Original Article: Neonatal Lung Disease

Weight-correction of carbon dioxide diffusion coefficient (DCO_2) reduces its inter-individual variability and improves its correlation with blood carbon dioxide levels in neonates receiving high-frequency oscillatory ventilation¹

Gusztav Belteki 0000-0002-2974-2011^{1*} MD, PhD, FRCPCH, Benjamin Lin¹, BA,
& Colin Morley¹ MD, FRCPCH

¹ Department of Neonatology, The Rosie Hospital, Cambridge University Hospitals NHS Trust, Cambridge, CB2 0SW, United Kingdom

The authors declare that they do not have any conflict of interest. In particular, none of the authors has a contract with Dräger Medical or has received any grant, sponsorship or funding for this research from Dräger Medical or any other company. Previously, Colin Morley received payment and travel funds from Dräger Medical for sponsored lectures.

*Corresponding author

Dr Gusztav Belteki

¹ This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as doi:10.1002/ppul.23759

Cambridge University Hospitals NHS Foundation Trust

Box 402 The Rosie Hospital, Robinson Way, Cambridge, CB2 0QQ

e-mail: gusztav.belteki@addenbrookes.nhs.uk; gbelteki@aol.com;

Tel: Office: +44 (0)1223 274183; Hospital switchboard: +44 (0)1223 245151
xt 4183; Fax: +44 (0)1223 217064

Key words: high-frequency oscillatory ventilation, hypercapnia, neonatal lung disease, normal range, pulmonary gas exchange, respiratory mechanics

Abbreviated title: Weight-corrected DCO₂ during HFOV

ABSTRACT

BACKGROUND: Carbon-dioxide elimination during high-frequency oscillatory ventilation (HFOV) is thought to be proportional to the carbon dioxide diffusion coefficient (DCO_2) which is calculated as frequency $\times$ (tidal volume)². DCO_2 can be used to as an indicator of CO_2 elimination but values obtained in different patients cannot be directly compared.

OBJECTIVES: To analyse the relationship between DCO_2 , the weight-corrected DCO_2 ($\text{DCO}_{2\text{corr}}$) and blood gas PCO_2 values obtained from infants receiving HFOV.

METHODS: DCO_2 data were obtained from 14 infants at 1/sec sampling rate and the mean DCO_2 was determined over 10-minute periods preceding the time of the blood gas. $\text{DCO}_{2\text{corr}}$ was calculated by dividing the DCO_2 by the square of the body weight in kg.

RESULTS: Weight-correction significantly reduced the inter-individual variability of DCO_2 . When data from all the babies were combined, standard DCO_2 showed no correlation with PCO_2 but $\text{DCO}_{2\text{corr}}$ showed a weak but statistically significant inverse correlation. The correlation was better when the endotracheal leak was $<10\%$. There was significant inverse but weaker correlation between the HFOV tidal volume (VThf) and the PCO_2 . In any baby, $\text{DCO}_{2\text{corr}} > 50 \text{ mL}^2/\text{sec}/\text{kg}^2$ or $\text{VThf} > 2.5 \text{ mL}/\text{kg}$ was rarely needed to avoid hypercapnia.

CONCLUSION: Weight-correction of DCO₂ values improved its comparability between patients. Weight-corrected DCO₂ correlated better with PCO₂ than uncorrected DCO₂ but the correlation was weak.

INTRODUCTION

During high-frequency oscillatory ventilation (HFOV), CO₂ elimination is affected by the frequency (Hz) and tidal volume (V_{Thf}) of the oscillations. Unlike during conventional ventilation, during HFOV the relationship between tidal volume and CO₂ elimination is not linear but increases exponentially with the tidal volume ^{1,2}. CO₂ removal is thought to be directly proportional to the carbon dioxide diffusion coefficient (DCO₂) which equals Hz x V_{Thf} ^{2,3}. As frequency is expressed as Hz = 1/sec and tidal volume as mL, the unit of DCO₂ is mL²/sec.

From experience, DCO₂ values can be used as a trend during HFOV for individual babies to predict changes in the arterial CO₂ (PaCO₂) and help adjust ventilator settings. However, knowing the DCO₂ does not enable a neonatologist to predict a baby's PaCO₂ and DCO₂ values from different infants cannot be compared because of differences in weight, pathophysiology and ventilator settings. We thought the limitation of using DCO₂ may, in part, be because the tidal volume used in the equation is expressed as mL and not

normalized to the body weight. During conventional ventilation, tidal volumes are routinely expressed and compared as mL/kg and the same may be appropriate for HFOV. Several papers discussing HFOV also described V_{Thf} as mL/kg, but DCO_2 was not weight-corrected⁴⁻⁸. To normalize DCO_2 to body weight it should be divided by the square of the weight as $DCO_2 = Hz \times V_{Thf}^2$, so weight-corrected DCO_2 (DCO_{2corr}) is expressed as mL²/sec/kg². In this study we investigated the relationship between DCO_2 , DCO_{2corr} and PCO_2 in newborn infants ventilated with HFOV.

METHODS

Patients

Ventilation data were obtained from the Babylog VN500 ventilator (Dräger, Lübeck, Germany) as part of a registered service evaluation project (authorized by the R & D department of Cambridge University Hospitals NHS Trust, registration number: 4572); therefore, individual participant consent or ethical approval was not required. The aim of the service evaluation was to assess ventilator alarms in babies on the Neonatal Intensive Care Unit. For this report we have re-analysed the data from the subset of infants who were ventilated with HFOV during the recordings. There were 18 recordings obtained from 14 infants, see Table 1 for details. Blood gas analyses were done routinely 6-8

hourly in these babies receiving HFOV. Additional blood gases were performed if the clinical team thought it justified. Blood gas measurements were done on a cobas b 221™ point of care blood gas system (Roche, Burgess Hill, United Kingdom).

Data retrieval and analysis

Tidal volumes of the high frequency oscillations (V_{thf}) are calculated by the ventilator from the flow measurements and are leak-compensated. The ventilator has a sampling frequency of one in 5.2 milliseconds with a low pass filter. V_{thf} values are averaged by the ventilator's internal computer over 1 second periods; these averaged values are displayed and updated every 1 second. DCO_2 values are calculated as frequency * V_{thf}^2 from the averaged V_{thf} during the 1-second period. Ventilator data were anonymously downloaded with 1/sec sampling rate to a laptop computer via a cable attached to one of the communication ports of the ventilator using software obtained from Dräger. Data were exported into comma-separated value (.csv) text files. Arterial and capillary blood gas measurements were obtained from electronic clinical records.

Data analysis and visualisation was performed using Python (version 3.5.1, <https://www.python.org>) and its add-on packages: ipython (version 5.1.1, <https://ipython.org>), NumPy (version 1.10.4, <http://www.numpy.org>), *pandas* (version 0.18.0, <http://pandas.pydata.org>) and *matplotlib* (version 1.5.1,

<http://matplotlib.org>. All the software we used is open-source and freely available. We performed analysis on a personal computer (MacBook Pro 2014 version, 2.6 GHz i5 processor and 8 Gb RAM memory). Relationship between DCO_2 and PCO_2 was assessed by Pearson's correlation analysis; p values <0.05 were considered statistically significant. Receiver-operating characteristic (ROC) analysis was performed and the optimal cutoff to predict risk of hypercapnia was determined using Youden's J statistic⁹. An iPython notebook containing all steps of data processing and statistical analysis can be viewed on GitHub (<https://github.com/belteki/DCO2>).

To use DCO_2 values which were more representative than single readings we calculated the mean of 600 DCO_2 values obtained during 10 minutes starting 12 minutes before and ending at 2 minutes before each blood gas measurement. We omitted the last two minutes before the gas analysis because the blood had already been collected and placed in the analyser during this period. We corrected DCO_2 data for the body weight by dividing by the square of the body weight in kilograms.

RESULTS

We obtained DCO_2 values from 18 recordings in 14 babies ventilated with HFOV. The combined duration of recordings was 952.5 hours (approximately

39.7 days), Table 1. There were 254 blood gas measurements during the recordings, of which, 106 (42%) were arterial.

When all the blood gases from all babies were considered together, uncorrected DCO_2 values showed no inverse correlation with PCO_2 data (Figure 1). The range of DCO_2 values was very wide (between 5.5 – 570 ml^2/sec) and DCO_2 readings from different patients “clustered” in different parts of the graph. This clustering and the lack of inverse correlation were also observed if only arterial blood gases were considered (E-Figure 1).

We then investigated whether weight-corrected DCO_2 ($\text{DCO}_{2\text{corr}}$) values showed better correlation with PCO_2 and less inter-individual variation. $\text{DCO}_{2\text{corr}}$ values showed significantly ($p < 0.0001$) less variability, the range was between 5.2 – 169 $\text{mL}^2/\text{sec}/\text{kg}^2$, (Figure 2). Unlike DCO_2 , $\text{DCO}_{2\text{corr}}$ from different patients showed an inverse correlation with PCO_2 values (Figure 3). This was weak ($r = -0.3025$, 95% confidence intervals: -0.4097, -0.1871) but statistically significant ($p < 0.001$). Also, the graph shows less clustering of values from individual patients. When only arterial blood gas measurements were considered there was also an inverse correlation but it was not statistically significant because of the small numbers (E-Figure 2).

We analyzed the individual patient slopes of the correlation between $\text{DCO}_{2\text{corr}}$ and PCO_2 , where at least 10 blood gases were available (14 out of the 18 recordings). All except two showed an inverse correlation between $\text{DCO}_{2\text{corr}}$

and PCO_2 although it was statistically significant ($p < 0.05$) in 6 out of 14 cases (Table 2 and see graphs in E-Figure 3). This is likely to be due to the smaller number of blood gas samples in individual cases. Also, weight-correction improved the inter-individual comparability of DCO_2 values. Therefore, a significant correlation on the whole cohort is still useful.

Analyses were done to determine whether $\text{DCO}_{2\text{corr}}$ value could be used to predict avoidance of hypercapnia ($\text{PCO}_2 > 8$ kPa or 60 mmHg). Receiver operating characteristic curve (ROC) analysis together with Youden's statistic showed that the optimal cutoff was $\text{DCO}_2 \geq 50 \text{ mL}^2/\text{sec}/\text{kg}^2$ which predicted a $\text{PCO}_2 \leq 8$ kPa with a positive predictive value of 0.886 and a negative predictive value of 0.278 (specificity = 0.825, sensitivity = 0.39, Youden score = 0.215, area under the curve = 0.638), see Figure 4. Moreover, of the 57 $\text{DCO}_{2\text{corr}}$ values $> 60 \text{ mL}^2/\text{sec}/\text{kg}^2$ (from 9 patients), only 5 were associated with a PCO_2 value > 8 kPa. Therefore, we suggest that $\text{DCO}_{2\text{corr}}$ values $> 60 \text{ mL}^2/\text{sec}/\text{kg}^2$ should not be routinely targeted unless hypercapnia persists.

During ventilation through an un-cuffed endotracheal tube a gas leak can occur around the tube. We investigated the effect of leak on $\text{DCO}_{2\text{corr}}$. Leak was calculated, similarly to DCO_2 , using the mean value of the 600 data points during 10 minutes before the blood gas was taken. Pragmatically, we divided the leak into two groups: $< 10\%$ (209 blood gases) and $\geq 10\%$ (45 blood gases). With $< 10\%$ leak the correlation between $\text{DCO}_{2\text{corr}}$ and PCO_2 improved ($r = -0.4342$, 95% confidence intervals: -0.5375 , -0.3181 and $p < 0.0001$)

compared to the total dataset (Figure 5), although the inverse correlation remained weak. In addition, the inverse correlation was statistically significant even when only arterial $p\text{CO}_2$ values were used (E-figure 4). In the subset with $\geq 10\%$ leak there was no correlation between DCO_2corr or PCO_2 or PaCO_2 (E-figure 5).

Previous reports have suggested a relationship between the VThf and PaCO_2 ⁷ or transcutaneous CO_2 ⁸. We investigated if there was inverse correlation between VThf or the square of VThf and PCO_2 . Interestingly, we found significant inverse correlation between both VThf and VThf^2 and DCO_2 , although they were slightly weaker than between DCO_2corr and PCO_2 . (E-Figure 6 & E-Figure 7). These data suggest that the VThf can also be used to target or predict normocapnia.

To investigate if time windows for DCO_2 averaging other than 10 minutes leads to better results, we performed the same analysis using different time windows between 2 and 20 minutes. DCO_2corr data obtained over 2, 5 and 15-minute windows also showed inverse correlation with PCO_2 albeit somewhat weaker than 10-minute data (data not shown). Data obtained with 20-minute time windows showed no inverse correlation.

DISCUSSION

There has been increasing interest in the tidal volumes delivered during neonatal HFOV (V_{Thf}), because modern ventilators now display this and it could give a better indication of ventilation than trying to assess chest wiggle¹⁰⁻¹². Some new neonatal ventilators can deliver a targeted tidal volume during HFOV. Reports of volume-targeted HFOV found that V_{Thf} of 1.5 – 2.5 mL/kg is usually required to maintain $PaCO_2$ within a normal range^{4,6}. Importantly, if tidal volume-targeted HFOV is used then DCO_2 changes from a measured parameter to a set parameter as both of its components (V_{Thf} and f_z) are set on the ventilator. This makes the clinical usefulness of the relationship between DCO_2 and PCO_2 even more important.

In this study, we found no correlation between uncorrected DCO_2 and PCO_2 . However, if DCO_2 was corrected to the square of body weight, there was a significant weak inverse correlation. When analysing gas exchange during HFOV in rabbits, Boynton et al, also used weight-corrected tidal volumes and found an inverse correlation between $PaCO_2$ and DCO_2 (see Figure 3 in reference 2). However, papers describing HFOV and DCO_2 in neonates have not used weight-corrected tidal volumes⁴⁻⁶.

We found that if the DCO_{2corr} was $>50 \text{ mL}^2/\text{sec}/\text{kg}^2$ the probability of significant hypercapnia ($PCO_2 >8 \text{ kPa}$) was 17.5% and if DCO_{2corr} was $>60 \text{ mL}^2/\text{sec}/\text{kg}^2$ it was $<10\%$. Therefore, when starting HFOV, clinician should not routinely use settings resulting in $DCO_{2corr} >60 \text{ mL}^2/\text{sec}/\text{kg}^2$. Moreover, we found an inverse correlation between V_{Thf}^2 and even V_{Thf} and PCO_2 , even

though the HFOV frequency in our recordings varied between 7-12Hz. Despite using a different ventilator to deliver HFOV, our results are in line with the findings of Dimitriou *et al*⁷, suggesting that $V_{Thf} > 2.5$ mL/kg are rarely needed to avoid hypercapnia.

Instead of relying on individual DCO_2 values at the time of a blood gas measurement, we calculated the average of 600 DCO_2 values obtained at (1 Hz over a 10-minute period. This is arguably better than recording a random DCO_2 value just before the blood gas as our data showed significant variability even during a 10-minute period with a standard deviation of >10 mL²/s/kg² (data not shown). This variability has also been reported by others and it is likely due to the spontaneous breathing of the infant ¹³.

The inverse correlation between DCO_{2corr} and PCO_2 was weak, although it improved slightly if only those blood gas measurements were used when the endotracheal tube leak was $<10\%$. There are several possible explanations for this. The DCO_2 formula was originally developed on the basis animal experiments done in dog ¹, rabbits ² and mathematical calculations ¹⁴. It is possible that the “true” DCO_2 correlating with PCO_2 volumes should be calculated as $DCO_2 = (Hz)^x \times (V_{Thf})^y$ where x and y are different from 1 and 2, respectively, and they may be fractions^{14,15}. Moreover, x and y may be different for different oscillators to move the gas and can also vary between different patients depending on their weights or lung pathologies. The instrumental dead space and anatomical dead space account for approximately

half the normal tidal volume which means that with V_{Thf} there will be a large proportion of expired CO_2 that is not exhaled. A baby needing HFOV will have inhomogeneous alveolar ventilation and ventilation perfusion mismatching so it is expected that the correlation between DCO_2 and PCO_2 will not be good. The movement of gas in the lung is very different between conventional ventilation and HFOV and so this is likely to influence the relationship between V_{Thf} and PCO_2 and the correlation with DCO_2 where V_{Thf} is a major component of the DCO_2 .

The limitations to this study are that it was retrospective with a convenience cohort. The blood gas measurements were a mixture of arterial and arterialised capillary specimens, making this a pragmatic study reflecting what happens during neonatal intensive care. We analysed the effect of arterial or capillary blood gases separately and showed little difference in the efficacy of DCO_{2corr} .

Although using weight adjusted V_{Thf} and DCO_2 would be preferable on neonatal ventilator displays this may not be practical without significant changes to ventilator “checks and balances” to ensure that the correct weight is entered. However, when a particular DCO_2 value is interpreted or targeted by clinicians, weight-correction using the square of the body weight should be used, as it is in conventional ventilation, when tidal volumes are interpreted as mL/kg. New research studies should report DCO_2 as weight corrected.

In conclusion, we suggest that weight-corrected DCO₂ data over 10-minute epochs may be more informative about CO₂ elimination during HFOV than DCO₂. DCO₂corr values over 50 mL²/sec/kg² are rarely needed to avoid hypercapnia.

ACKNOWLEDGEMENTS

We are grateful to the Technology & Intellectual Property Department of Dräger Medical for providing us with the recording tool.

References

1. Weinmann GG, Mitzner W, Permutt S: Physiological dead space during high-frequency ventilation in dogs. J Appl Physiol Respir Environ Exerc Physiol 1984;57:881–887.
2. Boynton BR, Hammond MD, Fredberg JJ, Buckley BG, Villanueva D, Frantz ID: Gas exchange in healthy rabbits during high-frequency oscillatory ventilation. J Appl Physiol 1989;66:1343–1351.
3. Mukerji A, Belik J, Sanchez-Luna M: Bringing back the old: time to reevaluate the high-frequency ventilation strategy. J Perinatol 2014;34:464–467.

4. Iscan B, Duman N, Tuzun F, Kumral A, Ozkan H: Impact of Volume Guarantee on High-Frequency Oscillatory Ventilation in Preterm Infants: A Randomized Crossover Clinical Trial. *Neonatology* 2015;108:277–282.
5. González-Pacheco N, Sánchez-Luna M, Ramos-Navarro C, Navarro-Patiño N, de la Blanca A: Using very high frequencies with very low lung volumes during high-frequency oscillatory ventilation to protect the immature lung. A pilot study. *J Perinatol* 2016;36:306–10.
6. Enomoto M, Keszler M, Sakuma M, Kikuchi S, Katayama Y, Takei A, et al.: Effect of Volume Guarantee in Preterm Infants on High-Frequency Oscillatory Ventilation: A Pilot Study. *Am J Perinatol* DOI: 10.1055/s-0036-1584141.
7. Dimitriou G, Greenough A, Kavvadia V, Laubscher B, Milner AD. Volume delivery during high frequency ventilation. *Arch Dis Child Fetal Neonatal Ed* 1998;78:F148 -F150.
8. Tingay D, Mills J, Morley C, Pellicano A, Dargaville P. Indicators of optimal lung volume during high frequency oscillatory ventilation in infants. *Crit Care Med* 2013;41:237-244
9. Youden, W.J. (1950). "Index for rating diagnostic tests". *Cancer* 1950;3: 32–35

10. Lista G, Fontana P, Castoldi F, Marangione P, Menchini M, Compagnoni G. Correlations between volume delivery (VTHF) in course of high frequency oscillatory ventilation n(HFOV) and severity of respiratory distress. *Pediatr Med Chir.* 2004 Mar-Apr;26(2):124-5.
11. John J, Harcourt ER, Davis PG, Tingay DG. Dräger VN500's oscillatory performance has a frequency-dependent threshold. *J Paediatr Child Health.* 2014 Jan;50(1):27-31.
12. Poulton DA, Schmölzer GM, Morley CJ, Davis PG: Assessment of chest rise during mask ventilation of preterm infants in the delivery room. *Resuscitation.* 2011;82:175-9.
13. Tingay DG, Mills JF, Morley CJ, Pellicano A, Dargaville PA: Indicators of optimal lung volume during high-frequency oscillatory ventilation in infants. *Crit Care Med.* 2013;41:237-44.
14. Chang HK: Mechanism of gas transport during ventilation by high frequency. *J Appl Physiol Respirat Exercise Physiol.* 1984;56:553-563.
15. Berdine GG, Lehr JL, McKinley DS, Drazen JM: Nonuniformity of canine lung washout by high-frequency ventilation. *J Appl Physiol.* 1986;61:1388-94.

TABLE LEGENDS:

Table 1: Characteristics of patients and recordings used in the analysis. Only recordings with more than 10 blood gases were used in the analysis and are shown in the table.

Table 2: Characteristics of the individual $p\text{CO}_2$ – corrected DCO_2 curves

FIGURE LEGENDS:

Figure 1: Lack of correlation between DCO_2 and PCO_2 . Graph showing all blood gas PCO_2 (arterial and capillary) data plotted against uncorrected DCO_2 . Data obtained from different patients are shown using different markers. There is no inverse correlation between DCO_2 and PCO_2 , and data obtained from the individual patients tend to cluster. “r” represents Pearson’s correlation coefficient with 95% confidence intervals.

Figure 2: Boxplots of DCO_2 and weight-corrected $\text{DCO}_{2\text{corr}}$ values obtained from all patients. $\text{DCO}_{2\text{corr}}$ shows significantly less variability than uncorrected DCO_2 .

Figure 3: Statistically significant inverse correlation between DCO_2 and PCO_2 . Graph showing all blood gas PCO_2 (arterial and capillary) data plotted against DCO_2 . Corrected for the square of the body weight. Data obtained from different

patients are shown using different markers. "r" represents Pearson's correlation coefficient with 95% confidence intervals.

Figure 4: Receiver operating characteristic (ROC) analysis of DCO₂corr values to predict a PCO₂ less than 8 kPa. The optimal cut-off is shown at 50 mL/s/kg² (sensitivity: 0.390, specificity: 0.82, Youden score = 0.215).

Figure 5: Relationship between DCO₂corr and PCO₂ in blood gases when the endotracheal tube leak was less than 10%. The inverse correlation is stronger than when all gases were considered. "r" represents Pearson's correlation coefficient with 95% confidence intervals.

SUPPLEMENTARY MATERIAL

E-Figure 1: No correlation between DCO₂ and arterial PaCO₂. In this graph only arterial PaCO₂ data are plotted against uncorrected DCO₂. Data obtained from different patients are shown using different markers. There is no inverse correlation between DCO₂ and PaCO₂. "r" represents Pearson's correlation coefficient with 95% confidence intervals.

E-Figure 2: Inverse correlation between DCO₂ and arterial PaCO₂. In this graph only arterial PaCO₂ data are plotted against weight-corrected DCO₂. Data obtained from different patients are shown using different markers. There is inverse correlation between DCO₂ and PaCO₂. "r" represents Pearson's correlation coefficient with 95% confidence intervals.

E-Figure 3: Graphs showing the relationship between DCO_2 and PCO_2 in the individual patients. Only recordings where at least 10 blood gases were available are shown.

E-Figure 4: Relationship between $\text{DCO}_{2\text{corr}}$ and arterial PaCO_2 in blood gases when the endotracheal tube leak was less than 10%. There is significant inverse correlation. "r" represents Pearson's correlation coefficient with 95% confidence intervals.

E-Figure 5: Relationship between $\text{DCO}_{2\text{corr}}$ and PCO_2 in blood gases when the endotracheal tube leak was more than 10%. There is no inverse correlation. "r" represents Pearson's correlation coefficient with 95% confidence intervals.

E-Figure 6: V_{Thf} vs pCO_2 : Relationship between tidal volume of high-frequency oscillations (V_{Thf}) and PCO_2 . There is significant inverse correlation although slightly weaker than between DCO_2 and PCO_2 .

E-Figure 7: Relationship between the square of tidal volume of high-frequency oscillations (V_{Thf}^2) and PCO_2 . There is significant inverse correlation although slightly weaker than between DCO_2 and PCO_2 .

Study number	Recording number	GA at birth	Postnatal days	Birth weight (g)	Weight at study (g)	Recording duration (hours)	Number of blood gases	Diagnoses	MAP* range (mbar)
DG005	DG005_1	32.4	16	550	1995	48.18	19	IUGR, NEC, suspected sepsis, CLD	12-15
DG006	DG006_1	28.0	4	600	650	24.11	10	RDS, suspected sepsis, IUGR, low WBC count, low platelets, laparotomy	15-20
DG009	DG009	26.9	31	975	1080	44.20	11	RDS, Sepsis, PH, PDA, IVH	12-15
DG017	DG017	28.0	1	1040	1040	79.98	25	MCMA surviving twin, RDS, PIE, Hydrops Pneumothoraces,	7-14
DG018	DG018_1	25.6	1	755	755	38.08	19	RDS, Hypotension, suspected sepsis, PH, IVH, Pneumothoraces	12-20
DG020	DG020	32.1	6	2162	2250	28.07	10	RDS, suspected sepsis, Jaundice, Hydrops	13-16
DG022	DG022	40.1	1	2850	2850	87.07	19	HIE, respiratory distress, pneumothoraces, PPHN	10-16
DG025	DG025	27.4	1	515	515	65.16	19	Oligohydramnios, IUGR, RDS	8-15
DG032	DG032_2	23.7	2	714	714	94.02	15	RDS, suspected sepsis, hypotension, IVH	13-17
DG038	DG038_1	27.1	4	1100	1100	121.77	31	PPROM, lung hypoplasia, RDS, PDA	10-14
DG038	DG038_2	27.1	15	1100	1310	115.59	20		9-19
DG040	DG040_1	24.4	2	560	570	48.99	19	RDS	11-14
DG040	DG040_2	24.4	14	560	660	67.49	17		13-17
DG046	DG046_1	28.3	4	1180	1180	46.64	15	PPROM, RDS, PPHN, chorioamnionitis, sepsis,	11-14

Table 1: Characteristics of patients used in the analysis

* I:E ratio was 1:1 in all cases

Median (5th – 95th percentile)

recording	equation	r (95% CI)*	p value
DG005_1	$y=-0.0176x+10.1310$	-0.1671 (-0.5775 , 0.3107)	p=0.4942
DG006_1	$y=-0.1515x+9.9216$	r=-0.6002 (-0.8925 , 0.0474)	p=0.0666
DG009	$y=-0.0932x+13.4458$	r=-0.7588 (-0.9337 , -0.2916)	p=0.0068
DG017	$y=-0.0245x+7.5918$	r=-0.7013 (-0.8586 , -0.4236)	p=0.0001
DG018_1	$y=-0.0210x+7.5859$	r=-0.1894 (-0.5926 , 0.2897)	p=0.4373
DG020	$y=-0.0380x+10.8140$	r=-0.7170 (-0.9278 , -0.1593)	p=0.0196
DG022	$y=-0.0063x+10.8582$	r=-0.3180 (-0.6747 , 0.1593)	p=0.1846
DG025	$y=-0.4691x+10.9389$	r=-0.5458 (-0.8014 , -0.1218)	p=0.0156
DG032_2	$y=-0.0420x+10.2766$	r=-0.3346 (-0.7229 , 0.2144)	p=0.2229
DG038_1	$y=-0.0460x+9.3383$	r=-0.5297 (-0.7443 , -0.2159)	p=0.0022
DG038_2	$y=0.0127x+6.6313$	r=0.1438 (-0.3190 , 0.5513)	p=0.5452
DG040_1	$y=-0.0218x+4.9033$	r=-0.1893 (-0.5926 , 0.2898)	p=0.4375
DG040_2	$y=-0.1963x+11.5732$	r=-0.4855 (-0.7833 , -0.0063)	p=0.0482
DG046_1	$y=0.0592x+4.0290$	r=0.3173 (-0.2328 , 0.7136)	p=0.2491

* Pearson's correlation coefficient with 95% confidence intervals

Table 2: Characteristics of the individual pCO₂ – corrected DCO₂ curves

Figure 1

Figure 1

Figure 2

Figure 2

Figure 3

Figure 3

Figure 4

Figure 5

Figure5

Minerva Access is the Institutional Repository of The University of Melbourne

Author/s:

Belteki, G;Lin, B;Morley, CJ

Title:

Weight-correction of carbon dioxide diffusion coefficient (DCO₂) reduces its inter-individual variability and improves its correlation with blood carbon dioxide levels in neonates receiving high-frequency oscillatory ventilation

Date:

2017-10-01

Citation:

Belteki, G., Lin, B. & Morley, C. J. (2017). Weight-correction of carbon dioxide diffusion coefficient (DCO₂) reduces its inter-individual variability and improves its correlation with blood carbon dioxide levels in neonates receiving high-frequency oscillatory ventilation. PEDIATRIC PULMONOLOGY, 52 (10), pp.1316-1322. <https://doi.org/10.1002/ppul.23759>.

Persistent Link:

<http://hdl.handle.net/11343/293162>