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Factors predicting length of stay in bronchiolitis

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ABSTRACT

Introduction: Despite advances in medical knowledge, the treatment of viral bronchiolitis is mainly supportive. Antiviral therapies are being investigated in clinical trials. Identifying population-attributable risk factors for RSV hospitalization may help prioritizing targeted treatment.
Aim: To utilize MDClone, a data acquisition tool, to examine factors associated with the risk of hospitalization and length of stay (LOS) in bronchiolitis.
Methods: A single tertiary medical center retrospective study. Infants discharged with a diagnosis of bronchiolitis between January 2001 and March 2019 were included. Demographic, clinical, laboratory, microbiologic parameters and co-morbidities were collected. Correlations with the risk of hospitalization and LOS were examined.
Results: A total of 4793 infants with bronchiolitis, 3851 (80.3%) previously healthy, were seen; 975 visited emergency room only; 3311 were hospitalized in pediatric wards and 507 required pediatric intensive care unit. O_2 saturation, age and fever correlated with the risk of hospitalization (OR = 0.703, $p < 0.0001$, OR = 0.4, $p = 0.024$ and OR = 2.388, $p < 0.0001$, respectively). Saturation, fever, gestational age and birth weight correlated with LOS (r = −0.283, $p = 0.000$; r = 0.16, $p = 0.000$; r = −0.12, $p = 0.00$; and r = −0.117, $p = 0.00$, respectively). Rates of hospitalization were higher (81.1% vs. 75.6%, $p = 0.0008$) and LOS was longer (median 2.97 vs. 2.73 days, $p < 0.001$) in Arabs than in Jews. In a multivariate model, saturation, fever, gestational age and age predicted LOS. Saturation and ethnicity predicted LOS for previously healthy infants. Prematurity and cardiac anomalies increased LOS ($p = 0.016$ and $p < 0.0001$, respectively).
Conclusions: Population-based data may enable predicting disease severity and LOS in bronchiolitis. Focusing on children at greatest risk may aid targeting new therapies.

1. Introduction

Viral bronchiolitis is one of the most common causes of lower respiratory tract infection among children less than two years of age [1] and the most common reason for hospitalizing young infants in the winter season [2]. The diagnosis of bronchiolitis is a clinical one: difficulty breathing, coryza, cough, wheeze and crepitations on chest auscultation. The disease is associated with viral infection. Respiratory syncytial virus (RSV) accounts for 50–80% of cases and was reported as associated with more severe disease [3]. It has a seasonal pattern, with the highest incidence in the winter months [4].

Despite the considerable burden of this disease, treatment is mainly supportive. Due to the paucity of evidence-based therapies and no clear guidelines, there is marked variability in the acute management of these children. Clinicians continue to struggle with finding predictors for the disease course, which can aid in determining the appropriate level of care.

Apart from health-related issues, prolonged hospital length of stay (LOS) is associated with a substantial economic and emotional burden. The cost of more days in hospital, the loss of working days for the parents, as well as the anxiety concerning the child's condition may have long-term consequences. Several clinical, epidemiologic and demographic factors have been associated with the disease severity and length of stay (LOS). Clinical factors on admission, such as young age [5], high clinical severity score [6], presence of hypoxia [7] or apnea [8] have been associated with prolonged LOS. RSV was found to be

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associated with more severe disease [3]. Multiple viral infections were found to be associated with more severe disease in some studies [9] but not in others [10].

Demographic factors, such as lower birth weight and prematurity [11], family history of atopy, maternal smoking, lack of breastfeeding [12] and crowding have also been associated with increased rates of hospitalization and prolonged LOS.

Laboratory findings have been investigated as possible predictors or LOS and disease severity. Hyponatremia (blood sodium levels <135 mmol/L) is common among patients with respiratory infections, and was associated with higher severity of disease in children with bronchiolitis admitted to the Pediatric Intensive Care Unit (PICU) [13]. Additionally, children with higher C-Reactive Protein (CRP) values had higher admission rates to the PICU, longer LOS and higher duration of need for supplemental oxygen [14].

In recent years, a tremendous effort has been made in developing new treatments targeting RSV in clinical trials. These treatments focus on preventing viral fusion with host cells or inhibiting virus replication. Some target RSV epitopes like the F protein, some aim for RNA chain termination, while others small interfering RNAs downregulate viral protein production. These new treatments will hopefully offer clinicians new therapeutic options in an era of supportive treatment [15]. For this, there is a need for larger studies to better define risk factors for disease severity and LOS. Once these therapies become available, they will possibly allow tailored treatment and define target populations with a more severe disease course.

Recent advances in the field of data acquisition from medical records (Big-Data), and the development of data acquisition platforms, have allowed easy and quick retrieval of large amounts of data from routinely used medical records. These platforms provide a unique way to retrieve retrospective data on a large number of patients in a quick and computerized method. Our tertiary medical center provides health services for Northern Israel (1.5 million people). A new platform, MDClone, was recently developed and adopted. Thus, our aim was to take advantage of our large inpatient database to find factors associated with the risk of hospitalization in infants with acute bronchiolitis and with LOS in our population of hospitalized infants.

2. Methods

2.1. Study design

This was a retrospective single center study. The study was approved by the institutional review board. We included all children below the age of two years visiting our medical center between January 2001 (the time at which the electronic health record was introduced) and March 2019, with the first episode of ICD-10 diagnosis of acute bronchiolitis on date of discharge.

Data was collected from the patients' files using MDClone, a data extraction and synthetization platform that provides patient level data around an index event (http://www.mdclone.com), recently used in a study by Gorelik et al. [16]. The data included the following variables:

- Demographics - gender, age on admission, ethnicity (Arab or Jew)
- Gestational age at birth, delivery type (caesarean or vaginal delivery), birth weight
- Clinical data – minimal (min) oxygen (O_2) saturation (O_2 Sat.), maximal (max.) body temperature (in degrees Celsius, °C)
- Laboratory data - continuous variables: sodium blood levels, partial pressure of CO_2 (PCO_2) and PH in blood gases, urea levels, white blood cells (WBC) count, CRP levels; categorical variables: presence of hyponatremia <135 mEq (yes/no), presence of leucocytosis (yes/no)
- Microbiologic data - RSV, Parainfluenza, Influenza A, Influenza B, Human Metapneumovirus (HMPV), Adenovirus
- Co-morbidities - prematurity (birth prior to 37 weeks of gestation), congenital heart anomaly and respiratory disease of the newborn including respiratory distress syndrome (RDS) and transient tachypnea of the newborn (TTN)

We included infants who visited our emergency room (ER) without admission (ER group); infants who were admitted to a pediatric ward (Peds group), and infants who required admission to PICU on presentation or anytime during their admission (PICU group). The ER group was compared to the Peds group for factors predicting risk of hospitalization, and the Peds group was analyzed for factors predicting LOS.

2.2. Statistical methods

The primary outcome was defined as length of stay – LOS. The secondary outcome was defined as risk of hospitalization. Statistical analysis was performed using SPSS version 25. The results are presented as mean ± SD or median with interquartile range (IQR) and percentages. Differences between groups (PICU, Peds and ER) for the quantitative parameters were analyzed by ANOVA or Kruskal Wallis tests with adjustment for multiple comparisons. Chi square tests were used for differences between groups for the categorical parameters. Pearson and Spearman's rho correlations were used to test the relationships between different predictors and LOS. Linear regression with the stepwise method were used to predict the LOS of the patients. Logistic regression model with forward methods was used to predict the risk of hospitalization.

LOS was also analyzed also for previously healthy children (GA>37 weeks, excluding any co-morbidities: chronic lung, cardiac, neuromuscular, metabolic diseases, immune deficiencies, and renal or hepatic insufficiency).

A value of $p < 0.05$ was considered as significant.

3. Results

From January 2001 until March 2019, a total of 4793 infants visited our medical center with a diagnosis of bronchiolitis at discharge. Of them, 975 visited the ER only (ER group), 3311 were hospitalized in the pediatric ward (Peds group) and 507 also required admission to the PICU (PICU group). Fig. 1 presents the number of children and median LOS per year. As can be seen, the LOS did not change significantly during these years, and mostly remained in the range of 2.5–3 days.

Table 1 presents the demographic and clinical characteristics of the patients, their co-morbidities and birth and delivery data (when available). As expected, the median LOS was longer in the PICU group compared to the Peds group [4.9 (2.7–9.4) vs. 2.75 (1.7–4.5) days, respectively; $p < 0.0001$]. Infants in the PICU group were younger, with a lower proportion of males compared to the ER group. The O_2 sat. in the PICU and Peds groups was lower than in the ER discharged group (90.1 ± 6.7 and 90.1 ± 6.2 vs. 94.9 ± 3.5, respectively; $p < 0.001$). Fever was highest in the Peds group and lowest in the ER group (38.1 ± 0.92 and 37.5 ± 0.92, respectively; $p < 0.0001$).

Data on ethnicity was available for 3079 patients. The proportion of Jews was highest in the ER group and lowest in the PICU group (72.6%, 67.2% and 57.3%, in the ER, Peds and PICU groups, respectively).

The co-morbidities of the patients are also presented in Table 1. As can be seen, most infants were previously healthy (3851 patients, 80.3%); as expected, their proportion was highest in the ER group (85.8%, 80.8% and 66.9% in the ER, Peds and PICU groups, respectively). Prematurity and cardiac anomalies were most prevalent in the PICU group [116 cases (23%) and 64 cases (13%), respectively].

Birth weight was lowest in the PICU group and highest in the ER group (3000 ± 650 and 3144 ± 604 g, respectively; $p = 0.041$).

Table 2 presents a multivariate model to predict the risk of hospitalization for patients presenting to the ER with bronchiolitis. The parameters included in the analysis were age, gender, ethnicity, O_2 sat.,

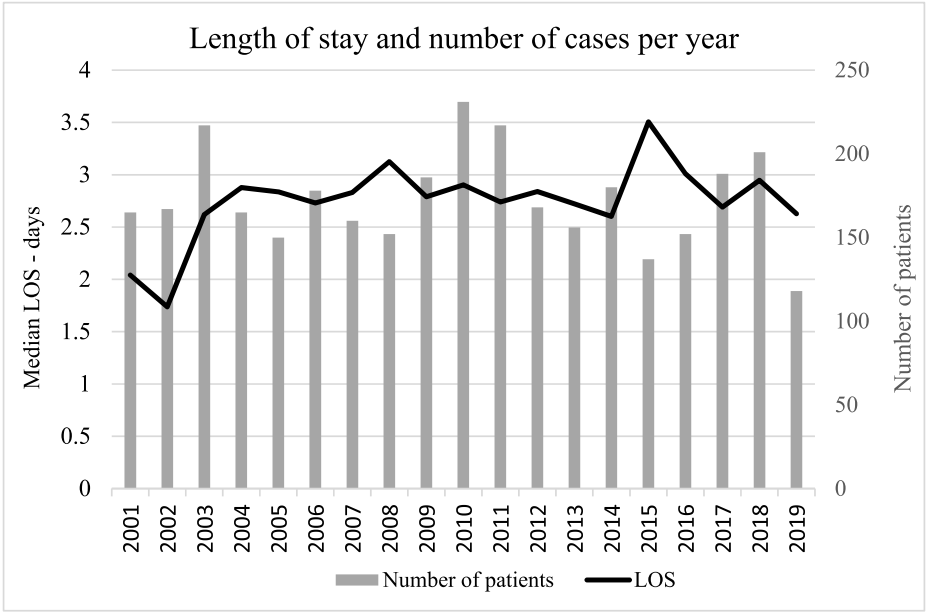

Fig. 1. Length of stay and number of cases per year.

Table 1
Patient characteristics.

	PICU n = 507	Peds n = 3311	ER n = 975	*P* value
LOS – days, median (IQR)	4.9 (2.7–9.4)	2.75 (1.7–4.5)	–	<0.0001
Age (years)	0.4 ± 0.37	0.47 ± 0.41	0.58 ± 0.39	<0.0001[1,2,3]
Gender, male	285 (56.2%)	1930 (58.3%)	607 (62.3%)	0.038[2]
O_2 sat. (min.)	90.1 ± 6.7	90.1 ± 6.2	94.9 ± 3.5	<0.0001[2,3]
Fever (max.)	37.8 ± 0.91	38.1 ± 0.92	37.5 ± 0.92	<0.0001[1,2,3]
Ethnicity	**(n = 3068)**			
Jews (%)	197 (57.3%)	1371 (67.2%)	505 (72.6%)	<0.0001[1,2,3]
Co-morbidities				
None	339 (66.9%)	2675 (80.8%)	837 (85.8%)	<0.001[1,2,3]
Prematurity	116 (23%)	330 (10%)	91 (9%)	<0.001[1,2]
Cardiac	64 (13%)	297 (9%)	31 (3%)	<0.001[1,2,3]
Respiratory	21 (4.1%)	137 (4.1%)	36 (3.7%)	0.82
Birth and delivery	**(n = 1828)**			
Gestational age	38.1 ± 2.8	38.3 ± 2.6	38.6 ± 2.2	0.026[3]
Birth weight (gr)	3000 ± 650	3082 ± 673	3144 ± 604	0.041[2]
Type of delivery				0.69
Spontaneous	96 (61.9%)	662 (61.3%)	376 (63.6%)	
CS	48 (31.0%)	362 (33.5%)	182 (30.8%)	
Vacuum	11 (7.1%)	56 (5.2%)	33 (5.6%)	

Values are presented as mean ± SD (unless otherwise specified).
PICU = intensive care unit; Peds = pediatric ward; ER = emergency room; [1] = PICU vs, Peds; [2] = PICU vs. ER; [3] = Peds vs. ER; LOS = length of stay; IOR = interquartile range; O_2 sat = oxygen saturation; min = minimal; max = maximal; gr = grams; CS=Caesarean-section.

fever, gestational age and a positive result for any virus. As can be seen, low age, low O_2 sat. or high fever increased the risk of hospitalization (OR = 0.4, 95% CI 0.180–0.188, $p = 0.024$, OR = 0.703, 95% CI 0.647–0.763, $p = 0.000$ and OR = 2.388, 95% CI 1.713–3.328, $p = 0.000$ for age, O_2 Sat. and fever, respectively).

Table 3 presents the correlation between several demographic and clinical parameters and LOS in the Peds group. As can be seen, O_2 sat., gestational age and birth weight were negatively correlated with LOS (r = −0.283, $p = 0.000$, r = −0.12, $p = 0.000$, r = −0.117, $p = 0.000$, respectively), while fever was positively correlated with LOS (r = 0.16, $p = 0.000$). Sodium levels had a weak correlation with LOS (r = 0.061, p = 0.028).

For the categorical parameters, we found that the Arab patients had a longer median LOS than the Jewish patients [2.98 (IQR 1.75–5.01) vs. 2.73 (IQR 1.67–4.1) days, respectively; ($p < 0.001$). Gender, type of

Table 2
Prediction of risk of hospitalization.

	p value	OR	95% CI for OR	
			Lower	Upper
Age	0.024	0.400	0.180	0.888
Gender	0.139	1.584	0.862	2.910
Ethnicity	0.258	1.508	0.74	3.072
O_2 sat (min.)	0.000	0.703	0.647	0.763
Fever (max.)	0.000	2.388	1.713	3.328
Gestational age	0.710	0.980	0.881	1.090
Any virus positive	0.890	1.054	0.502	2.213

OR = odds ratio; CI = confidence interval; min = minimal; max = maximal.

Table 3
Correlations with LOS.

	r	*p* value
Age (n = 3311)	−0.031	0.073
O_2 Sat (min.) (n = 2482)	−0.283	0.000
Fever (max.) (n = 1873)	0.16	0.000
Sodium (n = 1270)	0.061	0.028
PCO_2 (n = 286)	0.055	0.355
pH (n = 286)	0.017	0.77
Urea (n = 950)	−0.017	0.592
CRP (n = 510)	−0.005	0.904
WBC (n = 1473)	−0.009	0.734
Gestational age (n = 1080)	−0.12	0.000
Birth weight (gr.) (n = 1079)	−0.117	0.000

LOS = length of stay; Min = minimal; max. = maximal; PCO_2 = partial pressure of CO_2; CRP=C-reactive protein; WBC = white blood cell count; gr. = grams. The number after each parameter states the number of patients for whom the parameter was known.

delivery, hyponatremia (yes/no) and presence of leucocytosis (yes/no) were not correlated with LOS.

In the analysis of the co-morbidities, prematurity and cardiac anomalies were found to be correlated with LOS [median LOS 2.88 (IQR 1.75–4.89) vs. 2.74 (IQR 1.67–4.43) days in patients born prematurely, $p = 0.016$; median LOS 4.04 (IQR 2.08–7.62) vs. 2.68 (IQR 1.66–4.14) days in patients with cardiac anomalies, $p < 0.0001$]. Moreover, there was a linear correlation between the number of co-morbidities and LOS [median LOS 3.71 (IQR 2.16–5.35) vs. 2.65 (IQR 1.64–4.07) days with three vs. no co-morbidities, respectively; r = 0.143, $p < 0.0001$].

Microbiologic data was available for 1996 (41.6%) patients; 184/280 (65.7%), 1025/1321 (77.6%) and 318/395 (80.5%) samples were positive in the PICU, Peds and ER groups, respectively. The most common isolated virus was RSV, present in 166/276 (60.1%), 893/1301 (68.6%) and 293/390 (75.1%) samples in the PICU, Peds and ER groups, respectively ($p = 0.007$ for PICU vs. Peds; $p < 0.0001$ for PICU vs. ER: $p = 0.014$ for Peds vs. ER). Adenovirus, HMPV, Parainfluenza, Influenza A and Influenza B were positive in much smaller proportions [163/1584 (10.3%), 84/1114 (7.5%), 61/1544 (4%), 48/1553 (3.1%) and 12/1262 (1%), respectively]. For the Peds group, there was no significant correlation between the presence of each of the viruses and LOS, nor a correlation between the presence of any positive virus or the number of positive viruses (one versus two or more positive viruses) and LOS.

In the multivariate model for prediction of LOS in the Peds group, 3280 patients were included, and 31 patients (0.9%) with very long LOS (>20 days) were excluded. The parameters included were age, gender, ethnicity, fever, O_2 sat., sodium, co-morbidities and gestational age. Of these, four parameters were found to predict LOS: O_2 sat., fever, gestational age and current age. The formula developed to predict LOS: LOS = 8.247+[-0.198* O_2 Sat (%, min.)]+[0.497* fever (°C, max.)]+[-0.148* gestational age (weeks)]+[-0.738* age (years)].

For example, a patient born at 38 weeks of gestation presents at age one year with fever 38 °C and O_2 Sat. of 98%. According to the model, he is expected to stay for 1.367 days; if the same patient would present with a lower sat., 92%, he would be expected to be hospitalized for 2.56 days.

The multivariate model for previously healthy infants yielded the following formula: LOS = 26.559+[-0.264* O_2 sat. (%, min.)+0.613*ethnicity (Arabs = 1, Jews = 0)]. Thus, for example, an infant with O_2 sat. of 98% and Arab ethnicity is expected to be hospitalized for 1.3 days; if he were Jewish, the LOS would be 0.68 days.

4. Discussion

In this single-center retrospective study, we used a data extraction and synthetization platform to evaluate 4793 infants with bronchiolitis, 80.3% of them previously healthy. We identified several readily available clinical variables associated with the risk of hospitalization and LOS in infants with acute bronchiolitis. Despite 19 years of advances in medical technologies, there has not been a substantial change in the treatment of bronchiolitis, and the LOS in our study cohort remained stable. Similarly, in other studies, median LOS was 2 days [3,17].

Notably, almost 80% of children referred to our ER were hospitalized. Of those hospitalized, 507 (13%) required PICU. In a large multicenter study (38 ERs), 261 of 2722 (9.6%) study infants received escalated care (defined by HFNC, noninvasive ventilation and mechanical ventilation) [18]. The high percentage of hospitalization, and more specifically the significant need for PICU, reflects the high burden of bronchiolitis.

While most hospitalizations due to bronchiolitis are in previously healthy children, most studies assessing LOS, severity score and new treatments focus on children with co-morbidities and/or prematurity. The significant morbidity in previously healthy infants underscores the need for new and effective treatments for bronchiolitis, and for studies addressing this population. A novel therapy that would change the course of bronchiolitis can potentially decrease the disease burden, with a significant positive impact, even at the population level.

In our study, Arab patients tended to be hospitalized more than Jewish patients in Pediatrics wards, and even more in PICU. The rate of admission for bronchiolitis was 81.1% for Arabs and 75.6% for Jews, $p = 0.0008$. Notably, the rate of hospitalization for all causes in our pediatric ER during these years was 24.8% for Arabs and 17.5% for Jews.

As expected, we found that low age, low O_2 sat. or high fever increased the risk of hospitalization. A previous study found five predictors of admission, which included age, respiratory rate, heart rate, oxygen saturations and duration of symptoms. These factors were incorporated into a bronchiolitis risk of admission scoring system, which demonstrated good diagnostic accuracy [19].

Based on the large database, we assessed factors associated with LOS in 3311 hospitalized children discharged with clinical bronchiolitis. We found that low O_2 saturation, gestational age and birth weight, as well as high fever, Arab ethnicity, prematurity and cardiac anomalies were associated with prolonged LOS. Rodríguez-Martínez et al. assessed 303 hospitalizations, and found that age, history of prematurity and low initial O_2 saturation predicted prolonged LOS (defined as five or more days) [20]. Ramos-Fernandez el al identified additional predictors of LOS, which included initial apnoea, poor feeding, and bacterial superinfections. Similar to our study, prematurity and low birth weight (defined as less than 2300 gr) also correlated with a longerLOS [21].

Ghazaly & Nadel investigated children admitted to intensive care with acute bronchiolitis. Similar to our study, prematurity and comorbidities were found to be significant risk factors for prolonged LOS. Compared to our study, RSV infection and co-infection also predicted LOS [22].In our cohort, Arab patients had longer median LOS than did Jewish patients. Although ethnicity was not available for all patients, we were able to analyze a large group of 3079 infants. A study from southern Israel showed a higher rate of RSV hospitalization in Arab Bedouin children (a small Arab minority), with a relative risk of 3.3 compared to Jews [23]. Arabs in Israel generally have a lower socioeconomic status than do Jews, and more than 50% of the Arab population lives under the national poverty line [24]. Slain et al. found that living in a poorer community (as expressed by a lower Federal Poverty Threshold) was significantly associated with longer PICU LOS, longer hospital LOS, higher odds of needing mechanical ventilation, and increased hospital charges in children with bronchiolitis [25].

In another study of 309 children, the annual incidence of RSV hospitalization was April 5, 1000 and August 6, 1000 among Arab and Jewish children, respectively. Disease severity did not differ between the two ethnic groups, based on a clinical parameters and length of hospitalization [26].

Higher rates of hospitalization and longer LOS in the Arab population, as found in our cohort, may be attributed to different patterns of utilization of health care services or referral and differences in socioeconomic status [27]. Cultural factors may also play a role, including perception of disease severity and willingness to remain under medical supervision for more time. Higher familial smoking rate, less breast-feeding, different genetic background and modifier genes may all contribute to these differences, but were not evaluated in the current study.

The higher total rate of hospitalization in the Arab patients in our ER implies that the differences found in our study may be attributed to ethnic differences, rather than to differences related specifically to bronchiolitis.

When analyzing co-morbidities, we found that prematurity and, more strikingly, cardiac anomalies were correlated with increased LOS. Since 1998, the American Academy of Pediatrics has recommended administration of Palivizumab for defined high-risk groups, mainly infants born prematurely and those with severe congenital heart disease (CHD) [18]. In 410 infants with positive viral cultures, bronchopulmonary dysplasia (OR 7.2), congenital heart disease (OR 4.7), prematurity (OR 2.6), and fever (OR 1.8) predicted severe clinical scores [28]. In a large retrospective cohort study, predictors of severe disease included age <6 months, prematurity, CHD and mixed RSV-adenovirus infection

[29].

Recently, a series of systematic reviews examined morbidity and mortality of severe RSV in premature infants and those with congenital heart or lung diseases. In those born prematurely, there was a negative correlation between gestational age and disease severity [30]. Infants with chronic lung disease had a higher risk of hospitalization (OR 2.2–7.2) and a longer LOS [31]. Similarly, children with CHD had a higher risk of hospitalization and a more severe course, with 53% requiring PICU [32].

Interestingly, the presence of any virus, including RSV, did not correlate with LOS, nor did the presence of more than one virus. Although there is a clear association between bronchiolitis and RSV (or other viral agents), there is no consensus in the literature regarding their correlation with LOS. RSV isolation was associated with a longer LOS compared to other viruses; moreover, co-infection with RSV plus human rhinovirus (HRV) resulted in a longer hospitalization compared to RSV alone [3]. Rodríguez-Martínez also found that RSV isolation correlated with a longer LOS [20]. In our large sample size, non-RSV bronchiolitis was more prevalent in the PICU group. Similar to our study, Brand et al. found no association between infection by multiple viruses and disease severity [10].

We present a predictive model for LOS based on our large database. We found that O_2 sat., fever, gestational age and current age were able to predict LOS. These predictive factors are readily available to the clinician, allowing easy prediction of LOS on presentation. Notably, neither co-morbidities nor laboratory studies are included in the model; this probably reflects the high proportion of previously healthy children. Weisgerber et al. developed a predictive model (The Milwaukee Model) based on information collected on day 2 of admission to predict short or prolonged LOS (defined as $\geq$108 h); the number of hours of supplemental oxygen, respiratory rate, minimum supplemental oxygen use, gestation, and caloric intake were included [33]. The model for previously healthy infants includes only saturation and ethnicity. Again, it highlights our finding of a longer LOS in the Arab population, as previously discussed. This finding calls for in-depth studying of ethnic disparities.

The major strength of our study is the large number of children across almost 20 years of data acquisition. We were able to include a variety of demographic, clinical and laboratory variables. Data acquisition was optimized using a computerized query tool, limiting acquisition error. Another strength is the granularity of individual patient–level data to assess factors affecting LOS in a large database. A single center with a similar attitude towards admission and similar criteria for discharge eliminates site-to-site variability. The large sample group enabled us to assess ethnic disparities in hospital admission and LOS among Arabs.

Our study has several limitations. Due to the retrospective nature of the study, we were limited to data that was available in the medical records. Details on birth and delivery were only available for infants born in our medical center. The database was lacking other data relevant to the study, including status of RSV vaccine in eligible infants, history of breastfeeding, smoking exposure, family history of atopy, poor feeding, apnoea and bacterial super-infection. Severity score was not assessed routinely. The lack of a uniform definition in our medical records on specific therapies, such as hypertonic saline and non-invasive ventilatory support, precluded any analysis of their effect on LOS. Additionally, we only distinguished between different ethnicities as a correlate of the socioeconomic background. Other relevant factors that would provide a solid estimation for the family's socioeconomic background, such as the mother's highest educational degree were not available in our database.

An important factor in large data analyses is that the quality of the results is as good as the accuracy and reliability of the input data. Finally, the study presents findings from a single tertiary medical center, and therefore may not be generalizable to other institutions or population.

In conclusion, we found that our large database was useful in analyzing factors predicting disease severity and LOS in bronchiolitis. We also composed a model for predicting LOS based on readily available clinical parameters. The model for previously healthy infants highlights the longer LOS in Arabs, which could be more thoroughly addressed in future studies. Prospective larger studies, which will examine and validate the predictive model, could potentially aid in targeting new therapies for high-risk infants with bronchiolitis.

Author contribution

KM and MG – equal contribution; literature search, data collection & analysis, manuscript preparation: RL – the statistician – statistical analysis of the data. Review of manuscript: RBY – data collection & analysis; YT – data analysis, manuscript draft preparation; VN – literature search, data collection; GG - data collection & analysis; YBD – data collection, manuscript draft preparation; FH – literature search, review of manuscript; LB - responsible for study design, analysis of data, manuscript preparation and review.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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