ARTICLE

Cluster randomized control trial of nursing home residents' oral hygiene following the Mouth Care Matters education program for certified nursing assistants

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Abstract

Aims: The purpose of this study was to determine if the number of certified nursing assistants (CNAs) trained with the Mouth Care Matters (MCM) oral health educational program had an impact on nursing facility (NF) resident oral health.

Materials and methods: Three NFs participated in a cluster randomized control trial. In NF-A: all CNAs were offered the MCM program, NF-B: 3 CNAs were offered the MCM program, and NF-C: Control (no CNAs were offered the MCM program). Demographic information, systemic health data, and oral health data at baseline, 3-month, and 6-month intervals were collected and analyzed using Kruskal-Wallis, Wilcoxon signed-rank and Wilcoxon rank-sum tests. A total of 24 dentate residents participated in this study. Plaque control record scores for NF-A were significantly reduced compared to NF-B and NF-C ($P < .001$ and $P = .002$ respectively) and gingival bleeding index for NF-A were significantly reduced compared to NF-B and NF-C ($P = .002$ and $P < .001$ respectively).

Conclusion: Increasing the number of CNA's trained in the Mouth Care Matters educational program positively impacted NF residents' oral hygiene.

KEYWORDS
interprofessional education, nursing home, oral hygiene

1 | INTRODUCTION

Individuals over the age of 65 are the fastest growing segment of the US population. In 2016 adults over the age of 65 totaled 49.2 million individuals (15.2% of the US population). It is predicted that by year 2060 adults over the age of 65 will account for 94.7 million individuals (23.5% of the total US population).[1] This is a rapid increase that will be seen and felt around the nation. With increasing age comes an increasing prevalence of chronic diseases and disability. Those with the most severe disabilities requiring assistance in activities of daily living (eg, bathing, toileting, and brushing teeth) may reside in nursing facilities (NFs). The Centers for Disease Control and Prevention reports that in 2016 there were 15 600 NFs across the United States, and in 2015 1.3 million residents resided in NFs at any one point in time.[2]

Increasing age is a risk factor for poor oral health and the most vulnerable nursing home residents are at the highest risk of poor oral health.[3] Most recent estimates of oral disease in NF residents indicate 41-79% of residents experience caries in natural teeth,[3–11] 66-74% of all residents experience gingivitis,[3,6,8] 32-49% of residents are in need of periodontal treatment,[3,4,6,12] 5-17% experience dental pain,[3,6,9,12] and 20-51% have some form of oral soft tissue lesions.[13–15] Research shows poor oral health in NFs is not

localized to the United States; it has been a worldwide issue for many years with limited improvements.[16–23]

When caries is left untreated, teeth can fracture leading to dental pain, altered food selection favoring heavily processed, less nutritious and often cariogenic foods, impaired speaking ability, and fewer social interactions leading to a decreased quality of life.[24,25] Tooth loss has been associated with future decline in higher-level functional capacity, but replacement of teeth with a dental prosthesis slowed this decline.[26] Trouble chewing and a less diverse diet are associated with longer hospitalizations and higher medical expenses.[27] In addition, various studies have evaluated the oral-systemic link with particular focus on oral inflammatory markers effect on conditions such as coronary heart disease, diabetes, Parkinson's disease, and Alzheimer's disease.[28–31] Thus it is important to treat and prevent carious lesions, periodontal disease, and subsequent tooth loss in nursing facility residents for general health and quality of life purposes.

Certified Nursing Assistants (CNAs) are a subset of direct care workers (DCWs) that is primarily responsible for assisting NF residents in activities of daily living such as brushing teeth. However, CNAs receive little to no formal training in oral health care. Thus several studies have evaluated various educational programs for DCWs and CNAs with the goal of improving resident oral health, but studies have produced mixed results.[11,13,16–20,22,23,32–43] Coker et al completed a systematic review that evaluated different types of oral health educational programs for NF DCWs. This review found no specific type of educational program was more effective compared to others.[44] Additionally, a recent Cochrane Review on oral health educational programs and implementation strategies in NFs found no meaningful evidence for effectiveness.[45] However, no previous research has evaluated NF residents' oral health in relation to the number of DCWs trained with this type of oral health education program. The overall aim of this study was to evaluate whether the number of CNAs trained with the Mouth Care Matters (MCM) educational program effects NF residents' oral health status. Our hypothesis was that residents living in a facility with all CNAs trained in MCM would show improved oral health compared to residents of facilities with few or no CNA's trained in oral health and hygiene.

2 | MATERIALS AND METHODS

2.1 | Mouth Care Matters (MCM) oral health educational program

Iowa's Direct Care Workforce Initiative led to the development of the Prepare to Care curriculum under the direction of the Iowa Department of Public Health. The Prepare to Care curriculum includes a core training course to prepare professionals to work in a variety of direct care settings, as well as, a specialty training course in MCM oral health training. Additional specialty training courses were approved, but never developed before the initiative concluded. The development of the MCM educational program was led by the Iowa CareGivers association including a study investigator, who is a general dentist with extensive experience treating NF residents, a dental hygienist, and a nurse with the intent to train DCWs in oral care and supported by the Delta Dental of Iowa Foundation and the Lifelong Smiles Coalition, a group of local and state agencies with the goal of increasing access to oral health care for older adults. The MCM program is 1 day in length (approximately 8 hours) including both a PowerPoint presentation and a hands-on demonstration of oral care techniques. MCM is taught by dental hygienists who have been trained specifically to teach the MCM program. In this study, two MCM trained hygienists were used to teach the participating CNAs.

2.2 | Study design

This project was a cluster randomized controlled trial with the NFs as the cluster unit. Three local NFs of similar size within a 20-minute drive of Iowa City, IA agreed to participate in this project. Nursing facility A (NF-A), nursing facility B (NF-B), and nursing facility C (NF-C) contain 65, 90, and 57 beds respectively. The NFs were randomly assigned by picking names from a bowl to three different interventions: (1) NF-A (all CNAs were offered MCM training), (2) NF-B (3 CNAs were offered the MCM training) to simulate an oral health care champion model,[32] and (3) NF-C (control, no CNAs were trained in MCM). The Director of Nursing for NF-B selected which CNAs would undergo the MCM training. Oral exams were then completed at baseline (prior to CNAs participation in the MCM training), then 3 and 6 months after baseline. Examiners were not blinded to the facility's designated interventions. Resident participation in the study was concealed from CNAs.

The study was approved by the University of Iowa's Institutional Review Board (IRB #18184600).

2.3 | Participants

All residents in each of the NFs were contacted to participate. The only exclusion criterion for residents was the need for antibiotic prophylaxis prior to dental procedures. Those with designated Healthcare Powers of Attorney

were contacted. If consent was obtained, participants were enrolled in the study.

2.4 | Data collection and analysis

The REDCap (Research Electronic Data Capture) program was used to collect and manage study data. REDCap is a secure web-based application designed to support data capture for research.[46] Study examiners collected resident data including demographics, systemic health diagnoses, and medication lists. Oral exams included assessment of oral soft tissue lesions, denture plaque index (DPI),[47,48] plaque control record (PCR),[49] and gingival bleeding index (GBI).[50] Remaining root tips were not evaluated in this study. Following the oral exams, examiners evaluated resident's cooperation and evaluated resident's physical ability to thoroughly brush their own teeth.

Two examiners underwent training at the beginning of the project. Training included didactic review of study protocol followed by oral exams on 10 patients in a NF setting. Oral exams were performed with residents sitting in a chair or lying in a bed using a self-lighting dental mirror, disclosing solution to determine plaque control record, a toothbrush to brush teeth prior to periodontal probing, and a periodontal probe to determine gingival bleeding index. Disagreements encountered on the practice exercise were immediately discussed between examiners until consensus was achieved.

All intervention and control patient exams were performed following the same protocol as used in the examiner training. Additionally, the patient exams were completed in a private room so as not to alert staff to which residents were included in the study.

All analyses were performed in R version 3.6.1 and using a significance level of 5%. Descriptive statistics, including means, ranges, and standard deviations, were calculated for PCR and GBI scores at each NF over time as well as continuous baseline values. Counts and percentages were reported for baseline categorical variables. Fisher's exact tests and Kruskal-Wallis tests were used to test baseline differences in demographics variables. To assess the within and among NF changes over time, non-parametric statistical tests were used. Pairwise Wilcoxon signed-rank tests were used to look at differences between times within NFs. For these pairwise tests, reported P-values are adjusted using a Bonferroni correction to maintain a 5% type I error rate. To adjust for differences at baseline, pair- and group-wise comparisons of NFs used the changes between 0-3, 3-6, and 0-6 months as the response variable rather than the absolute measures at each time. Kruskal-Wallis and pairwise Wilcoxon rank-sum tests were used to assess these differences. These tests were done using the "stats"

R package. Mixed modeling, to account for repeated measures and within-NF correlation, was performed to determine the significance of oral health patterns over time within and among NFs after accounting for other oral health and demographic variables, including brushing ability using the "lme4" R package. Post hoc power was calculated for the three-way comparison and each pairwise comparison of the change from baseline to final for each of PCR and GBI using the "stats" package. Plots were created using the "ggplot2" package. The CONSORT guidelines were used in the preparation of this report.[51]

3 | RESULTS

At NF-A 17 out of 26 CNAs (65.4%) were trained in the MC program; at NF-B, 3 out of 51 (0.06%) CNAs were trained; and at NF-C no CNAs (0%) were trained. In addition, all CNA's who attended the MCM training maintained employment throughout the duration of the study. NF resident participation is described in Figure 1. The participation rate for residents in nursing NF-A, NF-B, and NF-C was 17% (11 residents/65 beds), 12% (11 residents/90 beds), and 16% (10 residents/57 beds), respectively. One resident died before the baseline exam; and of the remaining 31, 7 were edentulous and/or denture wearers (1, 4, and 2 in NF-A, NF-B, and NF-C, respectively). Due to the limited number of edentulous residents, denture plaque index was not calculated for each of the facilities. The remaining 24 dentate resident demographics can be found in Table 1. The most common comorbidities of participants included: hypertension (51.6%), depression (32.3%), arthritis (25.8%), gastroesophageal reflux disease (25.8%), and hypothyroidism (22.6%).

Among the three NFs' dentate participants, the mean number of remaining teeth present did not change between the initial and final exam for NF-A (21.6 teeth) while the mean for NF-B (20.1 teeth) decreased by 1.4% and NF-C (20.5 teeth) decreased by 4.3% between the initial and final exams.

PCR scores over time from NF-A, NF-B, and NF-C are reported in Figure 2. As shown in Table 2, NF-A's PCR scores decreased significantly from 0 to 3 months ($P = .01$) and 0 to 6 months ($P = .01$), but not between 3 and 6 months ($P = .2$). No other significant changes between time points were seen within NF-B or NF-C.

There were significant differences in PCR scores among the three NFs from 0-3 months ($P < .001$) and 0-6 months ($P < .001$), but not 3-6 months ($P = .09$). As noted in Figure 2, the mean PCR score from baseline to 3 months decreased in NF-A by 52.4% while it increased in NF-B by 5.7% and NF-C by 12.7%. Pairwise significance existed between these changes in NF-A compared
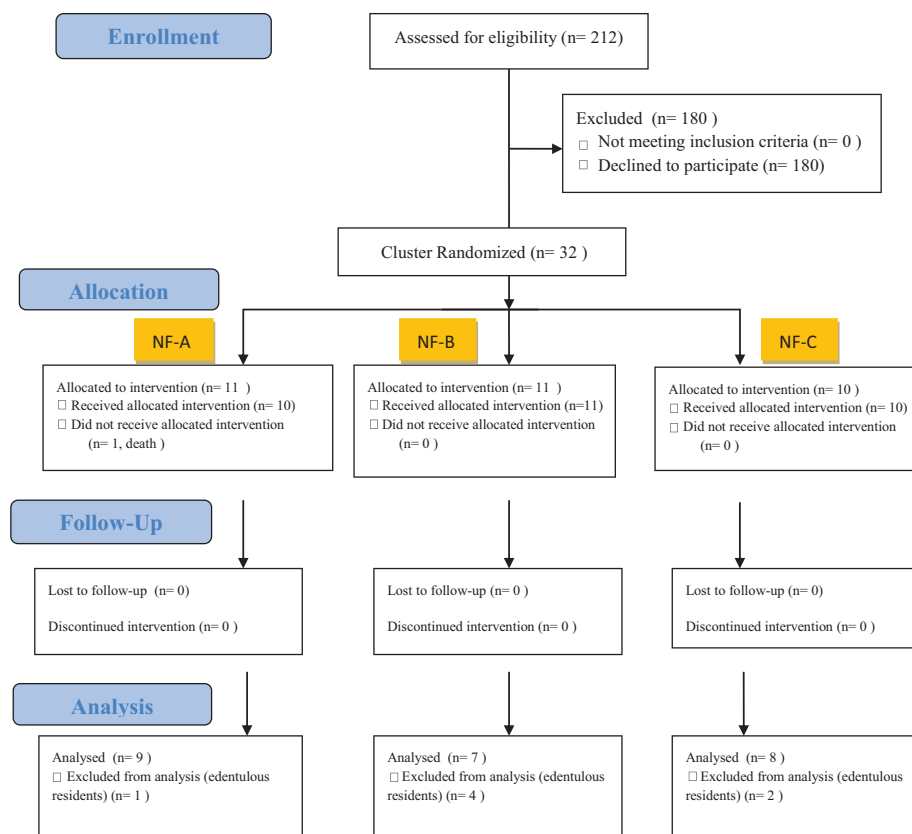
FIGURE 1 Nursing facility resident participation flow diagram. Figure was prepared in accordance with the CONSORT flow diagram[51]

TABLE 1 Dentate participant demographics

	NF-A	NF-B	NF-C	P value
N	9	7	8	–
Gender (female)	9 (100%)	3 (42.9%)	6 (75%)	.02
Race (White)	9 (100%)	6 (85.7%)	8 (100%)	.3
Age	89 (8.9)	79.1 (8.9)	83.2 (10.5)	.2
Comorbidities	6.9 (2.8)	6.9 (2.6)	7.6 (3.6)	1
Cooperative	9 (100%)	7 (100%)	7 (87.5%)	.6
ability to brush (independent)	1 (11.1%)	3 (42.9%)	2 (25%)	.4

to both NF-B ($P = .002$) and NF-C ($P < .001$). For each facility, the mean PCR score did not change significantly from 3 to 6 months (Table 2), nor were there significant pairwise differences between the three facilities during this time (Figure 2). The change in mean PCR from baseline to 6 months decreased in NF-A by 69.6% while NF-B and NF-C increased by 8.7% and 11.2% respectively. Pairwise significance existed between these changes in NF-A compared to both NF-B ($P < .001$) and NF-C ($P = .002$) over the entire course of the study (Figure 2).

The GBI scores over time for NF-A, NF-B, and NF-C are reported in Figure 3. As shown in Table 2, NF-A's GBI scores decreased significantly from 0 to 3 months ($P = .02$)

and 0 to 6 months ($P = .01$), but not between 3 and 6 months ($P = 1$). NF-C showed a marginally significant increase from 0 to 6 months ($P = .07$) while changes from 0 to 3 months and 3 to 6 months were not significant. Within NF-B no significant differences were recorded among the various time periods (Table 2).

There were significant differences in GBI changes among the three NFs from 0-3 months ($P < .001$) and 0-6 months ($P < .001$), but not 3-6 months ($P = .1$). Figure 3 shows the mean GBI scores from baseline to 3 months decreased in NF-A by 89.5% and NF-B by 9.8% while NF-C increased 124.1%. Pairwise significance existed between these changes in NF-A compared to NF-C ($P = .003$) but not compared to NF-B ($P = .1$). For each facility, the mean
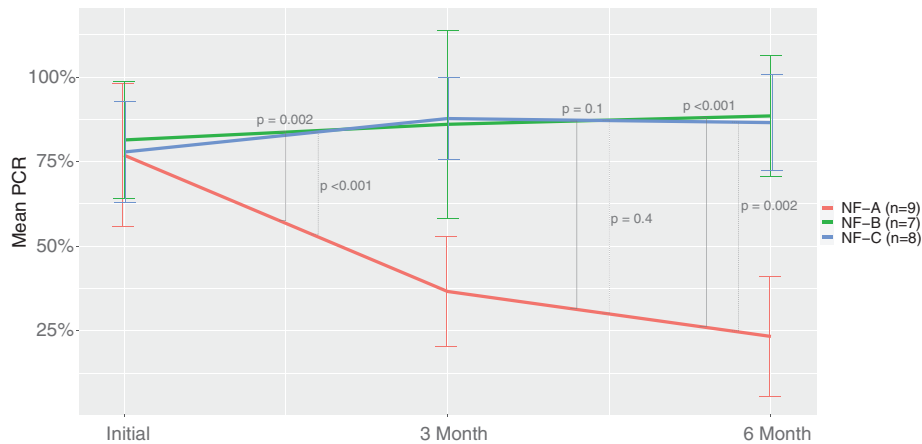
FIGURE 2 Nursing facilities mean plaque control record (PCR). Wilcoxon rank-sum *P*-values compare the slopes over time (0-3, 3-6, and 0-6 months, respectively) between NFs to adjust for differences at baseline. Wilcoxon rank-sum *P*-values comparing NF-B to NF-C were not statistically significant throughout the study and thus were not reported in the figure

TABLE 2 Plaque control record (PCR) and gingival bleeding index (GBI) within each nursing facility over time using pairwise Wilcoxon signed-rank tests

		Initial-three	Three-final	Initial-final
NF-A	PCR	0.01	0.2	0.01
	GBI	0.02	1.0	0.01
NF-B	PCR	1.0	1.0	0.4
	GBI	1	0.7	1
NF-C	PCR	0.5	1.0	0.3
	GBI	0.1	1.0	0.07

P values are adjusted using a Bonferroni correction.

GBI score did not change significantly from 3 to 6 months (Table 2), nor were there significant differences between the three facilities during this time (Figure 3). From baseline to 6 months the mean GBI scores decreased in NF-A by 88.7% and increased in NF-B 18.3% and NF-C by 157.1%. Pairwise significance existed between these changes in NF-A compared to NF-B (*P* = .002) and NF-C (*P* < .001) over the entire course of the study (Figure 2).

Mixed modeling was used to further confirm the significance of changes within NFs over time after accounting for baseline age, gender, and brushing ability. Both PCR and GBI scores decreased significantly over time in NF-A compared to NF-C, even after accounting for these demographics (both *P* < .001). Post-hoc power calculations showed a power of at least 95% for the three-way comparison of the NFs' changes from baseline to 6 months in both PCR and GBI. Post hoc power for the pairwise comparisons of NF-A to each of NF-B and NF-C was also greater than 95% for both measures, while for NF-B to NF-C it was lower, at 5.3% for PCR and 33.9% for GBI.

4 | DISCUSSION

Although this study enrolled a limited number of nursing facilities and nursing facility residents limiting the generalizability of the observed results, our results support our hypothesis that residents living in a facility with more CNAs trained in MCM can improve residents' oral health compared to facilities with few or no CNA's trained in MCM. Table 2 and Figures 2 and 3 show NF-A's significantly decreasing PCR and GBI scores over time both within the facility and compared to NF-B and NF-C; however, this effect flattened over time. This indicates the most significant improvements in residents' oral health occurred during the first 3 months following the MCM educational program. Previous research in this area similarly demonstrated educational programs improved resident's denture plaque,[17,19,32,33,41–43] dental plaque,[17,21,33,36,39,41,42,52] gingival health,[21,36,41–43] tongue health[32,33] and overall oral health,[16,38] though other studies have been unable to show improvement in denture plaque,[13,20] gingival health,[13] and dental plaque[13,18–20,34,52] following a DCW oral health education programs.

The resident gender was found to be statistically significant difference among the three facilities. However, there is no research to indicate that gender alone would alter CNA's ability to provide oral health assistance to these individuals especially since all but one resident in the entire study was cooperative for oral care.

A previous systematic review grouped studies according to three types of educational programs: a single in-service education session usually 60-90 minutes in length, a single in-service education session supplemented with a train-the-trainer approach (also known as "train the oral health care champion"), and multiple educational sessions supplemented with ongoing active involvement of a
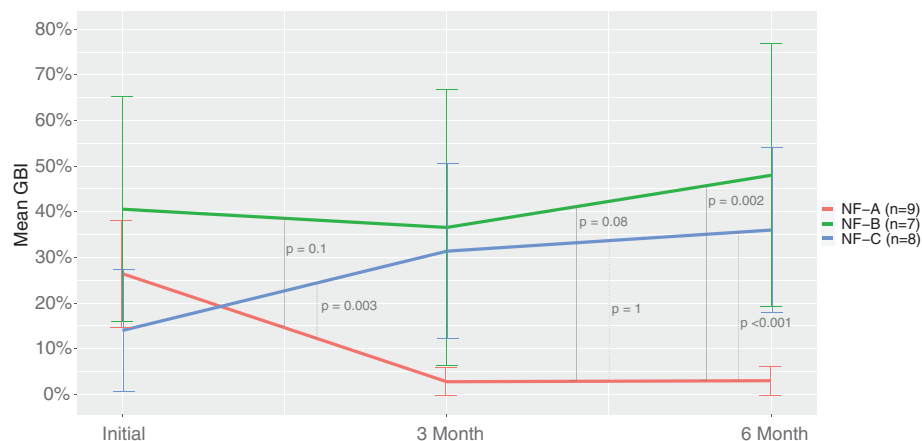
FIGURE 3 Nursing facilities gingival bleeding index (GBI). Wilcoxon rank-sum *P*-values compare the slopes over time (0-3, 3-6, and 0-6 months, respectively) between NFs to adjust for differences at baseline. Wilcoxon rank-sum *P*-values comparing NF-B to NF-C were not statistically significant throughout the study and thus were not reported in the figure

dental hygienist. This review found no specific type of educational program was more effective compared to others.[44] The MCM 8-hour education program does not match the three education types evaluated in the systematic review despite NF-B mimicking the oral health care champion model. Future research is needed to evaluate if the length of educational programs and hands-on training has any impact on the success of oral health education programs.

A limitation of our study was the relatively low resident participation in the three facilities (15%, 12%, and 16%), which introduces potential bias into the results of each facility. However, the post hoc power analysis was greater than 95% in both the three-way analysis and pairwise analyses of NF-A compared to both NF-B and NF-C indicating the significance of the results despite the low resident participation. More resident participation or increased nursing facility participation would be needed to confirm the lack of significant differences between both NF-B and NF-C. Despite the low resident participation in this study, participation was consistent with previous regional attempts to monitor resident oral health while attempting different interventions at the NF or staff level.[13] Studies in NFs also tend to lose patients to follow-up due to participant refusal, resident transfer to another facility, or death. This study only had one patient who did not receive the allotted intervention due to death. Additionally, it was our goal to train all CNA's at NF-A, but only 17 CNA's (65%) attended the MCM educational program. Due to the remaining untrained CNA's availability, MCM trainer availability, and requiring 8 hours for MCM training, it was not feasible to provide any additional MCM training to achieve 100% CNA participation at NF-A.

Additional limitations to this study include examiners were not blinded to the facility intervention assignment, interexaminer agreement was unable to be calculated, and

no demographic data was collected for the CNAs who participated in the MCM training which could lend potential bias. With regard to the clinical exams, examiners attempted to conceal resident participation from the NF CNAs by evaluating residents in private rooms, but that was not always possible. Some discrepancy was present in the number of teeth remaining in NF-B and NF-C between the initial and final exams. This can be attributed to teeth fracturing at the gum line during the period of our study (root tips were not counted as teeth present).

In NF-A 65% of CNA's underwent the MCM education program. However, few studies have reported the percent of DCWs trained with oral health education programs. Mojon et al reported that 76% of staff were trained with an oral health educational program which included a 45-minute slide presentation followed by practical demonstration on residents. However, the residents' plaque indices were statistically similar at baseline and at the 18-month follow-up.[18] Portella et al reported educating 70% of caregivers with a 2-hour lecture on oral health education and all caregivers (100%) were given hands on training in oral health. Authors reported a statistically significant improvement in oral health after 1 year. However, further analysis revealed only independent elderly and elderly with normal muscle strength showed a statistical improvement in oral health.[16] Zenthofer et al reported offering a 2-day oral health education program to all full time caregivers in a project that involved 14 different German NFs (8 intervention NFs and 6 control NFs). Eighty-seven caregivers completed training and at least one caregiver from each ward was trained, but the percent of caregivers who received training was not reported. Residents' plaque levels and denture hygiene significantly improved for both patients with and without dementia after 6 months.[17]

In NFs certified CNAs are the DCWs who provide 65% of the daily assistance and health-related care for residents.[53] The US federal regulations require at least 75 hours of initial training with a minimum of 16 clinical hours, plus 12 annual in-service training hours.[54] This study was conducted in a state that requires CNAs only receive the federal mandated training hours. However as of 2010, 31 states or districts required additional training hours above the federal minimum due to the increasing complexity of care which NF residents require.[55] Many states require CNAs to attend a state approved nursing assistant training programs, and many training programs' curriculum include oral hygiene education, but the length and quality of oral hygiene education is not specified. Hoben et al completed a systematic review and meta-analysis and found that 24% (7%-47%) of care providers reported lack of knowledge, education, or training in providing oral care as a barrier to providing care for residents. Additional barriers were responsive behaviors from residents, lack of dental care supplies, lack of time, staffing issues, and lack of communication between nurses and nurse aides.[3]

Based on the previous research with oral health educational programs and our project with the MCM educational program, it is imperative that all direct care workers receive good-quality training in oral health in order to improve NF resident's oral health, general health, and quality of life. Mandating oral health education for direct care workers will likely take a collaborative effort from national organizations in dentistry, medicine, nursing and nursing assistant associations in addition to political efforts both at the state and national level. However, the 1.3 million residents residing in long term care facilities across the nation deserve quality oral care just as one would provide quality care for the rest of the body.

5 | CONCLUSION

Extensive oral health education for all CNAs has the potential to improve NF resident's oral health compared to training a small number of oral health champions in each facility. However, more research and larger trials are needed in this area. Future efforts should focus on ensuring sufficient oral health training for all direct care workers with the support of state and federal government to improve residents' general health and quality of life.

CONFLICT OF INTEREST
Author Howard Cowen helped develop the Mouth Care Matters Educational Program. The other authors have no additional conflicts of interest to report.

ETHICS STATEMENT
This study was approved by the University of Iowa Institutional Review Board (IRB ID#18184600).

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