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Original Article

Pneumonia in Elderly Patients with Nasogastric Tubes: Factors to Consider

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A R T I C L E   I N F O

S U M M A R Y

Background: This study aims to explore the risk factors associated with the occurrence of community-acquired pneumonia (CAP) in elderly patients with nasogastric (NG) tubes receiving home care.
Methods: This retrospective study analyzed medical charts of elderly patients receiving home care from January 2018 to December 2019. Multivariate logistic regression, with stepwise variable selection, investigated the link between gastrointestinal medications and CAP in elderly patients with nasogastric tubes in home care.
Results: In this analysis of 144 elderly patients in home care, the average age was 84.4 ± 7.6 years. Sixty-nine patients (47.9%) were hospitalized for CAP. The primary diagnoses were cerebral degenerative disorders (50, 34.7%), stroke (35, 24.3%), and cancer (26, 18.1%). The most frequently reported clinical symptoms and signs were altered consciousness, followed by fever and dyspnea. Multiple logistic regression analysis revealed that the significant predictors of hospitalized CAP among elderly patients receiving home care were male gender (odds ratio [OR] = 3.38, 95% confidence interval [CI] = 1.60–7.11, *p* = 0.001), primary diagnosis of cancer (OR = 0.30, 95% CI = 0.11–0.81, *p* = 0.009), impaired consciousness (OR = 2.81, 95% CI = 1.29–6.12, *p* = 0.009), polypharmacy (OR = 2.82, 95% CI = 1.15–6.90, *p* = 0.023), and a Do Not Resuscitate (DNR) signature (OR = 3.10, 95% CI = 1.17–8.22, *p* = 0.023).
Conclusion: In the present study, we identified male gender, impaired consciousness, excessive polypharmacy, and a signed DNR order as significant risk factors, while cancer was found to be a negative risk factor for CAP in elderly patients with nasogastric tubes.

1. Introduction

Pneumonia remains a significant infectious disease globally, ranking as the third leading cause of death worldwide in 2019. This trend is reflected in Taiwan, where pneumonia is a major cause of mortality, particularly among the elderly, accounting for a staggering 92% of cases.[1] In the elderly population, pneumonia progresses rapidly and often leads to poor outcomes. This demographic is particularly vulnerable to severe disease, with mortality rates for severe pneumonia reaching up to 20%.[2] Overall mortality rates range from 7.3% to 13.3%, rising significantly among hospitalized patients.[3] According to the Ministry of Health and Welfare in Taiwan, the prevalence of nasogastric tube feeding in individuals aged 65 and older was 17.9% in 2020. In contrast, the rate is 11.6% in Japan and 6.6% in Germany.[4]

A review study identified several risk factors associated with community-acquired pneumonia (CAP), including older age, male gender, lifestyle factors such as smoking, alcohol abuse, and being underweight. Another previous study reported that nasogastric tube use, chronic respiratory disease, dementia, heart failure, anemia, and hypoalbuminemia were the risk factors associated with CAP in patients receiving home-based care.[5] However, the risk factors associated with CAP in participants with nasogastric (NG) tubes receiving home-based care have been limitedly discussed, particularly concerning polypharmacy and the use of gastrointestinal medications.

In a large hospital-based pharmacoepidemiologic cohort, the use of proton pump inhibitors (PPIs) was significantly associated with a higher likelihood of acquiring hospital-associated pneumonia.[6] Prokinetic agents may help reduce the risk of aspiration pneumonia in tube-fed patients by enhancing gastrointestinal motility. Previous studies reported that consistent administration of prokinetic agents prevents the occurrence of aspiration pneumonia in stroke patients being fed through nasogastric tubes.[7] Another study indicated that the use of prokinetic agents was not negatively associated with pneumonia in nasogastric tube-dependent patients.[8] The aim of this study is to investigate risk factors associated with CAP among elderly patients receiving home care with a NG tube.

2. Study and methods

2.1. Study design

We included elderly patients with NG tubes receiving home care in our study. Participants with or without CAP were included. The study investigated the risk factors associated with CAP.

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2.2. Study population

We enrolled elderly patients with advanced illnesses who received home care and were admitted with CAP at a secondary teaching hospital in Taiwan. In January 2021, we reviewed these patients' medical records, focusing on their hospitalizations between January 2018 and December 2019, and documented their condition during their most recent admission to our hospital.

2.3. Variables

The subsequent information was gleaned from the medical records: gender, age, primary diagnosis, the presence of invasive medical devices (such as NG tubes and urinary catheters), and the date of signature for the Do Not Resuscitate (DNR) document. Additionally, clinical signs and symptoms observed during the initial home visit of patients were documented. The data obtained during the initial home visit in this study were adapted from Lee et al.[9] An experienced registered nurse collected data on demographics, clinical symptoms and signs, and laboratory test results. The accuracy of the data was subsequently verified by one of the authors.

In the current study, we defined patients with pneumonia as those who met the following criteria: having a primary diagnosis recorded on both the admission and discharge medical records with ICD-10-CM codes, specifically J11.0, J12, J13, J14, J15, J16, J17, and J18; exhibiting at least one clinical symptom or sign (such as productive cough, fever with a body temperature > 38 °C, dyspnea, chest pain, crackles on auscultation, or a change in consciousness); and displaying a chest radiograph showing an opacity consistent with the presence of pneumonia.[10]

Additionally, we investigated specific medications that may be associated with CAP. The medications under investigation encompassed gastroprokinetic agents, as well as acid-suppressive agents such as PPIs and H2 blockers. We also recorded the number of prescribed medications for chronic diseases. Excessive polypharmacy was defined as the prescription of ≥ 10 daily drugs.[11] The period of medication exposure was calculated to be within seven days before the date of the CAP diagnosis. The number of daily medications was calculated, with each liquid medication counted as a single medication. Due to participants having NG tubes and being hospitalized, medication compliance should be regular in the current study.

The inclusion criteria for the current study were as follows: age ≥ 60 years, presence of an advanced illness, receipt of home-based care, use of an NG tube, and patients who died between 2018 and 2019. The exclusion criteria were age under 60 years, patients who were not confirmed dead or not between 2018 and 2019, and those with missing data.

2.4. Outcome measures

The primary outcome is to investigate the risk factors for hospitalization due to CAP in elderly patients with nasogastric tubes receiving home care.

2.5. Statistical analysis

All statistical analyses were performed using R (version 4.2.3; R Foundation for Statistical Computing, Vienna, Austria). A two-sided p-value of ≤ 0.05 was considered statistically significant. Continuous variables distribution properties were expressed as means ± standard deviations, while categorical variables were presented as frequencies and percentages. Normality was assessed using the Shapiro-Wilk test. Univariate analysis employed the two-sample t-test, Wilcoxon rank-sum test, chi-square test, and Fisher's exact test to examine differences in the distributions of continuous and categorical variables between the pneumonia (the P group) and the non-pneumonia group (the non-P group) as appropriate.

In the current study, we used multivariable regression analysis to control for potential confounders. Multivariate analysis involved fitting multiple logistic regression models using the stepwise variable selection procedure to determine vital predictors. All the variables listed in Table 1, including demographic data, clinical symptoms and signs, gastrointestinal medications, and other factors, were included in the multivariate regression analysis. The goodness of fit of the final logistic regression model was assessed based on the estimated area under the receiver operating characteristic curve (AUC). The Hosmer-Lemeshow test is a statistical method used to evaluate the fit of a logistic regression model.

2.6. Ethics statement

This study faced challenges in obtaining patient consent because it was a retrospective review, all patients were deceased, and the study period was between January 2018 and December 2019. This study received approval from the Research Ethics Committee of the institutional review board of Tainan Municipal Hospital (Managed by Show Chwan Medical Care Corporation), Taiwan (SCMH_IRB No: 1090104).

3. Results

The study encompassed a total of 151 elderly patients with nasogastric tubes who received home care and ultimately passed away in the hospital between 2018 and 2019. Exclusion criteria included patients under 60 years of age ($n = 4$) and those with missing data ($n = 3$). After these exclusions, a total of 144 elderly patients were included in the analysis. The study design is depicted in Figure 1.

In the current study, our findings indicate that out of the total 144 patients, 85 (59.0%) received gastrointestinal medications. The most common primary diagnosis was cerebral degenerative disorders. Comorbid diabetes was present in 55 patients (38.2%). The most prevalent clinical symptom observed was impaired consciousness. Notably, there was a significant difference in the incidence of impaired consciousness between the pneumonia group (46 patients, 66.7%) and the non-pneumonia group (25 patients, 33.3%) ($p = 0.022$). During the study period, polypharmacy affected 107 patients (74.3%) overall and was significantly more prevalent in the pneumonia group (58 patients, 84.1%) compared to the non-pneumonia group (49 patients, 65.3%) ($p = 0.010$) (Table 1).

In univariate analysis, the factors of male gender, impaired consciousness, and excessive polypharmacy were significantly associated with an increased risk of hospitalized CAP (Table 2). For the prediction of hospitalized CAP, multiple logistic regression was used. We found that male gender, primary diagnosis of cancer, impaired consciousness, polypharmacy, and a DNR signature (Table 3). The Hosmer-Lemeshow test passed successfully ($p = 0.532$). The Nagelkerke R-squared value stands at 0.272. The AUC (0.76, 95% CI = 0.682–0.838) for this predictive model was fair (Figure 2).

4. Discussion

In the current study, we identified male gender, impaired consciousness, excessive polypharmacy, and a signed DNR order as significant risk factors, while cancer was found to be a negative risk

Table 1
Demographic data of elderly patients with NG tube receiving home care.

Variables	Total, n (%)	No pneumonia, n (%)	Pneumonia group, n (%)	p value
n	144	75 (52.1)	69 (47.9)	
Gender				< 0.001
Female	77 (53.5)	51 (68.0)	26 (37.7)	
Male	67 (46.5)	24 (32.0)	43 (62.3)	
Age	84.4 ± 7.6	84.8 ± 7.8	84.0 ± 7.4	0.549
Primary diagnosis				
Cancer (all cancer)	26 (18.1)	17 (22.7)	9 (13.0)	0.134
Lung cancer	3 (2.1)	3 (4)	0 (0)	0.246
Colon-rectal cancer	9 (6.3)	5 (6.7)	4 (5.8)	0.829
Stomach or other cancer	14 (9.7)	9 (12)	5 (7.2)	0.336
Chronic obstructive pulmonary disease	10 (6.9)	5 (6.7)	5 (7.2)	0.891
Cerebral degenerative disorders (dementia and parkinsonism)	50 (34.7)	31 (41.3)	19 (27.5)	0.082
Stroke	35 (24.3)	14 (18.7)	21 (30.4)	0.100
End stage of renal disease	10 (6.9)	4 (5.3)	6 (8.7)	0.428
Congestive heart failure	7 (4.9)	2 (2.7)	5 (7.2)	0.202
Cirrhosis	6 (4.2)	2 (2.7)	4 (5.8)	0.348
Diabetes	55 (38.2)	27 (36)	28 (40.6)	0.609
Clinical symptoms/signs				
Impaired consciousness	71 (49.3%)	25 (33.3%)	46 (66.7%)	0.022
Fever	37 (25.7)	19 (25.3)	18 (26.1)	0.918
Dyspnea	25 (17.4)	14 (18.7)	11 (15.9)	0.666
Nausea/vomiting	7 (4.9)	4 (5.3)	3 (4.3)	0.784
Respiratory rate, time/min	144	18.5 ± 2.3	19.1 ± 2.6	0.152
SBP, mmHg	144	126.9 ± 20.1	127.2 ± 20.7	0.921
DBP, mmHg	144	72.3 ± 12.6	69.7 ± 12.6	0.204
Heart rate, beat/min	144	85.8 ± 18.2	84.8 ± 18.2	0.597
Urinary catheter	64 (44.4)	36 (48)	28 (40.6)	0.371
Medication numbers	144	12.1 ± 7.0	13.5 ± 4.9	0.058
Polypharmacy (≥ 10 tables)	107 (74.3)	49 (65.3)	58 (84.1)	0.010
Gastrointestinal medications	85 (59.0)	44 (58.7)	41 (59.4)	0.927
PPI	23 (16.0)	9 (12)	14 (20.3)	0.255
H2B	52 (36.1)	26 (34.7)	26 (37.7)	0.752
Gastroprokinetic agents*	35 (24.3)	22 (29.3)	13 (18.8)	0.143
PPI or H2B + prokinetic agents	21 (14.6)	13 (17.3)	8 (11.6)	0.330
PPI + prokinetic agents	8 (5.6)	5 (6.7)	3 (4.3)	0.544
H2B + prokinetic agents	13 (9.0)	8 (10.7)	5 (7.2)	0.474
Do Not Resuscitate	114 (79.2)	55 (73.3)	59 (85.5)	0.072

Abbreviations: DBP, diastolic blood pressure; H2B, histamine-2 blocker; NG, nasogastric; PPIs, proton pump inhibitors; SBP, systolic blood pressure.
* Gastroprokinetic agents included Mosapride, Metoclopramide, and Domperidone.
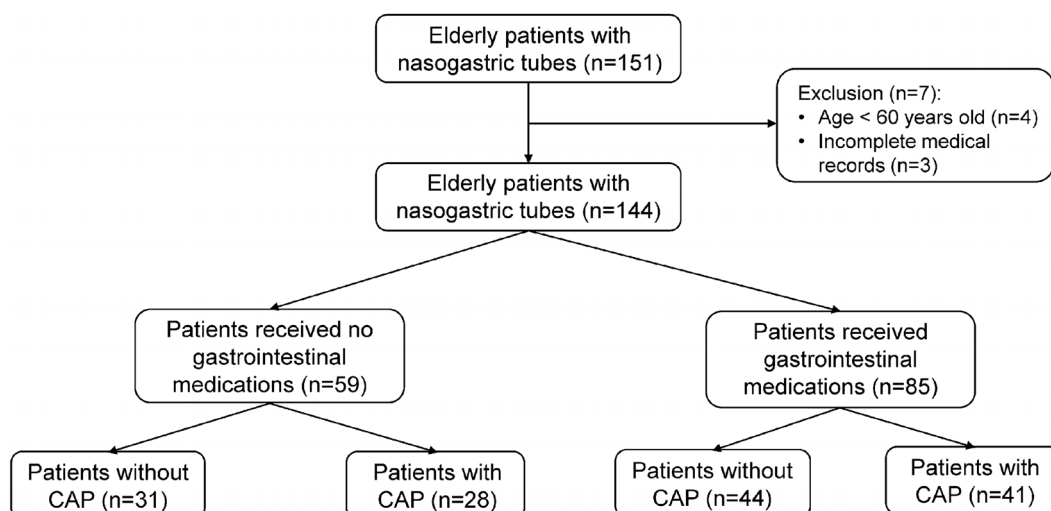
Figure 1. Flowchart depicting the number of patients screened and included in the study.

factor for CAP in elderly patients with nasogastric tubes. It is crucial for healthcare providers to be aware that elderly male patients receiving home care, especially those experiencing confusion and taking multiple medications, require close monitoring for an increased risk of developing CAP. However, the study found no significant correlation between the use of gastrointestinal medications and the in-

Table 2

Factors associated with the community-acquired pneumonia by univariate logistic regression.

Variables	Estimate	SE	OR (95% CI)	p
Gender				
Male vs. female	1.26	0.35	3.51 (1.77–6.99)	< 0.001
Age	-0.01	0.02	0.99 (0.95–1.03)	0.546
Primary diagnosis				
Cancer (all cancer)	-0.67	0.45	0.51 (0.21–1.24)	0.138
Lung cancer	-15.52	840.27	0 (0.00–∞)	0.985
Colon-rectal cancer	-0.15	0.69	0.86 (0.22–3.35)	0.830
Stomach or other cancer	-0.56	0.58	0.57 (0.18–1.80)	0.341
Chronic obstructive pulmonary disease	0.09	0.66	1.09 (0.30–3.95)	0.891
Cerebral degenerative disorders (dementia and parkinsonism)	-0.62	0.36	0.54 (0.27–1.09)	0.084
Stroke	0.65	0.40	1.91 (0.88–4.14)	0.103
End stage renal disease	0.53	0.67	1.69 (0.46–6.26)	0.432
Congestive heart failure	1.05	0.85	2.85 (0.53–15.21)	0.220
Cirrhosis	0.81	0.88	2.25 (0.40–12.67)	0.359
Diabetes	0.19	0.34	1.21 (0.62–2.38)	0.572
Clinical symptoms/signs				
Impaired consciousness	0.78	0.34	2.18 (1.11–4.28)	0.023
Fever	0.04	0.38	1.04 (0.49–2.20)	0.918
Dyspnea	-0.19	0.44	0.83 (0.35–1.97)	0.667
Nausea/vomiting	-0.21	0.78	0.81 (0.17–3.74)	0.784
Respiratory rate, time/min	0.10	0.07	1.11 (0.96–1.27)	0.155
SBP, mmHg	0.00	0.01	1.00 (0.98–1.02)	0.921
DBP, mmHg	-0.02	0.01	0.98 (0.96–1.01)	0.204
Heart rate, beat/min	-0.00	0.01	1.00 (0.98–1.02)	0.746
Urinary catheter	-0.30	0.34	0.74 (0.38–1.43)	0.371
Medication numbers	0.04	0.03	1.04 (0.98–1.10)	0.163
Polypharmacy (≥ 10 tables)	1.03	0.41	2.80 (1.26–6.23)	0.011
Gastrointestinal medications	0.03	0.34	1.03 (0.53–2.01)	0.927
PPIs	0.61	0.46	1.84 (0.74–4.57)	0.190
H2B	0.11	0.35	1.12 (0.56–2.21)	0.752
Gastroprokinetic agents	-0.58	0.40	0.56 (0.26–1.22)	0.145
PPI or H2B + prokinetic agents	-0.47	0.48	0.63 (0.24–1.62)	0.332
PPI + prokinetic agents	-0.45	0.75	0.64 (0.15–2.77)	0.547
H2B + prokinetic agents	-0.42	0.60	0.65 (0.20–2.11)	0.477
Do not resuscitate	0.76	0.43	2.15 (0.92–4.99)	0.076

Abbreviations: DBP, diastolic blood pressure; H2B, histamine-2 blocker; NG, nasogastric; PPIs, proton pump inhibitors; SBP, systolic blood pressure.
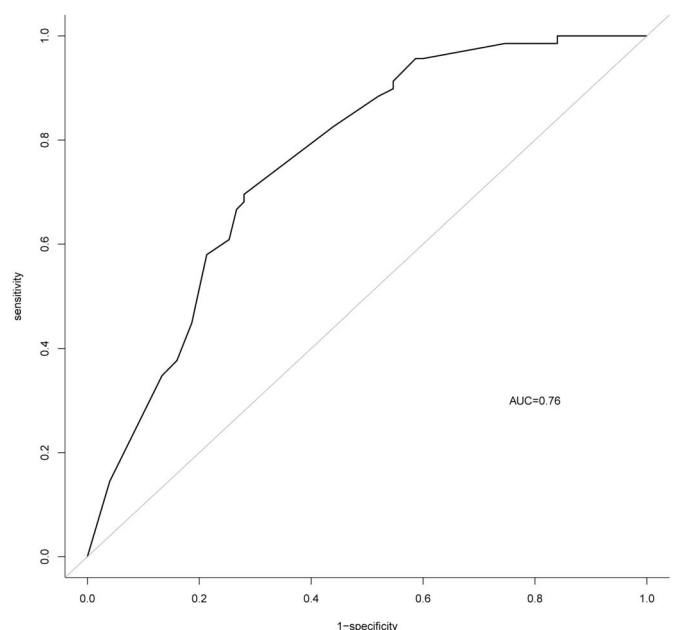* Gastroprokinetic agents included Mosapride, Metoclopramide, and Domperidone.

Table 3

The significant factors for community-acquired pneumonia by multivariate logistic regression.

Covariates	Estimate	S.E.	OR (95% CI)	p
Male vs. female	1.2170	0.3799	3.38 (1.60–7.11)	0.001
Do not resuscitate	1.1326	0.4971	3.10 (1.17–8.22)	0.023
Impaired consciousness	1.0321	0.3975	2.81 (1.29–6.12)	0.009
Cancer	-1.2174	0.5167	0.30 (0.11–0.81)	0.018
Polypharmacy	1.0367	0.4566	2.82 (1.15–6.90)	0.023
Intercept	-2.5670	0.6509		< 0.001

Figure 2. Receiver operating characteristic curve for predicting hospitalization due to CAP in elderly patients with nasogastric tubes receiving home care. The AUC is 0.76.

cidence of CAP in this population.

A systematic review revealed a lack of high-quality research confirming the benefits of NG tube feeding in improving health status and quality of life for palliative care patients.[12] Moreover, the prevalence of NG tube feeding among the elderly in Taiwan exceeds that in other countries.[4] NG tube feeding has been identified as a risk factor for CAP in elderly individuals across various care settings, including institutional care.[5]

In the current study, 67 male patients were included, with 43 (62.3%) being diagnosed with CAP. Among the patients who suffered from stroke and developed CAP, the majority were male. This trend was also observed among patients with cerebral degenerative disorders, where a significant majority were male. This observation supports previous findings that male patients with stroke and dementia often have more underlying comorbidities, potentially leading to a higher risk of CAP.[13]

Interestingly, we observed a reduction in the risk of CAP among

elderly cancer patients who received home care services. This finding is noteworthy, especially considering that widespread metastases often lead to mortality in cancer patients. A systematic review identified age, smoking, environmental exposures, malnutrition, previous episodes of CAP, chronic bronchitis/COPD, asthma, functional impairment, poor dental health, immunosuppressive therapy, oral steroids, and treatment with gastric acid-suppressive drugs as definitive risk factors for CAP. However, no definitive conclusion has been established regarding cancer as a risk factor for CAP.[14]

A decreased level of consciousness was associated with an increased risk of aspiration pneumonia in this study. Impaired consciousness was identified as an additional risk factor for aspiration in patients with an NG tube. This condition can result in the loss of the gag and cough reflexes, which are critical protective mechanisms against the aspiration of gastric contents.[15] These protective mechanisms may be further compromised in patients with an NG tube.

Previous studies have reported an increase in adverse drug events when the number of concomitant drugs exceeds five.[16] In this study, polypharmacy was defined as the consumption of more than 10 tablets per day. Polypharmacy itself can impair swallowing, and certain medications commonly prescribed to elderly patients with polypharmacy have been reported to induce aspiration pneumonia.[17] It is crucial to address polypharmacy, and further investigations are needed to understand the drugs with significant influence and identify the patients most likely to be affected.

We also found that the signing of DNR orders during hospitalization was associated with CAP. Prior studies have identified factors such as being aged 85 or older, having poor nutrition, a greater number and severity of comorbid diseases, and being transferred to the intensive care unit as independently associated with the documentation of DNR orders during hospitalization.[18]

Although several published studies have reported that the use of PPIs is associated with an elevated risk of CAP in adults, another study indicated that prokinetic agents may help reduce the risk of aspiration pneumonia in tube-fed subacute stroke patients.[6] However, in the current study, despite about two-thirds of the patients receiving gastrointestinal medications, no significant association with CAP was observed in elderly patients undergoing home care with an NG tube. The reasons might be that the sample size was not large enough and that the participants were elderly individuals with NG tubes receiving home-based care in the current study. These findings suggest that gastrointestinal medications can still be used for clinically appropriate indications. We advocate for further prospective studies with larger sample sizes to validate and confirm these observations.

A previous study found that the use of nasogastric tubes in dementia patients significantly increased the risk of hospitalization for CAP in home care patients in Taiwan.[5] In the current study, participants with cerebral degenerative disorders (dementia and parkinsonism) using NG tubes did not show an increased risk for CAP admission. The results warrant further large-sample size studies to clarify these findings. Based on the final model, we used the following significant variables to predict the risk factors of CAP in elderly patients with nasogastric tubes receiving home care: male gender, DNR status, impaired consciousness, primary diagnosis of cancer, and excessive polypharmacy. In the current study, the AUC was 0.76, indicating fair.

The present study has several limitations, including its reliance on retrospective medical record reviews which may contain information gaps and questionable data accuracy. The retrospective bias refers to the potential for systematic errors introduced when analyzing data collected from medical records or charts. Additionally, differences in how patients' charts are selected for review or inclusion in a study can introduce bias if certain types of cases are systematically overrepresented or underrepresented. Additionally, the absence of data on physicians' rationale for prescribing gastrointestinal medications limits deeper insight into observed associations. Generalizing the findings to other hospitals is challenging due to potential differences in practices and patient populations. The study also focused on a specific group of elderly patients with nasogastric tubes receiving home care, limiting its broader applicability. Future research should consider diverse cohorts and prospective designs to overcome these limitations and provide more comprehensive insights.

We observed that male gender, impaired consciousness, excessive polypharmacy, and a signed DNR order as significant risk factors, while cancer was found to be a negative risk factor for CAP in elderly patients with nasogastric tubes. We suggest that gastrointestinal medications could still be used for clinically appropriate indications. We advocate for further prospective studies with larger sample sizes to verify these findings. These results suggest that clinical practice should focus on monitoring and managing these risk factors — male gender, impaired consciousness, and excessive polypharmacy — to prevent CAP in this vulnerable population. Additionally, policy-making should prioritize guidelines and interventions targeting these high-risk factors to improve patient outcomes and reduce hospitalizations.

Conflicts of interest

Funding

Data availability statement

The datasets are not publicly available, but are available from the corresponding author on reasonable request.

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