Turkish Journal of Pediatric Disease

Original Article

From bedside to revisit: identifying risk factors for outpatient revisits following pediatric viral lower respiratory tract infections – insights from hospitalized cases of RSV, HBoV and influenza

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ABSTRACT

Objective: Acute lower respiratory tract infections (ALRTIs) are among the leading causes of hospitalization, particularly in children under five years of age. A substantial proportion of children discharged after hospitalization for viral ALRTIs experience recurrent respiratory tract infections; however, the clinical predictors of these recurrences have not yet been fully defined. This study aimed to investigate the relationship between recurrent hospital visits due to respiratory tract infections within one year post-discharge and various clinical and demographic factors in pediatric patients hospitalized with ALRTIs caused by respiratory syncytial virus (RSV), human bocavirus (HBoV), or influenza viruses (IFV).

Material and Methods: This retrospective observational study included pediatric patients hospitalized due to RSV, HBoV, or IFV infections between January and December 2023. Demographic characteristics, clinical presentation, hospitalization details, and post-discharge follow-up data were evaluated. Recurrent hospital visits related to respiratory tract infections within one year of discharge were analyzed.

Results: A total of 519 patients were evaluated. Recurrent hospital visits due to respiratory tract infections were identified in 216 patients (41.6%) during the follow-up period. Younger age ($p = 0.028$) and the presence of chronic illness ($p = 0.011$) were found to be significant risk factors for these repeat visits. No significant association was observed between recurrent visit frequency and variables such as sex, identified viral pathogen, laboratory parameters, or radiological findings.

Conclusion: Younger age and comorbid chronic illnesses were identified as important risk factors for recurrent hospital visits following viral ALRTIs. These findings highlight the need for more structured and targeted follow-up strategies in pediatric patients at higher risk after hospital discharge.

Keywords: Human bocavirus, influenza virus, respiratory syncytial virus

INTRODUCTION

Acute lower respiratory tract infections (ALRTIs) rank among the leading causes of morbidity and mortality in children under five years of age, particularly in low-income countries (1,2). Approximately 30–50% of children hospitalized with viral ALRTIs are reported to develop recurrent respiratory tract infections (3). Therefore, identifying clinical markers to predict which children are at high risk of recurrence following hospitalization is of critical importance (4). However, despite its clinical relevance, there is limited evidence to accurately predict which children will experience bronchiolitis recurrence or require further medical care after discharge (5).

Viral ALRTIs in childhood have been associated with recurrent respiratory tract infections and episodes of wheezing (6). However, whether the infectious etiology of ALRTIs influences short-term clinical outcomes, such as post-hospitalization recurrence, remains unclear (5). Human bocavirus (HBoV), respiratory syncytial virus (RSV), and influenza viruses (IFV) have been shown to cause clinical conditions that require hospitalization in pediatric patients (7-9). In contrast, other respiratory viruses, such as metapneumovirus, rhinovirus, and parainfluenza viruses, are generally associated with milder clinical courses that do not require hospitalization and are suitable for outpatient management (10-12). Previous studies have primarily focused on the relationship between early RSV

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Received : 14.08.2025
Accepted : 16.09.2025
DOI:10.12956/TJPD.2025.1219

infections and the risk of recurrent hospital visits, as well as the development of asthma and allergic diseases (13). In recent years, with the availability of more sensitive molecular diagnostic methods, other common viral pathogens such as HBoV and IFV, which can lead to more severe clinical presentations, have also begun to receive attention in research studies (14).

Recurrent hospital visits are known to impose a significant burden on healthcare systems (15). In pediatric populations, the presence of chronic illnesses and various sociodemographic factors contribute to this increased risk. The aim of this study was to identify clinical predictors of recurrent hospital visits during the post-discharge period and to develop appropriate preventive strategies accordingly. The findings were intended to strengthen follow-up care for discharged children, facilitate timely interventions when necessary, and help reduce the frequency of readmissions.

MATERIALS and METHODS

The study population consisted of patients hospitalized in the Departments of Pediatrics and Pediatric Infectious Diseases at Ankara Bilkent City Hospital Children Hospital between January and December 2023. Since RSV, HBoV, and IFV infections frequently require hospitalization in pediatric patients, only those admitted with acute lower respiratory tract infections (ALRTIs) in whom a respiratory viral panel identified a single viral pathogen—RSV, HBoV, or IFV—were included in the study. Multiplex real-time PCR testing (Rotor-Gene Q, QIAGEN, Germantown, Maryland, USA) was used to detect respiratory viruses from samples obtained during hospitalization. Patients were categorized according to the identified viral pathogen. Those with multiple viral pathogens, admissions outside the specified study period, hospitalizations unrelated to ALRTIs, absence of RSV, HBoV, or IFV detection on viral panels, or incomplete clinical data were excluded.

The hospitalization courses of the patients and their recurrent hospital visits within one year post-discharge were retrospectively analyzed. All visits to the pediatric emergency department and pediatric outpatient clinics within one year after discharge due to newly developed complaints were considered hospital visits. Presenting complaints and their characteristics were determined by reviewing the examination notes available in the hospital's electronic medical records. Only visits in which the primary presenting complaint involved any respiratory symptom or sign (e.g., cough, nasal/chest congestion, wheezing, respiratory distress, or hypoxemia) were classified as respiratory tract infection–related hospital visits. Follow-up visits conducted to assess clinical recovery after the same hospitalization episode were excluded from the analysis.

The patients' demographic characteristics (age, sex), presence of chronic illness, gestational age (preterm/term), date and season of hospitalization, presenting complaints, presence of tachypnea on initial physical examination, oxygen saturation levels, presence of hypoxia, chest radiograph findings, and laboratory data were recorded. Patients with an oxygen saturation level below 92% were classified as hypoxic. Laboratory assessments included liver transaminase levels, blood gas analyses (pH, pCO_2, HCO_3, lactate), complete blood counts (white blood cell, neutrophil, lymphocyte, and platelet counts), procalcitonin, erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP) levels. In patients for whom sputum or blood cultures were obtained, the corresponding culture results were also reviewed.

Data regarding the clinical unit of admission, length of hospital stay, administration of respiratory support or inhaled therapy, and, where applicable, the specific type of respiratory support provided were retrospectively recorded. Based on all these variables, the relationship between the identified viral pathogen group and hospital visits occurring within one year after discharge was evaluated.

Statistical analysis

Data entry and analysis were performed using the Statistical Package for the Social Sciences (IBM SPSS Statistics 25, IBM Corporation). The normality of numerical variables was assessed using the Shapiro–Wilk test. Descriptive statistics for parametric variables were reported as mean and standard deviation, whereas non-parametric variables were expressed as median values (minimum–maximum). Categorical variables were summarized as frequency and percentages. Group comparisons for categorical variables were performed using the chi-square test. For numerical variables, the independent samples t-test was applied when assumptions for parametric analysis were met; otherwise, the Mann–Whitney U test was used. A p-value ≤ 0.050 was considered statistically significant.

RESULTS

Respiratory tract infections are among the leading causes of hospital visits, particularly in childhood. In this study, pediatric patients hospitalized due to RSV, HBoV, and IFV infections—given their potential to cause severe clinical conditions requiring hospitalization—were followed for one year after discharge to evaluate recurrent respiratory tract infection–related hospital visits. Additionally, clinical and demographic factors potentially associated with these visits were assessed.

Data from a total of 519 patients were analyzed. Of these, 338 (65.1%) were male and 181 (34.9%) were female. The median age for the entire cohort was 3 years (IQR; 1–6). Based on the viral pathogens identified at the initial hospitalization, 98 patients (18.9%) were hospitalized due to RSV, 209 patients (40.2%) due to HBoV, and 212 patients (40.9%) due to IFV. Within one year post-discharge, 376 patients (72.4%) had at least one healthcare visit, 216 of which were attributed to respiratory tract infections. The median number of visits for these patients was

Table I: Sociodemographic and descriptive characteristics of the patients

Descriptive characteristic	Total	RSV	HBoV	IFV
Number of patients*	519	98 (18.9)	209 (40.2)	212 (40.9)
Gender*				
Male	338 (65.1)	70 (71.4)	144 (68.9)	124 (58.5)
Female	181(34.9)	28 (28.6)	65 (31.1)	88 (41.5)
Recurrent outpatient visit*				
Yes	376 (72.4)	67 68.3)	160 (76.5)	149 (70.2)
No	143 (27.6)	31 (31.7)	49 (23.5)	63 (29.8)
Recurrent RTI visit*				
Yes	216 (41.6)	45 (45.9)	96 (45.9)	75 (35.3)
No	303 (58.4)	53 (54.1)	113 (54.1)	137 (64.7)
Recurrent non-RTI visit*				
Yes	267 (51.4)	40 (40.8)	111 (53.1)	116 (54.7)
No	252 (48.6)	58 (59.2)	98 (46.9)	96 (45.3)
Number of recurrent RTI visit†	2 (1-3)	2 (1-3)	2 (1-3)	1 (1-3)
Number of recurrent non-RTI visit†	2 (1-2)	1 (1-2)	2 (1-2)	2 (1-2)
Age†	3 (1-6)	1 (1-2)	2 (1-4)	5 (2-8)

:** *n (%),* **†:** *median (Q_1-Q_3),* ***RTI: *Respiratory tract infection*

Table II: Laboratory parameters of patients during hospitalization

Laboratory Parameter	n	Value*
AST (U/L) 0-46	507	39 (30-57)
ALT (U/L) 0-32	507	23 (17-35)
LDH (U/L) 0-337	459	337 (293-396)
PH 7.35-7.45	381	7.43 (7.39-7.46)
PCO_2 (mmHg) 35-45	381	32.9 (28 .80-37.20)
HCO_3 (mEq/L) 22-25	381	21.4 (19.30-23.30)
Lactate (mmol/L)	381	1.95 (1.40-2 .69)
CRP (mg/L) 0-5	505	8.81 (2.98-23.30)
WBC x 10^9/L 5.4-13.8	505	8.39 (5.245-11.655)
ANC x 10^9/L 1.5-8.5	505	4.18 (2.140-6.955)
ALC x 10^9/L 2.2-8.5	505	2.39 (1.345-4.080)
PLT (/µL) 200-460	505	268.5 (221.000-405.750)

:** *median (Q_1-Q_3),* ***AST: *Aspartate Aminotransferase,* ***ALT:*** *Alanine Aminotransferase,* ***LDH:*** *Lactate Dehydrogenase,* ***CRP:*** *C-Reaktif Protein,* ***WBC:*** *White Blood Cell,* ***ANC:*** *Absolute Neutrophil,* ***ALC:*** *Absolute Lymphocyte,* ***PLT:*** *Platelet*

2 (IQR; 1–3). Additionally, 135 patients presented to healthcare facilities for both respiratory and non-respiratory reasons during the same period. The sociodemographic and descriptive characteristics of the study cohort are presented in Table I.

In the subgroup of patients who exhibited recurrent clinic visits, a comparison of the median ages of those with and without respiratory infections revealed that those experiencing respiratory infections were younger. Specifically, the median age of patients with respiratory infection was 3.42 years, compared to 4.68 years for those not suffering from such an infection, and this difference was found to be statistically significant (p = 0.028). Similarly, the relationship between presenting complaints at the initial hospitalization and subsequent recurrent visits was analyzed. Patients presenting with cough had a significantly higher rate of recurrent visits for respiratory infections (75.8 vs. 62.7; p<0.001). However, no significant association was found for fever (64.7 vs. 62.5; p=0.189) or sore throat (25.9 vs. 22.6; p=0.544). The season of initial hospitalization was not significantly associated with the need for recurrent visits (winter to autumn; 59.3, 20.8, 6.9 vs. 13.0; p= 0.112). Additionally, patient gender was not found to influence the frequency of such visits (p=0.476).

The relationship between the viral pathogens identified during hospitalization and the need for recurrent hospital visits due to respiratory tract infections was evaluated. No statistically significant difference was found among the RSV, HBoV, and IFV groups regarding the likelihood of recurrent hospital visits for respiratory tract infections (p=0.362). In contrast, a significant association was observed between the presence of chronic illness and an increased risk of recurrent visits due to respiratory tract infections (65.00 vs. 35.00; p=0.011).

No significant association was found between the presence of hypoxia during hospitalization (46.3 vs. 40.3; p=0.623) or the need for oxygen therapy via mask (58.3 vs. 47.8; p=0.217), high-flow nasal cannula oxygenation (HFNC) (25.5 vs. 26.2; p=0.478), non-invasive mechanical ventilation (NIV) (17.7 vs 18.9; p=0.474), or invasive mechanical ventilation (IMV) (p=0.238) and recurrent outpatient visits due to respiratory tract infections after discharge. Similarly, the presence of infiltrates on chest radiographs obtained during hospitalization was not associated with an increased risk of recurrent visits (71.2 vs. 67.4; p=0.610). However, when evaluated according to the site of hospitalization, patients admitted to general wards were found to have significantly higher rates of recurrent visits due to respiratory tract infections compared to those monitored in the intensive care unit (79.9 vs. 20.1; p<0.001).

The laboratory values of the entire patient group are presented

in Table II. Comparative analysis of the laboratory parameters between patients who revisit to the hospital and those who did not demonstrated no statistically significant differences ($p > 0.05$ for all comparisons).

DISCUSSION

Acute viral lower respiratory tract infections (ALRTIs) are typically self-limiting illnesses that often resolve with supportive care at home. However, a considerable number of pediatric patients require hospitalization for observation and supportive treatment (16). Approximately 30–50% of children hospitalized due to viral ALRTIs are at increased risk for recurrent respiratory illnesses (14,3). Therefore, identifying clinical parameters that can help stratify high-risk subgroups following viral ALRTIs is of substantial clinical importance (4). In this study, recurrent hospital visits due to respiratory tract infections within one year after discharge were evaluated in children hospitalized with respiratory infections caused by RSV, HBoV, and IFV. The primary aim was to investigate potential associations between these recurrent visits and factors such as patient age, sex, presence of chronic illness, hospitalization characteristics, and the identified viral pathogens.

Viral ALRTIs are among the leading causes of morbidity, mortality, and hospitalizations, particularly in younger children (2,17). Approximately 30–40% of children who experience these infections during the preschool period may develop recurrent episodes (18). Similar studies have reported that viral pathogens are most frequently identified in children under the age of four (19). The median age findings in our study are consistent with these results. Furthermore, it was demonstrated that younger children have a higher likelihood of recurrent hospital visits due to respiratory tract infections following hospitalization for ALRTIs (20). Our findings support these observations, as the rate of recurrent hospital visits due to respiratory tract infections was found to be higher in younger children. This may be related to the fact that children under the age of five—particularly those under two years—are at greater risk for ALRTIs and associated complications (21). Therefore, the risk of recurrent infections should be carefully considered during post-discharge follow-up of younger children.

A review of the literature reveals no consensus regarding the impact of viral pathogens identified in ALRTIs on long-term respiratory problems and recurrent hospital visits after discharge. In one study, RSV and non-RSV viruses were analyzed as separate groups, and it was reported that non-RSV viruses were associated with a higher risk of recurrent respiratory illnesses following infection (22). In a multicenter cohort study conducted in the United States, it was reported that in ALRTIs caused by a single viral pathogen without co-infections, the specific viral agent identified had no significant impact on recurrent hospital visits after discharge (5). The same study reported that RSV–rhinovirus co-infections were associated with increased rates of recurrent respiratory tract infection–related hospital visits. In another study, among infections caused by various viral pathogens such as RSV, HBoV, rhinovirus, metapneumovirus, IFV, and parainfluenza viruses, patients with rhinovirus infections demonstrated higher rates of recurrent respiratory tract infection visits during one-year follow-up (14). Similarly, another study reported that IFV infections were associated with higher rates of recurrent hospital visits compared to other viral agents (20). In our study, however, no significant differences were observed in the rates of recurrent respiratory tract infection–related hospital visits within one year post-discharge among the three patient groups classified according to RSV, HBoV, and IFV identified at the time of hospitalization. The literature suggests that geographical factors may influence clinical outcomes during the course of illness as well as the need for recurrent hospital visits in the post-recovery period, potentially leading to regional differences (17,15). The discrepancies between previous studies and our findings may be attributed not only to differences in patient populations but also to geographical variations among the countries and regions where the studies were conducted.

Previous studies have reported that blood gas analysis, complete blood count, and CRP results obtained during hospitalization for ALRTIs in children are associated with disease severity, the need for oxygen therapy, intensive care unit admission, and prolonged hospitalization. One study demonstrated that leukocytosis on complete blood count, elevated CRP levels, acidosis on blood gas analysis, and increased pCO_2 values were associated with intubation and intensive care unit admission (19). Another study demonstrated that elevated lactate levels were associated with prolonged hospitalization, increased disease severity, and the need for intubation (23). Although these studies identified significant associations between laboratory findings and disease severity, prolonged hospitalization, and increased need for respiratory support, their relationship with recurrent hospital visits due to respiratory tract infections after discharge was not evaluated. In our study, this issue was investigated, and it was observed that the likelihood of recurrent hospital visits could develop independently of disease severity and laboratory parameters. This finding suggests that all patients, regardless of clinical severity, should be assessed at discharge for the potential risk of recurrent visits, and appropriate follow-up planning should be implemented.

Although the majority of children with viral ALRTIs recover without serious complications after discharge, some experience clinical relapses leading to unplanned healthcare visits and rehospitalizations. The literature reports that comorbid chronic illnesses increase the likelihood of infection recurrence and the need for repeated healthcare visits following viral ALRTIs (5,24). Similarly, in our study, children with chronic illnesses were found to have a higher rate of recurrent hospital visits due to respiratory

tract infections within one year after discharge compared to otherwise healthy children. Therefore, in the follow-up of high-risk patient groups with chronic illnesses, the increased risk of infection should be considered, and this awareness should be integrated into the planning of preventive strategies.

Rehospitalization after discharge is relatively common among patients hospitalized with ALRTIs (25). Although this issue has been extensively investigated in adult patient populations, studies focusing on pediatric age groups remain limited (20). Although no clear consensus exists, recurrent hospital visits and readmissions have generally been reported to occur in the presence of chronic illnesses or following intensive care unit admissions due to severe acute illness (26). However, these studies have primarily focused on recurrent hospitalizations. In contrast, our study demonstrated that patients monitored in general wards had a significantly higher rate of hospital visits due to respiratory tract infections in the post-discharge period. This finding suggests that pediatric patients followed in general wards should also be closely monitored for recurrent respiratory tract infections.

Limitations

In this observational study, the one-year follow-up period after hospital discharge was evaluated. Therefore, treatment and follow-up practices may have varied among patients, and long-term outcomes may not have been fully captured. The study was single-center and retrospective in nature. Factors such as climate changes, variations in public awareness, public health programs, and infection prevention measures implemented during and after the SARS-CoV-2 pandemic may have influenced the seasonal distribution of viral pathogens. Furthermore, the absence of a universally accepted definition for bronchiolitis and ALRTIs may have led to inter-physician variability in clinical diagnoses (27,28). Moreover, although the study center is a tertiary care institution, patients may have sought medical care at different healthcare facilities within one year after discharge.

CONCLUSION

This study evaluated recurrent hospital visits due to respiratory tract infections within one year after discharge in pediatric patients hospitalized with ALRTIs caused by RSV, HBoV, and IFV. The findings demonstrated that such visits occurred more frequently in younger children and in those with comorbid chronic illnesses. No significant association was found between the frequency of recurrent visits and the type of viral pathogen or other clinical parameters. These results highlight the need for a more cautious and structured approach to post-discharge follow-up in children at increased risk.

Ethics committee approval

This study was conducted in accordance with the Helsinki Declaration Principles. The study was approved by Ankara Bilkent City Hospital (04.06.2025, reference number: 25-1341).

Contribution of the authors

Study conception and design: ***KC, MY,*** Data collection: ***KC***, Analysis and interpretation of results: ***KC, MY***, Draft manuscript preparation: ***KC, MY***

Source of funding

The authors declare the study received no funding.

Conflict of interest

The authors declare that there is no conflict of interest.

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