PREDICTIVE FACTORS FOR PEDIATRIC INTENSIVE CARE UNIT (PICU) ADMISSION IN CHILDREN WITH ASTHMA EXACERBATION IN MCH, ALAHSA

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Abstract:
Background and objective: Childhood asthma is recognized to be one of the most common chronic diseases in children. Several national and international reports have demonstrated an increase in the prevalence of pediatric asthma and asthma-related Pediatric Intensive Care Unit (PICU) admissions. In addition, PICU admission among asthmatic children has been associated with an increase in the risk of asthma-related mortality. However, the predictors and risk factors of acute severe asthma that required PICU admission haven't been identified. Thus, the purpose of this study was to investigate the predictive factors for PICU admission in children with asthma exacerbation.

Methodology: This study was conducted at the inpatient pediatric department of Maternity and Children Hospital (MCH), Alahsa, Saudi Arabia. Seventy-eight asthmatic patients, aged 1-13 years, who were admitted to either PICU or general pediatric ward as a case of asthma exacerbation between October 2022 and May 2023, were enrolled in this study. The diagnosis of asthma was identified by a pediatric allergist or pulmonologist who were involved in the inpatient or outpatient management care. The study design was a cross-sectional. The data collection sheet consisted of 6 sections of different variables including demographical data, characteristics of the current acute asthma exacerbation, asthma history, classification of asthma severity, asthma controlling therapy, and environmental triggers and atopy. The data was collected from the patients' medical records and by interviewing the patients' parents/caregivers.

Results: A total of 78 patients were enrolled in the study over a period of 8 months. Fifty-seven patients (73.1%) were admitted to the pediatric ward and 21 patients (26.9%) were admitted to the PICU. The gender ratio was approximately equal, with slight male predominance (56.4%). The mean age for the overall study population was 4.0 ± 2.6 years. The majority of the patients have healthy weight (42.3%) in both groups, with no obese patient was admitted to the PICU.
Baseline mean SPO2 saturation was found to be higher in those admitted to the ward (p=.000). Around 87% of the patients received systemic steroids at the ED before hospitalization. The percentage of patients who used systemic steroids in the ED was higher for those admitted to the PICU. Around 97% of the patients' exacerbations were triggered by infection. Meanwhile, mean length of stay was found to be approximately 33% (4.4 ± 2.2) higher in the PICU admissions (p=.043).
Less than one-fifth of the total cohort has been found to be following up in the outpatient clinic the

previous year (11/78, 14%). The history of prior therapy with ICS was found to be more prevalent in those who were admitted to PICU. Similarly, previous PICU admissions and prior hospital admissions were also more prevalent in those admitted to the PICU. However, it hasn't been shown to be statically significant.

Statistically significant differences were detected between SpO2 levels among children who were admitted to PICU as compared to those admitted to the pediatric ward, (86.2 ± 6.8%, p=.000). For each unit increase in the SpO2, there is a 0.8-fold increase in the odds of being admitted to the PICU (OR 0.8, 95% CI: 0.7–0.8, p=0.001). Nevertheless, pCO2 was another predictive factor for PICU admission, (OR 1.1, 95% CI: 1.0–1.2, p=0.013). Notably, previous PICU admission, last year admissions, and last year ED visits could not be quantified as predictive factors for PICU admission with statistical significance. Similarly, risk analysis between PICU admission and the type and severity of asthma did not reveal statistically significant results.

Conclusion: Oxygen saturation (SpO2) measurements at the ED and pCO2 level are predictors of needing intensive care admission for children with acute severe asthma exacerbation, aged 1–13 years. Further large-scale studies are needed to explore the modifiable predictors that would help in identifying children with a high risk for intensive care admissions.

INTRODUCTION:

Asthma is a common heterogenous respiratory disease in children, that usually characterized by chronic airway inflammation, obstruction, and hyperresponsiveness. [1] It is typically associated with recurrent reversible symptoms of shortness of breath, wheezing, cough, and chest tightness expressed by older children. [1][2]

Childhood asthma is recognized to be one of the most common chronic diseases in children.[3] The prevalence of asthma appears to be increasing globally, however, there is a wide variability across countries. While most areas have had an increase in the prevalence of asthma trends, some countries have maintained a plateau. [3][4]

As for Saudi Arabia, the Saudi Initiative for Asthma 2021 (SINA-2021) Guidelines have demonstrated a rise in the prevalence of childhood asthma, with a percentage reaching up to 25%.[2]

A cross-sectional study was designed to evaluate the asthma prevalence in Saudi Arabia over a period of 17 years, enrolling more than 1600 school-aged children selected randomly from different regions. It was concluded that there was a variability of asthma prevalence between different cities in the Kingdom, with the highest prevalence being in Hofuf city (Eastern area) reaching 33.7% and the lowest was in Jeddah city (Western area) with a percentage of 14.1%. [5]

There are several factors that have been suggested to be the contributors behind the increase of asthma prevalence in Saudi Arabia. These include lifestyle and dietary habits changes, increased asthma awareness and knowledge among Saudi physicians and population, hygiene hypothesis, and environmental factors, such as air pollutants, tobacco smoke exposure, and indoor allergens.[2]

Pediatric Asthma represents a huge burden on children and their caregivers, concerning the impaired quality of life, school and work absenteeism, recurrent emergency department (ED) visits, hospitalizations, and mortalities. [2] It is characterized by unpredictable acute attacks of worsening symptoms with variable severity, ranging from mild exacerbation that can be managed at home or ED to severe fatal or near-fatal exacerbation that required mechanical ventilation and Pediatric Intensive Care Unit (PICU) admission. [1]

A variety of factors has been identified to be the common triggers of asthma exacerbation. Respiratory infections, allergen exposure, including aeroallergens and food allergens, and inhaled respiratory irritants are among the major triggers for acute asthma attacks. [1][6] On the other hand, the Global Initiative for Asthma (GINA) Guidelines have established specific characteristics that are distinctly related to asthma-related mortalities. These features include a history of near-fatal asthma, history of hospitalization or ED visit in the past year, poor compliance to inhaled corticosteroid (ICS) and asthma control management plan, not being on regular ICS, recent use of

oral corticosteroid, and food allergy. [1]

Even though there have been multiple national and international reports that have demonstrated the increase in the prevalence of pediatric asthma, only limited studies were conducted on children with asthma-related PICU admissions. [7] Al-Eyadhy et al. published a study describing the clinical course of asthmatic Saudi children who required PICU admission for acute severe asthma and compared the outcomes with a local cohort that was conducted 10 years prior.

It was concluded that the rate of PICU admissions has significantly increased fourfold the number of the previous cohort. [8]

Relatively, few studies have identified the risk factors of PICU admission among children with asthma exacerbation, despite the noticeable increase in the prevalence of asthma-related PICU admission. [8][9] Belessis et al. reported various predisposing factors for PICU admission in asthmatic children including multiple ED visits during the past year, atopy with high level of serum immunoglobulin E (IgE), hypoxia on ED presentation with oxygen saturation (SpO$_2$) $\leq$ 91%, and longer asthma duration. [9]

A more recent study was published in Iran, investigating the clinical predictors of intensive care unit admission for asthmatic children, concluded that initial vital sign and blood gas analysis in the ED are identified predictors of severe asthma attack and subsequent PICU admission. [10]

Although PICU admission among asthmatic children has been associated with an increase in the risk of asthma-related mortality and the studies demonstrated an increase in the prevalence of PICU admission among asthmatic children, the predictors and risk factors of acute severe asthma that required PICU admission haven't been identified. [1][8][9] Therefore, the purpose of this study was to investigate the predictive factors for PICU admission in children with asthma exacerbation.

Materials and Methods
1.1 STUDY DESIGN:
Retrospective cross-sectional study

1.2 STUDY AREA:
The inpatient pediatric department of Maternity and Children Hospital (MCH), Alahsa, Saudi Arabia.

1.3 STUDY DURATION:
From the first of October 2022 to the thirty-first of May 2023.

1.4 STUDY POPULATION:
Seventy-eight asthmatic children were admitted to pediatric intensive care unit (PICU) and general pediatric ward with asthma exacerbation, in Maternity and Children Hospital (MCH).

Inclusion Criteria:
1. Age 1-13 years.
2. Presentation of asthma exacerbation.
3. Hospitalization to either PICU or general pediatric ward.

Exclusion criteria:
1. Children younger than 1 year.
2. Chronic pulmonary disease.
3. Hemodynamically significant congenital heart disease.
4. Foreign body inhalation.
5. Immunodeficiency.

Sample size and Sampling Technique:
- Sample Size: The estimated sample size is 384 patients, calculated by using the formula: n = P (P-1)/ (1.96/0.05)2, P= 50%.
- Sample Technique: Convenience.

1.5 STUDY PROCEDURE:
Asthmatic children aged 1-13 years, who were admitted to either PICU or general pediatric ward as a case of asthma exacerbation, were enrolled in this study. An informed consent was obtained from all the participants. The diagnosis of asthma was identified by a pediatric allergist or pulmonologist who were involved in the inpatient or outpatient management care. The design is a retrospective cross-sectional study including children who were admitted to PICU from the ED, referred from a local hospital or PHC requiring
PICU management, or transferred from the general pediatric ward, and children who were admitted to the general pediatric ward.
The data collection sheet was regulated based on GINA-identified factors that associated with an increase in the risk of asthma-related deaths, Asseri's study on the predictors of PICU admission among asthmatic children, and Belessis's cohort about the risk factors for PICU admission in children with asthma. [1][7][9] It consists of 6 sections of different variables including demographical data, characteristics of the current acute asthma exacerbation, asthma history, classification of asthma severity, asthma controlling therapy, and environmental triggers and atopy (Appendix 1). The data was collected from the patients' medical records and by interviewing the patients' parents/caregivers.

1.6 STATISTICAL ANALYSIS:
Data was analyzed using Statistical Package for the Social Sciences (SPSS), version 25.0.1. The data differences between PICU admissions and general pediatric ward admissions of the continuous normally distributed variables were analyzed by Student's t-test and presented as means (standard deviation). The categorical variables and their differences were assessed using a descriptive model and presented as frequencies and percentages of responses. The association between the categorical variables was tested using Pearson's Chi-sq test. The independent sample t-test was used to analyze the correlation between the continuous variables. For all analyses, P-value of <0.05 was regarded of a statistical significance.

4. RESULTS:
4.1. Baseline characteristics of the patients (Table 1):
A total of 78 patients were enrolled in the study over a period of 8 months. Fifty-seven patients (73.1%) were admitted to the pediatric ward and 21 patients (26.9%) were admitted to the PICU. The gender ratio was approximately equal, with slight male predominance (56.4%). The mean age for the overall study population was 4.0 ± 2.6 years. The majority of the patients have healthy weight (42.3%) in both groups, with no obese patient was admitted to the PICU. In addition, most of the patients in both groups were breastfed during the first 4-6 months of life (69.2%). No statistically significant differences were detected in the demographic characteristics with respect to children admitted to the pediatric ward and the PICU. The rest of the baseline demographic characteristics are shown in Table 1.

4.2. Characteristics of the Current Acute Asthma Exacerbation (Table 2):
Baseline mean SPO2 saturation was found to be higher in those admitted to the ward (91.2 $\pm$ 4.1, p=.000). Around 87% of the patients received systemic steroids at the ED before hospitalization. Dexamethasone was the commonly used type of steroid in 54/78 (69.2%). The percentage of patients who used systemic steroids in the ED was higher in the children admitted to the PICU. Around 97% of the patients' exacerbations were triggered by infection. Meanwhile,

mean length of stay was found to be approximately 33% (4.4 ± 2.2) higher in the PICU admissions (p=.043). Although the majority of the hospitalizations were during winter (84.6%), interestingly, most of the cases admitted during the spring season and all the summer admissions were admitted to the PICU. Though the season at the time of hospitalization was statically significant (p=.000), the other mentioned variables have no statistically significant differences between the PICU and general pediatric ward admissions.

In terms of laboratory parameters, mean pH and the partial pressure of carbon dioxide (pCO_2) were found to be higher in those admitted to PICU (p=.027 and .006, respectively). The total white blood cell and eosinophils counts did not differ between the two groups. Around 67% of the asthmatic children admitted in PICU have a finding of hyperinflation in chest X-ray.

4.3. Asthma/Atopy History (Table 3):

Less than one-fifth of the total cohort has been found to be following up in the outpatient clinic the previous year (11/78, 14%). The history of prior therapy with ICS was found to be more prevalent in those who were admitted to PICU, although ICS use was observed in about 19% of the patients, with only 4% were compliant to their medications. Similarly, previous PICU admissions and prior hospital admissions were also more prevalent in those admitted to the PICU. Furthermore, ED visits in the last year tend to be more frequent among the children admitted to the PICU. However, it hasn't been shown to be statically significant. As it is shown in table 3 that most of the patients who were hospitalized during the spring season were admitted to the PICU, allergic rhinitis was more prevalent in the PICU hospitalizations in comparison to the general pediatric ward admissions, but without significant differences. Interestingly, the patients' history of food allergy did not differ significantly between the two groups.

Table 1: Demographic characteristics

Variable	Overall (n=78)	Ward admission (n=57) 73.1%	PICU admission (n=21) 26.9%	p-value
Age (years), mean ± S.D	4.0 ± 2.6	4.1 ± 2.6	4.0 ± 2.6	.861
Weight (kg)	16.2 ± 7.3	16.5 ± 7.5	15.4 ± 6.9	.558
Age at the onset of first wheezing episode	1.4 ± 1.6	1.4 ± 1.5	1.3 ± 1.7	.757
Nationality (n)	Saudi = 74 (94.9%) Non-Saudi = 4 (5.1%)	Saudi = 55 (96.5%) Non-Saudi = 2 (3.5%)	Saudi = 19 (90.5%) Non-Saudi = 2 (9.5%)	.285
Gender	Males = 44 (56.4%) Females = 34 (43.6%)	Males = 34 (60.0%) Females = 23 (40.0%)	Males = 10 (47.6%) Females = 11 (52.4%)	.342
BMI	Underweight = 17 (21.8%) Healthy = 33 (42.3%) Overweight = 4 (5.1%) Obese = 9 (11.5%)	Underweight = 11 (19.3%) Healthy = 27 (47.4%) Overweight = 2 (3.5%) Obese = 9 (15.8%)	Underweight = 6 (28.6%) Healthy = 6 (28.6%) Overweight = 2 (9.5%) Obese = 0	.055
Breastfed during the first 4-6 months	54 (69.2%)	42 (73.7%)	12 (57.1%)	.160
Family history of eczema	34 (43.6%)	27 (47.4%)	7 (33.3%)	.268
Family history of asthma	51 (65.4%)	37 (64.9%)	14 (66.7%)	.885
Family history of food allergies	13 (16.7%)	11 (19.3%)	2 (9.5%)	.304
Family history AR	38 (48.7%)	30 (52.6%)	8 (38.1%)	.255

Table 2: Characteristics of the Current Acute Asthma Exacerbation:

Variable	Overall (n=78)	Ward admission (n=57) 73.1%	PICU admission (n=21) 26.9%	p-value
Time from the onset of wheeze till systemic steroid use	3.2 ± 3.1	3.2 ± 3.1	3.2 ± 3.1	.980
SPO2 in ED	89.8 ± 5.4	91.2 ± 4.1	86.2 ± 6.8	.000*
Temperature in ED	37.3 ± 0.9	37.4 ± 0.9	37.2 ± 0.8	.453
Steroid use in ED	None = 10 (12.8%) Hydrocortisone = 5 (6.4%) Dexamethasone = 54 (69.2%) Methylprednisolone = 9 (11.5%) Prednisone = 0	None = 7 (12.3%) Hydrocortisone = 4 (7.0%) Dexamethasone = 41 (72.0%) Methylprednisolone =5 (8.8%) Prednisone = 0	None = 3 (14.3%) Hydrocortisone = 1 (4.8%) Dexamethasone = 13 (61.9%) Methylprednisolone = 4 (19.0%) Prednisone = 0	.643
Laboratory parameters				
pH, mean ± S.D	7.3 ± 0.1	7.3 ± 0.0	7.3 ± 0.1	.027*
pCO2, mean ± S.D	40.0 ± 9.2	38.2 ± 7.7	44.8 ± 11.0	.006*
WBC, mean ± S.D	12.6 ± 5.9	12.3 ± 5.9	13.4 ± 6.2	.440
Neutrophil count, mean ± S.D	75.4 ± 16.0	74.7 ± 15.3	76.9 ± 17.8	.647
Lymphocyte count, mean ± S.D	18.9 ± 13.7	19.3 ± 12.8	17.8 ± 15.9	.746
Eosinophil count, mean ± S.D	0.4 ± 0.7	0.4 ± 0.8	0.3 ± 0.6	.553
CXR findings	Normal = 9 (11.5%) Hyperinflation = 57 (73.1%) Pneumonic infiltration = 12 (15.4%)	Normal = 7 (12.3%) Hyperinflation = 43 (75.4%) Pneumonic infiltration = 7 (12.3%)	Normal = 2 (9.5%) Hyperinflation = 14 (66.7%) Pneumonic infiltration = 5 (23.8%)	.452
Admission trigger	Infection = 76 (97.4%) Inhaled irritants = 2 (2.6%)	Infection = 55 (96.5%) Inhaled irritants = 2 (3.5%)	Infection = 21 (100%) Inhaled irritants = 0	.385
Season	Spring = 5 (6.4%) Summer = 3 (3.8%) Winter = 66 (84.6%) Autumn = 4 (5.1%)	Spring = 1 (1.8%) Summer = 0 Winter = 54 (94.7%) Autumn = 2 (3.5%)	Spring = 4 (19.0%) Summer = 3 (14.3%) Winter = 12 (57.1%) Autumn = 2 (9.5%)	.000*
Systemic steroid use during the last month	13 (16.7%)	9 (15.8%)	4 (19.0%)	.732
ICS use during the last month	27 (34.6%)	19 (33.3%)	8 (38.1%)	.695
Length of stay	3.6 ± 2.2	3.3 ± 2.1	4.4 ± 2.2	.043*

Table 3: Asthma History, Atopy and Environmental Triggers:

Variable	Overall (n=78)	Ward admission (n=57) 73.1%	PICU admission (n=21) 26.9%	p-value
Duration of asthma, mean ± S.D	2.7 ± 2.1	2.7 ± 2.1	2.8 ± 2.1	.731
Last year admissions	0.5 ± 1.5	0.5 ± 1.6	0.5 ± 1.4	.995
Last year ED visits	5.0 ± 4.8	4.4 ± 4.0	6.7 ± 6.3	.063
Admission history	22 (28.2%)	16 (28.1%)	6 (28.6%)	.965
Previous PICU admission	7 (9.0%)	5 (8.8%)	2 (9.5%)	.918
Follow up in clinic	11 (14.1%)	6 (10.5%)	5 (23.8%)	.135
Following up on management plan	10 (12.8%)	6 (10.5%)	4 (19.0%)	.318

On regular ICS	Yes, compliant = 3 (3.8%) Yes, non-compliant = 12 (15.4%) No = 63 (80.8%)	Yes, compliant = 2 (3.5%) Yes, non-compliant = 6 (10.5%) No = 49 (86.0%)	Yes, compliant = 1 (4.8%) Yes, non-compliant = 6 (28.6%) No = 14 (66.7%)	.134
Asthma classification	Intermittent = 25 (32.1%) Mild persistent = 10 (12.8%) Moderate persistent = 16 (20.5%) Severe persistent = 8 (10.3%) Episodic mild intermittent = 12 (15.4%) Seasonal =7 (9.0%)	Intermittent = 19 (33.0%) Mild persistent = 6 (10.5%) Moderate persistent = 11 (19.3%) Severe persistent = 6 (10.5%) Episodic mild intermittent = 10 (17.5%) Seasonal =5 (8.8%)	Intermittent = 6 (28.6%) Mild persistent = 4 (19.0%) Moderate persistent = 5 (23.8%) Severe persistent = 2 (9.5%) Episodic mild intermittent = 2 (9.5%) Seasonal =2 (9.5%)	.877
Previous ICS use	17 (21.8%)	10 (17.5%)	7 (33.3%)	.134
Asthma controlling therapy	None = 63 (80.8%) ICS = 10 (12.8%) ICS + LABA = 2 (2.6%)	None = 49 (86.0%) ICS = 4 (7.0%) ICS + LABA = 1 (1.8%)	None = 14 (66.75) ICS = 6 (28.6%) ICS + LABA = 1 (4.8%)	.095

	ICS + Montelukast = 1 (1.3%) ICS + LABA + Montelukast = 2 (2.6%)	ICS + Montelukast = 1 (1.8%) ICS + LABA + Montelukast = 2 (3.5%)	ICS + Montelukast = 0 ICS + LABA + Montelukast = 0	
Food allergy	17 (21.8%)	13 (22.8%)	4 (19.0%)	.721
Allergic rhinitis	24 (30.8%)	17 (29.8%)	7 (33.3%)	.766
Allergic conjunctivitis	12 (15.4%)	10 (17.5%)	2 (9.5%)	.384
Eczema	26 (33.3%)	21 (36.8%)	5 (23.8%)	.279
Smoking Exposure	22 (28.2%)	16 (28.1%)	6 (28.6%)	.965
Inhaled irritants Trigger	54 (69.2%)	37 (64.9%)	17 (81.0%)	.173
Pets	8 (10.3%)	5 (8.8%)	3 (14.3%)	.476
Carpets	10 (12.8%)	9 (15.8%)	1 (4.8%)	.196

4.4. Predictors of PICU admission (Table 4):

Statistically significant differences were detected between SpO2 levels among children who were admitted to PICU as compared to those admitted to the pediatric ward, (SpO2 in PICU group = $86.2 \pm 6.8\%$, p=.000). For each unit increase in the SpO2, there is a 0.8-fold increase in the odds of being admitted to the PICU (OR 0.8, 95% CI: 0.7–0.8, p=0.001; Table 4). Nevertheless, pCO2 was another predictive factor for PICU admission, (OR 1.1, 95% CI: 1.0–1.2, p=0.013; Table 4).

Notably, previous PICU admission, last year admissions, and last year ED visits could not be quantified as predictive factors for PICU admission with statistical significance. Similarly, risk analysis between PICU admission and the type and severity of asthma did not reveal statistically significant results.

Table 4: Predictive factors for PICU admission:

Variable	Odds ratio (95% CI)	p-value
Pco2	*1.1 (1.0 to 1.2)*	*.013**
ER SPO2	*0.8 (0.7 to 0.9)*	*.001**
Previous PICU admission	1.1 (0.3 to 3.7)	.918
Last year admissions	1.0 (0.7 to 1.4)	.995
Last year ED visits	1.1 (0.9 to 1.2)	.068

DISCUSSION:
5.2. Criteria for PICU admission:
Children were admitted to the PICU if they failed to show a clinical response to the initial acute asthma management, (including nebulized salbutamol, nebulized budesonide, nebulized ipratropium bromide, and magnesium sulfate (MgSo4) boluses), having significant respiratory distress needing respiratory support, exhaustion, worsening gas exchange as evident by SpO2 on pulse oximetry or by pCO2 in venous blood gases, or an altered sensorium.

5.2. Predictors of PICU admission:
This prospective cross-sectional study demonstrated two significant predictive factors for PICU admission in children with acute severe asthma. Oxygen saturation (SpO2) at the ED presentation and pCO2 level in the first blood gas taken in the ED are identified as significant predictive factors for PICU hospitalizations. Although there were no statically significant values in the history of previous PICU admissions and prior hospital admissions, they were found to be more prevalent in asthmatic children admitted to the PICU. In addition, the ED visits in the last year were more frequent among the patients admitted to the PICU. These findings highlight the importance of taking history, initial vital signs and blood gas in children presenting to the ED with acute asthma exacerbation.

Maher et al. reported a significant clinical correlation between the initial pCO2 and SpO2 levels and PICU admission, which is in accordance with our results, (SaO2 = 81±16.32 p=0.02, PaCo2 55±13.33, p=0.03).[10]

Asseri A. reported the importance of measuring oxygen saturation at the ED triage as an independent predictor for PICU admissions (OR 0.89, 95% CI: 0.80–0.99, p=0.03). Furthermore, it was identified that a history of previous admissions to the PICU is another significant predictor with high odds of being admitted to the PICU during the current asthma exacerbation.[7] Belessis et al. reported that an oxygen saturation of less than 91% is a risk factor for PICU admission in asthmatic children. Moreover, three or more presentations to the ED in the preceding 12 months and longer asthma duration were found to be statically significant risk factors for PICU admission.[9] Nevertheless, a very recent study, published in 2021, identified a lower SpO2 level within the first hour of ED presentation to be one of the independently associated factors for PICU admission, with odds of PICU admission increased 34% for each 5% lower SpO2.[11]

However, a previous clinical multicenter study published by Keahey et al. does not support using SpO2 alone as a clinically useful predictor of hospital admission in children who present to the ED with acute asthma.[12]

On the other hand, taking pCO2 level in the first blood gas in the ED as a significant predictive factor for PICU admission was not supported by some literatures. Belessis et al. demonstrated that most of their cohort in identifying the risk factors for PICU admission didn't have hypercapnic respiratory failure at the time of the presentation[9]. Moreover, Asseri A.'s cohort showed no significant difference in blood gas between the PICU and the general pediatric ward groups.[7]

Depending on pCO2 level as a predictor for PICU admission among asthmatic patients has several limitations. It is associated with a higher cost in asthma management and some ED lack the availability of blood gas analysis machine. However, further studies are needed to determine the

importance of pCO2 level as a predictive factor for PICU admission

5.3. Limitations:

The limitations of the study are that it consists of a small cohort, most of the data was taken during winter season, and part of the data collection was from interviewing the parents/care givers and depending on their memories to recite the history of their children's asthma.

5. CONCLUSION:

Oxygen saturation (SpO2) measurements at the ED and pCO2 level are predictors of needing intensive care admission for children with acute severe asthma exacerbation, aged 1–13 years. Further large-scale studies are needed to explore the modifiable predictors that would help in identifying children with a high risk for intensive care admissions.

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