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Burden of Respiratory Illnesses in Pediatric Intensive Care Unit and Its Outcome

Mostafa Ashry Mohamed, Hadier Khaled Mahmoud, Shaimaa Mohamed Mahmoud*
Pediatrics Department, Faculty of Medicine, Sohag University, Sohag, Egypt
***Corresponding author:** Shaimaa Mohamed Mahmoud, **Mobile:** (+20) 01040905278, **E-mail:** safaah003@gmail.com

ABSTRACT

Background: A significant portion of the pediatric intensive care unit's (ICU) disease burden is caused by respiratory infections and illnesses in children.

Objectives: The aim of the current study was to assess the incidence of respiratory illnesses, predictors and risk factors for mortality in pediatric ICU at Sohag university Hospital.

Methods: A prospective observational study conducted at Pediatric ICU, Faculty of Medicine, Sohag University. The study included 204 children admitted to PICU during the study period. Post traumatic and postoperative cases were excluded.

Results: The study included 204 cases admitted to PICU during the study period. Respiratory illness represented 36% of admissions to pediatric intensive care unit (PICU). Mean age of the studied cases was 3.01 ± 3.62 year with a median of (1.7), 54.9% of cases were males. Regarding pediatric index of mortality 2 (PIM 2), the mean PIM-2 was 2.03 ± 1.24 while PIM-3 showed a mean of -0.73 ± 1.83. Regarding distribution of respiratory illness, 51.4% of cases had pneumonia, 40.5% of them had bronchiolitis and 8.1% of them had asthma. Regarding PICU admission, mean of admission duration was 11.81 ± 11.45 days. Relation between presence of respiratory illness and PIM-3 showed that the cases with respiratory illness had significantly increase of PIM 3 in comparison to cases with non-respiratory illness (-0.28 ± 1.72 and -0.98 ± 1.85). Comparison between respiratory illnesses showed that there was significant increase in PIM-3 among cases with pneumonia (0.34 ± 1.28) in comparison to that value among cases with bronchiolitis and bronchial asthma (-0.95 ± 1.8 and -1.15 ± 2.51).

Conclusion: This study showed that respiratory illness represented high burden in PICU admissions and nearly half of cases with acute respiratory illness were due to pneumonia (51.4%). Cases with pneumonia represented the highest value of PIM-3 that indicated severity of disease, which need more concern and successful management. Cases with bronchiolitis showed the highest percentage of mechanical ventilation, central venous line (CVL) insertion, and inotropic agents need.

Keywords: Respiratory illness, Respiratory disease, Pediatric intensive care unit, critically ill children.

INTRODUCTION

Acute respiratory infections (ARIs), primarily pneumonias, account for one-fifth of deaths in children under five, making them a significant source of morbidity and mortality in this age group [(1)]. Worldwide, about 11.9 million severe and 3.0 million very severe acute lower respiratory infection (ALRI) episodes lead to hospitalization in young children [(2)].

Thus, a significant portion of the disease load in the PICU is caused by respiratory infections and diseases in children. In light of this, we looked at the clinical characteristics and risk factors that affect the outcome and mortality of children with ARIs [(3-5)].

The current study aimed to assess the incidence of respiratory illnesses, predictors and risk factors for mortality in PICU at Sohag university hospital.

PATIENTS AND METHODS

A prospective observational study was conducted at PICU, Pediatrics Department, Faculty of Medicine, Sohag University Hospitals. The study included cases admitted to PICU from May, 2023 to May, 2024 after fulfilling the eligibility criteria.

Inclusion criteria: All children from one month of age to 12 years old admitted to PICU during the study period.

Exclusion criteria: Post trauma cases, postoperative cases and admissions less than 6 hours PICU stay.

All patients in this study were subjected to the following:

History taking focusing on: name, age, sex, residence, family history for similar condition, underlying disease such as cardiac, respiratory, neurological, gastrointestinal, endocrine, nephrology or others, previous treatment and previous illness.

Complete clinical examination included: Vital signs, cardiovascular examination, abdominal examination, neurological examination as GCS, pupillary reaction, decrease capillary refill, lethargy.

Chest examination: Inspection for respiratory rate, pattern of breathing, retractions, cyanosis, grading of respiratory distress. Palpation: chest expansion, position of mediastinum, tactile vocal fremitus. Percussion and auscultation: for air entry, type of breath sound, any additional sounds like wheezes and crepitations.

Investigations: Complete blood count (CBC), C reactive protein (CRP) , chest X-ray**,** arterial blood gas **(**ABG**), e**lectrolytes**, r**andom blood sugar and creatinine.

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Severity of illness: Inotropic drugs, mechanical ventilation support, developing AKI, occurrence of multiorgan dysfunction, need of central venous line (CVL) insertion, sedation, blood transfusion and duration of hospital stay and calculation of PIM- 2 and PIM- 3 scores**.**

Ethical considerations:

The Sohag Faculty of Medicine's Ethical Scientific Committee accepted the study, and the parents of the study's participating children gave their informed written and verbal agreement. The study adhered to the Helsinki Declaration throughout its execution.

Statistical analysis

Data input and analysis were conducted using SPSS version 27.0. Quantitative variables were represented by means ± SD and median and interquartile range (IQR). The Kolmogorov-Smirnov test was used to determine if the data distribution was normal. Frequencies (percentages) were used to characterize qualitative characteristics. Groups of qualitative data were compared using the X^2-test. To compare two sets of independent variables in non-parametric data, the Mann-Whitney test was employed. More than two sets of independent variables of normally distributed data were compared using the ANOVA test. When the p-value was equal to or less than 0.05, it was deemed significant.

RESULTS

The study included 204 cases admitted to PICU during the study period. Respiratory illness represented 36% of admissions to PICU.

Table (1) described that the mean age of the studied cases was 3.01 ± 3.62 year. Regarding gender, 54.9% of cases were males. Regarding pediatric index of mortality 2 (PIM 2), the mean PIM-2 was 2.03 ± 1.24 while PIM-3 showed a mean of -0.73 ± 1.83. Regarding distribution of respiratory illness, pneumonia was the most common (51.4%).

Table (1): Demographic characteristics of the studied cases

Variable		**Summary statistics (n=204) No. (%)**
Age (Years)	**Mean ± SD**	3.01 ± 3.62
	Median (IQR)	1.7 (0.33-4)
Gender	**Male**	112 (54.9%)
	Female	92 (45.1%)
Residence	**Urban**	44 (21.6%)
	Rural	160 (78.4%)
Z score	**Normal**	72 (35.3%)
	Under weight	72 (35.3%)
	Severely under weight	58 (28.4%)
	Over weight	2 (1%)
PIM-2	**Mean ± SD**	2.03 ± 1.24
	Median (IQR)	1.68 (1.68:3.02)
PIM-3	**Mean ± SD**	-0.73 ± 1.83
	Median (IQR)	-0.74 (-2.44:0.95)
Cause of PICU admission	**Respiratory illness**	74 (36.27%)
	Non-respiratory illness	130 (63.73%)
Respiratory illness	**Pneumonia**	38 (51.0.4%)
	Bronchiolitis	30 (40.5%)
	Asthma	6 (8.1%)

PIM: pediatric index of mortality, PICU: pediatric intensive care unit

Table (2) described that there was no significant difference between respiratory illness that included pneumonia, bronchiolitis and bronchial asthma according to age, gender distribution, residence and Z score (P-value > 0.05).

Table (2): Relation between types of respiratory illness and characteristics of the studied cases

Variable			Pneumonia (n=38)	Bronchiolitis (n=30)	Bronchial asthma (n=6)	P-value
Age (Years)		**Mean ± SD**	3.36 ± 4.36	2.94 ± 4.03	1.45 ± 1.63	0.55
		Median (IQR)	2 (0.42-4)	0.6 (0.31-4.25)	0.95 (0.22: 2.62)	
Gender	**Male**	**No. (%)**	23 (60.5%)	11 (36.7%)	4 (66.7%)	0.11
	Female	**No. (%)**	15 (39.5%)	19 (63.3%)	2 (33.3%)	
Residence	**Urban**	**No. (%)**	8 (21.1%)	4 (13.3%)	0 (0%)	0.37
	Rural	**No. (%)**	30 (78.9%)	26 (86.7%)	6 (100%)	
Z score	**Normal**	**No. (%)**	11 (28.9%)	14 (46.7%)	2 (33.3%)	0.62
	Under weight	**No. (%)**	11 (28.9%)	9 (30%)	2 (33.3%)	
	Severely under weight	**No. (%)**	14 (36.8%)	7 (23.3%)	2 (33.3%)	
	Over weight	**No. (%)**	2 (5.3%)	0 (0%)	0 (0%)	

Table (3) described that cases with respiratory illness were significantly younger than cases with non-respiratory illness. Also, cases with respiratory illness had significantly increase of PIM 3 in comparison to cases with non-respiratory illness.

Table (3): Relation between presence of respiratory illness and characteristics of the studied cases

Variable		Summary statistics (n=204)		P-value
		Cases with respiratory illness (n=74)	Cases with non-respiratory illness (n=130)	
Age (Years)	**Mean ± SD**	2.01 ± 2.47	3.58 ± 3.93	0.002
	Median (IQR)	0.8 (0.25-3)	2 (0.53-5.12)	
Gender	**Male**	70 (53.8%)	42 (56.8%)	0.69
	Female	60 (46.2%)	32 (43.2%)	
PIM-2	**Mean ± SD**	1.77± 1.03	2.18 ± 1.33	0.14
	Median (IQR)	1.68 (1.68-2.25)	1.68 (1.68-3.02)	
PIM-3	**Mean ± SD**	-0.28 ± 1.72	-0.98 ± 1.85	0.03
	Median (IQR)	0.4 (-1.89:0.95)	-1.87 (-2.87:0.95)	

Table (4) showed that there was significant increase in PIM-3 among cases with pneumonia in comparison to that value among cases with bronchiolitis and bronchial asthma. Regarding need for mechanical ventilation, CVL insertion and vaso inotropic agents, cases with bronchiolitis showed significant increase in comparison to cases with pneumonia and bronchial asthma. However, cases with pneumonia showed significant increase in need for sedation in comparison to cases with bronchiolitis and bronchial asthma. On the other hand, there was no significant difference between types of respiratory illness and PIM-2 and incidence of AKI.

Table (4): Relation between types of respiratory illness and indicators of illness severity

Variable		Pneumonia (n=38) No. (%)	Bronchiolitis (n=30) No. (%)	Bronchial asthma (n=6) No. (%)	P-value
PIM-2	**Mean ± SD**	2.2 ± 0.88	2.46 ± 1.4	1.52 ± 2.46	0.17
	Median (IQR)	1.68 (1.68-3.02)	3.02 (1.68-3.02)	1.63 (-0.15-3.45)	
PIM-3	**Mean ± SD**	0.34 ± 1.28	-0.95 ± 1.8	-1.15 ± 2.51	0.012
	Median (IQR)	0.95 (0.4: 0.95)	-1.89 (-1.89: 0.95)	0.24 (-4.36: 0.54)	
AKI	**Yes**	6 (15.8%)	8 (26.7%)	0 (0%)	0.24
Need for mechanical ventilation	**Yes**	12 (31.6%)	21 (70%)	1 (16.7%)	0.002
Need for CVL insertion	**Yes**	16 (42.1%)	20 (66.7%)	0 (0%)	0.006
Need for vaso inotropic agents	**Yes**	18 (47.4%)	16 (53.3%)	0 (0%)	0.055
Need for sedation	**Yes**	24 (63.2%)	10 (33.3%)	0 (0%)	0.003
Need for blood product transfusion	**Yes**	38 (100%)	30 (100%)	6 (100%)	---

Table (5) showed that there was significant increase among cases with bronchiolitis regarding post PICU admission in comparison to cases with pneumonia and bronchial asthma. However, there was no significant difference between types of respiratory illness according to pre PICU admission PICU admission and total hospital admission.

Table (5): Relation between types of respiratory illness and duration of hospital stay

Variable		Summary statistics (n=204)			P-value
		Pneumonia (n=38)	Bronchiolitis (n=30)	Bronchial asthma (n=6)	
PICU admission (days)	**Mean ± SD**	17.03 ± 20.35	13.36 ± 8.32	10.66 ± 11.52	0.36
	Median (IQR)	11 (7.75-17.25)	11.5 (6.5-18.5)	6.5 (4.75-14.5)	
Post PICU admission (days)	**Mean ± SD**	4.03 ± 2.9	4.5 ± 5.78	0 ± 0	0.02
	Median (IQR)	5 (0-6)	4 (0-7)	0 (0-0	
Total hospital admission (days)	**Mean ± SD**	24.6 ± 23.19	19.7 ± 13.69	13.66 ± 10.76	0.25
	Median (IQR)	16 (13-35)	14 (10-29.5)	9.5 (6.5-21.25)	

DISCUSSION

Acute otitis media, sinusitis, bronchitis, and community-acquired pneumonia are among the respiratory tract infections (RTIs) that cause the most morbidity, hospitalization, and death among children globally, especially in low-income nations. The WHO reports that pneumonia accounted for 20% and 90% of hospitalized children under the age of five with ARIs in 2016 [(6)].

Furthermore, it is predicted that between 1.9 and 2.2 million children die each year from ARIs, with Africa and Southeast Asia accounting for 70% of these deaths. According to reports, the primary causes of ARIs are viruses and bacteria. The most frequently isolated viruses that cause ARIs in children under five years old include respiratory syncytial viruses, parainfluenza viruses, influenza viruses A and B, and human metapneumovirus. Streptococcus pneumonia and Haemophilus influenzae are the most often identified bacteria in ARIs, and initial viral infections might predispose to subsequent bacterial infections [(7)].

Limited studies were done to assess respiratory illness admitted to PICUs in Egypt. So, the current prospective study was conducted among 204 cases admitted at PICUs, Sohag University Hospitals from May, 2023 to May, 2024 to assess the incidence of respiratory illness and predictors and risk factors for mortality.

Regarding demographic characteristics of the studied cases, the mean age of the studied cases was 3.01 ± 3.62 years with median of 1.7 (0.33-4) years. More than half of cases were males (54.9%) and 45.1% of cases were females. Assessment of rate of respiratory illness showed that 36.27% of admitted cases had respiratory illness, more than half of them had pneumonia (51.4%), bronchiolitis (40.5%) and asthma (8.1%). In agreement of the results the prospective observational study that was done in India found that pneumonia accounted for 66.89% of respiratory hospitalizations among 293 children (Median age: 5 months; range, 1-132 months; male/female: 181/112) [(8)].

This study findings were partially agreed with the findings of the study by **Al-Eyadhy *et al.*** [(9)] on cases up to 14 years of age who were admitted to the PICU at King Khalid Hospital in Saudi Arabia between 2015 and 2018 with a viral infection. The study's objectives were to measure the prevalence of this infection among children admitted to the PICU and describe related outcomes. It revealed that the mean age of the included cases was 20.03 ± 34.83 months, 68.9% of the cases were males, and the primary admitting diagnosis was bronchiolitis (72.6%), pneumonia (13.4%), and asthma (1.2%) [(9)]. The variety in illness prevalence was related to geographic locations and consequent weather changes, or to the possible implications of global climate change with varying location affects, since respiratory disorders displayed seasonal fluctuations.

Our findings were in consistent with the study that was conducted at the PICU of a tertiary care hospital in Karachi, Pakistan, among 279 pediatric patients between January 1, 2021, and December 31, 2022, with the goal of identifying the burden of respiratory diseases, related risk factors, and predictors of morbidity and mortality. The study found that the majority of the patients (178 patients; 63.8%) were males, and the mean age of the cases was 28.4± 43 months with a median of nine months (IQR 4–36 months) [(10)]. The study results weren't in agreement with the findings of the multicenter retrospective study that was conducted on 6426 non-selective admissions admitted to PICU in Australia and indicated that subgroup analyses restricted to patients with ARIs (n=1.241), bronchiolitis (n=761), pneumonia (n=311), confirmed bacterial infection (n=345), and malignancy (n= 95) [(11)].

The study results weren't in agreement to the findings of the study that was conducted on 317 patients who were enrolled from 21 hospitals between November 1 and November 15, 2022, seven in each governorate. These hospitals included general, infectious diseases, and chest hospitals in Cairo, Giza, and Gharbia, Egypt. The study's goal was to assess how the pandemic affected the spread of seasonal non-SARS-CoV-2 respiratory viruses in Egypt, and it

showed that pneumonia accounted for three-fourths of cases, or 75.3% of patients admitted to the intensive care unit [12].

The second most frequent cause of mechanical ventilation (MV) is respiratory disorders. Additionally, children's physical and emotional health are greatly impacted by extended mechanical breathing [13]. Our results are in contrast to **Divecha *et al.*** [8] who reported that MV was required in 62.8% cases. The difference in percentage may be attributed to difference in sample size and severity of disease. Our results were in agreement with the results of who revealed that 27.2% of cases needed MV and 24.1% of cases needed inotrope support [10]. Comparison between causes of respiratory illness indicated that 31.6% of cases with pneumonia need MV in comparison to 70% of cases with bronchiolitis and 16.7% of cases with bronchial asthma. Our results weren't in line with the results of the retrospective study of children admitted to PICU from 2010 to 2014, aimed to characterize the prevalence of severe pneumonia in children and pinpoint risk factors for unfavorable results. which revealed that severe pneumonia consisted of 6.7% of PICU admissions and 68.4% of them needed MV [14].

Our study indicated that there was no significant difference between causes of respiratory illness with hospital and PICU admission. Our findings were in contrast to the findings of the study that was conducted between 2012 to 2015 among cases with pneumonia and bronchiolitis and indicated that cases with pneumonia were associated with increased LOS [11(7-18) vs. 5 (3-9)] days [15]. In our study, comparison between cases with AKI and cases without AKI showed that cases with AKI showed significant increase in need of MV (53.3%) in comparison to cases without AKI (29.9%). Our findings were in agreement with the findings of the study of patients who were admitted to a tertiary PICU that was conducted in Turkey from January 2018 and December 2020 aimed to determine whether children with AKI had a link between their PICU scores or not. The study included 62 cases with AKI and 654 cases without AKI and revealed that there was significant increase in need of MV among cases with AKI (67.77%) in comparison to cases without AKI (26.3%) [16].

Strengths of the study included the prospective design of our study is a significant advantage. Furthermore, we included consecutive PICU patients over a one-year period, increasing representativeness. Our study assessed severity and lines of management of respiratory illness that considered to our knowledge the first one in literature to be conducted in Egypt as the studies were done before discussed only viral respiratory infections.

Limitations included absence of control group and single center unit study.

CONCLUSION

This study showed that respiratory illness represented high burden in PICU admissions and nearly half of cases with acute respiratory infection were due to pneumonia (51.4%). Cases with pneumonia represented the highest value of PIM-3 that indicated severity of disease, which need more concern and successful management. Cases with bronchiolitis showed the highest percentage of mechanical ventilation, CVL insertion, and inotropic agents need.

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REFERENCES

1. **Wardlaw T, Johansson E, Hodge M *et al.* (2006):** Pneumonia: the forgotten killer of children. World Health Organization. https://iris.who.int/handle/10665/43640
2. **Nair H, Af Simões E, Rudan I *et al.* (2013):** Global and regional burden of hospital admissions for severe acute lower respiratory infections in young children in 2010: a systematic analysis. The Lancet, 381(9875): 1380-1390.
3. **Hendricks C, McKerrow N (2016):** Factors present on admission associated with increased mortality in children admitted to a paediatric intensive care unit (PICU). South African Journal of Child Health, 10(1): 57-62.
4. **Khilnani P, Sarma D, Singh R *et al.* (2004):** Demographic profile and outcome analysis of a tertiary level pediatric intensive care unit. Apollo Medicine, 1(2): 161-166.
5. **Shah G, Shah B, Thapa A *et al.* (2014):** Admission patterns and outcome in a pediatric intensive care unit in Nepal. British Journal of Medicine Medical Research, 4(30): 4939-4945.
6. **World Health Organization (2016):** World health statistics 2016: monitoring health for the SDGs, sustainable development goals. World Health Organization. pp. 121. https://iris.who.int/handle/10665/206498
7. **World Health Organization (2017):** Acute respiratory infections in children. World Health Organization. pp. 76. https://iris.who.int/bitstream/handle/10665/61873/WHO_ ARI_90.5. pdf
8. **Divecha C, Tullu M, Chaudhary S (2019):** Burden of respiratory illnesses in pediatric intensive care unit and predictors of mortality: Experience from a low resource country. Pediatr Pulmonol., 54(8): 1234-1241.
9. **Al-Eyadhy A, Almazyad M, Hasan G *et al.* (2023):** The burden of viral infections in pediatric intensive care unit between endemic and pandemic coronavirus infections: A tertiary care center experience. Journal of Infection and Chemotherapy, 29(1): 20-25.
10. **Ishaque S, Bibi N, Dawood Z *et al.* (2024):** Burden of respiratory disease in pediatric intensive care unit: experience from a PICU of a tertiary care center in Pakistan. Crit Care Res Pract., 24:6704727. doi: 10.1155/2024/6704727.
11. **Moynihan K, McGarvey T, Barlow A *et al.* (2020):** Testing for common respiratory viruses in children

admitted to pediatric intensive care: Epidemiology and outcomes. Pediatr Crit Care Med., 21(6): 333-341.

12. **Kandeel A, Fahim M, Deghedy O *et al.* (2023);** Multicenter study to describe viral etiologies, clinical profiles, and outcomes of hospitalized children with severe acute respiratory infections, Egypt 2022. Scientific Reports, 13(1): 21860. doi: 10.1038/s41598-023-48814-x.
13. **Hickey S, Sankari A, Giwa A (2024):** Mechanical ventilation. Treasure Island (FL): StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK539742/
14. **Koh J, Wong J, Sultana R *et al.* (2017):** Risk factors for mortality in children with pneumonia admitted to the pediatric intensive care unit. Pediatr Pulmonol., 52(8): 1076-1084.
15. **Shein S, Kong M, McKee B *et al.* (2016):** 933: Associations between pneumonia and clinical outcomes in picu patients with rsv bronchiolitis. Critical Care Medicine, 44(12): 309. DOI: 10.1097/01.ccm.0000509609.98678.7e
16. **Leblebici A, Bozan G, Tufan A *et al.* (2023):** Comparative analysis of intensive care prognosis scoring systems and acute kidney injury scores (AKIN and pRIFLE) in critically ill children. Children (Basel), 10(3): 484. doi: 10.3390/children10030484.