

The Burden of Respiratory Syncytial Virus Bronchiolitis on a Pediatric Inpatient Service

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ABSTRACT: **Background:** Respiratory syncytial virus bronchiolitis is the single leading cause of pediatric admissions for infants in the first year of life, presenting regularly in epidemic proportions in the winter months and impacting in a major way on pediatric inpatient services.

Objectives: To quantitate the burden of RSV disease on a pediatric service with the purpose of providing a database for proper health planning and resource allocation.

Methods: We conducted a prospective 5 year study of documented RSV infections in a single pediatric service. RSV disease was confirmed by direct immunofluorescence testing of nasal swabs from all hospitalized cases of bronchiolitis.

Results: On average, 147 ± 17 cases of RSV bronchiolitis were admitted annually in the November–March RSV season, representing 7%–9% of admissions and 10%–14% of hospital days. There was a consistent male preponderance of admissions (55–64%) and 15–23% of admissions were patients less than 1 month old. In peak months RSV cases accounted for as many as 40% of the hospitalized infants and was the leading cause of over-occupancy (up to 126%) in the pediatric ward during the winter.

Conclusions: RSV infection is a major burden for pediatric inpatient services during the winter season. This recurrent and predictable “epidemic,” which regularly leads to over-occupancy, requires increased manpower (nursing) and resources (beds, pulse oximeters) to facilitate proper care. Since this annual event is not a surprise nor an unexpected peak, but rather a cyclical predictable epidemiological phenomenon, proper planning and allocation of services are crucial.

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Respiratory syncytial virus is the leading cause of respiratory infection in the first year of life [1] and the leading single cause of hospitalization of infants aged 2 to 12 months old [2]. Prevalence studies have documented that up to 50% of

infants are infected by RSV by their first birthday and almost 100% by age 2. Most importantly, the hospitalization rate in the first year of life for RSV infection, primarily bronchiolitis, has been reported to be 1%–2% of all infants and 10–15% in high risk infants [3–7]. Thus, for every new cohort of 10,000 Israeli infants, with the usual spectrum and mix of risk, it has been calculated that there will be approximately 150 hospital admissions in the first year of their life. On a nationwide basis, given the nearly 150,000 births per year in Israel, there are an estimated 2500–3000 RSV pediatric admissions per year. Since RSV is not routinely or uniformly diagnosed by specific laboratory tests in all Israeli hospitals, and since it is not a reportable disease to the Ministry of Health, its true prevalence in Israel and the number of pediatric hospitalizations can only be estimated. Nonetheless, it should be noted that the estimate of 2500–3000 admissions nationally can be supported by extrapolations of surveys that report 100–120 pediatric intensive care unit admissions of infants with RSV infections per year in Israel [8].

RSV infections are seasonal and present primarily in the winter months [9]. As such, it poses a unique challenge to the medical care system in general and to pediatric inpatient services in particular to be prepared for this yearly inevitable “epidemic.” However, to date, there are scarce accurate data on the magnitude of this clinical problem in Israel, and extrapolation from epidemiological data of other countries runs the risk of inappropriate generalizations, with errors in both directions. In fact, the only study that even addressed, albeit partially, the issue of the RSV burden is the recent study by Hall et al. [10], who reported that 20% of pediatric patients who were hospitalized with a diagnosis of an acute respiratory infection had RSV disease. However, the percentage of all admissions or bed occupancy that the RSV cases represented was not reported.

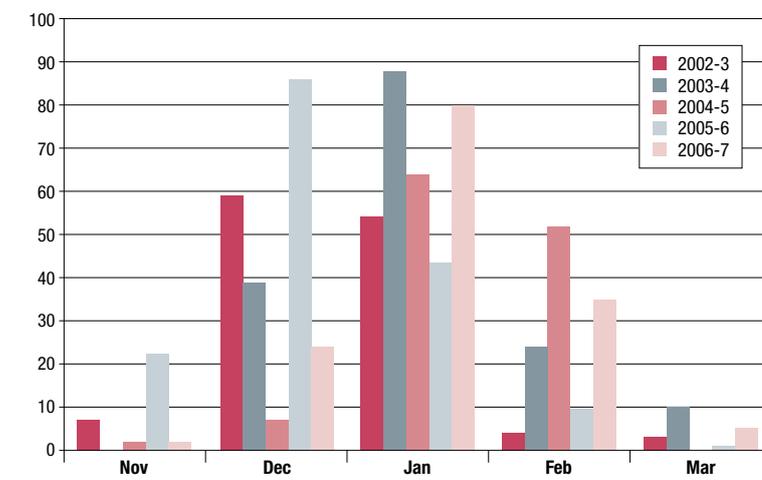
Therefore, we have prospectively collected data over a 5 year period from a single institution, the Shaare Zedek Medical Center, in the attempt to delineate both the pattern and enormity of the inpatient clinical load as well as the implications of the data for the organization of hospital pediatric services. Such data, we contend, are critically necessary for rational planning of health services and for the appropriate utilization of resources for what is a predictable cyclical phenomenon of pediatric medicine.

RSV = respiratory syncytial virus

Table 1. RSV admissions to Shaare Zedek Medical Center

	2002–3	2003–4	2004–5	2005–6	2006–7
Total admissions	134	165	127	164	146
Hospital days	870	721	719	601	670
LOS (days)	6.4	4.4	5.7	3.7	4.6
% total admissions	7	9	7	8	8
% of total hospital days	10	12	14	11	12
% male	64	59	64	63	55
% < 1 month	23	16	21	15	17

LOS = length of hospital stay

Figure 1. Monthly pediatric RSV hospitalizations: seasonal and variable

PATIENTS AND METHODS

Based on previous retrospective surveys the Israeli RSV season was defined as the 5 month period from November to March. For the period 2002–2007 (five seasons), diagnostic nasal swabs were applied to all infants hospitalized in Shaare Zedek Medical Center, Jerusalem, with a presumed clinical diagnosis of bronchiolitis. The swabs were analyzed for RSV antigen utilizing a commercial direct immunofluorescence test (PathoDx®). Routine studies for the detection of other viral pathogens were not performed. Clinical and epidemiologic data were collected prospectively on all hospitalized infants who had a nasal swab positive for RSV antigen. Admission criteria for symptomatic infants with presumed bronchiolitis were oxygen saturation below 92% in room air and/or clinical diagnosis of moderate respiratory distress, e.g., tachypnea, retractions and wheezing. Discharge criteria were not uniform and were based on the senior attending physician's assessment that the infant was clinically stable and that there was little or no need for supplementary oxygen. The absolute criterion for admission to the pediatric intensive care unit was the need for ventilation.

Additional admissions were based on the assessment of clinical severity by the treating physician (not the study personnel) weighed against the availability of a bed in the PICU.

RESULTS

Table 1 summarizes our experience over the 5 year period 2002–2007. As noted, only infants with a positive nasal swab for RSV antigen were included in the study. The number of admissions averaged 147 (± 17) per year and ranged from 134 to 165. On the other hand, the number of hospital days per year decreased from a peak of 870 in the 2002–2003 season to 670 in the 2006–2007 season, reflecting a decrease in the length of hospital stay from 6.4 days to 4.6 days. In all years, the majority of infants hospitalized were male (55–64%) and 15–23% were less than one month old at the time of hospitalization. Data from the last two seasons of the study noted that the percentage of admitted patients over age 2 years was 3.7 and 2.7% respectively.

Figure 1 illustrates both the seasonal aspects of RSV disease and the variability of the timing peak of the epidemic from year to year. As depicted, the majority of cases occurred in the months December to February, with the peak number of admissions per month occurring in December in the 2005–6 season, in January in the 2003–4 and 2006–7 seasons and in February in the 2004–5 season. During the entire RSV season (November to March) the infants with a diagnosis of RSV disease represented 7–9% of the total pediatric admissions but 10–14% of the hospital days. This reflected the longer stay for infants hospitalized for RSV disease as compared to the average length of stay of infants with other pediatric diagnoses. For example, during the period November 2006 to February 2007 the length of stay for the total pediatric population was 3.3 days compared to 4.6 days for the RSV population.

Most striking was the finding that during the peak month, in any given season, infants with RSV disease occupied upwards of 40% of the pediatric beds. Representative data from the peak months of the 2002–3 and the 2006–7 seasons are depicted in Figures 2 and 3 respectively. In January 2003 over 40% of the 35 pediatric beds were occupied with infants diagnosed with RSV while in January 2007 infants with RSV bronchiolitis "only" occupied 26% of the pediatric beds. Of note, during the 2006–7 season the occupancy rate for the inpatient pediatric service for the 4 month period November 2006–February 2007 was over 100% (November 113%, December 106%, January 128%, February 108%), while the RSV infants occupied 1.4% of the beds in November, 11.6% in December, 26.2% in January and 13.2% in February. During the study period 2 of the 157 Shaare Zedek-born infants who received palivizumab passive immunization (according to the Israeli Ministry of Health criteria) were hospitalized with

PICU = pediatric intensive care unit

RSV bronchiolitis. In addition, one additional infant who had received palivizumab from another hospital was hospitalized. None of these infants were admitted to the PICU.

Data were available for the number of admissions to the Shaare Zedek PICU for the four seasons in 2003–4, 2004–5, 2005–6 and 2006–7. The number of admissions was 11, 11, 5 and 3 respectively. There was a significant reduction in the last 2 years as compared to the previous 2 years ($P < 0.01$, two-tailed t -test), which occurred after the institution of a departmental policy to treat non-ventilated infants with moderate respiratory distress in the pediatric ward. Of the eight infants admitted to the PICU in the last two seasons (2005–6, 2006–7), all were born at a gestational age of ≥ 33 weeks and none had any underlying cardiac condition. On the other hand, the number of admissions of preterm infants who were born < 33 weeks gestation was 13, 10, 11, and 7 respectively for the same four seasons (2003, 2004, 2005, 2006), representing 7.9%, 7.9%, 6.7%, and 4.8% of the total RSV admissions for these seasons (difference not significant).

DISCUSSION

This study documents for the first time in Israel the magnitude of the burden of RSV bronchiolitis admissions on a pediatric inpatient service. Both the pattern of the disease, i.e., the seasonal aspects of presentation (winter months), and the variable and unpredictable timing of the peak load of cases (but not the magnitude) were previously reported in North America and Europe and this pattern apparently exists in Israel as well [9-11]. Most importantly, this 5 year survey confirmed the predictability of the RSV "epidemic" and the relatively little variation in the clinical burden on a pediatric service, year after year. Most striking was the finding that the RSV patients in the entire RSV season period represent 7–9% of the admissions but 10–14% of the hospital days. During the peak month of the season these admissions represent 20–40% of the inpatient pediatric bed occupancy. As occupancy in pediatric departments frequently exceeds 100% during these months (as documented in our study) it is clear that a major cause of this situation is the load of RSV cases.

To date, no single specific therapy has been proven efficacious in the care of RSV bronchiolitis, neither antiviral therapy nor bronchodilators [12,13]. The mainstay of care is "supportive," i.e., adequate hydration, airway toilet, supplementary oxygen and selective use of bronchodilators [14] – all care techniques that require attentive professional nursing. The need for supplemental oxygen is the critical admission criterion variable and the amount of supplemental oxygen, in turn, serves as a basis for discharge planning [15]. As such, the availability of continuous oxygen monitoring with a dedicated oxygen saturation monitor is essential for both anticipating a clinical deterioration and for making a decision to discharge home. Thus, the lack of sufficient monitors for

Figure 2. RSV admissions in relation to all admissions, 2002-3

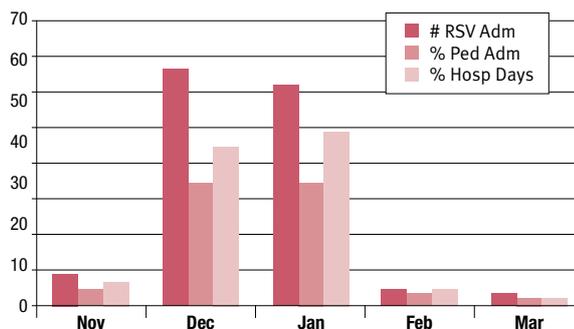
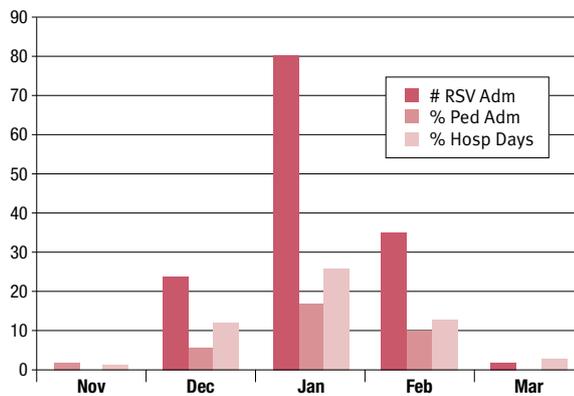


Figure 3. RSV admissions in relationship to all pediatric admissions, 2006-7



the hospitalized infants potentially interferes with rational and objective decision making. In simple terms, if the oxygen saturation level is the criterion for admission and discharge, randomized isolated measurements of oxygen saturation every few hours cannot accurately quantify the severity of the disease process.

The predictability of the yearly RSV "epidemic" has not changed and is independent of the recent introduction of the monoclonal antibody (palivizumab) immunoprophylaxis for high risk infants. Previous reports have estimated that this high risk population represents at most 10% of the total population of hospitalized infants with RSV disease [10,16]. Thus, palivizumab use, although justified for the individual infant, will most likely not significantly affect the overall (medical and nursing) burden for any given pediatric service. Prais and colleagues [8] surveyed the Israeli PICUs and compared the 2000–2001 and 2001–2002 RSV seasons – the seasons before and after introduction of immunoprophylaxis. Of interest, he did not note any significant reduction in the number of admissions to the PICUs or in the percentage of those admitted who required mechanical ventilation. Our data, which similarly noted a relatively consistent total number of admissions since immunoprophylaxis was introduced, support the conclusion

that immunoprophylaxis has only a minimal impact on the overall burden for the pediatric inpatient ward. As 159 infants who were born at Shaare Zedek during the study period were immunized, we can estimate that this prevented the hospitalization of 15–20 infants, less than 3% of the total number of the RSV admissions (n=736). Similarly, Hall and team [10] stated that “most children with RSV infection...have no coexisting medical conditions or characteristics that significantly identified them as being at risk for severe RSV disease except for being under 2 years of age. RSV’s major burden therefore occurs among previously healthy children whose risk of severe illness cannot be predicted.”

In contrast to Prais et al. [8], however, the number of admissions to the Shaare Zedek PICU did decline. We speculate that this is the consequence of the willingness of the responsible physicians to care for moderately ill infants on a pediatric ward on the one hand, and the frequent unavailability of beds in the PICU on the other. In addition, the PICU admissions during the last two seasons reflected an era of more routine immunoprophylaxis (palivizumab) in high risk premature infants (born at < 28 weeks gestation or with a diagnosis of bronchopulmonary dysplasia) and in those infants with symptomatic cardiac disease.

The limitation of this study is that it represents the experience of a single institution. However, given that the birth cohort in Share Zedek is approximately 10,000 per year, it was estimated that there would be 150 admissions per year, and that is exactly what happened. Thus, it is fair to conclude that our experience can be generalized to other Israeli and non-Israeli institutions, with appropriate modification for the risk factors in a given high risk population [17]. Most importantly, the pattern of RSV disease did not represent an unexpected peak, nor was it limited to an unusual pattern of circumstances for a few days. On the contrary, it was a *predictable recurrent phenomenon* that taxed the pediatric inpatient service, both in terms of manpower (nursing in particular) and physical reserve (beds and pulse oxygen monitors) for months. It is therefore our opinion that these data can serve as a guide to other institutions for proper planning and allocation of resources. Clearly, in view of the nature of RSV respiratory disease, certain steps are called for: nursing staffing for the winter months must be increased, additional inpatient beds must be allocated, and basic monitoring equipment for each infant must be provided. For example, in a 35 bed pediatric unit with 20–40% bed occupancy due to RSV disease, all cases oxygen dependent, there must be at least 8–10 pulse oximeters available for this population alone. Anything less would not meet the infants’ basic needs.

In conclusion, this study substantiates and quantitates the major burden that RSV respiratory disease imposes on a pediatric inpatient service. These data can serve as a basis for comparative rational health planning and allocation of medi-

cal and nursing resources for the infant population of Israel and for individual departments of pediatrics worldwide.

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