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RSV Burden on Ireland's Tertiary Children's Hospitals: An In-Depth Winter 2023/2024 review

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Abstract

Aim

This paper examines the burden of Respiratory Syncytial Virus (RSV) at Children's Health Ireland (CHI) at Crumlin and Temple Street during the 2023-2024 season. We aimed to quantify RSV admissions, and analyse patient demographics, their hospital course, and assess the impact on healthcare resources.

Methods

This was a retrospective cohort study examining paediatric RSV hospitalizations from October 10, 2023, to January 9, 2024. We included PCR-confirmed RSV cases, excluding those admitted before October 10 or readmitted to the ward within 5 days. Data were collected from the HIPE database for ward admissions and a prospective database for PICU admissions, followed by detailed chart reviews. Excel was used for analyses.

Results

We identified 869 patients: 712 (82%) at the ward level and 157 (18%) at the PICU level, with total healthcare costs exceeding €6 million. The peak in admissions occurred in November. At this time there a 61% reduction in elective surgeries which coincided with an over 100% PICU occupancy. Most patients 480 (55.2%) were under 6 months old, and 16% were born in October.

Discussion

The RSV surge heavily impacted on PICU admission and strained the already overburdened healthcare system, impacting admissions, surgeries and service delivery. The data highlights the need for improved preparedness during peak RSV seasons. Importantly, 43% of RSV admissions were for infants born before October 2023 and a significant number of older

patients admitted to the PICU had medical complexity. Future immunization programs should take this into account to better protect those at highest risk of severe disease as this immunization would have the greatest impact on those under 8 weeks who accounted for the majority of PICU admissions.

Introduction

Respiratory Syncytial Virus (RSV) is one of the leading causes of respiratory tract infections in infants and young children[1,2]. It triggers annual epidemics each year, peaking in autumn and winter months, when healthcare systems are already under considerable pressure from other circulating winter viruses. The only available treatment for RSV illness is supportive care. Until recently, the only available prophylactic option was palivizumab, which is authorised for use in infants with clearly defined additional risk factors for severe RSV and involves monthly administration throughout the RSV season. However, two new forms of universal passive immunisation against RSV have recently been approved for use in Europe, both requiring only a single dose; a maternal RSV vaccine (RSV preF, Abrysvo) and an infant monoclonal antibody (nirsevimab, Beyfortus)[3,4].

One of the first regions to introduce nirsevimab was Galacia in Spain, during the 2023/2024 season. They reported a remarkable impact from this form of passive immunisation, reducing hospitalisations by 82% in their region.[5] Other regions in Spain, France, Luxembourg, and the US have also introduced nirsevimab with similar encouraging results.[6]

The impact of RSV on the paediatric population, their families, and our healthcare system has not been evaluated, and is likely underestimated in the Republic of Ireland. Here, we describe the impact of RSV on two tertiary paediatric hospitals during the 2023-2024, prior to the introduction of universal immunisation. These data are crucial to healthcare policy makers; in both guiding decisions on who would benefit most from an immunisation programme, and in allowing ongoing assessment of RSV burden post nirsevimab.

Our objective was to outline the burden of RSV disease within two tertiary paediatric hospitals in Ireland during the most recent RSV season from October 2023-January 2024. This included all paediatric patients admitted to Children's Health Ireland (CHI) at Crumlin and Temple Street and included (1) patients admitted with RSV disease requiring ward level care, and (2) patients with RSV disease requiring Paediatric Intensive Care unit (PICU) level care. We aimed to describe the number of RSV positive admissions in both sub-cohorts; including demographics and length of stay. An additional aim was to review the impact on CHI from a healthcare utilization perspective, including healthcare resource and financial burden.

Methods

This was a retrospective cohort study in paediatric patients hospitalized at CHI Crumlin and Temple Street hospitals from 10th October 2023 to 9th January 2024. The ethics board of CHI (Rec-421-24) granted approval.

All patients admitted to the two centres with microbiologically confirmed RSV on PCR testing were added to a database. Inpatients with RSV illness during the study period but with an admission date prior to 10th of October were excluded. Additionally, patients readmitted within 5 days to the general paediatrics ward were excluded, but not those readmitted to PICU.

Patients were identified in two ways. For the ward cohort, patients were identified using the Hospital In-Patient Enquiry (HIPE) database using the search criteria of 'RSV positive'. Patients were excluded if they were labelled as RSV positive by HIPE but did not have microbiologically confirmed diagnosis on a CHI viral panel. For patients requiring PICU level care, all RSV positive patients were prospectively added by PICU staff to a database. This database was then shared with the study group and a detailed retrospective electronic medical chart review was later carried out on each patient.

Demographic data collected across both groups included number of admissions, gender, age at time of admission, length of stay and comorbidities. Patients requiring both ward level and PICU level care were considered PICU patients only for the purpose of the analysis. Comorbidities were defined separately in the two sub-cohorts. Co-morbidities amongst the non-PICU cohort were evaluated by reviewing previous hospital appointments, including visits to various subspecialty clinics. In the PICU sub-cohort, a patient was defined as having a comorbidity if they had an underlying congenital cardiac defect, genetic condition, neuromuscular or metabolic disorder or respiratory/ENT diagnosis. Within the PICU group, further co-variates were collected including ventilation requirements, antibiotic usage, source of admission and presence of siblings. Gestation, birth weight and breastfeeding were recorded in those who were less than two years of age in the PICU cohort. Data was analysed for both cohorts using excel. Hospital costs for ward and PICU days were calculated through HIPE records and PICANet database records[7].

Results

Sub-cohort 1 – Ward admissions

A total of 712 patients required ward level care. As outlined in Table 1, the cohort was 48.6% female with median length of stay of 3 days (IQR 1-4). Median age at admission was 24.6 weeks with the youngest patient being 9 days old in Crumlin and 23 days old in TSH. Age distribution showed that 71 patients (10%) were less than one month old, 291 patients (41%)

were between 1 to 6 months, 124 patients (17.4%) were between 6 to 12 months old and 226 patients (31.7%) were over 12 months old.

Table 1: Patient Demographics across Ward and PICU cohorts.

	Wards (Non PICU)			**PICU**	**Total**
	Crumlin	Temple St	Combined	Combined	Wards & PICU
Number of Admissions	343	369	712	157	869
Length of stay (Median days, IQR)	3(2-4)	3(1-4)	3(1-4)	4(3-7)	-
Number of Bed Days	1226	1202	2428	796	3224
Gender					
Males (%)	177(51.6)	189 (51.2)	366 (51.4)	90(58.8)	456(52.7)
Females (%)	166 (48.4)	180 (48.8)	346 (48.6)	63(41.2)	409(47.3)
Age on admission. (Median weeks, IQR)	23(8.5-61.9)	26(8.7-62.5)	24.6(8-62.4)	8.3 (4.6-24.9)	-
< 1 month (%)	31(9)	40(10.8)	71(10)	35(22.3)	106 (12.2)
≥1 month and <6 months (%)	148(43.1)	143(38.8)	291(40.9)	83(52.9)	374 (43)
≥ 6months and < 1 years (%)	60(17.5)	64(17.3)	124(17.4)	11(7)	135 (15.5)
≥ 1 years (%)	104(30.3)	122(33.1)	226(31.7)	28(17.8)	254(29.2)
Comorbidity (%)	47(13.7)	85(23)	132(18.5)	33(21.6)	-
Additional Viruses (%)	112 (32.7)	34 (9.2)	146 (20.5)	43(28.1)	189 (21.7)

Among those hospitalised with RSV, 20.5% had co-infections with other viruses. Within this group, 12.6% had co-infections with either rhinovirus or enterovirus, and the remaining 7.8% had co-infections with other types of viruses.

Sub-cohort 2 – PICU Admissions

There were 157 RSV admissions into PICU during the study period, including 99 (63%) in Crumlin and 58 (37%) in Temple Street. As 4 were readmissions, this left a total of 153 patients. As noted in table 1, the cohort was 41.2% female and median length of stay was 4 days. The median age at admission was 8.3 weeks. Notably, 76/157 (48.4%) of all admissions were under 8 weeks of age, and 75% of all RSV admissions to PICU were under 6 months of age.

Comorbidities were identified in 33/153 (21.6%) of PICU patients. Only 19/136 (14%) patients < 2 years old had an underlying comorbidity, however in those ≥ 2 years of age 14/17 (82%)

had a co-morbidity. Co-infections were identified in 43 (28.1%) patients, 35 of which were either rhinovirus or enterovirus. Birth data was available for the PICU cohort and revealed median gestation was 38+3 weeks, with 75% of all admissions born at term. Median birthweight was 3.28kg and a total of 37/136 (27.2%) were breastfed. (Table 2).

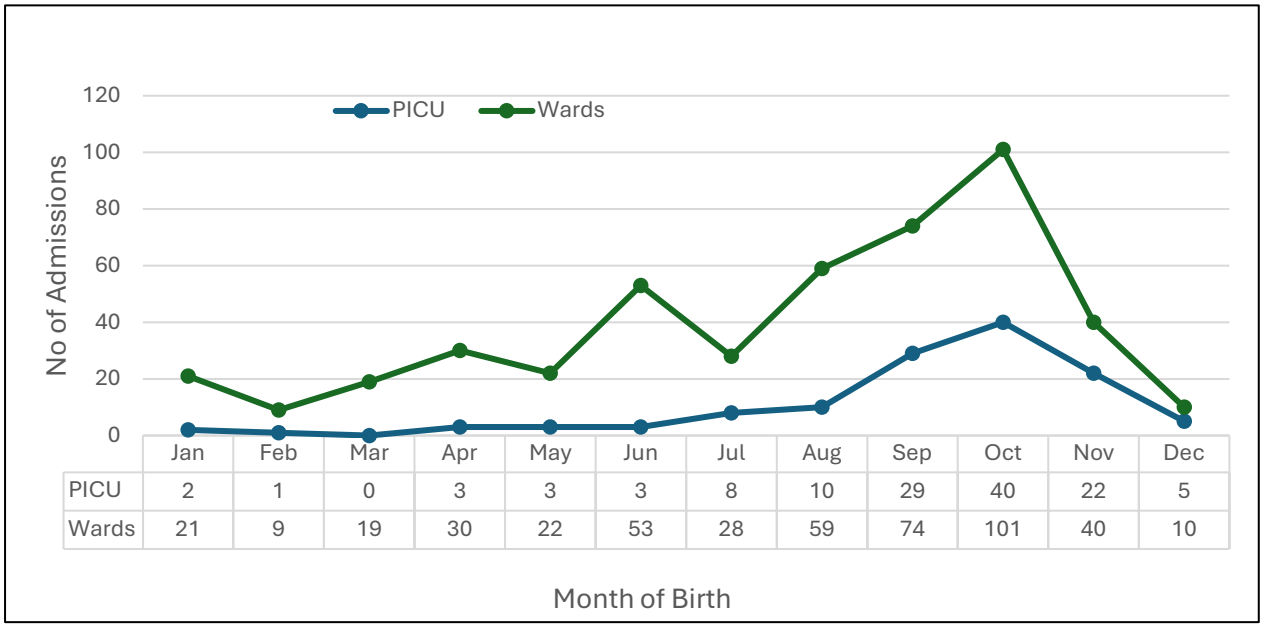
Patient Variables PICU Cohort	Results
Working weight. Median kg (IQR). N=155	5 (4.1-7.2)
Birthweight patients < 2 years. Median kg (IQR). N= 131	3.28 (2.89-3.69)
Gestation patients < 2 years. Median weeks (IQR) N=136	38+3 (37-39+5)
Extreme preterm <28weeks	0 (0%)
Very Preterm ≥28 and <32 weeks	2 (1.4%)
Moderate Preterm ≥32 and <34 weeks	7 (5.1%)
Late Preterm ≥34 and <37 weeks	25 (18.4%)
Term ≥37 weeks	102 (75%)
Siblings (N=145)	
Yes	124 (85.5%)
No	21 (14.5%)
Breastfeeding, Patients < 2years (N=136)	
Yes	37 (27%)
No	99 (73%)
Palivizumab Prophylaxis ™Synagis (N=153)	
Yes	1 (0.7%)
No	152 (99.3%)
Admission Source (N=157)	
Same Hospital	67(43%)
Other Hospital	90 (57%)
Antibiotics (N=157)	
Yes	136 (86.6%)
No	21 (13.4%)
Respiratory Support (N=157)	
Required Intubation	86(54.8%)
- *Including Non-Invasive Ventilation*	51/86
- *Excluding Non-Invasive Ventilation*	35/86
Required Non-Invasive Ventilation	103(65.6%)
- *Including Intubation*	51/103
- *Excluding Intubation*	53/103
Other support including Hiflow, Nasal cannula, Facemask	19(12.1%)

Table 2: Demographic and clinical variables for PICU cohort. N = Number of patients with recorded variable.

Of those admitted to PICU 124/145 (85.5%) had siblings. Only one patient had received palivizumab prophylaxis prior to admission. The majority of patients 136/157 (87%) received antibiotics during their admission. Transfers from other hospitals accounted for 90/157 (57%) of all PICU admissions.

Intubation was required in 86/157 (54.7%) of PICU admissions and 103/157(65%) required Non-Invasive Ventilation (NIV) during their admission. Almost a third of admissions, 51/157(32.5%) required both intubation and NIV. Median duration of invasive ventilation was 4 days (IQR 3-6 days). Median duration for those requiring NIV was 2 days (IQR 1-3 days). Admissions notably peaked in November (Epidemiological weeks 44-48) with 51.7% of total ward admissions and 52.9% of PICU admissions occurring during this time period[8]. *(Figure 1)*

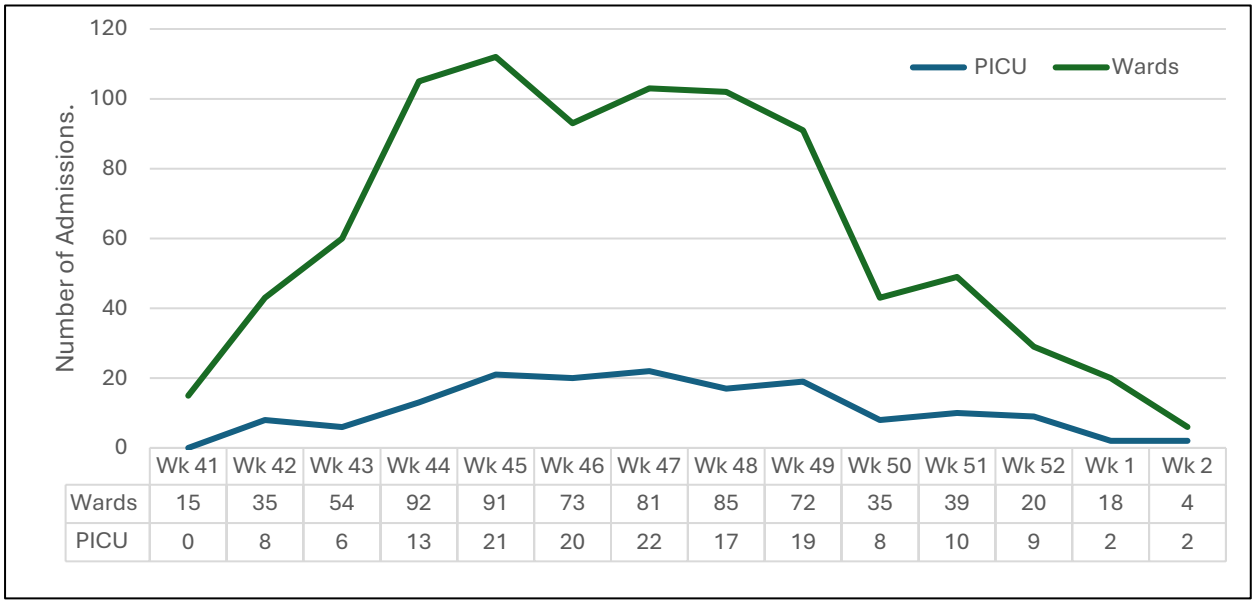
Figure 1: Number of RSV admissions per epidemiological week 2023-2024.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PICU	2	1	0	3	3	3	8	10	29	40	22	5
Wards	21	9	19	30	22	53	28	59	74	101	40	10

Of those in the ward cohort, 44% (315/712) were born between January and September 2023 and 21% (151/712) were born between Oct and Dec 2023. Of those requiring PICU admission, 38% (59/157) were born between January and September 2023 and 43% (67/157) were born between October and Dec 2023. *(Figure 2).*

Figure 2: Admissions based on month of Birth for infants born 2023.



	Wk 41	Wk 42	Wk 43	Wk 44	Wk 45	Wk 46	Wk 47	Wk 48	Wk 49	Wk 50	Wk 51	Wk 52	Wk 1	Wk 2
Wards	15	35	54	92	91	73	81	85	72	35	39	20	18	4
PICU	0	8	6	13	21	20	22	17	19	8	10	9	2	2

RSV burden on CHI

RSV had both direct and indirect financial and service impacts noted. Total bed days across both sites included 2,428 non-PICU bed days and 796 PICU days. The average cost per bed day for general (non-PICU) RSV patients was calculated to be €1,366. Taking length of stay across CHI Crumlin and CHI TSH as 2,428 days, this computes to a total cumulative cost for non-PICU inpatient RSV during the study period of approximately €3,316,648.00. The total PICU Bed Days were estimated to cost €2.5-3 million, leaving an overall estimated total cost of over €6 million for one season alone.

We also reviewed elective surgery cancellations during the winter season and compared to summer months. The number of completed elective surgeries decreased to 61% In November 2023, while RSV admissions were peaking. Additionally, bed occupancy levels in PICU were greater than 100% during peak RSV season.

Discussion

RSV is globally recognised as the leading cause of bronchiolitis and pneumonia in infants, exerting a significant strain on healthcare resources annually. With a paucity of data from Ireland, we aimed to describe the impact of RSV in Ireland's two tertiary level paediatric hospitals over the most recent RSV season. Our data demonstrate that RSV had a significant impact on admissions, bed occupancy and service provision during the winter season. Over three months, 842 infants were hospitalised across two hospitals, with 157 admissions requiring PICU level care, and a length of stay amounting to 2,428 bed days. Almost half of

admissions to PICU were infants less than eight weeks of age, whereas the median age of infants requiring hospitalisation without PICU level care was approximately 6 months of age. While the majority of patients were under 6 months of age, these data also highlights the burden on older infants as 46% of total RSV hospitalisations were over 6 months of age. Older patients with comorbidities were also disproportionately affected. In the PICU cohort, 82% of those ≥ 2 years of age had a documented co-morbidity, highlighting the impact on our medically complex population.

A surge in RSV presentations has a substantial impact on admissions and service provision in our already over-stretched healthcare system. During the 2023/2024 season, 25-39% of elective surgeries were cancelled each month over the winter period. While reasons for this may be multifactorial, there is little doubt that RSV was a large contributor.

Importantly, these data do not quantify the individual burden of RSV on unique patients and families. In the PICU cohort, 57% of patients were transferred from hospitals outside of Dublin, and 85% had siblings. The disruption to the family unit at a time of critical illness introduces significant stress to caregivers[9,10]. Severe RSV causes breathing and feeding difficulties, and can result in disruption to breastfeeding[11,12]. Severe early RSV is also associated with effects that may be long-lasting; given an increased risk of asthma or recurrent wheeze later in life[13].

There are several limitations to our study. Patients transferred from other hospitals to the ward were excluded if there was not microbiologically confirmed RSV within CHI, thus likely underestimating our numbers. Due to the absence of electronic health record outside of the PICU, co-morbidities could not be specified within the general paediatric group and were assumed based on an attendance to outpatient clinics within CHI. Finally, as the patients requiring PICU level care were excluded from the ward level care assessment of bed usage, we can assume there was an under-estimation of bed days calculated by approximately 200-300 days.

While these data highlight the burden on two tertiary centres in Dublin, the impact at a national level is much greater. There are eighteen other hospitals admitting paediatric patients in Ireland, and many more presentations to emergency departments, urgent care centres and primary care practices which must be considered. Attendances to our ED Departments were also not included in these analyses.

In conclusion, the data highlights the need for increased preparedness during peak RSV seasons. The high volume of cases led to substantial resource utilisation, including extended bed occupancy and intensive care for severe cases. The data confirms that RSV predominantly affects infants less than 1 year of age and those less than 6 months in particular, however older patients with comorbidities represent an important at-risk group. In addition these data

highlight that 43% of those admitted with RSV were born prior to winter season onset at Oct 2023. This must be considered when planning the inclusion criteria for future immunisation programs to ensure those at highest risk of severe disease are targeted with preventative measures.

The recent announcement regarding the planned introduction of nirsevimab for infants in Ireland for the 2024/2025 season is a timely and welcome one. In our 2023/2024 cohort, with a similar uptake of nirsevimab seen in Galacia, we potentially would have seen a reduction in hospitalisations in excess of 650 infants and children, and greater than 2000 bed days.(5) Additional benefits in terms of less exposure to antibiotics and psychosocial effects are likely.

We believe these data can be used to educate families and healthcare workers on the significance of RSV in the paediatric population and support the urgent implementation of a successful immunization program that will have undoubted value for our patients and healthcare system.

Declarations of Conflicts of Interest:

None declared.

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