Congenital diaphragmatic hernia
Long term follow-up

Francesco Morini
Department of Medical and Surgical Neonatology
Ospedale Pediatrico Bambino Gesù, IRCCS, Rome, Italy
CDH

✓ Prenatal diagnosis & treatment
✓ Mechanical ventilation
✓ Drugs
✓ Surgery
✓ +/- ECMO
✓ DISCHARGE
CDH: long term sequelae

“Now this is not the end. It is not even the beginning of the end. But it is, perhaps, the end of the beginning.”

Sir Winston Churchill, El Alamein, November 1942
### CDH: long term sequelae

<table>
<thead>
<tr>
<th>Category</th>
<th>Up to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auxological</td>
<td>70%</td>
</tr>
<tr>
<td>Cardio-pulmonary</td>
<td>60%</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>70%</td>
</tr>
<tr>
<td>NDO</td>
<td>40%</td>
</tr>
<tr>
<td>Orthopedic</td>
<td>30%</td>
</tr>
<tr>
<td>Surgical</td>
<td>50%</td>
</tr>
</tbody>
</table>
CDH

- Diaphragmatic defect
- Pulmonary hypoplasia
- Pulmonary hypertension
CDH

ASSOCIATED NON DIAPHRAGMATIC ANOMALIES AMONG CASES WITH CONGENITAL DIAPHRAGMATIC HERNIA

BY C. STOLL, Y. ALEMBIK, B. DOTT AND M.-P. ROTH

Table 1: Isolated and associated anomalies in 139 cases with congenital diaphragmatic hernia (CDH) ascertained from 1979 to 2007 in 386,088 consecutive pregnancies in Northeastern France

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>%</th>
<th>P&lt;sub&gt;c&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDH with associated anomalies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Nonchromosomal</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recognized conditions&lt;sup&gt;a&lt;/sup&gt;</td>
<td>24</td>
<td>17.3</td>
<td></td>
</tr>
<tr>
<td>MCA&lt;sup&gt;b&lt;/sup&gt;</td>
<td>36</td>
<td>25.9</td>
<td></td>
</tr>
<tr>
<td>Chromosomal</td>
<td>25</td>
<td>18.0</td>
<td></td>
</tr>
<tr>
<td><strong>Total Associated</strong></td>
<td>85</td>
<td>61.2</td>
<td>2.20</td>
</tr>
<tr>
<td>Isolated CDH</td>
<td>54</td>
<td>38.8</td>
<td>1.39</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>139</td>
<td>3.60</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>Included syndromes, associations, sequences, and complexes
<sup>b</sup>MCA: multiple congenital anomalies
<sup>c</sup>Prevalence per 10,000 pregnancies.

Stoll C et al., Genet Couns, 2015
CDH

✓ Prenatal treatment
✓ Mechanical ventilation
  ✓ FiO2
  ✓ Pressure
✓ Drugs
✓ ECMO
✓ Minimal access surgery
✓ Patch repair
CDH sequelae

Putnam LR et al., Pediatrics, 2016
CDH: long term sequelae

Long term follow-up in congenital diaphragmatic hernia

Laura E. Hollinger\textsuperscript{a,1}, and Terry L. Buchmiller\textsuperscript{b}

\textsuperscript{a}Department of Surgery, Medical University of South Carolina, 96 Jonathan Lucas Street, MSC 613/COB 417, Charleston SC 29425, USA
\textsuperscript{b}Department of Surgery, Boston Children's Hospital, Boston MA, USA

Hollinger LE & Buchmiller TL, Semin Perinatol, 2019
Giorgia

Lung Transplantation for Late-Onset Pulmonary Hypertension in a Patient with Congenital Diaphragmatic Hernia

Chiara Iacusso¹ Francesco Morini² Irma Capolupo¹ Andrea Dotta¹ Stefania Sgro² Francesco Parisi³ Adriano Carotti³ Pietro Iagolan³

- GA 33 wks; BW 1.6 kg
- STABILIZATION: 72 h
- LEFT CDH (Type D defect, Liver up, Stomach up)
- REPAIR: Patch
- PO COURSE: Uneventful (O2 dependent at 30 days)
- DISCHARGE: 60 days after birth
- No O2-support

Iacusso C et al., Eur J Pediatr Surg Rep, 2018
Giorgia

Lung Transplantation for Late-Onset Pulmonary Hypertension in a Patient with Congenital Diaphragmatic Hernia

Chiara Iacusso1 Francesco Morini1 Irma Capolupo1 Andrea Dotta1 Stefania Sgro2 Francesco Parisi3 Adriano Carotti3 Pietro Ilagolan1

4 years-old...climbing!

Iacusso C et al., Eur J Pediatr Surg Rep, 2018

• Regular follow up check-visits
• Unremarkable first 9 years of life...

JANUARY 21st, 2007

Abdominal pain, vomiting... Emergency admission...
Giorgia
Lung Transplantation for Late-Onset Pulmonary Hypertension in a Patient with Congenital Diaphragmatic Hernia

Chiara Iacuso, Francesco Morini, Ema Capolupo, Andrea Dotta, Stefania Sgro, Francesco Parisi, Adriano Carotti, Pietro Bagolan

2007
January
PHTn GERD

2008
Sildenafil
Bosentan
Furosemide

2009
March, 28th
Nissen + ileostomy closure
Post-op Lung Abscess

June, 16th
H/L Tx

2010
July, 1st
Pleural effusion (thoracic drain)
Ascites (peritoneal drain)

July, 28th
Intestinal obstruction
CDH recurrence
(bowel resection, ileostomy)

2011
May, 15th
Post vertebral Arthrodesis

2012
July, 27th
Exitus

2013
Dec, 28th
LTX

2014
March, 14th
Obliteration of left main bronchus

July, 27th
Exitus

Iacuso C et al., Eur J Pediatr Surg Rep, 2018

Sildenafil
Bosentan
Furosemide

PEJ
NIV
CDH & Persistent/recurrent PHTn

Addressing the causes of late mortality in infants with congenital diaphragmatic hernia

Carmen Mesas Burgos *, Agnes Modée, Elin Öst, Björn Frenckner

Department of Pediatric Surgery, Karolinska Institute, Stockholm, Sweden

considered. One of the patients dying from persistent pulmonary hypertension was treated during the newborn period, but had been free from medication and symptoms during several years until a new onset of pulmonary hypertension occurred, which at this time not responded to treatment. One patient died because of respiratory insuf-

Mesas Burgos C et al., J Pediatr Surg, 2017
# CDH & Lung Transplantation

Lung Transplantation for Late-Onset Pulmonary Hypertension in a Patient with Congenital Diaphragmatic Hernia

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>No. of patients</th>
<th>Prenatal diagnosis</th>
<th>ECMO</th>
<th>CDH side</th>
<th>Type of Tx</th>
<th>Age at Tx</th>
<th>Outcome</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Van Meurs et al</td>
<td>1994</td>
<td>1</td>
<td>No</td>
<td>Yes</td>
<td>R</td>
<td>Lung</td>
<td>17 d</td>
<td>Alive</td>
<td>4 y</td>
</tr>
<tr>
<td>Lee et al</td>
<td>2002</td>
<td>1</td>
<td>18 wk</td>
<td>Yes</td>
<td>L</td>
<td>Lung</td>
<td>36 d</td>
<td>Died 51 d post-Tx</td>
<td></td>
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<tr>
<td>Lee et al</td>
<td>2002</td>
<td>2</td>
<td>27 wk</td>
<td>Yes</td>
<td>L</td>
<td>Lung</td>
<td>105 d</td>
<td>Alive</td>
<td>3 y</td>
</tr>
<tr>
<td>Lee et al</td>
<td>2002</td>
<td>3</td>
<td>18 wk</td>
<td>Yes</td>
<td>L</td>
<td>Heart-lung</td>
<td>19 d</td>
<td>Died 84 d post-Tx</td>
<td></td>
</tr>
<tr>
<td>Rama et al</td>
<td>2010</td>
<td>1</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>Lung</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Rama et al</td>
<td>2010</td>
<td>2</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>Lung</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Schmidt et al</td>
<td>2013</td>
<td>1</td>
<td>ns</td>
<td>Yes</td>
<td>L</td>
<td>Lung</td>
<td>10 y</td>
<td>Died 109 d post-Tx</td>
<td></td>
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<tr>
<td>Iacusso et al (this study)</td>
<td>2017</td>
<td>1</td>
<td>31 wk</td>
<td>No</td>
<td>L</td>
<td>Heart-lung</td>
<td>12 y</td>
<td>Died 4 y after first Tx</td>
<td></td>
</tr>
</tbody>
</table>

Iacusso C et al., Eur J Pediatr Surg Rep, 2018
CDH & PHTn
Long-term follow up of infants with congenital diaphragmatic hernia

Pietro Bagolan, MD, Francesco Morini, MD

From the Department of Medical and Surgical Neonatology, “Bambino Gesù” Children’s Hospital, Rome, Italy.

<table>
<thead>
<tr>
<th>Author</th>
<th>Pts</th>
<th>Follow-up (mos)</th>
<th>GER (%)</th>
<th>Surgery for GER (%)</th>
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<tbody>
<tr>
<td>Stolar et al, 1990</td>
<td>17</td>
<td>32</td>
<td>17</td>
<td>0</td>
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<tr>
<td>Koot et al, 1993</td>
<td>31</td>
<td>6</td>
<td>52</td>
<td>16</td>
</tr>
<tr>
<td>Van Meurs et al, 1993</td>
<td>18</td>
<td>8–72</td>
<td>17</td>
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<tr>
<td>Nagaya et al, 1994</td>
<td>86</td>
<td>6–120</td>
<td>12</td>
<td>8</td>
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<td>Lund et al, 1994</td>
<td>33</td>
<td>5–72</td>
<td>—</td>
<td>18</td>
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<tr>
<td>D’Agostino et al, 1995</td>
<td>16</td>
<td>0.6–12</td>
<td>81</td>
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<td>Kieffer et al, 1997</td>
<td>74</td>
<td>36</td>
<td>62</td>
<td>32</td>
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<tr>
<td>Rais-Bahrami et al, 1997</td>
<td>33</td>
<td>24</td>
<td>76</td>
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<tr>
<td>Stolar et al, 1995</td>
<td>25</td>
<td>31</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Wischermann et al, 1995</td>
<td>45</td>
<td>7–360</td>
<td>13</td>
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<tr>
<td>Vanamo et al, 1996</td>
<td>60</td>
<td>355</td>
<td>63</td>
<td>18</td>
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<tr>
<td>Naik et al, 1996</td>
<td>15</td>
<td>6–36</td>
<td>13</td>
<td>13</td>
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<tr>
<td>McGahren et al, 1997</td>
<td>37</td>
<td>3–120</td>
<td>—</td>
<td>22</td>
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<tr>
<td>Schoeman ef al, 1999</td>
<td>8</td>
<td>2–32</td>
<td>67</td>
<td>62</td>
</tr>
<tr>
<td>Huddy ef al, 1999</td>
<td>13</td>
<td>24–84</td>
<td>23</td>
<td>15</td>
</tr>
<tr>
<td>Muratore et al, 2001</td>
<td>121</td>
<td>12–120</td>
<td>60</td>
<td>21</td>
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<tr>
<td>Bétrémieux ef al, 2002</td>
<td>12</td>
<td>12–72</td>
<td>50</td>
<td>—</td>
</tr>
<tr>
<td>Jalillard et al, 2003</td>
<td>51</td>
<td>24</td>
<td>27</td>
<td>6</td>
</tr>
<tr>
<td>Davis ef al, 2004</td>
<td>27</td>
<td>&gt;12</td>
<td>52</td>
<td>15</td>
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<tr>
<td>Hedrick ef al, 2004</td>
<td>19</td>
<td>0.7–88</td>
<td>47</td>
<td>11</td>
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<tr>
<td>Cortes ef al, 2005</td>
<td>16</td>
<td>24</td>
<td>62</td>
<td>60</td>
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<td>Colvin ef al, 2005</td>
<td>37</td>
<td>24–156</td>
<td>27</td>
<td>5</td>
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<tr>
<td>Crankson et al, 2006</td>
<td>31</td>
<td>6–108</td>
<td>26</td>
<td>6</td>
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<tr>
<td>Chiu et al, 2008</td>
<td>38</td>
<td>36</td>
<td>45</td>
<td>39</td>
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</tbody>
</table>

TOTAL 883

Bagolan P & Morini F, Semin Pediatr Surg, 2007
CDH & gastroesophageal reflux

Long term follow-up in high-risk congenital diaphragmatic hernia survivors: patching the diaphragm affects the outcome

Laura Valfrè*, Annabella Braguglia, Andrea Conforti, Francesco Morini, Alessandro Trucchi, Barbara Daniela Jacobelli, Antonella Nahom, Natalia Chukhlantseva, Andrea Dotta, Carlo Corchia, Pietro Bagolan

Neonatal Surgery Unit, Department of Medical and Surgical Neonatology, Bambino Gesù Children’s Research Hospital, 00161 Rome, Italy

**Gastroesophageal reflux (%)**

- 61 CDH survivors
- 61 @ 6 mos
- 49 @ 12 mos
- 43 @ 24 mos

Valfrè L et al., J Pediatr Surg, 2011

francesco.morini@opbg.net
CDH & gastroesophageal reflux

Endoscopic Surveillance for Congenital Diaphragmatic Hernia: Unexpected Prevalence of Silent Esophagitis

Anna Morandi1 Francesco Macchini1 Andrea Zani1 Noemi Pasqua1 Giorgio Farris1 Lorena Canazza1 Valerio Gentilini1 Antonio Di Cesare1 Ernesto Levi1

1Department of Pediatric Surgery, Fondazione IRCCS Ca’ Granda, Ospedale Maggiore Policlinico, Milano, Italy

Address for correspondence: Anna Morandi, MD, Department of Pediatric Surgery, Fondazione IRCCS Ca’ Granda Ospedale Maggiore Policlinico, Via Cornaredo 10 Milano 20122, Italy (e-mail: anna.morandi@triesteulin.it)

Materials and Methods Patients operated on for posterolateral CDH and undergoing general anesthesia for concomitant pathologies between January and October 2013 were included in the study. GERD was investigated both clinically (Manterola questionnaire) and endoscopically. The severity of esophagitis was evaluated according to the Hetzel–Dent classification and multiple biopsies were performed. The correlation between clinical score and severity of esophagitis was evaluated.

Results Twelve patients were included in the study (mean age: 14.5 years; range, 9–18 years). Only three children (25%) had a pathological questionnaire. At endoscopy, three children (25%) were affected by grade 1 esophagitis, six (50%) by grade 2, two (17%) by grade 3, and one (8%) by grade 4. One of the children presented Barrett esophagus. A moderate negative correlation was found between clinical data and endoscopic findings ($r$: −0.54 and $p$: 0.067).

- 12 CDH survivors
- Mean age 14.5 yrs
- 75% asymptomatic
CDH & gastroesophageal reflux

Gastroesophageal reflux

- Recurrent RTI
- Abnormal PFT
- Oral aversion
- Failure to thrive
- Feeding tube
CDH & gastroesophageal reflux

Preventive antireflux surgery in neonates with congenital diaphragmatic hernia: a single-blinded prospective study

Susanne Maier, Katrin Zahn, Lucas M. Wessel, Thomas Schabolic, Joachim Brade, Konrad Reinhagen

79 L-CDH survivors
36 wARS
43 controls
CDH & obstructive manifestations

1 year 2 years 8 years 12 years 27 years Follow-up

CDH & obstructive manifestations

Pulmonary function and exercise capacity in survivors of congenital diaphragmatic hernia


53 CDH survivors
Mean age 12 yrs
Asthma 28%

Peetsold MG et al., Eur Respir J, 2009
CDH & obstructive manifestations

Congenital diaphragmatic hernia and exercise capacity, a longitudinal evaluation

Leontien C.C. Toussaint-Duyster MPPT1,2
Monique H.M. van der Cammen-van Zijp PhD1,2
Johan C. de Jongste MD, PhD3
Dick Tibboel MD, PhD1
Rene M.H. Wijnen MD, PhD1
Saskia J. Gischler MD, PhD1
Joost van Rosmalen PhD4
Hanneke Usselstijn MD, PhD1

Toussaint-Duyster LCC et al., Pediatr Pulmonol, 2019
Obstructive manifestations vs PFT abnormalities (%)

- Basek et al, 2008
- Peetsold et al, 2009
- Valfrè et al, 2011

Clinical vs PFT
Resting and Exercise Cardiorespiratory Function in Survivors of Congenital Diaphragmatic Hernia

Daniel Trachsel, MD, Hiran Selvadurai, MD, PhD, Ian Adatia, MD, Desmond Bohn, MD, Jane Schneiderman-Walker, MS, Donna Wilkes, MS, and Allan L. Coates, MD

1.2 ± 1.6, P < 0.01. Exercise capacity was mildly reduced in CDH compared to controls and predictive data (maximum workload, 77% ± 12% vs. 91% ± 16% of predicted, P < 0.01). Cardiorespiratory response to exertion was not significantly different between groups. In conclusion, most adolescent CDH survivors have nearly normal exercise capacity and cardiorespiratory response to exertion. This study may prove useful in comparisons with future cohorts comprising more severely affected individuals now surviving due to improved neonatal care.

<table>
<thead>
<tr>
<th></th>
<th>CDH</th>
<th>Controls</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wmax (percent predicted for height)</td>
<td>77 ± 12</td>
<td>91 ± 16</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Wmax (watts)</td>
<td>116 ± 37</td>
<td>149 ± 53</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>Wmax/weight (watts/kg)</td>
<td>2.5 ± 0.6</td>
<td>2.8 ± 0.6</td>
<td>NS (0.08)</td>
</tr>
<tr>
<td>Wmax/LBM (watts/kg)</td>
<td>3.2 ± 0.6</td>
<td>3.7 ± 0.6</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Heart rate maximum (min⁻¹)</td>
<td>189 ± 11</td>
<td>191 ± 9</td>
<td>NS</td>
</tr>
<tr>
<td>Respiratory rate maximum (min⁻¹)</td>
<td>50 ± 7</td>
<td>54 ± 7</td>
<td>0.02</td>
</tr>
<tr>
<td>V̇Emax (l/min)</td>
<td>68 ± 21</td>
<td>84 ± 22</td>
<td>NS</td>
</tr>
<tr>
<td>V̇Emax/MVV*100 (%)</td>
<td>81 ± 19</td>
<td>83 ± 16</td>
<td>NS</td>
</tr>
<tr>
<td>V̇O₂max (percent predicted for height)</td>
<td>88 ± 17</td>
<td>99 ± 17</td>
<td>0.03</td>
</tr>
<tr>
<td>V̇O₂max (l/min)</td>
<td>1.8 ± 0.6</td>
<td>2.2 ± 0.8</td>
<td>NS (0.06)</td>
</tr>
<tr>
<td>V̇O₂max/Wmax (ml/min/watts)</td>
<td>0.016 ± 0.002</td>
<td>0.015 ± 0.002</td>
<td>NS</td>
</tr>
<tr>
<td>V̇CO₂max (l/min)</td>
<td>2.0 ± 0.7</td>
<td>2.5 ± 0.9</td>
<td>NS (0.07)</td>
</tr>
<tr>
<td>V̇CO₂max/Wmax (l/min/watts)</td>
<td>0.017 ± 0.002</td>
<td>0.017 ± 0.002</td>
<td>NS</td>
</tr>
<tr>
<td>V̇E/V̇CO₂ at Wmax</td>
<td>38 ± 6</td>
<td>39 ± 5</td>
<td>NS</td>
</tr>
<tr>
<td>V̇E/V̇CO₂ at Wmax</td>
<td>34 ± 5</td>
<td>35 ± 5</td>
<td>NS</td>
</tr>
<tr>
<td>V̇E/V̇CO₂ at Wmax</td>
<td>1.4 ± 0.45</td>
<td>1.6 ± 0.49</td>
<td>NS</td>
</tr>
<tr>
<td>V̇E/V̇CO₂ at Wmax</td>
<td>29 ± 5</td>
<td>30 ± 5</td>
<td>NS</td>
</tr>
<tr>
<td>Cardiac output (l/min)</td>
<td>10.5 ± 3.1</td>
<td>10.9 ± 1.8</td>
<td>NS</td>
</tr>
<tr>
<td>Cardiac index (l/min/m²)</td>
<td>7.3 ± 1.3</td>
<td>7.3 ± 1.1</td>
<td>NS</td>
</tr>
<tr>
<td>Stroke-volume index (ml/m²)</td>
<td>45 ± 11</td>
<td>48 ± 9</td>
<td>NS</td>
</tr>
</tbody>
</table>

Trachsel D et al., Pediatr Pulmonol, 2006
Physical Activity, Fitness, and Dyspnea Perception in Children With Congenital Diaphragmatic Hernia

Attilio Turchetta,1 Danilo Fintini,1 Giulia Cañiero,1 Armando Calzolari,1 Ugo Giordano,1 Renato Cutrera,3 Francesco Morini,3 Annabella Brugaglia,3 and Pietro Bagolan3

A difference in CDH severity between the two groups, Group A had a statistically significant lower duration of exercise (P < 0.01), maximal oxygen consumption (VO2 max P < 0.0001), VO2 ml/kg/min (P < 0.001), higher throat closing feeling (P < 0.004), chest dyspnea (P < 0.001), and effort perception (P < 0.04) compared to group B. No differences were found in lung function tests. In conclusion, our data may suggest that children with a history of CDH who are active maintain a higher level of performance with less perception of dyspnea and effort.

Turchetta A et al., Pediatr Pulmonol, 2011
CDH & Neurodevelopmental outcome

Neurodevelopmental Outcome in High-Risk Congenital Diaphragmatic Hernia Patients: An Appeal for International Standardization

Kitty G. Snoek¹ Irma Capoluco² Annabella Bruguglia¹ Lucia Alte³ Joost van Rosmalen³ Laura Vallée³ René M. Wijnen³ Pietro Bagolan³ Dick Tibboel³ Hanneke Usselstijn³

¹Intensive Care and Department of Pediatric Surgery, Erasmus MC-Sophia Children’s Hospital, and ²Department of Biostatistics, Erasmus MC, Rotterdam, The Netherlands; ³Department of Medical and Surgical Neonatology, Istituto Gaslini Children’s Hospital, Genoa, Italy

Different diagnostic tool (Bayley II vs III)
Different professional background (physical therapist vs developmental psychologist)
Different patients’ population

Snoek KG et al., Neonatology, 2016
CDH & Neurodevelopmental outcome

Bevilacqua F et al., Am J Perinatol, 2017

22% delay
CDH & Neurodevelopmental outcome

Neurodevelopmental outcomes at 5 years of age in congenital diaphragmatic hernia


The Center for Fetal Diagnosis and Treatment, The Children’s Hospital of Philadelphia, Philadelphia, PA, USA

Danzer E et al., J Pediatr Surg, 2017

Table S

<table>
<thead>
<tr>
<th>Low LHR</th>
<th>Prolonged ventilaary support</th>
<th>PHN</th>
<th>Tracheostomy</th>
<th>Need for supplemental O2 at DOL 30</th>
<th>pHTN</th>
<th>Need for fundoplication</th>
<th>Prolonged LOS</th>
<th>Below average RSID-III scores during infancy</th>
<th>Abnormal IVH/RRM</th>
<th>Below average length percentile at follow-up</th>
<th>Aspiration</th>
<th>Need for a-tube or j-tube or nutritional support</th>
<th>Microphtalmia</th>
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<td>b (95% CI)</td>
<td>P value</td>
<td>b (95% CI)</td>
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<td>b (95% CI)</td>
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<td>−13.4 (−25.1 to −1.6)</td>
<td>−12.6 (−24.2 to −0.9)</td>
<td>&lt;0.03</td>
<td>−6.9 (−19.3 to 5.5)</td>
<td>0.26</td>
<td>−6.4 (−18.5 to 5.9)</td>
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<td>−0.4 (−6.4 to 5.6)</td>
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<td>0.11</td>
<td>−14.2 (−25.1 to −0.3)</td>
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<td>−10.2 (−38.3 to −2.4)</td>
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<td>−26.3 (−44.6 to −7.9)</td>
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<td>−5.5 (−17.9 to 6.9)</td>
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<td>−18.5 (32.2 to −4.7)</td>
<td>0.01</td>
<td>−20.1 (−35.6 to −4.5)</td>
<td>0.01</td>
<td>−7.1 (−21.9 to 7.4)</td>
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<td>−13.5 (−27.2 to 0.2)</td>
<td>0.05</td>
<td>−12.6 (−26.5 to 0.4)</td>
<td>0.06</td>
<td>−15.2 (−29.7 to −0.9)</td>
<td>&lt;0.04</td>
<td>−13.1 (−26.5 to 0.4)</td>
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<td>&lt;0.0001</td>
<td>−0.1 (−0.1 to 0.03)</td>
<td>&lt;0.0001</td>
<td>−0.1 (−0.1 to 0.04)</td>
<td>&lt;0.0001</td>
<td>0.1 (−0.1 to 0.01)</td>
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<td>−14.8 (−21.3 to −8.7)</td>
<td>&lt;0.0001</td>
<td>−12.3 (−19.0 to −5.6)</td>
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<td>−13.8 (−20.8 to −6.7)</td>
<td>&lt;0.0001</td>
<td>−11.9 (−18.5 to −5.3)</td>
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<td>−30.9 (−49.9 to −20.9)</td>
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<td>0.001</td>
<td>−37.4 (−53.2 to −21.6)</td>
<td>&lt;0.0001</td>
<td>−25.7 (−40.9 to −10.8)</td>
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<td>0.02</td>
<td>0.105</td>
<td>0.007</td>
<td>0.3 (0.01 to 0.5)</td>
<td>&lt;0.05</td>
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<td>−28.7 (−48.8 to −8.5)</td>
<td>0.007</td>
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<td>−22.7 (−37.7 to −7.6)</td>
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<td>−18.1 (−35.9 to −0.2)</td>
<td>&lt;0.05</td>
<td>−17.3 (−33.5 to −1.9)</td>
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<td>−15.3 (−43.9 to 13.4)</td>
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<td>−13.1 (−49.4 to 14.1)</td>
<td>0.34</td>
<td>−19.8 (−49.9 to 10.3)</td>
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<td>−25.9 (−51.3 to −0.8)</td>
<td>0.04</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

LHR, long-to-head ratio; LOS, length of stay; HfON, high-frequency oscillatory ventilation; pHTN, pulmonary hypertension; DOL, day of life; RSID-III, Bayley Scales of Infant Development 3rd Edition; BABs, brainstem auditory evoked responses; g-tube, gastrostomy tube; j-tube, jejunostomy tube; f/u, follow-up.

Danzer E et al., J Pediatr Surg, 2017
CDH & Psychiatric problems

Neurodevelopmental outcomes at 5 years of age in congenital diaphragmatic hernia


The Center for Fetal Marganews and Treatment, The Children’s Hospital of Philadelphia, Philadelphia, PA, USA

Table 4
CDH CBCL scores in comparison to normative data.

<table>
<thead>
<tr>
<th></th>
<th>Prevalence of at risk or clinical significant CBCL/1.5–5 normative data [23]</th>
<th>Prevalence of at risk or clinical significant CBCL results of CDH patients</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total problems</td>
<td>18%</td>
<td>23%</td>
<td>0.48</td>
</tr>
<tr>
<td>Externalizing problems</td>
<td>17%</td>
<td>12%</td>
<td>0.42</td>
</tr>
<tr>
<td>Internalizing problems</td>
<td>21%</td>
<td>31%</td>
<td>0.15</td>
</tr>
<tr>
<td>Emotionally reactive</td>
<td>10%</td>
<td>23%</td>
<td>0.02</td>
</tr>
<tr>
<td>Anxious/depressed</td>
<td>8%</td>
<td>15%</td>
<td>0.18</td>
</tr>
<tr>
<td>Somatic problems</td>
<td>9%</td>
<td>12%</td>
<td>0.65</td>
</tr>
<tr>
<td>Withdrawn</td>
<td>7%</td>
<td>8%</td>
<td>1.00</td>
</tr>
<tr>
<td>Sleep problems</td>
<td>5%</td>
<td>8%</td>
<td>0.05</td>
</tr>
<tr>
<td>Attention problems</td>
<td>7%</td>
<td>12%</td>
<td>0.34</td>
</tr>
<tr>
<td>Aggressive behavior</td>
<td>7%</td>
<td>12%</td>
<td>0.34</td>
</tr>
<tr>
<td>DSM-affective</td>
<td>7%</td>
<td>12%</td>
<td>0.34</td>
</tr>
<tr>
<td>DSM-anxiety</td>
<td>8%</td>
<td>15%</td>
<td>0.18</td>
</tr>
<tr>
<td>DSM-pervasive</td>
<td>7%</td>
<td>27%</td>
<td>0.0003</td>
</tr>
<tr>
<td>DSM-ADHD</td>
<td>9%</td>
<td>4%</td>
<td>0.25</td>
</tr>
<tr>
<td>DSM-oppositional defiant</td>
<td>7%</td>
<td>8%</td>
<td>1.00</td>
</tr>
</tbody>
</table>

* The P-values were calculated using chi-square statistics.

Danzer E et al., J Pediatr Surg, 2017

Autism was diagnosed in 11% of female and 11% of male patients, which is significantly higher than the general population (0.5% and 2.4% respectively, P < 0.01) [25].
CDH: long term sequelae

✓ May be severe
✓ May be smoldering
✓ Tend to worsen over time
CDH: long term sequelae

Long term follow-up in congenital diaphragmatic hernia

Laura E. Hollinger and Terry L. Buchmiller

*Department of Surgery, Medical University of South Carolina, 96 Jonathan Lucas Street, MSC 613/CSC 417, Charleston SC 29425, USA

#Department of Surgery, Boston Children’s Hospital, Boston MA, USA

FOLLOW-UP NEEDED
CDH: long term follow-up

Long-term morbidity of congenital diaphragmatic hernia: A plea for standardization

Francesco Morini, Laura Valfrè, Pietro Bagolan

Annals Surgery Unit, Department of Medical and Surgical Anesthesiology, Rainbow Golli Children’s Hospital, IRCCS, Rome, Italy

Morini F et al., Semin Pediatr Surg, 2017
CDH follow-up

Postdischarge Follow-up of Infants With Congenital Diaphragmatic Hernia

 AAP Section on Surgery and Committee on Fetus and Newborn, Pediatrics, 2007
CDH sequelae: our long term follow-up

Multidisciplinary follow-up clinic:

Pediatrician

Pediatric surgeon

& physiotherapist, neurologist, radiologist, ENT, …

Psychologist

Nurse
CDH sequelae: our long term follow-up

Multidisciplinary follow-up clinic:

6 mos 12 mos 18 mos 24 mos 3 yrs 5 yrs 10 yrs
CDH follow-up: the tale of three cities

Long-term morbidity of congenital diaphragmatic hernia: A plea for standardization
Francesco Morini, Laura Vallée, Pietro Bagolan*  
Department of Medical and Surgical Neonatology, Bambino Gesù Children’s Hospital, Rome, Italy

4 wks
3-4 mos
6 mos
8 mos
12 mos
18 mos
2 yrs
3 yrs
5 yrs
Hospital for sick children Toronto
4 wks
3-4 mos
6 mos
8 mos
12 mos
18 mos
2 yrs
3 yrs
5 yrs
Pediatric surgeon
Neonatologist, pediatric surgeon, developmental psychologist (psychometric assessment)
Neonatologist, pediatric surgeon, clinical geneticist, cardiologist (ECHO, EEG), PFT (IC), MRI
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Sophia children’s hospital Rotterdam
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Hospital for sick children Toronto
4 wks
3-4 mos
6 mos
8 mos
12 mos
18 mos
2 yrs
3 yrs
5 yrs
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Morini F et al., Semin Pediatr Surg, 2017

francesco.morini@opbg.net
CDH follow-up

Multi-institutional follow-up of patients with congenital diaphragmatic hernia reveals severe disability and variations in practice

Safavi A et al., J Pediatr Surg, 2012
CDH follow-up

Ijsselstijn A et al., Pediatr Res, 2018
CDH follow-up

Defining outcomes following congenital diaphragmatic hernia using standardised clinical assessment and management plan (SCAMP) methodology within the CDH EURO consortium

Ijsselstijn A et al., Pediatr Res, 2018
CDH parents: who cares?

Seeing Their Children in Pain: Symptoms of Posttraumatic Stress Disorder in Mothers of Children with an Anomaly Requiring Surgery at Birth

Lucia Aite, PsD¹ Francesca Bevilacqua, PsD¹ Antonio Zaccara, MD² Edoardo La Sala, MS³ Simonetta Gentile, PsD¹ Pietro Bagolan, PhD⁵

✓ Failed project
✓ Uncertainty for the future
✓ Fear for loss
✓ Change of familial routine

Aite L et al., Am J Perinatol, 2016
CDH parents: who cares?

Couples Facing the Birth of a Newborn with a Congenital Anomaly: PTSD Symptoms in the First Year

Francesca Bevilacqua, PsD1 Francesco Morini, MD2 Antonio Zaccara, MD3 Chiara De Marchis, MD2 Annabella Braguglia, MD2 Simonetta Gentile, PsD1 Pietro Bagolan, MD2 Lucia Alte, PsD1

- Failed project
- Uncertainty for the future
- Fear for loss
- Change of familial routine

Parents with PTSD (%)

Bevilacqua F et al., Am J Perinatol, 2018
Take home messages

✓ CDH patients may have serious long term sequelae

✓ In CDH patients long term sequelae may be smoldering

✓ Long term, family-centered follow-up programs are needed

✓ Standardization of follow-up programs is desirable

✓ Future: TRANSITION
Thank you