Experimental and Therapeutic Medicine 24: 562, 2022

Abstract. In December 2019, there was an outbreak of pneumonia of unknown causes in Wuhan, China. The etiological pathogen was identified to be a novel coronavirus, named severe acute respiratory syndrome coronavirus type 2 (SARS-CoV-2), which causes coronavirus disease 2019 (COVID-19). The number of infected patients has markedly increased since the 2019 outbreak and COVID-19 has also proven to be highly contagious. In particular, the elderly are among the group of patients who are the most susceptible to succumbing to COVID-19 within the general population. Cross-infection in the hospital is one important route of SARS-CoV-2 transmission, where elderly patients are more susceptible to nosocomial infections due to reduced immunity. Therefore, the present study was conducted to search for ways to improve the medical management workflow in geriatric departments to ultimately reduce the risk of nosocomial infection in elderly inpatients. The present observational prospective cohort study analysed elderly patients who were hospitalised in the Geriatric Department of the First Affiliated Hospital with Nanjing Medical University (Nanjing, China). A total of 4,066 elderly patients, who were admitted between January and March in 2019 and 2020 and then hospitalised for >48 h were selected. Among them, 3,073 (75.58%) patients hospitalised from January 2019 to March 2019 were allocated into the non-intervention group, whereas the remaining 933 (24.42%) patients hospitalised from January 2020 to March 2020 after the COVID-19 outbreak were allocated into the intervention group. Following multivariate logistic regression analysis, the risk of nosocomial infections was found to be lower in the intervention group compared with that in the non-intervention group. After age stratification and adjustment for sex, chronic disease, presence of malignant tumour and trauma, both inverse probability treatment weighting and standardised mortality ratio revealed lower risk of nosocomial infections in the intervention group compared with that in the non-intervention group. To rule out interference caused by changes in the community floating population and social environment during this 1-year study, 93 long-stay patients in stable condition were selected as a subgroup based on 4,066 patients. The so-called floating population refers to patients who have been in hospital for <2 years. Patients aged ≥65 years were included in the geriatrics program. The incidence of nosocomial infections during the epidemic prevention and control period (24 January 2020 to 24 March 2020) and the previous period of hospitalisation (24 January 2019 to 24 March 2019) was also analysed. In the subgroup analysis, a multivariate analysis was also performed on 93 elderly patients who experienced long-term hospitalisation. The risk of nosocomial and pulmonary infections was found to be lower in the intervention group compared with that in the non-intervention group. During the pandemic, the geriatric department took active preventative measures. However, whether these measures can be normalised to reduce the risk of nosocomial infections among elderly inpatients remain unclear. In addition, the present study found that the use of an indwelling gastric tube is an independent risk factor of nosocomial pulmonary infection in elderly inpatients. However, nutritional interventions are indispensable for the long-term wellbeing of patients, especially for those with dysphagia in whom an indwelling gastric tube is the most viable method of providing enteral nutrition. To conclude, the present retrospective analysis of the selected cases showed that enacting preventative and control measures resulted in the effective control of the incidence of nosocomial infections.

Introduction

In December 2019, a cluster of pneumonia cases of an unknown cause was reported in Wuhan, China. The pathogen causing
As a result, no hospitalised patients or medical staff developed nosocomial SARS-CoV-2 infection and the incidence of nosocomial infections was significantly reduced. In the present study, measures used to control nosocomial infections in elderly patients during the COVID-19 pandemic were analysed. The objective was to compare the incidence of nosocomial infection in the previous routine medical setting with that following the implementation of epidemic prevention and control measures. These results show that epidemic prevention and control measures can improve the medical environment, in addition to reducing the burden and harm caused by nosocomial infection.

Patients and methods

Ethics. The present retrospective observational cohort study analysed elderly patients hospitalised in the Geriatric Department of The First Affiliated Hospital with Nanjing Medical University (Nanjing, China). The institutional review board of The First Affiliated Hospital with Nanjing Medical University approved this study and granted a waiver of informed consent from study participants because of the retrospective design. In the present retrospective study, patient data were obtained through the electronic medical record system.

Data collection. A total of 4,066 elderly patients admitted from January to March in 2019 and 2020 who were hospitalised at The First Affiliated Hospital with Nanjing Medical University for >48 h were selected. The inclusion criteria were as follows: i) Patients aged ≥65 years; and ii) hospital stay >48 h. The exclusion criteria were as follows: i) Patients aged <65 years; and ii) hospital stay ≤48 h. Among them, 3,073 (75.58%) patients hospitalised from January 2019 to March 2019 were designated into the non-intervention group, whereas the remaining 933 (24.42%) patients hospitalised from January 2019 to March 2019 were designated into the intervention group, whereas the remaining 933 (24.42%) patients hospitalised from January 2020 to March 2020 after the COVID-19 outbreak were designated into the intervention group. To rule out any changes caused by the community floating population and the social environment during this 2-year study, 93 long-stay patients in stable condition were selected as a subgroup based on the 4,066 patients for longitudinal analysis. The community floating population refers to patients who have been hospitalised in the Geriatric Department of The First Affiliated Hospital with Nanjing Medical University for <2 years. The age-adjusted Charlson Comorbidity Index (aCCI) is a more widely used comorbidity scoring system than CCI, which quantifies comorbidities based on the types and severity of a patient's diseases and can be used to predict the risk of death from a disease. The higher the aCCI score, the higher the risk of mortality. By contrast, the lower the aCCI score, the lower the risk (28-30).

Long-stay patients refer to those who have been hospitalised in the Geriatric Department of The First Affiliated Hospital with Nanjing Medical University for ≥2 years. Because this group of patients include those with multiple chronic diseases, homes or nursing homes cannot stabilise their physical condition and they therefore require long-term hospitalisation. The patients in stable conditions do not include those in acute phases of the disease or those that suffer from malignancies. Patients aged >65 years were included into the geriatrics program. The incidence of nosocomial infections during the epidemic prevention and control period (24 January 2020 to 24 March 2020) and the previous period of hospitalisation...
(24 January 2019 to 24 March 2019) was analysed. Of these 93 long-stay patients, 93 were all enrolled according to the inclusion criteria. The inclusion criteria were as follows: i) Patients aged ≥65 years; ii) hospital stay ≥2 years; and iii) patients in a stable condition. The exclusion criteria were as follows: i) Patients aged <65 years; ii) hospital stay <2 years; iii) patients in the acute phase of a disease; iv) patients with malignant tumours who were undergoing chemotherapy, radiotherapy, immunotherapy; or v) patients that had a terminal disease. The objective was to compare the incidence of nosocomial infection in the previous routine medical setting with that following the implementation of the epidemic prevention and control measures.

**Interventions.** On 24 January 2020, The First Affiliated Hospital with Nanjing Medical University officially launched its first-level response to the COVID-19 pandemic (31). Elderly patients in the geriatric department were mainly divided into the following groups: Inpatients; outpatients; discharged patients; and patients with chronic disease. These patients were followed up for personalised management according to their conditions.

During hospital visits, all patients were required to wear masks, following which their body temperatures were checked and epidemiological history was recorded. If any of the patients showed symptoms of fever and pneumonia, they were transferred to a special unit, namely the ‘fever unit’, which was designed to observe and isolate patients suspected of infection. For patients with suspected symptoms, novel coronavirus nucleic acid tests on oropharyngeal swabs, chest CT and blood tests, including routine blood test and C-reactive protein test, were performed in a negative-pressure isolation room (32,33). Novel coronavirus nucleic acid test was performed using reverse transcription-quantitative PCR (RT-qPCR). The clinical samples of patients with PCR-confirmed COVID-19 were obtained in the form of throat swabs. Different conserved SARS-CoV-2 gene sequences can be targeted for RT-qPCR detection. Proposals from previous reports suggest using RT-qPCR as the molecular assay for detecting SARS-CoV-2 (4,34). Throughout all processes, all medical staff must wear masks, isolation suits and wash their hands. A professional online service for assessment, diagnosis and treatment was also set up for the management of patients with chronic disease and follow-up of discharged patients to avoid unnecessary hospital visits, reduce the risk of nosocomial infections and burden of hospital outpatient service to facilitate the reasonable allocation of medical resources. A nosocomial infection is an infection acquired during hospital stay that did not previously occur or was at the incubation stage upon admission (17).

For pre-diagnosis, an outpatient waiting area was set up according to the 1-m social distance rule to avoid cross-infection in the hospital. Patients with mild illness were treated in a separate room both during the early outbreak (2019) and under the current management protocols (2020). In the outpatient geriatric department, due to the limited ability of self-care and communication difficulties displayed by the elderly patients, only one individual was allowed to accompany the patients into the consultation room. Doctors, patients and accompanying staff were all required to wear masks at all times. For outpatients with chronic diseases, the prescription dosage was extended to 3 months depending on the condition. In situations where the drug was urgently required by the patients but could not be procured, solutions included temporary procurement, logistics and delivery, door-to-door delivery and other professional online services. In addition, to guarantee the pharmacological needs of the patients during the epidemic, patients who are in urgent need of drugs (anticoagulants, insulin, anti-rejection drugs for organ transplantation and emergency drugs for sudden diseases) can contact the nearest drug handling enterprises in their residential areas for consultation and purchase drugs in cases of drug shortages in hospitals.

**Preventive management.** The First Affiliated Hospital with Nanjing Medical University has successfully formulated seven editions of hospitalisation standards for inpatients, of which the seventh version is quoted here (35). At the beginning of the outbreak, patients who had to be admitted to hospital due to their condition required examination before admission. Chest CT, C-reactive protein estimation, blood routine test and novel coronavirus nucleic acid tests were performed before hospitalisation. Patients without epidemiological exposure to COVID-19 cases were admitted to the hospital within 14 days of examination. At the epidemic control stage, the hospital ward was arranged into single rooms, where temporary isolation wards were allocated for nucleic acid testing, chest CT and blood sample analysis before the patients were admitted. If the results of nucleic acid detection, chest CT and blood sample analysis, along with the epidemiological history assessment, were negative, hospital-acquired COVID-19 infection would be ruled out. It was necessary to conduct nucleic acid detection tests twice for high-risk patients, such as those with a recent history of fever and characteristic signs of COVID-19 according to CT images. Multiple patchy ‘ground glass’ opacities in the bilateral multiple lobular regions with periphery distribution are typical chest CT features of COVID-19 pneumonia, where interlobular thickening and adjacent pleura can also occur (36). If the nucleic acid test results were positive, the patient would then be immediately isolated and sent to the negative pressure isolation room through a special channel. In addition, any medical staff members exposed to a patient suspected of COVID-19 were isolated under observation for 14 days.

The principle of ‘no companion for mild cases’ and ‘one companion for severe cases’ was implemented in the geriatrics ward. The accompanying personnel was required to undergo a nucleic acid test before entering the ward. In addition, patients and caregivers were not allowed to enter or leave the ward unauthorised.

During the hospitalisation period, family members were not allowed to visit the patients. Therefore, the elderly inpatients were encouraged to communicate with their families through ‘cloud visitation’. If the elderly inpatient did not know how to use the Internet for video chat, the nurses would provide assistance.

The COVID-19 outbreak has affected not only the lifestyle of elderly patients but also their mental health. Elderly patients, especially inpatients, tend to be more prone to depression, anxiety and insomnia (37,38). In particular, 10-15% elderly...
patients suffer from clinical depression, which requires serious expert intervention (37,38). Behaviour driven by negative emotions not only aggravate the disease course but can also adversely affect ward management (39). Therefore, psychological protection for elderly patients forms an important part of the clinical treatment strategy (40,41). To address this, a ‘mind comfort room’ managed by clinical psychologists and medical staff was set up at the hospital. This ‘mind comfort room’ is a spacious apartment for elderly inpatients, where they can read magazines, watch movies, listen to music and play chess. In addition, sufficient space was provided for elderly inpatients to perform exercises, such as Tai chi and aerobic gymnastics.

Publicity and education on epidemic prevention were provided for the discharged patients. Follow-up telephone calls were made and online lectures on diseases were conducted regularly. Management procedures for both outpatients and inpatients are shown in Figs. 1 and 2, respectively.

Statistical analyses. All categorical data were described as frequency (N, %) and calculated with the Wilson score using the 95% confidence interval (CI). Comparisons were performed using the non-parametric Mann-Whitney or Kruskal-Wallis tests for two- and multiple-independent samples, respectively. Univariate and multivariate logistic regression models were used to compare clinical outcomes between the groups, where the association between the outcome and each variable/research factor, including age, sex, nervous system, respiratory system, endocrine system, digestive system, cardiovascular system, urinary system, ELSE, malignant tumor, trauma and nosocomial infection, were first analysed. Although these factors can be used as independent risk factors, there may be correlations among different factors, where part of this correlation among these factors can be masked within the univariate analysis. As a result, multivariate logistic regression was then used to detect the interactions of the correlation among these factors with the results.

Propensity score matching analysis was performed to mitigate the effect of selection bias and potential confounding factors between two groups. Propensity scores were calculated using all variables except for interventions, namely age, sex and underlying disease. For propensity score matching, a nearest-neighbour 1:2 matching scheme (42) with a calliper size of 0.1 was used. Inverse probability treatment weighting (IPTW) (43,44) and standardised mortality ratio weight (SMRW) (45-47) were calculated based on the logistic regression model and used to evaluate the risk of nosocomial infections. Results were stratified for age, which is known to be associated with variations in the incidence of nosocomial infections (11,13). By contrast, the generalised estimating equation (GEE) model (48) with a negative binomial distribution was generated using an unstructured working correlation matrix to investigate the risk of nosocomial infections. This utilises a related structure describing the different measured outcomes without any assumptions being made about its structure:

\[
\text{corr}(Y_{ij}, Y_{ik}) = \begin{cases} 
1 & j = k \ a_{jk} \\
0 & j \neq k 
\end{cases}
\]

In this case, \(Y_{ik}\) represents the \(k\)th response of the \(i\)th patient, whereas \(a_{jk}\) represents the correlation coefficient between the \(j\)th response and the \(k\)th response. In particular, \(Y_{ik}\) represents the outcome of the \(j\)th hospitalisation of the \(i\)th patient, whilst \(Y_{ik}\) represents the outcome of the \(k\)th hospitalisation of the \(i\)th patient. Infection is the specific outcome. Specifically, model 0 represents the unadjusted base model, whereas model 1, represents that adjusted for sex and age at baseline. Model II represents model I that was adjusted further for chronicity disease, malignant tumor and CCI. The variables included in the GEE model are similar to those included in logistic regression. Since the outcome variables were derived from a patient's multiple hospitalisations, the GEE models took into account the clustering of multiple hospitalisations of the same patient to minimise bias when producing estimates (49). Nomogram construction and validation were performed in accordance with a previously reported guideline (50). A nomogram was constructed according to the independent prognostic factors of survival. Based on the logistic, dichotomous and sequential screening analyses, a nomogram incorporating the risk factors was created for predicting infection outcomes using the EmpowerStats statistical software 2.0 (http://www.empowerstats.net/), which was calculated using the R packages ‘Survival’ and ‘Rms’ (R version 3.4.3) (51-53).

Comparisons among categorical variables were analysed by the \(\chi^2\) test. All statistical tests were performed using SPSS 22.0 software (IBM Corp.) and the EmpowerStats statistical software 2.0 (www.empowerstats.com; X&Y Solutions Inc.). \(P<0.05\) was considered to indicate a statistically significant difference.

Results

Baseline characteristics of the participants. Among the 4,066 patients, >50% were elderly aged>70 years, where 66.3% were male. The three dominant chronic diseases in the cohort were disorders in the nervous system (n=1,080, 26.56%), digestive system (n=941, 23.14%) and cardiovascular system (n=466, 11.46%). Parameters (age, sex, nervous system, respiratory system, endocrine system, digestive system, cardiovascular system, malignant tumor, trauma, and nosocomial infection) between the intervention and non-intervention groups were different except for urinary system (Table I). Specifically, there was a higher proportion of patients in the nervous system, respiratory system, digestive system, cardiovascular system, trauma and nosocomial infection categories in the intervened group, whilst a higher proportion of patients was observed in the endocrine system and malignant tumor categories in the intervened group. The proportion of patients aged <70 years old was higher, whereas that of patients aged ≥70 years was lower, in the unintervened group compared with that in the intervened group. There was difference in the intervention and non-intervention groups at the sex ratios of the patients recruited in study setting with unweighted or propensity 1:2 matching, where patients included in the population analysis predominantly male. After adjusting for all covariates by Propensity score matching (PSM) analysis, a similar distribution in the different covariates was observed except for age, nervous system, digestive system, urinary system and malignant tumor. After the IPTW and SMRW adjustment, the association between intervening measures and nosocomial infection remained significant. However, none of
the other parameters had their significance preserved, although a difference was observed in age distribution after SMRW, which is similar to those after unadjusted analysis (Table I). Comprehensively, the nosocomial infection rate between the intervention and non-intervention groups was found to be significantly different regardless of the calculation methods used, where there was a lower proportion in the intervened group (non-intervention vs. intervention: Unweighted, 4.72 vs. 1.91%, P<0.001; propensity 1:2 matching, 4.94 vs. 1.73%, P<0.001; IPTW, 4.79 vs. 1.70%, P<0.001; SMRW, 5.0 vs. 1.91%, P<0.001).

Multivariate logistic regression and stratified analysis of interventions. In the multivariate logistic regression model, the risk of nosocomial infections was lower in the intervention group compared with that in the non-intervention group [odds ratio (OR)=0.36; 95% CI=0.22-0.59 and P<0.001; Table II]. Even after IPTW and SMRW adjustment, the differences remained significant (IPTW: OR=0.33; 95% CI=0.25-0.44 and P<0.001; SMRW: OR=0.35; 95% CI=0.21-0.61; P=0.002; Table II). Because it was found in previous clinical studies that nosocomial infection in the elderly is more common, age was considered to be a risk factor of nosocomial infection (11,13), it was necessary to stratify the analysis by age (aged 70-90 years: Unadjusted, OR=2.46; 95% CI=1.64-3.68 and P<0.001; IPTW, OR=2.35; 95% CI=1.71-3.24 and P<0.001; SMRW, OR=2.35, 95% CI=1.23-4.49 and P=0.0098; aged ≥90 years: Unadjusted, OR=3.39, 95% CI=2.14-5.39 and

Figure 1. Management procedures for outpatients. CRP, C-reactive protein.
P<0.001; IPTW, OR=3.47, 95% CI=2.42-4.98 and P<0.001; SMRW, OR=3.34; 95% CI=1.61-6.96; P=0.0012; Table II). In addition, a stratified analysis of gastric catheterisation was performed to exclude this confounding factor. After the age stratification and adjustment for sex, chronic disease, malignant tumour and trauma, the results of both IPTW and SMRW showed a lower risk of nosocomial infection in the intervention group compared with that in the non-intervention group (aged <70 years: IPTW, OR=0.39; 95% CI=0.23-0.68 and P=0.0008; SMRW, OR=0.47; 95% CI=0.16-1.44 and P=0.1887; aged 70-90 years: IPTW, OR=0.28, 95% CI=0.18-0.44; P<0.001; SMRW, OR=0.34; 95% CI=0.15-0.76 and P=0.0091; age ≥90 years: IPTW, OR=0.28; 95% CI=0.17-0.46 and P<0.001; SMRW, OR=0.26; 95% CI=0.10-0.68 and P=0.0064; Table III).

Baseline characteristics of the long-stay subgroup population. To rule out any changes owing to the community floating population and social environment during the present 1-year study, 93 long-stay patients in stable conditions were selected as the study population for longitudinal analysis. Charlson comorbidity index (CCI) was included as a new variable, which is commonly used to assess the impact of co-comorbidities on patient survival over 10 years in addition to the underlying disease for which the patient is currently being treated (28-30). The age-adjusted CCI (aCCI) is a more widely used Comorbidity scoring system than CCI (28). It quantifies comorbidities based on the patients' age, types and severity of a patient's diseases and can be used to predict the risk of mortality from a disease (28-30). By contrast, the generalised estimating equation (GEE)
Table I. Baseline characteristics of the elderly patients in the present study.

A, Unweighted sample (n=4,066)

| Characteristics                          | Total [n=4,066; n (%)] | Unintervened [n=3,073; n (%)] | Intervened [n=993; n (%)] | P-value |
|------------------------------------------|------------------------|--------------------------------|---------------------------|---------|
| Age, years                               |                        |                                |                           |         |
| <70                                      | 1,987 (48.87)          | 1,567 (50.99)                  | 420 (42.30)               | <0.001  |
| 70-90                                    | 1,404 (34.53)          | 1,040 (33.84)                  | 364 (36.66)               |         |
| ≥90                                      | 675 (16.60)            | 466 (15.16)                    | 209 (21.05)               |         |
| Sex                                      |                        |                                |                            | 0.005   |
| Male                                     | 2,696 (66.31)          | 2,001 (65.12)                  | 695 (69.99)               |         |
| Female                                   | 1,370 (33.69)          | 1,072 (34.88)                  | 298 (30.01)               |         |
| Nervous system                           | 1,080 (26.56)          | 857 (27.89)                    | 223 (22.46)               | <0.001  |
| Respiratory system                       | 329 (8.09)             | 280 (9.11)                     | 49 (4.93)                 | <0.001  |
| Endocrine system                         | 393 (9.67)             | 224 (7.29)                     | 169 (17.02)               | <0.001  |
| Digestive system                         | 941 (23.14)            | 766 (24.93)                    | 175 (17.62)               | <0.001  |
| Cardiovascular system                    | 466 (11.46)            | 388 (12.63)                    | 78 (7.85)                 | <0.001  |
| Urinary system                           | 141 (3.47)             | 107 (3.48)                     | 34 (3.42)                 | 0.931   |
| ELSE                                     | 59 (1.45)              | 51 (1.66)                      | 8 (0.81)                  | 0.05    |
| Malignant tumor                          | 597 (14.68)            | 376 (12.4)                     | 221 (22.26)               | <0.001  |
| Trauma                                   | 47 (1.16)              | 42 (1.37)                      | 5 (0.50)                  | 0.027   |
| Nosocomial infection                     | 164 (4.03)             | 145 (4.72)                     | 19 (1.91)                 | <0.001  |

B, Propensity 1:2 matching (n=2,466)

| Characteristics                          | Total [n=2,466; n (%)] | Unintervened [n=1,598; n (%)] | Intervened [n=868; n (%)] | P-value |
|------------------------------------------|------------------------|--------------------------------|---------------------------|---------|
| Age, years                               |                        |                                |                           | 0.793   |
| <70                                      | 1,094 (44.36)          | 702 (43.93)                    | 392 (45.16)               |         |
| 70-90                                    | 899 (36.46)            | 590 (36.92)                    | 309 (35.60)               |         |
| ≥90                                      | 473 (19.18)            | 306 (19.15)                    | 167 (19.24)               |         |
| Sex                                      |                        |                                |                            | 0.047   |
| Male                                     | 1,656 (67.15)          | 1,051 (65.77)                  | 605 (69.70)               |         |
| Female                                   | 810 (32.85)            | 547 (34.23)                    | 263 (30.30)               |         |
| Nervous system                           | 471 (19.10)            | 306 (19.15)                    | 165 (19.01)               | 0.933   |
| Respiratory system                       | 181 (7.34)             | 136 (8.51)                     | 45 (5.18)                 | 0.002   |
| Endocrine system                         | 274 (11.11)            | 128 (8.01)                     | 146 (16.82)               | <0.001  |
| Digestive system                         | 492 (19.95)            | 322 (20.15)                    | 170 (19.59)               | 0.737   |
| Cardiovascular system                    | 284 (11.52)            | 217 (13.58)                    | 67 (7.72)                 | <0.001  |
| Urinary system                           | 127 (5.15)             | 95 (5.94)                      | 32 (3.69)                 | 0.015   |
| ELSE                                     | 57 (2.31)              | 26 (1.63)                      | 31 (3.57)                 | 0.002   |
| Malignant tumor                          | 548 (22.22)            | 341 (21.34)                    | 207 (23.85)               | 0.152   |
| Trauma                                   | 32 (1.30)              | 27 (1.69)                      | 5 (0.58)                  | 0.02    |
| Nosocomial infection                     | 94 (3.81)              | 79 (4.94)                      | 15 (1.73)                 | <0.001  |

C, IPTW (n=4,066)

| Characteristics                          | Total [n=4,066; n (%)] | Unintervened [n=3,073; n (%)] | Intervened [n=993; n (%)] | P-value |
|------------------------------------------|------------------------|--------------------------------|---------------------------|---------|
| Age, years                               |                        |                                |                           | 0.058   |
| <70                                      | 1,987 (48.87)          | 1,510 (49.15)                  | 477 (48.04)               |         |
| 70-90                                    | 1,415 (34.80)          | 1,082 (35.2)                   | 333 (33.53)               |         |
| ≥90                                      | 664 (16.33)            | 481 (15.65)                    | 183 (18.43)               |         |
| Sex                                      |                        |                                |                            | 0.947   |
| Male                                     | 2,694 (66.26)          | 2,037 (66.28)                  | 657 (66.18)               |         |
| Female                                   | 1,372 (33.74)          | 1,036 (33.72)                  | 336 (33.82)               |         |
model with a negative binomial distribution and an unstructured working correlation matrix were used to investigate the longitudinal relationship between interventions and the risk of nosocomial infections. The working correlation matrix constitute the covariance of linear predictor of the generalised linear model which reflect the clustering of the multiple hospitalisations of the same patient. The unstructured working correlation matrix means that no relation assumption of the element in the matrix is assigned, so each element of the correlation matrix should be estimated (54).

The baseline characteristics of the 93 patients are listed in Table IV. In total, >90% of the patients were elderly aged >70 years, where 68.82% were male. Nervous system disease was the most common chronic malady in this population (75.27%). aCCI was used to score comorbidities, where it was found that 67.74% of the patients had higher scores (≥6). Among these inpatients, the risk of nosocomial infections was lower in the intervention group compared with that in the non-intervention group (22.58 vs. 37.63%, respectively; P=0.025), especially the risk of pulmonary infection (13.98 vs. 41.94%, respectively, P<0.001; Table IV).

GEE estimation of the risk of nosocomial infection associated with the interventions. The rates of nosocomial and pulmonary infections were lower in the intervention group compared with those in the non-intervention group based on the univariate analysis (nosocomial infection with GEE adjustment: OR=0.5165, 95% CI=0.2763-0.965 and P=0.0384;
Table II. Multivariate logistic regression analyses for nosocomial infection in IPTW- and SMRW-matched cohort.

A. Unadjusted

| Parameter                              | OR (95% CI)     | P-value   |
|----------------------------------------|-----------------|-----------|
| Intervention (yes vs. no)              | 0.36 (0.22-0.59)| <0.0001   |
| Sex (female vs. male)                  | 0.96 (0.68-1.34)| 0.7951    |
| Age (vs. <70)                          |                 |           |
| ≥70, <90                               | 2.46 (1.64-3.68)| <0.001    |
| ≥90                                    | 3.39 (2.14-5.39)| <0.001    |
| Nervous system (yes vs. no)            | 2.66 (0.36-19.71)| 0.339     |
| Respiratory system (yes vs. no)        | 1.34 (0.17-10.58)| 0.783     |
| Endocrine system (yes vs. no)          | 1.22 (0.15-9.84)| 0.849     |
| Digestive system (yes vs. no)          | 0.94 (0.12-7.27)| 0.95      |
| Cardiovascular system (yes vs. no)     | 1.47 (0.19-11.38)| 0.71      |
| Urinary system (yes vs. no)            | 2.40 (0.29-19.70)| 0.415     |
| ELSE (yes vs. no)                      | 1.18 (0.41-3.37)| 0.756     |
| Malignant tumor (yes vs. no)           | 1.98 (0.26-15.08)| 0.508     |
| Trauma (yes vs. no)                    | 2.50 (0.25-25.26)| 0.437     |

B. Adjusted with IPTW

| Parameter                              | OR (95% CI)     | P-value   |
|----------------------------------------|-----------------|-----------|
| Intervention (yes vs. no)              | 0.33 (0.25-0.44)| <0.0001   |
| Sex (female vs. male)                  | 0.89 (0.68-1.17)| 0.4009    |
| Age (vs. <70)                          |                 |           |
| ≥70, <90                               | 2.35 (1.71-3.24)| <0.001    |
| ≥90                                    | 3.47 (2.42-4.98)| <0.001    |
| Nervous system (yes vs. no)            | 3.22 (0.66-15.84)| 0.15      |
| Respiratory system (yes vs. no)        | 1.39 (0.26-7.28)| 0.7       |
| Endocrine system (yes vs. no)          | 1.66 (0.32-8.61)| 0.545     |
| Digestive system (yes vs. no)          | 1.39 (0.27-7.05)| 0.692     |
| Cardiovascular system (yes vs. no)     | 2.57 (0.51-12.91)| 0.253     |
| Urinary system (yes vs. no)            | 3.56 (0.67-18.77)| 0.135     |
| ELSE (yes vs. no)                      | 0.95 (0.36-2.48)| 0.914     |
| Malignant tumor (yes vs. no)           | 2.94 (0.59-14.64)| 0.189     |
| Trauma (yes vs. no)                    | 2.72 (0.40-18.60)| 0.307     |

C. Adjusted with SMRW

| Parameter                              | OR (95% CI)     | P-value   |
|----------------------------------------|-----------------|-----------|
| Intervention (yes vs. no)              | 0.35 (0.21-0.61)| <0.0001   |
| Sex (female vs. male)                  | 0.81 (0.46-1.42)| 0.463     |
| Age (vs. <70)                          |                 |           |
| ≥70, <90                               | 2.35 (1.23-4.49)| 0.01      |
| ≥90                                    | 3.34 (1.61-6.96)| <0.001    |
| Nervous system (yes vs. no)            | 2.89 (0.38-22.21)| 0.308     |
| Respiratory system (yes vs. no)        | 1.03 (0.09-11.63)| 0.983     |
| Endocrine system (yes vs. no)          | 1.55 (0.19-12.66)| 0.684     |
| Digestive system (yes vs. no)          | 1.36 (0.16-11.70)| 0.778     |
| Cardiovascular system (yes vs. no)     | 2.51 (0.30-21.22)| 0.398     |
| Urinary system (yes vs. no)            | 3.08 (0.32-29.14)| 0.327     |
| ELSE (yes vs. no)                      | 0.83 (0.05-12.82)| 0.895     |
| Malignant tumor (yes vs. no)           | 2.55 (0.33-19.63)| 0.37      |
| Trauma (yes vs. no)                    | 2.38 (0.05-112.79)| 0.659     |

*95% CI and P-values are based on errors clustered by nosocomial infection. OR, Odds Ratio; Ref, Reference; IPTW, Inverse Probability Treatment Weight; SMRW, Standardised Mortality Ratio Weight; ELSE, Skin system, Oculopathy system, Otolaryngological system, Musculoskeletal system, Rheumatism and Immunity.*
pulmonary infection with GEE adjustment: OR=0.2186, 95% CI=0.1129‑0.4231 and P<0.0001; Table V). In addition, a multivariate logistics regression model was constructed to evaluate the influence of the intervention on the risk of nosocomial and pulmonary infections. Compared with that in the non-intervention group, the intervention group had a lower risk of nosocomial and pulmonary infections (nosocomial infection with GEE adjustment: OR=0.50, 95% CI=0.27‑0.90 and P=0.0217; pulmonary infection with GEE adjustment: OR=0.23, 95% CI=0.12‑0.42 and P<0.0001) (Table VI). Furthermore, in both the univariate analysis and multiple logistic regression models, gastric catheterisation was found to be a high‑risk factor for infection (nosocomial infection with GEE adjustment: OR=2.33, 95% CI=1.12‑4.83 and P=0.0229; pulmonary infection with GEE adjustment: OR=3.59, 95% CI=1.69‑7.61; P=0.0009; Tables V and VI). Therefore, a stratified analysis for gastric catheterisation was adopted. Among the inpatients without gastric catheterisation, the risk of nosocomial and pulmonary infections was significantly lower in the intervention group compared with that in the non‑intervention group after adjusting with GEE in the multiple logistic regression model (nosocomial infection: OR=0.28, 95% CI=0.11‑0.61 and P=0.001; pulmonary infection: OR=0.10, 95% CI=0.03‑0.32; P<0.001; Table VII).

Table III. Effect of intervening measures in IPTW‑adjusted and SMRW‑adjusted logistic regression analyses for the risk of nosocomial infection, stratified according to the age.a

| Age group (years) | Intervened | Unadjusted | Adjusted with IPTWb | Adjusted with SMRWb |
|------------------|------------|------------|---------------------|---------------------|
|                  | No (n, %)  | Yes (n, %) | OR (95% CI) P-value | OR (95% CI) P-value |
| <70              | 1,567 (50.99) | 420 (42.30) | 0.48 (0.18‑1.27) 0.141 | 0.39 (0.23‑0.68) <0.001 | 0.47 (0.16‑1.44) 0.189 |
| ≥70, <90         | 1,040 (33.84) | 364 (36.66) | 0.33 (0.15‑0.70) 0.004 | 0.28 (0.18‑0.44) <0.001 | 0.34 (0.15‑0.76) 0.009 |
| ≥90              | 466 (15.16) | 209 (21.05) | 0.27 (0.11‑0.66) 0.004 | 0.28 (0.17‑0.46) <0.001 | 0.26 (0.10‑0.68) 0.006 |
| Total            | 3,039 (75.58) | 993 (24.42) | 0.36 (0.22‑0.59) <0.001 | 0.33 (0.25‑0.44) <0.001 | 0.35 (0.21‑0.61) <0.001 |

aThe 95% CI and P‑values were calculated based on errors clustered by nosocomial infection. bAdjusted with IPTW or SMRW model to adjust for the following: Sex; Nervous system; Respiratory system; Endocrine system; Digestive system; Cardiovascular system; Urinary System; Malignant Tumor; ELSE; and Trauma. CI, Confidence Interval; OR, Odds Ratio; Ref, Reference; IPTW, Inverse Probability Treatment Weight; SMRW, Standardised Mortality Ratio Weight.

Table IV. Baseline characteristics for the longitudinal study of long‑stay patients.a

| Characteristics | Total (n=186), n (%) | Unintervened (n=93), n (%) | Intervened (n=93), n (%) | P‑value |
|-----------------|----------------------|----------------------------|--------------------------|---------|
| Age, years      |                      |                            |                          |         |
| <70             | 18 (9.68)            | 9 (9.68)                   | 9 (9.68)                 |         |
| ≥70, <90        | 76 (40.86)           | 38 (40.86)                 | 38 (40.86)               |         |
| ≥90             | 92 (49.46)           | 46 (49.46)                 | 46 (49.46)               |         |
| Sex             |                      |                            |                          |         |
| Male            | 128 (68.82)          | 64 (68.82)                 | 64 (68.82)               |         |
| Female          | 58 (31.18)           | 29 (31.18)                 | 29 (31.18)               |         |
| Nervous system  | 140 (75.27)          | 69 (74.19)                 | 71 (76.34)               | 0.734   |
| Respiratory system| 24 (12.9)         | 14 (15.05)                 | 10 (10.75)               | 0.382   |
| Endocrine system| 72 (38.71)           | 41 (44.09)                 | 31 (33.33)               | 0.132   |
| Cardiovascular system| 155 (83.33) | 78 (83.87)                 | 77 (82.80)               | 0.844   |
| Malignant tumor | 9 (4.84)             | 3 (3.23)                   | 6 (6.45)                 | 0.305   |
| aCCI            |                      |                            |                          | 0.754   |
| <6              | 60 (32.26)           | 31 (33.33)                 | 29 (31.18)               |         |
| ≥6              | 126 (67.74)          | 62 (66.67)                 | 64 (68.82)               |         |
| Gastric catheterisation| 66 (35.48)    | 35 (37.63)                 | 31 (33.33)               | 0.54    |
| Nosocomial infection| 56 (30.11)  | 35 (37.63)                 | 21 (22.58)               | 0.025   |
| Pulmonary infection| 52 (27.96)    | 39 (41.94)                 | 13 (13.98)               | <0.001  |
| Other infections| 16 (8.60)           | 11 (11.83)                 | 5 (5.38)                 | 0.117   |

aχ2 tests were used for categorical variables. CCI, age‑adjusted Charlson Comorbidity Index.
### Table V. Univariate analysis of risk factors for infection based on the GEE model.

#### A, Nosocomial infection

| Parameters                      | Unadjusted                      | Adjusted With GEE                  |
|--------------------------------|---------------------------------|------------------------------------|
|                                | OR (95% CI) P-value             | OR (95% CI) P-value                |
| Intervention (yes vs. no)      | 0.48 (0.25-0.92) 0.027          | 0.5165 (0.2763-0.9653) 0.038       |
| Sex (female vs. male)          | 1.07 (0.54-2.09) 0.853          | 1.2652 (0.5568-2.8747) 0.574       |
| Age (vs. <70)                  |                                  |                                    |
| ≥70, <90                       | 2.04 (0.54-7.74) 0.296          | 1.1845 (0.2574-5.451) 0.828        |
| ≥90                            | 2.54 (0.68-9.44) 0.164          | 1.0932 (0.2251-5.307) 0.912        |
| Nervous system (yes vs. no)    | 2.48 (1.07-5.73) 0.034          | 1.6831 (0.6924-4.0913) 0.251       |
| Respiratory system (yes vs. no)| 1.47 (0.60-3.59) 0.4            | 1.3962 (0.5328-3.6584) 0.497       |
| Endocrine system (yes vs. no)  | 1.42 (0.75-2.69) 0.277          | 1.3113 (0.6176-2.7919) 0.479       |
| Cardiovascular system (yes vs. no) | 2.55 (0.92-7.03) 0.07  | 2.1568 (0.8579-5.4225) 0.102       |
| aCCI (≥6 vs. <6)               | 1.45 (0.72-2.89) 0.296          | 1.0225 (0.3931-1.1157) 0.617       |
| Gastric catheterisation (yes vs. no) | 2.42 (1.27-4.62) 0.007  | 2.3313 (1.1242-4.8348) 0.023       |

#### B, Pulmonary infection

| Parameters                      | Unadjusted                      | Adjusted With GEE                  |
|--------------------------------|---------------------------------|------------------------------------|
|                                | OR (95% CI) P-value             | OR (95% CI) P-value                |
| Intervention (yes vs. no)      | 0.23 (0.11-0.46) <0.001         | 0.2186 (0.1129-0.4231) <0.001      |
| Sex (female vs. male)          | 0.97 (0.49-1.95) 0.94           | 1.271 (0.5084-3.1775) 0.608        |
| Age (vs. <70)                  |                                  |                                    |
| ≥70, <90                       | 2.86 (0.60-13.54) 0.186         | 2.3157 (0.5904-9.8033) 0.229       |
| ≥90                            | 3.87 (0.84-17.93) 0.084         | 2.1334 (0.5572-8.1693) 0.269       |
| Nervous system (yes vs. no)    | 2.64 (1.10-6.36) 0.031          | 1.8451 (0.7142-4.7665) 0.206       |
| Respiratory system (yes vs. no)| 1.66 (0.68-4.07) 0.268         | 1.6081 (0.4203-6.1518) 0.488       |
| Endocrine system (yes vs. no)  | 1.71 (0.90-3.28) 0.104          | 1.7201 (0.7416-3.9897) 0.206       |
| Cardiovascular system (yes vs. no) | 1.76 (0.68-4.57) 0.247  | 1.3119 (0.4318-3.9863) 0.632       |
| Malignant tumor (yes vs. no)   | N/A N/A                         | N/A N/A                           |
| aCCI (≥6 vs. <6)               | 1.62 (0.79-3.33) 0.189          | 1.0359 (0.9442-1.1364) 0.456       |
| Gastric catheterisation (yes vs. no) | 3.31 (1.70-6.43) <0.001  | 3.5871 (1.6915-7.607) <0.001       |

#### C, Other infections

| Parameters                      | Unadjusted                      | Adjusted With GEE                  |
|--------------------------------|---------------------------------|------------------------------------|
|                                | OR (95% CI) P-value             | OR (95% CI) P-value                |
| Intervention (yes vs. no)      | 0.42 (0.14-1.27) 0.126          | 0.4421 (0.1489-1.3124) 0.142       |
| Sex (female vs. male)          | 3.17 (1.12-9.00) 0.03           | 3.0069 (1.1468-7.8838) 0.025       |
| Age (vs. <70)                  |                                  |                                    |
| ≥70, <90                       | 0.44 (0.07-2.64) 0.372          | 0.2084 (0.0036-11.9256) 0.448      |
| ≥90                            | 0.98 (0.20-4.88) 0.976          | 0.5239 (0.0066-41.8813) 0.772      |
| Nervous system (yes vs. no)    | 0.70 (0.23-2.13) 0.529          | 0.6582 (0.1559-2.7785) 0.569       |
| Respiratory system (yes vs. no)| 1.64 (0.43-6.23) 0.469         | 1.5633 (0.3953-6.1825) 0.524       |
| Endocrine system (yes vs. no)  | 1.66 (0.59-4.63) 0.336          | 1.7703 (0.5055-6.2001) 0.372       |
| Cardiovascular system (yes vs. no) | 3.21 (0.41-25.28) 0.267  | 2.4038 (0.2467-23.4249) 0.45       |
| Malignant tumor (yes vs. no)   | 1.35 (0.16-11.53) 0.784         | 0.601 (0.01-36.2662) 0.808        |
| aCCI (≥6 vs. <6)               | 2.19 (0.60-7.98) 0.237          | 1.0812 (0.9113-1.2828) 0.371       |
| Gastric catheterisation (yes vs. no) | 0.39 (0.11-1.43) 0.156  | 0.3795 (0.0721-1.9981) 0.253       |

The 95% CI and P-values were calculated based on errors clustered by nosocomial infection, pulmonary infection or other infections. GEE, generalised estimating equation; aCCI, age-adjusted Charlson Comorbidity Index; CI, Confidence Interval; OR, Odds Ratio; Ref, Reference; N/A, not available.
Table VI. Multivariate analysis of risk factors of infection based on the GEE model.ª

### A. Nosocomial infection

| Parameters | Unadjusted OR (95% CI) | P-value | Adjusted With GEE OR (95% CI) | P-value |
|------------|------------------------|---------|-------------------------------|---------|
| Intervention (yes vs. no) | 0.50 (0.25-0.97) | 0.042 | 0.50 (0.27-0.90) | 0.022 |
| Sex (female vs. male) | 1.11 (0.52-2.34) | 0.788 | 1.11 (0.50-2.48) | 0.803 |
| Age (vs. <70) | | | | |
| ≥70, <90 | 1.08 (0.24-4.78) | 0.923 | 1.08 (0.19-5.96) | 0.933 |
| ≥90 | 1.17 (0.26-5.33) | 0.842 | 1.17 (0.21-6.59) | 0.862 |
| Nervous system (yes vs. no) | 1.92 (0.76-4.85) | 0.168 | 1.92 (0.81-4.57) | 0.14 |
| Respiratory system (yes vs. no) | 1.30 (0.49-3.40) | 0.598 | 1.30 (0.50-3.35) | 0.593 |
| Endocrine system (yes vs. no) | 1.21 (0.59-2.48) | 0.609 | 1.21 (0.55-2.63) | 0.636 |
| Cardiovascular system (yes vs. no) | 2.10 (0.71-6.25) | 0.183 | 2.10 (0.81-5.43) | 0.126 |
| aCCI (≥6 vs. ≤6) | 1.21 (0.56-2.61) | 0.019 | 1.21 (0.49-3.00) | 0.086 |
| Gastric catheterisation (yes vs. no) | 2.33 (1.15-4.73) | <0.001 | 2.33 (1.12-4.83) | 0.023 |

### B. Pulmonary infection

| Parameters | Unadjusted OR (95% CI) | P-value | Adjusted With GEE OR (95% CI) | P-value |
|------------|------------------------|---------|-------------------------------|---------|
| Intervention (yes vs. no) | 0.23 (0.11-0.48) | <0.001 | 0.23 (0.12-0.42) | <0.001 |
| Sex (female vs. male) | 1.02 (0.46-2.28) | 0.954 | 1.02 (0.43-2.42) | 0.957 |
| Age (vs. <70) | | | | |
| ≥70, <90 | 1.78 (0.31-10.14) | 0.516 | 1.78 (0.39-8.11) | 0.456 |
| ≥90 | 2.09 (0.36-12.27) | 0.414 | 2.09 (0.47-9.20) | 0.329 |
| Nervous system (yes vs. no) | 2.16 (0.80-5.82) | 0.129 | 2.16 (0.92-5.04) | 0.076 |
| Respiratory system (yes vs. no) | 1.43 (0.52-3.94) | 0.488 | 1.43 (0.39-5.21) | 0.586 |
| Endocrine system (yes vs. no) | 1.46 (0.68-3.15) | 0.335 | 1.46 (0.62-3.43) | 0.387 |
| Cardiovascular system (yes vs. no) | 1.34 (0.45-3.96) | 0.598 | 1.34 (0.43-4.20) | 0.617 |
| CCI (≥6 vs. ≤6) | 1.31 (0.57-3.00) | 0.522 | 1.31 (0.50-3.43) | 0.581 |
| Gastric catheterisation (yes vs. no) | 3.59 (1.65-7.80) | <0.005 | 3.59 (1.69-7.61) | <0.001 |

### C. Other infections

| Parameters | Unadjusted OR (95% CI) | P-value | Adjusted With GEE OR (95% CI) | P-value |
|------------|------------------------|---------|-------------------------------|---------|
| Intervention (yes vs. no) | 0.46 (0.14-1.48) | 0.192 | 0.46 (0.16-1.36) | 0.16 |
| Sex (female vs. male) | 3.30 (1.00-10.86) | 0.049 | 3.30 (1.17-9.29) | 0.024 |
| Age (vs. <70) | | | | |
| ≥70, <90 | 0.23 (0.03-1.97) | 0.181 | 0.23 (0.01-8.54) | 0.427 |
| ≥90 | 0.51 (0.06-4.30) | 0.532 | 0.51 (0.01-21.63) | 0.722 |
| Nervous system (yes vs. no) | 0.57 (0.15-2.13) | 0.4 | 0.57 (0.14-2.34) | 0.432 |
| Respiratory system (yes vs. no) | 1.54 (0.33-7.22) | 0.585 | 1.54 (0.38-6.25) | 0.547 |
| Endocrine system (yes vs. no) | 1.87 (0.57-6.20) | 0.303 | 1.87 (0.53-6.63) | 0.33 |
| Cardiovascular system (yes vs. no) | 2.42 (0.28-21.26) | 0.425 | 2.42 (0.24-24.77) | 0.456 |
| Malignant tumor (yes vs. no) | 0.63 (0.04-9.19) | 0.737 | 0.63 (0.02-25.37) | 0.807 |
| CCI (≥6 vs. ≤6) | 2.13 (0.50-9.12) | 0.31 | 2.13 (0.43-10.54) | 0.356 |
| Gastric catheterisation (yes vs. no) | 0.38 (0.10-1.51) | 0.169 | 0.38 (0.07-2.00) | 0.253 |

ªThe 95% CI and P-values were calculated based on errors clustered by nosocomial infection, pulmonary infection or other infections. GEE, generalised estimating equation; CCI, Charlson comorbidity index; CI, Confidence Interval; OR, Odds Ratio; Ref, Reference; N/A, not available.
Predictive model for infection outcomes. Based on the logistic, dichotomous and sequential screening analyses, a nomogram incorporating the risk factors was created for predicting infection outcomes using the EmpowerStats statistical software 2.0 (www.empowerstats.com; X&Y Solutions Inc.), which uses the R packages ‘Survival’ and

| Table VII. Logistic regression model for the association between intervening measure and infection stratified by gastric catheterisation. a |
|---|---|---|
| **A, Model 0** | **Not catherised** | **Catheterised** | **Total** |
| **Type of infection** | **OR (95% CI) P-value** | **OR (95% CI) P-value** | **OR (95% CI) P-value** |
| Nosocomial infection (yes vs. no) | | | |
| Unadjusted | 0.28 (0.11-0.71) 0.007 | 0.96 (0.36-2.56) 0.94 | 0.49 (0.25-0.94) 0.032 |
| Adjusted with GEE | 0.28 (0.13-0.60) <0.001 | 0.96 (0.35-2.62) 0.941 | 0.49 (0.27-0.88) 0.016 |
| Pulmonary infection (yes vs. no) | | | |
| Unadjusted | 0.10 (0.03-0.35) <0.001 | 0.40 (0.15-1.10) 0.075 | 0.21 (0.10-0.45) <0.001 |
| Adjusted with GEE | 0.10 (0.03-0.31) <0.001 | 0.40 (0.15-1.11) 0.078 | 0.21 (0.11-0.40) <0.001 |
| Other infections (yes vs. no) | | | |
| Unadjusted | 0.38 (0.11-1.29) 0.121 | 0.55 (0.05-6.38) 0.633 | 0.40 (0.13-1.22) 0.109 |
| Adjusted with GEE | 0.38 (0.12-1.22) 0.104 | 0.55 (0.13-2.31) 0.414 | 0.40 (0.15-1.10) 0.076 |

| **B, Model I** | **Not catherised** | **Catheterised** | **Total** |
|---|---|---|---|
| **Type of infection** | **OR (95% CI) P-value** | **OR (95% CI) P-value** | **OR (95% CI) P-value** |
| Nosocomial infection (yes vs. no) | | | |
| Unadjusted | 0.25 (0.10-0.66) 0.005 | 1.00 (0.35-3.82) 0.999 | 0.49 (0.25-0.94) 0.032 |
| Adjusted with GEE | 0.25 (0.11-0.58) <0.001 | 1.00 (0.33-3.02) 0.999 | 0.49 (0.27-0.88) 0.016 |
| Pulmonary infection (yes vs. no) | | | |
| Unadjusted | 0.09 (0.02-0.32) <0.001 | 0.40 (0.14-1.11) 0.077 | 0.21 (0.10-0.44) <0.001 |
| Adjusted with GEE | 0.09 (0.03-0.30) <0.005 | 0.40 (0.14-1.14) 0.086 | 0.21 (0.11-0.40) <0.001 |
| Other infections (yes vs. no) | | | |
| Unadjusted | 0.34 (0.09-1.25) 0.104 | N/A | 0.43 (0.14-1.37) 0.154 |
| Adjusted with GEE | 0.34 (0.09-1.26) 0.107 | 0.48 (0.07-3.11) 0.438 | 0.40 (0.14-1.13) 0.083 |

| **C, Model II** | **Not catherised** | **Catheterised** | **Total** |
|---|---|---|---|
| **Type of infection** | **OR (95% CI) P-value** | **OR (95% CI) P-value** | **OR (95% CI) P-value** |
| Nosocomial infection (yes vs. no) | | | |
| Unadjusted | 0.27 (0.10-0.73) 0.01 | 1.01 (0.29-3.52) 0.985 | 0.52 (0.26-1.02) 0.058 |
| Adjusted with GEE | 0.27 (0.11-0.61) 0.002 | N/A | N/A |
| Pulmonary infection (yes vs. no) | | | |
| Unadjusted | 0.10 (0.02-0.37) <0.001 | 0.39 (0.12-1.20) 0.099 | 0.22 (0.10-0.48) <0.001 |
| Adjusted with GEE | 0.10 (0.03-0.32) 0 | 0.39 (0.12-1.24) 0.111 | 0.22 (0.11-0.42) <0.001 |
| Other infections (yes vs. no) | | | |
| Unadjusted | 0.29 (0.07-1.24) 0.094 | N/A | N/A |
| Adjusted with GEE | 0.29 (0.08-1.02) 0.053 | N/A | N/A |

aThe 95% CI and P-values were calculated based on errors clustered by nosocomial infection, pulmonary infection, or other infections. Model 0, unadjusted base model. Model I, adjusted for sex and age at baseline. Model II, Model I + adjusted for chronicity disease, malignant tumor and CCI. GEE, generalised estimating equation; CCI, Charlson comorbidity index; CI, Confidence Interval; OR, Odds Ratio; Ref, Reference; N/A, not available.
In all patients with infection, a total score was calculated based on age, sex, nasogastric feeding, diseases of the

['Rms' (R version 3.4.3) to calculate construct the nomograms (Figs. 3-5).]
cardiovascular, respiratory, nervous and endocrine systems, aCCI and intervention measures. However, the application of this model is relatively complex, therefore it has not been widely applied clinically. Further simplification is required.

Discussion

The novelty of the present study lies in the particularity of the study population. The study site was selected in the geriatric department with a slow turnover, where a large number of elderly inpatients were included into the study population. Elderly inpatients are particularly susceptible to nosocomial infections, especially in the lungs (55,56). Physiological function in the elderly deteriorates over time, with characteristics including decreases in age-related lung function, weakness in the respiratory muscles and loss of the clearance ability in the respiratory mucosa (57). These factors all contribute to increasing the incidence of pneumonia and other chronic diseases, such as chronic obstructive emphysema, chronic pulmonary heart disease and chronic heart failure, among this demographic (57). In addition, since the majority of elderly patients have comorbidities, ≥ one complications may occur based on the disease type. Following cerebrovascular accidents, including cerebral haemorrhage and cerebral infarction, elderly patients are also predisposed to succumbing to aspiration pneumonia, which is a common form of lung infection in elderly patients (58). Furthermore, patients with hemiplegia or those who are chronically bedridden have been reported to be more predisposed to *Streptococcus anginosus*-induced pneumonia (59). Patients with malignant tumours may also develop radiation pneumonia as a result of long-term radiotherapy (60). Long-term chemotherapy and chronic management using immunosuppressants may impair systemic immune system function, increasing the susceptibility to infection (57). Additionally, patients with malnutrition have diminished pathogen resistance, which increases the risk of infection-related diseases (61). Infection increases the bodily demand for nutrition, further aggravating malnutrition and to establish a vicious cycle (62). In addition, elderly patients frequently display a decreased ability to perceive their own health status, leading to treatment delays or even mortality (63). In elderly inpatients with pneumonia, the lack of clear clinical symptoms, ambiguous examination and test results, misdiagnosis, delayed treatment and coexistence of malnutrition, coupled with other diseases, all contribute to increasing the risk of lung infection (61). This in turn aggravates illness severity, prolongs the disease course and adds to the difficulty of accurate diagnosis and treatment, leading to irreversible consequences. The diagnosis and treatment of pulmonary infection in elderly inpatients remains a major challenge. Therefore, during the COVID-19 outbreak, appropriate measures were taken to prevent nosocomial infections in elderly patients.

During the pandemic, the Geriatric Department of The First Affiliated Hospital with Nanjing Medical University actively adopted preventive measures. The present retrospective analysis of the selected cases showed that implementing preventive and control measures could effectively control the risk of nosocomial infections. The key finding was the
need to effectively screen patients with infection before hospitalisation to prevent cross-infection. During hospitalisation, it remains important to reduce the flow of people in the hospital, wear masks for protection, effectively cut off the infection source and route of transmission (64). In the present study, preventive measures employed to reduce nosocomial infections in hospitalised patients in the geriatric wards during the COVID-19 pandemic were summarised. Results of the present retrospective analysis revealed that these measures significantly reduced the incidence of nosocomial infection among these patients. Further implementation of these measures may help to effectively control nosocomial infections in the future. Empirical recommendations are required in response to important paroxysmal public health incidents that occur in the future.

In the subgroup study, the nosocomial infection risk of 93 inpatients in the Geriatrics Department of The First Affiliated Hospital with Nanjing Medical University, excluding patients who recently underwent surgery and anti-tumour therapy, was analysed. These 93 patients with long-term stable conditions were selected for longitudinal analysis. The results showed that preventative measures could also effectively control the rate of nosocomial infections in this group. In addition, it was found that the use of indwelling gastric tube was an independent risk factor for nosocomial infections, especially pulmonary infection, among elderly inpatients. Clinically, the majority of elderly inpatients with indwelling gastric tubes also suffer from malnutrition, dysphagia or eating difficulty and severe coughing, all of which have clear indications for gastric tube placement (65). Poor nutritional status is common among elderly patients, especially in those who are hospitalised long-term. This is due to the impaired ability to chew or swallow, which also increases the risk of infection. However, regulating nutrition has been found to contribute to recovery (66-68). Gastric catheterisation is a common treatment method that can be used to effectively improve the nutritional status in the elderly (66). For cerebrovascular accidents, such as cerebral haemorrhage and cerebral infarction, swallowing dysfunction or cognitive impairment may lead to aspiration difficulties, coughing and aspiration pneumonia (69). Aspiration pneumonia is a common subtype of lung infection in elderly patients (58), such that gastric tube placement can effectively prevent aspiration pneumonia. For example, inserting a catheter into the stomach through the nose can reduce the risk of aspiration by eating through the mouth, thereby reducing the risk of aspiration pneumonia. However, the results of the present study revealed that the presence of an indwelling gastric tube was an independent risk factor for pneumonia in elderly inpatients. However, from previous clinical studies (70,71), it is likely that patients with an indwelling gastric tube are more predisposed to pneumonia because of their disease state, rather than the process of gastric tube insertion. Therefore, the focus should be on the placement, disinfection and replacement of the gastric tube, combined with the regular removal of oropharyngeal secretions and good positioning to avoid reflux and aspiration (69). In the present study, participants were patients receiving enteral nutrition who had undergone gastric tube implantation. The results showed that the indwelling gastric tube increased the risk of nosocomial infections. Nevertheless, nosocomial infections caused by an indwelling gastric tube should either be prevented altogether or at least reduced. Clinically, novel comprehensive nutritional indicators are required to evaluate the efficacy of specific interventions, whereby further research is required to explore the optimal time of intervention and treatment.

In the present study, the preventive and control measures adopted by the Geriatric Department of The First Affiliated Hospital with Nanjing Medical University during the epidemic prevention and control period were discussed. The previous medical environment was retrospectively summarised. In conclusion, epidemic preventative and control measures were able to effectively reduce the occurrence of nosocomial infections in elderly inpatients. However, owing to the limited research data from retrospective studies, the study participants in the present study also had regional limitations. Therefore, the results obtained may not apply to all geographic regions. It is necessary to further expand the sample collection area and conduct prospective multi-centre studies to improve upon existing measures. The ultimate aim should be to gradually establish a mature medical management system that is not limited to the prevention and control of the epidemic. This will certainly contribute to the prevention of nosocomial infections or reduction of their incidence in the future.

Acknowledgements
Not applicable.

Funding
The present study was supported by The National Key R&D Program of China (grant nos. 2018YFC2002100 and 2018YFC2002102).

Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors’ contributions
SSW, WL and MJZ conceived and designed the current study. MJZ, WL, SSW, KW, QS and YJH acquired, analyzed the data and performed statistical analysis. ML, SRS and BC participated in the acquisition of data (including screening of enrolled patients and collection of test indicators required for the study). JQW designed the study and interpreted the data. WL and KW confirm the authenticity of all the raw data. All authors critically revised the manuscript for important intellectual content, and read and approved the final version of the manuscript.

Ethics approval and consent to participate
The present study was approved by the Ethics Committee of the First Affiliated Hospital with Nanjing Medical University (approval no. 2020-SR-072; Nanjing). The institutional review
board of the The First Affiliated Hospital with Nanjing Medical University approved this study and granted a waiver of informed consent from study participants because of the retrospective nature of the present study. In the present retrospective study, patient data were obtained through the electronic medical record system.

Patient consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

References
1. Safiabadi Tali SH, LeBlanc JJ, Sadiq Z, Naseem S, Khan WA, LeBlanc JJ, Sadiq Z, Oyewunmi OD, Camargo C, Nikpour B, Armanfard N, Sagan SM and Jahnshahi-Anbahi S: Tools and techniques for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)/COVID-19 detection. Clin Microbiol Rev 34: 00228-20, 2021.
2. Ahadm F, Almuayqil SN, Humayun M, Naseem S, Khan WA and Jumaid K: Prediction of COVID-19 cases using machine learning for effective public health management. Comput Mater Contin 66: 2265-2282, 2021.
3. Ntambara J and Chu M: The risk to child nutrition during and after COVID-19 pandemic: What to expect and how to respond. Public Health Nutr 24: 3530-3536, 2021.
4. Malekifar P, Pakzad R, Shahbahrani R, Zandi M, Jafarpour A, Rezayat SA, Akbarpour S, Shahbestari AN, Pakzad J, Resi E, et al: Viral coinfection among COVID-19 patient groups: An update systematic review and meta-analysis. Biomed Res Int 2021: 5313832, 2021.
5. Zandi M, Farahani A, Zakeri A, Akhavan Rezayat S, Mohammadi R, Das U, Dimmock JR, Hafezi H, Hosseini P and Doroudi A, et al: Clinical symptoms and types of samples are critical factors for the molecular diagnosis of symptomatic COVID-19 patients: A systematic literature review. Int J Microbiol 2021: 5528786, 2021.
6. Soltani S, Zakeri A, Zandi M, Keshem MH, Tabibzadeh A, Dastranj M, Faramarzi S, Didehdar M, Hafezi H, Hosseini P and Farahani A: The role of bacterial and fungal human respiratory microbiota in COVID-19 patients. Biomed Res Int 2021: 6670798, 2021.
7. Hosseini P, Afzali S, Karimi MR, Zandi M, Zebardast A, Latifi T, Tabibzadeh A, Ramezani A, Zakeri A, Zakeri A, et al: The coronavirus disease 2019 and effect on liver function: A hidden and vital interaction beyond the respiratory system. Rev Med Microbiol 33: e161-e179, 2022.
8. Tsatsakis A, Petrakis D, Nikolouzakis TK, Docea AO, Calina D, Vinceti M, Goumenou M, Hamadi E, Micek ST, Martin-Loeches I, Torres A, Shorr AF, Fredrickson A, Roy SL, Akhavan Rezayat S, Akbarpour S, Shabestari AN, Pakzad I, and Hernández AF: COVID-19, an opportunity to reevaluate the hidden and vital interaction beyond the respiratory system. Rev Med Microbiol 33: e161-e179, 2022.
9. Jaccarino G, Grassi G, Borgia C, Ferri C, Sulvetti M and Volpe M: SARS-RAS Investigators: Age and multimorbidity predict death among COVID-19 patients: Results of the SARS-RAS study of the italian society of hypertension. Hypertension 73: 366-372, 2020.
10. Pedersen OB, Nissen J, Dinh KM, Schwinn M, Kaspersen KA, Boldsen JK, Didriksen M, Dowsett J, Sørensen E, Thorner LW, et al: Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection fatality rate among elderly danes: A cross-sectional study on retired blood donors. Clin Infect Dis 73: e2962-e2969, 2021.
11. Kadambri S, Klenerman P and Pollard AJ: Why the elderly appear to be more severely affected by COVID-19: The potential role of immunosenescence and CMV. Rev Med Virol 30: e2144, 2020.
12. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, Wang B, Xiang H, Cheng Z, Xiong Y, et al: Clinical Characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. JAMA 323: 1061-1069, 2020.
13. Smith PW: Nosocomial infections in the elderly. Infect Dis Clin North Am 3: 763-777, 1989.
14. Plonquet A, Bastuji-Garin S, Tahmasebi F, Bridaire C, Leduval K, Farcket J and Pailaud E: Immune risk phenotype is associated with nosocomial lung infections in elderly in-patients. Immun Ageing 8: 8, 2011.
15. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, Zhang L, Fan G, Xu J, Gu X, et al: Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 395: 497-506, 2020.
16. Kollef MH, Torres A, Shorr AF, Martin-Löeches I and Micek ST: Nosocomial infection. Crit Care Med 49: 169-187, 2021.
17. Garner JS, Jarvis WR, Emori TG, Horan TC and Hughes JM: CDC definitions for nosocomial infections, 1988. Am J Infect Control 16: 128-140, 1988.
18. Vickery K, Deva A, Jacobms A, Allan J, Valente P and Gosbell IB: Presence of biofilm containing viable multiresistant organisms despite terminal cleaning on clinical surfaces in an intensive care unit. J Hosp Infect 80: 52-55, 2012.
19. Wenzel RP: Perspective: Attributable mortality—the promise of better antimicrobial therapy. J Infect Dis 178: 917-919, 1998.
20. Rangel-Frausto MS, Pittet D, Costigan M, Hwang T, Davis CS and Wenzel RP: The natural history of the systemic inflammatory response syndrome (SIRS). A prospective study. JAMA 273: 174-179, 1995.
21. Magill SS, Edwards JR, Bamberg W, Beldavs ZG, Dumyati G, Kainer MA, Lynfield R, Maloney M, McAllister-Hollobol L, Nadle J, et al: Multistate point-prevalence survey of health care-associated infections. N Engl J Med 370: 1198-1208, 2014.
22. Kollef MH, Shorr A, Tabak YP, Gupta V, Liu LZ and Johannes RS: Epidemiology and outcomes of health-care-associated pneumonia: Results from a large US database of culture-positive pneumonia. Chest 128: 3854-3862, 2005.
23. Labelle A and Kollef MH: Healthcare-associated pneumonia: Approach to management. Clin Chest Med 32: 507-513, 2011.
24. Kollef MH, Hamilton CW and Ernst FR: Economic impact of ventilator-associated pneumonia in a large matched cohort. Infect Control Hosp Epidemiol 33: 250-256, 2012.
25. Du Q, Zhang D, Hu W, Li X, Xia Q, Wen T and Jia H: Nosocomial infection of COVID-19: A new challenge for healthcare professionals (Review). Int J Mol Med 47: 31, 2021.
26. Schwierzczek V, König JC, Kühn J, Mellmann A, Correa-Martínez CL, Omran H, Konrad M, Kaiser T and Kampeemeier F: First reported nosocomial outbreak of severe acute respiratory syndrome coronavirus 2 in a pediatric dialysis unit. Clin Infect Dis 72: 265-270, 2021.
27. Caranta B, Collins JT, Barlow-Pay F, Rickard F, Bruce E, Verduri A, Quinn TJ, Mitchell E, Price A, Vilches-Morgara A, et al: Nosocomial COVID-19 infection: Examining the risk of mortality. The COPE-nosocomial study (COVID in Older People). J Hosp Infect 106: 376-384, 2020.
28. Konš A, Bois A, Herter P, Prader S, Schneider S, Heitz F, Traut A, Alesina PF, Meier B, Balz W, et al: Prognostic value of the age-adjusted Charlson comorbidity index (ACCI) on short- and long-term outcome in patients with advanced primary epithelial ovarian cancer. Ann Surg Oncol 24: 3692-3699, 2017.
29. Brusselaers N and Lægsgård J: The charlson comorbidity index in registry-based research. Methods Inf Med 56: 401-406, 2017.
30. Frenkel WJ, Jongerius EJ, Mandjes-van Uitert MJ, van Munster BC and de Rooij SE: Validation of the charlson comorbidity index (ACCI) on long-term effects of opportunistic pathogens on viral epidemic/pandemic events and prevalence. Food Chem Toxicol 114: 11418, 2020.
31. Pan L, Wang L and Huang X: How to face the novel coronavirus infection during the 2019-2020 epidemic: The experience of Sichuan provincial people's hospital. Intensive Care Med 46: 573-575, 2020.
32. Neagu M, Calina D, Docea AO, Constantin C, Filippini T, Vinceti M, Dragoumis N, PoulaS K, Nikolouzakis TK, Spandonios DA and Tsatsakis A: Back to basics in COVID-19: The systematic review and meta-analysis of COVID-19 by early recognition and intervention: Experience of adults with community-acquired severe respiratory viral infection. Intensive Care Med 46: 573-575, 2020.
33. Pan L, Wang L and Huang X: How to face the novel coronavirus infection during the 2019-2020 epidemic: The experience of Sichuan provincial people's hospital. Intensive Care Med 46: 573-575, 2020.
34. Neagu M, Calina D, Docea AO, Constantin C, Filippini T, Vinceti M, Dragoumis N, PoulaS K, Nikolouzakis TK, Spandonios DA and Tsatsakis A: Back to basics in COVID-19: Antigens and antibodies-completing the puzzle. J Cell Mol Med 25: 4523-4533, 2021.
35. The First Affiliated Hospital of Nanjing Medical University: Patient Admission Procedure During COVID-19 (Edition 7). https://book.yunzhan365.com/ymkhc/oquc/mobile/index.html. Accessed August 27, 2020.
36. Chung M, Bernheim A, Mei X, Zhang N, Huang M, Zeng X, Cui J, Xu W, Yang Y, Fayad ZA, et al: CT imaging features of 2019 novel coronavirus (2019-nCoV). Radiology 295: 202-207, 2020.

37. National Health Commission of the People's Republic of China: COVID-19 prevention and control protocols. http://www.gov.cn/zhengce/zhengceku/2020-02/22/5482010/files/310fd736fa89431d977cc8f2dbd2b3e0.pdf. February 21, 2020.

38. Kok RM and Reynolds CF III: Management of depression in older adults: A review. JAMA 317: 2114-2122, 2017.

39. Farver-Vestergaard I, Jacobsen D and Zachariae R: Efficacy of psychosocial interventions on psychological and physical health outcomes in chronic obstructive pulmonary disease: A systematic review and meta-analysis. Psychother Psychosom 84: 37-50, 2015.

40. Sarris J, Moylan S, Camfield DA, Pase MP, Mischoulon D, and Ahalt SC: The secure medical research workspace: An IT style modification for anxiety disorders: A review of current evidence. Evid Based Complement Alternat Med 2012: 809653, 2012.

41. Messika J, Kalfon P and Ricard JD: Adjutant therapies in critical care: Music therapy. Intensive Care Med 44: 1929-1931, 2018.

42. Lim KK, Lee VSY, Tan CS, Kwan YH, Lim ZHX, Wee HL, Ostbye T and Low LL: Examining the heterogeneity in excess risks of coronary heart disease, stroke, dialysis, and lower extremity amputation associated with type 2 diabetes mellitus across demographic subgroups in an Asian population: A population-based matched cohort study. Diabetes Res Clin Pract 171: 108551, 2021.

43. Austin PC: Variance estimation when using inverse probability of treatment weighting (IPTW) with survival analysis. Stat Med 35: 5642-5655, 2016.

44. Austin PC and Stuart EA: Moving towards best practice when using inverse probability of treatment weighting (IPTW) using the propensity score to estimate causal treatment effects in a non-randomized setting: A retrospective trial. Arch Gynecol Obstet 304: 999-1006, 2021.

45. Liang KY and Zeger SL: Longitudinal data analysis using generalised linear models. Biomетrika 73: 13-22, 1986.

46. Allison PD: Longitudinal data analysis using stata. Statistical Horison, Stockholm, 2018.

47. Koo TK and Li MY: A guideline of selecting and reporting intra-class correlation coefficients for reliability research. J Clin Exp Med 15: 155-163, 2016.

48. Wu X, Wu L, Han J, Wu Y, Cao T, Gao Y, Wang S, Wang S, Liu Q, Li H, et al: Evaluation of the sexual quality of life and sexual function of cervical cancer survivors after cancer treatment: A retrospective study. Arch Gynecol Obstet 304: 999-1006, 2021.

49. Liu TT, Li R, Hsu C, Li JP, Yao J, Ji XL and Qu YQ: Identification of CD2K-related immune forecast model and ceRNA in lung adenocarcinoma, a pan-cancer analysis. Front Cell Dev Biol 9: 682002, 2021.

50. Sun D, Tian L, Zhu Y, Wu Y, Liu Q, Liu S, Li H and Hou H: Subunits of ARID1 serve as novel biomarkers for the sensitivity to immune checkpoint inhibitors and prognosis of advanced non-small cell lung cancer. Mol Med 26: 78, 2020.

51. Wu X, Wu L, Han J, Wu Y, Cao T, Gao Y, Wang S, Wang S, Liu Q, Li H, et al: Evaluation of the sexual quality of life and sexual function of cervical cancer survivors after cancer treatment: A retrospective trial. Arch Gynecol Obstet 304: 999-1006, 2021.

52. Liu TT, Li R, Hsu C, Li JP, Yao J, Ji XL and Qu YQ: Identification of CD2K-related immune forecast model and ceRNA in lung adenocarcinoma, a pan-cancer analysis. Front Cell Dev Biol 9: 682002, 2021.

53. Sun D, Tian L, Zhu Y, Wu Y, Liu Q, Liu S, Li H and Hou H: Subunits of ARID1 serve as novel biomarkers for the sensitivity to immune checkpoint inhibitors and prognosis of advanced non-small cell lung cancer. Mol Med 26: 78, 2020.

54. Hardin JW and Hilbe JM: Generalized estimating equations. 2nd edition. Chapman & Hall/CRC Press, London, 2012.

55. Li C, Duan J, Liu S, Meng X, Fu C, Zeng C and Wu A: Assessing the risk and disease burden of clostridium difficile infection among patients with hospital-acquired pneumonia at a university hospital in Central China. Infection 45: 621-628, 2017.

56. Li C, Wen X, Ren N, Zhou P, Huang X, Gong R, Feng L, Wu H, Liu Z, Fu C, et al: Point-prevalence of healthcare-associated infection in China in 2010: A large multicenter epidemiological survey. Infect Control Hosp Epidemiol 35: 1436-1437, 2014.

57. Cho SJ and Stout-Delgado HW: Aging and lung disease. Annu Rev Physiol 82: 433-459, 2020.

58. Zdravkovic M, Berger-Estilitta J, Sorbello M and Hагbach CA: An international survey about rapid sequence intubation of 10,003 anaesthetists and 16 airway experts. Anaesthesia 75: 313-322, 2020.

59. Hirai J, Sakashashi D, Hananaga S, Kinjo T, Hagihara M, Kato H, Suematsu H, Yamagishi Y, Fujita J and Mikamo H: Case-control study of pneumonia patients with Streptococcus anginosus group bacteria in their sputum. J Infect Chemother 22: 794-799, 2016.

60. Sangro B, Martínez-Urubistondo D, Bester L, Bilbao J, Coldwell DM, Flamen P, Kennedy A, Ricke J and Sharma RA: Prevention and treatment of complications of selective internal radiation therapy: Expert guidance and systematic review. Hepatology 66: 969-982, 2017.

61. Eraslan Dogany A and Cirik MO: Determinants of prognosis in geriatric patients followed in respiratory ICU; either infection or malnutrition. Medicine (Baltimore) 100: e27159, 2021.

62. Song P, Man Q, Li Y, Jia S, Yu D, Liu Z and Zhang J: Trends of underweight malnutrition among chinese residents aged 60 years and above-China, 1992-2015. China CDC Wkly 3: 232-236, 2021.

63. Shah FA, Pike F, Alvarez K, Angus D, Newman AB, Lopez O, Tate J, Kapur V, Wilsdon A, Krishnan JA, et al: Bidirectional relationship between cognitive function and pneumonia. Am J Respir Crit Care Med 188: 586-592, 2013.

64. Yu P, Xia Z, Fei J and Jha SK: An application review of artificial intelligence in prevention and cure of COVID-19 pandemic. Comput Mater Contin 65: 743-760, 2020.

65. Bischoff SC, Austin P, Boekyns K, Chouridakis M, Cuerda C, Jonkers-Schuitema C, Lichota M, Nyulasi I, Schneider SM, Stanga Z and Pironi L: Espen guideline on home enteral nutrition. Clin Nutr 39: 5-22, 2020.

66. Cena H and Chieppa M: Coronavirus disease (COVID-19-SARS-CoV-2) and nutrition: Is infection in Italy suggesting a connection? Front Immunol 11: 944, 2020.

67. Willig A, Wright L and Galvin TA: Practice paper of the Academy of Nutrition and Dietetics: Nutrition intervention and human immunodeficiency virus infection. J Acad Nutr Diet 118: 486-498, 2018.

68. Kris-Etherton PM, Petersen KS, Hibbeln JR, Hurley D, Kolick V, Peoples S, Rodriguez N and Woodward-Lopez G: Nutrition and behavioral health disorders: Depression and anxiety. Nutr Rev 79: 247-260, 2021.

69. Mandell LA and Niederman MS: Aspiration pneumonia. N Engl J Med 380: 651-663, 2019.

70. Liu Y, Wang Y, Zhang B, Wang J, Sun L and Xiao Q: Gastric-tube versus post-pyloric feeding in critical patients: A systematic review and meta-analysis of pulmonary aspiration and nutrition-related outcomes. Eur J Clin Nutr 75: 1337-1348, 2021.

71. Alkhawaja S, Martin C, Butler RJ and Gwadry-Sridhar F: Subunits of ARID1 serve as novel biomarkers for the sensitivity to immune checkpoint inhibitors and prognosis of advanced non-small cell lung cancer. Mol Med 26: 78, 2020.

This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0) License.