

REFERENCE

Marusiak MJ, Paulden M, Ohinmaa A. Professional oral health care prevents mouth–lung infection in long-term care homes: a systematic review. *Can J Dent Hyg.* 2023;57(3):180–90.

Supplementary Table S2. Description and findings (primary outcomes) of professional oral health care interventions (N = 13)

POHC program	Author, date, study design	Population (LTC home residents)	Intervention	Comparison (control group)	Primary & secondary outcome measures	Major findings, odds ratio (OR), risk ratio (RR)	Conclusions
Service provision only	Yoneyama et al. 1996 ²⁴ (Japan) RCT	46 LTC residents in 1 home. Intervention Group A: 21 residents, mean age 77 years (70 to 84) Intervention Group B: 25 residents, mean age 79 years (70 to 88)	During Period II (Group A) and during Period III (Group B), residents received POHC from a dentist and dental hygienist once/day for 6 months; mouth cleansed by nurses after each meal by gargling/swabbing pharynx with povidone iodine (1%)	Period I (first 6 months): Usual care only to Group A and Group B Period II Group A: POHC Group B: No POHC, only usual care Period III Group A: No POHC, only usual care Group B: POHC	Primary: Oral care improved febrile days ^a to a limited extent Secondary: Little difference in improved febrile days ^a between Group A and Group B	Incidence Group A: RR: 0.66; AR: POHC once/day: 10%; NNT: 10% Group B: RR: 0.88; AR: POHC program: 4%; NNT: 25%	Assuming causality, the exposure to POHC once/day from a dentist or dental hygienist for 6 months prevents disease, number of sputum.
Service provision only	Adachi et al. 2002 ²⁵ (Japan) RCT	88 dependent elderly in 2 LTC homes requiring daily care over 24 months. Intervention Group: 40 residents Control Group: 48 residents	Dental hygienists performed POHC with hand scaling, electric brush with automatic water supply, interdental brush, sponge brush to clean teeth & dentures once/week	Usual care by self-oral care or staff swabbing with sponge brush & denture cleaning	Primary: <i>C. albicans</i> decreased significantly in the treatment group at 6 months Secondary: Prevalence of fevers ^b & fatal AP ratio decreased significantly in the treatment group	Incidence Numbers of <i>C. albicans</i> in samples before POHC (2000 CFU/mL) compared to after POHC (700 CFU/mL) ($p < 0.01$).	Older adults who need daily nursing care and who received POHC from dental hygienists for 6 months showed a 1300 CFU/mL reduction and 2.9 times difference of reduction in <i>C. albicans</i> compared to going without POHC from dental hygienists.

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Service provision only	Yoneyama et al. 2002 ²⁶ (Japan) RCT	366 residents in 11 LTC homes investigated studied for 2 years. Intervention Group: 184 residents, mean age 82.0 years (74.2 to 89.8) Control Group: 182 residents, mean age 82.1 years (74.6 to 89.6)	Caregivers brushed the residents' teeth for ~5 min. If toothbrushing was ineffective, the oropharynx was swabbed with povidone iodine after each meal. Plus weekly POHC of plaque & calculus control by dentists or dental hygienists. Dentures cleaned with a denture brush daily & denture cleanser once/week	Some residents performed self-toothbrushing once a day or irregularly & none asked for oral care from caregivers. Dentures cleaned with a denture brush daily & denture cleanser once/week	Primary: Oral care significantly reduced plaque & debris; was beneficial in edentate and dentate residents Secondary: Residents receiving oral care had significantly decreased pneumonia rates, febrile days, ^a and deaths from pneumonia compared to control group	Incidence RR: 0.94; AR: professional oral care once/week: 3%; NNT: 33% (2.81, 95% CI = 1.39 to 5.69, $p < 0.01$)	Assuming causality, the exposure to POHC once/week from dentists or dental hygienists for 24 months prevents the disease mean debris indices, compared to the unexposed who did not receive POHC.
Service provision only	Adachi et al. 2007 ²⁷ (Japan) Cross-sectional; first study only	88 residents in 2 LTC homes. Intervention Group: 40 residents Control Group: 48 residents	A dental hygienist brushed teeth using an electric brush with automatic water supply, interdental brush, and sponge brush; cleaned teeth, buccal mucosa, tongue, and dentures	Usual care by resident self-oral care, staff or helper swabbing with sponge brush & denture cleaning	Primary: <i>C. albicans</i> was significantly lower in the POHC group compared to non-POHC group after 6 months Secondary: Fatal AP ratio and prevalence of fever ^b were significantly lower in POHC residents compared to non-POHC over 24-months	Prevalence Numbers of <i>C. albicans</i> were 1200 less in the POHC compared to the non-POHC group ($p < 0.001$). Poor oral hygiene groups had a higher DPI and significantly higher mean number of febrile days ^a than the good oral hygiene groups ($p < 0.01$) in 1 year	After POHC, numbers of <i>C. albicans</i> were significantly lower when compared to the non-POHC group. In the dentate group, the number of febrile days ^a and patients who developed pneumonia were significantly higher in the DPI poor group compared to the DPI good group.
Service provision only (intervals, duration)	Morino et al. 2014 ²⁸ (Japan) RCT	30 dentate residents in 1 LTC home; follow-up at baseline to 5 months.	2 dental hygienists provided manual toothbrushing only, after breakfast once/week for 1 month. Plus, residents received usual care	All residents received usual care by self-care or staff-assisted, at baseline to 5 months, using same products: manual	Primary: DPI significantly improved in the intervention group & was maintained for 3	Incidence DPI showed significant improvement in the intervention	Effect of POHC was maintained for 3 months after the intervention, with no

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& short-term POHC)		Intervention Group: 14 residents, mean age 86.2 years (84.7 to 87.7) Control Group: 16 residents, mean age 84.8 years (83.1 to 86.5)		toothbrush, end-tufted brush, and interdental brush only. Toothbrush, denture cleaner tablet, and ultrasonic cleaner were provided for dentures.	months after the intervention Secondary: DPI of residents with functional dependence (FIM ≤ 5) was significantly decreased	group (57%; 8/14) compared to the control group (13%; 2/16); Fisher's 2-tailed test, $p < 0.05$, (OR, 9.33; 95% CI, 1.74 to 75.66; $p < 0.01$).	differences in the control group. The variable, POHC intervention, showed significant association with ability to predict improvement in DPI
Service provision only (intervals and duration)	Lee et al. 2020 ²⁹ (Korea) RCT	135 residents in 3 LTC homes studied for 12 weeks. Intervention Groups: 38 residents, 1-week intervals, mean age 82.63 years (73.37 to 91.89). 43 residents, 2-week intervals, mean age 83.14 years (75.01 to 91.27). Control Group: 44 residents, mean age 85.02 years (79.26 to 90.78)	POHC provided for 6 minutes/resident; 4 dental hygienists performed denture cleaning using a suction device; teeth & tongue cleaning using rolling, Watanabe & Bass brushing, interdental brushes; mouth rinsing with water; debris removal & tongue wiped using chlorhexidine-soaked sponge brush; resident received an interdental brush, sponge brush, and denture cleanser	No POHC	Primary: POHC at 1-week intervals most significantly decreased, by 2-fold or greater, plaque, tongue coating, and gingival indices & increased saliva flow when compared to the 2-week interval group, relative to the control group Secondary: N/A	Incidence Plaque index decreased significantly by mean 0.90 in 1-week and mean 0.47 in 2-week interval groups (paired t-test, $p < 0.001$) after the intervention when compared to the control group.	Plaque index decreased most significantly in the 1-week interval group, followed by the 2-week interval group which was followed by the control group.
Education only	Schou et al. 1989 ³⁰ (Scotland) RCT	187 "well elderly" residents from 4 different institutions	1. Residents taught only 2. Staff taught only 3. Staff & residents taught Oral health education program comprising 3 one-	No oral health education program. Clinical examinations & questionnaire were completed in each group	Primary: Results showed poor oral health & oral hygiene, high objective need for oral care but low perceived need. Overall prevalence of	Incidence Group A: Staff taught oral health education only.	There was no statistically significant reduction in maxillary denture plaque scores in

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		<p>Intervention Group: 142 residents Control Group: 45 residents</p> <p>Mean age 82 years</p>	hour sessions at monthly intervals in groups of 5 to 6 residents and/or staff provided by 3 dental hygienists with staff in each institution.	before education program (Time 1: Jan 1985) & 2 months after (Time 2: Sept 1985) program was terminated, at 8 months.	denture stomatitis was significantly higher at Time 2 Secondary: N/A	<p><i>Poor score:</i> RR: 1.12; relative risk reduction: 12%</p> <p>Group B: Residents taught oral health education only. <i>Poor score:</i> RR: 0.64; relative risk reduction: 36%</p> <p>Group C: Both residents and staff given oral health education. <i>Poor score:</i> RR: 78%; relative risk reduction: 22%</p> <p>Group D: Control group; no oral health education. <i>Poor score:</i> RR: 137%; relative risk reduction: 37%</p>	the control and intervention groups before and after oral health education. Denture hygiene instruction taught to both residents and staff did not improve oral hygiene habits.
Service provision and education	Mojon et al. 1998 ³¹ (Switzerland) RCT	<p>116 dentate residents</p> <p>Intervention Group: 58 residents (5 wards), mean age 83.5 years (76.3 to 90.7)</p> <p>Control group: 58 residents (7 wards), mean age</p>	<p>Education: For 45 minutes, 1 dental hygienist provided oral health education to groups of 8 to 10 health care providers.</p> <p>POHC: 2 dental hygienists provided prophylaxis, scaling, resident brief oral hygiene instruction, instruction to nurse/nurse aide on extent resident could</p>	<p>Residents were treated by 1 dentist with mobile equipment if the resident, family or home caregivers requested it.</p> <p>Residents who needed dental treatment were treated onsite. Tooth extraction & denture repair were provided when residents' health did not</p>	<p>Primary: Root caries prevalence decreased significantly in intervention group; secondary caries prevalence increased significantly in the control group; <i>Mutans Streptococci</i> counts decreased significantly in the intervention group</p> <p>Secondary:</p>	<p>Incidence</p> <p>Plaque index at 18 months</p> <p>RR: 0.94; AR: POHC: 2%; NNT: 50%</p>	Less disease was observed in the group exposed to POHC than in the unexposed group. Assuming causality, the exposure to the POHC intervention with an RR <1 (RR is 0.94) is

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		84.6 years (77.4 to 91.8)	do self-oral care, & adapted recall system to the needs of the resident with maximum 6 months between visits. Residents received a toothbrush & fluoridated toothpaste at first and following visits.	permit comprehensive procedures.	N/A		preventing the disease plaque index.
Service provision and education	Budtz-Jorgensen et al. 2000 ³² (Belgium) Non-RCT	237 dependent/frail older adults; data collection at baseline and again at 18 months. Intervention Group: 122 residents (5 wards), mean age 85.1 years (66 to 101) Control Group: 115 residents (7 wards), mean age 86.2 years (66 to 101)	2 dental hygienists provided preventive POHC including examination, treatment plan, scaling & prophylaxis, toothbrushes & fluoridated toothpaste, & recall system (dentate max 6 months frequency; edentulous once/year between visits). Oral health education provided to health carers.	No systematic POHC program; teeth cleaned only if requested by dentist using mobile equipment	Primary: Prevalence of glossitis, mucosal lesions, palatal inflammation, denture stomatitis, colony counts, and yeast counts decreased significantly at 18 months Secondary: N/A	Prevalence RR: POHC: 0.7. Significant reduction in the numbers of <i>C. albicans</i> positive residents ($p < 0.05$) in the intervention group at 18-month follow-up. AR: POHC: 20%; NNT: 5%	Both intervention (90%) and control (90%) groups had <i>C. albicans</i> as the predominant yeast species. Assuming causality, exposure to the POHC program with an RR <1 (RR is 0.7) is preventing the disease <i>C. albicans</i> .
Service provision (6- to 18-month screening) and education/motivation, guidelines, standards, new routines	Samson et al. 2009 ³³ (Norway) Repeated cross-sectional non-randomized pretest & post-test design	88 residents; recorded level of oral hygiene before start of the study, after 3 months, and after 6 years Intervention Group: 88 residents Control Group: inherent	1. Educating/motivating nursing staff 2. Oral care cards with guidelines 3. Distribution of oral hygiene aids for standards, e.g., electric brush 4. Implementation of new routines using oral-care contact person 5. 6- to 18-month screening intervals by a dental hygienist to provide regular MPS measuring routines &	No control group	Primary: Statistically significant difference in improved oral hygiene after 3 months, and still significant after 6 years; dentate residents had statistically significant higher mean MPS than edentate residents; Residents with a manifest diagnosis of dementia had significantly better oral hygiene than residents with uncertain cognitive	Prevalence Oral hygiene (MPS) 2 to 4, n (%) baseline, 3 months & 6 years after intervention. Prevalence Ratio: 0.83. Statistically significant improvement in oral hygiene after 3 months ($p < 0.001$) and after 6 years ($p < 0.001$).	6 years after implementing the POHC program, 70% had MPS of 2 to 4 (good/acceptable oral hygiene state). Exposure to POHC program is protective as the prevalence ratio is less than 1; is 0.83 times as likely.

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			feedback to the ward for improvements		impairment ($p = 0.049$); positive correlation between degree of mucosal inflammation and amount of plaque ($r = 0.54$, $p < 0.001$). Secondary: N/A		
Service provision and remotivation, individual oral health instruction, and education	Zenthöfer et al. 2013 ³⁴ (Germany) RCT prospective, single-blinded (outcome evaluation)	102 residents in 8 LTC homes with a 12-week short-term follow-up period & 3-year long-term follow-up. Intervention Group: 79 residents 1: No remotivation (N = 26), no further intervention 2: Dentist remotivation (N = 27), dentist re-instructed & remotivated elderly after 4 & 8 weeks 3: Staff remotivation (N = 26), older adults received help twice/week and were remotivated by minimally educated staff Control Group: 23 residents	All 3 therapy groups had professional teeth & denture cleaning & individual instruction. POHC provided by a dentist using portable ultrasonic unit and polishing; dentures cleaned using ultrasonic bath. Dentist tailored oral hygiene instruction according to oral hygiene needs, manual & cognitive ability, for 30 min.	Usual oral hygiene care (not detailed). Baseline & recall exam performed after 2, 6, and 12 weeks for all 4 groups. At baseline, staff completed 2-hour oral hygiene lesson & provided help to participants twice/week	Primary: Mean plaque, gingival bleeding & denture hygiene indices were significantly lower, showing improved oral hygiene in the intervention group over 12-weeks; Indices were significantly worse than study recall at 3-year long-term follow-up Secondary: N/A	Incidence Primary: Mean Plaque Index in 18 months RR: POHC: 1.17; AR: POHC: 20%; NNT: 5% (95% CI, 29.1%/50.0%, $p < 0.001$, $n = 24$). All 3 groups had significant improvement in hygiene index over time compared to control group ($p < 0.023$); 3 years after the study the plaque index was significantly worse (27.4%, $p < 0.001$) when compared with baseline.	Observed less disease in group exposed to the POHC intervention than in the unexposed group. Assuming causality, exposure to the POHC intervention with an RR >1 (RR is 1.17) is preventing the disease <i>C. albicans</i> . 3 years after assessment, all indices were significantly worse and the mean plaque index increased by 38.0%, meaning effect of POHC with individual instruction decreased over time. Renewal is

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							necessary to maintain improved oral hygiene.
Dental exams & education, weekly hands-on support, customized oral hygiene report, & staff evaluation	Seleskog et al. 2018 ³⁵ (Sweden) RCT short-term study with longitudinal design	37 residents in 2 LTC homes at baseline; 31 residents after a 3-month follow-up. Intervention Group: 13 of 15 residents (2 residents died), mean age 89 years (83 to 95) Control Group: 18 of 22 residents (2 died; 2 refused an examination), mean age 88 years (83 to 93)	Two dental hygienists gave once/week support to nursing staff over 3 months by: 1. Participating in staff meetings at beginning of study, after 6 weeks, & end of study 2. Individualizing theoretical hands-on support per resident once/week 3. Customizing written oral hygiene prescriptions per resident for specialized oral care devices & routines	Usual oral care. Dentist did dental exams of all participating older adults in both LTC homes.	Primary: Dental plaque levels decreased significantly after the 3-month intervention Secondary: Questionnaire from nursing staff did not show significance, just improvement	Incidence Plaque levels after 3 months RR: Oral health educational program: 0.78; AR: oral health educational program: 11%; NNT: 9%. Residents' plaque levels at the intervention LTC home after 3 months were significantly decreased to median 0.9; $p \leq 0.05$. Residents' plaque levels at the control LTC home after 3 months were median 1.7	Observed less disease in the exposed group to the oral health educational program than in the unexposed group. Assuming causality, the exposure to the oral health educational program is preventing the disease plaque levels and improving oral health of residents in LTC homes.
Service provision (frequency and duration) and education and staff evaluation	Girestam Croonquist et al. 2020 ³⁶ (Sweden) RCT Evaluator-blinded open-ended	146 residents from 9 LTC homes randomly assigned to the intervention or control group at the LTC home level.	3 dental hygienists provided POHC of tooth brushing, interproximal cleaning and scaling of supragingival calculus, individual oral hygiene instructions, information & fluoridated toothpaste, soft toothbrush, & interproximal cleaning	Usual daily oral care was self-performed or nursing staff-assisted without any additional visits/instruction from a dental hygienist. N = 15 nursing staff participated at baseline & N = 15 at 6-month follow-	Primary: Significant improvement in MS between 3- and 6-month follow-ups when compared to the control group Secondary: At 6-month follow-up, the intervention group nursing	Incidence MS; from 3- and 6-month follow-ups ($p < 0.04$); RR: POHC and OHI: 0.92; AR: POHC and individual OHI: 7%; NNT: 14%.	Observed less disease in the group exposed to POHC and individual OHI than in the unexposed group. Assuming causality,

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		<p>Intervention Group: N = 72, mean age 89 years (85 to 93), 56 (78%) female, 16 (22%) male</p> <p>Control Group: N = 74, mean age 88.7 years (84.5 to 92.9), 52 (70.3%) female, 22 (29.7%) male</p> <p>At baseline, all residents received professional cleaning, home care instruction, written information, and oral hygiene products. Oral exam performed at baseline, 3 & 6 months.</p>	<p>aids, once/month, for 30 minutes, for 6 months.</p> <p>N = 35 nursing staff participated at baseline & N = 20 at 6-month follow-up, with N = 12 staff followed from baseline to 6-month follow-up & designated as the identified group.</p>	<p>up, with N = 2 staff followed from baseline to 6-month follow-up & designated as the identified group.</p> <p>Nursing staff completed 2 questionnaires to analyze attitudes (priorities) & knowledge regarding oral health care & oral health care needs for care-dependent older adults.</p>	<p>staff working with residents showed statistically significant improvement in OHCB, external and internal loci of control, compared to the control group</p>	<p>Improvement in MS was 20% in the intervention group compared to 13% in the control group. Significant difference in MS between the intervention group and control group between 3- and 6-month follow-ups.</p>	<p>exposure POHC and individual OHI is preventing the disease mucosal scores and improving oral health of residents in LTC homes.</p>

^aFebrile days defined as body temperature above 37°C

^bFevers are 37.8°C+

AP: aspiration pneumonia; AR: risk difference/attributable risk; DPI: Dental plaque index; FIM: functional independence measure; LTC: long-term care; MPS: mucosal plaque scores; MS: mucosal score index; NNT: number needed to treat; OHCB: oral health care beliefs; OHI: oral health instruction; OR: odds ratio; POHC: professional oral health care; RCT: randomized control trial; RR: risk ratio/relative risk

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