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RESEARCH

Endoscopic surveillance of poor oral hygiene in vulnerable patients at pneumonia risk

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Abstract

Objectives This study evaluated the routine use of upper gastrointestinal (UGI) endoscopy combined with oral-pharynx-larynx surveillance to assess oral hygiene and its impact on pneumonia development in vulnerable patients.

Materials and methods This retrospective observational study included 411 hospitalized participants who underwent UGI endoscopy with concurrent oral–pharynx–larynx examination. Poor oral hygiene was identified based on endoscopic findings, including nasopharyngeal pooling secretions, diffuse inspissated oral secretions, and food particles, tartar, or plaque. Among these, 68 participants were identified with poor oral hygiene, while the remaining 343 participants comprised the control group. Records of basic and clinical characteristics were analyzed.

Results Gastroenterologists identified 2.6% (68/2,567) of participants with poor oral hygiene during endoscopy. The frequency of pneumonia was notably higher in the poor oral hygiene group (3.0 ± 1.5 episodes/person-year) compared to the control group (0.6 ± 2.0 episodes/person-year, $p < 0.001$). Multivariable analysis showed that poor oral hygiene significantly increased the risk of pneumonia requiring hospitalization ($p < 0.001$). Enteral tube feeding was also independently associated with increased pneumonia risk ($p = 0.003$). Kaplan–Meier analysis indicated a significantly higher cumulative incidence of pneumonia in the poor oral hygiene group.

Conclusions Poor oral hygiene identified during the endoscopic examination was significantly associated with an increased risk of pneumonia requiring hospitalization.

Clinical relevance Gastroenterologists can identify vulnerable patients with poor oral hygiene during endoscopy, providing an opportunity for referral to dentists or primary caregivers for timely intervention and management.

Keywords Oral health · Oral hygiene · Pneumonia · Gastroenterologists · Endoscopy · Oral health assessment tool

Introduction

Oral hygiene plays an important role in preventing pneumonia, especially in vulnerable patients who are elderly, are cognitively impaired, receive tube feeding, or are bedridden with neurological disorders [1, 2]. The characteristic symptoms of neurological disorders, including impaired motor, sensory, and cognitive functions, often compromise adherence to oral care routines. The higher prevalence of these disorders among the elderly population further exacerbates oral health risks, necessitating specialized, long-term professional dental care. Proper oral hygiene, including regular brushing and maintaining good oral habits, is essential for keeping the oral cavity clean [3]. Conversely, poor oral hygiene may predispose patients to pneumonia and contribute to severe complications, including an increased risk of mortality, due to the potential aspiration of contaminated

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nasopharyngeal secretions, mucus, and food particles [2, 4, 5].

Gastroenterologists may identify patients with poor oral hygiene without proper oral care during routine endoscopy, providing an opportunity for timely referral to dentists or primary caregivers for appropriate interventions and management. For vulnerable patients at high risk of aspiration pneumonia, the mucosal plaque score, oral health assessment tool (OHAT), and related references were modified for this purpose.

The combination of UGI endoscopic examination and oral-pharynx-larynx surveillance allows for direct visualization of healthy oral mucosa, which should appear pink, moist, and free of debris. Additionally, UGI endoscopy can detect abnormal nasopharyngeal pooling secretions, diffuse inspissated oral secretions, and food particles, tartars, or plaques in most mouth areas in patients with poor oral hygiene.

Gastroenterologists can play a key role in multidisciplinary teams, helping to detect vulnerable patients who do not receive routine oral care. To our knowledge, there is limited research on oral hygiene-related aspiration pneumonia within gastroenterology, highlighting a significant knowledge gap regarding multidisciplinary approaches to managing oral hygiene and preventing aspiration pneumonia.

This study aims to evaluate the routine use of UGI endoscopy with an oral-pharynx-larynx examination to assess oral hygiene and its impact on pneumonia development in vulnerable hospitalized patients.

Materials and methods

Study design and data source

This retrospective observational study was conducted at a tertiary care hospital between 2015 and 2022 (Fig. 1). A total of 2,567 hospitalized participants who underwent UGI endoscopy were initially identified. Endoscopy was performed based on clinical indications such as dysphagia, anemia, gastrointestinal bleeding, unexplained weight loss, or chronic abdominal symptoms. Concurrent oral–pharynx–larynx examinations were conducted according to a standardized institutional protocol. Thus, the cohort represents a clinically indicated population rather than a randomly selected sample. Notably, oral hygiene assessment was incidental to the primary indication for endoscopy, allowing opportunistic identification of poor oral hygiene.

Participants were excluded due to age under 20 years, pregnancy, emergency endoscopy, inadequate pharyngolaryngeal visualization, or missing demographic or clinical data, leaving 411 participants for final analysis. Among these, 68 were identified as having poor oral hygiene based on endoscopic findings. The remaining participants without poor oral hygiene comprised the control group ($n=343$), ensuring a balanced and appropriate control-to-case ratio with similar clinical indications and hospitalization status.

Data were extracted from the hospital's electronic medical record system, which undergoes routine quality checks. Demographic information, clinical profiles, comorbidities, endoscopic findings, and pneumonia episodes were obtained from diagnostic codes, laboratory results, radiologic reports, and physician notes. Records with missing key variables were excluded to ensure data integrity.

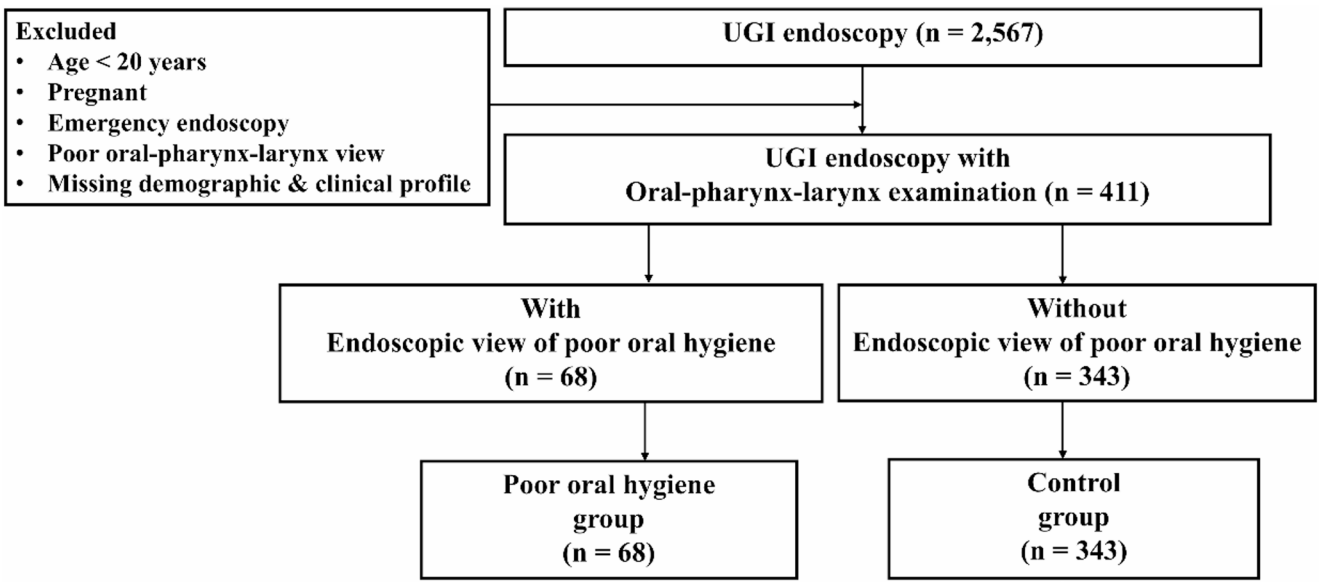

Fig. 1 Flowchart of the study design. Abbreviation: UGI (upper gastrointestinal)

Participants under age 20 were excluded due to regulatory limitations on consent and differences in oral hygiene characteristics, pneumonia risk factors, and clinical care pathways. Pediatric patients are also managed under distinct protocols, making them unsuitable for inclusion in this adult cohort. The study was approved by the Tri-Service General Hospital Institutional Review Board (TSGHIRB No. 2-108-05-136).

UGI endoscopy combined with an oral-pharynx-larynx examination

Participants fasted for at least four hours and were placed in the left lateral decubitus position. The tip of the UGI endoscope was inserted through a mouthpiece, aligned with the esophagus. As the endoscope advanced along the midline of the palate, the uvula was visualized over the base of the tongue. The scope was then rotated slightly past the uvula and gently advanced with anterior flexion to visualize the pyriform sinus, laryngeal vestibule, vocal cords, and upper part of the trachea [6, 7]. Participants were monitored for vital signs, including heart rate, electrocardiography, and oxygen saturation throughout the procedure.

The procedure was recorded using a digital video recorder (HVO-550MD; Sony, Tokyo, Japan). Connecting a video recording system to the endoscope is recommended for oral-pharynx-larynx examinations, as it allows for later review, reducing the risk of missed observations. Video recordings can also be referred to dentists and primary caregivers to aid in patient management. Additionally, these recordings serve as valuable tools for communication, teaching, research, and education.

Endoscopic surveillance of oral hygiene

During a UGI endoscopy with oral-pharynx-larynx examination, a healthy oral cavity should display mucosa that is pink, moist, and free of debris [3, 8]. Gastroenterologists identified participants with poor oral hygiene through three endoscopic findings (Fig. 2): (a) accumulation of nasopharyngeal pooling secretions [1, 4, 5], (b) diffuse inspissated oral secretions [4, 9], and (c) food particles, tartars, or plagues in mouth areas [2, 8].

Demographic and clinical characteristics

Basic and clinical participants characteristics, including age, gender, body mass index (BMI), serum albumin level, neurological disorders, enteral tube feeding, and pneumonia requiring admission, were recorded. The two

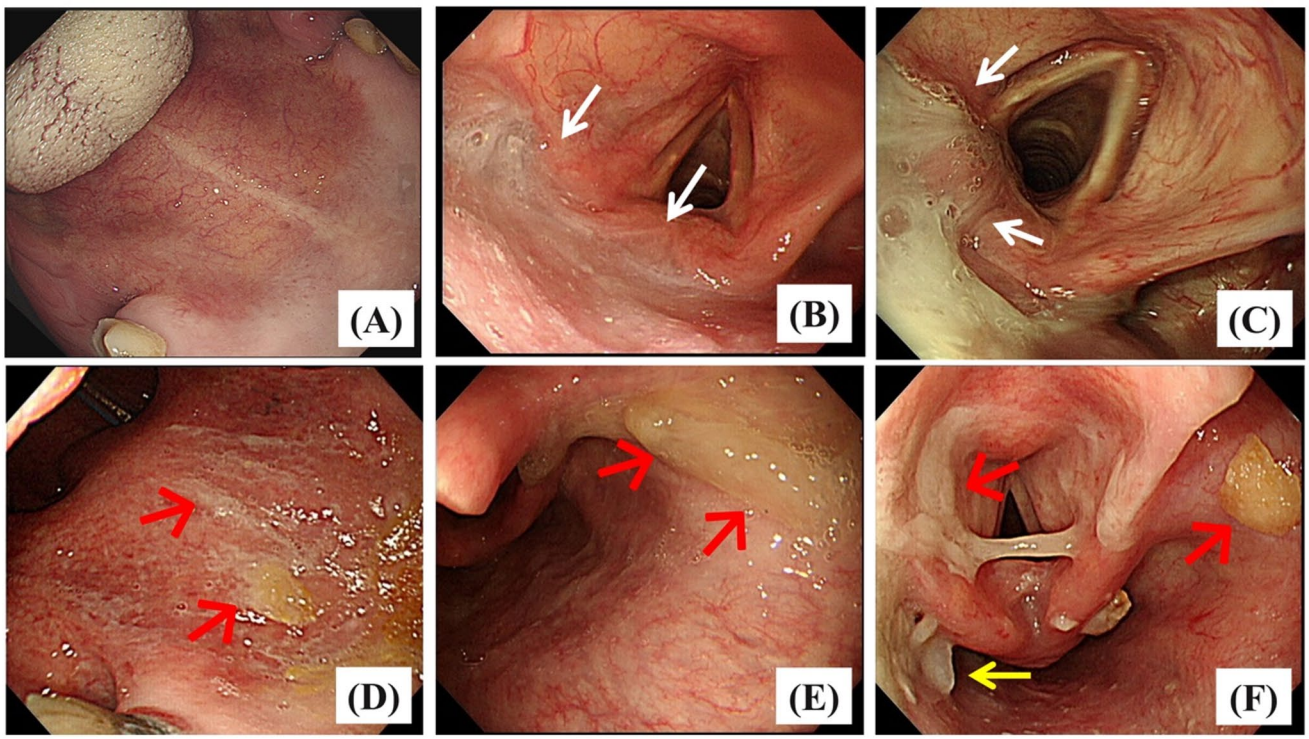

Fig. 2 Endoscopic view of oral hygiene. A healthy oral cavity should display mucosa that is pink, moist, and free of debris (**A**). However, nasopharyngeal pooling secretions (white arrow) can enter the laryngeal vestibule (**B**, **C**). Diffuse inspissated oral secretions (red arrow) may adhere to the hard palate (**D**), lateral pharyngeal wall (**E**), or laryngeal vestibule (**F**). Food debris particles (yellow arrow) can be found in the pyriform sinus (**F**)

common methods for enteral tube feeding are nasogastric tube placement and percutaneous endoscopic gastrostomy [6]. Pneumonia requiring admission was diagnosed based on physician documentation of clinical symptoms, radiological evidence of pulmonary consolidation, serum white cell count > 10,000/mm³, temperature > 38 °C, shortness of breath, and the need for hospital admission [10].

Statistical analysis

Statistical analyses were performed using SPSS version 22.0 (IBM Corp., Armonk, NY, USA). Shapiro-Wilk tests were used to assess the normality of continuous variables. For variables with normal distribution (e.g., BMI), the independent samples t-test was applied. For non-normally distributed variables (e.g., age and albumin), the Mann-Whitney U test was used. Categorical variables were analyzed using the chi-square test, with Yates' correction or Fisher's exact test applied as appropriate. Logistic regression was used to calculate adjusted odds ratios (ORs) with 95% confidence intervals (CIs) for factors associated with pneumonia. Multivariate logistic regression was performed to assess the independent risk of pneumonia, adjusting for potential confounders. To evaluate the predictive value of BMI for pneumonia, receiver operating characteristic (ROC) curve analysis was conducted using Youden's Index to determine the optimal cutoff point. Kaplan–Meier was performed to assess the cumulative incidence of pneumonia, after matching for age and gender, over a 24-month period. A p value < 0.05 was considered statistically significant.

Results

Demographic and clinical characteristics

UGI endoscopy identified 2.6% (68/2,567) of participants with poor oral hygiene during routine endoscopy. Baseline demographic and clinical characteristics differed significantly between the poor oral hygiene and control groups (Table 1). The median age in the poor oral hygiene group was significantly higher than in the control group (69.5 vs. 64.0 years; $p = 0.002$). Gender distribution did not differ significantly ($p = 0.962$). Neurological disorders were more prevalent in the poor oral hygiene group (41.2% vs. 16.6%; $p = 0.014$). The median serum albumin level and mean BMI were comparable between the two groups (albumin: 3.2 vs. 3.1 gm/dl, $p = 0.184$; BMI: 22.6 ± 5.0 vs. 22.7 ± 5.0 kg/m², $p = 0.429$). Enteral tube feeding was significantly more frequent in the poor oral hygiene group (55.9% vs. 14.9%; $p < 0.001$). The frequency of pneumonia was also markedly higher in the poor oral hygiene group (3.0 ± 1.5 vs. 0.6 ± 2.0 episodes/person-year, $p < 0.001$).

Multivariable analysis of factors associated with pneumonia

Table 2 represents the multivariable logistic regression analysis of factors associated with pneumonia. Age was significantly associated with an increased risk of pneumonia (70.8 ± 15.6 vs. 62.4 ± 17.6 years; adjusted odds ratio 1.02; 95% CI: 1.00–1.04; $p = 0.021$), indicating a modest risk increase with advancing age. Gender and serum albumin levels demonstrated no significant association with the pneumonia risk ($p = 0.303$; $p = 0.263$).

Lower BMI was independently associated with higher pneumonia risk (20.8 ± 5.6 vs. 22.9 ± 4.8 kg/m²; adjusted odds ratio 0.92; 95% CI: 0.87–0.97; $p = 0.003$), suggesting an inverse relationship between BMI and pneumonia incidence. To further refine this relationship, we conducted a ROC curve analysis. Based on the Youden's Index (sensitivity + specificity–1), the cutoff value for BMI to predict pneumonia risk was identified as 20.2 kg/m², which yielded a sensitivity of 74.6% and a specificity of 45.6%.

Enteral tube feeding was a significant risk factor compared to oral feeding (adjusted odds ratio 2.50; 95% CI: 1.36–4.60; $p = 0.003$). Most notably, poor oral hygiene was strongly associated with increased pneumonia risk (adjusted odds ratio 3.48; 95% CI: 1.84–6.56; $p < 0.001$).

Table 1 Baseline demographic and clinical characteristics
[a]: Enteral tube feeding includes nasogastric tube and percutaneous endoscopic gastrostomy feeding. Abbreviation: BMI - body mass index. p value: Chi-square test on category variables, independent samples t-test on continuous variables (mean ± SD), and Mann-Whitney U test on continuous variables (median)

Variable	Poor oral hygiene group ($n = 68$)	Control group ($n = 343$)	p value
Age (years), median	69.5	64.0	0.002
Gender (male/ female)	45 / 23	228 / 115	0.962
Neurological disorders (%)	28 (41.2%)	57 (16.6%)	0.014
Non-neurological disorders (%)	40 (58.8%)	286 (83.4%)	0.014
Albumin (gm/dl), median	3.2	3.1	0.184
BMI (kg/m^2), mean ± SD	22.6 ± 5.0	22.7 ± 5.0	0.429
Enteral tube feeding (%) [a]	38 (55.9%)	51 (14.9%)	< 0.001
Frequency of pneumonia (episodes/person-year)	3.0 ± 1.5	0.6 ± 2.0	< 0.001

Table 2 Multivariable analysis of the factors associated with pneumonia by using logistic regression

Variable	With pneumonia ($n=79$)	Without pneumonia ($n=332$)	Crude odds ratio (95% CI)	p value	Adjusted odds ratio (95% CI)	p value
Age (years)	70.8 ± 15.6	62.4 ± 17.6	1.03 (1.02–1.05)	< 0.001	1.02 (1.00–1.04)	0.021
Gender (%)						
Female	26 (32.9%)	112 (33.7%)	0.86 (0.55–1.35)	0.511	0.73 (0.40–1.33)	0.303
Male	53 (67.1%)	220 (66.3%)	Reference		Reference	
Albumin (gm/dl)	3.1 ± 0.6	2.7 ± 1.6	1.26 (1.07–1.48)	0.006	1.14 (0.91–1.43)	0.263
BMI (kg/m^2)	20.8 ± 5.6	22.9 ± 4.8	0.92 (0.89–0.96)	< 0.001	0.92 (0.87–0.97)	0.003
Feeding (%)						
Enteral tube feeding	42 (53.2%)	47 (14.2%)	4.06 (2.56–6.41)	< 0.001	2.50 (1.36–4.60)	0.003
Oral feeding	37 (46.8%)	285 (85.8%)	Reference		Reference	
Oral hygiene (%)						
Poor oral hygiene	32 (40.5%)	36 (10.8%)	5.60 (3.18–9.87)	< 0.001	3.48 (1.84–6.56)	< 0.001
Control	47 (59.5%)	296 (89.2%)	Reference		Reference	

Abbreviation: BMI - body mass index

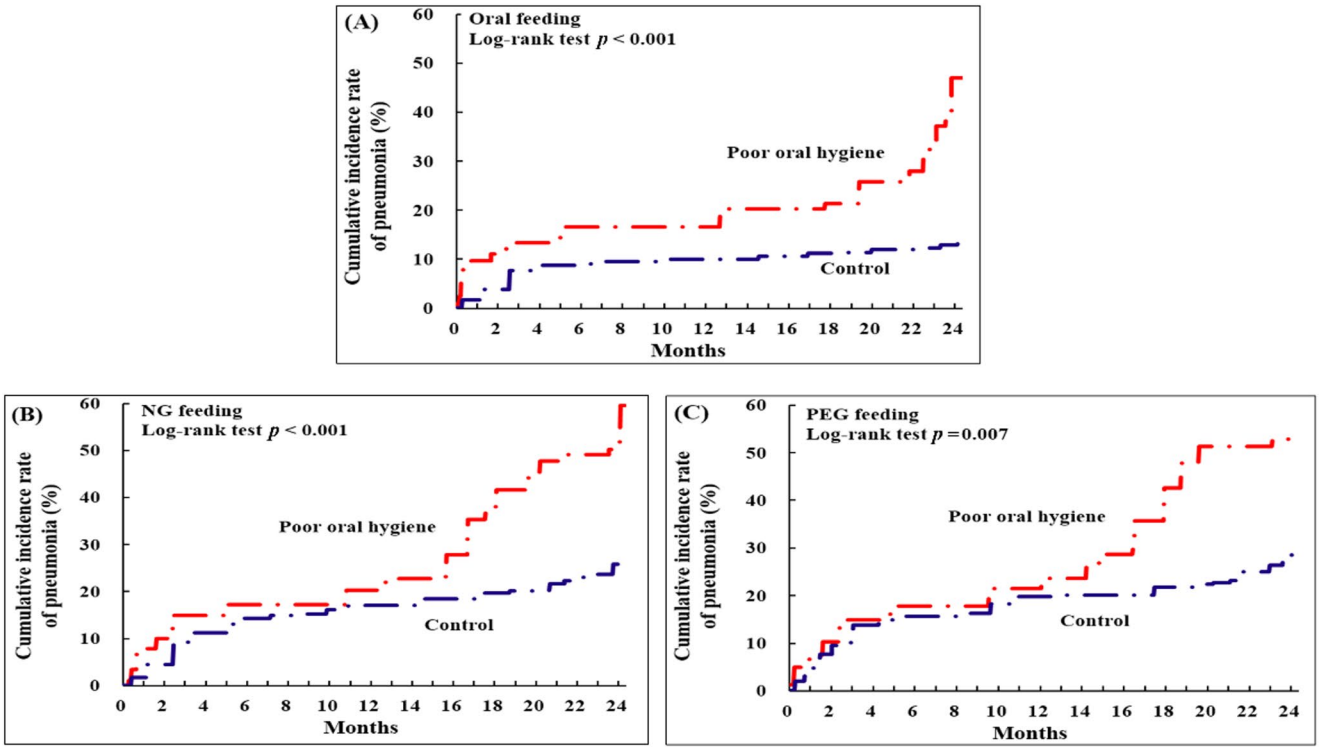

Fig. 3 Cumulative 24-month incidence of pneumonia in the poor oral hygiene and control group across three feeding subgroups: oral feeding (**A**), nasogastric (NG) feeding (**B**), and percutaneous endoscopic gastrostomy (PEG) feeding (**C**). Abbreviation: NG - nasogastric, PEG - percutaneous endoscopic gastrostomy

Cumulative incidence rate of pneumonia

The cumulative incidence of pneumonia over a 24-month period is shown in Fig. 3. Kaplan–Meier analysis demonstrated significantly higher pneumonia incidence in the poor oral hygiene group across all feeding subgroups: oral feeding ($p<0.001$; Fig. 3A), nasogastric (NG) feeding ($p<0.001$; Fig. 3B), and percutaneous endoscopic gastrostomy (PEG) feeding ($p=0.007$; Fig. 3C).

Discussion

Gastroenterologists frequently evaluate patients via UGI endoscopy to diagnose or treat gastrointestinal conditions. This unique position allows them to assess a diverse patient population, including those who may not visit dental clinics regularly and patients with neurological disorders presenting with gastrointestinal symptoms such as nausea, diarrhea, gastroparesis, and other related issues [11, 12].

Poor oral hygiene can lead to the accumulation of secretions, tenacious mucus plugs, and food particles, which may be aspirated into the respiratory tract, increasing the risk of airway disease and mortality [1, 13, 14]. Incorporating oral–pharynx–larynx examination into routine UGI endoscopy enhances the opportunistic oral hygiene assessment, allowing gastroenterologists to identify and address oral hygiene issues early in a cost-effective manner, particularly for patients with limited access to oral care.

The present cohort study comprised hospitalized adults undergoing UGI endoscopy with concurrent oral–pharynx–larynx examination, many of whom had significant comorbidities and functional limitations. A substantial proportion were elderly (median age: 69.5 years), had neurological disorders (41.2%), or required enteral tube feeding (55.9%)—clinical indicators of frailty and dependency. Previous literature has established that inadequate oral hygiene care is a significant factor in the development of hospital-acquired pneumonia among elderly patients [15]. Our findings also underscore the critical role of oral hygiene in pneumonia prevention, particularly among vulnerable hospitalized patients, including the elderly, those who are bedridden, and individuals with neurological disorders.

While tube feeding is a recognized risk factor for pneumonia, our stratified analysis confirms that poor oral hygiene further exacerbates this risk within each subgroup. Consequently, our statistical approach remains valid, demonstrating that the impact of poor oral hygiene is independently observable, even among tube-fed patients. BMI may serve as a useful risk stratification tool. Patients with BMI < 20.2 kg/m², especially those receiving enteral nutrition and exhibiting poor oral hygiene, represent a high-risk subgroup for pneumonia. Recognizing this high-risk subgroup can facilitate timely collaboration with dental professionals and allied care teams to reduce infection risks.

Oral care is often overlooked in hospitals and typically delegated to nursing staff or assistants, who may lack specialized training or standardized protocols [16]. However, favorable oral health at admission has been associated with shorter hospital stays [17]. Given their role in evaluating patients via UGI endoscopy, gastroenterologists can contribute significantly to multidisciplinary teams to develop comprehensive oral healthcare plans. This study underscores the importance of a multidisciplinary approach involving gastroenterologists, neurologists, dental professionals, and primary caregivers. Interprofessional education and collaboration can ensure that healthcare providers across disciplines acquire the necessary competencies to promote oral hygiene and prevent disease [18].

Routine oral hygiene assessments during UGI endoscopy can enhance gastroenterologists' ability to detect oral health issues and facilitate interdisciplinary care. Timely identification and management of oral health problems may help prevent complications such as aspiration pneumonia, especially in elderly and vulnerable populations [19, 20]. Moreover, professional intervention may improve cost-effectiveness by preventing readmissions and reducing long-term care needs. Evidence suggests that oral care performed by dentists and hygienists is a cost-effective strategy for preventing pneumonia in high-risk nursing home residents [21]. Additionally, incorporating oropharyngeal screening during UGI endoscopy requires minimal additional time or infrastructure, making it a practical approach, especially for patients unable to undergo formal swallowing studies or dental assessments due to frailty or logistical limitations. From a health system perspective, such assessments can be integrated using existing billing codes when risk factors—such as enteral feeding, dysphagia, or pneumonia susceptibility—are present. The findings of this study further support the cost-effectiveness of expanding the diagnostic scope for high-risk populations.

For non-dental healthcare professionals, selecting an appropriate oral health assessment tool depends on the specific objective of evaluating the oral cavity. The OHAT and revised oral assessment guide (ROAG) are particularly useful for screening, triage, and determining the need for dental referrals [22, 23]. Gastroenterologists are increasingly engaged in multidisciplinary care, especially in managing dysphagia and malnutrition in elderly and neurologically impaired patients. From the patient's perspective, non-invasive diagnostic approaches that minimize transfers and appointments are often preferred. Thus, integrating opportunistic oropharyngeal screening into UGI endoscopy aligns well with patient-centered care and may facilitate early detection of oral health issues while reducing diagnostic delays.

This study is a single-center, non-randomized design, which limits its generalizability to other populations and settings. The relatively small sample size may reduce the statistical power to detect subgroup differences. Additionally, endoscopy was performed based on clinical indications rather than general screening, which may introduce selection bias and limit the representativeness of the broader hospitalized population. Nevertheless, this approach reflects real-world clinical practice, where gastroenterologists may incidentally identify poor oral hygiene during routine procedures. However, patients undergoing endoscopy may have more complex comorbidities, which may confound the association with pneumonia risk. Furthermore, oral hygiene was assessed by gastroenterologists at the time of UGI endoscopy, which reflects the patient's condition at a single time point before any interventions. The detailed information on prior oral hygiene or dental care practices was not recorded

and could not be included in the analysis—an acknowledged limitation, as oral hygiene may deteriorate over time.

Despite these limitations, the study provides valuable insights into the relationship between poor oral hygiene and pneumonia risk, particularly among vulnerable hospitalized patients. It emphasizes the value of comprehensive oral health assessment and multidisciplinary care strategies for improving patient outcomes.

Conclusion

This study demonstrated that poor oral hygiene significantly increases the risk of pneumonia in vulnerable hospitalized patients. Integrating oral hygiene assessments into routine UGI endoscopy can enhance patient care by enabling the early detection of oral health issues. These findings highlight the need for a multidisciplinary approach to managing oral hygiene in hospital patients and emphasize the importance of further research to address existing knowledge gaps.

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Author contributions W.K.C. contributed to the study conception and design and data acquisition and interpretation. Y.L.P. contributed to the study conception and design and data acquisition, analysis, and interpretation. C.H.L. contributed to the study conception and design and data acquisition and interpretation. All authors read and approved the final manuscript.

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Data availability The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Ethical approval The study was approved by the Tri-Service General Hospital Institutional Review Board (TSGHIRB No 2-108-05-136).

Consent to participate and publication Not applicable.

Competing interests The authors declare no competing interests.

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