Improving Care and Increasing Survival for Infants with Severe Bronchopulmonary Dysplasia

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Introduction

The Royal Columbian Hospital (RCH), located in British Columbia, includes a Level 3 NICU with 24 beds which provides care for neonates from 22 weeks of gestational age.

Aim

To better our ventilation strategies for infants with Type 2 Severe Bronchopulmonary Dysplasia (BPD) and improve their outcomes.

Background

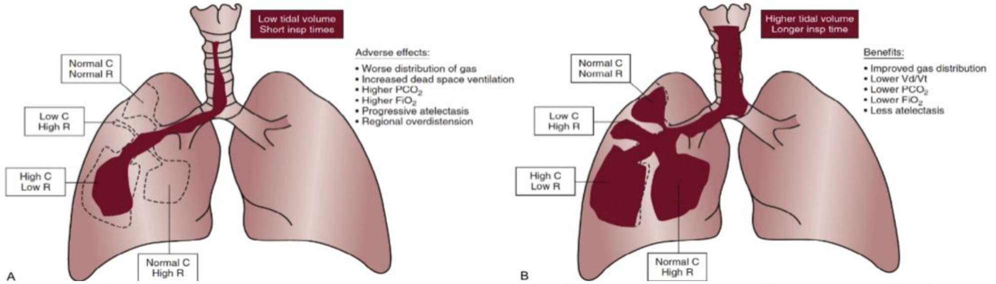


Figure: Concept of multi-zone heterogeneous disease with different time-constants (Abman et al., 2017)

Severe BPD is defined as the need for supplemental oxygen with an $FiO_2 \geq 0.30$ and/or mechanical ventilation or continuous positive airway pressure at 36 weeks corrected age (Abman et al., 2017).

BPD is further divided into 3 severity grades (mild, moderate and severe {type 1 and 2}) based on respiratory status at 36 weeks corrected GA. **Type 2 Severe BPD** has been defined as needing supplemental O_2 and mechanical ventilation at $\geq$ 36 weeks corrected GA (Abman et al., 2017).

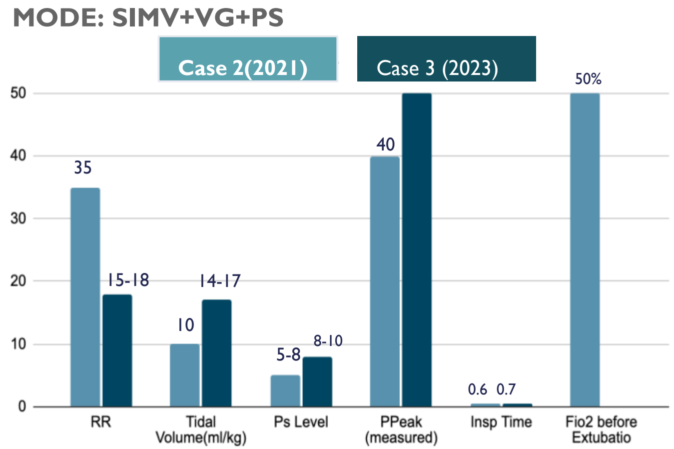
We would like to highlight 3 patients with severe BPD managed at RCH. Each patient was managed with different ventilation strategies. **Case 1 (2020)** was primarily ventilated with HFJV and then extubated to high NIV pressures with which the patient was managed on until transfer to a quaternary hospital. **Case 2 (2021)** was transitioned to conventional ventilation post failure of 2 extubations on the HFJV. **Case 3** currently remains at RCH on conventional ventilation in consult with the BPD collaborative team at Nationwide Children's Hospital, Ohio.

References:

Abman SH, Collaco JM, Shepherd EG, et al. Interdisciplinary Care of Children with Severe Bronchopulmonary Dysplasia. J Pediatr. 2017;181:12-28.e1. doi:10.1016/j.jpeds.2016.10.082

Miller AN, Kielt MJ, El-Ferzli GT, Nelin LD, Shepherd EG. Optimizing ventilator support in severe bronchopulmonary dysplasia in the absence of conclusive evidence. Front Pediatr. 2022;10:1022743. Published 2022 Nov 24. doi:10.3389/fped.2022.1022743

Data



The chart above demonstrates the two different ventilation strategies used with Case 2 and Case 3 in the mode SIMV+VG+PS.

	Case 1 (2020)	Case 2 (2021)	Case 3 (2023)
GA Birth Weight	23+4 740 g	25+5 285 g	23+0 610 g
Corrected GA when switched to CMV or extubated	31+3 (extubated)	38+3 (CMV)	31+6 (CMV)
Modes Used	HFJV → NIV→ NIV HFO	HFJV → ACVG→ SIMV+ VG+PS	HFJV → SIMV+ VG+PS
FiO_2 Pre→post ventilation strategy change	50%→55%	90%→50%	100%→50%

For **Case 2 (2021)**, a strategy of high respiratory rate & low tidal volume (8-10ml/kg) was used. Ventilation was targeting normal CO_2 and normal peak inspiratory pressures, thus the tidal volume was not increased as it would lead to high peak inspiratory pressures. This patient was extubated with FiO_2 > 50%. The patient failed extubation and was reintubated shortly after.

For **Case 3 (2023)**, a strategy of lower respiratory rate and higher tidal volume (15-17 ml/kg) has been used to decrease air trapping and improve air hunger. Ventilation is targeting oxygenation and patient comfort (work of breathing). High peak inspiratory pressures up to 55 cm H_2O are being tolerated and the goal is to extubate the patient once FiO_2 is <40% consistently.

Conclusions

- Case 1 and Case 2 did not survive and Case 3 remains at RCH currently ventilated on chronic phase conventional ventilation strategy in consult with the BPD collaborative team.
- Despite the use of different strategies in Case 2 and Case 3, major improvement in oxygen requirements were observed in both cases once they transitioned to SIMV+VG+PS.
- Ventilation strategies currently being implemented for prevention of BPD are:
  HFJV or HFOV using low tidal volumes, high respiratory rates, short inspiratory times, increased PEEP for lung recruitment and permissive hypercapnia.
- Ventilation strategies currently being trialed for established severe BPD are:
  Conventional ventilation using larger tidal volumes (based on weight and patient comfort), low respiratory rates allowing for longer expiratory time, permissive hypercapnia and PEEP 8-12 cm H_2O.