ORIGINAL ARTICLE

Probing the Prognostic Factors of Neonatal Outcomes in Congenital Diaphragmatic Hernia

MUHAMMAD USAMA AZIZ, NABILA TALAT, MUHAMMAD BILAL MIRZA, IMRAN HASHIM, WAJEEH UR REHMAN, SAJID IQBAL NAYYAR

Pak Pediatr J 2026; **50(1):** 48-53

Correspondence to:

Dr. Muhammad Usama Aziz,
Senior Registrar,
Department of Pediatric Surgery,
The University of Child Health Sciences and The Children's Hospital, Lahore

E-mail: drusamaaziz@gmail.com

Received for publication: Sept.18, 2025
Revision accepted: Dec. 31, 2025

How To Cite This: Aziz MU, Talat N, Mirza MB, Hashim I, Rehman WUr, Nayyar SI
Probing the Prognostic Factors of Neonatal Outcomes in Congenital Diaphragmatic Hernia

DOI:
https://doi.org/10.66347/ppj.v50i1.587

ABSTRACT

Objective: The study was to identify and compare factors affecting the outcome of Congenital diaphragmatic hernia (CDH) in neonates among survivors and non-survivors.

Study Design: It was a descriptive case series

Place and Duration of Study: The study was conducted from January 2024 to July 2024 at The University of Child Health Sciences and The Children's Hospital, Lahore

Material and Methods: Prospective data of 60 neonates presenting to our institution with the diagnosis of CDH was reviewed for its outcome, and associated factors were analyzed.

Results: The survival rate was 51.7%. We identified that early age of presentation, birth weight, prematurity, and pulmonary hypertension were the poor prognostic factors. Factors like gender, prenatal diagnosis, cardiac anomaly, arterial blood gases on admission, side of the defect, and intrathoracic liver did not have any effect on the outcome.

Conclusion: We concluded that we can improve the outcome of CDH in our setup by improving our pre- and post-natal care, aseptic measures and by treating pulmonary hypertension effectively.

Key Words: *Congenital diaphragmatic hernia, Neonates, Prognostic factors, Outcome, Developing country*

INTRODUCTION

The anomaly of congenital diaphragmatic hernia (CDH) is characterized by a defect in the diaphragm or its complete absence.[1] Incidence of CDH is 2.4 per 10,000 deliveries with 30% of the cases associated with other congenital anomalies.[2] Mortality from CDH has always been on higher side which is due to pulmonary hypoplasia and associated pulmonary hypertension.[3] Initial stabilization and then delayed surgical repair have been opted for worldwide rather than early surgery for CDH. Due to evolving management strategies, the survival rate of CDH in developed countries has improved a lot which is around 75-80%.[4] Literature has highlighted multiple prognostic factors of CDH including pre-maturity, low birth weight, ante-natal diagnosis, pulmonary hypertension and associated cardiac anomalies.[5] In this study, we

highlighted the poor prognostic factors and how they relate to the prognosis of neonates with congenital diaphragmatic hernia.

MATERIAL AND METHODS

The study was conducted from January 2024 to July 2024 after approval of the Institutional Review Board Committee IRB reference 738 dated 20-12-2023 from The Children's Hospital & University of Child Health Sciences Lahore. It was a descriptive case series and 60 patients were included in it. Data of the patients with diaphragmatic hernia who were treated at the hospital was reviewed for demography, gestational age, birth weight, prenatal diagnosis, arterial blood PcCO2, PcO2, and pH on admission, pulmonary hypertension, associated cardiac anomaly, side of the diaphragmatic defect, intra-thoracic liver, and outcome in terms of survival to discharge from the hospital. Patients presenting after the age of 4 weeks, were excluded from the study. The data were analyzed with the software SPSS (Statistical Package for Social Sciences) version 25.0.

RESULTS

The patients' mean age at presentation was 4.50 ± 3.91 days, with a range of 1 to 15 days, and their mean weight was 2.88 ± 0.34 kg. With a male to female ratio of 3.2:1, male newborns were more affected than female neonates. The majority of the patients (86.7%) had term delivery in our study. Low birth weight was found in 25% of the patients. In only 8.3% of patients, CDH was diagnosed antenatally **(table 1)**.

TABLE 1: Demographics and associated anomalies

Variable	n=60 (%)
Mean age of presentation (days)	4.50±3.91
Mean birth weight (Kg)	2.88±0.34
Low birth weight	(25.0)
Male: female	3.2:1
Term delivery	(86.7)
Pre-natal diagnosis	(8.3)
Cardiac anomalies	(26.7)
Pulmonary hypertension	(36.7)
Right sided CDH	(11.7)

Echocardiography showed that cardiac anomalies were found in 26.7% of the patients while pulmonary hypertension was detected in 36.7% of patients. Surgical management was done in 45 (75%) patients, all via an open abdominal approach. There was a predominance of left-sided CDH defects (88.3%) as compared to right-sided defects (11.7%) **table 1**. Right sided intrathoracic liver was present in 8.3% of the cases. The overall mortality rate was 48.3% with 15 (25%) patients expired before and 14 (23.3%) expired after the surgical management.

Age of presentation was significantly correlated with mortality of the patients. Non-survivors presented early to the hospital as compared to survivors (3.24 ± 3.03 vs 5.68 ± 4.3 days, p=0.014). Survivors had more male patients in their group as compared to the non-survivors (4.1:1 vs 2.6:1, p=0.451) **table 2.**

TABLE 2. Factors affecting outcome of CDH among non-survivors and survivors

Variable	Non-Survivors n=29 (%)	Survivors n=31 (%)	p value
Age at presentation (days)	3.24±3.03	5.68±4.3	**0.014**
Birth weight (Kg)	2.82±0.42	2.92±0.24	0.275
Male: female	2.6:1	4.1:1	0.451
Prematurity	8 (27.6%)	0 (0.0)	**0.022**
Gestational age (weeks)	37.17±2.25	38.81±1.22	**0.001**
Low birth weight	6 (31%)	6 (19.4)	**0.042**
Antenatal diagnosis	2 (6.9%)	3 (9.7)	0.697
Cardiac anomalies	10 (34.5%)	6 (19.4)	0.185
Mild to moderate pulmonary hypertension	10 (34.5%)	4 (12.9)	**0.048**
Severe pulmonary hypertension	8 (27.7%)	1 (3.2)	**0.008**
Mean $PaCO_2$ in mmHg	41.04±25.2	39.37±14.6	0.752
Mean PaO_2 in mmHg	92.78±46.8	92.46±46.6	0.979
Mean pH	7.26±0.18	7.28±0.12	0.592

Right sided defect	4 (13.8%)	3 (9.7)	0.620
Intra thoracic liver	3 (10.3%)	2 (6.5)	0.568

None of the 8 (13.3%) patients with preterm birth survived in our study which showed a highly significant p-value of 0.002. Non-survivors had a low mean gestational age as compared to the survivors (37.17 ± 2.25 vs 38.81 ± 1.22, p=0.001) which had a highly significant p-value **(table 2)**. After further stratifying the gestational age, we found that mortality was high among the gestational age group of 34-36 weeks (p=0.016).

Patients with low birth weight had a higher mortality rate (p=0.042). Both the non-survivors and survivors had a comparable number of patients in terms of antenatal diagnosis [2(6.9%) vs 3(9.7%), p=0.697]. The cardiac anomaly was not found to be significantly affecting the outcome of CDH among survivors and non-survivors (p=0.185) **table 2.**

Mild to moderate pulmonary hypertension was found to be affecting the outcome of CDH significantly (p=0.048). Mortality rates were even higher with severe pulmonary hypertension (p=0.008). Arterial blood gasses on admission among non-survivor and survivors showed non-significant values of mean PaCO2, pH and, PaO2. Right-sided CDH (p=0.620) and intrathoracic liver (p=0.568) were not found to be affecting the outcome of CDH **(table 2).**

DISCUSSION

Congenital diaphragmatic hernia (or CDH) is a developmental defect in the diaphragm that results in the protrusion of the contents of the abdomen into the thoracic cavity and improper lung development. Historically, CDH has been a burden on the mortality registers worldwide. Nevertheless, due to a better understanding of the pathology and the management strategies, mortality from CDH has been on a declining trend, especially in developed countries. Recent studies from the developed countries showed mortality rate of 25-31%.[6,7] In developing countries like Pakistan, mortality from CDH is still on the higher side. It is due to the unavailability of antenatal services, poor referral system, and lack of proper neonatal ICU settings. The survival rate of 56.3% been reported in our neighbor developing country.[5] We report a survival rate of 51.7% in our setup. In our study, 75% of patients survived up to the surgical management while the survival rate after surgery was 68.9%.

Early presentation to the hospital has been recognized as a predictor of mortality. Our study also showed very high mortality among early presenters to the hospital. We had 61.9% mortality among those who presented within 24 hours after birth (p=0.002). Larsen et al. from reported that 9 out of 21 non-survivors died during the first 24 hours of life.[8] One of the possible reasons for this high mortality is that age of presentation to the hospital is directly related to the degree of lung hypoplasia and the severity of the symptoms.

Low birth weight is another previously identified factor that increases mortality in CDH. Neonates with low birth weight showed more congenital malformations and bigger diaphragmatic deformities than normal-weight neonates.[9] Our study also showed a significant relationship between low birth weight and mortality (p=0.04). After stratifying the data for both genders, we found that mortality was very high (100%) among females with low birth weight (p=0.002).

Another documented factor of CDH mortality is prematurity. We had 100% mortality among the pre-matures (p=0.002). Chandrasekharan et al. stated that prematurity is a significant factor associated with mortality among CDH. Mortality decreased from 36% to 20% when gestational age was increased from 37 to 40 weeks.[10] This high mortality among pre-matures is due to the severity of pulmonary hypoplasia and its associated pulmonary hypertension.

At a mean gestational age of 24 weeks, more than 60% of cases of CDH can be diagnosed antenatally.[11] The prenatal diagnosis rate of CDH ranges from 15-60%, which can be attributed to variations in local prenatal care standards and ultrasonography proficiency.[12-14] In our setup, antenatal diagnosis is not usually available so we mostly rely on post-natal x-ray and ultrasonography of the chest and abdomen. The antenatal diagnosis was available in only 5 (8.3%) of the patients in this study.

Antenatal diagnosis is associated with high mortality. Prenatal diagnostics may identify patients with more severe pulmonary hypoplasia linked with visceral herniation, either in terms of severe degree or longer duration. Our results did not concur with the previous studies (p=0.697). Barrière et al. found in their study that 31.6% of the non-survivors had prenatal diagnosis which was highly significant (p=0.002).[15] The rationale behind this non-association of mortality and antenatal diagnosis in our study are that proper antenatal facilities are not available in our rural areas, there is no compliance for regular antenatal scans and mostly anomalies are not detected on scans as they are not done by professionals.

Patients usually present after birth with complaints of respiratory distress and cyanosis which is due to lung hypoplasia and subsequent pulmonary hypertension (PH). Newborns who have severely compromised lungs will present within the first few hours of life and have the highest mortality.[5] This respiratory distress is due to hypoplastic lungs and pulmonary hypertension. Pulmonary hypertension results from increased pulmonary vascular resistance, which ultimately results in right-sided heart dysfunction and failure. Pulmonary hypertension has been associated with mortality and long-term morbidity among CDH patients.[16-18] Our study showed that pulmonary hypertension was associated with the poor outcome of CDH. We had 58.6% of the non-survivors who had pulmonary hypertension (p=0.001).

Infants with severe respiratory distress require mechanical ventilation support. Conventional mechanical ventilation (CMV) is used as initial support in some centers while some use high-frequency oscillatory ventilation (HFOV). ECMO is being used in higher centers. But there is no statistically significant difference in the outcome of both approaches.[19] We used CMV mode in our setup with low positive end-expiratory pressure (PEEP) as facilities of HFOV and ECMO are not available in our setup.

There is always a debate whether the side of the lesion affects the outcome of CDH. The prenatal detection rate is 25% lower in the case of right-sided CDH (R-CDH). Surgical repair is also challenging on the right side of the diaphragm. DeKoninck et al. reported that morbidity and mortality are higher in R-CDH with only 52% survival rate.[20] But some studies support a better prognosis in the case of R-CDH. Collin et al. stated a 90% survival rate of R-CDH.[21] However Abramov et al. reported that there was no significant difference in the outcome of CDH in terms of laterality.[22] In our case, we observed a 42.8% survival rate in right-sided CDH as compared to 52.8% of L-CDH (p=0.62).

Abdominal contents herniate through the defect into the thoracic cavity depending upon the side of the defect. The intrathoracic liver is associated with higher mortality rates in CDH. Surgical management in such cases is typically difficult due to adhesions of the liver with the hypoplastic lung and an accessory vessel to the liver directly from the right atrium which should be ligated and divided. A study has reported that patients with greater proportion of intrathoracic liver had a very high mortality (p=<0.001).[23] In our study, we found out that the intrathoracic liver in 8.3% of patients was not significantly associated with poor prognosis (p=0.568). The possible reason for good survival is that in our patients only the left lobe or portion of the right lobe was protruding into the thoracic cavity which was less challenging.

In 30-40% of the cases, CDH is associated with cardiac, gastrointestinal, renal, neural, and abdominal wall anomalies. The outcome of CDH is significantly reduced when it is associated with other anomalies.[15] But our results did not concur with the previous studies. We found out that 34.5% of the non-survivors had cardiac anomalies and it did not affect the outcome of CDH significantly (p=0.185). It may be due to the inclusion of patients with all major and minor cardiac anomalies in our study.

Grizelj et al. stated in their study that predictors of mortality during the first 24 hours of admission were lower capillary PaO_2 (p=0.013), higher $PaCO_2$ (p= 0.02), and lower pH (p=0.03).[24] But in our study arterial blood gasses at the time of admission; PaO2 (p=0.979), $PaCO_2$ (p=0.752), and pH (p=0.592) did not affect the outcome of CDH.

The factors that affected the outcome of CDH in our study include the age of presentation, birth weight, prematurity, and pulmonary hypertension. Factors like gender, prenatal diagnosis, cardiac anomaly, arterial blood gases on admission, side of the defect, and intrathoracic liver did not have any effect on the outcome.

The prospective nature of the study is one of its strengths. As our center does not deal with obstetric procedures so all of the patients were out-born in our study and hidden mortality cannot be predicted. Another limitation was that long-term outcome was not recorded.

CONCLUSION

CDH is an error of fetal development which still leads to high mortalities around the globe. The survival rates of this study have been comparable with that of other developing countries. After data analysis, several factors have been identified, age at presentation, birth weight, gestational age, and pulmonary hypertension which were significantly affecting the outcome of CDH in our setup. We conclude that by improving our pre-and post-natal care, treating pulmonary hypertension effectively, and by improving aseptic measures we can improve the outcome of CDH in our setup.

Source of funding: None
Conflict of interest: None

Authors' affiliation

Dr. Muhammad Usama Aziz, FCPS, CHPE
Senior Registrar,
Department of Pediatric Surgery, The University of Child Health Sciences and The Children's Hospital, Lahore

Prof. Nabila Talat,
Professor and Dean of Pediatric Surgery,
Department of Pediatric Surgery, The University of Child Health Sciences and The Children's Hospital, Lahore

Prof. Muhammad Bilal Mirza,
Professor of Surgery,
Department of Pediatric Surgery, The University of Child Health Sciences and The Children's Hospital, Lahore

Dr. Imran Hashim,
Associate Professor,
Department of Pediatric Surgery, The University of Child Health Sciences and The Children's Hospital, Lahore

Dr. Wajeeh Ur Rehman,
Assistant Professor,
Department of Pediatric Surgery, The University of Child Health Sciences and The Children's Hospital, Lahore

Dr. Sajid Iqbal Nayyar
Assistant Professor,
Department of Pediatric Surgery, The University of Child Health Sciences and The Children's Hospital, Lahore

REFERENCES

1. Morche J, Mathes T, Jacobs A, Pietsch B, Wessel L, Gruber S, Neugebauer EA, Pieper D. Relationship between volume and outcome for surgery on congenital diaphragmatic hernia: a systematic review. Journal of Pediatric Surgery. 2020 Dec 1;55(12):2555-65.
2. Politis MD, Bermejo-Sánchez E, Canfield MA, Contiero P, Cragan JD, Dastgiri S, de Walle HE, Feldkamp ML, Nance A, Groisman B, Gatt M. Prevalence and mortality in children with congenital diaphragmatic hernia: a multicountry study. Annals of epidemiology. 2021 Apr 1;56:61-9..
3. Paoletti M, Raffler G, Gaffi MS, Antounians L, Lauriti G, Zani A. Prevalence and risk factors for congenital diaphragmatic hernia: a global view. Journal of pediatric surgery. 2020 Nov 1;55(11):2297-307.
4. Terui K, Nagata K, Kanamori Y, Takahashi S, Hayakawa M, Okuyama H, Inamura N, Yoshida H, Taguchi T, Usui N. Risk stratification for congenital diaphragmatic hernia by factors within 24 h after birth. Journal of Perinatology. 2017 Jul;37(7):805-8.
5. Chandramati J, Nair LS, Menon SM, Prabhu A, Abraham M, Viswanathan N, Ponthenkandath S. Outcome of Congenital Diaphragmatic Hernia: A Single Center Experience. Journal of Neonatal Surgery. 2020 May 6;8(4):29.
6. Wang Y, Honeyford K, Aylin P, Bottle A, Giuliani S. One-year outcomes for congenital diaphragmatic hernia. BJS Open. 2019 Jan 31;3(3):305-313.
7. Gupta VS, Harting MT, Lally PA, Miller CC, Hirschl RB, Davis CF, Dassinger MS, Buchmiller TL, Van Meurs KP, Yoder BA, Stewart MJ. Mortality in congenital diaphragmatic hernia: a multicenter registry study of over 5000 patients over 25 years. Annals of Surgery. 2023 Mar 1;277(3):520-7.
8. Larsen UL. Mortality and morbidity of infants with symptomatic Congenital Diaphragmatic Hernia treated at Odense University Hospital, a single center without ECMO: Symptomatic congenital diaphragmatic hernia treated at Odense University Hospital from 1998 to 2015–outcome from a non-ECMO center in Denmark.

9. Gupta VS, Ferguson DM, Lally PA, Garcia EI, KG, Tsao K, Lally KP, Harting MT, Congenital Diaphragmatic Hernia Study Group. Birth weight predicts patient outcomes in infants who undergo congenital diaphragmatic hernia repair. The Journal of Maternal-Fetal & Neonatal Medicine. 2022 Dec 12;35(25):6823-9.
10. Chandrasekharan PK, Rawat M, Madappa R, Rothstein DH, Lakshminrusimha S. Congenital Diaphragmatic hernia–a review. Maternal health, neonatology and perinatology. 2017 Dec;3:1-6.
11. Cordier AG, Russo FM, Deprest J, Benachi A. Prenatal diagnosis, imaging, and prognosis in congenital diaphragmatic hernia. InSeminars in perinatology 2020 Feb 1 (Vol. 44, No. 1, p. 51163). WB Saunders.
12. Burgos CM, Frenckner B, Luco M, Harting MT, Lally PA, Lally KP, Congenital Diaphragmatic Hernia Study Group. Prenatally versus postnatally diagnosed congenital diaphragmatic hernia–Side, stage, and outcome. Journal of pediatric surgery. 2019 Apr 1;54(4):651-5.
13. Abbasi N, Backley S, Ryan G, Johnson A. Prenatal diagnosis and risk stratification of congenital diaphragmatic hernia. World Journal of Pediatric Surgery. 2024 Oct 16;7(4):e000892.
14. Pollak M, Gur M, Bronshtein M, Solt I, Masarweh K, Bentur L. Incidence of congenital thoracic malformations detected by prenatal ultrasound. Pediatrics International. 2020 Jan;62(1):89-93.
15. Barrière F, Michel F, Loundou AD, Fouquet V, Kermorvant E, Blanc S, Carricaburu E, Desrumaux A, Pidoux O, Arnaud A, Berte N. One-year outcome for congenital diaphragmatic hernia: results from the French National Register. The Journal of Pediatrics. 2018 Feb 1;193:204-10.
16. Ferguson DM, Gupta VS, Lally PA, Luco M, Tsao K, Lally KP, Patel N, Harting MT, Congenital Diaphragmatic Hernia Study Group. Early, postnatal pulmonary hypertension severity predicts inpatient outcomes in congenital diaphragmatic hernia. Neonatology. 2021 Apr 13;118(2):147-54.
17. Harting MT. Congenital diaphragmatic hernia-associated pulmonary hypertension. InSeminars in pediatric surgery 2017 Jun 1 (Vol. 26, No. 3, pp. 147-153). WB Saunders.
18. Wong M, Reyes J, Lapidus-Krol E, Chiang M, Humpl T, Al-Faraj M, Ryan G, Chiu PP. Pulmonary hypertension in congenital diaphragmatic hernia patients: prognostic markers and long-term outcomes. Journal of pediatric surgery. 2018 May 1;53(5):918-24.
19. Pimenta J, Vaz Silva P, Pinto C, Dinis A, Carvalho L, de Castro O, Neves F. Improving outcome in congenital diaphragmatic hernia–experience of a tertiary center without ECMO. Journal of Neonatal-Perinatal Medicine. 2018 Jan 1;11(1):37-43.
20. DeKoninck P, Gomez O, Sandaite I, Richter J, Nawapun K, Eerdekens A, Ramirez JC, Claus F, Gratacos E, Deprest J. Right-sided congenital diaphragmatic hernia in a decade of fetal surgery. BJOG: An International Journal of Obstetrics & Gynaecology. 2015 Jun;122(7):940-6.
21. Collin M, Trinder S, Minutillo C, Rao S, Dickinson J, Samnakay N. A modern era comparison of right versus left sided congenital diaphragmatic hernia outcomes. Journal of pediatric surgery. 2016 Sep 1;51(9):1409-13.
22. Abramov A, Fan W, Hernan R, Zenilman AL, Wynn J, Aspelund G, Khlevner J, Krishnan U, Lim FY, Mychaliska GB, Warner BW. Comparative outcomes of right versus left congenital diaphragmatic hernia: A multicenter analysis. Journal of pediatric surgery. 2020 Jan 1;55(1):33-8.
23. Cruz-Martínez R, Etchegaray A, Molina-Giraldo S, Nieto-Castro B, Gil Guevara E, Bustillos J, Martínez-Rodríguez M, Gámez-Varela A, Saldivar-Rodríguez D, Chávez-González E, Keller R. A multicentre study to predict neonatal survival according to lung-to-head ratio and liver herniation in fetuses with left congenital diaphragmatic hernia (CDH): hidden mortality from the Latin American CDH Study Group Registry. Prenatal Diagnosis. 2019 Jun;39(7):519-26.
24. Grizelj R, Bojanić K, Pritišanac E, Luetić T, Vuković J, Weingarten TN, Schroeder DR, Sprung J. Survival prediction of high-risk outborn neonates with congenital diaphragmatic hernia from capillary blood gases. BMC pediatrics. 2016 Dec;16:1-7.

Author's Contribution

MUA: Proposed topic, basic study design, methodology and manuscript writing
NT: Literature review & referencing and quality insurer.
MBM: Literature review & referencing and quality insurer

IH: Literature review & referencing and quality insurer
WUR: Literature review & referencing and quality insurer
SIN: Literature review & referencing and quality insurer

All the authors have approved the final manuscript draft and accept the responsibility of research integrity.