# Abstracts from the Advances in Therapeutics and Technology: Critical Care of Neonates, Children, and Adults Conference March 26-30, 2019, Snowbird, Utah

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The 36th Annual Advances in Care Conference – Advances in Therapeutics and Technology: Critical Care of Neonates, Children, and Adults (formerly: High-Frequency Ventilation of Infants, Children & Adults) presented high quality education and networking opportunities to healthcare professionals who provide care for critically ill neonatal, pediatric, and adult patients with a focus on advances in therapeutics and technologies. Along with featured speakers, the conference includes abstract presentations on research on advances in these areas:

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**ATT2019-1**
Effects of soft PVC foam in reducing nasal skin breakdown in preterm neonates receiving non-invasive ventilation via RAM nasal cannula

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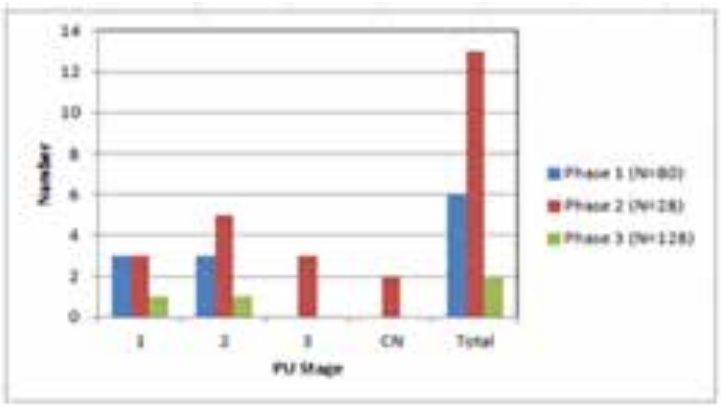
**Background:** Neonates rely on non-invasive ventilation (NC-PAP) for survival. Due to unique anatomical and physiological characteristics of neonatal columella area, bi-nasal prongs can lead to nasal trauma. Small bony maxillary spine, inadequate SQ and dermal tissue fail to off-load transmitted pressure, leading to deformation of skin layers, poor blood flow and ischemia. Lack of robust stratum corneum, increased heat and humidity delivered via prongs alter microclimate. Rates of neonatal nasal pressure injury (PI) range between 5 to 40%. NPUAP/EPUAP has recommended use of barrier products in all patients at risk for medical device related PI (MDRPI). The RAM Nasal Cannula is a simple cannula connected to ventilator capable of transmitting CPAP/O2. Manufacturer explains its theoretical advantage due to softer material, thinner walled prongs, and larger inner diameter prong resulting in lower resistance which may reduce nasal trauma. They recommend its use without offloading barrier device.

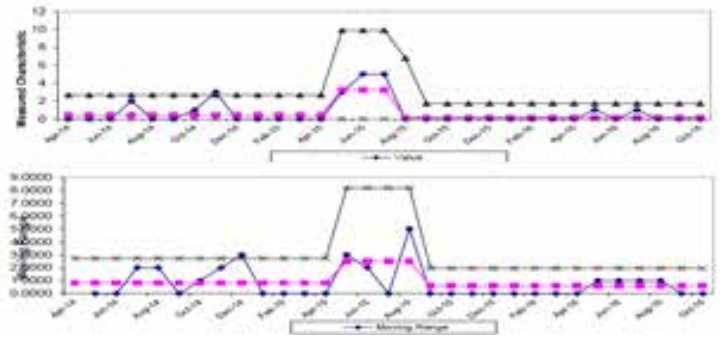
**Objectives:** Assess the incidence and severity of nasal pressure injury in premature infants receiving CPAP via RAM cannula and efficacy of PVS foam, Neoseal in reducing these injuries.
Method: Study conducted 04/2014-10/2016. All infants under 28 6/7 wks. GA requiring NCPAP. RAM cannula was set up accord-

ing to manufactures instructions. Soft PVC foam-Neoseal™ was placed on the bi-nasal prongs, without touching patients nasal skin and leaving 30-40% leak between nostrils and prongs. 3 time periods were compared. Period 1( 04/2014- 04/2015)- RAM cannula plus Neoseal. Period 2(05/2015-07/2015) RAM and No Neoseal. Period 3(08/2015-10/2016) –RAM plus Neoseal™
Statistics: Fisher exact test confirmed statistical differences in PI rate with and without Neoseal (P<0.0001) and in severity.

**Results:** Of 236 neonates, 80 evaluated during period1. (RAM +Neoseal). 6 PI were identified (3 –stage 1 and 3 stage 2) with rate of nasal injury 7.5%. 27 infants qualified during period 2(RAM only); 13 PI were identified (Stage1-3; stage2-5, stage 3-3 and columella necrosis-2) with the rate of 48%. PI rate had risen 6 times during Period 2, with 18% out of 48% staged as St 3 PI and columella necrosis. Period 3(RAM +Neoseal) -128 neonates, 2 PI-1.5 %(1-St1&1-St2). There were no significant differences (T-test) in the patient characteristics between 3 groups.

**Conclusion:** Unique anatomy of columella area, need for precise fit to deliver pressure and poor tolerability of device repositioning contributes to nasal MDRPI via sustained pressure and friction. RAM cannula, without a barrier is a significant risk factor for PI. Microclimate (increased moisture, temperature) generated by nasal cannula increases skin susceptibility. Younger and smaller babies, with prolong PEEP application are at risk for more severe injuries. We demonstrated clinically significant benefit in applying prophylactic soft PVC foam on RAM cannula in effort to prevent nasal injuries. To our knowledge this is the first study addressing incidence of nasal injuries in preterm neonates receiving non-invasive ventilation via RAM cannula. We conclude that preventative products must be used in conjunction with PEEP-delivering devices, including RAM nasal cannula.



**ATT2019-2**

Determining an Optimal Weaning Method of Nasal Continuous Positive Airway Pressure (CPAP) in Preterm Neonates

Venkatakrishna Kakkilaya, (1) Sheron Wagner, (2) Judy Ridpath, NNP, 2John Ibrahim, MD, (1) L. Steven Brown, (2) and Charles R. Rosenfeld (1)

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**Background:** Despite the wide adoption of CPAP for the respiratory support of preterm infants, optimal weaning strategy is not well established. While low level of CPAP (3 cm $H_20$) can help decrease apnea of prematurity and work of breathing, its benefits in weaning process has not been adequately evaluated.
Objective: To compare between stopping CPAP from a lower level after gradual pressure wean and discontinuation from standard therapeutic level.

**Design/Methods:** Single center, unblinded, prospective randomized control trial involving preterm infants born 23-32 week GA between October 2014 and February 2018. Infants meeting eligibility criteria were enrolled in the study after obtaining informed consent. Stability criteria to initiate weaning and failure criteria to restart CPAP were established a priori. CPAP was stopped at 5 cm $H_2O$ (Group1) or pressure was weaned stepwise and stopped at 3 cm $H_2O$ (Group 2). Primary outcome of interest was total CPAP days. 113 infants per group were required to achieve a 25% reduction in the primary outcome (Alpha 0.05, Power 0.8). Computer generated randomization sequence stratified by GA categories were placed in sealed opaque envelopes. ClinicalTrials.gov identifier NCT02064712.

**Results:** Of the 226 infants enrolled in the study, 116 infants belonged to Group 1 and 110 to Group 2 (Figure 1). In the intention to treat analysis, there were no differences in the baseline charac-

teristics between groups. Although CPAP was stopped earlier and at lower post- menstrual age in Group 1, primary outcome was not different between two groups. Higher proportion of infants in Group 1 failed initial attempt to stop CPAP (43% vs 27%, P 0.01) compared to Group 2. In the subgroup analysis, primary outcome was shorter among 30-32 week GA infants in Group 1 compared to Group 2 (P<0.01). Higher proportion of <30 week GA infants failed initial attempt to stop CPAP (54% vs 34%, P 0.02) and had ≥2 failed discontinuation attempts (26% vs 6%, P <0.01) in Group 1 compared to Group 2. Logistic analysis showed that Group 2 method is twice as likely to result in successful discontinuation of CPAP at first attempt compared to Group 1 [adjusted odds ratio 2.1 (1.2, 3.7)].

**Conclusion:** Stopping CPAP from standard therapeutic level is beneficial in decreasing duration of therapy among 30-32 week GA infants. Among <30 week GA infants, stopping CPAP from low level after gradual pressure wean can help achieve successful discontinuation at first attempt without prolonging the duration of therapy

**ATT2019-3**
The effects of altitude and definition on bronchopulmonary dysplasia and the role of the NRN BPD prediction algorithm

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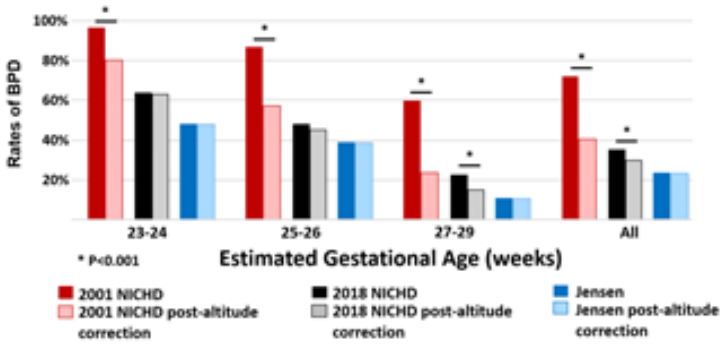
**Purpose:** Newer definitions for bronchopulmonary dysplasia (BPD) were developed to include current respiratory support strategies. We previously reported increased BPD rates at high altitude that normalized with altitude correction. The Neonatal Research Network developed a BPD prediction model for neonates 23-30 weeks gestational age (GA) with birth weight 501-1249g at various postnatal ages (Laughon, Am J Respir Crit Care Med, 2011) validated against the 2001 NICHD BPD definition. Our objective was to assess the effect of altitude correction on BPD rates and assess the validity of the NRN BPD prediction tool when using 3 different BPD definitions.

**Methods:** This is a retrospective review of neonates <30 weeks gestational age (GA) at University of Utah NICU from 1/2010 – 12/2017. BPD was defined using the following definitions: 2001 NICHD Consensus (Jobe, Am J Respir Crit Care Med, 2001), 2018 NICHD Consensus (Higgins, J Pediatr, 2018), and Jensen (PAS 2018). Effective FiO2 was determined at 36 weeks PMA (Benaron, Arch Pediatr Adolesc Med, 1994). Altitude correction was performed via the ratio of average barometric pressure (BP) in our unit of 640 mmHg (BP at 5000 feet) to 760 mmHg (BP at sea level). Probability of death and/or moderate-severe BPD was calculated at 14 days of age using the NRN BPD outcome estimator (https://neonatal.rti.org). Area under the curve (AUC) analysis and positive predictive values (PPV) were determined.

**Results:** 697 infants were identified (GA 27.0+1.9 weeks, BW 959±303g). BPD rates were inversely proportional to GA (Figure). BPD rate significantly decreased following altitude correction for all gestational ages (P<0.001) using 2001 NICHD definition and for the 27-29 week subgroup and overall (P<0.001) by the 2018 NICHD definition. There was no need for altitude correction with the Jensen definition. Post-altitude correction, 2001 NICHD BPD rates were significantly higher for all gestational ages (P<0.001) compared to 2018 NICHD and Jensen BPD definitions. Probability risk of BPD or death calculated at 14 days of age was similar by AUC for the 3 BPD definitions. PPV for BPD or death varied based on the BPD definition used (Table) and increased as the percentage risk of BPD or death increased.

**Conclusion:** Moderate to severe BPD rates differ based on the definition used. Altitude has less of an effect with the proposed 2018 NICHD BPD definition and no effect by the Jensen model, and may not need correction for altitude. With correction of FiO2 for altitude, the NRN BPD outcome estimator at 14 days of age remains a valid tool in predicting the risk of moderate-severe BPD or death in our NICU population when using recently proposed BPD definitions. Remodeling the BPD outcome estimator algorithm for newer BPD definitions may improve predictive properties.




| Predictive Risk at 14 days | 2001 NICHD | 2018 NICHD | Jensen |
|---|---|---|---|
| ≥50% | 76% | 61% | 51% |
| ≥60% | 80% | 65% | 55% |
| ≥70% | 84% | 70% | 59% |
| ≥80% | 85% | 76% | 61% |
| ≥90% | 90% | 86% | 71% |

Figure: Rates of moderate-severe BPD pre- and post-altitude correction based on definition used

Table: PPV of predicted risk at 14 days of age for 3 different BPD definitions

**ATT2019-4**
Decreasing the 3100A Inspiratory Percent as an Alternate to Increasing Hertz during Weaning

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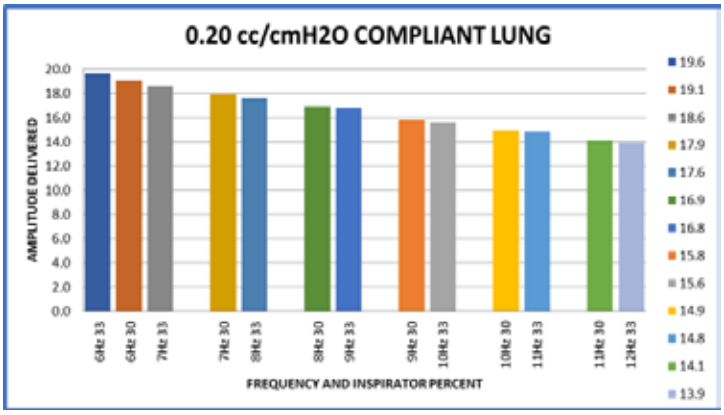
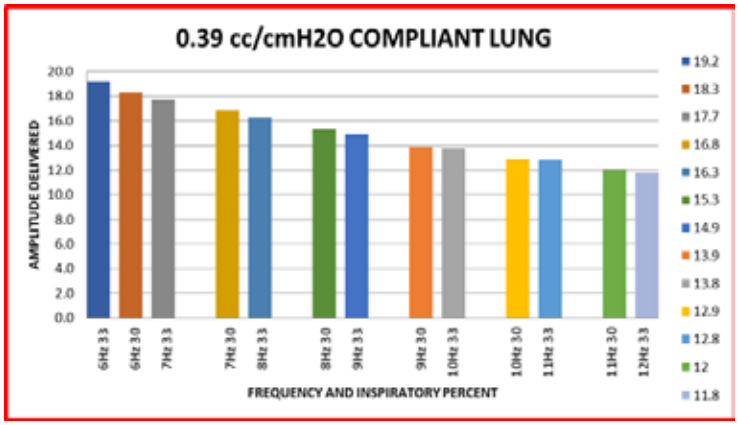
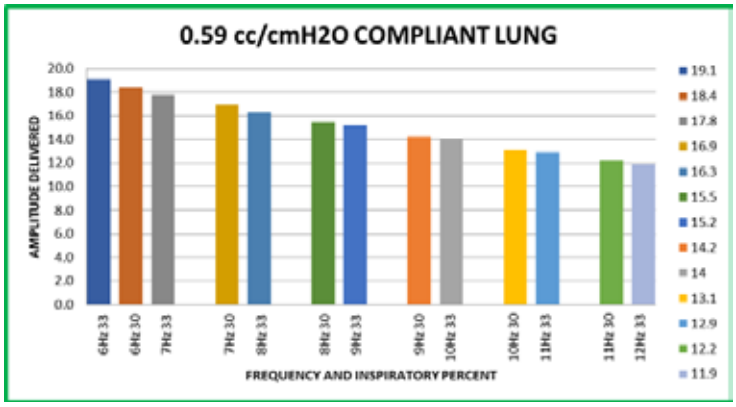
**Introduction:** This study looks at the relationship of the delivered Amplitude (amp) and Tidal Volume (Vt) using an inspiratory percent(I%) of 30 at one Hertz (Hz) vs the next greater HZ with an I% of 33 using a Sensor Medics 3100A High Frequency Oscillatory Ventilator (HFOV). Increasing HFOV Hz is an accepted method of weaning the HFOV ventilated patient. By increasing the Hz, you decrease the inspiratory time. The expiratory time in turn is then decreased. There is then an increased possibility of inadequate expiratory time for exhalation. The resulting consequence can be air trapping. The trapping of the expiratory gasses can result in hyper-expansion of the lungs. The hyper-expansion can impair gas exchange, increase shunting, and in some cases impair cardiac function if the hyper-expansion is severe enough. This study looks at the delivered amp's and Vt's to help understand if decreasing the I % is a viable choice in weaning the HFOV.

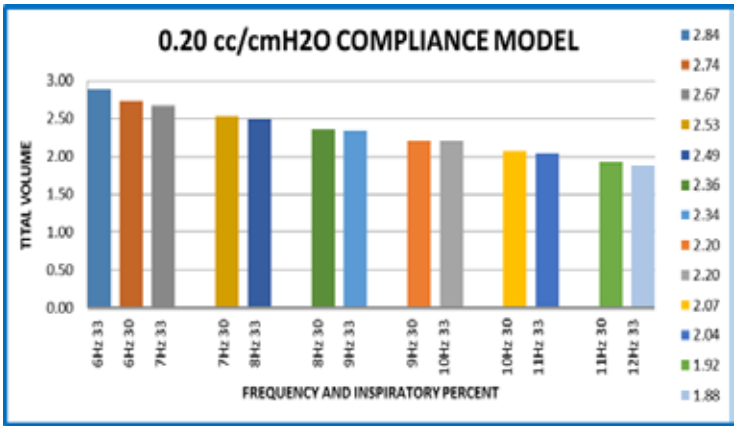
**Method:** A calibrated HFOV was connected to one of the three test lungs using a full-length endotracheal tube. The lung compliances and ETT's used were; 0.20cc/cmH2O with a 2.5 ETT, 0.39cc/cmH2O with a 3.0 ETT, and 0.59cc/cmH2O using a 3.5 ETT. The HFOV bias flow was maintained at 15 lpm throughout all testing. The MAP was set to 14 cmH2O (+- 0.1). As each parameter was set. The amp was measured from within the test lungs using a TSI Certifier. The Vt was measured using a Dragger VN 500 BabyLog ventilator as a volume monitor. The HFOV frequencies tested were 6Hz thru 12Hz. The I% was set to 30 and 33 for each frequency, except 12 Hz which ran at 33 I%, only. The amplitudes tested were; 16, 18, 20, 22, 24, 26, 28, and 30. Once the data was collected it was placed into a category. A category consisted of the averaged measured values from all eight Amp's tested from a single Hz frequency at a given I%. The categories were then paired. The pairing was a category of a Hz at 30 I% with the category of the next higher Hz at 33 I% (see graphs 1 thru 6). The Vt categories were then stratified further using the coefficient of the gas transport equation [(f * Vt2) / Kg] (see graphs 7, 8, and 9). Where the test lungs could not be assigned a patient weight, the weight aspect of the equation was not completed.

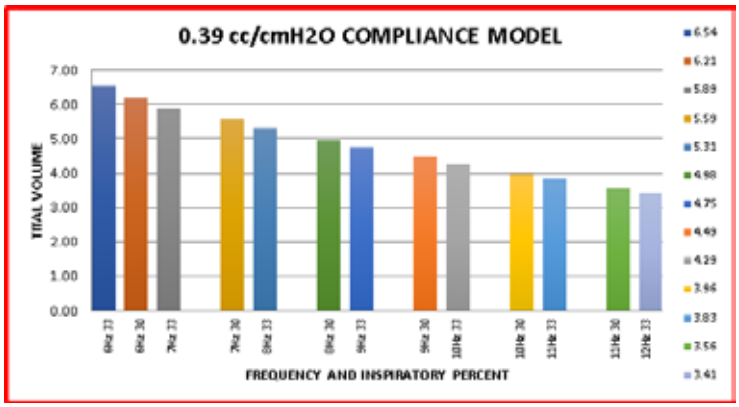
**Conclusion:** By decreasing the I% to 30 there is a demonstrated reduction in the delivered amp and Vt. The paired categories results are similar. The 30 I% values are slightly larger than the 33% measurements, except for a few examples. Where 30 I% values are larger you may expect that the change would be a lesser wean. However, when the Vt categories are stratified using the coefficient of the gas transport equation the data would suggest the Hz at 30 I% change would be a marginally greater wean than increasing the Hz at 33 I%. Only clinical application/trial will determine if these assumptions are correct.

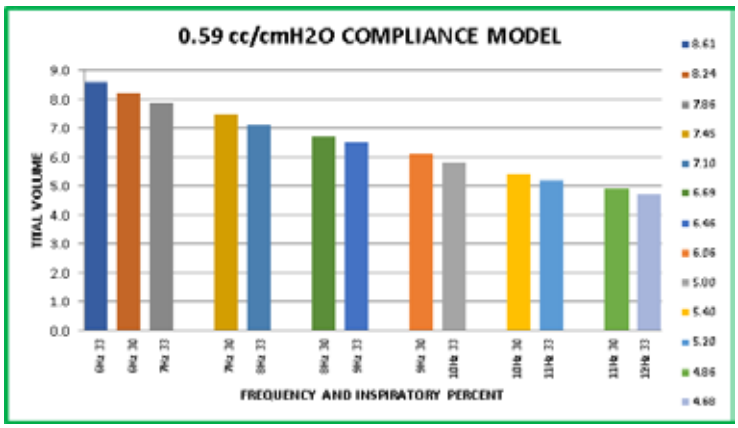


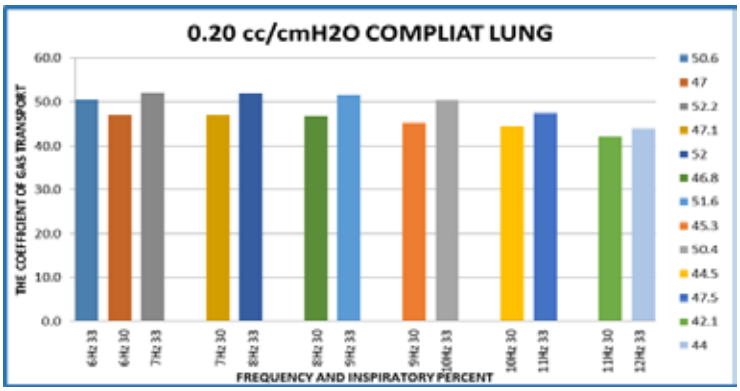



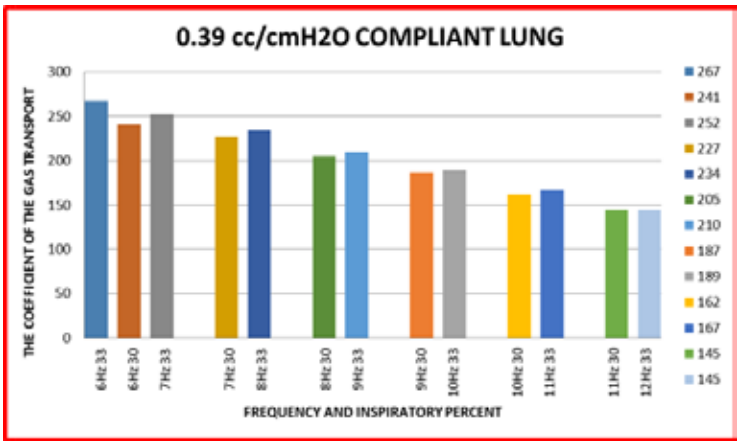



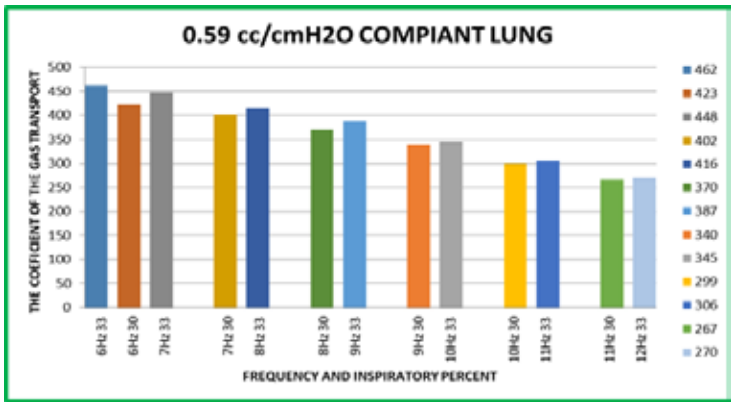






**ATT2019-5**

HFOV Tidal Volumes with Inspiratory Percent at 30 vs 33 at The Next Higher Hertz

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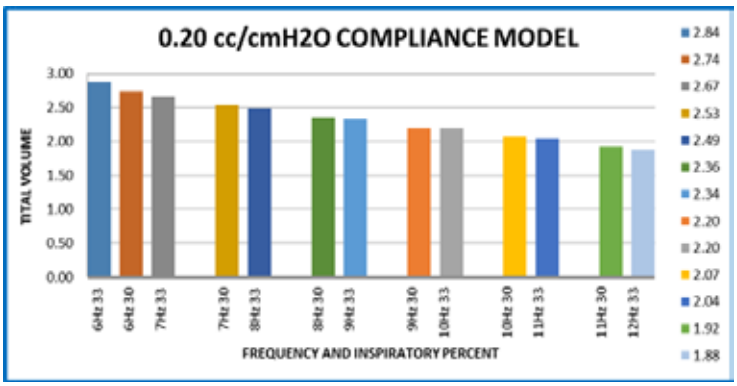
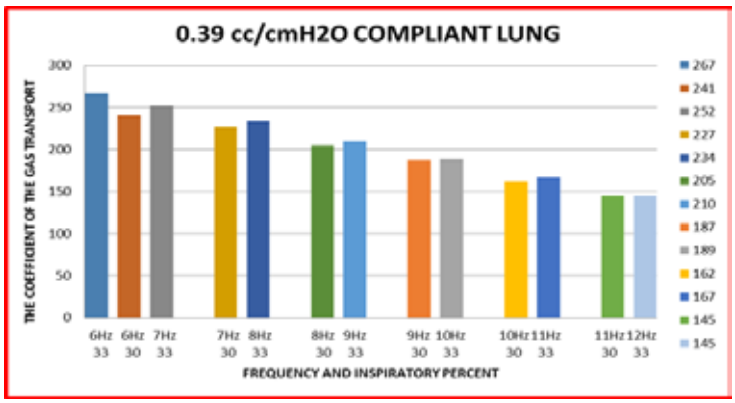
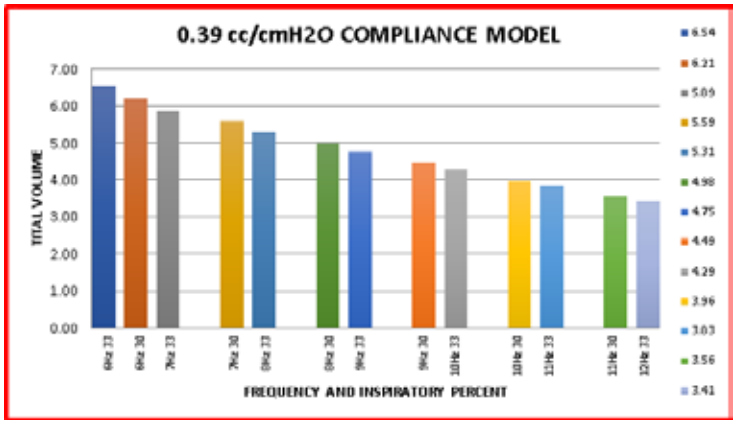
**Introduction:** This study looks at the relationship of the delivered Tidal Volume (Vt) using an inspiratory percent(I%) of 30 at one Hertz (Hz) vs the next greater HZ with an I% of 33 using a Sensor Medics High Frequency Oscillatory Ventilator (HFOV). In clinical care, increasing HFOV Hz is an accepted method of weaning the HFOV to increase the $PCO_2$ in the mechanically ventilated patient. The idea is by increasing the Hz you decrease the inspiratory time and it is assumed the Vt to the patient. The concern is increasing the Hz increases the possibility of inadequate expiratory time for exhalation. Air trapping can be a consequence. The trapping of ventilation gasses can result in hyper-expansion of the lungs. The hyper-expansion can impair gas exchange, shunting, and in some cases impair cardiac function if the hyper-expansion is severe enough. The goal of this study is to determine if decreasing the I% could deliver a similar out come as seen when the Hz in increased while at 33 I%, but with lowering the risk of air trapping. This study will look at the delivered Vt's to see if the assumption is correct.

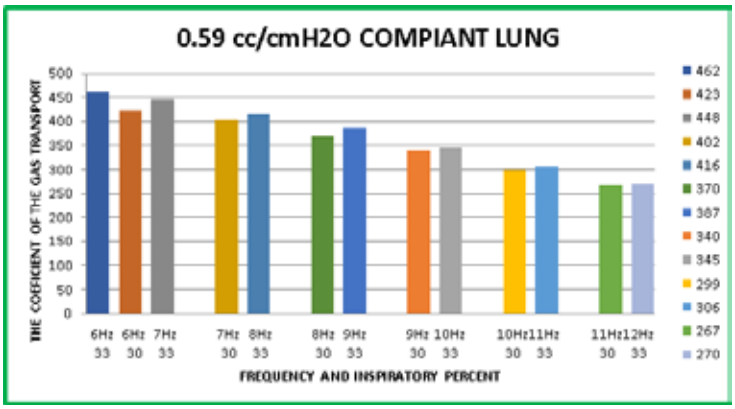
**Method:** A calibrated HFOV was connected to one of the three test lungs using a full-length endotracheal tube. The HFOV bias flow was maintained at 15 lpm throughout all testing. The MAP was set to 14 $cmH_2O$ (+- 0.1). As each parameter was set the Vt were measured using a Dragger VN 500 BabyLog ventilator. The VN 500 became a volume monitor by placing its' flow sensor between the HFOV circuit and ETT. The lung compliances and ETT's used were; 0.20cc/$cmH_2O$ using a 2.5 ETT, 0.39cc/$cmH_2O$ using 3.0 ETT, and 0.59cc/$cmH_2O$ using a 3.5 ETT. The HFOV frequencies tested were 6Hz thru 12Hz. The I% was set to 30 and 33 for each frequency, except 12 Hz which ran at 33 I% only. The amplitudes tested were; 16, 18, 20, 22, 24, 26, 28, and 30. Once the data was collected it was placed into a category. A category consisted of the averaged measured Vt's delivered from all Amp's, from a single Hz frequency at a given I%. The categories were then paired. The pairing was a category of a Hz at 30 I% with the category of the next higher Hz at 33 I% (see graphs 1, 2, and 3).

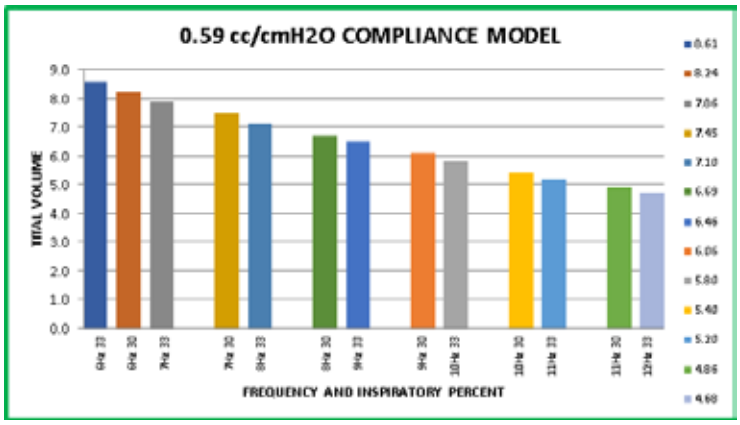
**Conclusion:** By decreasing the I% to 30 there is a demonstrated reduction in the delivered Vt. When looking at the paired categories they are very similar. If you only look at the delivered Vt you would think it is highly likely in a clinical setting if the I% were reduced to 30, rather that increasing the Hz on 33 I% the lab values would yield similar results. Only clinical application/trial will determine if either of these assumptions are correct.

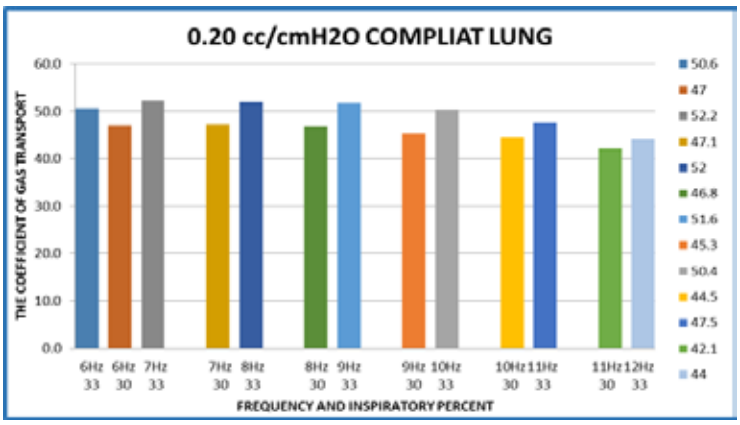



**ATT2019-6**

Delivered HFOV Amplitudes At 30 vs 33 Inspiratory Percent

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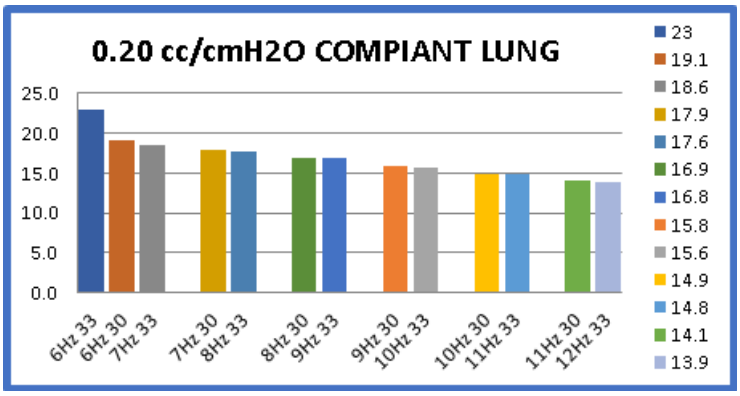
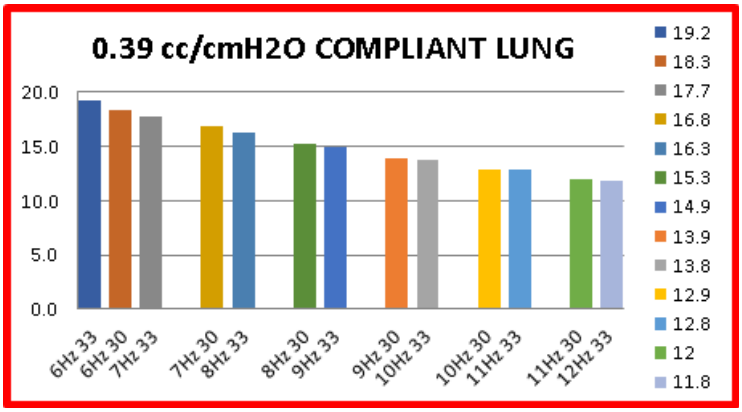
**Introduction:** This study looks at the relationship of the delivered amplitude using an inspiratory percent of 30 at one Hertz (Hz) vs the next greater HZ with an inspiratory of 33 using a Sensor Medics High Frequency Oscillatory Ventilator (HFOV). In clinical care, increasing HFOV Hz is an accepted method of weaning the HFOV to increase the $PCO_2$ in the mechanically ventilated patient. Increasing the Hz can have a negative effect in some patients. Air trapping is a common negative side effect. The trapping of ventilation gasses can result in hyper-expansion of the lungs, shunting, impair adequate gas exchange, and in some cases cause reduced cardiac function if the hyper-expansion is severe enough. The goal of this study is to determine if decreasing the inspiratory percent could deliver a similar out come as seen in increasing the Hz, but with a reduced possible air trapping in the lung.

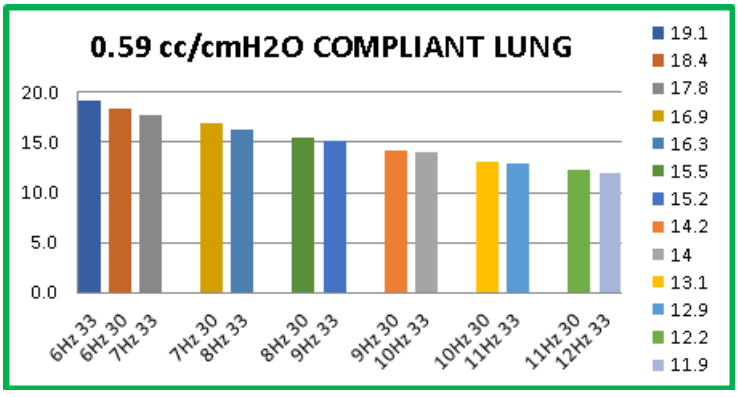
**Method:** A calibrated HFOV was connected to one of the three test lungs using a full-length endotracheal tube. The HFOV bias flow was maintained at 15 lpm throughout all testing. The MAP was set at 14 cmH2O (+- 0.1). Each parameter was set, and the pressures were measured within the test lungs using a TSI Certifier. The lung compliances and ETT's used were; 0.20 cc/cm$H_2O$ using a 2.5 ETT, 0.39 cc/cm$H_2O$ using a 3.0 ETT, and 0.59 cc/cm$H_2O$ using a 3.5 ETT. The HFOV frequencies tested were 6 Hz thru 12 Hz. The inspiratory percent was set to 30 and 33 for each frequency, with exception of the 12 Hz which was only ran at an inspiratory percent of 33. The amplitudes tested were; 16, 18, 20,

22, 24, 26, 28, and 30. Once the data was collected it was placed in a category and then averaged. A category consists of a specific Hz frequency at a single inspiratory percent, and all 8 amplitudes studied averaged. The categories were then paired. The pairing consisted of a Hz category at an inspiratory percent at 30 with the next higher Hz category inspiratory percent set at 33.

**Results/Conclusion:** By decreasing the inspiratory percent to 30 there was a demonstrated reduction in the delivered amplitude to the test lungs (see graphs). When comparing the categories, the findings are very similar to each other. It is highly likely in a clinical setting if the inspiratory percent were to be reduced to 30, rather that increasing the Hz at an inspiratory percent of 33 the lab value differences would be minorly different. Only a clinical trial/application will determine if this assumption is correct.




**ATT2019-7**

Assessment of the number of neuronal progenitor cells in the brain of preterm lambs.

Nabi A*, Pettet L, Rebentisch A, Wang Z, Dawson E, Dahl M, Yoder B, Null D, Albertine K.

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**Purpose of Study:** Although brain injury happens in chronically ventilated preterm infants, pathogenic mechanisms remain to be identified in part because brain tissue is not typically part of clinical material for study. We showed that preterm lambs supported by invasive mechanical ventilation (IMV) have more apoptosis, and less proliferation, of neurons and glial subtypes compared to non-invasive respiratory support (NRS). These results suggest that cell survival may be decreased in the brain of preterm lambs that are managed by IMV. Disruption might lead to shift to more progenitor cells as a compensatory response. Neural stem cells give rise to neuronal progenitor cells, which are identifiable by doublecortin. We hypothesized that decreased neuron survival during IMV may increase the number of neuronal progenitor cells in the brain.

**Methods Used:** Preterm lambs, treated with antenatal steroids and postnatal surfactant, were managed by IMV or NRS for either 3d or 21d (n=4/group). We use NRS (high-frequency nasal support) as the positive gold-standard for alveolar formation in the lung. At the end of 3d or 21d of respiratory management, cortical brain tissue from the temporal lobe was fixed. We used immunohistochemistry to localize doublecortin-positive neuronal progenitor cells. We used stereology to quantify numerical density of doublecortin-positive neurons in Layer II, using systematic, uniform, random sampling.

**Summary of Results:** We found a statistically significant difference in numerical density of doublecortin-positive neuronal progenitor cells in cortical layer II of the temporal lobe at 21d between the two modes of respiratory support. Numerical density was significantly lower for the 21d IMV group (0.021±0.002/cm3) compared to the 21d NRS group (0.027±0.005/cm3; $p<0.05$). No difference was detected at 3d between the two groups (3d IMV 0.024±0.003/ cm3 versus 3d NIS 0.029±0.005/ cm3, respectively). Conclusions: We conclude that 21d of IMV reduces the number of neuronal progenitor cells in layer II of temporal lobe gray matter compared to 21d of NRS. We speculate that the better outcome after NRS may lead to better neurodevelopmental outcomes later in life. Supported by R01 HL110002 and Division of Neonatology.

**ATT2019-8**

Mask resuscitation and continuing noninvasive respiratory support leads to better alveolar formation compared to invasive mechanical ventilation resuscitation and continuing invasive mechanical ventilation of preterm lambs.

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**Purpose of Study:** Chronic lung disease of prematurity is histopathologically characterized by alveolar simplification. We showed, using our preterm lamb model, that 3d of invasive mechanical ventilation (IMV) leads to thicker and less secondary septated distal airspace walls, both being indices of alveolar simplification, compared to preterm lambs supported by 3d of noninvasive respiratory support (NRS). An unknown is whether preterm lambs that are not endotracheally intubated, and therefore not supported by IMV, will have improved architectural formation of alveoli. Therefore, the aim of this study was to develop a preterm lamb model in which lambs were resuscitated noninvasively by facial mask.

**Methods** Used: Preterm lambs (delivered by Cesarean-section at 128d gestation; term ~150d; equivalent to ~28w gestation in humans) were either (1) intubated at birth, resuscitated by IMV, and continued on IMV ("IMV" group; n=4; control group) for 3d or (2) resuscitated by facial mask and continued with NRS ("NRS" group; n=5) for 3d. The NRS group was supported noninvasively by nasal cannula. All lambs were given surfactant prior to delivery and caffeine citrate after delivery. Both groups received two sustained lung inflations (35sec). Quantitative histology was used to measure indices of alveolar formation.
Summary of Results: IMV-managed preterm lambs had significantly thicker distal airspace walls (2.5±0.2 μm) compared to the NRS preterm lambs (2.0±0.1 μm; $p<0.05$ by unpaired t-test). Volume density of secondary septa was not significantly different for the IMV group (4.8±1.6%; $p=0.6$) compared to the NRS group (8.3±1.8%) of preterm lambs.

**Conclusions:** Noninvasive resuscitation and continuing noninvasive respiratory support leads to more rapid thinning of distal airspace walls compared to IMV resuscitation and continuing IMV of preterm lambs. Supported by R01 HL110002 and Division of Neonatology

**ATT2019-9**
Balance between proliferation and apoptosis of interstitial cells remains constant in the lung of former preterm lambs, regardless of the mode of respiratory support after preterm birth of preterm lambs.

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**Purpose of Study:** Alveolar simplification is the characteristic histopathology for bronchopulmonary dysplasia. We showed, using our chronically ventilated preterm lamb model, that days or weeks of invasive mechanical ventilation (IMV) leads to thicker distal airspace walls, an index of alveolar simplification, compared to noninvasive respiratory support (NRS). We also showed that the increased thickness is related to disproportionate proliferation of mesenchymal cells compared to their apoptosis. Our new former preterm lamb studies indicate that their lungs have alveolar walls that are persistently thicker at 5 months corrected postnatal age (cPNA) compared to unventilated term lambs matched for PNA. An unknown is whether the former preterm lambs have persistently disrupted proliferation versus apoptosis of alveolar wall interstitial (mesenchymal) cells.

**Methods Used:** Preterm lambs (delivered by Cesarean-section at 128d gestation; term ~150d; equivalent to ~28w gestation in humans) were either (1) intubated at birth, resuscitated by IMV, and continued on IMV for 6d ("IMV" group; n=6) or (2) resuscitated noninvasively by facial mask and continued NRS for 6d ("NRS" group; n=4). Both groups were weaned from all respiratory support and lived for ~6 months (former preterm (FPT) lambs; ~5 months corrected postnatal age; ~6y human). Control term lambs were not ventilated and lived 5 months. Quantitative immunohistochemistry was used to quantify proliferation and apoptosis.
Summary of Results: FPT lambs managed by IMV or NRS during their first week of postnatal life had comparable proliferation index (0.87±0.49 and 0.97±0.18, respectively; mean±SD; not different) and apoptotic index (apoptotic interstitial cells/total epithelial cells; 0.85±0.70 and 0.60±0.25, respectively; not different). These indices were comparable to those for control term lambs (0.64±0.41 for apoptotic index and 0.99±0.51 for proliferation index).

**Conclusions:** Our results suggest that the persistently thicker alveolar walls of FPT lambs that were managed by IMV for ~6d during their first week of postnatal life (Dahl, 2018) occurs without persistent disruption of the balance between proliferation and apoptosis of interstitial (mesenchymal) cells in alveolar walls. We speculate that the persistently thicker alveolar walls may be the result of reduced turnover of interstitial cells and/or excess accumulation of extracellular matrix (Pierce, Am J Physiol - Lung 1997). Supported by R01 HL110002 and Division of Neonatology

**ATT2019-10**
Jet 58: HFJV and Confessions of a NICU Mom

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To discuss the process of starting the HFJV program at our site and increase awareness on family centered care in the NICU thru the eyes of a NICU family.

Initiating a new ventilation program can be challenging. It involves multiple stakeholders who need to understand the therapy and also agree on strategies, techniques and management. The impact of these interventions on patients and families must be considered as well.

In this presentation we will discuss the implementation of the HFJV program at Royal Columbian Hospital and the learnings along the way. This includes the creation of a ventilation standard, appropriate timing of the intervention, and subsequent modifications with complementary strategies to allow skin to skin on the HFJV (construction of a "jet arm" for the patient box).

In addition, we will present the story of Baby girl Hazel. We will hear her journey of 6 months in the NICU from her mother and the multi-disciplinary clinicians that cared for her. We will share her 58 day "flight" on HFJV with multiple Respiratory interventions including, unique "outside of the box" events. Family experience from

admission to discharge will be highlighted including knowledge of the NICU environment, feedback on improvements from family, and post discharge.

**ATT2019-11**

Implementing the Use of Early Lung Recruitment for Newborn Respiratory Management in a Level II Nursery.

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**Background:** Newborn infants experience many physiologic changes at birth to enable transition to extra-uterine life. Newborns are at risk for respiratory distress due to many factors. A standardized ELR CPAP protocol in level two NICUs for newborns in respiratory distress, could improve quality of care, reduce the severity of respiratory distress during the immediate newborn period, and potentially reduce treatment duration.

**Purpose:** The purpose of this quality improvement project was to implement a standardized extended early lung recruitment (ELR/CPAP) protocol for infants who exhibit symptoms of respiratory distress within the immediate newborn period (within 10-120 minutes of life) for respiratory management. Specific aims were to improve respiratory management of newly born infants, increase the rate of infants transitioned to the mother-baby unit, promote maternal-infant proximity, and decrease the transfers to higher level III NICU.

**Methods:**

1. Education of ELR practice was provided to all staff who attend deliveries
2. Assessment of the process continued throughout administration of ELR/CPAP to ensure correct application/practice of the protocol.

**Results:**

Data collected suggests ELR/CPAP is beneficial for a specific patient population, the patients who were able to transition to the mother/baby unit after an extended transition period, who would have otherwise been transported to a higher level of care for ongoing respiratory management. This project provides a baseline for future studies to explore ELR in neonates.

**ATT2019-12**

Is Conventional Ventilation Actually High-Frequency Ventilation in Disguise?

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**Introduction:** Neonatal ventilation has been traditionally divided into two different categories. Conventional ventilation consists of tidal ventilation using a "conventional" ventilation rate typically less than 60 breaths per minute. High-frequency ventilation has been defined as ventilation in excess of 2.5 Hz or 150 breaths per minute. From earlier studies on high-frequency ventilation, we were able to demonstrate that high-frequency ventilation gives rise to harmonics of yet higher frequency waveforms. Some of these frequencies may have a clinically significant effect on ventilation.

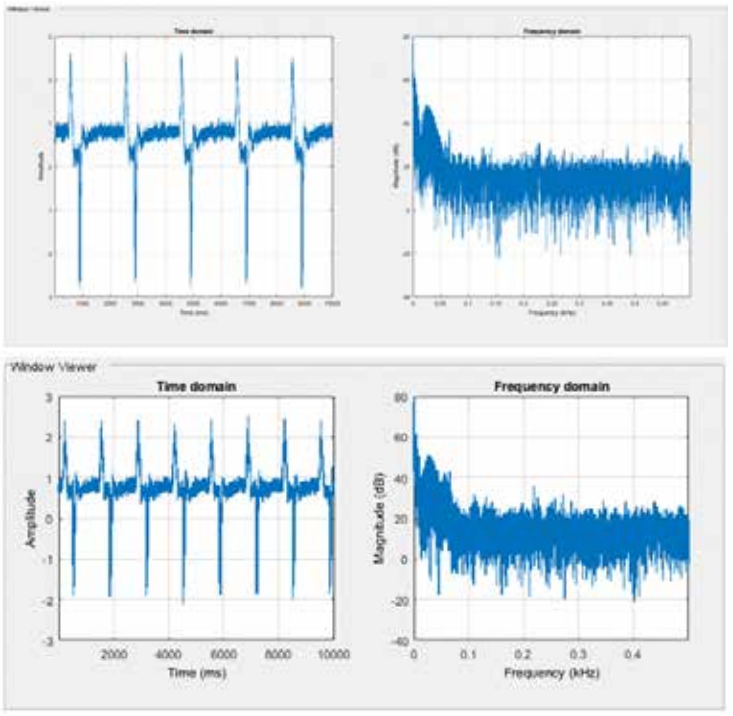
**Purpose:** We asked whether conventional ventilation produces harmonics that are in the high-frequency range.

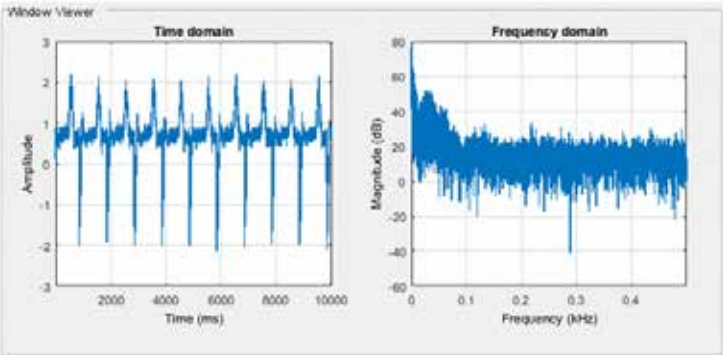
**Methods:** We used the Maquet SERVO-n Neonatal Ventilator (MAQUET Holding B.V. & Co., Rastatt, Germany) and the RD020 from Fisher and Paykel (Huntington Beach, CA) as our artificial lung for this study. The ventilator was set at a rate of 30, 45, and 60 BPM with pressures of 25/4 and an inspiratory time of 0.35. We studied different flow and pressure dynamics at each setting. Easy Sense UPC2100 software from Validyne (Northridge, CA) was used to obtain our measurements. Sampling was at 1000 Hz. 10 seconds of data or 10,000 measurements were taken at each of these settings. Data were analyzed using MATLAB (R2015B) and mapped in time and frequency domains.

**Results:** As noted in the Graphics below (30, 45, 60 bpm). In all samples, the frequency domain indicated substantial magnitude waveforms in the high-frequency range (i.e., a substantial bump in magnitude in the harmonics in the < 0.1 KHz range).

**Discussion:** Although the debate continues as to whether "conventional" or high-frequency ventilation is superior in the ventilation of neonates, it is readily apparent that the differences are not as well defined as previously described. There is a substantial component of high-frequency ventilation in conventional ventilation patterns. Ventilator dynamics and patient factors may affect the degree to which this effect is clinically significant, but it is clear that "conventional ventilation" also produces significant harmonics.

**Conclusion:** "Conventional" ventilation may, in fact, be high-frequency ventilation in disguise. Further research is indicated to define the precise operational frequencies.






**ATT2019-13**
Neonatology Today: Statistics, Logistics, and You

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Last February, Neonatology Today was acquired by Loma Linda Publishing Company, a Delaware 501-C3 Not-For-Profit operating as a Public Charity. In the 12 months since the journal has been under new ownership, we have initiated the following plan:

- All manuscripts submitted will be peer-reviewed. We plan to add additional reviewers as needed to accommodate the demand. Our commitment will be to provide feedback on any submission in fewer than 14 business days.
- We will continue to commit to not charge authors any fees whatsoever for publication of their manuscripts.
- We will continue to provide the journal for free to our readers.
- We will actively solicit and publish case reports that provide insights into the management of complex conditions confronting practicing neonatologists. Although many journals have discouraged case report submission, it is our feeling that these provide a way of disseminating meaningful academic information that may not otherwise see the light of day.
- We will be making Neonatology Today a multidisciplinary publication, open to all professionals who engage in academic pursuits in the fields of Neonatology, Perinatology, and Pediatrics.
- We hope to increase our readership by striving to be first to report on innovative new concepts in all of the associated specialties.
- We will expand our readership by adding an international component to our board.
- We are highlighting the work of the patient and provider advocacy community including organizations like the National Coalition for Infant Health (NCfIH),(infanthealth.org).
- We will have open conference calls to improve the journal content.
- We will have a dedicated message line for questions, concerns, and comments.
- We aim to provide CME's for our reviewers.

Since NT 's acquisition, the page count has tripled. We have added additional distribution models, increasing our circulation to 15,000 readers/month with a peak readership of 100,000 for the 12 month period. EBSCO and CiteFactor have indexed our journal. We are continuing to look for new content and new members of our editorial board. Please consider NT for your publication plans

**ATT2019-14**
Prongs and Velocities - Unraveling the Vapotherm Flow Dynamics

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**Background:**
The use of high flow therapy (HFT) is growing rapidly, particularly in the neonatal intensive care setting. Vapotherm (VT) is a HFT modality that was developed as a method for humidifying and warming inhaled gas, allowing for flow to be delivered in a way that is less traumatic to the nasal mucosa.

The VT cannula is not uniform in its diameter. The recommended cannula size will vary depending on the patient's weight, inner diameter of the nares and the outer diameter of the cannula prongs in use. VT cannulas were developed with the impression that their small size will increase gas velocity to more efficiently flush the nasal extra-thoracic dead space and therefore flush $CO_2$ at lower, more comfortable flows. This ability to flush the extra-thoracic dead space is important for the management of respiratory distress and hypercapnia.

**Objective:**
We evaluated the effect of varying the nasal cannula opening size in a typical VT cannula application, on the exit velocity of gas based on different flow rates.

**Design/Methods:**
Outer diameters of 1.5, 1.9, 2.7 and 4.8 mm were selected based on the cannula opening sizes provided by the Vapotherm manufacturer. Using the preselected recommended flow rate for each cannula, the exit flow velocity from the nasal cannula was calculated using known relationships between flow and velocity.

**Results:**
Decreasing cannula opening sizes and increasing flow rate lead to significant increases in nasal cannula velocity.

**Conclusion(s):**
High flow cannulas can vary considerably based on the diameter of the cannula opening. Smaller cannula size and increased flow allow for propagation of flow at higher velocities, theoretically influencing hypoxia, hypercapnia and work of breathing in patients with respiratory distress. It is important to be cognizant about the effect of weaning flow to the nasal cannula on the velocity of gas delivered. Clinicians should also take into account the size of prongs as this contributes significantly to the delivered velocity to the patient.

| Velocity (m/s) at Given Flow Rate and Cannula Size | | | | |
|---|---|---|---|---|
| | Cannula Size in mm | | | |
| | 1.5 | 1.9 | 2.7 | 4.8 |
| Liter per minute (LPM) Flow to Cannula | | | | |
| 1 | 9.4 | 5.9 | 2.9 | 0.9 |
| 2 | 18.9 | 11.7 | 5.8 | 1.8 |
| 3 | 28.3 | 17.6 | 8.7 | 2.8 |
| 4 | 37.7 | 23.5 | 11.6 | 3.7 |
| 5 | 47.2 | 29.3 | 14.5 | 4.6 |
| 6 | 56.6 | 35.2 | 17.4 | 5.5 |
| 7 | 66.0 | 41.1 | 20.3 | 6.5 |
| 8 | 75.5 | 46.9 | 23.2 | 7.4 |
| 10 | 94.3 | 58.7 | 29.0 | 9.2 |
| 20 | 188.6 | 117.3 | 58.0 | 18.4 |
| 30 | 283.0 | 176.0 | 87.1 | 27.7 |
| 40 | 377.3 | 234.6 | 116.1 | 36.9 |

**NT**


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