

# Significant Preoperative Predictors of Postoperative Outcome in Congenital Diaphragmatic Hernia - A Retrospective Analysis of 23 Cases

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## ABSTRACT

**Aim:** To determine the risk factors and outcomes of congenital diaphragmatic hernia (CDH).

**Methods:** A retrospective study was conducted on 23 CDH patients who went under surgery at The Children Hospital/ Institute of Child Health Multan and NICU King Abdul Aziz Specialist Hospital Taif, Saudi Arabia between Sept. 2012 and Aug. 2014. Clinical characteristics and risk factors were considered and analysis was performed to determine significant preop predictors for postop mortality.

**Results:-** Twenty three patients underwent surgery for CDH. The total post operative survival in patients with CDH was 69.5% (16/23) and the overall postoperative mortality was 30.4% (7/23). There was a significant difference between CDH patients who survived (n=16) and those who died (n=7) in the age on admission, 1-min and 5-minute Apgar score, cardiac malformations and presence of persistent pulmonary hypertension of newborn (PPHN), and high persistent preoperative oxygen index

**Conclusions:-** CDH carries high mortality despite best care. Risk factors for mortality in neonatal CDH were the age on admission, low apgar score, cardiac malformations and persistently high OI.

**Keywords:** Congenital diaphragmatic hernia, Oxygen Index, Neonatal, Ventilation

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## INTRODUCTION

CDH is one of the most challenging and perplexing malformations, associated with a high mortality (36% based on the CDH registry)<sup>1</sup> and one of the most common and serious congenital disorders in the neonatal intensive care unit (NICU). The estimated incidence of congenital diaphragmatic hernia is 1 in 2000–5000 live births<sup>2</sup>. The aetiology of congenital diaphragmatic hernia is unknown, however, 2% of cases have been noted to be familial and another 15% of patients have associated chromosomal abnormalities<sup>3</sup>.

Many initial clinical characteristics associated with poor outcome in infants with CDH have been identified as risk factors and they include birth weight<sup>3</sup>, a low 5-minute Apgar score<sup>1,4</sup>, prematurity<sup>4</sup>, an air leak<sup>4</sup> and the presence of other structural defects or chromosomal abnormalities<sup>5</sup>. Moreover, in cases of isolated CDH, pulmonary hypoplasia and associated persistent pulmonary hypertension of newborn (PPHN) are the main causes of death<sup>5</sup>.

The key to successful postnatal management of CDH is the use of mechanical ventilation and/or

extracorporeal membrane oxygenation (ECMO) to manage the pulmonary alveolar hypoplasia and the PPHN. Current management strategies consist of preoperative stabilization and delayed repair<sup>6</sup>. Many parameters were defined in determining the post operative prognosis in CDH including Arterial pH, preductal and postductal PO<sub>2</sub><sup>7</sup>. Main indices related to ventilation parameters are the criteria of Bohn, ventilatory index (VI), Red Cross Formula, Oxygenation Index (OI) and modifications of these parameters<sup>8</sup>. In this study we have focused on preoperative significant predictors of postoperative outcome in CDH, including OI, timing of admission, Apgar score and cardiac malformations..

## MATERIALS AND METHODS

A combined retrospective analysis was carried out at The Children Hospital & the Institute of Child Health Multan and NICU King Abdul Aziz Specialist Hospital Taif, Saudi Arabia. The medical records of 27 CDH patients, admitted to these hospitals, NICU between September 2012 and August 2014, were reviewed retrospectively. Four patients were excluded from the study due to extreme prematurity and respiratory distress syndrome in one, sepsis in the other, severe congenital heart disease in 3<sup>rd</sup> and Edward syndrome in 4<sup>th</sup> patient. 23 patients were included in this study and OI was calculated in all repeatedly. The Mann-Whitney U test was used for non-normally distributed variables.

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**RESULTS**

Twenty three patients were enrolled in this retrospective analysis. Gestational age was 29-40 weeks (median 37 weeks), and birth weight 1300-3520g (median 2800g); 32% of the neonates had prenatal diagnosis of CDH. The total survival rate of CDH was 69.5% (16/23). The overall post operative mortality was 30.4% (7/23). The total days of life that patients were admitted were 14.7; range: 9 to 26 days). All 23 patients underwent diaphragmatic repair at a median age of 136 hrs, range 72-175hrs .We concentrated mainly on preoperative oxygen index and found that irrespective of gestational age, birth weight, and sex. All patients survived with oxygen index less than 8 (Table 2) while all with OI >9 died after surgery (Table 3). There was significant difference in the admission age, 1 and 5 minute Apgar score, cardiac malformations & OI (Table 4).

Table-1: Variable Factors (n=23)

<b>Gestational age</b>	<b>29-40 Wks (Median 36.8 Wks)</b>
Weight	2200-3850 gms( Median 3180 gms)
Sex	Males= 14 , F= 9
1-min Apgar Score	5-8, (Median 7.6)
5-min Apgar Score	6-8, ( Mean 7.8)
Cardiac Malformations	10 ( 43%)
Preop ventilation	n= 23 (ALL)
HFV	n= 7 (30%)
Surfactant therapy	n= 4 (17%)
PPHN	n= 17 (73%)
Length of hospital stay	9-26 (Median 14.7 days)

Table-2: Oxygen Index in survivors (n=16)

n= 16	Oxygen Index (OI)
1	6.2
2	5.9
3	6.6
4	4.3
5	5.7
6	5.2
7	4.8
8	6.1
9	6.3
10	6.2
11	7.1
12	3.9
13	4.9
14	4.7
15	6.8
16	6.7

Table 3: Oxygen Index in non survivors (n=7)

n= 16	Oxygen Index (OI)
1	09.5
2	11.4
3	12.0
4	11.8
5	14.5
6	12.7
7	09.8

Table 4: Other significant factors between survivors/non survivors

Cardiac malformations	Survivors	Non survivors
	3(16)	7(7)
Apgar score	1 min > 6(16) 5 min > 8(16)	1 min < 6 (7) 5 min < 8 (7)
Age at admission	< 30 hrs (median 12.5)	> 30 hrs( Median 44.5)

**DISCUSSION**

Surgical repair of CDH used to be in the past a life-saving emergency. It is presently accepted that it should be undertaken only after cardio-respiratory functions are stable. A policy of “delayed” surgery coupled with gentle ventilation and occasionally ECMO support yields the best results recorded. For how long surgery has to be delayed is unclear, but a few days and even weeks may be beneficial. The goal of all preoperative treatments is to obtain “stabilization” of the patient and this means acceptable oxygenation (PaO2 > 40 mmHg) and CO2 disposal (PaCO2 < 60 mmHg) with stable pulmonary pressures (< 50% of systemic pressure), tolerable shunting, good myocardial function and adequate renal clearance with reduced or withdrawn inotropic drugs. Obviously, there are no magic indicators of stabilization (this may also be impossible) and a decision to operate is only made after a consensus among all the actors of these treatments has been reached. Once again, when critically reviewed, even the alleged benefits of delayed repair are not consistently documented<sup>9</sup>.

All of our 23 patients underwent stabilization with ventilation as well surfactant therapy was done in four patients. Surfactant has been used in an attempt to compensate for biochemical immaturity in CDH babies<sup>10</sup>, 2(8.5%) survived and 2(23) died. Colbye et al like us did not find much benefit of surfactant therapy in CDH in the process of stabilization<sup>11</sup>. Tamura et al are strong proponents of High-frequency, oscillatory ventilation in these patients in whom it allows adequate oxygenation and CO2 elimination with very low airway pressures<sup>12</sup>. Lung damage is apparently minimized while attaining the modest gasometric objectives set. 7(23) of our patients underwent HFV for preop stabilization.

The age on admission, onset of respiratory distress and presence of PPHN were high-risk factors related to the severity of clinical characteristics in CDH patients, however, only the age on admission remained significant in the forward stepwise logistic regression model and we found that the age on admission increases the risk of death in CDH. The median age on admission was 44.5 hr in the survivors and 12.5 hr in the non-survivors. This result suggests the more severe the clinical characteristics such as respiratory distress and the earlier the onset, the higher the mortality. Cardiac malformations have

been described by previous investigators as risk factors for poor outcomes in CDH patients<sup>13,14</sup>. Sun W et al also found an association between cardiac malformations and the risk of death which was increased 18.54 fold<sup>15</sup>. We also found an association between cardiac malformations and the risk of death, all of our 7(23) patients who died had CHD. Cardiac malformations are the most common anomalies associated with CDH but their etiology is still unclear. Most of the CDH-associated cardiac malformations contribute to the worsening of hemodynamic status, which is already severely compromised in patients with CDH. We found that there was a significant difference in the admission age, 1-minute Apgar score, presence of PPHN, lung hypoplasia, time of stabilization prior to surgery, and highest OI after operation between the survivors and non-survivors post-operatively. Low 1-minute and 5-minute Apgar scores have been said to be major independent predictors of total mortality rate<sup>18</sup>. Our results also suggest that the non-survivor group of CDH patients had lower Apgar scores compared to the survivors. Apgar scores are a strong early marker of lung function, cardiovascular adaptation, and response to resuscitation in infants with CDH. The lower the Apgar scores, the more severe the asphyxia, and thus early prenatal diagnosis and elective intubation following birth and resuscitation (avoiding barotraumas to the hypoplastic lung) should be led by a highly skilled neonatology team. Our main focus was on Oxygen index as prognostic criterion for preoperative stabilization and postoperative outcome. Our 16(23) patients whose OI before surgery was less than 8, all of them survived and 7(23) with OI more than 9, all died. Sinha et al also mentioned low OI as a prognostic criterion for post operative survival<sup>16</sup>. According to Basiewicz-Slaczka et al inability to achieve OI <10 within 24 hours of standardized invasive treatment involving HFV and NO indicates high risk of unfavorable outcome regardless whether surgical treatment was performed or not<sup>17</sup>.

Oxygen index is calculated based on mean airway pressure, FIO<sub>2</sub>, and partial pressure of oxygen. OI will be less if MAP and FIO<sub>2</sub> will be low because when lung compliance is good, pulmonary hypertension is less and hypoxia is decreased, values of MAP and FIO<sub>2</sub> will decrease and partial pressure of oxygen will increase and in result OI will decrease and vice versa. So OI has an indirect relationship with function or dysfunction of hypoplastic lungs and gives a clue when to operate these patients with minimum preoperative ventilator dependency and early postoperative weaning.

## CONCLUSION

Our study showed that OI was a strong prognostic indicator of survival in infants with CDH. It reflects the extent of pulmonary dysfunction or improvement of the hypoplastic lung in CDH.

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