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Implementation of a nursing oral health care protocol in a university teaching hospital: A cluster-randomized stepped-wedge design

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Abstract

Introduction: Providing oral care is an essential part of basic nursing care but receives little priority in daily practice, with a risk of adverse events. Also, nurses report many barriers to adequate provision of oral care, such as time restraints, insufficient materials, fear of causing pain, lack of knowledge and a negative attitude towards providing oral care.

Methods: We performed a cluster-randomized, stepped-wedge study to explore the effect of the the implementation of a new nursing evidence-based oral care protocol on nurses' knowledge, attitude and protocol adherence. The study population included both nursing students, graduated nurses and patients in selected wards. The implementation strategy included oral and written information, instruction videos and reminders. Nurses' knowledge and attitude towards oral care were assessed at baseline and after the implementation of the protocol with a validated 47-item questionnaire with a score range of 0–100. Secondarily, nurses' protocol adherence to teeth brushing, measured in Activities of Daily Living (ADL) dependent patients, was evaluated. The Standards for Reporting Implementation Studies (StaRI) Statement was used.

Results: At baseline, the questionnaire was completed by 226 nurses; after implementation by 283. Knowledge had significantly improved from 68.8 to 72.3. Nurses' attitude improved not significantly. Protocol adherence was assessed in 73 ADL-dependent patients at baseline, in 51 after implementation. Adherence to teeth brushing significantly decreased in patients with permanent teeth. Also, adherence to both teeth brushing and usage of soap decreased in patients with (partial) dentures.

Conclusion: Nurses' knowledge and attitude of oral care increased somewhat after the implementation of a new nursing evidence-based protocol. After implementation, there was an unexplained decreased adherence to oral care in ADL-dependent patients.

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1 | INTRODUCTION

Providing oral care is an essential part of basic nursing care[1] but receives little priority in daily practice.[2] Activities of Daily Living (ADL) dependent patients in both hospitals and nursing homes are, therefore, at risk of poor oral health.[3–5] A systematic review by Terezakis et al (2011) concluded that hospitalization is associated with deterioration in oral health, particularly in intubated patients.[6] Poor oral health can contribute to malnutrition, pain, infections, diminished health-related quality of life[1,4,6–8] and could even have fatal consequences such as aspiration pneumonia.[9–11] With the aging of the population, the number of dependent patients with complex oral health is expected to increase.[12]

Furthermore, nursing plans often do not include oral care or include oral care only after problems have occurred.[3–5] Nurses report many barriers to adequate provision of oral care, such as time restraints, insufficient materials, fear of causing pain, lack of knowledge and negative attitude towards providing oral care.[7,13,14]

Previous studies on oral nursing care have mostly been carried out in long-term settings, such as nursing homes and intensive care settings (i.e. ventilated patients). A systematic review found evidence that an oral healthcare education programme improved care home nurses' oral healthcare knowledge and attitude, but not their oral hygiene care skills.[15] An implementation study of an oral healthcare guideline in 12 nursing homes found a significant difference in the presence of denture plaque in residents between the intervention group ($n = 177$) and the control group ($n = 166$).[16] De Visschere and colleagues found that care staff' heavy workload was the greatest barrier to compliance with an oral hygiene protocol in nursing homes.[5] To our knowledge, only three studies on this topic have been performed in hospital general wards.[3,4,17] Ab Malik and colleagues investigated oral health knowledge among stroke-care nurses in a cross-sectional study and found deficiencies in both knowledge and clinical practice.[17] A survey study among general hospital nurses found that the majority of surveyed nurses viewed oral care as an important aspect of nursing, but nevertheless lacked adequate knowledge on oral care.[3] Coker and colleagues investigated nurses' oral hygiene care practices with hospitalized older adults in post-acute settings and found that the provided oral hygiene care was not evidence-based, and not embedded in bedside routines.[4] Currently, it is unclear how oral care is provided in ADL-dependent patients in a Dutch university teaching hospital where only an outdated, not evidence-based protocol is available. Besides that, nurses' level of knowledge and attitude regarding oral care has not been studied before. Because of the importance of sufficient oral care in ADL-dependent patients, we created a new, evidence-based oral care protocol together with dental hygienists.

The aim of this study is to assess the effect of implementation of a new evidence-based nursing oral care protocol in a Dutch university teaching hospital on both nurses' level of oral health-related knowledge and attitude as well as nurses' protocol adherence to oral care in ADL-dependent patients.

2 | METHODS

2.1 | Design

We performed a stepped-wedge, cluster-randomized controlled trial in four clusters of general wards of a 560-bed university teaching hospital in the Netherlands from 1 November 2018 to 1 November 2019. The main advantages of a stepped-wedge design are that the implementation rolls out to all participants and a larger number of ADL-dependent patients (who make up a small proportion of the total patient population) can be included. The trial consisted of three parts: a two-month pre-implementation phase, a four-week implementation phase in which all implementation strategy components were carried out and a 2-month post-implementation phases (Figure 1). An independent statistician assigned randomly the order in which participating clusters started with the implementation phase. Each of the four clusters was made up of two or three clinical units on the same floor, with a total of 10 units (both internal medicine and surgery). Reporting of this study is according to the Standards for Reporting Implementation Studies (StaRI) Statement.[18]

The study population involved nurses and patients from selected units. All nursing students and graduated nurses working on these units were eligible for inclusion. Nursing students were included since in this hospital, they are an integral part of the nursing team, with the same responsibilities towards oral care as registered nurses. A convenience sample was recruited, consisting of nurses at work when the principal investigator visited the relevant unit and who were willing to provide consent.

The aim of this study focused on ADL-dependent patients, defined as patients who were dependent on nurses for oral care, including handing the toothbrush and other necessities or assisting in walking to the bathroom. However, both ADL-independent and ADL-dependent patients were included since we did not know beforehand which patients were ADL-dependent. Only patients who were identified as ADL-dependent were subsequently included for further data analysis. Patients were eligible if they met the following criteria: admitted on selected floors, ≥18 years and Dutch speaking.

	Pre-implementation (T=0)	Phase 1 (T=1)		Phase 2 (T=2)		Phase 3 (T=3)		Phase 4 Post-implementation (T=4)	
Cluster 1 Systemic diseases Renal and vascular diseases	Questionnaire nurses and patients	Four weeks Implementation	Questionnaire patients	Questionnaire patients		Questionnaire patients		Questionnaire nurses and patients	
Cluster 2 Hepato-Pancreato-Biliary diseases Oncological surgery	Questionnaire nurses and patients	Questionnaire patients		Four weeks Implementation	Questionnaire patients	Questionnaire patients		Questionnaire nurses and patients	
Cluster 3 Cardiology Cardiothoracal surgery Lung diseases	Questionnaire nurses and patients	Questionnaire patients		Questionnaire patients		Four weeks Implementation	Questionnaire patients	Questionnaire nurses and patients	
Cluster 4 Neurology Neurosurgery Hematology	Questionnaire nurses and patients	Questionnaire patients		Questionnaire patients		Questionnaire patients		Four weeks Implementation	Questionnaire nurses and patients

FIGURE 1 Study design.

2.2 | Study procedure

2.2.1 | Pre-implementation phase (usual care)

During the 2 months pre-implementation phase, we measured nurses' knowledge and attitude towards oral care, as well as adherence to the existing protocol while usual care was given. The research team provided no special attention to oral care during this period. An oral care protocol was available in the hospital, but was outdated and not evidence-based. A team of nurses and dental hygienists developed a new evidence-based protocol, targeted to Activities of Daily Living (ADL)-dependent adult patients, including ventilated patients. Adjustments in the new protocol are based on the 'The guideline Oral Health Care for dependent residents in long term care facilities'.[19] The main difference between the old and new protocols is the distinction in the new protocol between different tooth types (e.g. dentures and permanent teeth) and the use of evidence-based information in drawing up the new protocol. A summary of the new protocol 'Oral care in ADL-dependent patients' can be found in Appendix 1.

2.2.2 | Implementation period

During the 8-month implementation phase, we implemented the new protocol according to the stepped-wedge design, implying that patients on units where implementation had not yet started received usual oral care. The Implementation Model of Change of Grol and Wensing was used to structure the implementation of the oral care protocol.[20] This model contains seven steps: (1) development of concrete proposal/targets for improvement of change; (2) assessment of the actual performance in practice and deviations from the desired care; (3) analysis of performance, target group and setting; (4) development/selection of implementation strategies; (5) development, testing and execution of implementation plan; (6) integration of change into practice routines; and (7) evaluation. Our implementation strategies took into account existing barriers and facilitators—such as lack of knowledge, disliking providing oral care and fear of causing pain[21]—and focused on intrinsic motivation (such as knowledge and attitude, and changing nurses' behaviour). The Effective Practice and Organization of Care (EPOC) taxonomy was the basis for developing the implementation strategies[22] We have chosen implementation strategies that have proven to be effective, such as local opinion leaders,[23] education[24] and reminders.[25] We used combined strategies because this approach has been found more effective than the use of a single strategy.[26]

The implementation strategies were operationalized as follows;

(1) Local opinion leaders: On every participating unit, a nurse was appointed oral care champion, and was instructed to encourage and assist the nurses in the daily delivery of oral care according to protocol. These oral care champions were also responsible for bringing necessary information to the attention of their colleagues.

(2) Education:

2a. Inter-professional education: During a one-hour informative oral presentation, performed by a dental hygienist, the theoretical and practical essentials of the protocol and general oral care were provided. The objective of the presentation was to increase knowledge on oral care problems, the care needed for different sorts of dentures and possibilities to consult a dental hygienist. Two sessions per floor were organized. Presentation slides were distributed to nurses who could not attend.

2b. Educational materials: Informative posters and flyers were handed out in participating units, containing both the hyperlink to the new protocol and consequences of poor oral care, such as increased risk of pneumonia. The aim of the poster and flyer was to generate attention for oral care in general and the new protocol in particular.

2c. Short instruction videos were made to visualize the different steps of the protocol and dental hygienists explained the differences between oral care for permanent teeth and dentures. Each nurse received the link to the videos by email.

(3) Reminders:

3a. A colourful keychain with false teeth was handed out to all nurses as a reminder to pay attention to oral care.

3b. Each nurse received an email containing all of the above-mentioned information and an invitation to the oral presentations.

All implementation strategy components were carried out during the four-week implementation periods (Figure 1).

2.2.3 | Post-implementation phase

After the new protocol had been implemented in all clusters, the two-month post-implementation phase started, during which knowledge, attitude and adherence were measured.

2.3 | Measurements

The primary outcome measures were nurses' knowledge and attitude about oral care. The secondary outcome was nurses' protocol adherence.

2.3.1 | Knowledge and attitude

We assessed the level of nurses' knowledge and attitude with a 47-item questionnaire in three parts.[27] The questionnaire had been developed and validated after implementing an oral healthcare protocol in nursing homes. The Dutch-language version of the questionnaire had been validated, and content and construct validity had been assessed by experts in the field of gerodontology, including a dental hygienist and three dentists.[27]

The first part covered personal characteristics, including age, gender, education and years of experience; the second part knowledge; and the third part attitude.

The level of nurses' knowledge was measured with 15 statements assessing knowledge of oral pathology and oral hygiene, with response options 'true', 'false' and 'I do not know'. Some examples of statements are: 'the symptoms of gingivitis are red, swollen, and bleeding gums', and 'dentures should be rinsed after every meal'. Total scores (1 for a correct answer, −1 for a wrong answer and 0 for 'I don't know') were standardized to 100, with a higher score reflecting a higher level of knowledge.

Attitude was measured with 28 statements assessing nurses' attitude regarding oral care. Some examples of statements are: 'I consider it as my responsibility to take care of the patients' oral hygiene', and 'I think that theoretical knowledge about oral care is important to perform adequate oral care'. Responses were scored on a 4-point Likert scale (4=strongly agree, 3=agree, 2=disagree, 1=strongly disagree). Reversed coding was used in negatively worded statements. Total scores were standardized to 100, with a higher score reflecting a more positive attitude.

2.3.2 | Protocol adherence

Protocol adherence was verified with patients instead of nurses, to prevent response bias and was measured with a self-developed 9-item questionnaire, with a distinction in (partial) dentures and permanent teeth. The first question aimed to determine whether the patient was dependent on nurses for oral care. To assess protocol adherence, only ADL-dependent patients were invited to answer further questions about the oral care performed by the nurse on the morning the questionnaire was completed. We defined adherence to the oral care protocol in two ways: (a) whether tooth brushing was provided; and (b) if so, whether this had been done with the right product prescribed in the protocol, e.g. soap for (partial) dentures and toothpaste for permanent teeth.

Data were electronically collected by research assistants, using an iPad. To ensure uniformity, they had received training from the principal investigators on the use of the questionnaires and the way data should be collected. The research assistants visited included floors regularly and invited nurses and patients to participate after having confirmed with the nurse in charge whether a patient could be invited. Patients who were considered too ill or who were sleeping were not invited. The research assistant or, if possible the patient, entered the answers on an iPad. All data stored in the iPads was handled confidentially and we used case record numbers that corresponded with the patient identification number which we kept in a separate file. All data was only accessible to members of the research team on a secured disk.

2.4 | Ethical considerations

The local medical ethics review board of Erasmus MC approved this study (MEC-2018-1328). Nurses gave their individual consent when they filled out the questionnaire. Patients gave their individual consent after reading the Patient Information Form and signing the Informed Consent form.

2.5 | Sample size calculation

It was expected that the implementation would have a moderate effect. Given the number of admissions on selected floors and the estimation prior to the study that 30% of the patients would be ADL-dependent, it was calculated that to reach of power of 80% and using a two-sided significance level of 0.05, at least 200 ADL-dependent patients needed to be included – 100 before and 100 after the implementation period –spread over four floors.

2.6 | Statistical analysis

Categorical data are presented as numbers and percentages. Non-normally distributed data variables are summarized as median

(interquartile range) and normally distributed data as mean (standard deviation). Characteristics of nurses who participated in both the pre- and post-implementation group were compared with the paired t-test or Wilcoxon signed rank test. Knowledge, attitude and adherence between the pre- and post-implementation group were compared with chi-square tests or Fisher exact tests for dichotomous or categorical variables and either independent samples t-tests or Mann–Whitney U tests for continuous variables. General linear models for repeated measurements were performed to explore the differences in knowledge and attitude between baseline and after implementation, with the co-variates: time of implementation, department, type of education and years of experience. An unstructured covariance matrix was assumed to account for the within-nurse correlations.

A p-Value of <0.05 was considered statistically significant. Data were analysed using IBM SPSS Statistics version 25.0.

3 | RESULTS

3.1 | Nurses

We included 509 nurses; 226 in the pre-implementation period and 283 in the post-implementation period. Sixty-one nurses (27%) completed the questionnaire both at baseline and after the implementation of the oral care protocol. Seven of these 61 nurses were nursing students. Three of them rotated to another ward after the pre-implementation phase. Three others graduated between the pre- and post-implementation phases but continued working on the same ward. Another nursing student participated in both the pre- and post-implementation phases while working on the same ward. The 54 graduated nurses who participated in both the pre- and post-implementation phases did not rotate after the pre-implementation phase. Of the other 448 nurses, it was unknown whether they had changed ward during the 12-month study.

The median age of the nurses was 28 (IQR 23–35) and 25 (IQR 22–32) years, respectively for the pre- and post-implementation periods. The number of nursing students was slightly higher in the post-implementation group. The median number of years of work experience, including both student nurses and registered nurses, in healthcare in the pre-implementation group was significantly higher than that in the post-implementation group, respectively 7 (IQR 4–15) and 5 (IQR 3–12) ($p=0.028$). The 61 nurses who participated in both the pre-implementation and post-implementation periods did not demographically differ from the other nurses. Details are shown in Table 1.

3.2 | Patients

One hundred and twenty-four (10.2%) of the 1213 consenting patients were ADL-dependent; 75 in the pre-implementation period and 51 in the post-implementation period (Figure 2).

TABLE 1 Demographic characteristics nurses.

	Pre-implementation N = 226	Post-implementation N = 283	p-Value
Age (in years)[a]	28 (23–35)	25 (22–32)	0.019
Gender (%)			
Female	204 (90.3)	242 (85.5)	0.106
Male	22 (9.7)	41 (14.5)	
Years of work experience[a]	7 [4–15]	5 [3–12]	0.028
Educational level			
Nursing student (%)	37 (16.6)	59 (21.1)	
Bachelor nurse (%)	98 (43.9)	123 (44.1)	0.352
Vocational nurse (%)	88 (39.5)	97 (34.8)	
Type of ward (%)			
Ward 1: Cardiology, Cardiothoracic surgery, Lung diseases	62 (27.4)	87 (30.7)	0.140
Ward 2: Neurology, Neurosurgery, Haematology	84 (37.2)	78 (27.6)	
Ward 3: Systemic diseases, renal and vascular diseases	45 (19.9)	64 (22.6)	
Ward 4: Hepato-Pancreato-Biliary diseases, Oncological surgery	35 (15.5)	54 (19.1)	

[a]Median (IQR).

The median length of stay of ADL-dependent patients was almost twice as long as that of ADL-independent patients. The median age of the ADL-dependent patients was 64 years, in both the pre-implementation and post-implementation periods. Demographic characteristics of ADL-dependent patients are presented in Table 2. Demographic characteristics of ADL-independent patients are presented in Table S1.
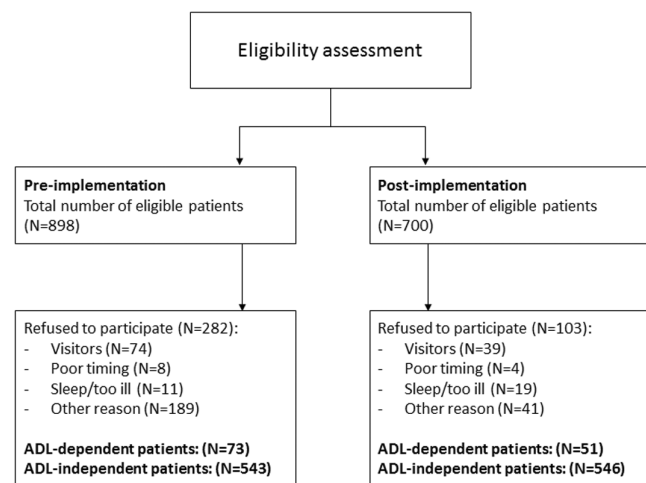

FIGURE 2 Flowchart inclusion.

3.3 | Knowledge

In univariate analyses, the mean knowledge score had significantly increased by 3.5 points from 68.8 (95% CI = 67.5–70.2) to 72.3 (95% CI = 71–73.5) ($p = 0.001$) after the implementation. In the general linear modelling analyses, nurses scored on average 3.4 (95% CI = 1.7–5.2) points higher after the implementation of the oral care protocol. Bachelor-educated nurses' knowledge improved more than that of vocational-educated nurses and student nurses ($p = 0.001$) and longer work experience had a positive effect on knowledge improvement ($p = 0.001$). Ward type was not significantly associated with nurses' knowledge level (Table 3).

The largest knowledge improvement concerned the statement 'The hardest substances in teeth are enamel, dentine, and cementum'. Before implementation, 45.1% of the nurses correctly confirmed this statement; after implementation, this percentage had increased to 61.5% ($p < 0.001$). Regarding four statements, the knowledge level had slightly decreased after the implementation: 'Without plaque no tartar' (true 36.3% vs. 32.9%), 'General health can be affected by oral health' (true 99.1% vs. 98.9%), 'In a patient with large spaces between the teeth, an interdental brush is better for cleaning these spaces than a toothpick' (true 85.5% vs. 85.2%) and 'Gingivitis develops as a result of periodontitis' (false 23.5% vs. 21.9%).

TABLE 2 Demographic characteristics of ADL-dependent patients.

	ADL-dependent patients		
	Pre-implementation	Post-implementation	
	n = 73	n = 51	p-Value
Age (in years)[a]	64 (56–72)	66 (59–74)	0.498
Length of stay (in days)[a]	11 (7–20)	15 (8–27)	0.079
Gender (%)			
Female	38 (52.1)	20 (39.2)	0.159
Male	35 (47.9)	31 (60.8)	
Tooth type (%)			
Permanent teeth	38 (52.1)	25 (49)	0.729
Dentures	24 (32.9)	20 (39.2)	
Partial dentures and permanent teeth	11 (15.1)	6 (11.8)	
Ward type (%)			
Ward 1: Cardiology, Cardiothoracic surgery, Lung diseases	21 (28.8)	7 (13.7)	<0.001
Ward 2: Neurology, Neurosurgery, Haematology	30 (41.1)	2 (3.9)	
Ward 3: Systemic diseases, renal and vascular diseases	3 (4.1)	22 (43.1)	
Ward 4: Hepato-Pancreato-Biliary diseases, Oncological surgery	19 (26.0)	20 (39.2)	

[a]Median (IQR).

TABLE 3 Adjusted general linear model analysis with nurses' knowledge score (range 0–100) as outcome variable.

Parameter	Estimate	95% CI	p-Value
Intercept	72.0	69.19–74.90	
Implementation			
Post-implementation	3.44	1.69 to 5.19	<0.001
Pre-implementation	0[a]		
Ward type			
Cardiology, cardiothoracic surgery, lung diseases	1.64	−1.28 to 4.58	0.270
Neurology, neurosurgery, haematology	−0.68	−3.56 to 2.18	0.638
Systemic diseases, renal and vascular diseases	−1.83	−4.90 to 1.23	0.240
Hepato-pancreato-biliary diseases, oncological surgery	0[a]		
Educational level			
Nursing student	−4.25	−6.85 to −1.65	0.001
Vocational nurse	−0.69	−2.84 to 1.46	0.527
Bachelor nurse	0[a]		
Number of years of work experience	0.15	0.06–0.25	0.001

[a]Reference category.

We also assessed knowledge level with the option 'I don't know' counted as an incorrect answer. This option was chosen 572 times (16.9%) in the pre-implementation period and 527 times (12.4%) in the post-implementation period. In univariate analyses, the mean knowledge score had significantly increased by 5.9 points from 60.1 (95% CI=58.2–62.0) before the implementation to 66.0 (95% CI=64.5–67.6) ($p < 0.001$) after the implementation.

3.4 | Attitude

In univariate analyses, the mean score on the variable attitude had increased non-significantly by 0.6 point from 70.2 to 70.8 ($p = 0.32$). In the general linear model, the nurses' attitude scores were 0.7 point (95% CI=0.4–1.8) higher after implementation. Longer years of work experience had a significant positive effect on attitude ($p = 0.015$). Other co-variates did not have any significant effect on nurses' attitude (Table S2).

The largest improvement was found in the statement 'most patients know the importance of sufficient oral care'. Before implementation, the percentage of nurses who (totally) agreed with this was 38.8%; after implementation, this percentage had increased to 46.3% ($p = 0.046$). For eight statements, the attitude score decreased after the implementation. The largest non-significant decrease was found for statement 'I think that every patient is responsible for their own oral care'. Before implementation, 52.3% of the nurses (totally) disagreed with this, after implementation this percentage had decreased to 43.8% ($p = 0.19$).

The 61 nurses who participated in both the pre-implementation group and the post-implementation group scored higher on the variable knowledge after the implementation, from 70.7 pre-implementation to 76.0 post-implementation ($p = 0.001$). The attitude score had not significantly changed, from 72.1 pre-implementation to 72.4 post-implementation ($p = 0.59$).

3.5 | Protocol adherence

Adherence to providing oral care in ADL-dependent patients by protocol had decreased significantly from 60% of 73 patients before implementation to 35% of 51 patients post-implementation ($p = 0.006$). Table 4 shows the results also broken down by type of teeth (permanent teeth and [partial] dentures). In patients with (partial) dentures, respectively 35 and 26 patients, adherence to brushing teeth had not changed significantly ($p = 0.458$). However, the use of soap for brushing teeth in patients with (partial) dentures had declined from 37.1% to 19.2% of patients ($p = 0.129$). Table S3 provides an overview of protocol adherence in a subset of patients with a combination of permanent teeth and partial dentures.

4 | DISCUSSION

After having implemented a new nursing oral care protocol for ADL-dependent hospitalized patients, we measured a significant improvement in nurses' knowledge about oral care. Yet, we find the increase in 3.5 points not clinically relevant. Nurses' attitude towards oral care had not changed significantly. Adherence to the protocol had improved in patients with (partial) dentures but worsened in patients with permanent teeth. Further, adherence to the use of soap to clean (partial) dentures had worsened. Overall, we found a significantly negative effect of the implementation on protocol adherence for all types of teeth combined.

The improvement in nurses' knowledge we found is in line with earlier research on this topic. Simons and colleagues found an improvement in knowledge after an oral health education training for carers of the elderly in residential homes. However, there was no measurable improvement in the elderly's oral health after the training.[28] Also, Janssens and colleagues implemented an oral healthcare protocol in addition to education and found a significant difference in the variable knowledge between the intervention and control groups in favour of the intervention group after 6 months.[27] The improvement in the intervention group amounted to 18.4 points, which compares favourably to the improvement of

TABLE 4 Overview adherence per teeth type.

	Pre-implementation (N = 73)	Post-implementation (N = 51)	p-Value
Adherence (in total)	44 (60%)	18 (35%)	0.006
Permanent teeth	(N = 38)	(N = 25)	
Today teeth brushed?	31 (81.6%)	13 (52%)	0.012
Toothpaste used?	31 (81.6%)	13 (52%)	0.012
Dentures	(N = 35)[a]	(N = 26)[a]	
Today dentures brushed?	21 (60%)	18 (51.4%)	0.458
Denture brushed with soap?	13 (37.1%)	5 (19.2%)	0.129

[a]Partial dentures: n = 11 in pre-implementation period and n = 6 in post-implementation period.

3.5 points we found. Frenkel and colleagues found a significant improvement on nurses' knowledge, of which the main predictors were age and dental attendance pattern.[29] In their study, besides the intervention, the level of education and years of working experience were the predicting covariables for the knowledge on oral health care. The above-mentioned studies have been conducted in the nursing home setting. Besides the standardization of the results of the knowledge questionnaire as described in earlier research[27] with three response options (1 for a correct answer, −1 for a wrong answer and 0 for 'I don't know'), with a higher score reflecting a higher level of knowledge, we also took in analysis the option 'I don't know' as being a 'wrong answer'. This resulted in a significant increase of 5.9 points in knowledge, but a relatively low baseline score of 66.0.

With an increase in 0.6 points, the attitude score had not significantly changed after the implementation, in conformity with findings by Janssens and colleagues.[27] The latter study identified three predicting variables for attitude: age, educational level and the type of ward the nurses were working at. In the present study, only the number of years of work experience was found to be a predicting variable. This could suggest a positive influence of a long career as a nurse on attitude towards oral health care. Comparably, Ford and colleagues found experience with the patient group an important determinant of nurses' attitude.[30] Huis and colleagues described in their systematic review different techniques to improve attitude, such as persuasive communication and reinforcement of behavioural progress with praise, encouragement or material rewards.[31]

In the present study, implementation of the new oral care protocol resulted in decreased protocol adherence. Our implementation strategies took into account existing barriers and facilitators as mentioned in literature - such as lack of knowledge, disliking providing oral care and fear of causing pain.[21] However, prior to implementation, we did not identify potential barriers and facilitators in our setting so probably our implementation interventions were not matched with these barriers and facilitators. Education was one of our implementation strategies but as recognized by earlier research, we conclude that behavioural change cannot be obtained only by knowledge improvement.[16,32] With regard to protocol adherence, however, we need to mention that many patients themselves refused the use of soap to clean dentures because they were using for example cleansing tablets

at home. Also, patients with different types of teeth (permanent teeth and dentures) often used only a toothbrush and toothpaste to brush the complete dentition, including dentures in the home situation. Of note is that nurses often do not insist on protocolized oral care if a patient refuses this, and leave it to the patient. This is in line with a recent study by van Noort and colleagues, which showed that both nurses and patients acknowledged that they did not prioritize oral care in daily practice due to lack of positive attitude, and knowledge.[2] Further, they identified that nurses have a lack of skills and resources. Another frequently cited reason by nurses for not performing oral care is lack of time or not having the proper materials, such as soft bristle toothbrushes.[21] Our implementation strategies did not take into account these barriers. However, as concluded in a systematic review of Spoon et al, there is not a single implementation strategy, or combination of strategies, that can be linked directly to successful implementation.[33] Dagnew et al reported as a first step to change the attitude of nurses from viewing oral care solely as comfort measure to oral care as a necessity. This could be achieved by providing on-the-job training and workshops.[34] A process evaluation is needed to evaluate the implementation strategies and how these strategies affect nurses' adherence to oral care.[35] Qualitative research may be useful to gain more insight into how nurses have applied and perceived the implementation strategies. In that way, the working mechanism of the strategies in relation to the findings, for example, protocol adherence could be understood.

4.1 | Limitations of the study

First, the sample size was smaller than projected. Approximately 10% of the included patients were ADL-dependent, which was considerably lower than the presumed 30%. We might have missed ADL-dependent patients because nurses tend to protect their patients from possible burden inflicted for example by research. This so-called gatekeeping[36] by nurses may have resulted in selection bias because we do not know if these patients were treated differently with regard to oral care than the included patients. Second, our implementation strategy was based on barriers and facilitators identified in international studies; the local context had not been sufficiently explored. For instance, the success of oral care also

relies on the patient's motivation. The nurses sometimes took care of patients who were not used to cleaning their teeth on a daily basis. Third, personnel turnover at the hospital was relatively high in the one-year time frame of this study, which was also apparent from the small number of nurses who participated in both the pre-implementation and post-implementation periods. This could have influenced the effectiveness of the implementation in that a proportion of nurses included in the post-implementation group may have missed the pre-implementation instructions. A related limitation is that it is unknown how many nurses attended the oral presentation by the dental hygienists, or watched the instruction video. Still, the presentation slides and video had been made available to all nurses. Fourth, earlier research reported that the content and construct validity of the questionnaire had been assessed by experts in the field of gerodontology.[27] However, information on the validation process and construct validity scores were not reported. Fifth, in three of the included units, nurses carried out additional ward-related initiatives aimed at improving oral care. In two units, nurse students performed a presentation about oral care for their master theses. A special 'oral care kit for neurology patients' had been developed and introduced in the third unit. It cannot be excluded that these activities could have positively affected nurses' knowledge and attitudes improvement in these units. Furthermore, not all wards have received the implementation in exactly the same way.

5 | CONCLUSION

The results of this study indicate that nurses' knowledge had increased somewhat after the implementation of an oral care protocol, but that nurses' attitude had not significantly improved. Additional implementation strategies such as praise, encouragement or material rewards might be essential to improve nurses' attitude towards oral care. After implementation, there was an unexplained decreased adherence to oral care in ADL-dependent patients. A process evaluation is needed to explain this effect and analyse barriers and facilitators to improve oral care protocol adherence.

6 | CLINICAL RELEVANCE

6.1 | Scientific rationale of study

With the ageing of the population, the number of ADL-dependent patients admitted to a hospital will increase further in the coming years. In addition, patients retain their own permanent teeth for longer. Due to these developments, investments are needed to improve the level of knowledge and attitude of nurses to prevent problems in the oral care of patients. There is a lack of studies investigating aspects of oral care in the hospital setting, and most studies are executed in nursing homes. This study has shown the level of knowledge and attitude of nurses in a hospital setting as well as protocol adherence before and after the implementation of a new, evidence-based protocol. A

process evaluation is needed to explain the decreased adherence and to analyse barriers and facilitators. Implementation strategies that take into account these barriers should be considered.

6.2 | Principal findings

This paper describes the implementation of an evidence-based oral care protocol in a university teaching hospital. To increase protocol adherence, the implementation strategy should focus on improving nurses' attitudes towards oral care; in addition, the role of the patient needs to be considered. Besides that, we found that nurses' adherence to oral care was insufficient in daily practice. To increase adherence, oral care should be embedded in the nursing plan and become part of the nurses' daily routine.

6.3 | Practical implications

To increase nurses' oral care protocol adherence, a more positive attitude towards oral care is needed, and specific barriers and facilitators regarding compliance should be explored. Also, the role of the patient in oral care needs to be taken into account. To prevent oral problems, nurses should embed daily oral care in the nursing plan for each ADL-dependent patient before problems occur. Besides that, enough time, sufficient materials and oral care education should be provided in healthcare facilities.

CONFLICT OF INTEREST STATEMENT
All authors declare that they have no conflicts of interest.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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11

APPENDIX 1

Protocol 'Oral Care in ADL-dependent patients'.
Procedure

1. General

- Provide oral care in patients minimally twice a day.
- Provide oral care in ventilated patients minimally every four hours.
- Take into account the five moment of hand hygiene.

2. Preparation

- Tell the patient the purpose of oral care.
- Make an inventory of whether the patients has permanent teeth, dentures or both.
- Ask the patient if he or she is able to perform oral self-care.
- Disinfect hands and put on non-sterile gloves.
- Position the patient in the correct position to avoid aspiration.
- Ask the patient for oral pain complaints and discomforts.
- Remove blood clots, secretions or excess mucus with oral swabs soaked in NaCl 0.9%.

3. Execution

3.1. Patients with permanent teeth

- Brush teeth with a soft-bristle (electric) toothbrush and toothpaste with fluoride.

- Use a fixed order of brushing, for example: outside lower and upper jaw, inside lower and upper jaw, chewing surfaces lower and upper jaw.
- Rinse mouth with water.
- In case of dry or chapped lips, apply Vaseline to lips.

3.2. Patients with (partial) dentures

- Remove dentures from the mouth.
- Brush dentures with a soft-bristle (dentures) toothbrush and liquid soap. Do not use toothpaste as it may scratch dentures.
- Rinse dentures with water after brushing.
- Clean palate, buccal surfaces, gums and tongue with a in NaCl 0.9% soaked toothbrush or oral swabs.
- Rinse mouth with water.
- In case of dry or chapped lips, apply Vaseline to lips.
- Keep dentures overnight preferably out of mouth to allow the oral cavity to recover.
- Keep de cleansed dentures dry in an open denture cup overnight.
- In the morning, rinse the dentures with water and place back in a clean mouth.

4. Aftercare

- Rinse the toothbrush well under running water and allow to air dry.
- Check oral cavity for irregularities and consult if necessary a doctor or oral hygienist.