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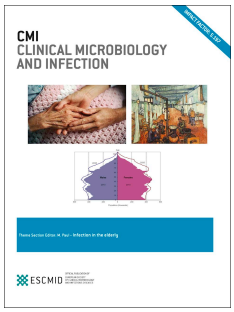

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The prevalence and outcomes of viremia in patients with acute respiratory viral infection: a systematic review and meta-analysis

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Abstract

Background: Viremia has been detected in a significant proportion of patients with acute respiratory viral infection, yet its clinical value remains underappreciated.

Objectives: This study synthesized available evidence to comprehensively assess the prevalence of viremia and its impact on clinical outcomes.

Data sources: Data were retrieved from Medline (via Ovid), Embase, and the WHO COVID-19 database.

Study eligibility criteria: This review included original clinical studies analyzing the prevalence of viremia in patients with acute respiratory viral infection or its association with clinical outcomes, while excluding non-original research, insufficiently detailed studies, inconsistent pathogen observations, or those with inadequate sample sizes.

Participants: Patients with acute respiratory viral infection.

Exposure: Respiratory viral infection-related viremia

Methods of data synthesis: Data synthesis utilized random-effects models to pool prevalence and hazard ratios (HR), odds ratios (OR), and adjusted HR/OR for clinical outcomes.

Results: In the comprehensive analysis of viremia prevalence, data were pooled from 101 studies, which included a total of 16,388 non-overlapping patients. Viremia was present in 34% (95% CI: 28%–41%) of patients with acute respiratory viral infection. 45 studies provided information on the clinical outcomes of 2,002 patients with viremia and 3,907 patients without viremia. Viremia was associated with increased risks of mortality (OR 6.83, 95% CI: 4.92–9.48; aHR 2.91, 95% CI: 1.87–4.53; aOR 3.68, 95% CI: 2.37–5.71), ICU admission (OR 4.74, 95% CI: 2.66–8.46; aOR 4.89, 95% CI: 1.61–14.91), mechanical ventilation (OR 4.12, 95% CI: 2.25–7.52), and hepatic complications (OR 3.10, 95% CI: 1.30–7.40).

Conclusions: Viremia is prevalent in patients with respiratory viral infection and is associated with elevated risks of adverse clinical outcomes.

Keywords viremia, acute respiratory viral infection, mortality, ICU, mechanical ventilation

Introduction

Acute respiratory viral infection is a significant health concern. The pandemics initiated by influenza A H1N1 and severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) caused global medical resource shortage and claimed several million deaths, echoing the significant impact of acute respiratory viral infection on the global health landscape and healthcare system. Beyond the respiratory manifestations, acute respiratory viral infection has been associated with various complications, such as acute kidney injury, liver function abnormality, cardiac injury[1], and multiorgan dysfunction in its severe forms[2, 3], which are termed respiratory viral sepsis[4, 5]. The incidence of influenza-associated sepsis was reported to be 8.8 per 100,000 person-year[6]. Sepsis has been observed in 39.6% of cases among hospitalized patients with non-influenza respiratory viral infection[7]. Furthermore, a meta-analysis has reported a high prevalence of COVID-19-related sepsis in the ICU, at 77.9%[8].

Bacteremia is essential in the progression of bacterial sepsis and serves as an important indicator of the condition[9]. Timely administration of antibacterial treatments is a cornerstone in improving the survival of patients with sepsis[10]. In a similar vein, viremia, the presence of viral particles in the bloodstream, is associated with the development of viral sepsis. However, in clinical care for sepsis patients, seeking evidence of viremia is much less done than the blood culture of bacteria, causing the underdiagnosis of viral sepsis and insufficient research related to antiviral treatments in sepsis[11]. Viremia in patients with acute respiratory viral infection has not been systematically studied. The recognition of viremia will benefit the understanding of viral sepsis, and consequently, contribute to decisions on proper clinical interventions and good prognosis, especially for patients under critical care. Although there have been reports in small cohorts indicating an association between viremia and adverse outcomes in acute respiratory viral infection, systematic reviews on the association between viremia, sepsis, and clinical outcomes in patients with acute respiratory infection are lacking.

Therefore, we conducted a systematic review of the existing literature regarding viremia in patients with acute respiratory viral infection. By synthesizing the available evidence, we aim to provide a comprehensive understanding of the prevalence and clinical significance of viremia in these patients, as well as to offer valuable insights into the relationship between respiratory viral infection-related viremia and prognosis.

Methods

Search and Selection

The protocol of this systematic review was registered in PROSPERO (CRD42023465764). Medline (via Ovid), Embase, and the WHO COVID-19 database were used as information sources for searching records. There were no restrictions based on language or publication status in the literature search. We have regularly searched the databases since the initiation of this review. The last update of the literature search was on March 6, 2024. We also hand-searched the reference list of relevant reviews and included studies for potential eligible research.

This review aimed to address two key questions: First, what is the prevalence of viremia in patients with acute respiratory viral infection? Second, is viremia associated with poor clinical outcomes? The

inclusion criteria for study selection were as follows: (1) Original research that assessed the prevalence of viremia in patients with respiratory viral infection and/or viremia-related outcomes by comparing with non-viremia patients. (2) Original human studies that provided sufficient information for analysis. (3) Respiratory viruses were defined as those typically infecting the respiratory tract, including coronaviruses like SARS-CoV, SARS-CoV-2, Middle East respiratory syndrome coronavirus (MERS-CoV), etc., influenza, parainfluenza, rhinovirus (RV), respiratory syncytial virus (RSV), and metapneumovirus. (4) Viremia is defined as the presence of viral particles in blood samples, with viral nucleic acids detected using PCR-based methods or antigens identified through ELISA-based methods.

Studies were excluded based on the specified criteria: (1) Non-eligible study designs including reviews, commentaries, animal studies, and case reports or case series. (2) Studies not specifying pathogens of respiratory viral infection. (3) Studies where inconsistent pathogens were observed between respiratory infection and viremia. (4) Studies observing viremia preceding the acute respiratory viral infection. (5) Studies reporting positive viremia detection based on sample number that did not correspond to patient number. (6) Studies with a sample size of less than 10. (7) Abstract-only studies and studies with no full text available.

Two investigators (Y.Y. and L.S.) independently performed literature screening *via* Rayyan[12] and Endnote X9 to identify eligible studies.

Outcomes

The primary clinical outcome was all-cause mortality without restriction on time points (including 28-30 day, 42-day, 90-day, and in-hospital mortality, etc.). Additional outcomes included ICU admission, mechanical ventilation (MV) utilization, and extrapulmonary complications in the heart, liver and kidney.

Data Extraction and Quality Assessment

Two reviewers (Y.Y. and L.S.) independently performed data extraction and quality assessment, and any disagreement was resolved through discussion. Information extracted from the included studies were: (1) authors; (2) study design; (3) research period; (4) region; (5) population characteristics; (6) sample size; (7) viremia group (target of detection, definition, number); (8) number of non-viremia group; (9) event numbers of outcomes in each group for calculating crude odds ratio (OR); (10) effect measures (hazard ratios, HR; OR; adjusted HR, aHR; adjusted OR, aOR).

Research conducted by the same study groups in overlapped time periods and locations was considered to have probably overlapped populations. To avoid patient overlap, the results observed in a longer research period or a greater population size were selected and others were excluded.

Newcastle Ottawa scale (NOS)[13] and an adapted version[14] were used for assessing the methodological quality of observational studies. Trials were considered observational studies for quality assessment as only baseline viremia prevalence was included in the analysis.

Statistical Analysis

For viremia prevalence, we calculated the reported proportions of patients with viremia divided by the total number of patients receiving blood tests in each study and pooled them by transforming them into logProportion.

To assess the association between viremia and clinical outcomes, we compared the risks between

patients with and without viremia. Crude ORs were calculated based on the original event numbers reported by the authors. aORs were pooled using the generic inverse variance method with logOR and standard error (SE). Crude and adjusted HRs were pooled separately using the same method as aORs. We used random-effects models throughout the study when pooling the data. For studies using multiple different methods to detect viremia, the analysis included the first proportions or effect measures mentioned in these studies. For outcomes with more than 10 included studies, we generated funnel plots and used Egger's test to detect funnel plot asymmetry with a *p*-value threshold of 0.05. Subgroup analysis was conducted based on virus type, hospitalization status, detection target, blood sample type, and observation period of outcome. Univariable meta-regression was performed to identify the mortality risk of viremia in relation to age and sex. The median and interquartile range (IQR) were converted to mean and standard deviation (SD) for age data[15]. To determine whether the differences between pooled adjusted and unadjusted results were attributable to the effect of adjustments, we analyzed studies reporting both crude and adjusted effect measures, pooling their crude and adjusted HR/OR separately. All statistical analyses were performed using R packages "meta" (version 6.5-0)[16] and "metafor" (version 4.2-0)[17]. When there was insufficient data for quantitative analysis, a descriptive summary was provided instead.

Results

As depicted in **Figure 1**, we initially identified 8,434 records from databases and added 17 records by hand search. 104 full-texts reporting viremia following relevant respiratory infection were eligible for the systematic review. The main characteristics of the included studies are shown in **Table S1**, and the quality assessment is shown in **Table S2**. The eligible studies covered influenza, MERS-CoV, RSV, RV, SARS-CoV, and SARS-CoV-2. Seventy-six studies were conducted among hospitalized patients, whereas only two studies were among non-hospitalized patients. The remaining studies either examined both inpatients and outpatients or did not explicitly specify the hospitalization status of the patients.

101 studies reported the proportions of viremia in non-overlapped populations with acute respiratory viral infection. Three studies conducted in potentially overlapped populations were excluded from the analysis of prevalence[18-20]. The pooled prevalence of viremia was 34% (95% CI: 28%–41%) across 16,388 patients (**Table 1 & Figure S1**). The *p*-value for Egger's test was not significant (**Figure S2**). The prevalence of influenza viremia, pooled from 5 hospitalized populations and a group of hematopoietic cell transplant (HCT) recipients, was determined to be 30% (95% CI: 11%–60%). RV viremia had a pooled proportion of 10% (95% CI: 8%–12%) in patients with RV-positive nasopharyngeal (NP) swabs or bronchoalveolar lavage in 5 studies. SARS-CoV viremia information was available from 3 studies of hospitalized SARS patients, with a summarized prevalence of 64% (95% CI: 40%–82%). Eighty-five studies of 14,970 COVID-19 patients were pooled to show the prevalence of SARS-CoV-2 viremia, which was estimated to be 36% (95% CI: 29%–43%). Kim et al.[21] detected MERS-CoV in whole blood or serum of 7/21(33.33%) patients. RSV viremia was detected in 30.43% of HCT recipients with virologically confirmed RSV lower respiratory disease[22]. The subgroup analysis of non-SARS-CoV-2 viruses was conducted since SARS-CoV-2 took up the main part of the included studies. The prevalence

of non-SARS-CoV-2 viremia was pooled to be 27% (95% CI: 16%–42%) (**Figure S3**).

The included studies involved a total of 12,228 hospitalized patients with acute respiratory viral infection, with a pooled prevalence of 39% (95% CI: 32%–47%) (**Figure S4A**). In 2,059 non-hospitalized patients from 4 COVID-19 studies, the pooled prevalence was 14% (95% CI: 5%–33%) (**Figure S4B**). It should be noted that the hospitalization status of the remaining patients was not clearly reported. Twelve studies of SARS-CoV-2 particularly investigated viremia in ICU patients, and the prevalence was pooled to be 49% (95% CI: 34%–64%) (**Figure S4C**), which was numerically higher than non-ICU hospitalized COVID-19 patients (38%, 95% CI: 11%–76%) (**Figure S4D**). Antigenemia detection demonstrated a higher positivity rate compared to nucleic acid detection **(Figure S5**). Furthermore, the detection of viral particles in plasma exhibited a greater positive rate than that observed in serum samples (**Figure S6**).

The pooled estimates of the risk of poor clinical outcomes are summarized in **Table 2**. For the association between viremia and all-cause mortality of patients with acute respiratory viral infection, we analyzed 29 studies (**Table S3**) that respectively reported the event numbers of mortality in patients with and without viremia. The pooled crude OR was 6.83 (95% CI: 4.92 – 9.48) (**Figure 2**), indicating a higher risk of mortality in patients with viremia. The Egger's test showed a *p*-value of 0.0112 (**Figure S7**). OR for influenza viremia-related mortality pooled from three studies was estimated as 6.96 (95% CI: 2.86–16.95).. Twenty-three studies were conducted in COVID-19 patients. Patients with SARS-CoV-2 viremia were at a greater risk of mortality compared to patients without viremia (OR 6.64, 95% CI: 4.64–9.48). While non-SARS-CoV-2 viremia was associated with an OR for mortality at 8.01 (95% CI: 3.62 – 17.74) (**Figure S8**).

Figure S9 shows mortality risk at different time points. For the 28-30 day mortality endpoint, the analysis of 8 studies yielded a pooled OR of 7.38 (95% CI: 4.42-12.32) for all-cause mortality. Analysis of in-hospital mortality included 5 studies, with a pooled OR of 13.16 (95% CI: 7.35-23.55). In the analysis of hospitalized patients, viremia was associated with an elevated risk of mortality (OR 6.06, 95% CI: 4.30–8.53) (**Figure S10A**). This increased risk remained significant when the analysis was further limited to the ICU group (OR 5.57, 95% CI: 1.92–16.12) (**Figure S10B**). In the univariable meta-regression analysis presented in **Figure S11**, data from 14 studies with age information and 25 studies with sex information were incorporated. The analysis revealed age and sex were not significantly associated with the OR for mortality.

The literature review identified 7 studies that reported aHR and 6 studies that reported aOR after adjusting for important confounders in the multivariable analysis (**Table S4**). The pooled aHR was 2.91 (95% CI: 1.87–4.53), while the pooled aOR was 3.68 (95% CI: 2.37–5.71), indicating a significant association between viremia and mortality in patients with acute respiratory viral infection (**Figure 3**). Five studies reporting aHR also provided unadjusted HR, with adjustments numerically increasing the pooled estimates from 2.24 (95% CI: 1.76–2.86) to 2.94 (95% CI: 1.68–5.13) (**Figure S12 A&B**). Similarly, for aOR, adjustments numerically raised the estimates from 3.26 (95% CI: 2.14–4.96) to 3.61 (95% CI: 2.19–5.95) (**Figure S12 C&D**).

Studies reporting the association between viremia and ICU admission, MV utilization, and

extrapulmonary complications are summarized in **Table S3**. The pooled crude OR for ICU admission from 18 studies was 4.74 (95% CI: 2.66–8.46) (**Figure 4A**), indicating a significantly increased risk of ICU admission among patients with viremia. Studies of SARS-CoV-2 infection reported adjusted effect measures for the risk of ICU admission. Solis et al.[27] found that COVID-19 children with viremia had an increased risk of being admitted to the ICU, with an aHR of 3.62 (95% CI: 2.04–12.13). Four studies reported aOR of SARS-CoV-2 viremia for ICU admission (**Table S4**), which were pooled to an estimated aOR of 4.89 (95% CI: 1.61–14.91) (**Figure 4B**).

Moreover, in the analysis of clinical deterioration in respiratory infection, specifically the need for MV, thirteen publications were included. A pooled OR of 4.12 (95% CI: 2.25–7.52) indicated that patients with viremia following acute respiratory infection had a higher risk of requiring ventilation assistance compared to patients without viremia (**Figure S13**). There was no sign of significant funnel plot asymmetry in both analyses for ICU admission and MV (**Figure S14**).

The association between SARS-CoV-2 viremia and extrapulmonary complications was examined in a few studies. Viremia was not significantly related to cardiac complications (OR 2.22, 95% CI: 0.77–6.39) (**Figure S15A**) or renal complications (OR 1.35, 95% CI: 0.61–2.99) (**Figure S15B**). We observed a significant association between viremia and hepatic complications (OR 3.10, 95% CI: 1.30–7.40) (**Figure S15C**). A reported aHR of severe liver dysfunction in COVID-19 patients with viremia reached 6.359 (95% CI: 1.336–30.253) [28].

Discussion

Our review presents a comprehensive illustration of viremia in patients with acute respiratory viral infection. In the predominantly hospitalized population of eligible studies, we identified a relatively high prevalence of viremia following relevant acute respiratory infection. Besides, we found that viremia was associated with increased risks of mortality, ICU admission, MV utilization, and hepatic complications in these patients.

The prevalence of viremia is influenced by several factors, including the type of virus, disease severity, and patient-specific characteristics. We showed that coronavirus infection in the respiratory tract resulted in a higher prevalence of viremia, whereas RV infection was related to a relatively low prevalence. The tissue-destructive potential of different respiratory viruses may indeed play a role in the observed impacts on viremia prevalence. However, this assessment could not be made before appropriately controlling for other confounding factors. The pooled prevalence of viremia varied among non-hospitalized patients (14%), hospitalized patients (39%), and those admitted to the ICU (49%), indicating that viremia might become more prevalent as the disease severity increases. Moreover, immunosuppressed hosts were more likely to develop viremia in acute respiratory viral infection. A study comparing solid organ transplant (SOT) COVID-19 patients with non-SOT COVID-19 patients noted a significantly higher occurrence of viremia in the SOT group (57.4% vs. 18.9%) [29]. Additionally, viral load in the respiratory tract plays a critical role in the dissemination of viruses into the bloodstream. The higher detection rate of viral components in the blood is associated with elevated viral loads in nasopharyngeal samples at the time of diagnosis [30-32]. Underlying conditions may further contribute

to this systemic dissemination. For instance, SARS-CoV-2 RNAemia has been observed more frequently in patients with severe chronic comorbidities[33]. Similarly, a history of airway diseases has been shown to increase the likelihood of viremia in RV-infected patients[34].Differences were observed between crude and adjusted estimates of the mortality risk of patients with viremia. However, when restricting the analysis to studies that reported both unadjusted and adjusted HR/OR, the impact of adjustment was relatively modest. This may be attributable to the greater number of studies contributing to the pooled crude OR, which encompassed a broader range of viral types and more heterogeneous populations. Nevertheless, the risk of mortality remained significant across all these analyses.

The association between viremia and poor clinical outcomes established in this study highlights its potential as a risk stratification tool for identifying patients at higher risk for complications or death. Although viremia does not necessarily equal to viable or replicating viruses, it has been proposed as a candidate biomarker for active viral infection[38], systemic viral dissemination[39, 40], and immune dysregulation[41, 42]. The progression from viremia to adverse outcomes is thought to involve viral sepsis, a severe systemic response that can occur with respiratory viruses such as RV, influenza, SARS-CoV-2, and SARS-CoV [43]. Respiratory viruses disrupt the barrier functions of airway epithelial and endothelial cells, allowing them to breach into the bloodstream and distribute widely[44, 45]. Evidence shows that respiratory viruses can be detected not only in respiratory and blood samples but also in urine and stool[46, 47]. Autopsy studies have also identified the presence of influenza[48], SARS-CoV[49], MERS-CoV[50], and SARS-CoV-2[51] in various extrapulmonary organs. Such systematic infection can initiate a dysregulated host response. Activation of the immune response leads to the release of cytokines and chemokines, which further exacerbates inflammation and culminates in a cytokine storm[52]. This hyperinflammatory response ultimately results in organ dysfunction[53]. The immunosuppressive state characterized by decreased lymphocyte counts and T-cell exhaustion also contributes to the development of organ failure[4, 54]. Respiratory failure and dysfunction of extrapulmonary organs lead to the mortality of patients with viremia[55]. Besides the organ dysfunction in sepsis, the widespread dissemination of viruses can cause direct damage by inducing infection in distant organs and tissues. However, the mechanisms underlying these associations remain incompletely understood. Future research should aim to clarify the causal pathways and establish the prognostic value of viremia in different populations and disease contexts, ultimately informing clinical management strategies. Furthermore, novel treatment approaches are expected to be determined based on future research on viremia.

This meta-analysis emphasized that the detection of viremia should be generally valued and used as it provides an opportunity for early recognition of viral sepsis[39]. Antigen rapid tests offer a convenient method for viremia identification. The analysis revealed a higher pooled prevalence of antigens compared to nucleic acids in the blood, consistent with findings from studies using both detection methods, which have reported a higher detection rate of antigenemia[26, 30, 36]. This may be due to viral surface proteins being more readily exposed in the bloodstream, or the greater stability of proteins, which are less prone to degradation than RNA[31, 37]. Despite this, antigen detection has shown a comparable predictive value for mortality to that of nucleic acid detection[26].

Detecting various viruses in the bloodstream should be applied when identifying unknown pathogens, which will facilitate the prompt initiation of antiviral treatments and potentially halt the progression to viral sepsis. The included studies comparing outcomes between patients with and without viremia did not provide specific blood viral load measurements. However, there was evidence showing the significance of quantifying the viral load in the blood. Critical cases of COVID-19 exhibited higher concentrations of viral RNA in the serum compared to moderate-severe cases[56, 57], and non-survivors had higher viral load compared to survivors[56, 58]. Future research determining the risk of poor clinical outcomes based on viral load will help establish an optimal cutoff value for clinical interventions and prognosis prediction.

This study incorporates various respiratory viruses and utilizes viral nucleic acids and antigens as detection markers. We also acknowledge certain evidence gaps that indicate the need for future research. First, it is important to note that the included studies had limited populations, with minimal focus on non-hospitalized patients and insufficient testing among mildly symptomatic hospitalized patients, potentially affecting the estimation of viremia prevalence and its clinical significance. Considering the correlation between symptom severity and viremia prevalence, the actual prevalence of viremia among respiratory infection patients might be lower than reported in this review. The second prominent limitation lies in that most studies were about SARS-CoV-2 as described in the results, limiting its representativeness for the condition. The results of Egger's test indicated the existence of small-study effects for mortality outcome, potentially caused by publication bias. Another limitation is the variation in the sample collection days from symptom onset. Many of the studies included in this review collected blood samples either upon or shortly after admission[26] or throughout the entire hospitalization period[59]. Since the detection of viremia is time-sensitive[27], this inconsistency may undermine the reliability and consistency of the findings.

In summary, this meta-analysis outlines the existence of viremia in acute respiratory viral infection and confirms the association between viremia and poor clinical outcomes. Our study highlights the significance of viremia in patients with acute respiratory infection.

Notes

Author Contributions

YY, LS, and BC conceived the study. LS designed protocol for literature retrieval. YY and LS performed article screening, data extraction and statistical analysis. YY wrote the first manuscript. BC, JX, GF, XG, and YW provided critical revision to the manuscript.

Declaration of Interest

We declare no competing interest.

Disclaimer

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

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Table 1. Summary of the Pooled Prevalence of Viremia in Patients with Acute Respiratory Infection

Virus	No. of Studies	No. of Patients	Prevalence (%)	95% CI (%)	I^2 (%)
Influenza	6	272	30	11–60	89
MERS-COV	1	21	33	15–57	-
RSV	1	92	30	21–41	-
RV	5	945	10	8–12	7
SARS-COV	3	88	64	40–82	80
SARS-COV-2	85	14970	36	29–43	97
Overall	**101**	**16388**	**34**	**28–41**	**97**

MERS-CoV, Middle East respiratory syndrome coronavirus; RSV, respiratory syncytial virus; RV, Rhinovirus; SARS-CoV, severe acute respiratory syndrome coronavirus; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; 95% CI, 95% confidence interval.

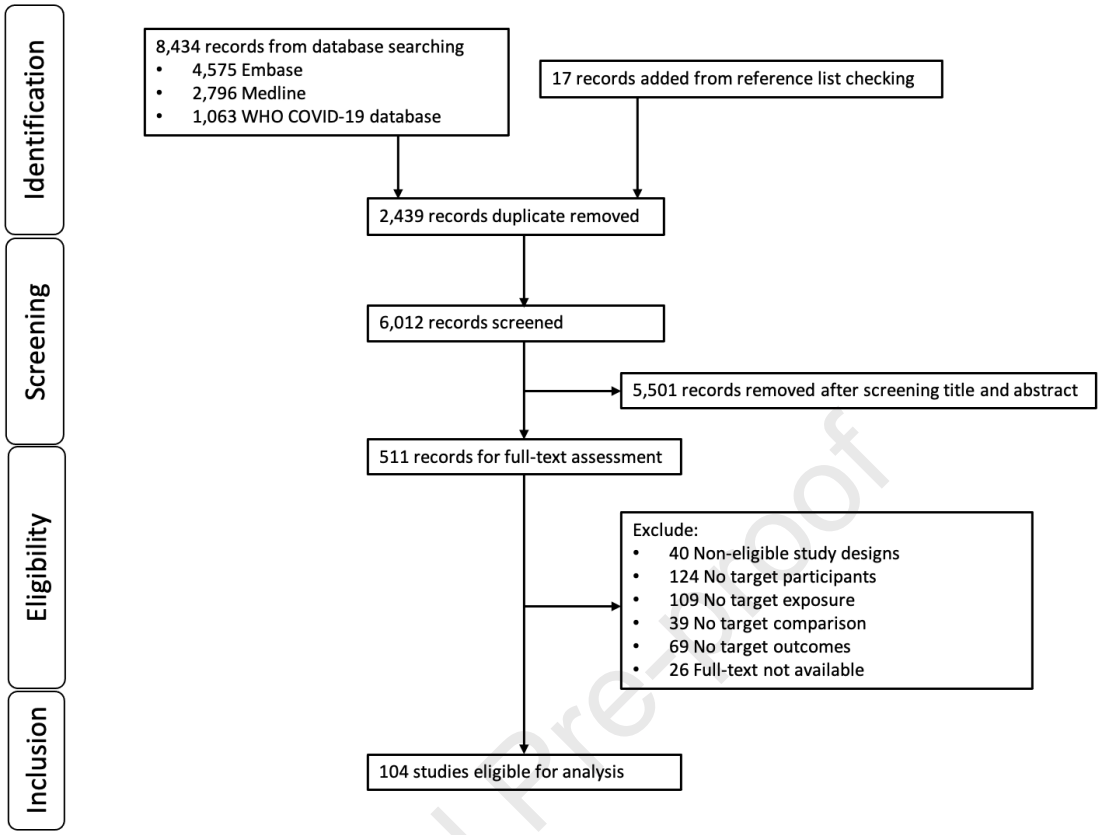
Table 2. The Associations between Viremia and Poor Clinical Outcomes in Patients with Acute Respiratory Infection

Outcome	No. of Studies	No. of Patients with Viremia	No. of Patients without Viremia	OR	95% CI	I^2 (%)	Adjusted effect size (95% CI)
All-cause Mortality	29	1199	2968	**6.83**	**4.92–9.48**	46	**aOR：3.68 (CI: 2.37–5.71) (in 7 studies) aHR: 2.91 (1.87–4.53) (in 6 studies)**
ICU Admission	18	873	1709	**4.74**	**2.66–8.46**	76	**aOR：4.89 (1.61–14.91) (in 4 studies)**
Mechanical Ventilation	13	596	1275	**4.12**	**2.25–7.52**	58	/
Cardiac complications	4	326	315	2.22	0.77–6.39	63	/
Renal complications	4	336	327	1.35	0.61–2.99	40	/
Hepatic Complications	3	124	119	**3.10**	**1.30–7.40**	0	/

"/": Not reported by included studies

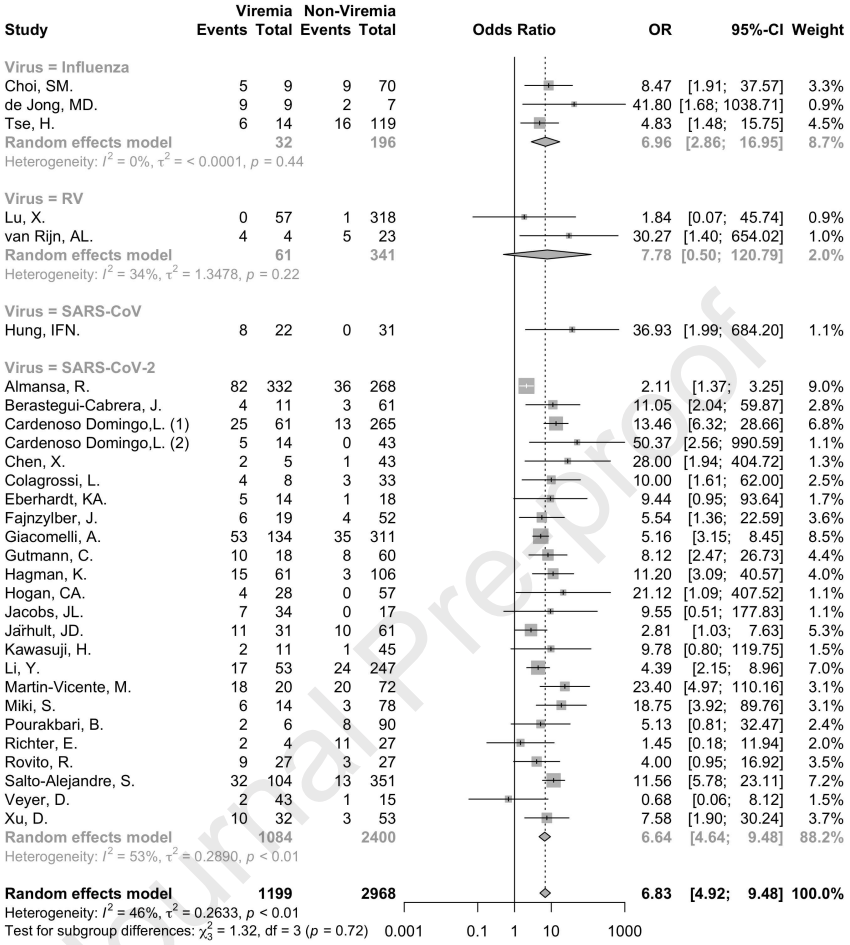
ICU, intensive care unit; OR, odds ratio; 95% CI, 95% confidence interval.

Figure 1. Flowchart of study selection.



WHO, World Health Organization; COVID-19, coronavirus disease 2019.

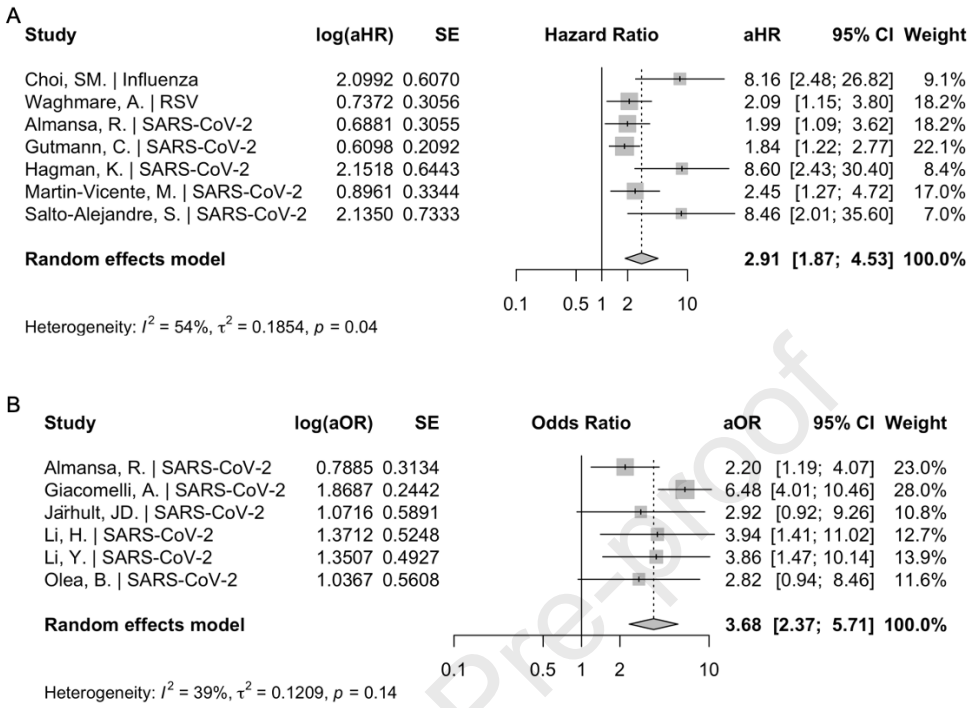
Figure 2. The association between viremia and risk of mortality in patients with acute respiratory viral infection, data pooled from crude OR.



Different cohorts in the same study were marked as Author (1), (2), etc.

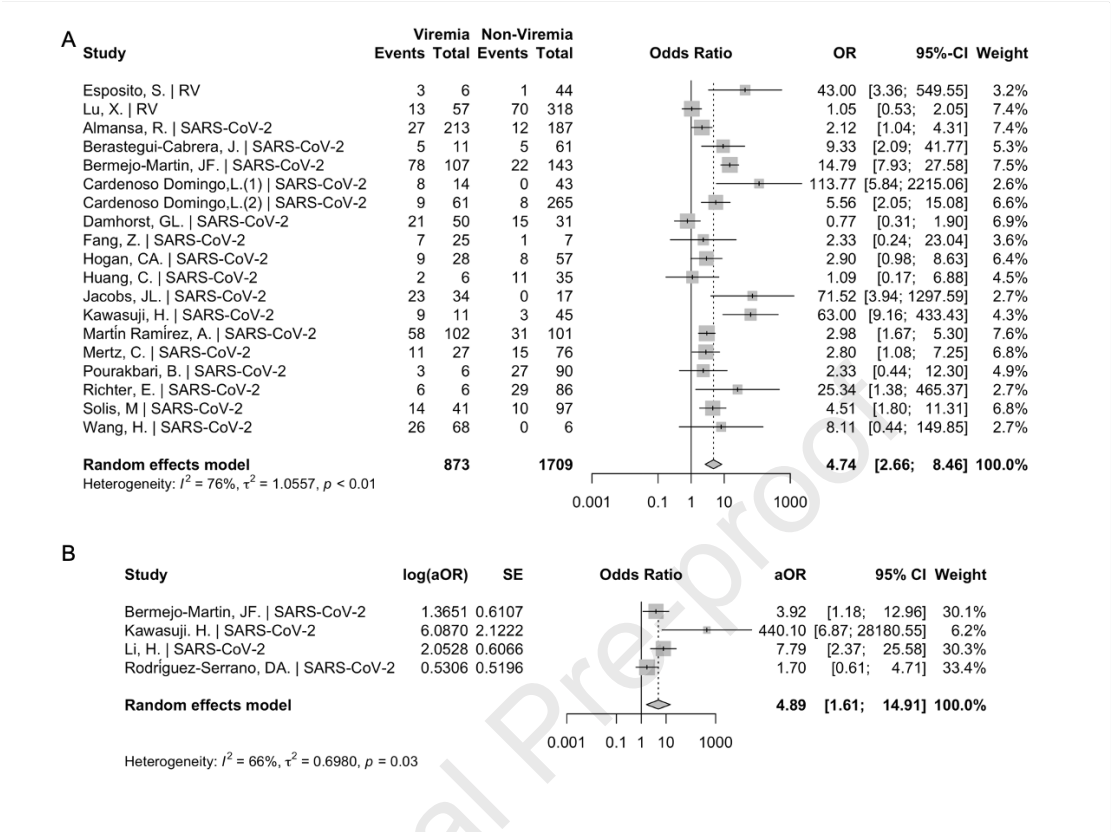
OR, odds ratio; RV, Rhinovirus; SARS-CoV, severe acute respiratory syndrome coronavirus; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2;95% CI, 95% confidence interval.

Figure 3. The association between viremia and risk of mortality in patients with acute respiratory viral infection after adjustment, data pooled from aHR (A) or aOR (B).



aHR, adjusted hazard ratio; aOR, adjusted odds ratio; RSV, respiratory syncytial virus; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; SE, standard error; 95% CI, 95% confidence interval.

Figure 4. The association between viremia and risk of ICU admission in patients with acute respiratory viral infection, data pooled from crude OR (A) and aOR (B).



Different cohorts in the same study were marked as Author (1), (2), etc.

aOR, adjusted odds ratio; ICU, intensive care unit; OR, odds ratio; RV, Rhinovirus; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; SE, standard error; 95% CI, 95% confidence interval.