

Original Research Article

Oxygen requirements in multisystem inflammatory syndrome in children admitted in tertiary care hospital of North India

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ABSTRACT

Background: Study was aimed to describe the oxygen requirements among children admitted as multisystem inflammatory syndrome in children (MIS-C) in Indira Gandhi Medical College, Shimla.

Methods: We conducted a cross-sectional study, from January 2021 to July 2021, in the pediatric ward of Indira Gandhi Medical College (IGMC), Shimla. Children admitted with a diagnosis of MIS-C were included. Data regarding socio-demographic factors and oxygen requirements were extracted and analyzed using Epi Info V7 software.

Results: A total 31 children diagnosed as MIS-C were included. Tachypnea was present in 18 (58.1%) respiratory distress in 15 (48.4%). Optimal oxygen saturation (SpO₂) more than 94% in 9 (25.8%), 93-94% in 8 (25.8%), 91-92% in 5 (16.1%), 86-90% in 2 (6.5%), 81-85% in 4 (12.9%), 75-80% in 1 (3.2%), 71-75% in 1 (3.2%) and <60% in 1 (3.2%). Oxygen at the rate of 2 l/min in 1 (3.2%), 3 l/min in 2 (6.5%), 4 l/min in 1 (3.2%), 5 l/min in 5 (16.1%) and 10 l/min in 9 (29.0%), was given through nasal prong in 1 (3.2%), Venturi mask in 3 (9.7%), NRM in 7 (22.6%) and mechanical ventilation in 7 (22.6%). Duration was for 2 days in 4 (12.9%), for 3 days in 7 (22.6%), for 4 days in 3 (9.7%), for 7 days in 1 (3.2%), for 10 days in 1 (3.2%), for 11 days in 1 (3.2%) and for 13 days in 1 (3.2%). Ventilatory support was given to 7 (22.6%), for 4 days in 2 (6.5%), for 7 days in 2 (6.5%), for 10 days in 1 (3.2%), for 11 days in 1 (3.2%) and for 13 days in 1 (3.2%).

Conclusions: Oxygen is a crucial component of MIS-C therapy, children, observing a dip in SpO₂ level should immediately start oxygen therapy.

Keywords: Oxygen requirement, Multisystem inflammatory syndrome in children, Respiratory distress

INTRODUCTION

Pulmonary involvement presenting as severe respiratory distress is the most concerning clinical presentation of multisystem inflammatory syndrome in children (MIS-C) in any age group. Initial reports during the COVID-19 pandemic suggested that children have milder illness during acute infection. Severe respiratory illness in MIS-C typically occurs, towards the end of the first week after the onset of symptoms. The most common presenting

symptom is breathlessness or dyspnea, which is often accompanied by hypoxemia, which worsens as the disease progresses. Patients with severe respiratory distress typically require supplemental oxygen therapy and need to be monitored closely for worsening of respiratory status because these patients may progress to severe acute respiratory distress syndrome.^{1,2}

Coronavirus remains to be a predominantly respiratory virus that gravely impairs respiratory function, causing

widespread inflammation in the vital organs like lungs, heart, skin, and gastrointestinal tract. Inflammation in the lungs and respiratory tract can cause a diminished supply of oxygenated blood in the body, making a patient breathless, developing a dry cough, and experiencing breathing difficulties.³⁻⁵

Normal oxygen saturation levels lie between 94 to 99% in any individual. When the coronavirus causes lung inflammation, by attaching to the angiotensin converting enzyme-2 (ACE-2) receptors, using it to gain entry into the cells, and it takes over the cell machinery to replicate itself and infect other cells, resulting in damage to the alveoli, affecting the epithelial as well as the endothelial cells, resulting in pulmonary edema, pneumonia, thus, impairing gas exchange leading to a drop in oxygen saturation levels in the body. When the optimal oxygen saturation (SpO₂) levels drop below 93%, it is a sign that the patient immediately needs oxygen therapy. Medical oxygen therapy is then required when they are unable to use environmental oxygen to maintain the oxygen demand of the tissue systems.³⁻⁶

The SpO₂ in children is considered in between 92% to 96%. Considering direct and indirect evidence from experience in children with MIS-C across the globe suggests that a SpO₂ less than 92% or more than 96% may be harmful to health.^{1,4,5}

There is a paucity of data regarding oxygen requirement in MIS-C-affected children in this hilly region located at a height of 7400 feet. Against this backdrop, the study was conducted to describe the degree of oxygen requirements among children admitted as a case MIS-C in Indira Gandhi Medical College (IGMC), Shimla.

Aims and objectives

Aims and objectives include: to evaluate the oxygen requirements associated with MIS-C.

METHODS

We conducted a retrospective, review of hospital records of children admitted, the tertiary care center of the Western Himalayas, at the Department of Pediatrics, IGMC, Shimla in Himachal Pradesh. The study was carried out in between January 2021 to July 2021.

All children admitted to the pediatric department fulfilling the diagnostic criteria as per the operational definition of MIS-C as per World Health Organization (WHO) criteria were included in the study. Operational definition for a case of MIS-C, children and adolescents 0–19 years of age with fever >3 days, and two of the following: rash or bilateral non-purulent conjunctivitis or mucocutaneous inflammation signs (oral, hands or feet); hypotension or shock; features of myocardial dysfunction, pericarditis, valvulitis, or coronary abnormalities (including echocardiography (ECHO) findings or elevated

troponin/NT-proBNP); evidence of coagulopathy (by PT, PTT, elevated d-dimers); and acute gastrointestinal problems (diarrhea, vomiting, or abdominal pain). Elevated markers of inflammation such as erythrocyte sedimentation rate (ESR), C-reactive protein, or procalcitonin. No other obvious microbial cause of inflammation, including bacterial sepsis, staphylococcal or streptococcal shock syndromes. Evidence of COVID-19 (RT-PCR, antigen test or serology positive), or likely contact with patients with COVID-19.

Age

The study excludes patients with perinatal related lung disease.

Timing

Within 1 week of a known clinical insult, respiratory failure not fully explained by cardiac failure or fluid overload, chest imaging findings of new infiltrate(s) consistent with acute pulmonary parenchymal disease on invasive mechanical ventilation.

Pediatric acute respiratory distress syndrome (PARDS) (no severity stratification)

Full face-mask bi-level ventilation or continuous positive airway pressure (CPAP) >5 cm H₂O, PF ratio <300, SF ratio <264, invasive mechanical ventilation - mild: 4<OI<8, or 5<OSI<7.5; moderate: 8<OI<16, or 7.5<OSI<12.3; and severe: OI>16, or OSI>12.3.⁷

The study was approved by the institutional ethics committee. The data were collected from the record files of admitted children, compiled and entered in Microsoft excel, and analyzed using appropriate statistical tools in software Epi info V7 by applying the appropriate statistical test in terms of frequencies and percentage.

RESULTS

In the present study, a total of 31 children were diagnosed and admitted as a case of MIS-C in the pediatric ward of IGMC Shimla in Himachal Pradesh in between January 2021-July 2021.

In this study, the mean age of the children diagnosed with the MIS-C was 7.12±4.78 years. 12 (38.7%) children belonged to the age group 5-10 years followed by 10 (32.3%) of age group 6-10 years, 8 (25.8%) of 11-15 years, and 1 (3.2%) of 15-19 years age group. Of the total, 51.6% were males while 48.4% were females. 29 (93.5%) belonged to rural areas while 2 (6.5%) to urban areas. We studied the respiratory symptoms and the level of oxygen saturation at presentation. The most common presenting symptom was tachypnea seen in 58.1% (n=18) children while respiratory distress was present in 48.4% (n=15) patient. At time of admission SpO₂ (measured by pulse oximeter) was more than 94% in 25.8% (n=9) children, 93-

94% in 25.8% (n=8) children, 91-92% in 16.1% (n=5), 86-90% in 6.5% (n=2), 81-85% in 12.9% (n=4), 75-80% in 3.2% (n=1), 71-75% in 3.2% (n=1) and <60% in 3.2% (n=1) (Table 1).

Table 1: Respiratory presentation among MIS-C cases.

Respiratory presentation	Frequency	Percent
Tachypnea		
Yes	18	58.1
No	13	41.9
Respiratory distress		
Yes	15	48.4
No	16	51.6
SpO₂ at admission (%)		
94 or above	9	29.0
93-94	8	25.8
91-92	5	16.1
86-90	2	6.5
81-85	4	12.9
75-80	1	3.2
71-75	1	3.2
<60	1	3.2

Table 2: Oxygen support in MIS-C cases.

Oxygen support	Frequency	Percent
Respiratory support		
Yes	16	51.6
No	15	48.4
O₂		
Yes	18	58.1
No	13	41.9
Rate (l/min)		
Not given	13	41.9
2	1	3.2
3	2	6.5
4	1	3.2
5	5	16.1
10	9	29.0
Modality of administration		
Not given	13	41.9
Nasal prong	1	3.2
Venturi mask	3	9.7
NRM	7	22.6
Ventilator	7	22.6
Duration of O₂ (days)		
0	13	41.9
2	4	12.9
3	7	22.6
4	3	9.7
7	1	3.2
10	1	3.2
11	1	3.2
13	1	3.2

Respiratory support was needed by 51.6% (n=16) children. Support in the form of oxygen inhalation was given to 58.1% (n=18) children, of these O₂ was given at rate of 2 l/min in 1 (3.2%) patient, 3 l/min in 2 (6.5%) patients, 4 lit/min in 1 (3.2%) patient, 5 l/min in 5 (16.1%) and 10 l/min in 9 (29.0%) patients. 18 patients, received O₂ through nasal prong in 1 (3.2%) patient, through Venturi mask in 3 (9.7%) patients, through non rebreathing mask (NRM) in 7 (22.6%) patients and 7 (22.6%) patients, required mechanical ventilation. Duration of oxygen support for 2 days in 4 (12.9%) patients, for 3 days in 7 (22.6%) patients, for 4 days in 3 (9.7%) patients, for 7 days in 1 (3.2%), for 10 day in 1 (3.2%) patient, for 11 days in 1 (3.2%), for 13 days in 1 (3.2%) patient (Table 2).

Mechanical ventilation was required in 22.6% (n=7) patients. Among these, 2 (6.5%) patients remained on mechanical ventilation for 4 days, 2 (6.5%) children for 7 days, 1 (3.2%) for 10 days, 1 (3.2%) for 11 days and 1 (3.2%) child for 13 days (Table 3).

Table 3: Ventilatory support in MIS-C cases.

Ventilatory support	Frequency	Percent
0	24	77.4
1	7	22.6
Duration of mechanical ventilation		
0	24	77.4
4	2	6.5
7	2	6.5
10	1	3.2
11	1	3.2
13	1	3.2

DISCUSSION

Supplementary oxygen therapy is needed when respiratory symptoms like breathlessness start to progress and become severe. For example, a child suffering from MIS-C may also require supplementary oxygen therapy when his/her shortness of breath/tachypnea progresses to respiratory distress. Early respiratory support in the form of oxygen therapy, helps to alleviate the distressing symptoms and also lowers the risk to progress to severe respiratory distress.³⁻⁶

In the present study age of the children diagnosed as a MIS-C was 7.12±4.78 years. Maximum 12 (38.7%) were of age group 5-10 years followed by 10 (32.3%) of age group 6-10 years, 8 (25.8%) of 11-15 years, and 1 (3.2%) of 15-19 years age group. Of the thirty-one children, 16 (51.6%) were males while 15 (48.4%) were females. 29 (93.5%) belonged to the rural area while 2 (6.5%) to the urban areas. Similar types of results were observed in the studies done by Hoste et al, Fouriki et al, Leora et al and Ahmed et al.⁷⁻¹¹

Tachypnea was the only respiratory symptom in 18 (58.1%) children while, 15 (48.4%) presented as severe

respiratory distress. Among the total 31 children, SpO₂ greater than 94% was seen in 9 (25.8%), 93-94% in 8 (25.8%), 91-92% in 5 (16.1%), 86-90% in 2 (6.5%), 81-85% in 4 (12.9%), 75-80% in 1 (3.2%), 71-75% in 1 (3.2%) and <60% in 1 (3.2%) children. Of these respiratory support was required in 16 (51.6%) and oxygen inhalation was required in 18 (58.1%) children. Rate of oxygen delivery was, rate of 2 l/min in 1 (3.2%), 3 l/min in 2 (6.5%), 4 l/min in 1 (3.2%), 5 l/min in 5 (16.1%) and 10 l/min in 9 (29.0%). Mode of oxygen delivery was through nasal prong in 1 (3.2%), by Venturi mask in 3 (9.7%), through NRM in 7 (22.6%) and mechanical ventilation in 7 (22.6%) patients. Duration of O₂ therapy was for 2 days in 4 (12.9%), for 3 days in 7 (22.6%), for 4 days in 3 (9.7%), for 7 days in 1 (3.2%), for 10 days in 1 (3.2%), for 11 days in 1 (3.2%) and for 13 days in 1 (3.2%) child. Mechanical ventilation support was given to 7 (22.6%) children, among these, for 4 days in 2 (6.5%), for 7 days in 2 (6.5%), for 10 days in 1 (3.2%), for 11 days in 1 (3.2%) and for 13 days in 1 (3.2%). Similar types of results were observed in the studies conducted across the globe, although the rate, duration and mode of oxygen delivery has not been studied to such an extent as our study.⁸⁻¹¹

According to clinical management guidelines of MIS-C in children, supplementary oxygen therapy can be provided depending on the children's condition and other symptoms. Depending on the severity of the disease, oxygen therapy may be needed for a protracted time as well. A patient's requirement for oxygen depends on his/her SpO₂ levels, as well as the severity of respiratory symptoms. Clinical management protocol in MIS-C suggests that a patient may require an oxygen flow of 5 l/min. However, some children may also end up, responding to lower flow rates of oxygen between 2-3 l/min).³⁻⁵ High flow nasal cannula oxygen therapy or non-invasive/ invasive ventilation is further considered if the children having MIS-C have trouble in coping with normal oxygen flow. This is especially seen in severe or critical MIS-C cases. Normally in children, oxygen saturation levels between 94 to 98% are considered to be sufficient. In moderate to serious cases of MIS-C, where oxygen therapy is a major component of treatment, doctors should aim at achieving the SpO₂ levels of 92-96% at room air.³⁻⁶

Limitations

The major limitation of our study is its retrospective design and the small number of patients and the short period of our study, also it is a single-center study. As our study center is a tertiary institute with a large number of referrals, hence most of the children included in the study had a severe illness hence greater degree of oxygen requirement.

CONCLUSION

Tachypnea, respiratory distress and low SpO₂ were present in roughly half of the patients of MIS-C. Respiratory

support and O₂ was required in more than half of patients while ventilatory support was also needed in a quarter of children. Given that oxygen therapy is crucial component of therapy, MIS-C patients who start observing a dip in their SpO₂ levels should immediately start using oxygen therapy, and report to the emergency department at the earliest.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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