Letters to the Editor

Why is the infant placed on a High-Frequency Oscillatory Ventilation (HFOV) set primarily at a bias flow (BF) of 20 LPM?

Letter to the Editor

As a respiratory therapist in the NICU with over 15 years of experience, there are many questions asked of me regarding HFOV. When calibrating a Sensormedics 3100-A HFOV, it states to set the BF at 20 LPM for proper calibration, as noted on the ventilator manual and the quick guide. (1) BF is typically the first parameter set by the clinician because it is part of the oscillator peruse calibration. If the BF is set too low, it may result in increased $P_a\text{CO}_2$ secondary to inadequate circuit washout. (2) If the BF is set too high, it may inhibit CO_2 elimination.

On the contrary, an increased bias gas flow will increase airway pressure, thus improving oxygenation. (3) Also available within the quick guide, it gives the different bias flows that a practitioner may select based on the potential age range (preterm, near-term, small child, and large child). There is even guidance to use the lowest bias flow needed to achieve the desired settings. An interesting study by Turner et al. looked at how bias flow showed no influence in ventilation in pediatric lung models looking at 10, 20, 30, and 40 LPM bias flows. (4) When they used linear regression analysis, it showed no statistically significant change in PaCO_2 when controlling for power and amplitude. As mentioned by the manufacturer, only the minimum bias flow to deliver the ventilatory pressures is needed. Is there any evidence of how different bias flows could generate more or less driving pressures? In a quick literature review, there appears a rationale for using different BF rates for achieving these pressures, but what are the

consequences?

References:

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Dear Mr. Lora,

The effect of using higher flows on the oscillator than that which is necessary can produce significant flow and pressure issues that may ultimately contribute to lung disease. The flow issues are challenging to explain because one must look at the second derivative with respect to time to get to a number that describes not the acceleration but the change in acceleration, particularly at the inflection points where negative flow changes to the positive flow and vice versa. The analogy of a car moving along the highway at a gradually increasing velocity under constant acceleration and then slamming headlong into a brick wall is similar to what can happen with an oscillator provided with the excess flow. Excess flow is analogous to excess speed. The higher the speed that the car hits the wall, the more damage.

A more straightforward way of approaching this issue is using wavelength. Longer wavelengths are associated with better propagation across distance. The classic example is a tidal wave. It promulgates over many hundreds or thousands of miles before causing damage on some distant shore. Wavelengths can also be calculated from ventilation circuitry. Using parameters from the Endotracheal tube dimensions, frequency, and theoretical bias flow, we presented data regarding this phenomenon this Fall at the 2021 American Academy of Pediatrics NCE.

Simulated oscillator settings were used for this model (Sensor-Medic 3100-A, Vyair Medical, Inc., Yorba Linda, CA). Bias flows of 10 LPM, 15 LPM, 20 LPM, 25 LPM, and 30 LPM were analyzed for endotracheal tube sizes 2.5 mm, 3.0 mm, 3.5 mm, 4.0 mm, 4.5 mm, 5.0 mm, 5.5 mm, and 6.0 mm at frequencies of 5 Hz, 10 Hz, and 15 Hz. The flow velocity used in this calculation is: $v = Q / (\pi \cdot (\phi / 2)^2)$, where $v = Q / A$, $A = \pi \cdot r^2$, and $r = \phi / 2$. Q = Volume flow rate, v = Flow velocity, A = Cross-sectional area, r = Radius, and ϕ = Diameter. Wavelength (λ) was calculated using the rela-

Tube Diameter, Wavelength, and Frequency; categorized by Flow

Flow: 10

Flow: 15

Flow: 20

Flow: 25

Flow: 30

tionship $\lambda = v/f$, where f represents the oscillator frequency.

For this analysis, it was assumed that there were uniform flow conditions within the entire cross-sectional area of the endotracheal tube, without any loss of speed due to friction or shear at the inner aspect of the ETT wall or the presence of water vapor in the circuit.

Graphically, the result can be represented as above.

Comparing the wavelength above propagated with a flow of 10 lpm to 30 lpm across all frequencies demonstrates this situation. Smaller tubes are more dramatically affected by lower oscillator frequency and higher flow – these same smaller tubes are used for our most at-risk preterm infants.

Although theoretical, it would seem logical to use the lowest flows necessary to achieve the desired ventilation. 20 LPM is probably not necessary with smaller babies and correspondingly small endotracheal tube size.

References:

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Erratum (Neonatology Today October 2021)

Neonatology Today is not aware of any erratum affecting the October, 2021 edition.

Corrections can be sent directly to LomaLindaPublishingCompany@gmail.com. The most recent edition of Neonatology Today including any previously identified erratum may be downloaded from www.neonatologytoday.net.

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Loma Linda Publishing Company

A Delaware "not for profit" 501(c) 3 Corporation.

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© 2006-2021 by Neonatology Today ISSN: 1932-7137 (online)

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