

Tobacco, Nicotine, and Oral Health: Current Evidence, Public Health Perspectives, and the Expanding Role of Dental Professionals-A Comprehensive Review

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Abstract Tobacco use remains one of the leading preventable causes of morbidity and mortality worldwide and continues to pose a major challenge to oral and public health. In recent years, the growing popularity of alternative nicotine delivery systems, including electronic cigarettes, heated tobacco products, and nicotine pouches, has further complicated tobacco control efforts and raised concerns regarding their long-term effects on oral health. This comprehensive review summarizes the current evidence on the biological mechanisms through which tobacco and nicotine products contribute to oral diseases, including dental caries, periodontal disease, oral potentially malignant disorders, oral cancer, impaired wound healing, and complications affecting implant and prosthodontic outcomes. The review also compares the oral health effects of conventional and emerging tobacco products and highlights the influence of social determinants on tobacco-related oral health disparities. Particular emphasis is placed on the expanding role of dental professionals in tobacco prevention and cessation through evidence-based behavioral interventions, pharmacotherapy, patient education, and interdisciplinary collaboration. Finally, emerging innovations such as artificial intelligence, telerdentistry, mobile health, salivary diagnostics, and precision public health are discussed as promising approaches to strengthen tobacco cessation and improve population oral health.

Keywords: Tobacco, Nicotine, Oral health, Tobacco cessation, Dental professionals, Public health, Electronic cigarettes, Periodontal disease, Oral cancer

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1. Introduction

Tobacco use remains one of the leading preventable causes of disease and premature mortality worldwide, representing a major public health challenge. Despite ongoing tobacco control efforts, the use of combustible and non-combustible tobacco products continues to contribute significantly to the global burden of non-communicable diseases, healthcare costs, and health inequalities. [1] In parallel, the nicotine landscape has rapidly evolved with the emergence of electronic cigarettes, heated tobacco products, nicotine pouches, and

other alternative nicotine delivery systems. Although these products are often promoted as reduced-risk alternatives, their long-term effects on health, particularly oral health, remain incompletely understood. [2]

The oral cavity is the primary site of exposure to tobacco smoke, smokeless tobacco, and nicotine-containing aerosols, making it highly vulnerable to their adverse effects. Tobacco constituents induce oxidative stress, inflammation, immune dysregulation, vascular changes, and alterations in the oral microbiome, contributing to the initiation and progression of oral diseases. [2] Tobacco use has been strongly associated with periodontal disease, oral mucosal lesions, oral potentially malignant disorders, oral cancer, impaired

wound healing, peri-implant complications, and reduced treatment outcomes. While the harmful effects of conventional tobacco products are well established, emerging nicotine products require continued evaluation due to increasing patterns of use, particularly among younger populations. [3,4]

Dental professionals play a critical role in tobacco control due to their frequent interaction with patients and their ability to identify early oral manifestations of tobacco exposure. Dental visits provide opportunities for tobacco screening, patient education, behavioral counseling, and referral for cessation support. [5] With the emergence of new nicotine products and increasing recognition of oral health within public health frameworks, an updated comprehensive review is needed. This review aims to summarize current evidence regarding the impact of tobacco and nicotine products on oral health, discuss their public health implications, and highlight the expanding role of dental professionals in tobacco prevention and cessation.

2. Methods

A comprehensive literature search was conducted to identify relevant evidence regarding tobacco and nicotine product use, oral health outcomes, public health implications, and the role of dental professionals in tobacco cessation. Searches were performed using major biomedical databases, including PubMed, Scopus, Embase, Web of Science, and the Cochrane Library. Relevant keywords and MeSH terms included *tobacco*, *nicotine*, *smoking*, *electronic cigarettes*, *vaping*, *heated tobacco products*, *nicotine pouches*, *oral health*, *periodontal disease*, *oral cancer*, *tobacco cessation*, and *dental professionals*. Additional relevant articles were identified through reference screening of selected publications.

Peer-reviewed studies, clinical research, epidemiological studies, and relevant review articles addressing the effects of tobacco and nicotine products on oral health, tobacco cessation interventions, and public health strategies were included. Publications unrelated to oral health, non-relevant studies, and articles without sufficient scientific evidence were excluded. The selected literature was critically evaluated and synthesized narratively based on major themes,

including tobacco-related oral diseases, emerging nicotine products, prevention strategies, and the role of oral healthcare providers in tobacco cessation. Due to the heterogeneity of available evidence, findings were summarized qualitatively rather than through quantitative analysis.

3. Tobacco and Nicotine Products: Classification and Trends

Tobacco and nicotine products have evolved substantially over recent decades, shifting from traditional combustible and smokeless products to a wide range of alternative nicotine delivery systems. These products differ in their composition, route of administration, nicotine delivery, toxic constituents, and potential effects on oral and systemic health. While combustible tobacco remains the leading contributor to tobacco-related disease burden, emerging products such as electronic nicotine delivery systems, heated tobacco products, and nicotine pouches have gained popularity, creating new challenges for public health surveillance and prevention strategies. [6,7,8,9,10] Table 1

4. Biological Mechanisms of Tobacco-Induced Oral Disease

Tobacco and nicotine products exert their harmful effects on the oral cavity through multiple interconnected biological mechanisms. Nicotine and other toxic constituents initiate oxidative stress, chronic inflammation, immune dysregulation, alterations in the oral microbiome, epigenetic modifications, and impaired wound healing, collectively disrupting oral tissue homeostasis. These pathways contribute to the development and progression of periodontal disease, oral potentially malignant disorders, oral cancer, peri-implant complications, and delayed tissue repair. Although the relative contribution of each mechanism varies depending on the type, duration, and intensity of tobacco or nicotine exposure, their cumulative effects significantly increase the risk of oral disease and adversely affect treatment outcomes. [11,12,13,14] Figure 1

Table 1. Tobacco and Nicotine Products

Category	Examples	Characteristics and Trends
Combustible Tobacco Products	Cigarettes	The most widely used tobacco product globally. Combustion produces thousands of chemicals, including carcinogens, reactive oxygen species, and toxic compounds responsible for systemic and oral health effects.
	Cigars and Cigarillos	Contain tobacco leaves with higher tobacco content than cigarettes. Use may involve inhalation or exposure of oral tissues to tobacco smoke, contributing to oral mucosal changes and cancer risk.
	Pipe Tobacco	Traditional tobacco product involving burning tobacco in a pipe. Although less common in many regions, it remains associated with exposure to carcinogens and tobacco-related oral diseases.
Smokeless Tobacco Products	Chewing Tobacco	Tobacco products placed in the mouth and chewed or held against oral tissues, resulting in prolonged exposure to nicotine and carcinogenic compounds. Associated with gingival changes, oral lesions, and oral cancer risk.
	Snuff (Dry and Moist)	Finely ground tobacco products consumed orally or nasally. Moist snuff is commonly associated with localized mucosal lesions at the site of placement.
	Gutka	A mixture containing areca nut, tobacco, slaked lime, and flavoring agents, widely used in South Asia. Strongly associated with oral submucous fibrosis, potentially malignant disorders, and oral cancer.
	Khaini	A smokeless tobacco preparation containing tobacco and slaked lime, commonly used in South Asia. It delivers high nicotine levels and is linked to periodontal and oral mucosal changes.

Category	Examples	Characteristics and Trends
	Betel Quid With Tobacco	A traditional product containing areca nut, betel leaf, lime, and tobacco. Associated with significant risk of oral potentially malignant disorders and oral squamous cell carcinoma.
Electronic Nicotine Delivery Systems (ENDS)	E-cigarettes, Vape devices, Disposable vapes	Battery-powered devices that heat nicotine-containing liquids to produce an aerosol rather than smoke. Although lacking many combustion products, aerosols may contain nicotine, flavoring agents, metals, and other chemicals with potential oral health effects. Increasingly used among adolescents and young adults.
Heated Tobacco Products (HTPs)	Heat-not-burn devices	Devices that heat processed tobacco rather than burning it, producing an aerosol containing nicotine and other chemicals. Marketed as reduced-risk alternatives, but long-term oral and systemic health effects remain under investigation.
Nicotine Pouches	Tobacco-free nicotine pouches	Oral nicotine products placed between the lip and gingiva. They contain nicotine, flavoring agents, and fillers without tobacco leaf. Their increasing popularity has raised concerns regarding long-term effects on oral tissues and dependence.
Novel and Emerging Nicotine Products	Nicotine lozenges, dissolvable products, synthetic nicotine products, dual/poly-tobacco use	New products continue to emerge with changing patterns of nicotine consumption. Dual or multiple-product use is increasingly recognized and may increase cumulative nicotine exposure and complicate cessation efforts.

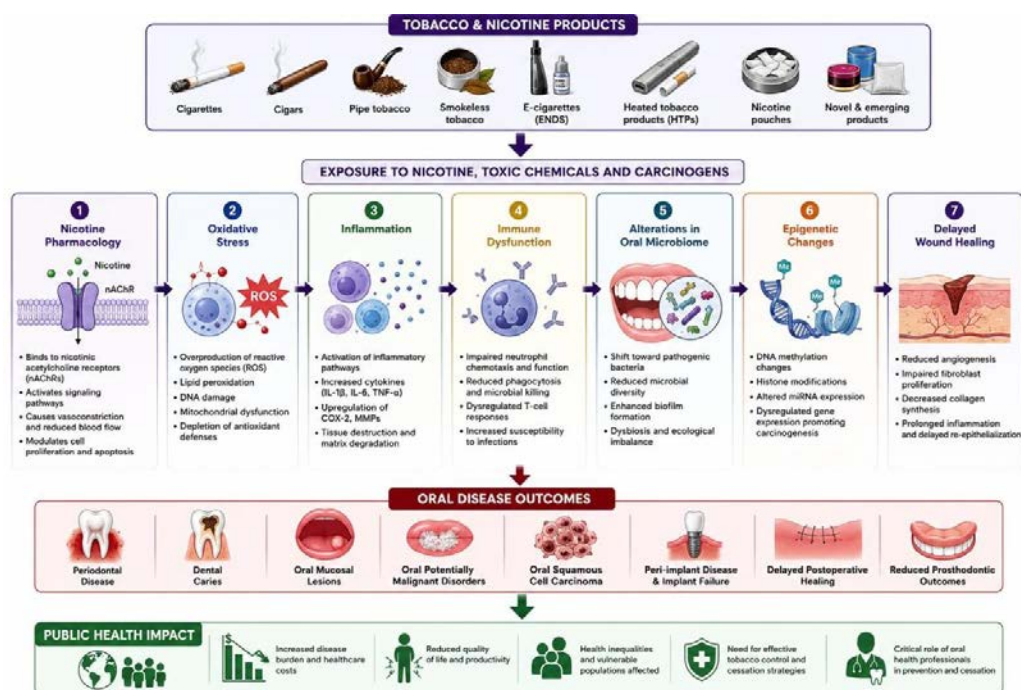


Figure 1. Biological mechanism of Tobacco induced oral disease

5. Oral Health Consequences of Tobacco and Nicotine Use

Tobacco and nicotine exposure has extensive effects on oral tissues, affecting both hard and soft tissues through multiple biological pathways, including oxidative stress, chronic inflammation, immune dysregulation, vascular impairment, and microbial alterations. The clinical consequences range from reversible conditions such as tooth discoloration and halitosis to severe diseases including periodontal destruction, oral potentially malignant disorders, oral cancer, impaired wound healing, and compromised outcomes of dental rehabilitation. Although the relationship between conventional tobacco use and oral disease is well established, emerging nicotine products require continued investigation to determine their long-term effects on oral health. [14]

5.1. Dental Caries

The association between tobacco use and dental caries is complex and influenced by factors such as altered

salivary function, oral hygiene practices, dietary behaviors, and socioeconomic determinants. Tobacco exposure may reduce salivary flow, alter saliva composition, promote microbial dysbiosis, and impair protective mechanisms such as buffering capacity and remineralization, potentially increasing susceptibility to dental caries. [15] Smokeless tobacco products containing sweeteners and flavoring agents may further contribute to localized changes in the oral environment. Additionally, individuals who use tobacco products often demonstrate higher prevalence of untreated dental disease due to reduced utilization of preventive dental services. [15]

5.2. Periodontal Diseases

Periodontal disease represents one of the most well-established oral consequences of tobacco use. Smoking increases the risk, severity, and progression of periodontitis through several mechanisms, including impaired neutrophil function, altered inflammatory responses, reduced vascular supply, and changes in the subgingival microbiome. [16] Tobacco users often exhibit increased periodontal attachment loss, alveolar bone

destruction, and tooth loss compared with non-users. Nicotine-induced vasoconstriction may mask clinical signs such as gingival bleeding, potentially delaying diagnosis and treatment. [16] Importantly, smoking cessation has been associated with improved periodontal outcomes and enhanced response to periodontal therapy.

5.3. Oral Potentially Malignant Disorders

Tobacco exposure is a major risk factor for oral potentially malignant disorders (OPMDs), which represent lesions with an increased potential for malignant transformation. [17]

5.3.1. Leukoplakia

Oral leukoplakia is one of the most common tobacco-associated potentially malignant lesions. It presents as a white patch that cannot be clinically characterized as another disease and is strongly associated with tobacco exposure, particularly smokeless tobacco use. [18]

5.3.2. Erythroplakia

Erythroplakia is less common but carries a substantially higher risk of dysplasia and malignant transformation compared with leukoplakia. Tobacco and alcohol exposure are recognized contributing factors. [19]

5.3.3. Oral Submucous Fibrosis

Oral submucous fibrosis is a chronic, progressive fibrotic disorder strongly associated with areca nut and tobacco-containing products. It results in mucosal stiffness, restricted mouth opening, functional impairment, and increased risk of oral squamous cell carcinoma. [20]

5.3.4. Oral Cancer

Tobacco use remains the most significant preventable risk factor for oral cancer, particularly oral squamous cell carcinoma. Carcinogenic compounds in tobacco products induce DNA damage, genetic mutations, oxidative stress, and alterations in cellular signaling pathways that contribute to malignant transformation. The risk varies according to product type, duration and intensity of exposure, and combined exposure with alcohol. Early identification of tobacco-related mucosal changes and routine oral cancer screening by dental professionals are essential components of prevention strategies. [21]

5.3.5. Oral Mucosal Lesions

Tobacco use is associated with various oral mucosal alterations, including smoker's melanosis, nicotine stomatitis, tobacco pouch keratosis, and chronic mucosal irritation. These changes may reflect direct chemical irritation, increased melanin production, inflammatory responses, or adaptive epithelial changes caused by prolonged exposure. Recognition of these lesions is important because some may indicate continued carcinogenic exposure and increased risk of malignant transformation. [22]

5.3.6. Tooth Discoloration and Halitosis

Extrinsic tooth staining and halitosis are common consequences of tobacco use. Tar and other combustion

products from tobacco smoke adhere to enamel surfaces, resulting in discoloration and aesthetic concerns. Tobacco also promotes changes in oral microbial composition and reduces salivary cleansing, contributing to persistent malodor and impaired oral hygiene. These effects may negatively influence patient confidence, social interactions, and quality of life. [23]

5.3.7. Xerostomia

Tobacco and nicotine exposure may contribute to xerostomia through alterations in salivary gland function, reduced salivary secretion, and medication or behavioral factors associated with tobacco use. Reduced salivary flow increases susceptibility to dental caries, mucosal discomfort, difficulty wearing dentures, and impaired oral function. Xerostomia is particularly relevant among older adults and patients requiring prosthodontic rehabilitation. [24]

5.3.8. Dental Implant Failure

Tobacco use negatively influences implant therapy outcomes by impairing osseointegration, increasing peri-implant inflammation, and delaying healing around implant surfaces. Nicotine-mediated vasoconstriction, reduced oxygen availability, altered immune response, and increased microbial colonization contribute to higher rates of implant failure among smokers compared with non-smokers. Smoking cessation before and after implant placement significantly improves treatment predictability. [25]

5.3.9. Delayed Surgical Healing

Tobacco exposure adversely affects surgical outcomes by impairing angiogenesis, fibroblast activity, collagen synthesis, and immune response. These effects contribute to delayed wound healing, increased postoperative complications, and higher risk of infection following oral surgical procedures. Patients undergoing extractions, periodontal surgery, implant placement, or maxillofacial reconstruction may benefit from preoperative tobacco cessation interventions. [26]

5.3.10. Prosthodontic Considerations

Tobacco use has important implications in prosthodontic care, affecting both treatment planning and long-term outcomes. Smoking may contribute to periodontal deterioration, implant complications, mucosal irritation, reduced denture tolerance, and compromised tissue adaptation following prosthetic rehabilitation. In patients requiring maxillofacial prosthetic rehabilitation, tobacco cessation is particularly important because improved tissue health and healing are essential for successful functional and aesthetic outcomes. [27]

5.3.11. Salivary Biomarkers

Saliva represents a promising non-invasive diagnostic medium for evaluating the biological effects of tobacco exposure and detecting early disease changes. Tobacco use has been associated with alterations in salivary inflammatory mediators, oxidative stress markers, DNA damage indicators, and microbial profiles. Salivary biomarkers may provide future opportunities for risk assessment, early detection of oral disease, and personalized prevention strategies; however, further

validation is required before widespread clinical application. [28]

6. Comparative Effects of Different Tobacco and Nicotine Products

The rapid diversification of tobacco and nicotine products has created challenges in evaluating their relative risks and clinical implications. While combustible

cigarettes remain the most harmful and extensively studied tobacco product due to the generation of smoke containing numerous carcinogens and toxic chemicals, alternative nicotine products may also produce biological effects relevant to oral health. The following table summarizes the current understanding of major tobacco and nicotine products, focusing on exposure characteristics, oral health effects, and public health considerations. [29,30,31,32,33] Table 2

Table 2. Comparative Effects of Different Tobacco Products

Product Category	Primary Exposure Characteristics	Oral Health Effects	Current Evidence and Public Health Considerations
Combustible Cigarettes	Burning tobacco generates smoke containing nicotine, tar, carbon monoxide, carcinogens, and reactive oxygen species.	Strongly associated with periodontal disease, oral cancer, oral mucosal lesions, impaired wound healing, implant failure, tooth discoloration, and halitosis.	Considered the most harmful tobacco product. Extensive evidence supports a causal relationship between cigarette smoking and oral diseases. Smoking cessation significantly improves oral and systemic health outcomes.
Electronic Cigarettes (ENDS)	Devices heat nicotine-containing liquids to produce aerosols containing	May contribute to xerostomia, mucosal irritation, inflammatory	Although exposure to some combustion-related toxicants is lower compared with cigarettes, e-cigarettes
	nicotine, flavoring agents, metals, and other chemical compounds.	changes, oxidative stress, altered oral microbiome, and possible periodontal effects. Long-term effects remain uncertain.	are not risk-free. Increasing use among adolescents and young adults remains a major public health concern.
Heated Tobacco Products (HTPs)	Heat processed tobacco without combustion, producing nicotine-containing aerosols with reduced levels of some toxicants compared with cigarette smoke.	Potential effects include inflammatory changes, oxidative stress, altered periodontal environment, and impaired tissue response. Long-term oral health outcomes are still under investigation.	Marketed as reduced-risk alternatives; however, independent long-term evidence regarding oral and systemic health effects remains limited.
Smokeless Tobacco Products	Oral placement of tobacco products such as chewing tobacco, snuff, gutka, khaini, and tobacco-containing betel quid results in prolonged exposure to nicotine and carcinogens.	Strongly associated with oral potentially malignant disorders, oral submucous fibrosis, leukoplakia, gingival recession, periodontal disease, and oral cancer.	Particularly significant in South Asia and other regions where traditional products are culturally prevalent. Considered a major contributor to oral cancer burden.
Nicotine Pouches	Tobacco-free oral products containing nicotine, flavoring agents, and fillers	Potential effects include localized mucosal irritation, gingival changes, altered microbial	Rapidly increasing popularity, especially among young adults. Their role as smoking cessation aids versus products
	placed between the lip and gingiva.	environment, and nicotine-related effects; long-term evidence is limited.	promoting nicotine dependence remains debated.
Dual/Poly- Tobacco Users	Concurrent use of multiple products (e.g., cigarettes plus e-cigarettes or smokeless tobacco).	May result in cumulative nicotine exposure, persistent oral tissue injury, and continued risk of periodontal disease and oral lesions.	Increasingly recognized as a challenge for tobacco control because switching between products may maintain nicotine dependence rather than promote cessation.

7. Public Health Perspectives

Tobacco-related oral diseases remain a significant public health concern, contributing substantially to the global burden of preventable morbidity and healthcare costs. Tobacco use is a major risk factor for periodontal disease, oral potentially malignant disorders, and oral cancer, disproportionately affecting populations in low- and middle-income countries where tobacco consumption is high and access to preventive healthcare is often limited. The increasing use of emerging nicotine products further highlights the need for effective tobacco control policies, oral health promotion, and early prevention strategies. [34,35]

The burden of tobacco-related oral diseases is strongly influenced by social determinants of health. Individuals with lower socioeconomic status and educational attainment generally have higher tobacco use prevalence and poorer oral health outcomes due to limited health literacy and reduced access to preventive care. [36] Rural

communities frequently experience additional barriers, including shortages of dental professionals, financial constraints, and geographic inaccessibility to oral healthcare services. Similarly, racial and ethnic minority populations often face disparities in tobacco exposure, healthcare utilization, and disease burden resulting from broader social and structural inequities. Addressing these disparities requires comprehensive public health approaches that integrate tobacco cessation, oral health education, equitable access to dental care, and policies targeting the social determinants of health. [37]

8. Tobacco Cessation in Dentistry

8.1. Role of Dental Professionals in Tobacco Cessation

Tobacco cessation is one of the most effective interventions for reducing the burden of tobacco-related oral and systemic diseases. Because tobacco use is

associated with periodontal disease, oral potentially malignant disorders, oral cancer, peri-implant diseases, and impaired wound healing, dental professionals are uniquely positioned to identify tobacco users and initiate evidence-based cessation interventions during routine clinical care. Regular dental visits provide repeated opportunities to screen patients, educate them about the oral consequences of tobacco use, assess nicotine dependence, and encourage quitting. Even brief advice delivered by dental professionals has been shown to increase quit attempts and improve long-term abstinence rates. [38]

8.2. Evidence Supporting Dental-Based Tobacco Cessation

A growing body of evidence supports the effectiveness of tobacco cessation interventions delivered in dental settings. Systematic reviews have demonstrated that behavioral counseling provided by dentists and dental hygienists, particularly when combined with pharmacotherapy, significantly improves smoking cessation outcomes compared with usual care. Integrating cessation services into routine dental practice not only reduces tobacco use but also improves periodontal treatment outcomes, wound healing, implant success, and overall oral health. [39]

8.3. The 5A's Model

The **5A's model** is the most widely recommended evidence-based framework for tobacco cessation in healthcare settings.

- **Ask:** Identify and document tobacco use at every patient visit.
- **Advise:** Provide clear, personalized advice to quit.
- **Assess:** Determine the patient's willingness to quit.
- **Assist:** Offer behavioral counseling, pharmacotherapy, and educational resources.
- **Arrange:** Schedule follow-up visits to monitor progress and prevent relapse.

The 5A's model can be implemented efficiently during routine dental appointments and forms the foundation of tobacco cessation counseling. [40]

8.4. The 5R's Model

For patients who are unwilling or not yet ready to quit, the **5R's model** is recommended to enhance motivation for behavior change.

- **Relevance:** Explain why quitting is personally important.
- **Risks:** Discuss the oral and systemic risks of continued tobacco use.
- **Rewards:** Highlight the health and quality-of-life benefits of cessation.
- **Roadblocks:** Identify barriers that may prevent quitting.
- **Repetition:** Reinforce these messages during subsequent visits.

This patient-centered approach helps increase readiness to quit while respecting individual motivation and

circumstances. [41]

8.5. Brief Behavioral Counseling

Brief behavioral counseling is a practical intervention that can be delivered within a few minutes during routine dental visits. Counseling should include assessment of tobacco use, discussion of individual triggers, advice on coping with withdrawal symptoms, assistance in selecting a quit date, and reinforcement of the oral health benefits of cessation. Incorporating clinical findings, such as periodontal disease or oral mucosal lesions, can strengthen patient motivation by demonstrating the direct effects of tobacco use on oral health. [42]

8.6. Motivational Interviewing

Motivational interviewing is a patient-centered counseling technique that aims to resolve ambivalence and strengthen intrinsic motivation for behavior change. It emphasizes empathy, active listening, and collaborative goal setting rather than confrontation. Evidence suggests that motivational interviewing improves patient engagement and increases smoking cessation rates, particularly among individuals who are initially reluctant to quit. [43]

8.7. Pharmacotherapy

Pharmacotherapy should be considered for patients with nicotine dependence, particularly when combined with behavioral counseling.

8.7.1. Nicotine Replacement Therapy (NRT)

Nicotine replacement therapy is considered first-line treatment for tobacco dependence and is available as transdermal patches, chewing gum, lozenges, inhalers, and nasal sprays. NRT reduces withdrawal symptoms and nicotine cravings by providing controlled doses of nicotine without exposure to harmful combustion products. [44]

8.7.2. Varenicline

Varenicline is a partial agonist of the $\alpha 4 \beta 2$ nicotinic acetylcholine receptor that reduces nicotine cravings while decreasing the rewarding effects of smoking. It has consistently demonstrated higher smoking cessation rates than placebo and several alternative therapies. [45]

8.7.3. Bupropion

Bupropion is an atypical antidepressant that aids smoking cessation by modulating dopaminergic and noradrenergic neurotransmission. It reduces withdrawal symptoms and nicotine cravings and is an effective alternative for patients who cannot use varenicline or nicotine replacement therapy. [46]

8.7.4. Cytisine

Cytisine is a plant-derived partial nicotinic receptor agonist that has recently gained attention as a cost-effective smoking cessation medication. Clinical studies suggest that its efficacy is comparable to varenicline, however, its availability varies across countries. [47]

8.8. Referral Pathways

Patients with severe nicotine dependence, repeated unsuccessful quit attempts, psychiatric comorbidities, or complex medical conditions should be referred to specialized tobacco cessation services, primary care physicians, behavioral health professionals, or national quitline programs. Collaboration with multidisciplinary healthcare teams enhances treatment success and ensures comprehensive patient care. [46]

8.9. Follow-up Protocols

Follow-up is essential for maintaining long-term abstinence and preventing relapse. Patients should be reassessed after their quit date to evaluate progress, manage withdrawal symptoms, reinforce motivation, and adjust treatment strategies when necessary. Follow-up may be conducted during routine dental appointments or through telephone calls, telehealth services, or digital health applications. Continuous support and repeated reinforcement substantially improve long-term smoking cessation outcomes. [47] [Figure 2]

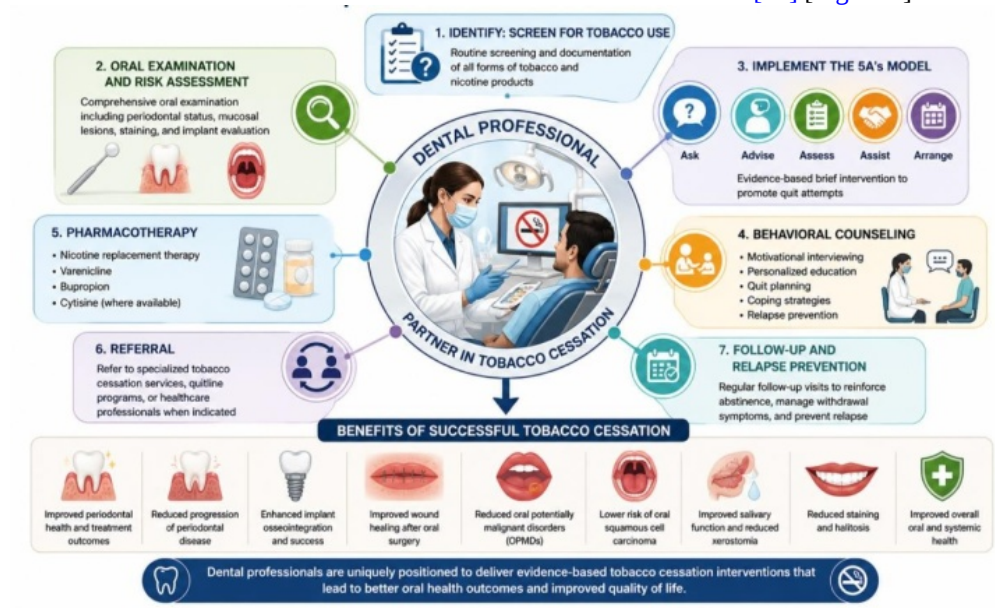


Figure 2. Role of Dental Professionals in Tobacco cessation

9. Future Directions

Advances in digital health, artificial intelligence (AI), and precision medicine are transforming tobacco cessation and oral healthcare. Emerging technologies have the potential to improve early detection of tobacco-related oral diseases, personalize cessation interventions, enhance patient engagement, and expand access to preventive care. Integrating these innovations into routine dental practice and public health programs may strengthen tobacco control efforts and improve long-term oral health outcomes.

9.1. Artificial Intelligence

Artificial intelligence is increasingly being applied in dentistry to support disease detection, risk assessment, clinical decision-making, and patient management. AI algorithms have shown promise in identifying tobacco-related oral lesions, detecting early signs of oral cancer from clinical images, and assisting clinicians in diagnosis. AI-powered decision support systems may also help identify tobacco users at high risk of adverse oral health outcomes and facilitate evidence-based treatment planning. [48]

9.1.1. Personalized Tobacco Cessation

AI-driven predictive models can enable personalized

tobacco cessation by analyzing demographic, behavioral, clinical, and genetic factors to tailor counseling strategies and pharmacotherapy. Personalized interventions have the potential to improve patient adherence, optimize treatment selection, and increase long-term quit rates compared with standardized approaches. [49]

9.1.2. Risk Prediction

Machine learning models are increasingly being developed to predict the risk of periodontal disease, oral cancer, treatment failure, and relapse among tobacco users. Early risk prediction may allow targeted preventive interventions and more effective allocation of healthcare resources. [50]

9.2. Teledentistry

Teledentistry offers an effective platform for delivering tobacco cessation counseling, follow-up consultations, and oral health education, particularly for individuals living in rural and underserved communities. Remote consultations can improve access to care, facilitate timely referrals, and support continuous monitoring of patients attempting to quit tobacco. [51]

9.3. Mobile Health (mHealth)

Mobile health technologies, including smartphone applications, text messaging services, and wearable-

connected platforms, provide accessible tools for tobacco cessation. These technologies can deliver educational content, medication reminders, motivational messages, progress tracking, and real-time behavioral support, improving patient engagement and treatment adherence. [52]

9.4. Digital Behavioral Interventions

Digital behavioral interventions, including web-based counseling programs, interactive educational modules, virtual coaching, and chatbot-assisted support, have emerged as effective adjuncts to traditional cessation strategies. These interventions offer scalable, cost-effective solutions that can complement counseling provided in dental settings and facilitate long-term behavior change. [53]

9.5. Precision Public Health

Precision public health combines clinical, behavioral, environmental, and population-level data to develop targeted tobacco control strategies. By identifying high-risk populations and tailoring preventive interventions according to demographic and socioeconomic characteristics, precision public health may enhance the effectiveness of tobacco cessation programs while reducing oral health disparities. [54]

9.6. Salivary Diagnostics

Saliva is increasingly recognized as a valuable, non-invasive diagnostic medium for detecting biomarkers associated with tobacco exposure, oxidative stress, inflammation, and early malignant transformation. Advances in salivary diagnostics may facilitate early disease detection, monitor treatment response, and support personalized preventive strategies in tobacco users. [55]

9.7. Wearable Technologies

Wearable devices and biosensors represent an emerging area in tobacco cessation and oral healthcare. These technologies can monitor physiological parameters, detect smoking behaviors, provide real-time feedback, and integrate with mobile health platforms to deliver personalized cessation support. Although still in early stages of development, wearable technologies may play an important role in future tobacco control programs and patient-centered oral healthcare. [56]

10. Conclusion

Tobacco and nicotine use continue to pose a significant threat to oral and general health, contributing to a wide spectrum of conditions ranging from periodontal disease and oral potentially malignant disorders to oral cancer and impaired treatment outcomes. While the harmful effects of conventional tobacco products are well established, the increasing use of emerging nicotine products presents new challenges that require continued research and careful public health surveillance.

Dental professionals play a pivotal role in tobacco prevention and cessation through early detection, patient education, behavioral counseling, pharmacotherapy, and timely referral. Integrating evidence-based tobacco cessation strategies into routine dental practice can substantially reduce the burden of tobacco-related oral diseases while improving both oral and systemic health outcomes. From a public health perspective, reducing tobacco-related oral diseases requires a comprehensive approach that combines effective tobacco control policies, equitable access to oral healthcare, community-based prevention programs, and interdisciplinary collaboration. Future efforts should focus on strengthening the role of dentistry in tobacco control while leveraging advances in artificial intelligence, digital health technologies, salivary diagnostics, and precision public health to support personalized prevention and cessation strategies. Continued high-quality research is essential to better understand the long-term oral health effects of emerging nicotine products and to guide evidence-based clinical practice and public health policy.

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