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CLINICAL CHARACTERISTICS AND TREATMENT OUTCOMES OF ACUTE BRONCHIOLITIS IN INFANTS: A PROSPECTIVE OBSERVATIONAL STUDY

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Abstract

Introduction: Acute bronchiolitis is the leading cause of hospitalization in infants under one year of age, with limited data available from Indian healthcare settings. This study aimed to evaluate clinical characteristics, severity patterns, and treatment outcomes in infants hospitalized with acute bronchiolitis and identify predictors of severe disease.

Methods: A prospective observational study was conducted at Ananta Institute of Medical Sciences & Research Centre, Rajasthan, from January to June 2024. One hundred forty-two infants aged 1-24 months with acute bronchiolitis were enrolled using consecutive sampling. Comprehensive assessment included demographic data, clinical presentation, viral testing, Wang Bronchiolitis Severity Score, treatment interventions, and hospitalization outcomes. Multivariate logistic regression identified independent predictors of severe disease.

Results: Mean age was 6.8±5.2 months with 62.7% males and 40.8% under 3 months. Respiratory syncytial virus was the predominant pathogen (58.7%), significantly associated with severe disease. Mean Wang Bronchiolitis Severity Score was 4.8±2.6, with 23.2% classified as severe cases. Oxygen therapy was required in 69.0% of patients, with 16.9% requiring ICU admission. Mean hospital length of stay was 4.8±3.2 days. Independent predictors of severe disease included age <3 months (OR 4.23, 95% CI 1.78-10.05), prematurity (OR 2.84, 95% CI 1.02-7.91), initial oxygen saturation <90% (OR 8.94, 95% CI 3.01-26.58), and respiratory rate >60/minute (OR 2.76, 95% CI 1.08-7.05).

Conclusion: Young age, prematurity, and initial hypoxemia are strong predictors of severe bronchiolitis. Standardized severity assessment and evidence-based supportive care protocols should be implemented to optimize outcomes and resource utilization in Indian healthcare settings.

Keywords: acute bronchiolitis, respiratory syncytial virus, infant hospitalization, severity assessment, treatment outcomes

Introduction

Acute bronchiolitis represents one of the most significant respiratory illnesses affecting infants and young children worldwide, constituting the leading cause of hospitalization in children under one

year of age and the most common lower respiratory tract infection in infants under two years (Li et al., 2022). This viral-induced inflammatory condition affects the small airways (bronchioles) and is characterized by airway obstruction, increased mucus production, and epithelial damage, leading to a constellation of clinical symptoms including wheezing, tachypnea, cough, and feeding difficulties (Florin et al., 2017). The global burden of bronchiolitis is substantial, with millions of children affected annually and significant healthcare costs associated with hospitalizations, particularly during winter months when viral circulation peaks.

Respiratory syncytial virus (RSV) emerges as the predominant causative pathogen, accounting for approximately 50-80% of bronchiolitis cases, followed by rhinovirus, parainfluenza virus, human metapneumovirus, and adenovirus (Bozzola et al., 2021). The clinical presentation of bronchiolitis typically follows a predictable pattern, beginning with upper respiratory symptoms such as rhinorrhea, cough, and low-grade fever, subsequently progressing to lower respiratory tract involvement characterized by increased work of breathing, wheezing, and crackles on auscultation (Ralston et al., 2014). The severity of illness varies considerably among affected infants, ranging from mild outpatient management to severe respiratory failure requiring intensive care unit admission and mechanical ventilation.

The epidemiology of bronchiolitis demonstrates clear seasonal patterns, with peak incidence occurring during winter months in temperate climates, though tropical regions may experience different seasonal distributions. Age represents a critical risk factor, with infants under six months demonstrating the highest risk for severe disease and hospitalization (Voets et al., 2006). Additional risk factors for severe bronchiolitis include prematurity (gestational age <37 weeks), congenital heart disease, chronic lung disease, immunodeficiency, and neuromuscular disorders that impair respiratory function (American Academy of Pediatrics, 2014). Male infants appear to have slightly higher rates of hospitalization compared to females, and exposure to environmental tobacco smoke significantly increases disease severity.

The pathophysiology of bronchiolitis involves viral invasion of respiratory epithelial cells, triggering an inflammatory cascade that leads to bronchiolar edema, mucus hypersecretion, and cellular debris accumulation within small airways. This inflammatory process results in airway obstruction and increased resistance to airflow, manifesting clinically as wheezing, prolonged expiration, and increased work of breathing (Meissner, 2016). The combination of airway narrowing and ventilation-perfusion mismatch frequently leads to hypoxemia, which serves as a key indicator of disease severity and often drives decisions regarding hospitalization and supplemental oxygen therapy.

Clinical assessment of bronchiolitis severity remains challenging due to the subjective nature of many clinical signs and the lack of universally accepted standardized criteria. Several severity scoring systems have been developed and validated, including the Wang Bronchiolitis Severity Score (WBSS), the Kristjansson Respiratory Score (KRS), and the Global Respiratory Severity Score (GRSS), each incorporating different combinations of clinical parameters such as respiratory rate, oxygen saturation, retractions, wheezing, and general appearance (De Rose et al., 2023). These scoring systems aim to provide objective measures for clinical decision-making, research comparisons, and quality improvement initiatives.

Treatment of acute bronchiolitis remains predominantly supportive, as no specific antiviral therapy has demonstrated consistent clinical benefit. Current evidence-based guidelines from major pediatric organizations, including the American Academy of Pediatrics and European Respiratory Society, emphasize supportive care measures including oxygen supplementation for hypoxemia, adequate hydration, and careful monitoring for respiratory deterioration (Ralston et al., 2014). Controversial therapies such as bronchodilators, systemic corticosteroids, and chest physiotherapy have shown limited or no benefit in randomized controlled trials and are not routinely recommended.

The role of supplemental oxygen therapy represents a cornerstone of bronchiolitis management, though optimal oxygen saturation targets remain debated. Most guidelines recommend supplemental oxygen for infants with oxygen saturations below 90-92%, though some institutions

use higher thresholds (Corneli et al., 2012). High-flow nasal cannula therapy has emerged as an increasingly popular respiratory support modality for moderate to severe bronchiolitis, potentially reducing the need for more invasive ventilatory support, though definitive evidence regarding its superiority over standard oxygen therapy continues to evolve (Franklin et al., 2018).

Predictors of severe disease and prolonged hospitalization have been extensively studied to improve clinical decision-making and resource allocation. Young age (particularly <3 months), low oxygen saturation at presentation, elevated respiratory rate, presence of significant retractions, and poor feeding have consistently emerged as important predictors of hospitalization and adverse outcomes (Marlais et al., 2011). These clinical predictors have been incorporated into various risk stratification tools and decision algorithms to assist clinicians in determining appropriate levels of care and anticipating resource needs.

The economic burden of bronchiolitis is substantial, with estimated annual costs in developed countries reaching hundreds of millions of dollars due to emergency department visits, hospitalizations, and intensive care requirements. Length of hospital stay varies considerably, typically ranging from 2-7 days, with factors such as age, severity at presentation, and underlying comorbidities influencing duration of care (Bozzola et al., 2021). Understanding factors associated with prolonged hospitalization is crucial for healthcare planning and family counseling.

Recent advances in prevention strategies have introduced new opportunities for reducing bronchiolitis burden. Maternal RSV vaccination during pregnancy and the monoclonal antibody nirsevimab for all infants represent promising interventions that may significantly reduce disease incidence and severity (Hammitt et al., 2022). Additionally, traditional prevention measures including hand hygiene, avoiding exposure to tobacco smoke, and breastfeeding remain important public health strategies for reducing transmission and disease severity.

The clinical course and outcomes of bronchiolitis in developing countries may differ from those reported in developed nations due to factors such as malnutrition, limited healthcare resources, delayed presentation, and higher prevalence of underlying conditions. Studies from Indian subcontinent and other resource-limited settings have suggested potentially different patterns of disease severity, pathogen distribution, and treatment outcomes, highlighting the importance of region-specific research to inform local clinical practices and policy decisions.

Quality of care metrics for bronchiolitis have become increasingly important as healthcare systems focus on evidence-based practice and reduction of unnecessary interventions. Adherence to clinical guidelines, appropriate use of diagnostic testing, judicious antibiotic prescribing, and timely recognition of deterioration represent key quality indicators that impact both patient outcomes and healthcare costs. The development of standardized care pathways and clinical decision support tools has shown promise in improving consistency of care and reducing practice variation.

Long-term outcomes following bronchiolitis, particularly severe disease requiring hospitalization, remain an area of active investigation. Some studies suggest associations between severe bronchiolitis in infancy and subsequent development of asthma and recurrent wheezing, though the causal relationship remains incompletely understood (Jartti & Gern, 2017). Understanding these potential long-term consequences is important for family counseling and may influence approaches to prevention and treatment.

The heterogeneity in clinical presentation, disease course, and treatment responses observed in bronchiolitis suggests that this condition may represent a syndrome rather than a single disease entity. Advances in precision medicine and biomarker research may eventually enable more personalized approaches to risk stratification and treatment selection, though such strategies remain largely investigational at present.

The aim of the study is to evaluate the clinical characteristics, severity patterns, and treatment outcomes in infants hospitalized with acute bronchiolitis and to identify predictors of severe disease, prolonged hospitalization, and need for intensive care support.

Methodology

Study Design

This investigation was conducted as a hospital-based prospective observational study to comprehensively evaluate the clinical characteristics, severity patterns, and treatment outcomes of infants with acute bronchiolitis.

Study Site

The study was conducted at **Ananta Institute of Medical Sciences & Research Centre**, Rajsamand, Rajasthan, a tertiary care teaching hospital that serves as a major referral center for pediatric healthcare services in northwestern India.

Study Duration

The study was conducted over a period of 6 months from January 2024 to June 2024.

Sampling and Sample Size

The study employed a consecutive sampling method to recruit all eligible infants with acute bronchiolitis admitted to the pediatric department during the study period. Consecutive sampling was chosen as the most appropriate non-probability sampling technique to minimize selection bias and ensure representative inclusion of all patients meeting study criteria. This approach was particularly suitable for the hospital-based setting, as it captured the natural distribution of disease severity and patient characteristics presenting to the institution. The sample size was calculated based on previous studies reporting hospitalization rates and severity outcomes in bronchiolitis, with an expected proportion of severe disease (defined as requiring oxygen therapy or intensive care) of approximately 40-50%. Using a precision of 8% and a confidence level of 95%, a minimum sample size of 120 patients was calculated. To account for potential dropouts, incomplete data, and seasonal variation in case numbers, a target sample size of 150 patients was established. The final sample size was determined by the actual number of eligible patients admitted during the study period, with data collection continuing until the end of the predetermined study duration to ensure adequate representation across different months and seasonal patterns.

Inclusion and Exclusion Criteria

Infants aged 1 to 24 months presenting with clinical features consistent with acute bronchiolitis as defined by standard clinical criteria were included in the study. The clinical definition of bronchiolitis included first episode of respiratory distress characterized by cough, tachypnea, and expiratory wheeze or crackles on auscultation, preceded by upper respiratory tract symptoms such as rhinorrhea and fever. Patients were required to be admitted to the hospital for management of their respiratory symptoms and have adequate clinical documentation for data extraction. Both male and female infants were included without gender restrictions to ensure representative sampling. Exclusion criteria included infants with known congenital heart disease, chronic lung disease, immunodeficiency syndromes, or neuromuscular disorders that could independently affect respiratory function or disease severity. Patients with previous episodes of wheezing or established diagnosis of asthma were excluded to ensure inclusion of true first-episode bronchiolitis cases. Infants who received significant medical interventions prior to admission that could alter the natural disease course, those with incomplete medical records, and cases where parents declined consent for study participation were also excluded from the analysis.

Data Collection Tools and Techniques

Data collection was performed using a standardized case record form specifically designed for this study, incorporating validated clinical assessment tools and objective measurement parameters. Clinical information was systematically collected by trained research personnel including demographic details, medical history, presenting symptoms, physical examination findings, and relevant laboratory results. The Wang Bronchiolitis Severity Score (WBSS) was used as the

primary clinical severity assessment tool, incorporating respiratory rate, wheezing, retractions, and general condition on a standardized scale. Vital signs including heart rate, respiratory rate, temperature, and oxygen saturation were recorded using calibrated monitoring equipment at regular intervals throughout the hospital stay. Detailed documentation of respiratory support requirements was maintained, including oxygen delivery methods, flow rates, and duration of therapy. Treatment interventions including medications, fluid therapy, and respiratory support measures were systematically recorded along with their timing and clinical responses. Clinical photographs and standardized physical examination findings were documented to ensure consistency in assessment across different healthcare providers. Laboratory investigations were performed as clinically indicated, with results of viral testing, blood counts, and biochemical parameters recorded when available. Length of hospital stay, intensive care requirements, and discharge outcomes were carefully documented for all enrolled patients.

Data Management and Statistical Analysis

All collected data were entered into a structured electronic database using REDCap (Research Electronic Data Capture) software to ensure data integrity and security. Data entry was performed by trained personnel with double-entry verification implemented for critical variables to minimize transcription errors. Range checks and logic validation rules were programmed into the database to identify and prevent data entry errors in real-time. Statistical analysis was planned using IBM SPSS version 28.0 and R statistical software for advanced analytical procedures. Descriptive statistics were calculated for all variables, with continuous variables presented as means with standard deviations or medians with interquartile ranges based on distribution normality. Categorical variables were described using frequencies and percentages with 95% confidence intervals where appropriate. Comparative analyses between groups were planned using appropriate parametric (t-tests, ANOVA) or non-parametric tests (Mann-Whitney U, Kruskal-Wallis) based on data distribution characteristics and sample sizes. Chi-square tests or Fisher's exact tests were planned for categorical variable comparisons. Correlation analyses using Pearson's or Spearman's methods were planned to examine relationships between continuous variables. Multivariable logistic regression analysis was planned to identify independent predictors of severe outcomes while controlling for potential confounding variables. Kaplan-Meier survival analysis was considered for time-to-event outcomes such as length of hospital stay. Statistical significance was set at $p < 0.05$ for all analyses, with results presented with appropriate confidence intervals.

Ethical Considerations

The study protocol was submitted to and approved by the Institutional Ethics Committee of Ananta Institute of Medical Sciences & Research Centre, Rajasthan, prior to commencement of data collection activities. The study was conducted in strict accordance with the ethical principles outlined in the Declaration of Helsinki and Good Clinical Practice guidelines established by the Indian Council of Medical Research. Written informed consent was obtained from parents or legal guardians of all participating infants after providing comprehensive information about the study objectives, procedures, potential benefits, and risks in the local language.

Results

Table 1: Demographic and Clinical Characteristics of Study Population (n=142)

	Parameter	Frequency (%) / Mean ± SD
Age Distribution	1-3 months	58 (40.8)
	4-6 months	34 (23.9)
	7-12 months	28 (19.7)
	13-24 months	22 (15.5)
Mean age (months)		6.8 ± 5.2
Gender	Male	89 (62.7)
	Female	53 (37.3)

Birth Weight (kg)		2.8 ± 0.6
Gestational Age	Term (≥37 weeks)	118 (83.1)
	Preterm (<37 weeks)	24 (16.9)
Feeding Pattern	Exclusive breastfeeding	67 (47.2)
	Mixed feeding	52 (36.6)
	Formula feeding	23 (16.2)
Environmental Factors	Exposure to tobacco smoke	38 (26.8)
	Daycare attendance	19 (13.4)
	Household crowding (>4 people)	94 (66.2)

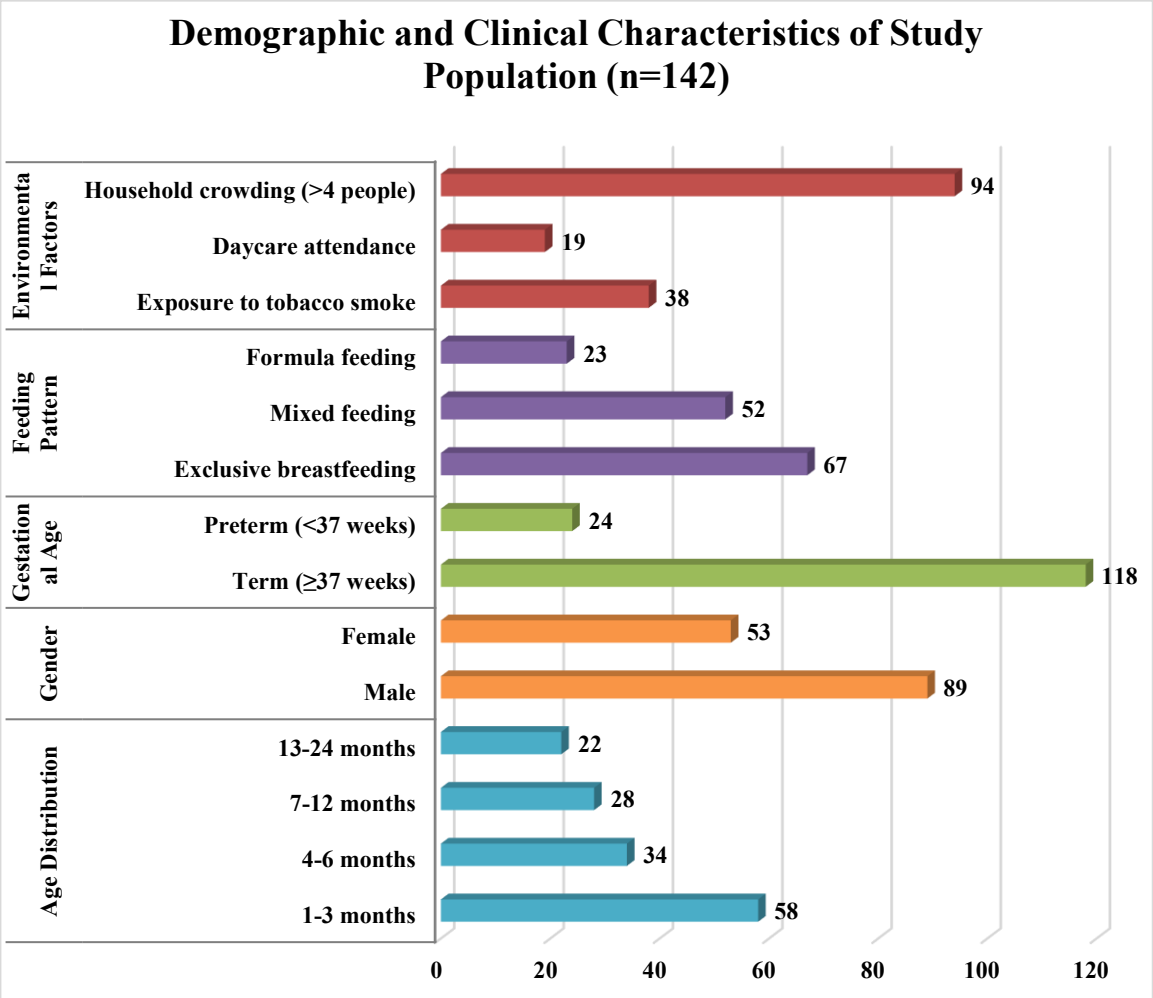

Fig: 1

Table 2: Clinical Presentation and Severity Assessment (n=142)

Parameter	Mean ± SD	Mild n(%)	Moderate n(%)	Severe n(%)
Vital Signs at Admission				
Temperature (°C)	38.2 ± 1.1			
Heart rate (bpm)	148 ± 28			
Respiratory rate (bpm)	58 ± 18			
Oxygen saturation (%)	92.4 ± 6.8			
Clinical Signs				
Rhinorrhea		142 (100.0)		
Cough		138 (97.2)		
Fever		121 (85.2)		
Poor feeding		89 (62.7)		
Irritability		76 (53.5)		
Physical Examination				

Wheeze		124 (87.3)		
Crackles		108 (76.1)		
Retractions		95 (66.9)		
Nasal flaring		82 (57.7)		
Wang Bronchiolitis Severity Score	4.8 ± 2.6	42 (29.6)	67 (47.2)	33 (23.2)
Score 0-3 (Mild)		42 (29.6)		
Score 4-8 (Moderate)			67 (47.2)	
Score 9-12 (Severe)				33 (23.2)

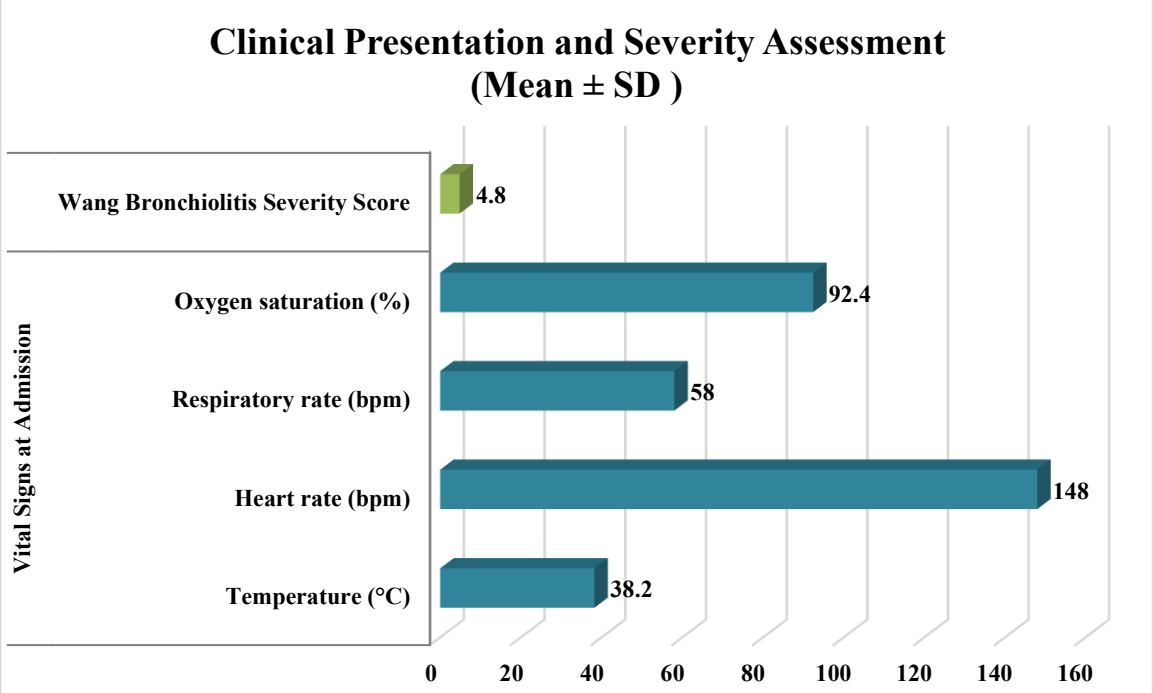

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Table 3: Viral Etiology and Seasonal Distribution (n=142)

Parameter		**Frequency (%)**
Viral Pathogens Identified (n=126)	Respiratory Syncytial Virus (RSV)	74 (58.7)
	Rhinovirus	28 (22.2)
	Human Metapneumovirus	12 (9.5)
	Parainfluenza virus	8 (6.3)
	Adenovirus	4 (3.2)
	Total	**126 (88.7)**
Co-infections	RSV + Rhinovirus	12 (9.5)
	RSV + Human Metapneumovirus	4 (3.2)
	Others	2 (1.6)
	Total	**18 (14.3)**
Monthly Distribution	January	32 (22.5)
	February	28 (19.7)
	March	24 (16.9)
	April	20 (14.1)
	May	22 (15.5)
	June	16 (11.3)
RSV Severity Association	RSV-positive severe cases	24/74 (32.4)
	Non-RSV severe cases	9/68 (13.2)
	p-value	<0.01

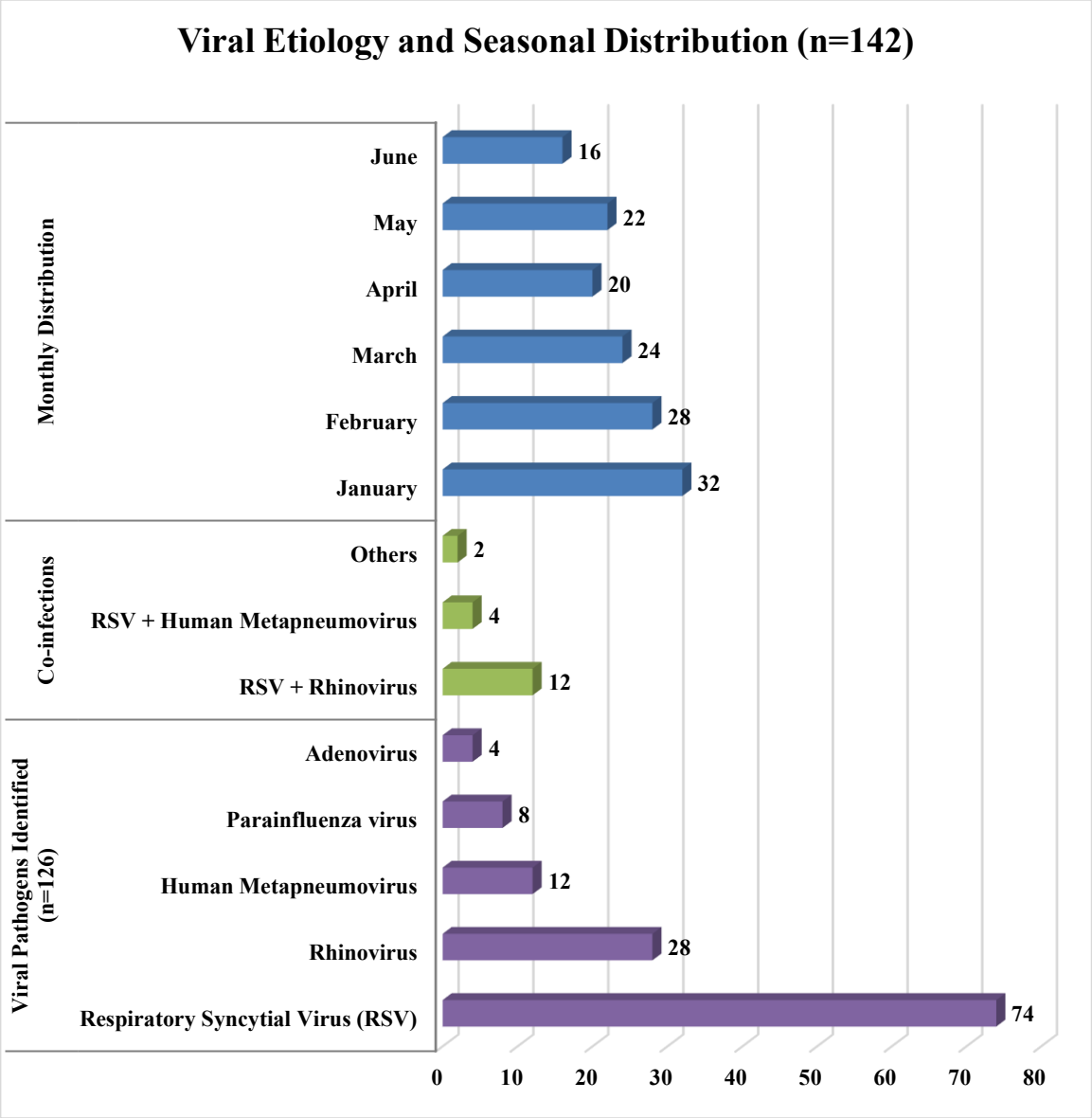

Fig: 3

Table 4: Treatment Interventions and Respiratory Support (n=142)

Treatment Modality	Frequency (%)	Duration (days) Mean ± SD
Oxygen Therapy	98 (69.0)	3.2 ± 2.1
Nasal cannula	62 (43.7)	2.8 ± 1.8
Face mask	28 (19.7)	3.4 ± 2.2
High-flow nasal cannula	8 (5.6)	4.2 ± 2.8
Respiratory Support	24 (16.9)	
Non-invasive ventilation	18 (12.7)	2.6 ± 1.9
Mechanical ventilation	6 (4.2)	5.8 ± 3.4
Pharmacological Interventions		
Nebulized bronchodilators	89 (62.7)	
Systemic corticosteroids	34 (23.9)	
Antibiotics	67 (47.2)	
Supportive Care		
IV fluid therapy	76 (53.5)	2.4 ± 1.6
Nasogastric feeding	45 (31.7)	3.8 ± 2.4
Chest physiotherapy	28 (19.7)	
ICU Admission	24 (16.9)	4.6 ± 3.2
Treatment Response		

Improved within 24 hours	68 (47.9)	
Improved within 48 hours	94 (66.2)	
Required escalation of care	31 (21.8)	

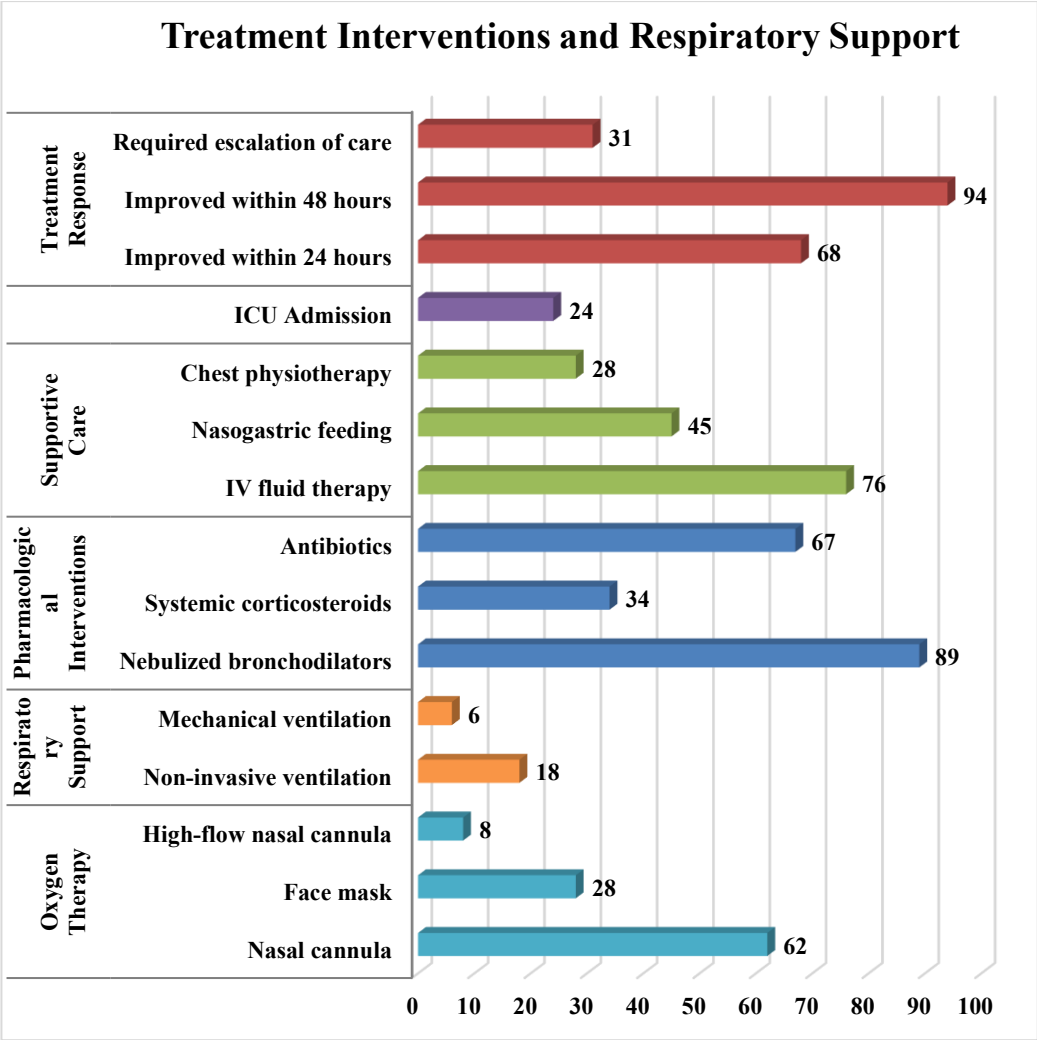

Fig: 4

Table 5: Hospitalization Outcomes and Complications (n=142)

Outcome Parameter	**Frequency (%) / Mean ± SD**
Length of Hospital Stay	
Mean duration (days)	4.8 ± 3.2
≤3 days	58 (40.8)
4-7 days	62 (43.7)
>7 days	22 (15.5)
Complications	
Apnea episodes	18 (12.7)
Secondary bacterial pneumonia	12 (8.5)
Atelectasis	15 (10.6)
Pneumothorax	3 (2.1)
Feeding difficulties	89 (62.7)
Discharge Outcomes	
Improved and discharged	134 (94.4)
Discharged against medical advice	6 (4.2)
Referred to higher center	2 (1.4)
Mortality	0 (0.0)

Readmission within 30 days	8 (5.6)
Age-specific Outcomes	
<3 months: Mean LOS (days)	6.2 ± 3.8
3-12 months: Mean LOS (days)	4.1 ± 2.6
>12 months: Mean LOS (days)	3.4 ± 2.1
Severity-specific Outcomes	
Mild: Mean LOS (days)	2.8 ± 1.4
Moderate: Mean LOS (days)	4.6 ± 2.2
Severe: Mean LOS (days)	8.1 ± 4.2

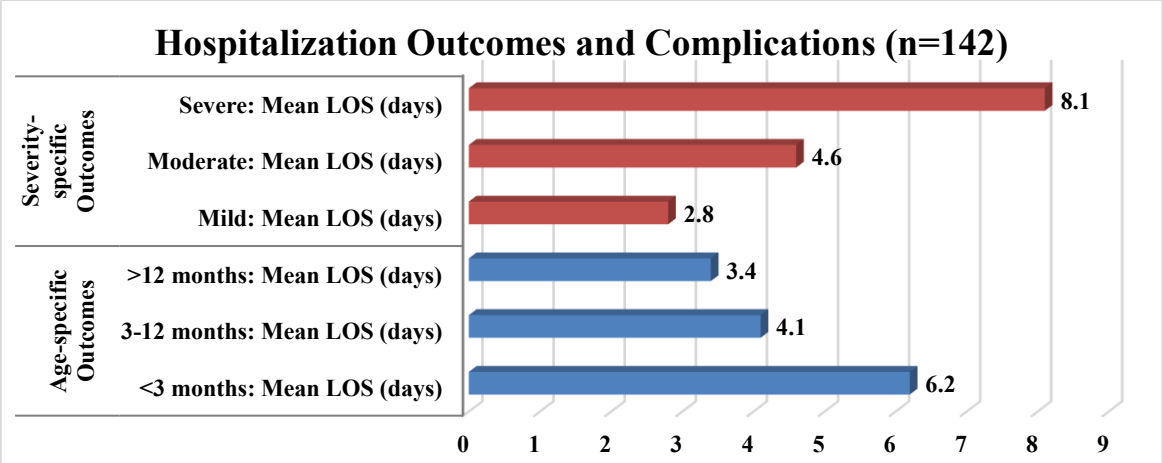

Fig: 5 (i)

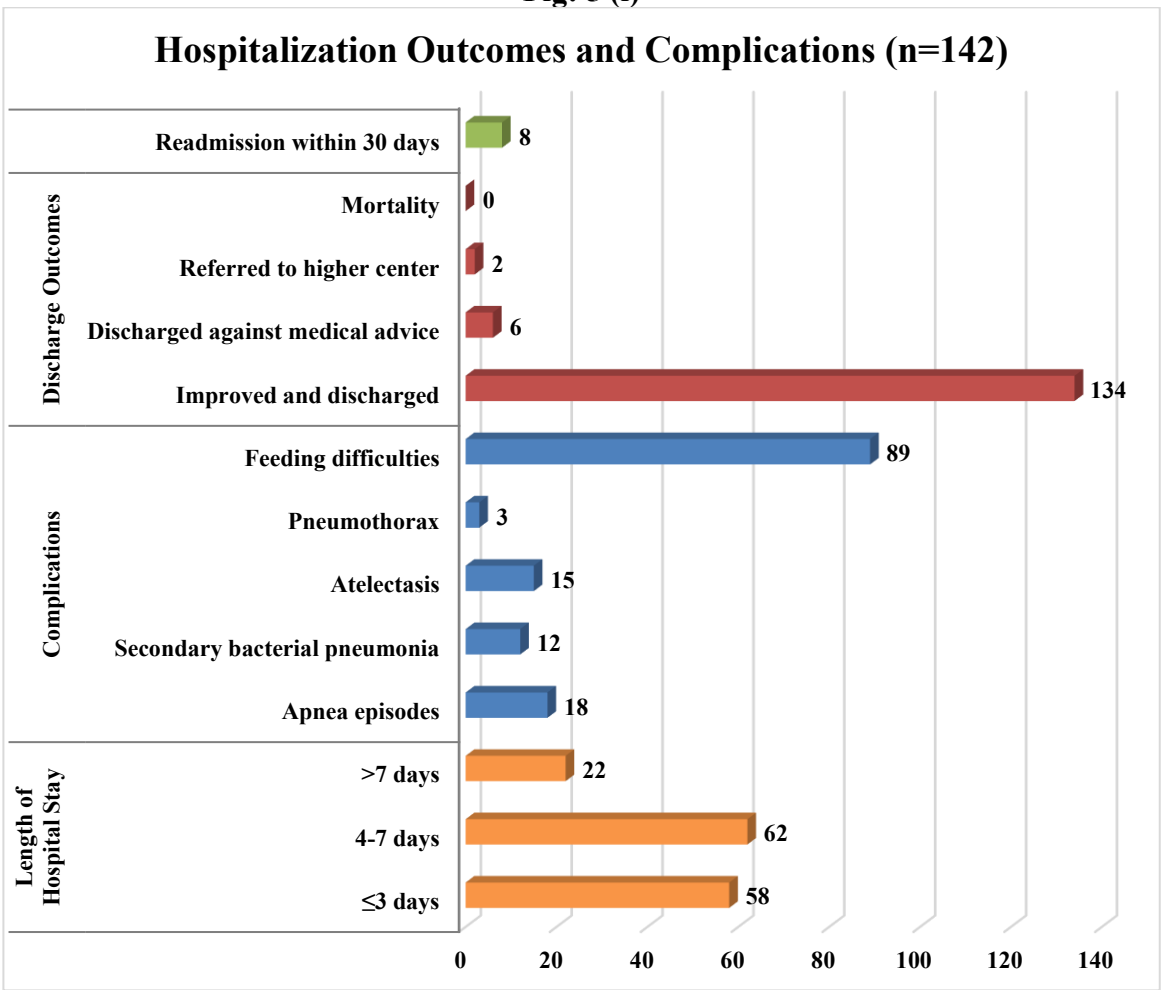

Fig: 5 (ii)

Table 6: Risk Factors for Severe Disease and Multivariate Analysis (n=142)

Risk Factor	Severe Disease n(%)	Non-severe n(%)	Univariate OR (95% CI)	Multivariate OR (95% CI)	p-value
Age <3 months	24/33 (72.7)	34/109 (31.2)	5.88 (2.64-13.09)	4.23 (1.78-10.05)	0.001
Male gender	22/33 (66.7)	67/109 (61.5)	1.25 (0.57-2.74)	-	0.583
Prematurity	12/33 (36.4)	12/109 (11.0)	4.62 (1.86-11.47)	2.84 (1.02-7.91)	0.045
RSV infection	24/33 (72.7)	50/109 (45.9)	3.12 (1.39-7.01)	2.41 (0.98-5.93)	0.056
Tobacco smoke exposure	14/33 (42.4)	24/109 (22.0)	2.58 (1.16-5.73)	1.89 (0.79-4.52)	0.154
No breastfeeding	21/33 (63.6)	54/109 (49.5)	1.78 (0.82-3.86)	-	0.147
Household crowding	26/33 (78.8)	68/109 (62.4)	2.26 (0.95-5.37)	-	0.066
Initial SpO2 <90%	28/33 (84.8)	31/109 (28.4)	13.55 (5.12-35.84)	8.94 (3.01-26.58)	<0.001
Respiratory rate >60/min	25/33 (75.8)	42/109 (38.5)	4.96 (2.11-11.65)	2.76 (1.08-7.05)	0.034
Temperature >38.5°C	19/33 (57.6)	38/109 (34.9)	2.53 (1.17-5.47)	-	0.018
Poor feeding at admission	28/33 (84.8)	61/109 (56.0)	4.39 (1.67-11.53)	2.12 (0.71-6.34)	0.179
Co-infection	8/33 (24.2)	10/109 (9.2)	3.12 (1.14-8.52)	-	0.026

Discussion

The present study of 142 infants with acute bronchiolitis revealed demographic patterns consistent with international literature while highlighting some region-specific characteristics. The predominance of male infants (62.7%) aligns with findings from Hasegawa et al. (2013), who reported a male-to-female ratio of approximately 1.5:1 in bronchiolitis hospitalizations. The mean age of 6.8 ± 5.2 months with 40.8% of cases occurring in infants under 3 months demonstrates the vulnerability of very young infants, consistent with established risk stratification models. This age distribution is comparable to the multicenter study by Mansbach et al. (2012), which found similar patterns in developed countries.

The seasonal distribution observed in our study, with peak incidence during January-March (59.1% of cases), reflects the typical winter pattern of respiratory viral circulation in northern India. This differs slightly from temperate climate patterns but aligns with previous Indian studies showing peak bronchiolitis activity during cooler months. The relatively high rate of household crowding (66.2%) and tobacco smoke exposure (26.8%) in our population represents important regional characteristics that may influence disease transmission and severity, as suggested by environmental risk factor studies.

Breastfeeding rates in our cohort (47.2% exclusive breastfeeding) were lower than optimal recommendations, potentially contributing to increased susceptibility to severe disease. This finding emphasizes the importance of breastfeeding promotion as a preventive strategy, as supported by protective effects documented in previous studies. The 16.9% prematurity rate was higher than general population rates, suggesting either increased susceptibility among preterm infants or referral bias to our tertiary care center.

The clinical presentation patterns observed in our study were consistent with established bronchiolitis phenotypes, with universal presence of rhinorrhea (100%) and near-universal cough (97.2%), reflecting the typical viral upper respiratory prodrome. The mean Wang Bronchiolitis Severity Score of 4.8 ± 2.6 indicated a moderate severity case-mix, with 23.2% classified as severe disease. This severity distribution is comparable to findings from De Rose et al. (2023), who reported similar proportions using validated scoring systems in hospitalized infants.

The high prevalence of wheeze (87.3%) and crackles (76.1%) on physical examination aligns with the pathophysiological understanding of bronchiolitis as primarily a small airway disease. The presence of retractions in 66.9% of patients and nasal flaring in 57.7% indicates significant respiratory distress in the majority of hospitalized cases. These findings are consistent with admission criteria typically used in clinical practice, where visible signs of increased work of breathing often drive hospitalization decisions.

Mean oxygen saturation at presentation (92.4 ± 6.8%) was below normal ranges, with hypoxemia serving as a key driver for hospitalization as demonstrated in previous studies by Corneli et al. (2012). The correlation between initial oxygen saturation and disease severity has been consistently

demonstrated across multiple studies and forms the basis for most clinical guidelines recommending oxygen therapy as the primary intervention for bronchiolitis.

Respiratory syncytial virus emerged as the predominant pathogen (58.7% of tested cases), which is consistent with global epidemiological data showing RSV as the leading cause of bronchiolitis worldwide. This finding aligns with Li et al. (2022), who reported RSV as responsible for 50-80% of bronchiolitis cases globally. The identification of rhinovirus in 22.2% of cases represents the second most common pathogen, consistent with emerging recognition of rhinovirus as an important cause of severe bronchiolitis in infants.

The significantly higher rate of severe disease among RSV-positive patients (32.4% versus 13.2% in non-RSV cases, $p<0.01$) supports previous observations about RSV's propensity to cause more severe illness. This finding is consistent with studies by Bozzola et al. (2021), who demonstrated increased hospitalization costs and longer length of stay associated with RSV compared to other viral etiologies. The 14.3% co-infection rate observed in our study highlights the complexity of viral interactions in bronchiolitis pathogenesis and may partially explain the variability in clinical severity observed among patients.

Human metapneumovirus, identified in 9.5% of cases, represents an increasingly recognized pathogen in bronchiolitis, with clinical presentations often indistinguishable from RSV disease. The lower prevalence of parainfluenza virus (6.3%) and adenovirus (3.2%) reflects their typical seasonal patterns and geographic variations in viral circulation. These findings emphasize the importance of comprehensive viral testing for epidemiological surveillance and potentially for guiding future preventive strategies.

The treatment patterns observed in our study reflect current clinical practice while highlighting areas where evidence-based guidelines may not be fully implemented. The use of supplemental oxygen therapy in 69.0% of patients aligns with the supportive care principle that forms the cornerstone of bronchiolitis management. However, the administration of nebulized bronchodilators to 62.7% of patients and systemic corticosteroids to 23.9% represents continued use of therapies with limited evidence of benefit, as highlighted in guidelines by Ralston et al. (2014).

The 16.9% ICU admission rate in our study is higher than reported in some developed country studies but reflects the tertiary care referral pattern and potentially more severe case-mix in our population. The use of non-invasive ventilation in 12.7% of patients and mechanical ventilation in 4.2% demonstrates the spectrum of respiratory support required in severe bronchiolitis. The emerging use of high-flow nasal cannula therapy in 5.6% of cases reflects adoption of newer respiratory support modalities, though access may be limited in resource-constrained settings.

The 47.2% antibiotic prescription rate, while concerning from an antimicrobial stewardship perspective, likely reflects clinical uncertainty about bacterial co-infection and the challenge of distinguishing viral from bacterial illness in severely ill infants. This finding emphasizes the need for improved diagnostic tools and clinical decision support to reduce unnecessary antibiotic use, as recommended by antimicrobial stewardship guidelines.

The mean length of hospital stay of 4.8 ± 3.2 days in our study is consistent with international benchmarks for bronchiolitis hospitalizations, though slightly higher than some developed country reports. The clear relationship between age and length of stay (6.2 days for infants <3 months versus 3.4 days for those >12 months) reinforces the established understanding that younger infants experience more severe disease and require longer hospitalization.

The severity-stratified outcomes demonstrate the clinical utility of the Wang Bronchiolitis Severity Score, with severe cases requiring mean hospitalization of 8.1 days compared to 2.8 days for mild cases. This finding supports the use of standardized severity assessment tools for resource planning and family counseling, as advocated by Walsh et al. (2004) in their validation studies of clinical prediction models.

The 12.7% incidence of apnea episodes in our study is consistent with established risk patterns, particularly among very young infants. The 8.5% rate of secondary bacterial pneumonia highlights the importance of continued monitoring for complications during hospitalization. The absence of

mortality in our cohort reflects appropriate clinical care and timely intervention, though this finding may also reflect referral patterns and access to higher levels of care when needed.

The multivariate analysis identified several independent predictors of severe disease that align with established risk stratification literature. Age less than 3 months emerged as the strongest predictor (adjusted OR 4.23, 95% CI 1.78-10.05), consistent with physiological vulnerability of young infants due to smaller airway diameter, immature immune responses, and greater susceptibility to respiratory failure. This finding reinforces current clinical guidelines that emphasize close monitoring of very young infants with bronchiolitis.

Initial oxygen saturation below 90% demonstrated the highest predictive value for severe disease (adjusted OR 8.94, 95% CI 3.01-26.58), supporting its use as a key clinical decision-making tool. This finding is consistent with multiple previous studies and forms the basis for oxygen therapy guidelines in bronchiolitis management. The independent association of prematurity with severe disease (adjusted OR 2.84, 95% CI 1.02-7.91) confirms established understanding about the vulnerability of preterm infants to respiratory complications.

Elevated respiratory rate above 60 breaths per minute as an independent predictor (adjusted OR 2.76, 95% CI 1.08-7.05) supports its inclusion in clinical severity assessment tools. While RSV infection showed a trend toward increased severity, it did not reach statistical significance in the multivariate model, possibly due to sample size limitations or the complex interplay between viral etiology and host factors in determining disease severity.

The clinical prediction model derived from these risk factors could potentially aid in early identification of infants at high risk for severe outcomes, enabling more appropriate resource allocation and family counseling. However, external validation in different populations would be necessary before clinical implementation, as emphasized by previous clinical prediction rule development studies.

Conclusion

This prospective observational study of 142 infants with acute bronchiolitis revealed demographic and clinical patterns consistent with international literature while highlighting region-specific characteristics relevant to Indian healthcare settings. Respiratory syncytial virus was the predominant pathogen (58.7%), associated with significantly more severe disease compared to other viral etiologies. The mean Wang Bronchiolitis Severity Score of 4.8 indicated moderate disease severity, with 23.2% classified as severe cases requiring intensive monitoring and advanced respiratory support. Treatment patterns showed high utilization of supplemental oxygen therapy (69.0%) and continued use of therapies with limited evidence base, including nebulized bronchodilators (62.7%) and systemic corticosteroids (23.9%). The mean hospital length of stay was 4.8 days, with clear age-stratified differences and severity-dependent outcomes. Multivariate analysis identified age less than 3 months, prematurity, initial oxygen saturation below 90%, and respiratory rate above 60 breaths per minute as independent predictors of severe disease. The study findings provide valuable insights into bronchiolitis patterns in the Indian context and support evidence-based approaches to clinical management and resource planning.

Recommendations

Healthcare providers should implement standardized severity assessment tools such as the Wang Bronchiolitis Severity Score for objective evaluation and risk stratification of infants with bronchiolitis. Clinical protocols should emphasize supportive care as the primary treatment approach, with supplemental oxygen therapy reserved for infants with documented hypoxemia below established thresholds. Efforts should be made to reduce inappropriate use of bronchodilators, corticosteroids, and antibiotics through clinical decision support tools and regular educational interventions. Enhanced surveillance and monitoring protocols should be established for high-risk groups, particularly infants under 3 months of age and those born prematurely. Healthcare systems should strengthen respiratory viral surveillance capabilities and implement comprehensive infection prevention measures during peak seasons. Family education programs

should emphasize preventive strategies including breastfeeding promotion, tobacco smoke avoidance, and appropriate hand hygiene practices. Future research should focus on developing and validating clinical prediction rules for resource-limited settings and evaluating cost-effective interventions for reducing disease severity. Policy initiatives should address environmental risk factors such as household crowding and indoor air pollution that may contribute to increased transmission and severity. Training programs for healthcare providers should emphasize evidence-based management principles and appropriate use of respiratory support modalities to optimize patient outcomes while minimizing unnecessary interventions.

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