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High bacterial coinfection rates and associated mortality among hospitalized older adults with laboratory-confirmed respiratory syncytial virus infection

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ABSTRACT

Background: Emerging evidence highlights that respiratory syncytial virus (RSV) poses a significant risk to older adults. However, detailed clinical data on elderly patients hospitalized with RSV remains limited. This study investigates the clinical characteristics and outcomes of older adults (aged ≥50 years) hospitalized with RSV infection.

Methods: This retrospective cohort study included hospitalized patients aged ≥50 years with respiratory symptoms and laboratory-confirmed RSV infection at China Medical University Hospital between January 1, 2011, and December 31, 2023. Data on demographic characteristics and clinical presentations were collected. RSV infection-related outcomes were analyzed across various subgroups.

Results: This study included 36 patients, with the most prevalent comorbidities being diabetes mellitus (47.2 %), immunocompromised status (36.1 %), and chronic lung disease (30.6 %). Pneumonia was identified in 72.2 % of patients, while 41.7 % required invasive mechanical ventilation, and the hospital mortality rate was 33.3 %. Non-survivors had higher rates of comorbidities, particularly chronic lung disease (66.7 % vs. 12.5 %, $p = 0.002$), higher disease severity, elevated procalcitonin levels, and were more likely to develop septic shock and acute respiratory distress syndrome. A bacterial coinfection rate of 33.3 % was observed, with patients experiencing pneumonia or bacterial coinfection showing poorer outcomes. Moreover, patients with chronic lung disease exhibited significantly worse day-28 survival (log-rank $p < 0.001$).

Conclusions: The disease burden of RSV in older adults is amplified by comorbidities such as chronic lung disease, with pneumonia and bacterial coinfections further worsening outcomes. Our findings highlight the need for a more comprehensive understanding and effective preventive strategies to protect this vulnerable population.

1. Introduction

Respiratory syncytial virus (RSV), an enveloped, single-stranded ribonucleic acid virus belonging to the *Pneumoviridae* family, typically circulates during seasonal epidemics. It is widely recognized as a significant cause of severe respiratory tract infections in infants and young children.[1,2]

RSV infection is estimated to account for 1.5 million episodes of acute respiratory infections annually among older adults, with approximately 14.5 % of these cases requiring hospitalization.[3] However, evidence on the true incidence of RSV infections in hospitalized adults remains limited,[4,5] primarily due to the lack of routine RSV screening in

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this population, which may lead to an underestimation of its clinical impact.[6,7] A notable surge in RSV infections and RSV-related hospitalizations among adults during the post-coronavirus disease-2019 pandemic period has been observed globally.[8–10] One possible explanation is the increased use of syndromic diagnostic testing, including syndromic reverse transcription polymerase chain reaction (RT-PCR), which may contribute to the elevated number of detected cases.[11,12] Additionally, this trend has sparked debate around the concept of "immunity debt".[13,14]

Increasing evidence indicates that RSV poses a serious risk to older and vulnerable adult populations, comparable to non-pandemic influenza, frequently causing severe complications, life-threatening illnesses, and poorer outcomes than influenza.[2,7,15–17] The disease burden from RSV results is caused not only by the infection itself but also by the worsening of underlying conditions, inducing higher healthcare utilization.[8,17] A recent study revealed that patients with RSV and chronic heart failure or airway diseases frequently experience exacerbations of their underlying conditions shortly after seeking medical care.[8] The current evidence indicates that RSV is expected to pose a major health burden among adults in the coming years.[8,18]

An effective antiviral treatment against RSV remains unavailable, but recent advancements in preventive therapies have shown promise. Two vaccines, GSK's Arexvy and Pfizer's Abryvso, which target the RSV fusion (preF) glycoprotein, have been approved by the Food and Drug Administration for use in adults aged ≥60 years.[19] Understanding the disease burden of RSV in adult patients will further support preventive strategy implementation.

Detailed clinical data on hospitalized older adults aged ≥50 years and the prognosis in this population remains limited.[20,21] Therefore, our study aimed to determine the clinical characteristics and outcomes of older adults hospitalized with RSV infection.

2. Materials and methods

2.1. Patients and study design

This retrospective cohort study included all hospitalized patients aged ≥50 years with respiratory symptoms and laboratory-confirmed RSV infection at China Medical University Hospital (CMUH) from January 1, 2011, to December 31, 2023. RSV diagnosis was confirmed by a positive RSV antigen test (BinaxNOW™ RSV Card, Abbott, Chicago, IL, USA), RSV culture, RT-PCR using either FilmArray respiratory panel (FARP, BioFire Diagnostics, USA) or pneumonia panel (FAPP, BioFire Diagnostics, USA) from nasopharyngeal or sputum samples.

The study was approved by the Institutional Review Board of CMUH (approval number: CMUH113-REC2-097) and conducted in accordance with the Declaration of Helsinki and the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

2.2. Definitions and data collection

Clinical data for the cases included in the study were collected from electronic medical records. Documented information included presenting symptoms, demographic data (age, sex, smoking status), underlying diseases, and a history of hospital admissions or antibiotic exposure within 90 days. Disease severity on the index date of RSV diagnosis was assessed using the Acute Physiologic Assessment and Chronic Health Evaluation (APACHE II) score and Sequential Organ Failure Assessment (SOFA) score, as well as CURB-65 and Pneumonia Severity Index (PSI) in patients with pneumonia. Inflammatory biomarkers including C-reactive protein (CRP), procalcitonin (PCT), and monocyte distribution width (MDW), were recorded if available within three days of RSV diagnosis.

Pneumonia types in patients with pneumonia were classified as community-acquired pneumonia (CAP), hospital-acquired pneumonia (HAP), or ventilator-associated pneumonia (VAP).[22,23] Coinfection was defined as the detection of a respiratory pathogen determined simultaneously by multiplex RT-PCR or from other test methods within five days of RSV diagnosis.

2.3. Outcome variables

This study recorded the highest oxygen requirements or respiratory support during hospitalization and documented RSV infection complications, including respiratory failure requiring invasive mechanical ventilation, septic shock, acute respiratory distress syndrome (ARDS), and hospital mortality.

2.4. Statistical analysis

Statistical Package for the Social Sciences version 25 (SPSS, Chicago, IL, USA) was used for all statistical analyses. Ordinal and continuous data were expressed as medians with interquartile ranges (IQRs), and differences between groups were evaluated using the Mann–Whitney *U* test. Categorical variables were presented as counts and percentages and analyzed with the Chi-square test. Day-28 mortality was analyzed with the Kaplan–Meier method and compared with the log-rank test. All tests were two-sided, and a p-value of <0.05 indicated statistical significance.

3. Results

3.1. Demographic characteristics

During the study period, 65 adult patients were diagnosed with RSV infection. After excluding patients under 50 years of age, those with duplicate test results, and those who were not hospitalized, 36 patients were included in the analysis (Fig. 1).

Fig. 2 illustrates the quarterly RSV case distribution determined in this study, along with the RSV detection trend from the respiratory viral surveillance database of the Taiwan Centers for Disease Control (Taiwan CDC) during the study period.

Table 1 shows the demographic characteristics of enrolled patients, stratified by hospital survival. Among the 36 patients, 20 were male (55.6 %), with a median age of 69.3 years (IQR: 61.6–81.3). The median Charlson Comorbidity Index was 6 (IQR: 5–8). The most prevalent comorbidities included diabetes mellitus (47.2 %), chronic lung diseases

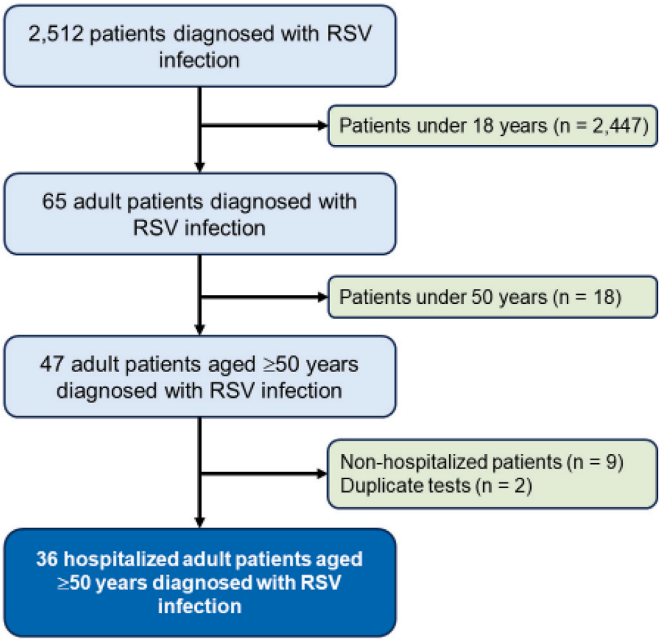

Fig. 1. Study algorithm. RSV, respiratory syncytial virus.

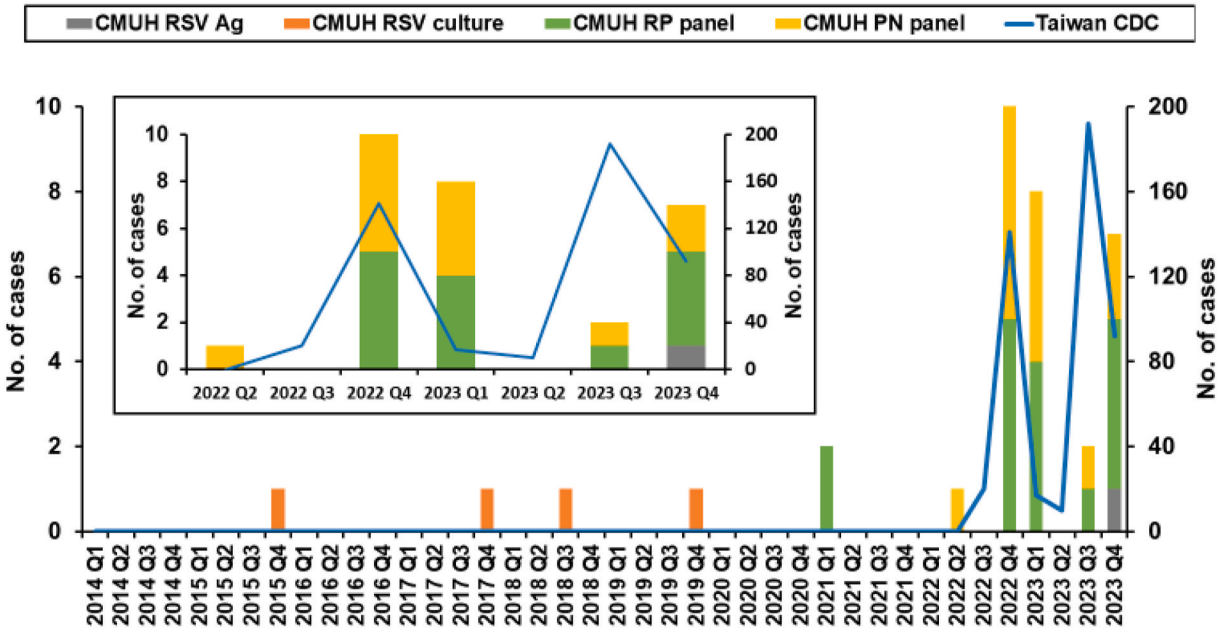

Fig. 2. Quarterly distribution of RSV cases in the study period. Bars indicate the case numbers in this study. The blue line indicates the trend of RSV infection surveillance by the Taiwan Centers for Disease Control (Taiwan CDC). This figure was modified according to the database from the Taiwan CDC website (https://nidss.cdc.gov.tw/). The data from Taiwan CDC was available since 2nd quarter in 2022. CMUH, China medical university hospital; PN panel, FilmArray pneumonia panel; RP panel, FilmArray respiratory panel; RSV, respiratory syncytial virus.

(30.6 %), and immunocompromised status (36.1 %). Hospital non-survivors appeared older (71.6 vs. 66.3 years) and demonstrated a higher prevalence of diabetes mellitus (58.3 % vs. 41.7 %; $p = 0.345$), chronic kidney disease (25 % vs. 8.3 %), and malignancies (25 % vs. 8.3 % for solid tumors; 16.7 % vs. 4.2 % for hematologic malignancies). A significantly higher proportion of non-survivors experienced chronic lung disease (66.7 % vs. 12.5 %, $p = 0.002$).

3.2. Clinical presentation

The most common respiratory symptoms were dyspnea (66.7 %), sputum production (61.1 %), and cough (44.4 %), while fever was present in 52.8 % of patients (Table 2). A total of 26 patients had radiological evidence of pneumonia, with 9 (25 %) classified as CAP and 17 (47.2 %) as HAP/VAP.

Most patients were diagnosed with the RT-PCR method, with 41.7 % tested with FAPP and 44.4 % tested with FARP. The testing methodology varied significantly between survivors and non-survivors ($p = 0.041$), with FAPP being utilized more frequently for RSV detection in non-survivors, who demonstrated a higher incidence of pneumonia (25 % vs. 20.8 % in CAP; 66.7 % vs. 41.7 % in HAP/VAP; $p = 0.21$).

3.3. Coinfections and laboratory findings

Among these patients, 9 (25 %) had viral coinfections, 6 (16.7 %) had bacteria coinfections, and 10 (27.8 %) had multiple pathogens detected. In total, 12 (33.3 %) patients presented with bacterial coinfections, either alone or in combination with other pathogens, and 4 (33.3 %) of them received appropriate empirical antibiotic treatment at the time of bacterial coinfection diagnosis (Table 2). The details of the detected pathogens are summarized in Table 3.

The inflammatory marker levels, including CRP, PCT, and MDW, were not markedly elevated. Non-survivors exhibited higher CRP levels (8.8 vs. 4.7; $p = 0.317$) and significantly higher PCT levels (5.0 vs. 0.5; $p = 0.006$).

3.4. Complications and outcomes

Oxygen or respiratory support was required in >70 % of patients, with 15 (41.7 %) receiving invasive mechanical ventilation and requiring intensive care unit (ICU) admission (Table 2). Non-survivors demonstrated significantly higher disease severity than survivors, as indicated by PSI (192 vs. 119, $p = 0.005$), APACHE II score (27 vs. 13, $p = 0.002$), and SOFA score (11 vs. 3.5, $p = 0.001$), as well as a higher proportion of septic shock (75 % vs. 20.8 %, $p = 0.001$) and ARDS (58.3 % vs. 12.5 %, $p = 0.007$).

Clinical outcomes associated with different types of coinfections are presented in Table 4. Patients with bacterial infections, with or without other pathogens, exhibited more severe outcomes, while no association was found between viral coinfection and worse outcomes.

The hospital mortality rate was 33.3 %, and non-survivors demonstrated a longer length of hospital stay (17 vs. 9.5 days, $p = 0.196$). Kaplan–Meier curves revealed no survival difference between patients aged 50–60 years and those aged ≥60 years (Fig. 3A). Patients with pneumonia and bacterial coinfection demonstrated a trend toward poorer day-28 outcome (Fig. 3B and C). Day-28 survival was significantly worse in patients having chronic lung diseases (log-rank $p < 0.001$, Fig. 3D).

4. Discussion

This study provides information on hospitalized elderly patients (aged ≥50 years) with RSV infection, primarily diagnosed via PCR methods over 12 years. A high proportion of these patients reported comorbidities, with many experiencing pneumonia and a notable rate of bacterial coinfection. ICU admission was required in >40 % of the patients, and the in-hospital mortality rate was 33.3 %. Patients with pneumonia and bacterial coinfection demonstrated worse outcomes, with significantly lower day-28 survival observed in those with comorbid chronic lung disease.

Consistent with previous reports indicating that older patients have a higher incidence of RSV infection and worse outcomes,[4,24,25] our study revealed a high overall hospital mortality rate and prolonged

Table 1
Demographic characteristics of study population stratified by hospital survival.

Parameter	All (n = 36)	Survivors (n = 24)	Non-survivors (n = 12)	*P* value
Age, median (IQR), years	69.3 (61.6–81.3)	66.3 (61.1–81.5)	71.6 (62.6–80.9)	0.763
Sex, male, n (%)	20 (55.6)	12 (50)	8 (66.7)	0.343
Smoking status, n (%)				0.715[d]
Never smoker	25 (69.4)	16 (66.7)	9 (75)	
Ex-smoker/Current smoker	11 (30.6)	8 (33.3)	3 (25)	
BMI, median (IQR), kg/m^2	23.8 (20.0–26.1)	22.5 (19.6–25.1)	24.2 (23.4–28.1)	0.169
Charlson comorbidity index, median (IQR)	6 (5–8)	6 (4.3–8)	7 (6–9)	0.092
Comorbidities, n (%)				
Diabetes mellitus	17 (47.2)	10 (41.7)	7 (58.3)	0.345
Coronary artery disease	4 (11.1)	4 (16.7)	0	0.278[d]
Chronic lung disease[a]	11 (30.6)	3 (12.5)	8 (66.7)	0.002[d]
Immunocompromised[b]	13 (36.1)	8 (33.3)	5 (41.7)	0.720[d]
Chronic kidney disease	5 (13.9)	2 (8.3)	3 (25)	0.307[d]
End stage renal disease	6 (16.7)	3 (12.5)	3 (25)	0.378[d]
Malignancy with ongoing treatment				0.117[d]
Solid tumor	5 (13.9)	2 (8.3)	3 (25)	
Hematologic malignancy	3 (8.3)	1 (4.2)	2 (16.7)	
Liver cirrhosis	5 (13.9)	3 (12.5)	2 (16.7)	1.00[d]
Transplantation				0.522[d]
Solid organ	3 (8.3)	2 (8.3)	1 (8.3)	
Hematopoietic stem-cell	3 (8.3)	1 (4.2)	2 (16.7)	
Central nervous system disease[c]	2 (5.6)	2 (8.3)	0	0.543[d]
Risk factors, n (%)				
Previous admission within 90 days	14 (38.9)	7 (29.2)	7 (58.3)	0.148[d]
Antibiotic exposure within 90 days	8 (22.2)	4 (16.7)	4 (33.3)	0.397[d]

BMI, body mass index; IQR, interquartile range.
[a] Asthma, chronic obstructive lung disease, bronchiectasis, interstitial lung disease.
[b] Chronic steroid use (prednisolone 5 mg/day or equivalent >1 month or >30 mg/day) or other immunosuppressive therapy for diseases such as connective tissue disease, rheumatic disease or solid organ transplantation.
[c] Old cerebral vascular accident, central nervous system degenerative diseases.
[d] Fisher's exact test.

hospitalization. A recent study in France involving 104 immunocompetent adults hospitalized due to RSV infection found that 26 patients (25 %) required ventilatory support, 21 patients (20 %) were admitted to the ICU, and the overall 1-month mortality rate was 13 %.[8] The worse outcomes observed in our study may be attributed to the inclusion of immunocompromised patients and a high proportion of patients with comorbid chronic lung diseases. Furthermore, we did not observe a difference in day-28 mortality between the two age groups (50–60 years vs. ≥60 years), suggesting that patients with comorbidities aged ≥50 years are at risk for poor outcomes. This finding aligns with prior literature, indicating that RSV is a significant pathogen not only in individuals aged ≥65 years but also in those aged 50–64 years.[26–29]

The disease burden among hospitalized patients with RSV has also been widely reported. A systematic review revealed that the length of hospitalization for elderly populations with RSV generally ranged from 3 to 6 days. However, the hospitalization duration extended to 14 days in a cohort with a mean age of 76 years. Additionally, 10 %–31 % of older adults required ICU admission. The risk of mortality in hospitalized patients with RSV-related illnesses is approximately 6 %–8 %, with a marked increase among older adults.[24] Our study revealed a median hospital length of stay of 11 days, which was significantly longer among non-survivors at 17 days (IQR: 5.8–28.8). Furthermore, 41.7 % of

Table 2
Microbiological and clinical characteristics of patients stratified by hospital survival.

Parameter	All (n = 36)	Survivors (n = 24)	Non-survivors (n = 12)	*P* value
Symptoms, n (%))				
Dyspnea	24 (66.7)	16 (66.7)	8 (66.7)	1.00[a]
Sputum	22 (61.1)	13 (54.2)	9 (75)	0.292[a]
Fever	19 (52.8)	13 (54.2)	6 (50)	0.813
Cough	16 (44.4)	12 (50)	4 (33.3)	0.343
Sorethroat	4 (11.1)	3 (12.5)	1 (8.3)	1.00[a]
Test location, n (%))				0.229[a]
Emergency department	2 (5.6)	1 (4.2)	1 (8.3)	
Ordinary ward	22 (61.1)	17 (70.8)	5 (41.7)	
Intensive care unit	12 (33.3)	6 (25)	6 (50)	
Test methodology, n (%))				0.041[a]
Respiratory panel	16 (44.4)	14 (58.3)	2 (16.7)	
Pneumonia panel	15 (41.7)	7 (29.2)	8 (66.7)	
Viral culture	4 (11.1)	2 (8.3)	2 (16.7)	
RSV antigen	1 (2.8)	1 (4.2)	0	
Coinfections, n (%))				0.222[a]
No	11 (30.6)	9 (37.5)	2 (16.7)	
Virus(es)	9 (25)	7 (29.2)	2 (16.7)	
Bacteria(e)	6 (16.7)	4 (16.7)	2 (16.7)	
Multiple pathogens	10 (27.8)	4 (16.7)	6 (50)	
Bacterial coinfection, n (%)	12 (33.3)	6 (25)	6 (50)	0.157[a]
Appropriate empirical antibiotic coverage for bacterial coinfections, n (%)	4 (33.3)	2 (33.3)	2 (33.3)	–
Pneumonia, n (%))				0.181
No	10 (27.8)	9 (37.5)	1 (8.3)	
CAP	9 (25)	5 (20.8)	4 (33.3)	
HAP/VAP	17 (47.2)	10 (41.7)	7 (58.3)	
Inflammatory markers, median (IQR))				
CRP, mg/L (n = 31)	5.7 (1.6–10.2)	4.7 (1.4–9.4)	8.8 (2.1–14.1)	0.317
PCT, ng/mL (n = 18)	0.6 (0.4–7.2)	0.5 (0.2–0.8)	5.0 (0.7–25.3)	0.006
MDW, U (n = 27)	23.4 (21.6–26.5)	23.3 (21.6–25.1)	24.9 (21.1–29.9)	0.490
Oxygen demand, n (%))				0.009[a]
No	10 (27.8)	10 (41.7)	0	
Nasal canula	3 (8.3)	2 (8.3)	1 (8.3)	
Venturi-Mask	2 (5.6)	2 (8.3)	0	
High flow nasal oxygen	1 (2.8)	0	1 (8.3)	
Non-invasive ventilation	3 (8.3)	2 (8.3)	1 (8.3)	
Invasive mechanical ventilation	15 (41.7)	6 (25)	9 (75)	
Hospital LOS before RSV test, median (IQR), days	4 (1.3–13.5)	3 (1–11.3)	7.5 (3–14.8)	0.219
Hospital LOS after RSV test, median (IQR), days	11 (5–24.5)	9.5 (5–20.3)	17 (5.8–28.8)	0.196
Intensive care unit admission, n (%)	15 (41.7)	6 (25)	9 (75)	0.004
Disease severity)				
CURB-65, median (IQR) (n = 26)	2 (1–4)	2 (1–2)	3 (3–4)	0.028
PSI, median (IQR) (n = 26)	137 (111.3–196)	119 (97–139)	192 (160–233)	0.005
APACHE II score, median (IQR)	14 (9.3–22)	13 (8.3–16.5)	27 (16–35)	0.002
SOFA score, median (IQR)	5 (3–9)	3.5 (3–6.8)	11 (5.3–14)	0.001
Septic shock, n (%)	14 (38.9)	5 (20.8)	9 (75)	0.003[a]
ARDS, n (%)	10 (27.8)	3 (12.5)	7 (58.3)	0.007[a]

APACHE, Acute Physiologic Assessment and Chronic Health Evaluation; ARDS, acute respiratory distress syndrome; CAP, community-acquired pneumonia;

CRP, C-reactive protein; HAP, hospital-acquired pneumonia; LOS, length of stay; IQR, interquartile range; MDW, monocyte distribution width; PCT, procalcitonin; PSI, pneumonia severity index; RSV, respiratory syncytial virus; SOFA, Sequential Organ Failure Assessment; VAP, ventilator-associated pneumonia.
[a] Fisher's exact test.

Table 3
Pathogen distribution in co-infections among CAP and HAP/VAP Cases.

Pathogen	All (n = 36)	CAP (n = 9)	HAP/VAP (n = 17)
Virus			
SARS-CoV-2	8	1	4
CMV	3	–	3
HSV	2	–	1
Adenovirus	2	1	–
Parainfluenza 3	1	–	–
Human Rhinovirus/Enterovirus	1	1	–
Bacteria		–	
Streptococcus parasanguinis	1	1	–
Streptococcus pneumoniae	1	1	–
Staphylococcus aureus	1	–	1
Corynebacterium striatum	1	–	1
Pseudomonas aeruginosa	4	1	3
Acinetobacter calcoaceticus-baumannii complex	3	1	2
Klebsiella pneumoniae group	3	1	2
Enterobacter cloacae complex	2	1	1
Serratia marcescens	1	–	1
Others			
Pneumocystis jirovecii	4	1	3
Aspergillus spp.	4	1	3

CAP, community-acquired pneumonia; CMV, Cytomegalovirus; HAP, hospital-acquired pneumonia; HSV, herpes simplex virus; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; VAP, ventilator-associated pneumonia.

Table 4
Clinical outcomes associated with different types of coinfections.

	Virus only (n = 9)	Bacteria only (n = 6)	Multiple pathogens (n = 10)	Bacteria with or without other pathogens (n = 12)
Septic shock, n (%)	0	4 (66.7)	5 (50)	7 (58.3)
ARDS, n (%)	0	2 (33.3)	6 (60)	6 (50)
Intensive care unit admission, n (%)	0	4 (66.7)	8 (80)	9 (75)
Invasive mechanical ventilation, n (%)	0	4 (66.7)	8 (80)	9 (75)
Hospital mortality, n (%)	2 (22.2)	2 (33.3)	6 (60)	6 (50)

ARDS, acute respiratory distress syndrome.

patients required ICU admission, with a 33 % hospital mortality rate. Variations in reported values across different studies may be related to differences in inclusion criteria, as well as variations in comorbidity and healthcare resource distributions. Patients in our study were more vulnerable, as evidenced by a high proportion of recent hospital admissions or antibiotic exposure, along with a high pneumonia incidence. However, this research contributes to existing evidence, emphasizing that the disease burden remains substantial even in regions with well-established healthcare systems.

The primary comorbidities in our study included pre-existing cardiopulmonary diseases, immunocompromised status, and diabetes mellitus, which is congruent with previous research on the effect of comorbidities on RSV-related hospitalizations.[28,30–32] Among these, the mutual effect between RSV and chronic lung diseases has been widely recognized.[33,34] A large-scale study conducted in the United States of America revealed that chronic obstruction pulmonary disease (40.0 % vs. 32.0 %) and other chronic lung diseases (9.1 % vs. 4.4 %) were significantly more prevalent in patients with severe outcomes compared to those without severe outcomes.[35] Our study revealed that patients with chronic lung disease demonstrated significantly worse day-28 survival. We were unable to further subclassify comorbidities because of limited case numbers, but our results support existing evidence that chronic lung disease increases the risk of severe illness and morbidity in RSV infection.[25]

Our results indicated that 33 % of patients had bacterial coinfections, with the rate increasing to 50 % among non-survivors. This finding was consistent with previous studies indicating that bacterial coinfection causes increased ICU admissions, prolonged hospital stays,[6] and higher mortality rates among elderly patients.[34,36] Additionally, patients with bacterial coinfection exhibited poorer day-28 survival, which approached statistical significance. The coinfection rate in our cohort was higher than that reported in a recent study, which revealed that 15.4 % (16/104) of patients experienced confirmed bacterial superinfections.[8] This discrepancy may be explained by their study's inclusion of only immunocompetent adults, whereas a substantial proportion of our participants were immunocompromised or had malignancies. Another recent study on hospitalized adults, which involved a significant number of patients with comorbidities, such as chronic pulmonary disease, end-stage kidney disease, and malignancies, revealed a bacterial coinfection rate of 57.9 %.[37] It should be noted that only 33.3 % of patients with bacterial coinfection received appropriate empirical antibiotic treatment at the time of bacterial coinfection diagnosis in our study. While we were unable to determine the sequence of RSV infection and bacterial coinfection, understanding the distribution of co-pathogens during the acute RSV infection period is crucial for guiding the selection of empirical antibiotic treatment. The distribution of these pathogens varies between patients with CAP and HAP/VAP, with a higher prevalence of *Pseudomonas aeruginosa*, *Acinetobacter calcoaceticus-baumannii* complex, and *Klebsiella pneumoniae* group in HAP/VAP cases (Table 3). Our study revealed that viral coinfection was not associated with poorer outcomes, aligning with previous research demonstrating that the prevalence of severe outcomes did not increase in patients with viral co-detections compared to those infected with RSV alone.[35]

We revealed a moderate increase in inflammatory markers; however, PCT levels were significantly higher among non-survivors. This result may partly reflect the increased incidence of pneumonia and bacterial coinfections, which are related to a higher risk of ARDS, septic shock, and poor outcomes. Clinicians should remain vigilant, considering the high rate of bacterial coinfection during RSV episodes. Immediate empiric antibiotic therapy should be considered for patients with a clinical suspicion of bacterial coinfection, especially when increased inflammatory markers are observed.

This study has several limitations. First, this is a single-center study with a relatively small sample size and lacked a control group, which limits our ability to conduct regression analyses to determine independent outcome predictors or perform more detailed analyses according to comorbidities. Second, selection bias may be present, as approximately 50 % of the cases were diagnosed with pneumonia panel, indicating that this testing method was more frequently applied to patients with pneumonia and severe disease. Third, determining whether deaths were specifically attributable to RSV is challenging because this is a retrospective study; instead, we report all-cause mortality rather than RSV-related mortality. Fourth, although the prognostic effect of coinfection was assessed, due to the retrospective nature of this study, we were unable to infer causality between RSV infection and other hospital-acquired infections. Finally, the classification of pneumonia may lack precision, as RSV testing was not conducted at standardized times, potentially causing misclassification. Similar to other respiratory

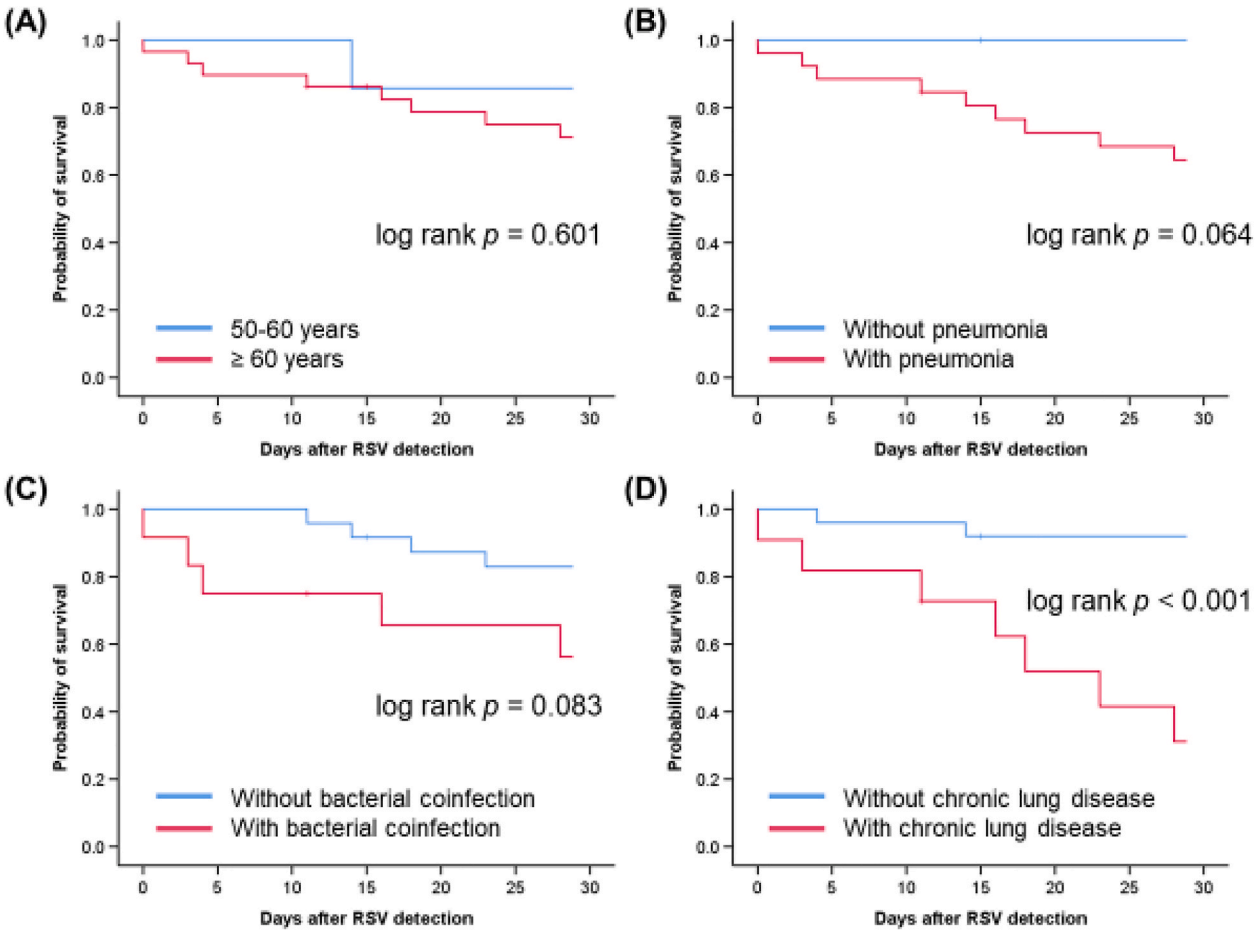

Fig. 3. Kaplan–Meier curves of day-28 survival among different subgroups. RSV, respiratory syncytial virus.

viruses, RSV detection using multiplex nasopharyngeal PCR testing can remain positive for over four weeks.[11]

In conclusion, this study investigates the clinical characteristics and outcomes of hospitalized adults aged ≥50 years with RSV infection. The findings highlight that the high prevalence of comorbidities, pneumonia, and bacterial coinfections significantly contributed to poorer outcomes, particularly in patients with chronic lung disease. These results emphasize the importance of advancing our understanding of this vulnerable population and implementing effective preventive strategies.

CRediT authorship contribution statement

Yu-Chang Fu: Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Ting-wei Lai:** Methodology, Investigation, Data curation, Conceptualization. **Yu-Hua Su:** Validation, Supervision, Software, Resources, Data curation. **Yu-Chao Lin:** Resources, Formal analysis, Data curation, Conceptualization. **Chih-Yen Tu:** Investigation, Formal analysis, Data curation, Conceptualization. **Chieh-Lung Chen:** Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Po-Ren Hsueh:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Ethical approval

The institutional review board of China Medical University Hospital waived the requirement for written informed consent because the study involved minimal risk to the patients (IRB number: CMUH113-REC2-097).

Data availability statement

The data of this study is available on request from the corresponding author.

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Declaration of competing interest

No conflicts exist for the specified authors.

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