Dental Care For Older Adults: A Review Of Needs, Barriers, And Best Practices

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Abstract

As global populations age, oral health among older adults has emerged as a critical public health priority. This review synthesizes evidence on the epidemiology, clinical needs, barriers to care, best practices, and future directions in geriatric dentistry. Older adults experience disproportionately high rates of caries, periodontal disease, edentulism, xerostomia, and oral mucosal disorders, often complicated by multimorbidity, polypharmacy, functional limitations, and cognitive decline. The integration of Artificial Intelligence (AI), Internet of Things (IoT) devices, and augmented/virtual reality technologies provides new opportunities to enhance diagnostic accuracy, personalize treatment, and expand access to care—particularly for patients with mobility restrictions or limited dental service availability. AI-enabled tools improve early detection of oral diseases, optimize prosthodontic and implant planning, and support minimally invasive, patient-centered approaches. Barriers such as financial constraints, workforce shortages, digital literacy gaps, and privacy concerns continue to limit equitable care for older adults. The review emphasizes the importance of interdisciplinary collaboration, ethical AI adoption, diverse datasets, regulatory frameworks, and continuing education to ensure safe and effective implementation of digital tools in geriatric dentistry. Future innovations will rely on integrating AI with wearable devices, predictive analytics, and smart health ecosystems to support preventive, efficient, and accessible oral healthcare for aging populations.

Keywords: Older adults, Geriatric dentistry, Oral health needs, Barriers to dental care Artificial Intelligence (AI), Internet of Things (IoT, Diagnostic technologies, Predictive analytics, Prosthodontics and implant planning, Periodontal disease

CHAPTER 1: INTRODUCTION AND EPIDEMIOLOGY OF ORAL HEALTH IN OLDER ADULTS

Paragraph 1

The rapid aging of global populations has positioned oral health among older adults as an essential public health concern. Older individuals experience a higher burden of caries,

periodontal disease, tooth loss, xerostomia, and oral cancer, creating complex care needs that require coordinated clinical attention. As healthcare systems adapt to this demographic shift, the integration of advanced technologies such as artificial intelligence (AI) offers new opportunities for improving screening and diagnostic accuracy in geriatric dentistry. AI tools support clinicians by analyzing large clinical datasets, identifying patterns, and enhancing early detection of disease progression in older adults, ultimately strengthening care quality and outcomes (Dyar, 2022; Tartaglia, 2021). Their contribution is particularly important given the diagnostic challenges created by comorbidities common in aging populations (Vaziri et al., 2019; Yansane et al., 2021).

Paragraph 2

Epidemiological data consistently show that older adults have disproportionately high rates of untreated dental caries and periodontal disease, conditions that worsen with age due to physiological changes, medication effects, and declining immune function. These oral diseases can significantly impair chewing efficiency, nutritional intake, and systemic health. Emerging AI applications can support epidemiological surveillance by identifying trends across populations and helping clinicians recognize early warning signs, particularly in settings with limited dental workforce capacity (Vaziri et al., 2019; Ederer et al., 2019). As AI continues to transform healthcare delivery, its potential to enhance disease monitoring and stratify risk in older adults becomes increasingly valuable (Tartaglia, 2021; Yansane et al., 2021). Such tools help address long-standing gaps in geriatric oral health management.

Paragraph 3

Aging often brings complex medical conditions, including diabetes, cardiovascular disease, and neurodegenerative disorders, all of which directly influence oral health and complicate dental treatment. These comorbidities heighten susceptibility to infections, impair wound healing, and increase the prevalence of xerostomia, a major contributor to caries and mucosal disease in older individuals. AI-driven systems enhance clinicians' ability to integrate multidisciplinary data, supporting accurate diagnosis and personalized treatment planning for medically compromised seniors (Andrade & Pinto, 2020; McGleenon & Morison, 2021). The evolution of AI—particularly deep learning algorithms—enables the precise interpretation of radiographs and clinical indicators, helping practitioners recognize subtle disease patterns more rapidly than traditional methods (Badran, Keraa & Farghaly, 2023; Ederer et al., 2019).

Paragraph 4

Poor oral health in older adults has significant functional consequences, including difficulty eating, impaired speech, reduced social engagement, and diminished quality of life. Untreated dental disease may also contribute to systemic inflammation, increasing risks associated with chronic illnesses. Accurate assessment is therefore essential, yet diagnostic errors or delays remain common. AI tools address these challenges by reducing variability in clinical interpretation and enabling early detection of changes that may otherwise progress unnoticed (Tartaglia, 2021; Perry, Bridges & Burrow, 2022). Through machine learning and image analysis, AI systems detect subtle lesions and early periodontal breakdown, allowing for timely interventions in older patients (Yansane et al., 2021; Vaziri et al., 2019). Improved diagnostic precision ultimately enhances long-term outcomes.

Paragraph 5

Tooth loss remains one of the most visible indicators of oral health decline in aging populations, affecting chewing efficiency, nutritional status, and psychological well-being. Replacing missing teeth is not always straightforward due to bone resorption, systemic disease, and financial limitations. AI improves care planning by assisting clinicians in evaluating anatomical structures and designing prosthetic solutions tailored to the needs of older adults (Alamer, 2022; Buetow & Zawaly, 2022). These technologies streamline the

design of dentures and implant-supported prostheses, reducing errors and shortening production times. Furthermore, AI-supported workflows empower clinicians to make more informed chairside decisions, especially when treating patients with complex health needs (Buddhikot et al., 2023; Moriña, 2021).

Paragraph 6

Periodontal disease is highly prevalent among older adults due to cumulative plaque exposure, systemic inflammation, and reduced immune responsiveness. The disease often progresses silently until severe damage occurs. AI-powered diagnostic tools can detect early periodontal changes from radiographs and clinical datasets, supporting more personalized risk assessment and treatment planning (Milder et al., 2021; Moriña, 2021). These technologies also help overcome barriers associated with cognitive decline or communication difficulties, which may limit patient-reported symptoms. By offering remote diagnostic support, AI expands access to periodontal evaluation for seniors in underserved or mobility-restricted settings (Tartaglia, 2021; McGleenon & Morison, 2021). Such innovations are essential for maintaining periodontal stability in aging populations.

Paragraph 7

Xerostomia, typically caused by polypharmacy, is a major contributor to dental caries, mucosal irritation, and difficulty swallowing in older adults. Early recognition is critical, yet symptoms may be underreported due to cognitive impairment or lack of awareness. AI-enhanced preventive systems analyze patient histories to identify medication-related risks, enabling clinicians to implement protective strategies before significant oral damage occurs (Bethesda, 2021; Memon, 2022). Predictive models assist in recognizing high-risk individuals and guiding targeted interventions such as fluoride therapy or salivary substitutes (Vaziri et al., 2019; Ederer et al., 2019). These capabilities make AI an important tool for preserving oral moisture and preventing rapid deterioration of oral tissues in older adults.

Paragraph 8

Oral cancer incidence increases significantly with age, often presenting at advanced stages due to delayed detection. Screening older adults poses challenges because early lesions may be subtle, and comorbidities complicate clinical assessment. AI-driven imaging tools enhance the early detection of oral cancers by identifying patterns in radiographic and photographic records that indicate malignant transformation (Perry, Bridges & Burrow, 2022; Yansane et al., 2021). By improving diagnostic consistency and reducing reliance on clinician experience alone, AI supports earlier referral and intervention. Additionally, AI systems help monitor lesion progression over time, informing evidence-based decisions that are essential in geriatric oncology (American Dental Association, 2021; Yansane et al., 2021).

Paragraph 9

Frailty, reduced mobility, and cognitive impairments hinder many older adults from receiving regular dental care. These functional limitations often result in long periods without clinical assessment, increasing the risk of undetected disease progression. AI-enabled telehealth platforms offer solutions by facilitating remote consultations, triage, and preliminary diagnosis (Tartaglia, 2021; Memon, 2022). Virtual tools help older adults access professional guidance without traveling, a critical advantage for homebound or institutionalized seniors. AI-generated visual treatment explanations also support patient comprehension and adherence, strengthening communication between clinicians and aging patients (Buetow & Zawaly, 2022; Perry, Bridges & Burrow, 2022). Such technologies help bridge gaps in access created by physical or cognitive limitations.

Paragraph 10

Socioeconomic disparities significantly shape oral health outcomes among older adults. Limited income, inadequate insurance coverage, and reduced access to specialized geriatric dentistry create substantial barriers to care. AI can mitigate some of these disparities by offering cost-effective diagnostic support and allowing resource-limited practices to access high-quality analytical tools (Milder et al., 2021; Moriña, 2021). Remote AI-supported evaluations reduce dependence on expensive equipment or specialist consultations, expanding access for underserved populations. Additionally, AI enhances consistency in clinical decision-making, reducing inequities stemming from variable practitioner expertise (Tartaglia, 2021; McGleenon & Morison, 2021). These innovations contribute to a more equitable distribution of high-quality dental services for aging communities.

Paragraph 11

Oral health literacy is often lower among older adults, particularly those with limited education or cognitive impairments. Misunderstanding treatment recommendations can lead to delayed care, poor hygiene practices, and worsening disease. AI-powered educational tools support clearer communication through visual aids, personalized instructions, and simplified explanations (American Dental Association, 2021; Yansane et al., 2021). These tools help older adults better understand disease risk and treatment options, improving compliance and reducing preventable complications. AI-supported teleconsultations also facilitate repeated reinforcement of oral hygiene instructions, allowing seniors and caregivers to follow care plans more effectively (Tartaglia, 2021; Memon, 2022). Enhanced communication contributes significantly to improved oral health outcomes.

Paragraph 12

Institutionalized older adults, such as those living in nursing homes, face heightened risk for poor oral health due to dependence on caregivers and limited professional oversight. AI can help caregivers conduct routine oral assessments by providing guided digital tools that identify potential problems and recommend when professional evaluation is necessary (Buetow & Zawaly, 2022; Moriña, 2021). These systems strengthen oral disease surveillance in long-term care settings and support timely referrals. Additionally, AI helps clinicians remotely monitor residents' oral health trends, reducing the need for frequent in-person visits while maintaining high-quality oversight (Milder et al., 2021; Moriña, 2021). Such platforms are critical for improving oral health in care-dependent seniors.

Paragraph 13

The consequences of poor oral health in older adults extend far beyond the mouth, influencing systemic diseases, nutritional intake, and mental well-being. Despite this, oral health is often overlooked in geriatric care planning. AI supports more integrated care by linking dental and medical data, allowing clinicians to recognize how oral and systemic conditions interact (Awasthi & Walumbwa, 2023; Tartaglia, 2021). Through pattern recognition and predictive analytics, AI helps identify individuals at risk of complications, prompting early intervention. These tools also facilitate collaboration across healthcare disciplines, improving continuity of care for medically complex seniors (McGleenon & Morison, 2021; Vaziri et al., 2019).

Paragraph 14

Diagnostic delays are a major contributor to deteriorating oral health among older adults, especially those with mobility challenges or limited access to dental specialists. AI enhances early detection by analyzing images, identifying abnormalities, and supporting clinicians in making timelier decisions (Ederer et al., 2019; Dyar, 2022). These capabilities are particularly valuable in identifying early caries or periodontal changes that may otherwise remain unnoticed until severe. Furthermore, integrating AI with augmented reality platforms may improve remote assessment and caregiver training, enabling earlier

recognition of disease symptoms (Bethesda, 2021; Peadon, Hurley & Hutchinson, 2020). Such innovations improve the timeliness of care delivery for older adults.

Paragraph 15

As the demand for geriatric dental services grows, healthcare systems must adopt integrated approaches that consider older adults' medical, functional, and psychosocial complexities. AI offers a transformative opportunity to enhance diagnostic precision, improve preventive care, and strengthen patient engagement across diverse care settings (Ederer, 2019; Dyar, 2022). Future advancements—including AI-supported robotics and smart monitoring systems—may further improve treatment safety and accessibility for aging populations (Bethesda, 2021; Peadon, Hurley & Hutchinson, 2020). By supporting evidence-based decision-making and expanding access to high-quality care, AI helps address many of the challenges associated with aging, ultimately contributing to improved oral and systemic health outcomes for older adults.

CHAPTER 2: ORAL HEALTH NEEDS AND CLINICAL CONSIDERATIONS IN OLDER ADULTS

Paragraph 1

Older adults present a distinct set of oral health needs due to physiological aging, systemic illness, and functional decline. Root caries, periodontal disease, tooth wear, and oral mucosal abnormalities become increasingly prevalent with age, requiring careful diagnostic evaluation. AI-enhanced imaging systems support clinicians by identifying subtle changes in dental structures, improving early detection of caries and periodontal involvement in older patients (Verma et al., 2019; Marchan, Thorpe & Balkaran, 2022). Deep learning models can reveal patterns that may be overlooked in routine exams, strengthening preventive strategies for seniors (Kim, 2020; Cho, Lee & Kim, 2020). Given the growing geriatric population, effective diagnosis tailored to age-related oral challenges is essential for improving long-term outcomes.

Paragraph 2

Root caries is a major concern in older adults due to gingival recession and reduced salivary flow. These lesions progress rapidly and may remain undetected during routine examinations. AI-powered caries detection tools enhance diagnostic precision by analyzing radiographs for early demineralization that may not be visible clinically, allowing intervention before extensive damage occurs (Karimbux et al., 2023; Kalra, 2022). Machine learning systems further help predict lesion progression based on radiographic and clinical indicators, supporting individualized treatment planning for aging patients (Manzoor et al., 2019; Mabrouk, Marzouk & Afify, 2019). Integrating AI in routine assessments provides clinicians with a more accurate understanding of root surface pathology common in older populations.

Paragraph 3

Periodontal disease is highly prevalent among seniors due to cumulative plaque exposure, immune dysregulation, and systemic conditions such as diabetes. AI technologies improve periodontal assessments by accurately identifying bone loss patterns and predicting disease severity using radiographic analysis (Byrne & Tickle, 2019; Hashim et al., 2021). Convolutional neural networks (CNNs) can detect subtle periodontal changes that clinicians may overlook, enabling more targeted scaling and root planing strategies (Solanki et al., 2021; Dharrie-Maharaj & Garner, 2019). These capabilities are especially valuable for

older adults whose periodontal disease progression is often complicated by mobility limitations, medication effects, and challenges in maintaining daily plaque control.

Paragraph 4

Edentulism remains common among older adults and significantly affects nutrition, speech, and psychosocial well-being. The transition from natural dentition to dentures requires careful planning and adaptation. AI-assisted imaging improves pre-prosthetic evaluation by identifying anatomical variations that influence denture stability and comfort (Mabrouk, Marzouk & Afify, 2019; Northridge, Kumar & Kaur, 2020). Deep learning models enhance CBCT interpretation, offering detailed three-dimensional visualization essential for designing dentures or implant-supported prostheses in older adults (Xu et al., 2022; Galaiya, Kinross & Arulampalam, 2020). These tools allow for precise diagnosis and treatment planning, ultimately improving functional outcomes for edentulous seniors.

Paragraph 5

Denture-related complications, including stomatitis, ulceration, and poor retention, frequently affect older adults due to anatomical changes, hygiene challenges, and xerostomia. AI-based tools assist clinicians by detecting early mucosal inflammation and identifying prosthetic misalignments through image analysis, allowing timely adjustments (Choi et al., 2019; Cho, Lee & Kim, 2020). Additionally, AI improves the design of digital dentures by refining occlusal relationships and fit accuracy, minimizing irritation and improving comfort (Kalra, 2022; Hashim et al., 2021). By integrating AI into denture assessment and fabrication, clinicians can significantly reduce complications and improve satisfaction for older patients.

Paragraph 6

Xerostomia is common among seniors due to polypharmacy and systemic illness, contributing to caries, oral infections, and difficulty wearing dentures. Early identification is essential, yet symptoms are often underreported. AI-enhanced imaging and data analysis detect early enamel demineralization and mucosal dryness patterns, improving diagnostic accuracy (Verma et al., 2019; Marchan, Thorpe & Balkaran, 2022). Predictive models also assess medication profiles and clinical risk indicators to identify individuals susceptible to xerostomia-related complications (Kim, 2020; Karimbux et al., 2023). These tools support personalized preventive strategies such as fluoride therapy and salivary substitutes, which are crucial for maintaining oral health in xerostomic older adults.

Paragraph 7

Oral mucosal lesions—including candidiasis, lichen planus, and precancerous changes—occur more frequently in older adults, especially those with systemic disease or prosthetic appliances. AI tools significantly enhance detection by analyzing tissue images for abnormalities with high precision (Byrne & Tickle, 2019; Solanki et al., 2021). These systems can identify early changes suggestive of malignant transformation, enabling timely referral and reducing the need for invasive biopsies in certain cases (Choi et al., 2019; Cho, Lee & Kim, 2020). Early recognition is essential for older adults, who often present with complex health profiles that may delay diagnosis or mask early symptoms.

Paragraph 8

Multimorbidity is a hallmark of aging and greatly influences oral health needs. Diseases such as cardiovascular disorders, diabetes, and rheumatoid arthritis alter immune responses and healing capacity. AI supports comprehensive assessment by integrating medical and dental datasets, helping clinicians identify disease interactions affecting oral health (Manzoor et al.,

2019; Xu et al., 2022). Machine learning models can predict risk profiles based on systemic conditions and guide clinicians toward personalized, safer treatment decisions (Northridge, Kumar & Kaur, 2020; Verma et al., 2019). Such capabilities enhance clinical decision-making for medically complex older adults who require highly individualized oral care.

Paragraph 9

Polypharmacy is common among older adults and frequently leads to adverse oral effects, including xerostomia, mucosal fragility, and increased risk of caries. AI-driven systems can analyze medication lists to predict oral complications and flag high-risk patients for more intensive monitoring (Marchan, Thorpe & Balkaran, 2022; Kim, 2020). These tools also support clinicians in understanding drug interactions that influence treatment responses in geriatric patients (Karimbux et al., 2023; Kalra, 2022). By incorporating AI into medication-related risk assessment, dental practitioners can better anticipate age-related vulnerabilities and tailor management strategies accordingly.

Paragraph 10

Cognitive decline and dementia significantly impair oral hygiene performance, making older adults more susceptible to oral disease. AI-based monitoring systems detect early oral health deterioration by tracking changes in images and clinical data, enabling caregivers to intervene promptly (Byrne & Tickle, 2019; Hashim et al., 2021). Additionally, AI-powered image analysis helps clinicians identify early lesions in patients unable to communicate symptoms effectively (Solanki et al., 2021; Dharrie-Maharaj & Garner, 2019). These tools support more proactive management of vulnerable older adults with cognitive impairment.

Paragraph 11

Frailty and reduced manual dexterity hinder older adults' ability to maintain oral hygiene. Clinicians must adapt care plans based on functional capacity. AI supports these decisions by analyzing risk indicators and predicting disease progression in individuals with limited self-care ability (Choi et al., 2019; Northridge, Kumar & Kaur, 2020). Imaging tools enhanced by AI provide detailed assessments that guide minimally invasive treatment approaches appropriate for frail patients (Galaiya, Kinross & Arulampalam, 2020; Solanki et al., 2021). These adaptations ensure that dental management aligns with the patient's physical limitations.

Paragraph 12

Comprehensive assessment is fundamental in geriatric dentistry. AI enhances this process through advanced data interpretation, allowing clinicians to integrate medical histories, imaging findings, and risk profiles more efficiently (Manzoor et al., 2019; Mabrouk, Marzouk & Afify, 2019). Deep learning algorithms identify clinically significant patterns across multiple data sources, supporting more complete evaluations for older adults (Byrne & Tickle, 2019; Solanki et al., 2021). These tools promote individualized care planning that reflects the complex health needs of aging patients.

Paragraph 13

Individualized preventive plans are essential for managing age-related oral health changes. AI-powered predictive models help identify patients at heightened risk for caries, periodontal disease, or mucosal disorders, enabling targeted preventive measures (Verma et al., 2019; Marchan, Thorpe & Balkaran, 2022). These systems also evaluate longitudinal imaging to assess treatment effectiveness and modify care plans to maintain stability in

older adults (Kim, 2020; Cho, Lee & Kim, 2020). Tailored preventive strategies help preserve oral function and reduce complications in senior populations.

Paragraph 14
Minimally invasive dentistry is especially important for older adults who may not tolerate extensive procedures due to systemic illness or frailty. AI facilitates early diagnosis, allowing clinicians to use conservative treatments before disease progression necessitates more invasive interventions (Karimbux et al., 2023; Kalra, 2022). AI-enhanced radiographic interpretation identifies subtle pathology that can be addressed through remineralization therapies, selective caries removal, or atraumatic restorative techniques (Xu et al., 2022; Northridge, Kumar & Kaur, 2020). These approaches align with the goals of geriatric dental care—comfort, safety, and preservation of oral function.

Paragraph 15
Effective denture care, early caries management, and periodontal stability are central goals of geriatric oral health. AI strengthens these efforts through precise diagnostic imaging, improved treatment planning, and enhanced monitoring of clinical changes (Mabrouk, Marzouk & Afify, 2019; Verma et al., 2019). Predictive analytics help clinicians anticipate complications and modify interventions before significant functional decline occurs (Galaiya, Kinross & Arulampalam, 2020; Solanki et al., 2021). By integrating AI-driven insights with clinical expertise, dental practitioners can deliver safer, more effective, and more personalized care that supports the complex needs of older adults.

CHAPTER 3: BARRIERS TO ACCESSING DENTAL CARE AMONG OLDER ADULTS

Paragraph 1
Older adults face numerous barriers that prevent them from receiving timely and adequate dental care, including transportation difficulties, financial limitations, mobility restrictions, and limited availability of geriatric-focused dental services. These barriers are further compounded by age-related health challenges that require specialized treatment planning. AI-assisted orthodontic, prosthodontic, and implantology tools can mitigate some access gaps by improving diagnostic precision and reducing the number of required in-office visits (Choi et al., 2021; Kim, 2021). AI-supported workflows enhance accuracy in treatment planning, making care more efficient for seniors who struggle with frequent appointments (DePaola & Grant, 2019; Cantor et al., 2021). While not a substitute for clinical care, AI helps reduce logistical burdens that often deter older adults from seeking treatment.

Paragraph 2
Financial barriers are among the most significant challenges older adults encounter, as many lack dental insurance coverage following retirement. The high cost of prosthodontic and implant treatments often prevents them from restoring oral function. AI-driven prosthetic design systems reduce production errors and minimize adjustment appointments, ultimately decreasing overall treatment costs (Kammoe, 2020; Pan, 2021). Furthermore, AI enhances material selection and design precision, supporting cost-effective dental solutions for seniors with limited income (Johnston et al., 2021; Graham et al., 2019). By improving efficiency and lowering the need for repeat procedures, AI-supported workflows offer an important opportunity to improve affordability for older adults who struggle with financial constraints.

Paragraph 3
Mobility limitations, common among older adults, make it difficult to attend in-person assessments. Many seniors rely on caregivers or public transport, creating significant scheduling challenges. AI-powered simulations allow clinicians to plan treatments with fewer in-office visits by generating predictive models of tooth movement, implant placement, and prosthetic fit remotely (Cha & Cohen, 2022; Abutayyem et al., 2021). AI-based visualizations help clinicians monitor progress and communicate adjustments through virtual consultations, reducing the need for repeated travel (Cheong et al., 2019; Obadan-Udoh et al., 2021). These innovations alleviate mobility-related barriers and promote accessible care for homebound or physically limited older adults.

Paragraph 4
Cognitive impairment, including dementia and mild cognitive decline, significantly reduces the likelihood of older adults seeking or understanding dental care. Many patients struggle with remembering appointments or comprehending complex treatment plans. AI-generated visuals simplify communication by providing clear, step-by-step representations of orthodontic, prosthodontic, or implant procedures (Choi et al., 2021; Kim, 2021). Visual models increase comprehension and reduce anxiety, especially for patients with memory or processing difficulties (DePaola & Grant, 2019; Cantor et al., 2021). Enhanced communication strategies help cognitively impaired patients and their caregivers make informed decisions and adhere to treatment recommendations.

Paragraph 5
Limited dental provider availability—particularly those trained in geriatric dentistry—hinders access to comprehensive care for older adults. AI tools partially address this gap by standardizing treatment planning and providing precise guidance in complex cases such as implant placement, even in practices without advanced specialist expertise (Choi et al., 2021; Woeltje et al., 2019). Real-time AI feedback during procedures ensures quality and reduces the need for referrals, improving treatment access for seniors in underserved regions (Clemente et al., 2021; Cantillon, De Grave & Dornan, 2021). These technologies support practitioners in delivering high-quality care despite workforce shortages.

Paragraph 6
Transportation challenges and physical disability often prevent older adults from maintaining routine dental visits. AI-guided simulations and remote treatment planning models allow clinicians to conduct virtual consultations, reducing the necessity of frequent in-person appointments (Cha & Cohen, 2022; Abutayyem et al., 2021). AI-generated visuals also help patients understand how prosthetics or orthodontic appliances will function before treatment begins, minimizing the number of visits required (Cheong et al., 2019; Obadan-Udoh et al., 2021). These capabilities support continuity of care for older adults who struggle with transportation barriers.

Paragraph 7
Frailty and chronic illness limit the ability of many older adults to tolerate lengthy or repeated dental procedures. AI helps streamline workflows by boosting accuracy in prosthetic fabrication and implant planning, reducing chair time and improving comfort for medically complex seniors (Kammoe, 2020; Pan, 2021). Machine learning tools minimize procedural complications by optimizing material selection and predicting functional outcomes (Johnston et al., 2021; Graham et al., 2019). Their contribution

supports safer, shorter, and more efficient care, addressing major barriers experienced by frail geriatric patients.

Paragraph 8

Fear and dental anxiety, particularly common among older adults with negative past experiences, discourage regular dental visits. AI-generated 3D treatment simulations give patients a clear understanding of expected results, helping reduce fear through visual reassurance (Choi et al., 2021; Kim, 2021). These tools enhance trust by demonstrating how implants, dentures, or aligners will restore function and aesthetic appearance (DePaola & Grant, 2019; Cantor et al., 2021). Better communication reduces anxiety and increases the likelihood that anxious older adults will pursue necessary treatment.

Paragraph 9

Health literacy challenges contribute significantly to poor access, as many older adults struggle to understand diagnoses and treatment options. AI-enhanced visualizations simplify communication by converting complex dental concepts into understandable images (Cha & Cohen, 2022; Abutayyem et al., 2021). These tools improve informed consent by illustrating expected outcomes, risks, and benefits in ways that seniors can easily comprehend (Cheong et al., 2019; Obadan-Udoh et al., 2021). Improving comprehension empowers older adults to make appropriate decisions regarding their care.

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Older adults in rural or underserved areas often experience long wait times and limited availability of specialized procedures such as implantology or advanced prosthodontics. AI-guided surgical planning enhances accuracy and reduces complications, enabling general dentists in remote areas to perform complex procedures safely (Choi et al., 2021; Woeltje et al., 2019). Real-time intraoperative AI feedback improves safety and efficiency, reducing reliance on specialist availability (Clemente et al., 2021; Cantillon, De Grave & Dornan, 2021). This increases access to advanced treatments for seniors living far from urban healthcare centers.

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Ethical concerns related to AI may hinder both clinician adoption and patient acceptance. Older adults must be informed when AI influences treatment decisions, which can be challenging given varying levels of technological trust. Transparent communication about AI's role in designing prosthetics or orthodontic plans supports informed consent (Cha & Cohen, 2022; Abutayyem et al., 2021). Clinicians must also explain how AI contributes to accuracy and safety, reinforcing trust in AI-supported care (Cheong et al., 2019; Obadan-Udoh et al., 2021). These efforts reduce mistrust that could otherwise limit access.

Paragraph 12

Data privacy concerns represent another barrier, especially for older adults who may feel uncomfortable with digital data collection. AI systems depend on patient data to generate personalized treatment plans, requiring strong privacy protections (Kammoe, 2020; Pan, 2021). Ensuring compliance with data protection regulations and clearly explaining storage procedures builds patient confidence in AI-enhanced care (Johnston et al., 2021; Graham et al., 2019). When privacy worries are addressed transparently, seniors become more willing to participate in AI-supported treatment processes.

Paragraph 13

Over-reliance on AI by clinicians poses risks if systems are used without appropriate human oversight. This barrier affects older adults indirectly—if clinicians misuse AI tools,

treatment safety may be compromised. Proper training ensures dental professionals can evaluate AI-generated recommendations critically (Choi et al., 2021; Woeltje et al., 2019). Educational programs emphasizing balanced decision-making support safe integration of AI into geriatric care (Clemente et al., 2021; Cantillon, De Grave & Dornan, 2021). Skilled clinicians using AI responsibly improve access and outcomes for seniors.

Paragraph 14
High implementation costs can limit AI adoption in clinics serving older adults, particularly in low-income regions. However, over time, AI-driven efficiency reduces material waste, treatment errors, and the number of follow-up visits required—ultimately lowering overall costs (Cha & Cohen, 2022; Abutayyem et al., 2021). Communicating these long-term benefits to administrators and patients improves acceptance and supports adoption (Cheong et al., 2019; Obadan-Udoh et al., 2021). Increased affordability expands access for seniors who otherwise face financial barriers to care.

Paragraph 15
AI's ability to streamline interdisciplinary collaboration enhances access for seniors who require coordinated care across multiple specialties. By consolidating radiographs, CBCT scans, and prosthodontic or orthodontic plans, AI ensures seamless communication between providers (Choi et al., 2021; Woeltje et al., 2019). This integration improves treatment continuity and reduces fragmented care, a common barrier for older adults navigating complex health systems (Clemente et al., 2021; Cantillon, De Grave & Dornan, 2021). Improved collaboration strengthens patient outcomes and expands access to comprehensive geriatric dental care.

CHAPTER 4: BEST PRACTICES AND MODELS OF CARE FOR IMPROVING ORAL HEALTH IN OLDER ADULTS

Paragraph 1
Best practices for improving oral health in older adults require integrating advanced diagnostics, personalized treatment strategies, and interdisciplinary care models. AI-supported diagnostic tools enhance early detection of caries, periodontal disease, and oral cancer, conditions commonly affecting seniors (Bercasio, Rowe & Yansane, 2020; Teoh, McCullough & Moses, 2022). By analyzing subtle anomalies in radiographs and CBCT scans, AI standardizes diagnostic outcomes, reducing practitioner variability (Borrell et al., 2023; Coulthard et al., 2020). These capabilities are essential for aging populations, where delayed diagnosis often leads to functional decline, tooth loss, and impaired quality of life. Incorporating AI-driven screening into routine geriatric assessments strengthens preventive care and ensures timely interventions for vulnerable older adults.

Paragraph 2
Comprehensive geriatric dental care emphasizes early identification of oral disease, functional assessment, and individualized treatment planning. AI-driven systems automate imaging analysis, enabling clinicians to evaluate complex anatomical changes common in older adults more efficiently (Ende, 2020; Voskanyan et al., 2021). For example, AI-generated 3D models help practitioners design precise prostheses that accommodate age-related bone resorption or occlusal instability (Cheng, Yen & Lee, 2019; Affendy et al., 2021). These technologies reduce manual workload and streamline planning, allowing clinicians to prioritize patient interaction. Such efficiency aligns with geriatric care goals,

where tailored guidance and empathetic communication significantly influence treatment adherence and long-term oral health outcomes.

Paragraph 3
Personalized care is a cornerstone of effective geriatric dentistry. AI tools analyze patient-specific factors—including medical history, salivary conditions, and functional limitations—to generate tailored recommendations that address individual needs (Calvo et al., 2021; Tattoli et al., 2019). Predictive analytics identify seniors at high risk for caries, periodontal disease, or oral infections, allowing clinicians to implement preventive strategies proactively (Bercasio, Rowe & Yansane, 2020; Rooney et al., 2020). AI-assisted monitoring tracks treatment responses over time, prompting timely adjustments and ensuring optimal outcomes. Such personalized care is crucial for older adults, many of whom require ongoing support due to declining manual dexterity or cognitive impairment.

Paragraph 4
Geriatric dental care models emphasize prevention, minimally invasive treatment, and functional restoration. AI reduces treatment errors by increasing diagnostic precision and minimizing the likelihood of prosthetic misfit or inappropriate intervention (Borrell et al., 2023; Teoh, McCullough & Moses, 2022). AI-streamlined workflows allow clinicians to detect early disease and implement conservative treatments that preserve tooth structure—a key priority for medically fragile older adults (Ende, 2020; Voskanyan et al., 2021). These practices reduce complications, shorten recovery times, and improve long-term oral function. The integration of AI within minimally invasive dentistry enhances predictability and supports sustainable care models tailored to aging populations.

Paragraph 5
Effective geriatric dental care requires seamless integration with primary medical services. AI facilitates interdisciplinary collaboration by standardizing treatment plans and enabling the exchange of diagnostic information across care teams (Cheng, Yen & Lee, 2019; Affendy et al., 2021). This is particularly beneficial for older adults with multimorbidity, where dental and systemic conditions interact closely. AI-driven predictive models help clinicians anticipate complications related to chronic diseases or medication interactions (Calvo et al., 2021; Tattoli et al., 2019). Such coordinated models of care ensure safer interventions and reduce fragmentation in healthcare delivery for older adults.

Paragraph 6
Geriatric-focused preventive strategies rely heavily on early detection and patient education. AI improves screening accuracy for high-risk individuals, particularly those with limited ability to self-report symptoms due to cognitive decline (Bercasio, Rowe & Yansane, 2020; Teoh, McCullough & Moses, 2022). Standardized diagnostic outputs from AI tools improve decision-making consistency during preventive visits (Borrell et al., 2023; Coulthard et al., 2020). These insights help clinicians develop personalized preventive regimens, such as fluoride applications, antimicrobial rinses, and targeted hygiene instruction. Enhanced prevention reduces disease burden and avoids invasive procedures, especially beneficial for older adults who may not tolerate extensive treatments.

Paragraph 7
Home-based and institutional dental care models are essential for seniors with mobility limitations. AI supports remote assessments by enabling digital analysis of patient-submitted photographs and radiographs, broadening access to care (Ende, 2020;

Voskanyan et al., 2021). AI-driven teleconsultations help clinicians triage emergencies, monitor prosthetic fit, and detect early signs of disease in homebound or institutionalized patients (Cheng, Yen & Lee, 2019; Affendy et al., 2021). These tools enhance continuity of care and reduce the need for transportation—one of the major barriers to geriatric dental services. Remote monitoring also supports caregivers by providing actionable guidance for daily oral hygiene.

Paragraph 8
Models of care emphasizing prosthodontic rehabilitation must address the unique challenges of aging tissues. AI improves denture and implant-supported restoration design by producing highly accurate digital prosthetics that account for anatomical changes associated with aging (Calvo et al., 2021; Tattoli et al., 2019). These customized designs reduce the incidence of denture-related injuries, enhance comfort, and improve masticatory efficiency (Bercasio, Rowe & Yansane, 2020; Rooney et al., 2020). AI's precision in prosthetic fabrication reduces adjustment visits, making it highly beneficial for older adults with mobility restrictions or chronic conditions.

Paragraph 9
To ensure high-quality care, clinicians must navigate the ethical considerations of integrating AI into geriatric dentistry. Clear communication with older adults about how AI contributes to diagnosis and treatment fosters transparency (Borrell et al., 2023; Teoh, McCullough & Moses, 2022). This is particularly important for seniors who may be unfamiliar with digital technologies. Emphasizing the collaborative role of AI—rather than suggesting replacement of clinical judgment—helps strengthen patient trust (Ende, 2020; Voskanyan et al., 2021). Ethical adoption ensures that AI enhances, rather than complicates, dental care for older adults.

Paragraph 10
Cost-effective care models are essential in geriatric dentistry, where many older adults face financial limitations. Although AI requires significant initial investment, its ability to reduce treatment errors and streamline workflows lowers long-term costs for both clinics and patients (Cheng, Yen & Lee, 2019; Affendy et al., 2021). AI improves practice efficiency by automating administrative tasks such as scheduling and data entry, allowing dental professionals to dedicate more time to patient-centered care (Borrell et al., 2023; Teoh, McCullough & Moses, 2022). Increased efficiency ultimately enhances access to care for financially vulnerable seniors.

Paragraph 11
Training dental professionals in AI-supported tools is a best practice for improving geriatric care models. Many practitioners initially resist AI adoption due to lack of familiarity or misconceptions about digital technologies (Calvo et al., 2021; Tattoli et al., 2019). Professional development programs that demonstrate AI's practical benefits—such as increased diagnostic accuracy and reduced procedural time—encourage acceptance (Bercasio, Rowe & Yansane, 2020; Rooney et al., 2020). Building clinician competence ensures safe and effective integration of AI in treatment planning for older adults.

Paragraph 12
To maximize effectiveness, AI tools must rely on diverse, representative datasets. Many current systems are trained on limited populations, posing risks when applied to older adults with unique anatomical and medical complexities (Borrell et al., 2023; Teoh, McCullough

& Moses, 2022). Ensuring dataset diversity improves diagnostic accuracy and reduces disparities in care for underserved senior populations (Ende, 2020; Voskanyan et al., 2021). Models developed with comprehensive data are more reliable in predicting treatment outcomes and guiding geriatric care decisions.

Paragraph 13
Collaborative care models integrating AI create more connected and responsive treatment systems. AI consolidates clinical data, imaging records, and treatment histories, enabling seamless communication between general dentists, geriatric specialists, and prosthodontists (Cheng, Yen & Lee, 2019; Affendy et al., 2021). Such interdisciplinary coordination improves continuity of care and supports safer decision-making for older adults with complex medical needs (Calvo et al., 2021; Tattoli et al., 2019). These models reduce fragmentation and promote holistic care tailored to aging patients.

Paragraph 14
AI-enhanced virtual consultations and patient engagement tools strengthen the involvement of older adults in their treatment decisions. Visual simulations help seniors visualize outcomes and understand procedural steps more clearly (Bercasio, Rowe & Yansane, 2020; Rooney et al., 2020). This improves adherence and reduces anxiety, especially for patients with cognitive or sensory limitations (Borrell et al., 2023; Teoh, McCullough & Moses, 2022). Empowering older adults through visualization-based communication is a key component of effective care models.

Paragraph 15
Looking forward, the most promising models of geriatric dental care will integrate AI with emerging technologies such as 3D printing and augmented reality. These advancements will enhance diagnostic precision, treatment customization, and rehabilitation outcomes for older adults (Ende, 2020; Voskanyan et al., 2021). As algorithms become more accurate and data security improves, AI will play an increasingly central role in supporting equitable, efficient, and patient-centered geriatric dentistry (Cheng, Yen & Lee, 2019; Affendy et al., 2021). Embracing these innovations will allow dental professionals to meet the growing and complex needs of aging populations.

CHAPTER 5: RECOMMENDATIONS, FUTURE DIRECTIONS, AND POLICY IMPLICATIONS

Paragraph 1
Future advancements in dental care for older adults will depend on integrating AI with emerging technologies to enhance prevention, diagnosis, and long-term monitoring. The rise of AI-enabled IoT devices, such as smart toothbrushes and oral sensors, supports continuous monitoring by collecting real-time oral health data and allowing clinicians to track disease risk remotely (Palmer et al., 2019; Rashwan & Mahmoud, 2021). These systems predict early signs of periodontal disease, helping prevent complications that often burden aging populations (Marchan, Coppin & Balkaran, 2022; Johnston, Archer & Martin, 2023). As oral diseases in older adults frequently progress silently, leveraging AI-driven predictive models provides timely interventions that maintain oral function and quality of life.

Paragraph 2
AI-powered IoT systems are essential for creating personalized preventive strategies, particularly for seniors with limited access to routine dental care. Smart devices that monitor

brushing patterns and oral hygiene behaviors can provide automated feedback to improve self-care, while dentists receive alerts when changes signify disease progression (Palmer et al., 2019; Rashwan & Mahmoud, 2021). These predictive systems help minimize the need for invasive procedures by identifying early periodontal inflammation or caries development (Marchan, Coppin & Balkaran, 2022; Johnston, Archer & Martin, 2023). Integrating IoT into geriatric care models enhances independence for older adults and supports preventive dentistry on a population scale.

Paragraph 3
Augmented Reality (AR) and Virtual Reality (VR) offer powerful tools for education, treatment planning, and patient communication. AR overlays anatomical information onto the treatment field, improving surgical precision during procedures such as implant placement or restorations (Doğramacı & Rossi-Fedele, 2022; Javaid et al., 2021). VR provides immersive training environments where clinicians can practice complex cases without risk to patients, a major advantage in geriatric dentistry where medically fragile individuals require accurate, minimally invasive care (Mwita, 2022; Perry, Bridges & Burrow, 2022). As AI enhances these AR/VR tools, they will play an increasingly vital role in teaching best practices and refining clinical technique.

Paragraph 4
Ensuring high-quality AI predictions depends on developing diverse, representative datasets. Many existing datasets lack demographic variation, which compromises the accuracy of diagnostics for older adults and underserved groups (Bordonaba-Leiva et al., 2019; Osegueda-Espinosa et al., 2020). To overcome this limitation, global collaborations should enable the sharing of anonymized clinical data, improving the generalizability of AI tools (Ensaldo-Carrasco et al., 2021; Afrashtehfar, Assery & Bryant, 2020). Strengthening dataset diversity ensures that AI-supported diagnostic and treatment systems serve all populations equitably, particularly seniors who present unique oral health complexities.

Paragraph 5
Implementing AI ethically and effectively requires structured professional development. Dental practitioners must remain informed about advances in AI through continuing education programs, hands-on workshops, and certification opportunities (Trockel et al., 2020; Karimbux et al., 2023). Continuous training ensures clinicians understand both the capabilities and limitations of AI, reducing risks of misuse or overreliance (Javaid et al., 2021; Doğramacı & Rossi-Fedele, 2022). Competency-based education empowers practitioners to apply AI-driven insights responsibly, fostering safer, more efficient care for older adults and other vulnerable populations.

Paragraph 6
A comprehensive regulatory framework is vital for guiding AI adoption in dentistry. Policymakers must develop clear regulations addressing data privacy, algorithm transparency, and clinical accountability to maintain patient trust (Kalenderian et al., 2021; Foy et al., 2020). Mandatory validation and certification processes for AI systems will ensure safety and reliability before clinical deployment (Afrashtehfar, Assery & Bryant, 2020; Bordonaba-Leiva et al., 2019). Additionally, licensing requirements for dental practitioners could incorporate AI-specific competencies, promoting ethical, informed use of these technologies.

Paragraph 7
The vision of a fully integrated AI-driven dental ecosystem includes seamless connections between electronic health records (EHRs), wearable devices, and clinical AI tools. This integration will enable real-time data exchange, improve care coordination, and support dynamic treatment plans tailored to each patient's evolving needs (Palmer et al., 2019; Marchan, Coppin & Balkaran, 2022). For older adults, such systems offer enhanced continuity of care and better monitoring of systemic–oral health interactions (Perry, Bridges & Burrow, 2022; Javaid et al., 2021). The future ecosystem will also include interactive patient education tools that strengthen engagement, adherence, and satisfaction.

Paragraph 8
To ensure the successful integration of AI, dental practices must address practitioner hesitation. Resistance often stems from unfamiliarity with the technology or concerns about job displacement (Mwita, 2022; Johnston, Archer & Martin, 2023). Peer-led workshops and interdisciplinary training initiatives can build confidence by demonstrating how AI supports, rather than replaces, clinical judgment (Karimbux et al., 2023; Rashwan & Mahmoud, 2021). Supporting clinicians through structured learning opportunities ensures a smooth transition into digitally enhanced practice models.

Paragraph 9
AI supports interdisciplinary collaboration by linking dental care with broader healthcare systems. For example, AI can detect oral signs of systemic conditions such as diabetes or cardiovascular disease, prompting referrals and improving whole-body health management (Ensaldo-Carrasco et al., 2021; Perry, Bridges & Burrow, 2022). Comprehensive care models benefit older adults who frequently manage multiple comorbidities. Collaborative learning sessions and shared CE programs encourage dentists, physicians, and specialists to work together, leveraging AI insights for holistic patient care (Palmer et al., 2019; Afrashtehfar, Assery & Bryant, 2020).

Paragraph 10
Patient-centered care will be significantly strengthened as AI continues to evolve. AI-powered virtual assistants may soon handle patient inquiries, appointment scheduling, and personalized oral care reminders, improving adherence and satisfaction (Javaid et al., 2021; Bordonaba-Leiva et al., 2019). These tools can help older adults navigate their care plans more easily, especially those with cognitive or functional limitations. AI-generated personalized insights and visualizations empower patients to take a more active role in maintaining their oral health (Osegueda-Espinosa et al., 2020; Palmer et al., 2019).

Paragraph 11
Future AI systems will likely incorporate advanced natural language processing (NLP) to improve communication between clinicians and patients. NLP can help simplify complex treatment explanations, supporting comprehension among older adults with hearing impairments or cognitive challenges (Doğramacı & Rossi-Fedele, 2022; Karimbux et al., 2023). Meanwhile, autonomous robotic systems may enhance precision during minimally invasive procedures, reducing human error and improving outcomes (Rashwan & Mahmoud, 2021; Foy et al., 2020). These innovations highlight the transformative potential of AI to redefine dental practice.

Paragraph 12
AI will play an increasingly important role in overcoming geographic barriers to care. Remote diagnostic tools and AI-driven mobile applications can extend dental services to underserved or rural populations (Bercasio, Rowe & Yansane, 2020; Rooney et al., 2020). By enabling preliminary assessment and personalized preventive advice, these technologies reduce dependency on physical clinic visits. They are especially beneficial for seniors with limited mobility, providing equitable access to high-quality dental guidance (Borrell et al., 2023; Teoh, McCullough & Moses, 2022).

Paragraph 13
Future research should prioritize integrating AI with salivary biomarker analysis, genetic testing, and systemic health indicators. Building multimodal AI models will support earlier detection of oral-systemic interactions, such as inflammatory pathways affecting periodontal disease (Palmer et al., 2019; Johnston, Archer & Martin, 2023). Expanding research collaborations enables more robust datasets, improving the accuracy of AI predictions for diverse populations (Ensaldo-Carrasco et al., 2021; Afrashtehfar, Assery & Bryant, 2020). These advancements will refine risk assessment models and support preventive dentistry for aging populations.

Paragraph 14
To ensure equitable adoption of AI, policymakers must address digital literacy gaps among older adults. Training programs that teach seniors how to use AI-enabled devices, such as smart toothbrushes or mobile oral-health apps, can significantly improve engagement (Rashwan & Mahmoud, 2021; Marchan, Coppin & Balkaran, 2022). Community-based initiatives should integrate AI-supported oral health education, ensuring accessibility and usability across all age groups (Perry, Bridges & Burrow, 2022; Javaid et al., 2021). Increasing digital literacy enhances the effectiveness of AI-driven preventive care models.

Paragraph 15
The future of dental care lies in a balanced integration of technology, human expertise, and patient empowerment. AI-based systems will continue to improve diagnostic accuracy, treatment personalization, and patient engagement, but their responsible use requires ethical oversight, comprehensive training, and strong regulatory support (Kalenderian et al., 2021; Foy et al., 2020). As practices adopt advanced systems such as IoT-enabled wearables and AR-enhanced planning tools, dentistry will become more efficient, precise, and accessible (Palmer et al., 2019; Perry, Bridges & Burrow, 2022). Embracing these innovations ensures a sustainable, patient-centered future for all populations, especially older adults.

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