

Title:

The impact of the quality improvement bundle on short-term outcomes in neonates with congenital diaphragmatic hernia.

Authors:

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Background:

Congenital diaphragmatic hernia (CDH) is associated with significant morbidity and mortality, primarily due to lung hypoplasia and pulmonary hypertension. The severity of pulmonary hypertension and cardiac dysfunction in CDH are major determinants of patient survival.

Objective:

To evaluate the effect of the integration of the quality improvement (QI) bundle on short-term outcomes in neonates with CDH.

Design/Methods:

This was a retrospective cohort study done during two epochs (epoch I = January 2013 – December 2017; epoch II = January 2018 – March 2021) in a quaternary neonatal intensive care unit (NICU). All infants born at gestational age ≥ 34 weeks and admitted to BC Women's Hospital NICU with diagnosis of CDH based on postnatal radiographic evidence and/or antenatal scans were included in the study. Demographic and cardiorespiratory data during both epochs were analyzed. During epoch II, we introduced a QI bundle consisting of various modifications in clinical care (Table 1). Overall mortality, composite outcome of death or need of respiratory support (CPAP/NIV/tracheostomy) at discharge and individual short-term outcomes, were compared between epoch I and epoch II.

Results:

A total of 57 infants met the inclusion criteria (37 during epoch I and 20 during epoch II). Baseline characteristics were similar among the infants during both epochs (Table 2). Median (IQR) ages at surgery during epoch I and epoch II were 4 (2.8 – 5) and 3.5 days (2 – 4.3) (p-value = 0.45), respectively. There was a significant decline in overall mortality among the infants with CDH during epoch II (epoch II = 0% [n=0] vs epoch I = 27% [n=10]; p-value = 0.010) (Table 3). During epoch II, duration of all inotropes was high among users (4 days vs 22.5 days; p-value = 0.007) but not in the use of iNO, benzodiazepines, opioids and muscle relaxants. No differences were observed in composite outcome of mortality (all) or respiratory support on discharge and other short-term neonatal outcomes (Table 3).

Conclusion:

With the introduction of the quality improvement bundle, we demonstrated a significant reduction in overall mortality without any increase in short-term neonatal morbidities in this cohort of infants with CDH.

Table 1. Components of Quality improvement bundle

1. Introduction of the Canadian CDH Collaborative clinical practice guidelines
2. Dedicated targeted neonatal echocardiography assessment pre and post operatively
3. Multidisciplinary* care during the acute phase of illness.
4. Gentle ventilation and judicious use of high frequency jet ventilation before, during and after surgery

**NICU including TnEcho team, surgery, anesthesia, ECMO team, cardiology, radiology, and allied health services.*

Table 2. Baseline clinical and demographic characteristics of infants with CDH.

	Epoch I 2013.1-2017.12 (n=37)	Epoch II 2018.1-2021.3 (n=20)	p-value	
Gestational age at birth (weeks), median [IQR]	39 [38 – 39]	38 [38 – 40]	0.721	
Birth weight (g), median [IQR]	3384 [2960 – 3670]	2972 [2685 – 3737]	0.450	
SGA, n (%)	6 (16.2)	3 (15.0)	1.000	
Male, n (%)	16 (43.2)	11 (55.0)	0.568	
Outborn, n (%)	28 (75.7)	15 (75.0)	1.000	
C-section, n (%)	22 (59.5)	9 (45.0)	0.443	
APGAR 5min<7, n/N (%)	14/34 (37.8)	5/20 (25.0)	0.364	
SNAP II score \geq 20, n/N (%)	21/35 (60.0)	11/20 (55.0)	0.938	
Prenatal diagnosis, n/N (%)	28 (75.7)	13 (65.0)	0.584	
Fetal MRI, n/N (%)	9 (24.3)	11 (55.0)	0.042	
Associated malformation, n/N (%)	6 (16.2)	5 (25.0)	0.653	
Left side CDH, n/N (%)	34 (91.9)	18 (90.0)	1.000	
Only bowel identified in the thoracic cavity	11 (29.7)	9 (45.0)	0.249	
CDHSG Staging, n (%)	A	1 (3.1)	2 (10.0)	0.185
	B	22 (68.8)	8 (40.0)	
	C	7 (21.9)	8 (40.0)	
	D	2 (6.2)	2 (10.0)	
Age at surgery (days) [§] , median [IQR]	4 [2.8 – 5]	3.5 [2 – 4.3]	0.450	
Approach for repair surgery, n (%)	Planned Open	23 (62.2)	18 (90.0)	0.534
	Converted to open	1 (2.7)	1 (5.0)	
	Thorascopic	5 (13.5)	1 (5.0)	
	Laparoscopic	2 (5.4)	0 (0.0)	
	Unknown	1 (2.7)	0 (0.0)	

Abbreviations: IQR, interquartile range; SGA, small for gestational age; SNAP II, the score for neonatal acute physiology II; CDH, congenital diaphragmatic hernia; CDHSG, congenital diaphragmatic hernia study group.

Numeric comparison: Wilcoxon (non-parametric); Categorical comparison: Chi-square (parametric) or Fisher's (non-parametric) [§]Age at surgery does not include those who passed away before surgery.

Table 3. Comparison of short-term neonatal outcomes of infants with congenital diaphragmatic hernia.

	Epoch I 2013.1-2017.12 (n=27 survivors, unless specified)	Epoch II 2018.1-2021.3 (n=20 survivors)	p-value	
Overall Mortality, n (%)	10/37 (27.0)	0 (0.0)	0.010	
Mortality before surgery, n (%)	5/37 (13.5)	0 (0.0)	0.151	
Days to death after surgery, median [IQR]	14 [10 – 17]	0	N/A	
Duration of iNO (median days) among the users	6 [2.5 – 11.5]	11.5 [5.5 – 13.8]	0.294	
Total inotrope duration among users (days), median [IQR]	4 [0 – 13]	22.5 [6.5 – 33.2]	0.007	
Duration of prostaglandin E1 (days), median [IQR]	9.5 [3.8 – 12.8]	10 [6.5 – 14]	0.508	
Duration of benzodiazepines (days), median [IQR]	12 [6 – 18.5]	18 [13.5 – 34]	0.167	
Duration of opioid (days), median [IQR]	14.0 [9 – 24.5]	18.5 [7.3 – 35.5]	0.529	
Duration of muscle relaxants (days), median [IQR]	5 [2 – 11]	8.5 [4.5 – 11.2]	0.557	
Total duration of invasive and non-invasive ventilation (days), median [IQR]	20 [7 – 35]	24.5 [13.8 – 35.2]	0.354	
Duration of invasive ventilation (days), median [IQR]	8.0 [6 – 19]	12 [5.8 – 19]	0.880	
Type of invasive ventilation, n (%)	CMV	6 (22.2)	7 (35.0)	0.185
	HFOV	4 (14.8)	0 (0)	
	HFJV	9 (33.3)	9 (45.0)	
ECMO requirement, n (%)	1 (3.7)	2 (10.0)	0.567	
Duration of TPN (days), median [IQR]	17 [11 – 24.5]	21.5 [12 – 31.5]	0.401	
Mortality (all) or resp support on discharge (CPAP/NIV/tracheostomy), n (%)	12 (32.4)	5 (25.0)	0.736	
CPAP/NIV/tracheostomy on discharge, n (%)	2 (7.4)	5 (25.0)	0.094	
G-tube/NG feeding on discharge, n (%)	9 (33.3)	10 (50.0)	0.250	

Abbreviations: iNO, inhaled nitric oxide; CMV, continuous mandatory ventilation; HFOV, high frequency oscillatory ventilation; HFJV, high frequency jet ventilation; ECMO, extra corporeal membrane oxygenator; TPN, total parenteral nutrition; CPAP, continuous positive airway pressure; NIV, noninvasive ventilation; G-tube, gastrostomy tube ; NG , nasogastric.

Numeric comparison: Wilcoxon (non-parametric); Categorical comparison: Chi-square (parametric) or Fisher's (non-parametric)