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Pilot Testing of Intervention Protocols to Prevent Pneumonia among Nursing Home Residents

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Abstract

Objectives—To test intervention protocols for feasibility, staff adherence and effectiveness in reducing pneumonia risk factors (i.e., impaired oral hygiene, swallowing difficulty) in nursing home residents.

Design—Prospective study.

Setting—Two nursing homes.

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Participants—Fifty-two nursing home residents.

Interventions—Thirty residents with impaired oral hygiene were randomly assigned to manual oral brushing + 0.12% chlorhexidine oral rinse at different frequencies daily. Twenty-two residents with swallowing difficulty were randomly assigned to upright feeding positioning, teaching swallowing techniques, or manual oral brushing. All protocols were administered over 3 months.

Measurements—Feasibility was assessed monthly and defined as high if the protocol took < 10 minutes to administer. Adherence was assessed weekly and defined as high if full staff adherence was demonstrated in >75% of assessments. Effectiveness for improved oral hygiene (i.e., reduction in oral plaque score) and swallowing (i.e., reduction in cough during swallowing) was assessed at 3 months compared to baseline.

Results—Daily manual oral brushing + 0.12% chlorhexidine rinse demonstrated high feasibility, high staff adherence and effectiveness in improving oral hygiene ($p < 0.001$ compared to baseline); this combination administered twice per day showed the highest plaque score reduction. Daily manual oral brushing and upright feeding positioning demonstrated high feasibility, high staff adherence, and effectiveness in improving swallowing.

Conclusion—Manual oral brushing, 0.12% chlorhexidine oral rinse, and upright feeding positioning demonstrated high feasibility, high staff adherence, and effectiveness in pneumonia risk factor reduction. A protocol combining these components warrants testing for its ability to reduce pneumonia among nursing home residents.

Keywords

pneumonia; nursing home; prevention

INTRODUCTION

Recent epidemiologic studies confirm the increasing public health burden of pneumonia in United States citizens over the age of 65 years (i.e., older adults). Older adults who reside within nursing homes are at highest risk, and they develop pneumonia at a rate of one episode per 1000 days of care (1,2). This rate is 10-fold greater than the rate of pneumonia in elderly community dwellers. Pneumonia is the major cause of mortality among nursing home residents, it results in burdensome functional impairment among survivors, and it requires significant resource utilization (3,4).

Since its description as a distinct clinical entity (5), risk factors for nursing home acquired pneumonia have been identified and underscore the primary role of aspiration of oropharyngeal flora in this unique subset of healthcare associated pneumonia (6–13). In a cohort of 613 elderly residents of Connecticut nursing homes, two modifiable risk factors (i.e., impaired oral hygiene, swallowing difficulty) were validated to be independently associated with radiographically documented pneumonia over a 12 month prospective surveillance period (14).

Strategies to improve oral hygiene (e.g., manual oral brushing, oral chlorhexidine) and swallowing (e.g., instruction in chin tuck positioning during swallowing, manual oral brushing, elevation of head during feeding, angiotensin converting enzyme inhibitors) among older adults have been reported. Manual oral brushing, in particular, has two biologically plausible effects: it improves oral hygiene by reducing bacterial pathogen colonization, and its associated gum stimulation has been associated with the release of a local hormone, substance P, that is associated with an improved swallowing reflex (15–18). Nonetheless, there are no intervention protocols to reduce pneumonia that have documented

feasibility and staff adherence within nursing homes of the United States. In this pilot study, we evaluated feasibility and staff adherence of risk factor intervention protocols and assessed their effectiveness at improving oral hygiene and swallowing among nursing home residents. The goal was to identify a multicomponent intervention protocol that was feasible to administer, adhered to by staff, and effective in risk factor reduction to warrant testing for its ability to reduce pneumonia.

METHODS

Inclusion and eligibility criteria

Nursing home residents > age 65 years were screened and excluded for eligibility if they were: 1) residents < 4 weeks; 2) residents for short-term rehabilitation only; 3) estimated to survive < 6 months by nursing staff; or 4) tube fed or had a tracheostomy. Initial eligibility screening for impaired oral hygiene required either no documented dental examination for >12 months or assessment by nursing staff that oral hygiene was poor. Residents who met one of these screening criteria were examined by a dentist consultant and were eligible if their oral plaque score was > 1.0. The oral plaque scoring method was adapted from published and validated plaque scoring tools (19,20). For dentate patients (i.e., > 6 teeth), plaque was scored as follows: 0= no plaque noted, 1= plaque seen only when the tip of a probe was passed over tooth (or tissue bearing side of denture surface), 2= plaque obvious with naked eye (or visible on <50% of denture surface), 3= gross deposits of plaque over entire tooth (or on >50% of denture surface). The plaque score was based on the average of 6 teeth for dentate residents without prosthesis, or the average of 6 teeth and any prosthesis for dentate residents with prosthesis. For edentulous residents without prosthesis, plaque was scored from exam of the buccal mucosa and tongue as follows: 0= no plaque noted, 1= debris noted only when tongue depressor passed over tissue, 2= debris noted only when tongue depressor passed over tissue and tongue was coated, 3= gross debris was noted and tongue was coated. For edentulous residents with prosthesis, the plaque score was the average of the buccal mucosa/tongue and the prosthesis.

Eligibility for swallowing difficulty required that the resident had cough during swallowing documented by staff during at least one meal within the previous week (21). In 2 New Haven area nursing homes, a total of 419 residents were screened and 270 were eligible (i.e., impaired oral hygiene, swallowing difficulty). Among the 270 eligible residents, 120 consented to participate. Among the 120 who consented, 52 were enrolled.

The study was approved by the Human Investigation Committee at Yale University School of Medicine and both participating nursing homes. All participants, or their surrogate decision makers, provided written informed consent.

Choice and assignment of intervention protocols

The intervention protocols, targeted at oral hygiene and swallowing, were selected based upon: 1) biological plausibility for risk factor reduction; 2) feasibility in the nursing home setting; and 3) published evidence of effectiveness in risk factor reduction in older adults (15,16,21–23).

The 52 enrolled participants were randomly assigned to one of the intervention protocols for a 3-month observation period for feasibility, staff adherence, and effectiveness in risk factor reduction; no participant was assigned >1 intervention protocol. Thirty participants with impaired oral hygiene were randomly assigned to: 1) manual oral brushing qAM plus 0.12% chlorhexidine rinse qPM (n=10); 2) manual oral brushing qAM plus 0.12% chlorhexidine rinse qAM and qPM (n=10); or 3) manual oral brushing qAM plus 0.12% chlorhexidine rinse, both qAM and qPM (n=10). Twenty-two participants with swallowing difficulty were

randomly assigned to: 1) feeding position >90 degrees with each meal (n=7); 2) instruction in swallowing techniques with each meal (n=7); or 3) manual oral brushing qAM (n=8).

Description of intervention protocols to improve oral hygiene and swallowing

The protocol for oral hygiene required that CNAs adapt to the specific needs of participants, who were divided into 4 groups: 1) dentate (i.e., at least 6 teeth); 2) dentate plus prosthesis; 3) edentulous; and 4) edentulous plus prosthesis. Each group was subdivided based on whether the participant was capable of self care or required assistance. For participants capable of self care, the CNA supervised the protocol in which: 1) the subject removed their prosthesis (if present) and the prosthesis was brushed with a fluoride containing toothpaste (i.e., Colgate Total) for 2 minutes followed by 0.12% chlorhexidine (depending on the specific protocol assigned); 2) the oral cavity and gums/residual teeth were brushed with toothpaste for 2 minutes; and 3) the patient rinsed their mouth with 15 cc of 0.12% chlorhexidine and expectorated. For participants who required assistance or total care, the CNA completed the first two steps, and applied chlorhexidine with a swabbette to teeth and all accessible oral soft tissue.

For upright feeding positioning, the participant was placed at 90 degree upright position prior to, and for 15–20 minutes after, each meal. For instruction in swallowing techniques, participants who were independent in feeding were seated in an upright position and instructed to: 1) chew food thoroughly; 2) swallow more than once; 3) take time between swallows; 4) alternate solids with liquids; 5) gently clear throat or cough to clear any residue; 6) not talk while chewing; 7) take small bites and sips; 8) keep head in neutral or lower position during swallowing. Participants who required assistance in feeding were seated in an upright position with the following method: 1) feed with small spoonfuls; 2) allow to chew thoroughly; 3) take time between each mouthful; 4) alternate solids with liquids; 5) angle spoon so that it is lower than participant's mouth to create a "chin tuck" position and gently lower head during swallowing if needed.

Performance, training, and monitoring of intervention protocols

All protocols were administered as part of the daily care by Certified Nursing Assistants (CNAs) who were the primary care providers to the residents. All nursing staff and CNAs were trained by a Geriatrics Nurse investigator, prior to initiating the protocol, through educational sessions that: 1) described why the study was being conducted; 2) provided the steps of performing the individual protocols, and 3) answered questions about practical implementation. Individualized training sessions for CNAs were continued on a weekly basis for the first 6 weeks to assist in troubleshooting implementation.

Feasibility and adherence assessments

For all protocols, residents and staff were assessed once per month to measure feasibility and once per week to measure staff adherence. Feasibility was determined by the average number of minutes per day required to complete the intervention protocol. Intervention protocols that required <10 minutes per day were considered highly feasible; protocols that required >10 minutes per day, were not considered highly feasible. The number of minutes per day required for each intervention protocol was determined by self-report of CNAs and corroborated by periodic direct observation of a study investigator.

Adherence was determined by a study investigator, during unannounced visits at times representing either feeding or oral care; they occurred once per week to determine if adherence was full, partial, or none. Intervention protocols in which staff showed full adherence for >75% of assessments were considered highly adherent. Those with full

adherence for 50–75% of assessments were considered moderately adherent, and those showing full adherence for <50% of assessments were considered low adherent.

Effectiveness assessments for risk factor reduction

For oral hygiene, effectiveness of intervention protocols was assessed by reduction in average oral plaque score of at least one point comparing oral examination by a dental consultant at the end of the 3 month study period to the oral examination at baseline. This reduction in plaque score was based on consultation with a Geriatric Dentist consultant and published observations of the anticipated effect (22,23). For swallowing difficulty, effectiveness of the intervention protocols was assessed by the reduction in the frequency of cough during swallowing, assessed through interviews with CNAs who were asked to quantify the number of episodes of coughing while eating in the previous week as follows: never, sometimes (<50% of time), frequently (>50% of time), always. For a subset of residents with swallowing difficulty (n=10), an additional measure of swallowing was assessed by a fiberoptic swallowing study at baseline. Criteria for defining swallowing difficulty by fiberoptic study included: retention of a 5cc bolus in the valleculae or piriform sinus (mild impairment), laryngeal penetration of the bolus in laryngeal vestibule but above the vocal folds (moderate impairment), or aspiration of the bolus below the level of the vocal folds (severe impairment). Among these participants who had a fiberoptic swallowing exam, all showed moderate or severe swallowing impairment corroborating the bedside assessment of cough during swallowing.

Adverse events assessments

All participants were monitored for potential adverse events twice per week through interviews with nursing staff, and review of medical records. Results were reported to a safety monitor.

Statistical analysis

For descriptive analyses, means, medians, standard deviations, ranges, and proportions were used. The difference between the pre and post-intervention ordinal variable was tested using a paired t-test. The difference between the pre and post-intervention categorical variable was tested using the Fisher's exact test. All reported p-values are two-sided.

RESULTS

Participants included 52 nursing home residents with baseline features shown in Table 1. As shown, the cohort consisted of elderly adults (mean age, 86 + 7.8 years; median = 88 years). Most participants were women (90%); 8% were Hispanic and racial minorities. Most suffered from an underlying comorbid disease, had episodes of daily confusion, incontinence, and required assistance with activities of daily living. A notable minority exhibited behavioral or sensory impairments commonly encountered in nursing home populations.

Results of feasibility assessments for each intervention protocol targeted to oral hygiene and swallowing are shown in Table 2. Based on criteria that high feasibility required the protocol to be completed within 10 minutes, all three oral hygiene intervention protocols demonstrated high feasibility for 100% of assessments. For swallowing intervention protocols, manual oral brushing revealed high feasibility on 100% of assessments, and upright feeding positioning showed high feasibility for 95% of assessments; instruction in swallowing techniques showed high feasibility for 48% of assessments.

Results of staff adherence assessments for each of the intervention protocols are shown in Table 3. For all three oral hygiene intervention protocols, staff demonstrated full adherence for >75% of assessments (i.e., they were highly adherent). For swallowing intervention protocols, staff demonstrated full adherence for >75% of assessments (i.e., highly adherent) for manual oral brushing (96% of assessments) and feeding positioning (81% of assessments). For instruction in swallowing techniques, staff demonstrated full adherence for 73% of assessments (i.e., moderately adherent).

Assessments for determining improvement in oral hygiene were completed on 27 of the 30 participants in the oral hygiene protocols. Of the 3 not having both pre- and post-intervention measures, 1 died, 1 was transferred to a hospital, and 1 had an incomplete measurement of the baseline oral plaque score. The average pre-intervention plaque score was 2.2. Results showed that 24 of 27 (90%) had a clinically significant reduction in plaque scores (i.e., a reduction of at least one point in plaque score) with a mean reduction of 1.45 ($+0.52$; $p<0.001$) at the end of the three month oral care intervention. Comparing the three oral hygiene intervention options, the reduction in plaque scores revealed a measure of dose response: participants receiving oral brushing qAM + chlorhexidine qPM had a mean plaque score reduction of 1.31; participants receiving oral brushing q AM + chlorhexidine qAM and qPM had a mean plaque score reduction of 1.44, and those receiving oral brushing + chlorhexidine, both qAM and qPM had a mean plaque score reduction of 1.69.

Assessments for swallowing improvement were completed in the 22 participants assigned to swallowing intervention protocols. Results revealed that, compared to baseline, episodes of cough during swallowing were reduced at the end of 3 months in 6 of 8 (75%) participants assigned to manual brushing, 3 of 7 (43%) of participants assigned to feeding positioning, and 3 of 7 (43%) of participants assigned to instruction in swallowing techniques. Manual brushing was not significantly more effective than the other two intervention protocols ($p=0.31$).

Over the 3 month surveillance of 52 participants, there was one study related adverse event: an episode of epistaxis and hemoptysis thirty minutes after a fiberoptic swallowing study. The participant had a history of eight previous episodes of epistaxis in the previous year related to chronic thrombocytopenia and aspirin therapy.

DISCUSSION

In this pilot study of 52 elderly nursing home residents, manual oral brushing, 0.12% oral chlorhexidine, and upright feeding positioning during meals demonstrated high feasibility, high staff adherence, and effectiveness in improving oral hygiene and swallowing. A multicomponent intervention protocol that combines all three procedures warrants testing for its effectiveness in reducing pneumonia in elderly nursing home residents.

Nursing home acquired pneumonia is a growing public health problem. Grouped housing in extended care facilities of older adults with impairments in immune function, coexisting illnesses, and severe functional limitations all increase the risk of infection, particularly pneumonia (24). Although clinical pathways have been tested outside the United States to reduce hospitalization (25), transfer to acute care facilities remains common. Prevention efforts represent the most logical means of reducing pneumonia burden and healthcare utilization in this population (26). As in other geriatric clinical conditions in which multifactorial risk factors were identified and targeted by effective prevention strategies (i.e., falls, delirium), pneumonia has at least two modifiable risk factors (i.e., impaired oral hygiene and swallowing difficulty) that have biological plausibility and prospective

validation (14,27,28). Testing strategies targeted to these two risk factors represents a first step in developing an intervention protocol to prevent pneumonia in the nursing home.

Clinical care within nursing homes occurs in an environment challenged by understaffed personnel, and limited diagnostic and treatment resources. Certified nursing assistants (CNAs) supervise and assist in oral hygiene for nursing home residents, but data have shown that these residents suffer the worst oral health of any US population. Lack of evidence for the benefits of oral care, lack of staff education on techniques, and perceptions of poor feasibility are identified barriers (29). Therefore, any intervention strategy to prevent pneumonia will need to be feasible, adhered to by nursing staff, yet effective in reducing risk factors. Among the oral care strategies tested, all combinations of manual oral brushing and 0.12% oral chlorhexidine demonstrated high feasibility (i.e., required less than 10 minutes per day to administer), high adherence among staff, and effectiveness in improving oral hygiene by reduction in oral plaque scores. Among strategies tested to improve swallowing, manual oral brushing and upright feeding positioning also demonstrated high feasibility, high adherence, and effectiveness as demonstrated by reduced cough during swallowing. These results corroborate previous work, and support the hypothesized link between gum stimulation and secretion of the hormone, substance P, that improves the swallowing reflex (12,15,16). Instruction in swallowing techniques was less feasible and less adhered to by staff, making this option a less practical alternative.

This pilot study had limitations. First, there were a small number of participants in whom the intervention protocols were evaluated. Second, the duration of observation (i.e., 3 months) was short, making long term feasibility and adherence unknown. Third, the CNAs who assessed cough during swallowing also administered the swallowing protocols; therefore, they were not blinded. Fourth, in assessing effectiveness of oral hygiene interventions, we measured the amount of oral plaque, and not the specific bacteria within the plaque. However, we believe that quantifying the amount of plaque was a more comprehensive and reliable measure of oral hygiene. Identifying the specific bacteria within plaque is problematic given that: 1) the possibilities of sampling error exist; 2) not all bacteria in the oropharynx are culturable; and 3) the specific bacteria within oral cavity may change over time, and can be affected by diet, medication use, and health status (30).

These limitations notwithstanding, this pilot evaluation demonstrated that an intervention protocol to prevent pneumonia had evidence for feasibility, staff adherence, and effectiveness in improving oral hygiene and swallowing among nursing home residents at risk for pneumonia. This evidence supports the need to test this multicomponent intervention protocol for its ability to prevent pneumonia among this vulnerable population of citizens.

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Table 1

Baseline Characteristics of Study Participants Residing in Two Nursing Homes in the New Haven, Connecticut, Area (N=52)

Characteristic	Number (%) of Participants
Age, years *	
<88	26 (50)
>88	26 (50)
Gender	
Female	47 (90)
Male	5 (10)
Race	
Non-white	4 (8)
White	48 (92)
Comorbid conditions †	
Dementia	44 (85)
Diabetes	14 (27)
Stroke	11 (21)
Congestive heart failure	10 (19)
Chronic obstructive lung disease	8 (15)
Cancer	7 (13)
Kidney disease	6 (12)
Daily episodes of confusion	30 (58)
Required assistance with activities of daily living ‡	
Dressing	47 (90)
Toileting	42 (81)
Transferring	41 (79)
Ambulation	37 (74)
Eating	20 (38)
Total incontinence	
Bladder	31 (60)
Bowel	26 (50)
Behaviors Exhibited §	
Verbal abuse	13 (25)
Socially disruptive	13 (25)
Resistance to care	11 (21)
Physical abuse	8 (15)
Hearing impairment	20 (38)
Vision impairment **	26 (50)

* mean age (+ SD), 86 + 7.8 years; range 65 – 101 years;

† mean number of comorbid conditions (+ SD), 1.9 + 1.0, range 0 – 4;

‡ limited or extensive assistance, or total dependence;

§ within the previous 7 days as determined by staff;

|| assessed with hearing aid, if used;

** assessed with glasses, if used

Table 2

Feasibility Results: Time Required by Staff to Administer Intervention Protocols Targeted to Improve Oral Hygiene and Swallowing.

Intervention strategy	Total number of feasibility assessments	Number (%) of assessments in which intervention was completed within time period	
		< 10 minutes	> 10 minutes
<i>Oral Hygiene Interventions</i>			
Manual oral brushing qAM + chlorhexidine qAM	30	30 (100)	0 (0)
Manual oral brushing qAM + chlorhexidine qAM and q PM	27	27 (100)	0 (0)
Manual oral brushing + chlorhexidine, both qAM and qPM	29	29 (100)	0 (0)
<i>Swallowing Interventions</i>			
Upright feeding positioning with each meal	19	18 (95)	1 (5)
Instruction in swallowing Techniques with each meal	21	10 (48)	11 (52)
Manual oral brushing qAM	23	23 (100)	0 (0)

Table 3

Staff Adherence to Intervention Strategies Targeted to Improve Oral Hygiene and Swallowing.

Oral Hygiene Intervention Protocols	Total Number of Adherence Assessments	Number (%) with Full Adherence*	Number (%) with Partial Adherence [†]	Number (%) with No Adherence [‡]
Manual brushing qAM + chlorhexidine qAM	123	109 (89)	8 (7)	6 (5)
Manual brushing qAM + chlorhexidine qAM and qPM	109	105 (96)	2 (2)	2 (2)
Manual brushing + chlorhexidine both qAM and qPM	124	116 (94)	4 (3)	4 (3)
Upright Feeding positioning with meals	90	73 (81)	17 (19)	0 (0)
Instruction in swallowing Techniques with meals	104	76 (73)	25 (24)	3 (3)
Manual Brushing qAM	107	103 (96)	2 (2)	2 (2)

* adherence to all components of the intervention protocol

[†] adherence to some, but not all, components of the intervention protocol

[‡] no adherence to any of the components of the intervention protocol