Antibiotic prophylaxis should be limited to patients at high risk of developing infective endocarditis, according to the recommendations and protocol of the American Heart Association as summarized above.

- Oral amoxicillin is still the antibiotic of choice to reduce bacteraemia.
- IV amoxicillin-clavulanic acid could be used for patients at high risk of developing IE who require invasive dental procedures and are treated under general anaesthesia.
- In patients with penicillin allergies, oral azithromycin showed higher efficacy for the reduction of bacteraemia.
- The use of clindamycin should be reviewed.

Prophylactic antibiotics prior to dental procedures in patients with prosthetic joints
Based on the updated systematic review and the 2015 ADA clinical practice guidelines state: "In general for patients with prosthetic joint implants, prophylactic antibiotics are NOT recommended prior to dental procedures to prevent prosthetic joint infection" [5]

However, a commentary published in February 2017 issue of JADA written by American Dental Association appointed experts, calls for appropriate decision-making criteria and to encourage dentists to continue using the 2015 guidelines.[6] It is recommended that dentists, patients and orthopedic surgeons should discuss and weigh the potential risks and benefits before making a decision. It is also recommended that the dentists consult the appropriate use criteria as needed and respect the patients' specific needs and preferences when considering antibiotic prophylaxis before dental treatment.[5]

In cases where antibiotics are deemed necessary, it is most appropriate that the orthopaedic surgeon recommend the appropriate antibiotic regimen and when reasonable write the prescription.[7]

Prophylaxis for preventing implant failures

The use of antibiotics in implant dentistry is controversial. The evidence-based data suggests that a single dose 2gm of amoxicillin given orally 1 hour preoperatively is effective and efficacious and significantly reduce failures of dental implants placed in ordinary conditions.[8,9,10] It is still unknown whether postoperative antibiotics are beneficial, and which is the most effective antibiotic.

Prophylaxis for preventing infection in third molar extractions

There is evidence that prophylactic antibiotics reduce the risk of infection, dry socket and pain following third molar extractions and result in mild and transient adverse effects. It is unclear whether the evidence is generalizable to individuals with concomitant illnesses or immune-deficiencies, or those undergoing the extraction of teeth due to severe caries or periodontitis.[11]) In a recent systematic review and meta-analysis it was concluded that there is little conclusive evidence to suggest the routine use of antibiotic as prophylaxis for third molar extraction surgery in healthy young adults.[12]

Oral and Dento-Facial infections

As a general guideline antibiotic therapy should be reserved for those patients with clearly established infections who have regional or systemic body manifestations e.g., presence of pronounced oedema (cellulitis), limited mouth opening (trismus), increased heart rate (tachycardia), difficulty swallowing (dysphagia), general malaise, fever and should be used as an aid to fight infection.[13] Such patients should be treated surgically as early as possible. Adjunctive treatment should include endodontic therapy, or extraction of the causative tooth and surgical drainage of any areas of pus accumulation.

Life threatening sepsis[1]

Patients with infection spreading to the eye (orbital cellulitis), or throat (Ludwig's angina), or presenting with symptoms indicating a life threatening sepsis such as an altered mental state, decreasing respiration rate, oxygen saturation below 92%, and increased heart rate >130bpm, systolic BP <90mmHg, should be referred to an Oral Maxillo-Facial Surgeon for immediate treatment with intravenous antibiotics and appropriate surgical intervention.[14]

Abscess

Acute dentoalveolar cellulitis and abscess usually require antibiotic therapy. Chronic dental abscesses need no antibiotic therapy.

Pericoronitis

The bacteria responsible for pericoronitis are all Gram-negative anaerobic bacteria. Debridement by irrigation and possible extraction of the offending tooth usually are sufficient without requirement for antibiotic therapy.[15] However if the patient presents with temperature elevation and trismus preventing adequate surgical therapy, then the use of antibiotics may be necessary for several days before surgery can be performed. Penicillin is the drug of choice.[15]

Osteomyelitis

Osteomyelitis usually requires surgical and antibiotic therapy for successful treatment. Special care must be taken to identify the causative organisms using anaerobic and aerobic culture of tissue removed at surgery for appropriate antibiotic therapy. Osteomyelitis must be treated with antibiotics for much longer period than soft tissue infections.[15]

Management of maxillo-facial fractures

Administration of antibiotics should begin as early as possible after diagnosis to diminish the chance of clinical infection.

Dento-facial infections can be treated with less extensive and aggressive surgical and antibiotic therapy, reduced hospitalization costs and fewer complications if approached earlier when diagnosed during premature clinical manifestations.[16]

Odontogenic infections

Current clinical guidelines for the rational use of antibiotics in the United Kingdom on treating acute dental infections is provided by the Faculty of General Dental Practice (FGDP) 17, British National Formulary[18], and Scottish Dental Clinical Effectiveness Programme.[19]

The primary care for odontogenic infections is by local intervention through drainage and or removal of the cause of infection by means of endodontic or surgical therapy. It is suggested that the correct diagnosis and local intervention should be given the greatest attention by the dentist, whilst the choice of antibiotic playing a secondary role, provided

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that the antibiotic used fits in with the spectrum that has been proved effective in the treatment of odontogenic infections.[13] The safety and cost of antibiotic should be taken into account.

Management of odontogenic infections includes diagnosis of causative organisms, clinical management including appropriate antibiotic selection, and referral to a specialist where indicated.[20,21,22]

Endodontic (pulpal-and periapical-related) infections

Studies have shown that adjunctive antibiotics are not effective in preventing or ameliorating signs and symptoms in cases of irreversible pulpitis, symptomatic apical periodontitis, or localized acute apical abscess, when adequate local debridement, medication and incision for drainage, if indicated, have been achieved.[23-28]

A clinical practice guideline just released by an expert panel of the American Dental Association made the following recommendations on antibiotic use for the urgent management of pulpal- and periapical-related conditions in immunocompetent adult patients.[29]

- Antibiotics should not be prescribed for immunocompetent adult patients with pulpal- or periapical-related conditions where definitive conservative dental treatment is available, including pulpotomy, pulpectomy, or incision drainage of an abscess.

- Prescribing antibiotics in immunocompetent adults are not recommended owing to potentially negligible benefits and likely large harms associated with their use.

- Antibiotics should be prescribed for immunocompetent adult patients with pulp necrosis and localized acute apical abscess, in settings where no definitive conservative dental treatment is available.

- It is suggested good practice to prescribe oral amoxicillin (500mg, 3 times per d, 3-7d) or oral penicillin V potassium (500mg, 4 times per d, 3-7d) for immunocompetent adults with pulp necrosis and acute apical abscess with systemic involvement.

Antibiotics should only be used as adjuvant therapies in cases with evidence of systemic involvement.[29] In addition patients who are immune-compromised or having predisposing conditions such as previous endocarditis should receive prophylactic antibiotics. When using adjunctive antibiotics in addition to adequate debridement and surgical drainage, such as in cases with spreading infections, the practitioner should use the shortest effective course of antibiotics, minimize the use of broad spectrum antibiotics and monitor the patient closely.[30] Penicillin VK and amoxicillin are the first line of antibiotics used for urgent management of pulpal- and periapical- related pain and intra-oral swelling.[30] However,

Table 2: Recommended antibiotic regimens for orofacial infections in children [34,35]

Infection	Recommended antibiotic regimen	Infection	Recommended antibiotic regimen for penicillin-allergic patient
Cellulitis, Necrotizing ulcerative gingivitis or pericoronitis	Amoxicillin (2-3 days, max 5 days) Children >3 mths and <40kg: 20-40mgs/kg/day in divided doses 8 hourly Children >40 kg 250-500mg 8 hourly 0r 500-875mg 12 hourly	Cellulitis Necrotizing ulcerative gingivitis pericorinitis	Metronidazole (3 days): Children: 30mg/kg/day in divided doses 6 hourly (max 4gm/24 hr) Adolescents: 7.5mg/kg/ 6 hourly (max 4g/24hrs OR Azithromycin (3 days): Children < 6mths – 16 yrs: 5-12mg/kg/daily for 3 days (max 500mg/day OR Clarithromycin (7 days) 7.5mg/kg 12 hourly 13-18yrs: 250mg 12 hourly
Aggressive periodontitis	Amoxicillin 50mg/kg/day AND Metronidazole 30mg/kg/day 8 hourly for 7 days	Aggressive periodontitis	Azithromycin (3 days) 10mg/kg daily OR Metronidazole 30mg/kg/day 8 hourly for 7 days

(Adapted from: Geller, Lovegrove, Shehab et al, 2018)[49]

amoxicillin is the preferred antibiotic because it is more effective against various Gram-negative anaerobes and has a lower incidence of gastrointestinal adverse effects.[29]

As an alternative for patients with a history of penicillin allergy, but without a history of anaphylaxis, angioedema, or hives with penicillin, ampicillin or amoxicillin, oral cephalexin (500mg, 4 times per d, 3-7 d) is recommended.

As an alternative for patients with a history of penicillin allergy, and a history of anaphylaxis, angioedema, or hives with penicillin, ampicillin or amoxicillin, oral azithromycin (loading dose of 500mg on day 1, followed by 250mg for an additional 4 days, or oral clindamycin (300mg 4 times per d , 3-7 d). Bacterial resistance rates for azithromycin are higher than for other antibiotics and clindamycin substantially increases the risk of developing Clostridiosis difficile infection after a single dose.[29, 30]

The recommended dose regimen for amoxicillin is 500mg tds, with or without a loading dose of 1000mg.

Periodontal infections

Antibiotics are not needed for most cases of periodontal infections. Non-surgical mechanical debridement by deep scaling and root planing (SRP) resolves a considerable amount of infection on its own. Antibiotics adjunctive to SRP should be assessed on an individual risk basis against the necessity for further therapy.[32] Specific indications for prescribing antibiotics as an adjunct to mechanical debridement are multiple deep pockets, especially in the molar area, severe periodontitis with a rapid rate of progression and ANUG.[32] So far, no antibiotic or combination of antibiotics, has shown clinical or microbiological superiority to amoxicillin 500mg tds and metronidazole 400mg tds in any appropriately conducted randomized clinical trial.[32] Poor quality mechanical debridement and poor oral hygiene is a contraindication for prescribing antibiotics.[32] Administration of antibiotics has been identified as a risk for the development of periodontal abscesses if subgingival debridement in the apical portion of a lesion is incomplete.[33] It is also suggested that the use of topical or local administration of antibiotics (e.g., 10% Doxycycline) can reduce or avoid the need for systemic therapy and subsequent gut microbiome exposure.[34]

Pediatrics – Treatment of acute dental infections

A systematic review of the literature revealed that the main indication for use of antibiotics in children were for cellulitis, aggressive periodontitis, ulcerative gingivitis and pericoronitis. Amoxicillin was found to be the most commonly recommended antibiotic for short durations of 3-5 days, with metronidazole or azithromycin being the alternative antibiotic in penicillin-sensitive patients.[35]

Children should be followed up for a few days to evaluate response to treatment, and the development of unwanted side effects.[35]

The recommended antibiotic prescribing clinical guidelines by the Faculty of General Dental Practitioners (UK)[17] for acute dental infections in children are as follows:

A review point two to three days after drainage of an acute dental infection is a key element of the guidance. Those patients whose infections have resolved, and body

Table 3: Alternative recommended antibiotic prescribing clinical guidelines for children[17]

Amoxicillin dosing	Metronidazole dosing
1mth -1 yr	125mg every 8 hrs, increased if necessary up to 30mg/kg every 8 hrs
1-5 yrs	250 mg every 8 hrs, increased if necessary up to 30mg/kg every 8 hrs
5-12 yrs	500 mg every 8 hrs (max 1gm every 8 hrs)
12-18 yrs	500 mg every 8 hrs, in sever infections 1 gm every 8 hrs
Metronidazole dosing	
1 - 3 yrs	100mg tds for up to 5 days- review after 2-3 days and discontinue if resolved
3-7 yrs	200mg bd for up to 5 days- review after 2-3 days and discontinue if resolved
7-10 yrs	200mg tds for up to 5 days - review after 2-3 days and discontinue if resolved

temperature returned to normal, should be instructed to stop taking the antibiotics.[37]

Fundamental clinical guidelines for pediatric antibiotic stewardship, embrace the following principles[17,38]:

- Avoid prescribing antibiotics for conditions where antibiotics are not indicated.
- Reduce macrolides.
- Increase first-line guideline concordant.
- Review after 2-3 days and discontinue if infection has resolved.

Ethical considerations and medical risk

Patients have the right to expect that clinicians will examine them thoroughly, diagnose their needs correctly, provide a clear treatment plan and treat them accordingly. Dentists must be prepared to decline requests for a particular treatment if they judge it would not benefit the patient's health, such as when a patient requests antibiotics without any real indication for a prescription.[39] The dentist has an obligation to explain the consequences and/or risks of not continuing the treatment and ensure the patient knows that they are responsible for any future problems which arise as a result of not following or completing the treatment.

The practitioner should in consultation with the patient consider if there are possible clinical circumstances that may suggest the presence of a significant medical risk in providing dental care without antibiotic prescribing. Any antibiotic prescribing recommendations should be integrated with the practitioner's professional judgement in consultation with the patients' physician, and the patient's needs and preferences. All communications between the dentist and the patient in this regard must be recorded in the patients' notes.

Due to the increasing prevalence of bacteria, which are resistant to treatment by currently available antibiotics, clinicians should consider carefully treating all patients' with antibiotics. This is likely to do more harm than good.[11] Ultimately dentists must weigh the benefits and risks of antibiotics and make and informed decision with their patients on the appropriateness of using antibiotics. The benefits of giving antibiotics should always outweigh the risks of antibiotic-related allergy, toxicity, super infection and the development of drug-resistant strains.[15]

It is the duty of every dentist to arrive at a correct diagnosis in order to avoid inappropriate use of antibiotics. When selecting an antibiotic that fits in with the action spectrum that has been proved effective for treatment, safety of antibiotic use and product cost should always be taken in consideration.[13]

Conclusion

Primary indications for using antibiotics to prevent and fight bacterial infections in the dental setting are: prophylaxis to prevent infective endocarditis, when there is systemic body response to infection, and in patients that are immune-supressed or immune-compromised. Antibiotic prescribing in the dental setting should always be based on the narrowest spectrum antibiotic for the shortest duration possible. In addition, effective plaque control must also be prioritised. As a society we need to recognize that antibiotics are fundamental to how we practice modern dentistry, and therefore use and value antibiotics prudently and cautiously. It is essential to understand that antibiotic therapy will fail if the source of infection is not removed. Primary dental care, including periodontal debridement, endodontic therapy, extractions, drainage and/or surgical intervention should always be the first line of care, with antibiotics serving as adjunctive therapy in indicated cases. Antibiotics are not a replacement for surgical drainage or debridement.

Any antibiotic prescribing should be based on the practitioner's professional judgement, in consultation with the patients' physician, and the patient's needs and preferences. The benefits of giving antibiotics should always outweigh the risks of antibiotic-related allergy, toxicity, super infection and the development of drug-resistant strains.

References

The full list of References 1-39 is available in the References document

The moral compass of a dental practitioner: A balancing act between ethical principles, moral values, and professionalism

Johan Hartshorne

Executive summary

Importance
- A moral compass is the foundation of professional practice that upholds the dignity and integrity of dental practitioners, fosters trust between patients and practitioners, is vital to successful patient outcomes, and the overall reputation of the dental profession.

Key points
- The core elements of ethics, moral values and professionalism are complimentary to each other guiding how dental professionals should interact with patients and peers, make indecisions and behave.
- Continuously self-reflecting upon our personal values and beliefs, ethical principles and professional conduct is a professional responsibility that we all share.

Practice implications
- Commitment to life-long learning and continuing professional development to strengthen clinical competencies, advance communication skills, enhance professional judgment, and to continuously improve of quality of care.

Background
In modern dentistry dental practitioners frequently encounter ethical dilemmas that challenge their integrity, judgements, and decision-making.[1] These dilemmas often arise from lack of communication, patient non-compliance, commercial or business pressures, and the rapid integration of new technologies.[1]

Navigating and resolving these ethical challenges demands a deep understanding of ethical principles, moral values, and professionalism, coupled with practical strategies for decision-making, to balance patient desires with professional conduct that will uphold patient safety and well-being, trust, professional integrity, and the highest standards of care.

Ethical principles, moral values and professionalism, collectively referred to as a 'moral compass', are cornerstone elements upon which dentist-patient relationships

and a successful dental practice is built.[2] A moral compass is defined as: "a natural feeling that makes people know what is right and wrong and how they should behave"[3], or "a set of beliefs or values that help guide ethical decisions, judgments, and behaviour".[4]

Whilst we often feel we have an innate understanding of the concepts of ethics, moral belief and professionalism, there is no single clear definition as to what they really mean in dentistry. Furthermore, most people use the terms ethics, morals and professionalism synonymously and interchangeably to help explain the differences between right and wrong.[5-7] The definitions of ethics, moral values, and professionalism however, are slightly more complicated with subtle differences between the three concepts. Moreover, in our busy professional lives, many of us do not spend a great deal of time reflecting upon ethical principles, moral values, and professionalism, why we hold them, and where they come from. Nor do we consciously refer to them when difficult decisions need to be made.[8] As members of the dental profession, we all share a professional responsibility to reflect upon our ethical principles, our own moral values and professional conduct (behaviour) in our personal and professional domain. These core elements serve as the key pillars for establishing trust and integrity within the dentist-patient relationship and the broader dental community.

Purpose

This article aims to explore the core elements of a dental practitioners' moral compass, the key differences between the concepts of ethical principles, moral values and professionalism, and to provide some clarity and understanding on their role and best practices in guiding ethical decision-making, judgements, and professional conduct that will not only honour the dignity, rights, and well-being of patients, but also create a positive and healthy practice culture, and ensure the integrity of the profession.

Ethical principles

The fundamental ethical principles that govern dental practice: autonomy, beneficence, nonmaleficence, justice[9] and veracity,[10-12] are a core element of a dental practitioners moral compass. (Table 1) Ethical principles are guiding principles, or a set of rules of conduct, or correct behaviour, in a particular institution or professional group such as the dental community.[6,8,13] It deals with the key aspects of human behaviour and decision making of what is 'right' or 'wrong', 'good' or 'bad', 'just' or 'unjust'.[11] Ethical principles are a fundamental cornerstone of professional practice that

upholds the dignity of the dental profession and fosters trust between patients and practitioners.[1,2]

Upholding ethical principles in dentistry is crucial for a practice's compliance, reputation, and overall success. Failing to uphold these principles could leave your dental practice liable for mistakes, leading to malpractice claims and a serious hit to your personal and professional reputation. The Health Professions Council of South Africa (HPCSA) (Dental Councils and Dental Boards) have the power to suspend or remove a dentist's registration, even when no law has been broken. Professional ethics and conduct is therefore highly enforceable because the dentist's registration is at stake. From this you will deduce that ethical behaviour is mandatory for a career in dentistry and not voluntary.[8] The characteristics of ethical principles are summarized in Table 1.

Patient autonomy

Autonomy in dentistry refers to respecting the patient's right to self-determination, enabling them to make informed decisions and choices about their treatment that are aligned with their values, preferences and ability to afford treatment. Patients today are well-informed about health, treatments, and their rights as patients, and want to participate in the decision-making process. It is the foundational ethical principle on which informed consent and confidentiality is based, and ensuring trust in the dentist-patient relationship.[1] Respecting autonomy also includes the right for a patient to assess all the information provided by the professional, yet still make a choice that is not the one most valued by the professional — informed refusal. Both informed consent and confidentiality are not merely about adhering to legal standards but are integral to respecting individual rights and maintaining the dignity of the therapeutic relationship.[1]

Autonomy is a crucial aspect of healthcare. It ensures that a medical, dental or any procedure in healthcare cannot proceed unless it represents the patient's wishes. Furthermore, the patient should not have any undue influence on their decision making process, thus a patient's decision must be free of manipulation, coercion and deceit.[14]

Best practice guidelines that will support patient autonomy:

- Actively listen to patients' needs, preferences, and concerns and engage in patient-centered communication, answering questions thoroughly.
- Clearly lay out the treatment options without giving preference to the most profitable options.

Table 1: A synopsis of the core concepts and characteristics of a dentist's moral compass

CORE CONCEPTS	ETHICAL PRINCIPLES	MORAL VALUES/BELIEFS	PROFESSIONALISM
DEFINITION	Guiding normative standard of principles, or set of rules of conduct, or correct behaviour, in a particular institution of professional group. Principles are an objective reality that is not bound by cultures and individuals	Principles or habits relating to right or wrong conduct based on an individual's own compass or beliefs of right or wrong, or good or bad. (Personal values) Moral values guide consequential attitudes and actions of how people think, feel and behave. Values are internal, subjective and flexible.	A set of values, behaviours, habits, and relationships that underpin the trust the public has in doctors. Professionalism is the behaviour by which we demonstrate that we are worthy of the trust bestowed upon us by the public, because we are working for the public good. Upholding the highest standards of ethical conduct, integrity, respect and accountability.
CORE ELEMENTS (Best practice guidelines)	• Autonomy- right to self-determination • Beneficence- patients best interest • Non-maleficence – do no harm • Justice – fairness and accountability • Veracity - Being truthful	• Honesty / Trustworthiness • Respect / Self-respect • Humility • Reliability • Accountability • Loyalty • Caring /Kindness/Generosity • Thoughtfulness • Selflessness / altruism • Compassion • Gratitude • Self-awareness • Self-discipline • Self-reflection • Self-improvement • Open minded / cognitive flexibility • Tolerance • Frugality	• Integrity • Excellence • Selflessness / Advocacy/ Altruism • Competence/Skilfulness • Continuing professional development / Self-improvement • Self-awareness / Knowledge of limits • Appearance • Compassion/empathy • Trustworthiness • Accountability/Responsibility • Respect for others • Generosity • Assertiveness • Being honest • Communication/Collaboration / Cooperation/Teamwork/Transparency
ETYMOLOGICAL ORIGIN	'Ethos' meaning character	'Mos' meaning customs or beliefs	'Professiō' meaning public acknowledgment
FRAMED OR GOVERNED BY	Determined by professional or legal norms (external source)	Self-determined and influenced by societal and cultural norms (Internal belief system)	Decided and governed by society, and professional organisations.
DEALS WITH	Principles of what is deemed as right or wrong conduct / behaviour.	Moral values are personal beliefs of what is deemed as right or wrong behaviour.	Refers to the way in which professionals conduct themselves, the attitudes they convey, and the ways they communicate with their patients, colleagues and staff.
CONSISTENCY	Ethical principles remain consistent across professions, industries and institutions. Principles are universal and constant in nature.	Values and beliefs are personal and differ across society and cultures – varies from individual to individual	Professionalism involves consistently upholding high standards of professional conduct. It needs to be earned, practiced and improved every day. This trait will vary between individuals.

- Discuss the potential benefits and risks of treatments, allowing patients to weigh their choices thoughtfully.
- Ensure that patients understand the individual stages of atreatment and the cost thereof.
- Obtain informed consent, documenting the patient's agreement to the chosen treatment plan.

Beneficence
The principle of 'beneficence' refers to 'doing good' and promoting patient well-being.[9] Dental practitioners, based on

their acquired body of knowledge and skills, requires taking all appropriate actions, and use all reasonable means, that will produce good consequences that benefit the patient.[15] It also refers to prioritizing patient welfare to maximize the benefits they receive and to provide a high standard of care that is in the patients' best interest, even when the interests of the latter conflict with the practitioner's personal self-interest. The needs and interests of the patient always take precedence over the practitioners own interests.[16] The "best interests" of patients means that professional decisions by the dentist must consider patients' values and personal preferences.[12] This requires that dentists carefully listen to, and communicate with their patients. Patients must be informed of preferred and alternative treatment options, with benefits, risks and costs of each option. Together, the risks, benefits, and burdens can be balanced. It is only after such consideration that the "best interests" of patients can be assured.[12]

Unlike medicine, dentistry has increasingly become viewed as a business, as over the last decade there has been a focus on commercialization of dentist services and the rise of "corporate dentistry".[17,18] Although lip service is paid to putting the clients' needs first in the business world, it is generally accepted that the needs of the patient should always take precedence over self-interest, or the financial priorities of the practice.[16]

Best practice guidelines for 'doing good' and serving the patients' best interest:
- Take time to thoroughly assess a patient's condition and determine the best treatment option.
- Providing treatment recommendations tailored to each patient's needs, demands, and preferences.
- Staying attuned to patients' emotional and physical concerns and offer solutions to ease their physical and emotional anxieties.
- Maintain up-to-date knowledge of the latest dental advancements and evidence-based practices to provide the best treatment options for patients.
- Regularly assess treatment progress to ensure positive and satisfactory patient outcomes.
- Be attentive to patients' pain and discomfort, providing timely pain relief and follow-up care.

Non-maleficence (Do no Harm)
The principle of non-maleficence obligates us to refrain from actions or treatments that could cause harm to patients.[9,14] The principle on non-maleficence means avoid harming

a patient intentionally or unintentionally by weighing the risks of a treatment against the benefits, and choosing the treatment that poses the most benefits to the patient. Both intentional or unintentional harm to patients can apply to laws of negligence. Intentionally imposing unreasonable risks of harm, or unintentionally causing harm to a patient due to carelessness.[14] Patients who seek dental services place themselves in the care of another person and, at a minimum, should expect that no additional harm will result from that act. The patient grants the clinician the privilege of access to a portion of his or her body for an explicit purpose, a privilege founded in trust. Fundamental to that trust is that the health care provider will do no harm to the patient.[15]

Over time, non-maleficence has evolved to include preventing and removing harm. Therefore, healthcare providers have an obligation to 'do no harm' as well as to 'prevent harm'. Prevention of harm clearly is a domain of dentists and dental hygienists as great emphasis is placed on educating patients about preventing dental caries and periodontal disease.[15]

Through the implementation of recommended strategies and best practices, cultivate a patient safety culture, enhance communication, mitigate risks and continually improve patient safety outcomes. The dissemination of knowledge and the active involvement of all stakeholders are crucial for promoting patient safety and establishing a safe dental healthcare system.

Nonmaleficence and beneficence are complementary principles where dentists commit to causing no harm and actively work for the patient's benefit, respectively.[2]

Best practice guidelines for avoiding harm to patients:
- Collect all personal demographic, behavioural, medical and dental history to identify potential risks and contraindications, and to mitigate the risks of treatment.
- Carefully assess the risks and benefits of treatments and take necessary precautions to prevent harm during procedures.
- Promote and prioritize patient safety by following adequate safety and infection control protocols during procedures to prevent harm.
- Participate in continuing education to improve safety measures for patients.
- Employ the latest safety protocols and equipment during dental procedures to minimize risks.
- Continuously improving knowledge and skills through

ongoing education to enhance patient safety and effective care.

• *Justice (Fairness)*

The principle of justice means treating all patients 'equally', 'impartial', 'fair' and in a 'just' manner, regardless of their race, class, background, financial situation, or other diversifying factors.[2,9] Dentists should avoid discrimination and ensure that all patients receive appropriate standard of care regardless of their emotional, personal, family and cultural background or financial status.

Fundamental to the principle of justice is an effort to treat people who have similar needs in a similar or identical manner. For example, all patients who seek treatment for the prevention of periodontal disease should receive the same level of care and attention from the dentist or dental hygienist regardless of personal or social characteristics.[15] This principle is built on the profession's social contract; it pursues the profession's commitment to seek the common good, dignified existence, and the establishment of fairness, equity and justice.

Best practice guidelines to ensure fairness of treatment to all patients:

- Giving patients the same amount of time for similar appointments.
- Treat all patients with respect, regardless of their age, gender, ethnicity, cultural, religious or socioeconomic status.
- Make accommodations as necessary for patients with different cultural backgrounds or disabilities.
- It is unethical for a dental professional to recommend or refer treatment to a specialist that is unnecessary, or recommending a product to a patient for own benefit.
- Ensure that the allocation of appointments and treatment availability is fair and not influenced by personal biases.
- Be mindful of the cultural backgrounds of patients, adapting care to accommodate individual needs and preferences.
- Participate in community outreach programs or pro bono initiatives to provide dental care to the needy, disadvantaged and underserved populations.

Veracity

Veracity is defined as being honest, telling the truth and respecting the trust that is the bedrock in the dentist-patient relationship. The dentist relies on the honesty of the patient to gather the information necessary to form a proper diagnosis. The patient relies on the dentist to be truthful so that truly informed decision-making can occur. Honesty in dealing with the public, colleagues, and self are equally important.[12] It involves truthful communication without deception and maintaining intellectual integrity. Dentists should regard truth and truthfulness as the basis of trust in their professional relationships with their patients, staff, colleagues, dental technicians and other health care providers.

Patients are expected to be truthful about their medical history, treatment expectations, and other relevant facts. Clinicians, for their part, must be truthful about the diagnosis, treatment options, benefits and disadvantages of each treatment option, cost of treatment, and the longevity afforded by the various treatment options. This allows patients to use their autonomy to make decisions in their own best interest.[19] The obligation of veracity, is based on respect for patients autonomy, is acknowledged in most codes of ethics.[10-12]

Guidelines for ethical decision-making

The process of ethical decision making involves assessing, judging, deciding and choosing. Ethical decision-making require that all decisions, choices and actions by dentists, demonstrate: (i) regard for self-determination (respect for autonomy); (ii) the reduction and avoidance of doing harm (nonmaleficence); (iii) the promotion of well-being and the patients best interest (beneficence); and (iv) fairness in the distribution of services and goods (justice).[10,11,12] Various approaches for ethical decision in the dental practice setting have been summarized in Dental Professional Codes of Conduct.[10-12]

Moral values

Moral values refer to the personal beliefs, values, and upbringing that shape an individual's behaviour and decision-making in distinguishing right from wrong, good from bad, and acceptable from unacceptable behaviour.[5,6,13] Core moral values are a person's most central ideas or beliefs about themselves, others and the world through which every situation and life experience is seen, and guide consequential attitudes and actions of how they think, feel and behave in their personal and professional lives. In order to create honest, credible, and fair judgments and relationships with patients, clients, colleagues, staff and friends in daily life, the awareness of one's morals - along with self-awareness - is crucial. A person's moral values are often influenced by factors such as culture, religion, upbringing, family traditions,

and personal experiences.[20]

The core elements and characteristics of moral values associated with a strong moral compass or high moral character are summarized in Table 1: [11,12,20]

Best practice guidelines include:
- Honesty (Being truthful, transparent and trustworthy in interactions)
- Respect (Respect all people regardless of their age, religion, cultural, social or economic background, nationality, beliefs, or point of view.)
- Reliability/Dependability (Keeping your word)
- Loyalty (Being faithful and supportive to patients and people in your life)
- Humility (Not being arrogant)
- Compassion / Caring / Kindness (Showing empathy, being kind, showing concern, and giving support towards others)
- Thoughtfulness (Being considerate towards other people)
- Self-reflection (Deep thinking, introspection and self-improvement)
- Self-improvement (Pursuit of knowledge, personal growth and to better yourself)
- Gratitude (Gratitude is the willingness to express appreciation for what you have, and never take anybody - or anything - for granted.)
- Self-respect and Self-awareness (Caring about yourself, being happy, and health and wellness)
- Adaptability (Ability to adjust to changes)
- Open-mindedness/ cognitive flexibility (Open to new perspectives, creativity)
- Frugality (Spending money carefully)
- Generosity (Willingness to offer time, money, support, and kindness)
- Community (Belonging to a group)
- Tolerance (Ability or willingness to tolerate the existence, opinions, dislikes or disagreements of others)

Professionalism

Professionalism signifies a set of values, behaviours, conduct and relationships of how we ought to act, that mirrors a dentist's approach to clinical practice, and underpins the trust the public has in professionals.[8,12,21-27] Professionalism has been viewed as that quality of conduct and character that accompanies the use of superior knowledge, skills, judgment, and experience to the benefit of a patient,

prior to any consideration of self-interest.[12] The **Merriam-Webster** dictionary defines professionalism as *"the conduct, aims, or qualities that characterize or mark a profession or a professional person"; and it defines a profession as "a calling requiring specialized knowledge and often long and intensive academic preparation."* [4]

The core elements, characteristics and traits of professionalism[26,28] will vary between professionals depending on a person's personal values, behaviour and conduct, including that of others' individuals', (i.e.: colleagues, supervisors, patients, public), as well as institutional, professional organizations, and societal expectations how professionals should conduct themselves.[29] Contemporary professionalism in a culturally diverse society has moved beyond personal virtue to a collective commitment to patients, the public, and their health.[30] It is about demonstrating the values of the profession. *"A professional person must have a sense of responsibility and a degree of self-control regarding personal behaviour. Doing what is right - when the law requires it, as well as for ethical or moral reasons - should be a matter of personal pride for the professional person."* [31] Professionalism conflicts can arise when expectations and assumptions of behaviour differ during an interaction and/or situation with. *"Professionalism is simply about choices, and making the right ones, for the right reasons, no matter what stage in your professional career these decisions arise."* [32]

The core elements and characteristics of professionalism associated with a strong moral compass or high moral character are summarized in Table 1. [26,28] The core elements of professionalism are complimentary to ethical principles and moral values, guiding how dental professionals should interact with patients and conduct their business practices. Professionalism is a characteristic that needs to be earned, practiced and improved every day.

Best practice guidelines for Professionalism
Communication
- Assertiveness (Communicate in a confident manner.)
- Being honest (Speaking and acting truthfully - telling the truth, keeping one's word, or able to be trusted/adherence to the facts, and being forthright in interactions with patients, and peers.[32])
- Transparency (Being open, upfront, and honest in communications relating to treatments, their benefits and limitations, errors, costs and billing practices. [1,33])
- Collaboration/Cooperation/Teamwork (Working together

and communicating effectively with patients, and colleagues to achieve a common goal - the patients best interest. [33])

Capacity to Consent

Mental health conditions can sometimes impair cognitive function, making it difficult for patients to make informed decisions. It is therefore essential that DHCP assess the patient's capacity to understand and consent to treatment. If a patient lacks the capacity to consent, DHCP may need to involve legal guardians or healthcare proxies in the decision-making process while ensuring that the patient's best interests are prioritized.

Attitudes

- Trustworthiness (Being reliable, dependable and credible is considered the "cornerstone of the doctor-patient relationship".[34])
- Compassion (Listening attentively and showing empathy and kindness towards concerns of patients.)
- Accountability (Accepting responsibility and to be held accountable for your actions and mistakes, and to avoid letting self-interest override the patient's interest.[33,35] Hold yourself to the same clinical, moral and legal standards as others.)
- Respect (Treating others with respect and dignity - It's fundamental to ensuring that the care provided is not only effective, but also respectful and considerate of patients' rights for example privacy and confidentiality, and well-being.[1])
- Generosity (With time and kindness)

Conduct

- Integrity (Consistently doing the right thing – being committed to upholding the profession's Codes of Ethics, and to safeguard, influence, and promote the highest professional standards,[4,12,32] obeying laws and complying with regulations.[34])
- Excellence (Dedication and striving to achieve the highest standards of care through self-reflection, and continual self-improvement. [3, 33])
- Selflessness / Advocacy (altruism) (Putting the interests of one's patients over one's own interest.[33])
- Competence and Skilfulness (Achieving and maintaining a combination of knowledge, skills and experience that meets the requirement of appropriateness and acceptable standard, effectively and successfully.[36] Maintaining competence requires continual self-

assessment about the outcome of patient care, and involves a commitment to lifelong learning.[12,33])

- Continuing professional development (Life-long pursuit of, and a commitment to improvement of professional knowledge and skills[24], to strengthen clinical competencies, advance communication skills, enhance professional judgment, and to continuously improve quality of care (excellence), through self-reflection and continuing education activities.[24,28, 33]) CPD compliance is mandatory by law, for all health practitioners registered with the HPCSA to ensure quality and good health care provision, and protection of the public.
- Self-awareness (Knowledge of professional abilities and limitations - This includes recognition of the need for guidance or supervision, or referral to a specialist, when faced with complexed cases.)
- Appearance and behaviour (Presenting and behaving yourself in a professional manner - maintaining appropriate workplace hygiene, appearance, clothing, speaking,[16] being law-abiding, and of good character.[31])

Conclusions

Dentistry is a recognised profession, however, at the same time it is a business, whereby dentists employ their skills to earn a living. There is a potential conflict of interest between these two aspects of dentistry and maintaining an appropriate balance between patient, professional, and business interests. Resolving these conflicts demands a deep understanding of ethical principles, moral values and professionalism, coupled with practical strategies for ethical decision-making.

In a world where medical ethics are more scrutinized than ever, maintaining high ethical, moral and professional standards, thus upholding a strong moral compass, is indispensable for the success and sustainability of a dental practice. It is these standards that reassure patients of their safety and quality of care, building a foundation of trust and respect that is crucial to the therapeutic relationship between patient and dental practitioner.

Ethical principles, moral values and professionalism are complimentary to each other, guiding dental practitioners how to make ethical decisions and judgements, how to interact with patients and other individuals involved in daily practice, and how they ought to behave and conduct their clinical and business practices. The primary purpose of a moral compass, is to guide dental practitioners in providing

compassionate, effective, and ethical care. Upholding a strong moral compass not only upholds the integrity, trustworthiness, and competency of dental practitioners, but also fosters trust, respect, and compassion in doctor-patient relationships.

By upholding ethical principles, moral values and professionalism, dentists not only contribute to the health and well-being of their patients but also enhance the reputation and integrity of the dental profession and its status in society. Furthermore, a strong moral compass can lead to greater self-worth, increased happiness, better relationships, and greater success in practice and in life.

One's moral compass may change as we face new experiences in life, exposed to new technologies, gain knowledge, or cope with business hardships. Therefore, everyone's moral compass is unique and dynamic. This commitment to ethical excellence, moral values, and professionalism is not static but an ongoing process of growth and adaptation to new technologies, treatments, and societal expectations. Thus, continuously reflecting upon our personal values and beliefs, ethical principles and professional conduct is a professional responsibility that we all share. Dental practitioners are thus obligated to engage in continual professional development and to rigorously apply the ethical principles and professional standards that are at the heart of their practice. As professional people we must remain accountable not only for our adherence to the law but also for the ethical principles, moral values and professional behaviour that characterise our approach to dentistry and to the professional standards that we aspire to. Those practitioners whose attitudes, actions, and or conduct fall below the expected standard, dishonour not only themselves, but the profession as a whole.

References
The full list of References 1-39 is available in the References document

Navigating the bi-directional relationship between oral diseases and mental disorders – Clinical management implications and ethical considerations for dental practitioners

Johan Hartshorne

Keywords: Ethical considerations, global burden, oral health, mental health, oral diseases, mental disorders, bi-directional relationship, oral manifestations, risk factors, interventions.

Executive summary

Importance
- Oral disease has an impact on mental health, or conversely, mental disorders can affect oral health.
- Understanding the bi-directional relationship between oral and mental health is essential for ethical and integrated approach towards oral health care.

Key points
- Individuals with oral diseases and/or mental disorders share common risk factors.
- Individuals with mental disorders tend to have poor oral health, are more likely to present with decayed teeth and periodontal disease.
- Dry mouth is a common side-effect of many psychotropic medications.

Practice implications
- Coordinate and collaborate with primary care physicians and mental health care providers for a holistic approach to treatment planning and oral health care.
- Be aware of side-effects and drug interactions between medications used.
- Encourage oral hygiene measures and preventive dental care.
- The core of professionalism is a therapeutic relationship built on competent and compassionate care.

Background
Oral diseases and mental disorders are recognized global public health problems.[1,2,3,4,5] Although the relationship between oral and mental health has been controversial,[6] the global importance of oral health and mental health and their bi-directional relationship is underscored by their extensive impacts on overall health, quality of life, and social well-being.[7,8,9,10,11,12] Irrespectively, both oral health and mental health has long been neglected in the global health agenda and less attention has been given to the links between oral disease and mental disorders, and their reciprocal impact on each other is less understood.[6,13,14] Oral health care is an essential part of care for patients

with mental health disorders.[15] However, individuals with mental health problems generally have poor oral health, are often overlooked due to patients' lack of motivation, lack of awareness, poor economic status, phobias, and unwelcoming attitudes by dentists.[16]

Worldwide different treatment strategies are used in the dental treatment of patients with mental disabilities.[17] Furthermore, it has also been reported that currently insufficient evidence exists on the impact of oral health management on mental health.[6,11] Dentists may find treating patients with mental disorders challenging due to a lack of understanding and awareness in modifications of dental care delivery for individuals with special needs.[16] Also, polypharmacy is common amongst individuals with mental disorders, further complicating dental care while prescribing routine medications as potential drug interactions and side effects must be considered.

This is exacerbated by the longstanding separation of dental care from other health services.[18] As a result, people with severe mental disorders (SMD) are significantly less likely to visit a dentist than the general population,19 and if they do, they are less likely to be adherent with treatment recommendations.[20] Furthermore, dental professionals may also be unprepared to spend additional time in explaining the importance of oral health and making people with mental disorders feel comfortable.[18] It has also been suggested that avoidance and dismissive behaviours by dental staff may lead to stigmatization of people with mental disorders and further hinder optimal delivery of oral health care.[21,22]

In addition, the COVID-19 pandemic has had a profound impact on both oral health, mental health, and general well-being of people world-wide. The pandemic led to the temporary closure of many dental practices, significantly reducing access to routine and emergency dental care and resulting in disruption in dental services contributing towards deterioration in oral health.[23] Concurrently, the pandemic has precipitated a significant rise in mental health issues in both patient and provider.[24,25] due to fear of the virus, social isolation, economic uncertainty, and changes in daily routines.[26,27] In addition, the chronic stress induced by the pandemic led to various maladaptive coping mechanisms, such as increased alcohol and substance use, poor sleep patterns, and reduced physical activity, all of which negatively impact oral and mental health. [26,28] In addition, the prolonged social isolation and the lack of face-to-face interactions have been linked to increased feelings of loneliness and social anxiety.[29,30,31] This is especially pronounced among vulnerable populations, such as the elderly and those with pre-existing mental health conditions.

All these factors, individually and combined, has led to multiple clinical and ethical dilemmas.

Purpose

Although oral and mental health are both critical components of overall well-being and quality of life, their interconnection and impact on each is not well understood.[6,14] This review aims to explore the global burden of oral diseases and mental disorders and their bi-directional relationship. Understanding this relationship is essential for increasing awareness, developing holistic and ethical oral health care strategies, and encouraging better self-care and help-seeking behaviours, ultimately leading to better treatment outcomes, overall well-being and quality of life (QoL).

The global burden of oral disease

Oral diseases, such as dental caries, periodontal disease, and oral cancer, are among the most prevalent (ranking No.1) non-communicable diseases (NCD's) affecting approximately 3.5 billion people globally.[3,13,32] The combined estimated number of cases of oral diseases globally is approximately 1 billion higher than cases of all five main NCDs combined (mental disorders, cardiovascular disease, diabetes mellitus, chronic respiratory diseases and cancers).[32]

Although largely preventable, oral diseases, pose a major health burden and affect people throughout their lifetime,[13] causing pain, discomfort, and difficulty in chewing, swallowing, and speaking, and even death.[1] Oral diseases also impact on appearance negatively affecting confidence, social interactions, and relationships which are important determinants of general health, well-being, and QoL.[2,30]

Furthermore, the costs of treating oral diseases impose a major economic burden to the individuals affected and to public health care systems[2,13] primarily because oral diseases disproportionally affect poorer and marginalized groups.[13] Thus, vulnerable populations including individuals with mental disorders, often face greater challenges in accessing and affording dental care.[1]

The global burden of mental health disorders

Mental disorders are among the top ten leading causes of health care burden worldwide,[5,33] with more than 1 of 8 individuals globally living with a diagnosable mental disorder.[32,34] Mental disorders are categorized according to two primary classification systems namely the Diagnostic and Statistical Manual of Mental Disorders[35] and the International Classification of Diseases.[36] Both systems

Table 1: Impact of oral disease/disorders on mental health

Oral Disease/ Disorders	Shared risk factors	Oral manifestations	Mental health manifestations	Impact on mental health/well-being	References
Periodontal disease	Stress/ cortisol Smoking Alcohol Oral hygiene neglect Chronic systemic diseases Immune dysfunction/ deficiencies	High plaque index Halitosis Bleeding gums Tooth mobility Chronic pain Halitosis Tooth loss / Loss of function	Stress Low self-esteem Embarrassment Social withdrawal Reduced social interaction	Depression Anxiety Cognitive decline/ Dementia Reduced Quality of Life (QoL)	18,51,52,53,54
Dental caries	Dietary factors (sugar intake) Oral hygiene neglect Financial stress	Chronic pain/discomfort Halitosis Visible dental decay/ Aesthetics & Appearance	Self-consciousness Low self-esteem Stress Dental phobia	Social Anxiety Compromised QoL Avoidance behaviours Depression	7,53,55,56
TMJ Disorders	Stress Disrupted sleep/Apnea Compulsive disorder/ behaviour	Bruxism/clenching Chronic Oro-facial pain Jaw dysfunction Malocclusion & dental interferences Tooth wear/fractures	Insomnia /sleep disturbance Stress	Anxiety Depression Reduced QoL	57,58,59
Oral cancers & Oral infections	Alcohol Smoking Auto-immune Nutritional deficiencies Oral hygiene neglect Co-morbid systemic conditions	Chronic pain Oral infection Loss of teeth	Stress Fatigue Reduced motivation	Anxiety Depression	59,60

are designed to help clinicians diagnose and treat mental health conditions more effectively by providing standardized criteria and descriptions. The most common mental disorders seen are depression, anxiety disorders, and SMD such as schizophrenia, bipolar disorder, and dementia.[37,38]

Mental health disorders affect hundreds of millions of people worldwide[39] and depression alone the leading cause of "years lived with disability".[5,40,41] The new Global Burden of Disease analysis show that depression and anxiety are among the top causes of health loss worldwide, and has significantly increased due to the COVID-19 pandemic.[24,25] Mental health disorders, such as depression and anxiety, directly affect emotional stability, mood, and overall psychological well-being.[42]

Current evidence suggests that good mental health facilitates better interpersonal relationships, social support, community engagement, and improved QoL.[43,44,45] It has also been reported that mental health conditions can impair cognitive functions, including memory, attention, and decision-making, affecting work and daily activities and increased absenteeism.[46] It is suggested that the burden of mental illness in terms of both health and economic losses may be much higher than previously assessed.[47]

Mental health disorders are often comorbid with systemic health conditions. For example, depression is common among individuals with chronic diseases such as diabetes and cardiovascular disease, and it can worsen their prognosis.[48] The high rate of physical comorbidity, which often has poor clinical management, drastically reduces life expectancy for people with mental illness, and also increases the personal, social, and economic burden of mental illness across the lifespan.[4,49] People with SMD have up to 60% higher chances of dying prematurely due to preventable and treatable chronic systemic conditions.[40]

Bi-directional relationship between oral health and mental health

Oral health and mental health are an integral part of general health, sharing common pathways and affecting each other in a bi-directional fashion that involve complex interconnected biological, social, psychological, and behavioural, processes.[15,20] This means that poor oral health can contribute directly towards, or exacerbate existing mental health issues, or conversely, mental health disorders can lead to, or exacerbate oral diseases. Currently, no causal relationship has yet been proved.[50]

Impact of oral diseases on mental health

Several oral health conditions have been associated with poor mental health. Oral diseases, shared risk factors, manifestations and their impact on mental well-being is summarized in Table 1. The number one oral health factor that has a significant impact on mental health is periodontal disease.[51] Patients with periodontal disease had almost a two-fold likelihood of developing depression over the following 5-11 years.[61] The evidence supporting the bi-directional relationship between both periodontal disease and tooth loss with cognitive decline is growing and continues to highlight the importance of overall oral health and preventative care.[62]

Dental aesthetics and appearance play a significant role in self-perception and social interactions. Poor oral health manifested through, neglected (i.e., visible decay), missing or discoloured teeth, and halitosis, can negatively affect self-esteem and body image, social interaction, potentially contributing to social anxiety and avoidance behaviours, particularly among individuals with mental disorders. This, in turn, affects an individual's ability to interact socially and maintain relationships, contributing to feelings of isolation and depression.[18,51,52,53,54, 55,56] It is also reported that tooth loss is positively associated with an increased risk of dementia in adults.[63,64]

The impact of mental disorders on oral health

The relationship between mental disorders and oral health is well-documented, revealing a significant impact of mental health conditions on oral health outcomes.[7] Mental disorders, shared risk factors, manifestations and their impact on oral health is summarized in Table 2. Oral diseases in individuals with mental illnesses are mostly associated with adverse side effects of the psychotropic medications,[38,69] lack of motivation or ability (i.e., cognitive impairment) to maintain good oral hygiene, lifestyle factors (e.g., eating disorders, alcohol, tobacco, and other substance use), difficulty to access health services, and a lack of cooperation in dental treatments,[3,10,20,37] leading to increased incidence of dental caries, periodontal disease, and tooth loss.[20,65]

Antipsychotic medications used by patients with schizophrenia or bipolar disorder, and use of antidepressants and anxiolytics by patients with depression and anxiety often cause dry mouth and other side effects that increase the risk of dental and periodontal problems.[60,66,67]

Brain-stomatognathic axis and its biomechanisms

The brain-stomatognathic (BS) connection refers to a complex multifaceted bi-directional relationship between the brain (central nervous system) and the stomatognathic system, which includes the structures involved in mastication, (chewing), speech, and swallowing.[14,15] This connection is maintained through intricate neural pathways and influenced by biological (inflammatory process, neurotransmitter imbalance, and microbiome dysbiosis) [80,81], psychological, behavioural and life style, and socio-economic risk factors.[3,13,15,18] Understanding the BS axis is crucial for diagnosing and treating various conditions affecting oral-, mental-, and overall well-being and highlights the importance of integrated healthcare approaches.

Microbiome imbalance

Emerging evidence suggests a potential link between the oral microbiome and mental health.[77,78,79,80] It is suggested that disruptions in oral microbiota composition (dysbiosis) possibly influence mental health through inflammatory pathways and neurotransmitter production.[80,81] The presence of periodontal pathogens and their byproducts within the bloodstream and CNS can have detrimental effects on the brain by stimulating the body's neuroinflammatory response.[79, 81]

Inflammatory processes

Chronic systemic inflammation is a common factor linking periodontal disease and mental health disorders such as anxiety, depression and schizophrenia,[82,83,84] and is often indicated by elevated levels of pro-inflammatory cytokines mediated by lipopolysaccharides from the outer membrane of associated gram-negative bacteria.[20,85,86,87] These cytokines can cross the blood-brain barrier and influence brain function, contributing to the development or exacerbation of mental health conditions like depression and anxiety. Exosomes from cells, which act as mediators of intercellular communication, may also play a role in transmitting inflammation from the oral cavity to the central nervous system (CNS) thereby affecting function and behaviour.[78,88]

Neurotransmitter Imbalance

Neurotransmitters like serotonin and dopamine are involved in both mental health and oral health and play an important role in mood regulation and pain perception. It is suggested that dysbiosis of the oral and gut microbiome can impact on neurotransmitters including serotonin, dopamine, availability, contributing to mental disorders like depression.[89] Furthermore, imbalances in neurotransmitters associated

with depression also play a role in pain perception and inflammation. Oral inflammation and infection can alter the production and function of these neurotransmitters, influencing mood and anxiety levels.[79] Chronic persistent pain can also alter pain perception pathways in the brain, leading to heightened sensitivity and emotional distress.[79]

Immune dysregulation

Psychosocial stress may be a common contributor to both chronic oral and non-oral diseases.[90,91] Chronic stress and mental health disorders can dysregulate the hypothalamic-pituitary-adrenal axis (HPA axis), leading to increased cortisol production.[59,90,91] Elevated cortisol levels can impair immune function, reducing the body's ability to fight off infections, including oral infections and periodontal disease, thus exacerbating oral health problems.[59] Conversely, oral pain and discomfort can activate the stress response, further disrupting the HPA axis.[90]

Ethical considerations

Oral/Dental health care providers (DHCP) face several ethical considerations when dealing with patients with mental health problems. The 4 main ethical principles that need consideration are beneficence, nonmaleficence, autonomy, and justice.[92] Addressing these ethical challenges requires sensitivity, understanding, and adherence to professional guidelines.

Autonomy and Informed Consent

Autonomy is defined by the right to self-determination and respects the individual's right to make informed decisions. Informed consent, truth-telling, and confidentiality arise from the principle of autonomy.

Capacity to Consent

Mental health conditions can sometimes impair cognitive function, making it difficult for patients to make informed decisions. It is therefore essential that DHCP assess the patient's capacity to understand and consent to treatment. If a patient lacks the capacity to consent, DHCP may need to involve legal guardians or healthcare proxies in the decision-making process while ensuring that the patient's best interests are prioritized.

- Clear Communication

DHCP should provide information in a clear, truthful and straightforward manner, avoiding medical jargon that might confuse patients with cognitive impairments or anxiety.

Repeating information and checking for understanding will encourage full participation in treatment decisions, and will also help ensure that patients are making informed decisions about their care.

Confidentiality and Privacy Concerns

DHCP must handle sensitive information about a patient's mental health with confidentiality. This includes information disclosed during dental visits that may pertain to the patient's psychological state or mental health history. Sharing patient information with other healthcare providers should be done only with the patient's consent or if legally required, ensuring that only relevant information is disclosed.

Non-Maleficence and Beneficence

Beneficence is defined as acting in the best interest of the individual thus providing benefit. Non-maleficence on the other hand means avoiding and doing no harm to the individual. Compassion, a prelude to caring presupposes sympathy, is expressed in beneficence.[93] It is critical not take advantage of patients by deception or coercion and not treat beyond the scope of one's competence.

Providing Appropriate Care

DHCP should not recommend treatments or radiographic examinations or tests that have no therapeutic benefit for the patient, or increase the risk of harm to the patient relative to the expected benefit. Oral health care providers must avoid treatments that could harm patients, particularly those with mental health conditions that might make them more vulnerable to anxiety, stress or pain. Creating a supportive and non-judgmental environment can help reduce anxiety and improve the patient's overall experience. It is considered appropriate to decline to treat a patient who exhibits behaviours that will impede good outcome and to refer to an appropriate provider that has the necessary skills. Behaviour management techniques and sedation are frequently used.[17]

Holistic Care

Consider the patient's overall health, including mental health, when developing treatment plans. The goal of treatment should always be – to promote general health and well-being of patients. This might involve adjusting dental treatments to accommodate the patient's psychological state or working with mental health professionals to manage the patient's care. Dentists should always collaborate with colleagues and specialists in a manner that can enhance patient care.

Table 2: Impact of mental illness/disorders on oral health

Mental disorders	Shared risk factors	Mental illness manifestations	Oral manifestations	Impact on oral health	References
Depression Anxiety	Financial stress Fear Antidepressants Anxiolytics Comorbid systemic conditions Stress	Feeling of hopelessness Loss of interest in personal care Lack of motivation Heightened alert Asking many questions Fatigue Stress Harmful behaviours (alcohol, smoking) Poor dietary choices	Poor oral hygiene Bruxism and teeth clenching -Tooth wear and fractures Medication side effects – Xerostomia Dental phobia Burning mouth syndrome	Oral health neglect Periodontal disease Dental caries Tooth loss TMJ disorders Reduced QoL Dental avoidance behaviour Chronic pain	3,20,37,60,61, 65,66,67,68, 69,75,76
Severe mental illnesses: Schizophrenia Bipolar disorder Psychosis	Mood stabilizers Antipsychotic medication Psychotropic medication Opiates Methadone Comorbid systemic conditions	Disorganized though Disorganized behaviour Selfcare deficits Mood changes Apathy Lack of motivation Tardive dyskinesia Cognitive impairment Dental phobia	Xerostomia (medication side-effects) Oral hygiene neglect Trauma to oral tissues Loss of teeth Bruxism	Poor oral health, Dental caries Periodontal disease Gingival hyperplasia Oral infections Abnormal flavour perception Excessive tooth wear TMJ disorders	3,20,37,38,55, 60,65,66,67,69, 71,76
Eating disorders: Bulimia Anorexia nervosa	Nutritional deficiencies Mental health issues Stress Comorbid systemic conditions	Shame Guilt Body image issues Obsessive compulsive beha-viour Anxiety	Dental erosion/ tooth wear Increased sensitivity Dental caries Dental avoidance behaviour	Poor oral health Dental aesthetics issues Pain and discomfort Poor QoL	72,73
Substance use: Methamphetamine Cocaine Alcohol	Comorbid systemic conditions Stress Comorbid mental disorders	Apathy Unhealthy dietary habits Cognitive impairment	Oral health neglect Tooth loss Chronic pain Xerostomia	Poor oral health Exacerbate dental caries, periodontal disease, oral infections, oral cancers	3,18,20,61,65, 70,74,75

Professionalism

The core of professionalism is a therapeutic relationship built on competent and compassionate care by a clinician that meets the expectations and benefits a patient.[93] In this relationship, which is rooted in the ethical principles of beneficence and nonmaleficence the DHCP is required to fulfill their professional obligations including: (i) prevent oral disease; (ii) promote oral health; (iii) treat and cure disease; (iv) educate and council patients; (v) avoid harm to patients in the course of their care; and (vi) maintain competency. Professionalism demands placing the interest of patients above those of the provider, setting and maintaining standards of competence and integrity, and providing expert advice to society on matters of health.[96] In all interactions with patients, besides clinical and technical competence of a clinician, the human element of caring (one human to another) is needed. In different situations, caring can be expressed verbally and non-verbally (e.g., the manner of communication with both clinician and patient closely seated, and with unhurried, softly spoken words); a gentle touch especially when conveying "bad news"; and a firmer touch or grip to convey reassurance to a patient facing a difficult treatment choice.

Justice and Fair Treatment

Justice is generally interpreted as fair, equitable, and appropriate treatment of persons.[93]

Access to Care

Individuals with mental health disorders may face barriers in accessing regular dental care due to financial constraints, transportation issues, fear or anxiety related to dental visits, or stigma associated with seeking healthcare.[18, 38] Stigma and discrimination further exacerbate these disparities, leading to underdiagnosis and undertreatment,[22,94,95] leading to an increased risk in caries and periodontal disease.[38] Strategies

to improve mental health care access and reduce stigma are essential for addressing these disparities and improving overall mental health outcomes globally.[22,95]

DHCP should provide non-discriminatory and equitable care to all patients, regardless of their mental health status, ensuring that patients with mental health conditions have the same access to dental services and the same quality of care as other patients.

Fairness

Making reasonable accommodations for patients with mental health issues, such as scheduling longer appointments or providing a quiet space, can help ensure fair treatment. Increased social awareness accompanied by positive experiences characterized by empathy, reassurance and shared decision-making, are suggested to be empowering for patients.[95]

Interventions to address oral diseases in patients with mental disorders

Oral diseases and mental disorders are an expanding threat, which requires raised awareness, education, prevention, and treatment initiatives nationally and globally.[15,97] Dealing with their combined impact through integrated and preventive care approaches, and targeted interventions can lead to significant improvements in health outcomes and quality of life.[38,97] Additionally, taking into consideration shared risk factors (Table 1 & 2), can enhance the relevance and success of interventions.[98]

By considering the following treatment strategies, DHCP can provide more empathetic and effective care, ensuring a positive experience for patients with mental disorders.

Assessment of medical and dental history

Prior to beginning dental treatment, the clinician should establish good rapport with the patient, carer or legal guardian, and take a thorough medical history, including medications and comorbid conditions that might impact on oral and mental health.[20] The clinician should be non-judgemental, which can allow for more information to be disclose.[38]

Clinical assessment

Assess the stability of the patient's. If the patient is experiencing symptoms this may be a sign that he/she is not being managed effectively or they are not adhering to their medications. Record all medications and be aware of possible oral side-effects and interactions. The commonly used psychotropic medications to treat patients with

psychiatric illnesses such as selective serotonin reuptake inhibitor, tricyclic antidepressants, antidepressants, and benzodiazepines frequently exhibit oral manifestations that promote oral diseases.[38,99] Dental practitioners should be aware of these potential manifestations and work closely with mental health care providers to manage the oral health and well-being of these patients effectively.

The oral cavity is also linked to potential physical manifestations of psychological origin. Oral symptoms such as facial pain, oral dysaesthesia, extreme palatal erosion, or self-inflicted harm are perhaps the first or sole signs of mental health issues.[100] Dental practitioners should be able to recognize these changes early in the course of the condition and provide appropriate treatment or collaborate with psychiatrists to make necessary modifications in the prescriptions.[99]

Establish an individualized oral care plan

Promoting good oral hygiene is of critical importance, therefor, a customized oral hygiene plan that accommodates the patient's unique needs and preferences, considering factors such as dexterity, mobility, and cognitive function should be established. Be flexible with appointment lengths and frequency based on the patient's ability to cope.

Providing education and training on proper oral hygiene techniques and the importance of diet can significantly reduce the risk of dental problems such as dental cavities and gum disease. Use clear, simple language and visual aids and allow extra time for explanations and for answering questions. Promoting oral hygiene and regular dental check-ups among individuals with mental health disorders can help prevent oral health complications and improve overall well-being.

Adaptive Tools and Techniques

Managing oral hygiene in patients with physical and cognitive disabilities requires a tailored approach to address the unique challenges they may face.[20] Promote the use of ultrasonic (Smart) toothbrushes with larger and extended, or angled handles for easier grip and for more effective removal of biofilm and oral hygiene. Their superior plaque removal capabilities, ease of use, and smart features enhance oral hygiene, while their role in establishing routines, boosting self-esteem, reducing dental anxiety, and promoting mindfulness can positively impact mental well-being. Consider preventive measures such as use of fluoride and antimicrobial tooth pastes and/or mouth rinses, fluoride treatments, sealants to reduce the risk of dental problems.

Positioning and Environment

DHCP need to be aware of, and manage several practical implications when treating patients with mental disorders.[20] Ensure the patient is in a comfortable and stable position during oral care. Minimize bright lights, loud noises, and strong smells to limit sensory sensitivity.

Caregiver and family Involvement

Some patients have to rely on caregivers or family to get access to oral health care facilities. Provide education and training for caregivers or family members on proper oral hygiene techniques and the use of adaptive tools to assist individuals with mental disorders.[20] Establish a consistent oral care routine that fits into the patient's daily schedule. Social support networks (family members) can influence health behaviours, including those related to oral health, by providing emotional and practical support.[20]

Addressing specific needs

It is important to be aware of the many interactions and side effects of the drugs used for the treatment of these patients. It is advisable for the dentist to contact the treating psychiatrist before initiating any medications.[37] Monitoring for medication side effects such as dry mouth is essential for maintaining oral health.[67] Prevention of oral mucosal and dental implications of dry mouth should be addressed by avoidance of caffeinated beverages, smoking cessation, advice on taking frequent sips of water throughout the day for adequate hydration, the use of artificial oral lubricants, (i.e., Biotene) saliva substitutes or saliva stimulants (i.e. sugarless gum with Xylitol) to help improve salivary flow.[37,67] Chlorhexidine rinses or gel can be used to assist with plaque control to help prevent periodontal disease. Fluoride rinses can also be used to prevent caries. Patients should be advised to limit sweetened beverages. Advise on a balanced diet that minimizes sugary and acidic foods to prevent decay and erosion. Patients should have frequent recalls to monitor their oral health and to ensure the preventive measures are effective at suppressing the progression of oral diseases.[38]

Manage behavioural and lifestyle Issues

Fear of going to the dentist is a common condition seen in patients with mental disorders with a prevalence oscillating between 6 and 20%, independent from culture and country, and is more frequent in females.[37] The most frequent fears regarding dentist consults are fear of the noise of the equipment, the vibrations in the mouth, and the needles.[37]

Implementing desensitization techniques through gradual introduction to dental tools and procedures, use of positive reinforcement, and a calm, supportive demeanor is suggested to manage behavioural issues.[101] Use techniques like deep breathing, calming music, or a weighted blanket to comfort the patient. Consider mild oral sedation or anaesthesia for highly anxious patients. Schedule appointments consistently at the same time of day to maintain routine. Send pre-visit information to familiarize the patient with what to expect.

Lifestyle issues should also incorporate smoking cessation, dietary and nutritional advice and stress reduction techniques, as they have synergistic effects on both oral and mental health.[20] Collaborate with a psychologist or behavioural therapist and involve caregivers to assist with lifestyle issues and to address the management of severe behavioural challenges during dental visits.

Collaboration with Other Healthcare Providers

An integrated care approach that involves collaborative efforts between DHCP and psychiatrists, psychologists, behavioural therapists, physical therapists, and primary care physicians, are crucial for addressing the complex interplay between oral health and mental health disorders, and to facilitate a holistic approach towards preventive, restorative and rehabilitative treatment planning that can improve outcomes for patients with both oral and mental health concerns.[12,15,20,38,71,97,102]

Public Health Strategies

Increasing education and awareness about the link between mental health and oral health can encourage better self-care and help-seeking behaviours. Interventions should include interdisciplinary education and training, improved communication, and strategies to reduce financial barriers and anxiety in dental practice.[98] Enhancing access to dental and mental health services, particularly for vulnerable populations, is essential for improving health outcomes. Regular dental check-ups and mental health screenings can help identify and address issues early.

Conclusions

The global importance of oral health and mental health is underscored by their extensive impacts on individual health, public health, economic productivity, and social well-being and QoL. Concurrently, the COVID-19 pandemic has precipitated a significant rise in mental health issues, including anxiety, depression, and chronic stress that has had a profound impact on both oral health and mental health world-wide.

Mental health disorders can negatively impact oral health, while poor oral health can exacerbate mental health issues through interplay of various biological, psychological, behavioural and social mechanisms. The complex bidirectional relationship between oral health and mental health emphasizes the need for integrated care approaches that address both aspects to improve overall well-being and QoL. Patients with mental disorders are generally more susceptible to dental cavities and periodontal disease due lack of motivation, poor oral hygiene, fear of visiting the dentist, difficulty to access health services, and adverse effects of medications, mainly xerostomia.

Effective management of oral and mental health requires a combination of reviewing medical and medication history, regular dental care, good oral hygiene practices, healthy lifestyle choices, stress reduction techniques, and professional oral and mental health support. Collaboration between dental care providers, mental health professionals, caregivers, and patients themselves is key to optimizing outcomes and promoting overall well-being. In all interactions with patients, besides the clinical and technical competence, the human element of caring is most needed. Overall good oral health will boost self-esteem and confidence, prevent dental pain and discomfort, reduce stress and anxiety, enhance social interactions, improved sleep quality, reduce the risk of systemic health issues, and promote a sense of well-being.

While more research is needed to fully understand the mechanisms and causal relationships between oral health and mental health, the existing evidence supports the notion that maintaining good oral health is important not only for physical health but also for psychological well-being. Integrated approaches to healthcare that consider both oral health and mental health are increasingly recognized as essential.

References

The full list of references 1-102 is available in the references document

Duties, responsibilities and obligations to patients, colleagues, society, and self

Johan Hartshorne

Keywords: Duties, obligations, responsibilities, rights, ethics, legal, dental practitioners, self-care, social responsibilities, patient care, public health, professional responsibilities.

Executive summary

Importance

This review explores the ethical, moral and legal duties that dental practitioners have in four key areas: to patients, society, colleagues (and the profession), and themselves.

Key points

- A dental practitioner's primary professional duty is to serve the patients best interests and well-being.
- Open communication where patients feel heard and understood is crucial.
- Involve patients in the treatment planning process and respect their choices.
- Be upfront about the cost, benefits and limitations of treatments.
- Protect the confidentiality and privacy of patients' information.
- Engage in continuous professional development to enhance knowledge and skills and to stay current with advancements in best dental practices and technologies.
- Consult and cooperate with other members of the dental team or healthcare professionals to promote patients best interests.
- Uphold an appropriate standard of conduct to maintain the public's trust and confidence and to protect the good reputation of the profession

Practice implications

- Informed consent and confidentiality are foundational elements of ethical dental practice, and ensuring trust in the dentist-patient relationship.
- You must hold appropriate professional indemnity cover (insurance).
- Discuss fees and provide written estimates beforehand.
- Regular self-assessment and reflecting on ones practice, continually striving for personal and professional growth.
- Engage in lifelong learning, staying current with advancements in technology, techniques, and best practices.
- Prioritizing self-care to avoid burnout and to preserve mental well-being.

Background

"Being registered under the Health Professions Act No. 56 of 1974, gives healthcare

practitioners certain authority and privileges. In return, they have a duty to meet the standards of competence, care and conduct set by the health professions Council of South Africa and its Professional Boards." [1] A dental practitioner's primary professional duty is to "regard concern for the best interests or well-being of their patients"[2] However, the importance of their obligations, duties, and responsibilities extends beyond the patient and technical aspects of dental care, and touches on broader ethical, legal, social, professional, institutional, and personal dimensions relating to patients, public, peers and selfcare.

The terms 'obligations', 'duties', and 'responsibilities', are words frequently used interchangeably in everyday language because they refer to commitments or tasks that individuals are expected to fulfil.[3] In certain contexts, especially within legal and philosophical discussions, there can be subtle distinctions and nuances between the three terms.[3] Obligations are legally or ethically mandated actions or requirements that must be followed. A duty on the other hand is often more general and broader in scope than an obligation, and comes from a sense of morality or ethical principles which guide an individual to perform a particular task, function, or action that is considered right. Responsibilities encompass a broader accountability, not just for performing tasks, but also for ensuring quality care, patient safety, accurate diagnoses, maintaining hygiene standards, and promoting oral health education. In this review the terms 'duty', 'obligation' and 'responsibility' will be used synonymously referring to the ethical, moral and legal duties that dental practitioners have toward their patients, colleagues, profession, society and themselves. Maintaining these duties has become increasingly important as dentists in many countries are experiencing great frustration in practising their profession, whether because of limited resources, increased competition and business pressures, government and/or corporate micro-management of health care delivery, rapid integration of new technologies, sensationalist media reports of dental errors and unethical conduct, or challenges to their authority and skills by patients and other health care providers.[4] The constant change affecting both the dental profession and the public necessitates regular evaluation and reflection of professional duties of dentists and the rights of patients in meeting the challenges in the future.[5]

Purpose

This review explores the ethical, moral and legal duties that dental practitioners have in four key areas: to patients, society, colleagues (and the profession), and themselves. Understanding the basic duties and their challenges will ensure that dental practitioners go above and beyond upholding the principle of 'patient first', but also promoting and upholding the well-being of society and self, and the dignity and reputation of the profession.

I. Duties to Patients

A dental practitioner holds a critical position in the healthcare ecosystem, responsible for ensuring the overall oral health and well-being of patients. The overall aim of 'duty to patients' is to provide a standard of care that ensures their patients' best interest, safety, and well-being, covering a wide range of practices to protect patients from harm, and respecting a patients right to self-determination, privacy, and fairness.[5]

Patient care and serving the patients' best interests

A dental practitioner's primary professional duty is to serve the patients best interests and well-being.[5,6] This duty involves: (i) providing competent high-quality care; (ii) diagnosing conditions accurately, recommending and providing appropriate and fair treatment; (iii) preventing oral/dental disease; (iv) promoting oral health; (v) ensuring patient safety and comfort; and (vi) upholding informed consent and confidentiality.[5] The rationale behind these duties is rooted in the ethical principles of beneficence (doing good / what is best for the patient), non-maleficence ("do no harm"), autonomy (patients right to make decisions regarding his/her treatment), and fairness.

Compliance with infection control and environmental safety standards

Compliance with appropriate safety requirements and infection control standard of care is an ethical obligation and is at the core and key to quality care and excellence in dentistry. Your dental surgery should always meet modern health and safety requirements, including easily accessible facilities, properly staffed, and services provided under acceptable professional standards. All equipment and instrumentation should be sterilised and packed appropriately. Rigorous infection control measures should also be implemented.

Informed consent and effective communication

A dental practitioner has an ethical and legal duty to obtain valid informed consent from a patient before starting

treatment or physical investigation.[6,7] Dentists' therefore have an ethical duty to provide patients with sufficient and appropriate information in a manner that they can understand, to enable them to exercise their right to make informed decisions about their treatment.[6] This involves clear and effective communication about (i) diagnosis of conditions and their implications; (ii) explaining treatment options, including that of 'no treatment'; (iii) their benefits, potential risks, and limitations, including the cost of treatment options; (iv) explain the clinical reasons behind their recommendations and consider patient preferences and concerns to find mutually acceptable solutions, enabling patients to give voluntary informed consent, without any coercion, manipulation, misrepresentation, before carrying out any treatment.[8] For an individual to make a valid informed consent decision, capacity (absence of mental/cognitive impairment) or competence is a prerequisite.[9]

The rationale behind the duty of informed consent/refusal is rooted in the ethical principles autonomy (patients right to self-determination). Respecting patient autonomy is also the foundation for establishing a trustworthy relationship.[6,7,10,11] This collaborative approach not only respects patient autonomy but also helps align their expectations with realistic clinical outcomes.

Promoting general health and well-being

Oral health is intricately connected to general health and well-being. Conditions such as heart disease, diabetes, rheumatoid arthritis, Alzheimer's Disease, and other chronic systemic diseases are often linked to poor dental hygiene and periodontal disease. Chronic systemic diseases, mental health disorders, stress related disorders, sleep deprivation, and oral cancers directly impacts a patient's quality of life and longevity. Dental practitioners can contribute towards patients' general health and well-being, including their mental health by means of: (i) educating patients on the link between poor oral hygiene and systemic diseases; (ii) oral cancer screening; and (iii) advising patients on nutrition, diet, lifestyle behaviour (i.e., smoking, alcohol, sleep, exercise). The rationale behind the duty of promoting general health and well-being is rooted in the ethical principle beneficence (doing good).[6]

Disclosure of adverse events

A dental practitioner has an ethical duty to: (i) disclose adverse events to patients that may occur during treatment (e.g., separated endodontic file), or as soon as possible afterwards; (ii) the nature and possible consequences of the adverse event; (iii) taking the necessary steps to address any harm caused to the patient, including advising on, or arranging for, further treatment or care if it is required; (iv) responding openly, honestly and professionally to any questions from a patient, or where appropriate, a parent, guardian or carer, in language and terms they can understand; and (v) recording the details of the adverse event in the patient's records, including information regarding communications with the patient and with third parties, such as parents or carers. The rationale behind the duty of disclosure of adverse events is rooted in the ethical principles beneficence (doing good), non-maleficence (do no harm), and fairness.[6]

Availability and emergency care

A dentist should be available, within reason, to address acute dental conditions (e.g., pain) of his/her patients as soon as possible. A person with an emergency condition should be examined and either treated or referred for treatment. In such situations, the patient's health and comfort must be the dentist's primary concern, not compensation or convenience. If a dentist cannot accommodate the patient's emergent needs, a reasonable effort should be made to have the patient seen in a timely manner by someone capable of treating the condition.[12] Dental practitioners are also responsible for making necessary arrangements for patients to access alternative care when they are not available (i.e., on sick leave or holiday).

Record keeping

A dental practitioner has a duty to keep a complete record of any consultations and treatment procedures carried out, documenting all aspects of patient care. The purpose of keeping health records are: to keep track of clinical findings; treatment completed, ensure continuation of care; and to provide evidence of the standard of care.[13] Compulsory elements of a patients record are: (i) personal details; (ii) medical and dental history; (iii) time and date of consultation/treatment; (iv) proposed management; (iv) medication and dosage prescribed; (v) referral details; (v) patients response to treatment; (vi) investigations ordered and their results, including radiographic assessments; and (vii) written proof of informed consent.[13] A patients record should comply with the following principles: contemporaneous; integrity; attributable; accessible ; and securely stored to ensure confidentiality and privacy.[13]

According to the HPCSA guidelines on the retention of

medical records: Records should be kept for at least six years after they become dormant. The records of minors should be kept until their 21st birthday. The records of patients who are mentally impaired should be kept until the patient's death.[13]

Confidentiality / Privacy of personal information

Dental practitioners hold information about patients that is private and sensitive. They therefor have a legal and ethical duty to safeguard the privacy of patients' personal and medical information, that protects the patient's rights and promotes trust in the practitioner-patient relationship. The National Health Act (No.61 of 2003) states that all patients have a right to confidentiality, and this is consistent with the right to privacy in the South African Constitution. Confidentiality and privacy is central to trust between healthcare practitioners and patient. The National Health Act provides that personal information must not be given to other unless the patient consents, or the healthcare practitioners can justify disclosure of information concerning them.[1] Dental practitioners should make sure that patients are aware that personal information about them will be shared within the healthcare team (i.e., specialist and laboratory technicians, medical aid) - and patients must be told the reasons for this. Make sure that the patient understands what information will be disclosed / shared and to whom.

Dental practitioners may only disclose information regarding a patient in the following circumstances: (i) if it is done in terms of a statutory provision; (ii) an instruction of court; (iii) in the public interest; (iv) with the express consent of a patient; (v) with a written consent of a parent or guardian of a minor under the age of 12 years; (vi) or in the case of a deceased patient, with the written consent of the next of kin or the executor of the deceased estate.[1] According the Protection of Personal information Act No.4 of 2013 (also referred to as the POPI Act), dental practitioners and companies are legally required to carefully manage data capture, storage processes, and disclosing and communicating personal information to other stakeholders (i.e., healthcare practitioners, laboratory technicians, medical aids, and referral to specialists). The purpose of the POPI Act, a privacy law that safeguards the integrity and sensitivity of personal/private information, is to provide for the rights of persons regarding unsolicited electronic communication and automated decision-making, and to regulate the flow of personal information.

Dental practitioners have the following responsibilities regarding communication and safeguarding privacy and disclosure of personal information: (i) accountability for ensuring POPIA compliance; (ii) personal information must only be collected for a specific purpose; (iii) further processing must be compatible with the original purpose of the collection of information; (iv) steps must be taken to ensure that personal information records are complete, accurate and up to date; (v) disclose only certain information to specific data subjects; (vi) ensure that appropriate, reasonable and organisational measures and safe-guards are implemented and maintained to prevent loss, damage or unauthorised destruction or unlawful use or access to personal information, and (vii) data subjects (patient) have the right to request personal information that a responsible party (dental practitioner) holds about them and in circumstances request access to such information. Dental practitioners are also responsible for ensuring that receptionists, assistants and other staff respect confidentiality in the performance of their duties.

Continuing Professional development and updating competence

Dentists have a duty to maintain technical competence, stay updated with the latest advancements in knowledge, and adopt evidence-based practices and skills, to offer the best possible standard of care. The ethical practice of the health profession requires consistent ongoing commitment to lifelong learning by all health practitioners through a process of Continuous Professional development (CPD). The Health Professions Act , 1974 (Act No.56 of 1974) endorses CPD as the means for maintaining and updating professional competence.[14]

All registered health practitioners are required to complete accredited continuing education activities annually. Health Practitioners may select activities at any level of learning that meet their particular needs and the demands of their practice environment.[14] A dentist is required to engage in CPD and accumulate a total of 30 continuing education units (CEUs) per 12 month period of which 5 CEUs should be for ethics, human rights and health law. All CEUs are valid for a period of 24 months from the date that the activity took place/ended.[14]

"Practitioners may obtain the CEUs within their own discipline, speciality or subspeciality or within another relevant discipline, speciality or sub-speciality that is relevant to their own professional practice." [14]

Issuance of a CPD certificate is no longer mandatory. CPD providers will provide attendance information to the

HPCSA for every activity that a dental practitioner has attended. South African healthcare practitioners attending accredited professional meetings or activities internationally, will be recognised for CPD purposes.

Dental practitioners who are not compliant with CPD requirements may be subjected to the following actions: (i) changing the category of their registration to supervised practice, until proof of compliance with CPD requirements are submitted; (ii) suspension from the Register until submission of proof of compliance with CPD requirements is submitted; (iii) successfully passing a Board Examination; or (iv) any other resolution by the relevant Professional Board.[14]

Ensure continuity of care and avoid patient abandonment

Dental practitioners must approach ending a professional relationship with patients ethically, ensuring continuity of care during transition periods. To avoid patient abandonment, dentists should: (i) provide adequate notice to the patient if the dentist intends to discontinue treatment or retire; (ii) offer assistance in finding a new dental provider and transferring patient records if needed; and (iii) ensure that the patient's immediate oral health needs are addressed before the transition.

II. Duties to colleagues, peers, and other health care practitioners

With the rapid growth in scientific knowledge and its clinical applications, dentistry has become increasingly complex and integral part of the health ecosystem. Individual dentists cannot possibly be experts in all their patients' oral diseases and potential treatments and they need the assistance of other members of the dental healthcare team, including specialists, oral hygienists and laboratory technicians and other healthcare professionals such as medical specialists, pharmacists and speech therapists.

Collaboration and professionalism with other healthcare providers

Harmonious and effective teamwork is essential to provide patients with the best care. A dental practitioner's responsibilities to colleagues, other healthcare practitioners, as well staff members, include fostering a collaborative and respectful work environment. In professional relationships, dentists must uphold the principles of justice, ensuring that they treat colleagues and other members of the healthcare team, fairly, respect professional boundaries, and contribute to a positive and ethical work environment.[12] To foster

ethical collaborations and to ensure the highest standard of patient care, dental practitioners should: (i) maintain open communication and mutual respect when consulting or collaborating with other healthcare professionals; (ii) ensure that patient referrals are based on clinical needs and not influenced by financial incentives; (iii) respect the scope of practice of other healthcare providers and avoid encroaching on their expertise; (iv) respect differing opinions and engage in constructive dialogue; and (v) accept and support professional development and mentorship among peers.[4]

Referring patients to specialists with patient's best interest in mind

The FDI International Code of Dental Ethics states that dentists "*should refer for advice and/or treatment for any patient requiring a level of competence beyond that held.*"[4] Referring patients to specialists should prioritize the patient's well-being and align with their treatment needs. To make referrals ethically, dental practitioners have the following duties: (i) timely and accurate referrals to other healthcare professionals when patients require specialized care; (ii) discuss the reason for the referral with the patient and explain the benefits of seeing a specialist; (iii) provide the specialist with relevant patient information and treatment history to ensure continuity of care; (iv) communicate with the patient and specialist to coordinate treatment plans and follow-up care; and (v) document all relevant information regarding referrals.

Confidentiality and sharing of patient information

Sharing of information about a patient with members of a health care team providing a health service to a patient (e.g., specialist) would be permissible to the extent that: (i) it is necessary to enhance quality of care to be provided to the patient; and (ii) the patient has given consent to treatment and disclosure of such information to another healthcare practitioner.[6,9]

Reporting unethical behaviour, misconduct, and violations of patient rights

Dentistry has traditionally taken pride in its status as a self-regulating profession including, established high standards of behaviour for its members, and disciplinary procedures to investigate accusations of misbehaviour. Dental practitioners have a duty to: (i) report unethical behaviour; (ii) misconduct; (iii) impairment (i.e., alcohol and substance abuse); (iv)

substandard care within the profession (incompetence); or (v) violations of patient rights.[2] This upholds the integrity of the profession and ensures that patients are not subjected to harm due to misconduct or negligence (i.e., dishonesty, violence, alcohol and substance abuse, or criminal acts).

The main requirement for self-regulation, however, is wholehearted support by dentists for its principles and their willingness to recognise and deal with unsafe and unethical practices. In recent years additional steps have been taken to make the profession more accountable, for example, by appointing lay members to regulatory authorities (HPCSA) and use of constructive and mutually supportive professional peer review. Irrespectively, reporting colleagues to a disciplinary authority should normally be a last resort after other alternatives have been tried and found wanting. The first step might be to approach the colleague and say that you consider his or her behaviour unsafe or unethical. If the matter can be resolved at that level, there may be no need to go further. If not, then it may be necessary to take the next step of informing a disciplinary authority.[4]

III. Duties to Society (Social responsibilities)

Although most dental practitioners may consider themselves first and foremost as private practitioners with a primary responsibility to their patients, they also have a social responsibility towards public, communities, environment, and laws and policies that affect public health.[4]

Promote oral health, general public health, and well-being

Dental practitioners have a broader social responsibility extending beyond the confines of their dental practices to promote public health and contributing to the well-being of society including: (i) active participation oral health education campaigns, and educational initiatives aimed at improving oral health awareness and preventing oral disease; (ii) participating in community outreach programs offering dental services particularly to underserved or marginalized populations who may face barriers to accessing oral health services or who cannot afford dental care; (iii) advocating policies for promoting equitable access to dental care, and better oral health practices; and (iv) staying informed about societal health issues that affect their patients, supporting initiatives that reduce dental health disparities and systemic inequalities.[4,7]

By contributing to these initiatives, dental practitioners help reduce the burden of oral diseases, which can have significant impacts on overall health. Dental practitioners should continuously aspire towards contributing to the betterment of society in accordance with their professional abilities and standing in the community. This engagement and relationship with the larger community also enhances the reputation of the profession.[4,12]

In addition, some dental organisations are strongly influenced by religious teachings, which impose additional obligations on their members besides those applicable to all dentists.[4] "*Maintaining the social power of the profession is an important endeavour as social prestige, financial reward, professional autonomy, and public legitimacy once lost, are not easily regained.*"[15]

Allocation of scares resources and preventing wastage

The new understanding of the dentist's responsibility to society relating to allocation of scarce resources and preventing wastage, is reflected in the FDI International Principles of Ethics for the Dental Profession where it states: "*The dentist should support and promote accepted measures to improve the oral health of the public.*"[4] One way that dentists can exercise this responsibility insofar as it involves the allocation of resources is by avoiding wasteful and inefficient practices, even when patients request them. Clinical practice guidelines are available for some dental conditions; they help to distinguish between effective and ineffective treatments. Dentists should familiarise themselves with these guidelines, both to conserve resources and to provide optimal treatment to their patients.

Dental practitioners should also refrain from unnecessary wastage and participating in improper financial arrangements, especially those that escalate costs and disadvantage individuals unfairly.[2]

Environmental responsibility

Environmental ethical dentists are mindful of their impact on the environment, adopting eco-friendly practices, and minimizing waste to contribute to a sustainable future. Dentists are also responsible for practicing sustainably by using environmentally friendly materials and ensuring that health care waste is dispersed legally and in an environmentally friendly way and minimizing to environmental degradation.

Advertising - transparency, disclosure and misrepresentation

Dental practitioners should accurately represent themselves to the public and their peers. The dentist has a duty to: (i)

represent professional qualifications accurately without overstatement of fact or implying credentials that do not exist; (ii) avoid shaping the conclusions or perceptions of patients or other professionals by withholding or altering information that is needed for accurate assessment; (iii) disclose commercial relationships with companies when recommending products of those companies; (iv) disclose commercial relationships in professional presentations or publications where the dentist promotes or features products of those companies; (v) in case where a dentist have ties to commercial entities, they should fully disclose such relationships to patients and professional colleagues when nondisclosure would lead to differing conclusions, perceptions, or misrepresentation.[12])

IV. Duty to oneself (Personal responsibility)

In many parts of the world, being a dentist has required devoting oneself to the practice of dentistry with little consideration for one's own health and personal well-being. Dentistry can be physically demanding, with long hours, repetitive motions, and high levels of concentration, which can lead to stress or burnout. Working weeks of 60-80 hours are not uncommon and vacations are considered to be unnecessary luxuries. Although some dentists seem to do well in these conditions, they themselves, their families and patients may be adversely affected. Some dentists clearly suffer from this pace of professional activity, with results ranging from chronic fatigue, substance abuse to suicide.[4] Impaired dentists, due to stress and fatigue can result in dental errors and harm to the patient.

Selfcare - maintaining physical and mental health

Maintaining physical and mental health is essential for personal and professional well-being, happiness and ability to provide effective care. Dental practitioners therefor have a personal and professional responsibility to: (i) prioritize self-care; (ii) manage workload and stress; (iii) maintain work-life balance; and (iv) seek support when needed, to avoid compromising their physical and mental well-being, and consequently, the quality of care they provide.[16] Besides avoiding activities that may affect their health and well-being that may lead to impairment such as, overwork or substance abuse, dentists should protect and enhance their own health and well-being by identifying stress factors in their professional and personal lives and by developing and practising appropriate coping strategies.[2] When these fail, they should seek help from colleagues and appropriately qualified professionals for personal problems that might adversely affect their relationships with family, patients, society or colleagues.[4]

Registration as a dental practitioner with the Health Professions Council of South Africa (HPCSA)

Dental practitioners are expected to adhere to legal and regulatory frameworks that govern the profession, including licensing requirements, continuing education, and compliance with public health guidelines. Legally, a dental practitioners' scope of duties is governed Health Profession Act, (Act No.56 of 1974). This duty of care Act sets out the obligations and standards expected of dentists working in South Africa.

This ensures that they provide care in a manner that is safe, ethical, and in line with societal expectations.

Indemnity cover

Although professional indemnity cover or insurance is not a statutory requirement in South Africa, it is recommended that all dental practitioners have professional indemnity cover that can protect them against a claim or liabilities arising from their practice. This will protect them against a legal liability to compensate third parties (patients) who have sustained injury, loss, or damage due to professional negligence or breach of professional duty in the conduct of ones' profession or occupation.[17]

There are basically two types op professional indemnity: Occurrence-based indemnity underwritten by Dental Protection[17] will provide protection at all times, whilst you practice, when you retire, and even after you die, as claims can still be made against your estate for adverse incidents that occurred whilst you were practicing. The second type of indemnity is a Claims made insurance policy underwritten by PPS Health Professions Indemnity 24- provides indemnity for incidents that occur while your policy is in place. It does not provide contract certainty with regard to run-off cover after termination of your policy.

Self-reflection and continuous lifelong learning

Ethically, dentists must also reflect on themselves as well as their own practice(s), continually striving for personal and professional growth. The aim of self-reflection is: (i) a way of aiding development; (ii) improving wellbeing; and (iii) deepening professional commitment.18 Personal integrity and accountability are at the core of this duty, as practitioners must recognize their own limitations and seek further training or referrals when necessary.

Self-reflective practice is an intrinsic part of healthcare provision and training, and it has become synonymous with CPD. It involves regular self-assessment, seeking peer feedback, and being open to constructive criticism. Self-reflection is a key requirement of the learning process that helps to elicit deeper learning. In healthcare, it uses experiential activities to produce knowledge that compels the clinician to change their practice.[20] In medical education, reflective practice is rapidly becoming a competence in its own right; it enhances personal responsibility for learning and supports professional development.[21] *"The use of reflection 'leads to personal insight, improved practice and greater professionalism, all of which are key attributes to developing a safe and holistic practitioner."* [21]

Through self-reflection and life-long learning, dental professionals can identify areas for improvement and develop strategies to enhance or update their practice. By implementing self-reflection as a continuous process, dental professionals can enhance their knowledge and skills, ultimately improving patient care and outcomes.[19] Not only does this afford greater clinical confidence and job satisfaction, but it also ensures high-quality, evidence-based patient care.[22] The constituent elements of lifelong learning - choices, collegiality, challenges and consequences- can work synergistically in the interests of patients and well-being of healthcare practitioners alike.[25]

Manage conflict of interest between patient and business

While dentistry is first a profession, the practice of dentistry usually involves financial compensation for professional services and therefor regarded as a business or commercial entity. Since dentists are in a position to gain financially from their professional recommendations or services, they are at risk of having a conflict of interest, whether actual or perceived. The patient is the beneficiary of the dentist's services. If the dentist is being compensated for professional services, then the dentist is also technically a "beneficiary" of his or her recommendations or treatment to a patient. Although a patient's ability to pay for services may be a consideration in these professional decision-making and treatment recommendations, the level of financial gain must never be a consideration. If the patient's relevant interests are always considered, the profession of dentistry can ethically exist within a business structure.[12] No treatment or treatment plan should ever be motivated by self-interest, greed, or financial gain, to the detriment of the patient.[16]

Personal behaviour and manners – maintaining integrity, confidence and public trust

A dental practitioners' status as members of a respected profession brings many privileges that are not enjoyed by people in other walks of life. If we abuse those privileges, we do so at our own peril because a position of trust and respect is much more easily lost, than it is regained after having been lost.[15,23]

There are subtle components of conduct and behaviour by which a person communicates what he or she stands for, not only in the acts the person chooses, but also both in how those acts are chosen and in how the person presents to others in carrying them out.[12]

A healthcare professional such as a dentist arguably needs a slightly different set of core values compared to a politician or military leader. What is more important, perhaps, is that the public will expect certain things of doctors, dentists and other healthcare professionals. Thus, when a dental practitioners behaviour falls short of the expected standards, it is often quite easy for us to conclude that this is unacceptable behaviour for someone in that position. Appropriate personal behaviour and manners, also referred to as etiquette, inside and outside the workspace include: (i) use appropriate language and refrain from swearing; (ii) always follow appropriate workplace dress code or norms; (iii) refrain from gossiping; (iv) don't talk about work on the social media; (v) be polite, and courteous and stay humble; and (v) always smile and be positive.

Healthcare professionals should therefore always keep to professional etiquette and have good manners inside and outside the workplace as this will earn them the respect of other employees and staff, and will uphold their professional reputation, as well as that of the practice, or organization and profession.

Conclusion

Dental practitioners hold a critical position in the healthcare ecosystem, with the primary duty of providing comprehensive, ethical, and patient-centered oral health care, that will ensure the well-being and best interest of their patients. To meet this objective, a dental practitioner's duties span multiple dimensions, from patient care, to professional collaboration, societal contributions, and maintaining personal well-being.

To patients, dentists must provide high-quality, safe, compassionate care with respect for their autonomy and rights. To staff, colleagues, other health care professionals,

they must foster a respectful, collaborative, and ethical work environment. Their social contract demands that they contribute towards promoting public health and advocating for equitable access to care, while adhering to legal and ethical standards. Lastly, they must prioritize their own well-being and engage in continuous education and professional growth, recognizing that this not only directly affects their ability to fulfil their broader obligations of improving patient care and outcomes, but will also afford greater clinical confidence, job satisfaction, personal fulfilment and professional credibility.

By upholding these responsibilities, dental practitioners not only maintain the trust placed in them by their patients and society but also contribute to the integrity and advancement of the profession. The balance of knowledge, technical expertise, ethical conduct, and personal care is essential for the long-term success and sustainability of a dental practitioner's career.

References
A full list of References 1-25 is available in the References document