Align Technology Position on Oral Health and Older Adults

I. Oral Health: A Cornerstone of Healthy Aging

The global demographic landscape is shifting in significant ways. Worldwide, the older adult population is growing at a faster rate than those in other age ranges, and the number of people aged 65 and older globally is anticipated to double over the next 30 years, reaching around 1.6 billion by 2050. In the U.S., the EU, China, Australia and New Zealand, older adults already constitute at least 15-18% of the overall population. In some developed countries, like Sweden, Norway, Germany or France, adults aged 65 and over already make up around one-fifth of the populace, while in Italy or Japan, they account for as much as 30%. In all these countries, the number of older adults is projected to surpass that of younger individuals within the next two decades. While increased longevity is a significant achievement, ensuring the health and well-being of this growing older population poses a major public health and socioeconomic challenge.[1]

The WHO recognizes oral health as a critical component of healthy aging. It is essential for basic functions such as nutrition and speech as well as social confidence and overall quality of life. And more importantly, research is increasingly finding that oral health is a key component of overall health, with a bidirectional relationship between oral diseases – such as dental caries, periodontitis, and edentulism (the loss of all teeth) – and infections such as community acquired pneumonia and major non-communicable diseases (NCDs) like diabetes and cardiovascular disease.[2] There is also substantial evidence linking oral health to overall mental wellbeing, with established links between oral disease, dementia and Alzheimer's, and a growing consenus that poor oral health leads to increased rates of depression, anxiety and social isolation in older adults.[3]

Innovative dental technologies such as intraoral scanners, advanced imaging technologies, AI-supported diagnosis, treatment planning and treatment as well as remote and telehealth diagnosis and treatment supervision and patient monitoring can play a pivotal role in supporting oral health and mitigating these age-related challenges.

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[1] FDI World Dental Federation (2018), Oral Health for an Ageing Population; U.S. Department of Health and Human Services (HSS) (2021), Oral Health in America. Advances and Challenges: 4; European Union (2020): Ageing Europe – statistics on population developments, accessed April 2025; Madison Trust Company, The Top 50 Countries with the Largest Percentage of Population Aged 65 and Up, accessed May 2025.

[2] UN Decade of Healthy Ageing: Plan of Action 2021-2030 (2021); PE Petersen and T Yamamoto (2005), Improving the oral health of older people: the approach of the WHO Global Oral Health Programme, Community Dentistry and Oral Epidemiology 33(2): 81–92.

[3] AR Kamer et al. (2008), Inflammation and Alzheimer's disease: possible role of periodontal diseases, A&D 4(4):242–50; IF Díaz-Garcia et al. (2022), Oral Health and Prevention in Older Adults, in: Oral Health Care – An Important Issue of the Modern Society, ed. LC Ardelean and LC Rusu, Dentistry. IntechOpen. doi:10.5772/intechopen.95132; G Bolukbasi and N Dundar (2024), Oral health in older adults: current insights and tips, J Gerontol Geriatr 72(2):96-107.

II. Challenges in Accessing Oral Health Care for Aging Populations

Despite being largely preventable by means of regular oral health screenings, dental services and maintenance of basic oral hygiene, oral diseases are highly prevalent among older adults. Globally, approximately 23% of people aged 60 and older and between 30-40% of those above age 75 are edentulous – lacking any natural teeth. Over 40-50% of adults aged 60 and above (and roughly 60% of those over 75) suffer from some form of periodontitis or severe gum disease.[4]

Beyond age-related physiological changes, a lack of access to dental services puts many older adults at high risk of oral disease even in developed regions. Physical and cognitive impairments can restrict the ability to perform oral hygiene tasks or limit regular in-office visits to dental care providers. Additional barriers – such as mobility limitations, transportation challenges or social isolation – further limit access to care, particularly for homebound individuals and those who may reside in long-term care facilities.[5] Societal ageism and acceptance that a decline in oral health is a normal part of old age also contribute to a de-prioritization of consistent dental care, resulting in a low awareness among older adults and their caregivers of the critical importance of oral health in later life.[6] Greater understanding of the causal links between oral healthcare and overall health are leading to growing efforts to overcome these barriers and to bring screening and consultation directly to patients by using digital solutions, including tele-dentistry platforms and mobile intraoral scanning technologies.[7]

[4] WHO (2022), Global oral health status report: 43; Centers for Disease Control and Prevention (2024), Oral Health Surveillance Report: Dental Caries, Tooth Retention, and Edentulism, United States 2017–March 2020: 24; S Jacob (2012), Global prevalence of periodontitis: A literature review, IAJD 3(1):26-30; PI Eke et al. (2018), Periodontitis in U.S. Adults: National Health and Nutrition Examination Survey 2009–2014, JADA 149(7):576–88; WHO (2023), Global oral health status report. Towards universal health coverage for oral health by 2030. Summary of the WHO European Region: 12.

[5] P Crete et al. (2018), Access to preventive oral health services for homebound populations: a pilot program, Journal of Dental Hygiene 92(6):24–32; S Zimmerman et al. (2017), Readily Identifiable Risk Factors of Nursing Home Residents' Oral Hygiene: Dementia, Hospice, and Length of Stay, Journal of the American Geriatric Society 65(11):2516–2521.

[6] FDI World Dental Federation (2018), Oral Health for an Ageing Population; Association of State & Territorial Dental Directors (2024), Older Adults and Oral Health: A Continuing Challenge: 8.

[7] SE Alavi et al. (2024), Assessment of teledentistry in improving access to dental care: a systematic review, Aust D J 70(1):4-41; R Thakkar et al. (2024), Connecting Smiles: Bridging Gaps in Oral Health Access with Teledentistry, in: A Comprehensive Overview of Telemedicine, ed. TF Heston and CR Doarn, Biomedical Engineering. IntechOpen. doi:10.5772/intechopen.1002138; G. Goffin et al. (2024), Role of teledentistry in enabling improved oral care outcomes, Br Dent J 236:162-168; F Angelone et al. (2023), Diagnostic applications of intraoral scanners: A systematic review, J Imaging 9(7):134.

III. The Critical Link between Oral Health and Non-Communicable Diseases

Oral health is not merely a quality-of-life issue; it is a vital component of systemic health. Increasingly, evidence links poor oral health to the onset and progression of major NCDs – underscoring the need for integrated care models and the utilization of innovative digital dentistry tools to enable frequent and consistent oral health monitoring.[8]

- **Diabetes**: A well-documented bidirectional relationship exists between periodontal disease and diabetes. Individuals with diabetes are three times more likely to develop periodontitis, which in turn impairs glycemic control. Treatment of periodontal disease, combined with good oral hygiene and steps such as managing sugar intake, has been shown to lower systemic inflammation and improve blood glucose regulation.[9]
- **Cardiovascular Disease (CVD)**: Periodontitis has been associated with an elevated risk of CVD, and its treatment may contribute to better cardiovascular outcomes. Tooth loss is also linked to increased CVD risk. The inflammatory response triggered by periodontitis appears to exacerbate atherosclerotic vascular disease in a two-way mechanism.[10]
- **Neurodegenerative Diseases**: Studies suggest connections between periodontal disease, edentulism, and dementia. Some research indicates that periodontal pathogens may contribute to the buildup of amyloid beta – a hallmark of Alzheimer's.[11]

[8] FDI World Dental Federation (2018), Oral Health for an Ageing Population; HSS (2021), Oral Health in America. Advances and Challenges: 3A-25.

[9] D Liccardo et al. (2019), Periodontal disease: a risk factor for diabetes and cardiovascular disease, Int J Mol Sc 20(6):1414; MG Kudiyirickal and JM Pappachan (2015), Diabetes mellitus and oral health, Endocrine 49(1):27–34; H Artese et al. (2015), Periodontal therapy and systemic inflammation in type 2 diabetes mellitus: a meta-analysis, PLoS One 10(5); TC Simpson et al. (2022), Treatment of periodontitis for glycaemic control in people with diabetes mellitus, Cochrane Database Syst Rev 24(4); W Teeuw et al. (2010), Effect of periodontal treatment on glycemic control of diabetic patients: a systematic review and meta-analysis, Diabetes Care (33):33-42.

[10] S Hopkins et al. (2024), Oral Health and Cardiovascular Disease, The Am J Med 137(4):304-307; LL Humphrey et al. (2008), Periodontal disease and coronary heart disease incidence: a systematic review and meta-analysis, J Gen Int Med 23(12):2079–86; A Almeida et al. (2018), Is there an association between periodontitis and atherosclerosis in adults? A systematic review, Cur Vasc Pharmacol 16(6):569– 82; A Bahekar et al. The prevalence and incidence of coronary heart disease is significantly increased in periodontitis: a meta-analysis, Am Heart J 154:830-7; G Aarabi et al., Interaction between periodontal disease and atherosclerotic vascular disease, Atherosclerosis 241(2):555-60.

[11] JM Noble et al. (2013), Poor oral health as a chronic, potentially modifiable dementia risk factor: review of the literature, Curr Neurol Neurosci Rep 13(10):384; YL Lee et al. (2017), Periodontal disease associated with higher risk of dementia: population-based cohort study in Taiwan, J Am Geriat Soc 65(9):1975–80; D Cerutti-Kopplin D et al. (2016), Tooth loss increases the risk of diminished cognitive function: a systematic review and meta-analysis, JDR Clinical & Translational Research 1(1):10–19; K Yaffe et al. (2008), The metabolic syndrome, inflammation, and risk of cognitive decline, J Am Med Assoc 292(18):2237–42; AR Kamer et al. (2008), Inflammation and Alzheimer's disease: possible role of periodontal diseases, A&D 4(4):242–50; PP Tonsekar et al. (2017), Periodontal disease, tooth loss and dementia: Is there a link? A systematic review, Gerodontology 34(2):151–63.

- **Rheumatoid Arthritis (RA)**: Untreated oral infections may worsen RA. Periodontal therapy has been shown to reduce markers of RA disease activity, and certain pathogens may even act as autoimmune triggers.[12]

IV. Digital Dentistry and Intraoral Scanning: Innovation in Elder Care

Align believes that the lack of regular preventive oral health care and oral health hygiene support for many older adults needs to be addressed head on and that digital dentistry can be a critical key to improve access, patient screening, diagnosis, treatment planning and easier and more comfortable patient outcomes.

To this end, Align is participating in a longitudinal study being conducted by the Missouri Office of Dental Health aimed at improving the oral and overall health of people residing in long-term care facilities who are frail or immobile. In particular, the study's goal is to reduce the incidence of nursing-home acquired pneumonia – a highly prevalent infection that drives significant morbidity and mortality and contributes substantially to health care costs (see Executive Summary in the Appendix).[13]

For over 25 years, Align has been continually innovating and expanding the Align Digital Platform – a combination of software, systems and services designed to provide an end-to-end workflow that integrates and connects all users – doctors, labs, and patients. In working to help secure foundational oral health and wellness for patients, Align can influence overall population health and ultimately contribute to reducing the burden and costs of a range of NCDs on society.

Appendix

Executive Summary: Missouri Office of Dental Health Nursing Home Pilot Project

In 2024, the Missouri Office of Dental Health embarked on a pilot project to address high rates of death and serious illness (mortality and morbidity) in nursing home residents related to inadequate levels or the complete absence of oral care in these individuals. The pilot uses a novel solution – telehealth-enabled patient screening, assessment and triage by remote dentists using 3D oral scans and photographs ***(enabled by Align iTero intraoral scanners)*** undertaken and collected by advanced trained dental nurses in the nursing home facilities. Once diagnosed, dentists create an appropriate treatment plan, carry out treatment (either in the nursing home or the dentist's clinic) and monitor patients through follow on care and help the care home staffs support each resident's basic oral hygiene needs.

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[12] S Kaur el a. (2014), Does periodontal treatment influence clinical and biochemical measures for rheumatoid arthritis? A systematic review and meta-analysis, Seminars in Arthritis and Rheumatism 44(2): 113-122; CO Bingham CO III and M Moni (2013), Periodontal disease and rheumatoid arthritis: the evidence accumulates for complex pathobiologic interactions, Current Opinion in Rheumatology 25(3):345-53.

[13] Association of State & Territorial Dental Directors, Dental Public Health Project/Activity Descriptive Report Form, accessed April 2025.

Goals of the pilot are simple: reduce cases of lethal nursing-home acquired pneumonia, reduce the burden of other non-communicable systemic diseases like diabetes and heart disease, and generally improve the oral and overall health of care-home bound elderly residents.

The situation is serious. Inhalation of oral infections is estimated to **cause over 25% of the cases of nursing home-acquired pneumonia (NHAP), the leading cause of death in this population**. While some causes of NHAP like dysphagia (trouble swallowing) are difficult to address, controlling oral infections with simple daily tooth-brushing assistance and regular dental check-ups and cleanings could save and improve the quality of life of thousands and significantly reduce state and federally funded healthcare costs associated with emergency transportation and hospitalization of patients with NHAP.

The pilot began in Missouri in 2024 and is currently expected to run for a total of 3 years. Residents are now enrolled and under care and data is beginning to come in. Additional locations in other states and countries are also being considered. ***Align Technology is supporting this project with the loan of three iTero 5D scanners, user training and support, software updates and consumables.***

The facts are stark:

- Today, there are more than 1.1 million Missourians over the age of 60. Approximately 52,000 older adults in Missouri currently live in licensed care facilities.[14]
- Surveillance by the Missouri Office of Dental Health (ODH) estimates that less than 5% of Missouri nursing home residents have seen a dental professional in the previous 12 months. Review of scientific literature indicates a range of 5% -16%.[15]
- ODH estimates over 75% of the nursing home population have some form of active oral infection: either gum infection from caked accumulated plaque or tooth abscess.[16]
- This is both an oral health ***and*** medical problem because inhalation of oral infections is estimated to cause 26% - 90% of NHAP cases.[17]
- Nursing home-acquired pneumonia is the #1 reason for the transport of nursing home residents to emergency medical facilities and the leading cause of death in this population,

[14] Missouri Department of Health & Senior Services (2024), Masterplan on Aging, accessed May 2025; Missouri Department of Health & Senior Services (2025), Bed Census, accessed May 2025.
[15] S Zimmermann et al. (2017), Readily Identifiable Risk Factors of Nursing Home Residents' Oral Hygiene: Dementia, Hospice, and Length of Stay, J Am Geriatr Soc 65(11):2516–2521; S Zimmermann et al. (2020), Effectiveness of a Mouth Care Program Provided by Nursing Home Staff vs Standard Care on Reducing Pneumonia Incidence A Cluster Randomized Trial, JAMA New Open 3(6):e204321.
[16] ODH Surveillance.
[17] S Zimmermann et al. (2020), Effectiveness of a Mouth Care Program Provided by Nursing Home Staff vs Standard Care on Reducing Pneumonia Incidence A Cluster Randomized Trial, JAMA New Open 3(6):e204321; K Hama et al. Pneumonia incidence and oral health management by dental hygienists in long-term care facilities: A 1-year prospective multicentre cohort study, Gerodontology 39(4):374-383; 48; S Munro and D Baker (2018), Reducing missed oral care opportunities to prevent non-ventilator-associated hospital-acquired pneumonia at the Department of Veterans Affairs, Applied Nursing Research 44:48-53.

with 1 – 1.2 cases of NHAP per 1000 residential days and with a **37% 60-day mortality rate and a 67% mortality rate 12 -24 months after** the first occurrence.[18]

- Studies show that the incidence of NHAP can be reduced by over 26% by regular dental cleanings and by helping nursing home residents brush their teeth daily.[19]
- Each time a patient is hospitalized with NHAP the cost is approximately $38,000. The cost savings from avoiding these hospitalizations would more than pay for providing infection-control dental care to nursing home residents.[20]
- In addition to NHAP, studies also show that oral infections significantly impact and can worsen systemic diseases such as diabetes, atherosclerotic vascular disease, and rheumatic arthritis.[21]

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[18] S Ocrospoma and MI Restrepo MI (2024), Severe aspiration pneumonia in the elderly, J Intensive Med 10;4(3):307-317; A Putot et al. (2023), Long-term survival after aspiration pneumonia in older inpatients: a comparative study, J Am Med Dir Assoc 24:1088–91; DR Mehr et al. (1998), Mortality from lower respiratory infection in nursing home, J Fam Pract 47(4):298-304; Mills et al. (2009), Treatment of nursing home-acquired pneumonia, American Family Physician 79(11): 976–982; 66; EN Vergis et al. (2001), Pneumonia in Long-term Care: A Prospective Case-Control Study of Risk Factors and Impact on Survival, Arch Intern Med 161(19):2378–2381; A Liapikou et al. (2014), A Worldwide Perspective of Nursing Home-Acquired Pneumonia Compared With Community-Acquired Pneumonia, Respiratory Care 59(7):1078-1085; X Bosch et al. (2012), Aspiration pneumonia in old patients with dementia. Prognostic factors of mortality, European Journal of Internal Medicine 23(8):720-72; M Lopes et al. (2021), Incidence of Antibiotic Treatment Failure in Patients with Nursing Home-Acquired Pneumonia and Community-Acquired Pneumonia, Infect Dis Rep 5/13(1):33-44; R Pereira et al. (2016), Nursing home-acquired pneumonia presenting at the emergency department, Intern Emerg Med 11(7):999-1004.

[19] S Zimmermann et al. (2017), Readily Identifiable Risk Factors of Nursing Home Residents' Oral Hygiene: Dementia, Hospice, and Length of Stay, J Am Geriatr Soc 65(11):2516–2521; S Munro and D Baker (2018), Reducing missed oral care opportunities to prevent non-ventilator associated hospital acquired pneumonia at the Department of Veterans Affairs, Applied Nursing Research 44: 48-53.

[20] S Munro and D Baker (2018), Reducing missed oral care opportunities to prevent non-ventilator associated hospital acquired pneumonia at the Department of Veterans Affairs, Applied Nursing Research 44: 48-53; CP Wu CP et al. (2017), National Trends in Admission for Aspiration Pneumonia in the United States, 2002-2012, Ann Am Thorac Soc 14(6):874-879; KK Giuliano et al. (2023), Incidence, mortality, and cost trends in nonventilator hospital-acquired pneumonia in Medicaid beneficiaries, 2015-2019, Am J Infect Control 51(2):227-230.

[21] K Mills et al. (2009), Treatment of nursing home-acquired pneumonia, American Family Physician 79(11):976–982; M Son et al. (2020), Association between oral health and incidence of pneumonia: a population-based cohort study from Korea, Sci Rep 12/10(1):9576; K Hama et al. (2022), Pneumonia incidence and oral health management by dental hygienists in long-term care facilities: A 1-year prospective multicentre cohort study, Gerodontology 39(4):374-383; S Awano et al. (2008), Oral health and mortality risk from pneumonia in the elderly, J Dent Res 87:334-339; S Munro and D Baker (2018), Reducing missed oral care opportunities to prevent non-ventilator associated hospital acquired pneumonia at the Department of Veterans Affairs, Appl Nurs Res 44:48-53; CM Barnes (2014), Dental hygiene intervention to prevent nosocomial pneumonias, J Evid Based Dent Pract 14 Suppl:103-14; CD van der Maarel-Wierink et al. (2011), Meta-analysis of dysphagia and aspiration pneumonia in frail elders, J Dent Res 90:1398-1404; H Artese et al. (2015), Periodontal therapy and systemic inflammation in type 2 diabetes mellitus: a meta-analysis, PLoS One 10(5):e0128344; D Liccardo et al. (2019), Periodontal disease: a risk factor for diabetes and cardiovascular disease, Int J Molecular Science 20(6):1414; TC Simpson et al. (2022), Treatment of periodontitis for glycaemic control in people with diabetes mellitus, Cochrane Database Syst Rev 14(4); W Teeuw et al. (2010), Effect of periodontal treatment on glycemic control of diabetic patients: a systematic review and meta-analysis, Diabetes Care 33:33-42; A Bahekar et al. (2007), The prevalence and incidence of coronary heart disease is significantly increased in periodontitis: a meta-analysis, Am Heart J 154:830-7; IM Velsko, IM et al. (2014), Active invasion of oral and aortic tissues by Porphyromonas gingivalis causally links periodontitis and atherosclerosis, PLoS One 9:e97811; G Aarabi et al. (2015), Interaction between periodontal disease and atherosclerotic vascular disease—Fact or fiction? Atherosclerosis 241(2):555-60; S Hopkins et al. (2024), Oral Health and Cardiovascular

Data sources and references for the statistics are available on request.

Disease, The American Journal of Medicine 137(4):304-307; S Kaur et al. (2014), Does periodontal treatment influence clinical and biochemical measures for rheumatoid arthritis? A systematic review and meta-analysis, Seminars in Arthritis and Rheumatism 44(2):113-122; CO Bingham III and M Moni (2013), Periodontal disease and rheumatoid arthritis: the evidence accumulates for complex pathobiologic interactions, Curr Opin Rheumatol 25(3):345-53.