Is the partial pressure of carbon dioxide in the blood related to the development of retinopathy of prematurity?

Balazs Gellen, Neil McIntosh, Janet R McColm, Brian W Fleck

Abstract

Aims—To determine the role of carbon dioxide in the development of retinopathy of prematurity (ROP).

Methods—This was a retrospective cohort study of 25 consecutive infants admitted to the neonatal unit with continuously recorded physiological data. The daily mean and standard deviation (SD) of transcutaneous carbon dioxide partial pressure (tcPCO₂) was compared between infants who had stage 1 or 2 ROP and stage 3 ROP. The time spent hypocarbic (<3 kPa) and/or hypercarbic (>10 kPa and >12 kPa) was also compared between these groups. Intermittent arterial carbon dioxide tension was also measured and compared with the simultaneous tcPCO₂ data.

Results—There were no significant differences in carbon dioxide variability or time spent hypocarbic and/or hypercarbic between the ROP groups on any day. 86% of transcutaneous values were within 1.5 kPa of the simultaneous arterial value.

Conclusion—TcPCO₂ measurement can be a very useful management technique. However, in this cohort neither variable blood carbon dioxide tension nor duration of hypercarbia or hypocarbia in the first 2 weeks of life was associated with the development or severity of ROP.

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In this study blood carbon dioxide levels were measured by a continuous transcutaneous monitoring system for 14 days which is in contrast with other studies that have used intermittent blood gas analysis. To ensure that the transcutaneous measurements were accurate they were compared with the simultaneous but intermittently measured arterial carbon dioxide tension. We found that agreement between the methods was usually excellent and the comparison was clinically highly satisfactory.

The transcutaneous measurements resulted in nearly 20000 data points per baby—each of which in itself was a 1 minute average of 60 one second points. This allowed an objective analysis of the variability of the carbon dioxide tension.

The number of infants enrolled in the study was small but the confidence intervals of the results suggest that the lack of difference between groups is unlikely to be related to small numbers creating a type II error. It would certainly be preferable to involve more babies, but during the 2 year period of investigation only 25 infants met the requirements of the inclusion criteria.

The known effects of carbon dioxide tension on small vessel calibre make it inappropriate to discard carbon dioxide as an important factor based on this study alone. Our group has developed an animal model of ROP based on clinically relevant fluctuations in oxygen and we plan to use this to investigate the combination of oxygen variability and hypercarbia on the development and severity of ROP.

We wish to acknowledge the assistance given to us by the clinical staff and thank Dr Elizabeth Wold for her role in the paediatric ophthalmological examination. Dr Gellen was funded by a Royal Society/NATO fellowship.


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**Table 1.** Mean (SD) of concurrent tcPCO₂ (kPa) during the first 14 days of life in ROP1,2 and ROP3 groups. Significance was defined at p ≤0.05 because there were no significant differences between the groups on any day.

<table>
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<tr>
<th>Day</th>
<th>ROP1,2 tcPCO₂ mean</th>
<th>ROP1,2 tcPCO₂ variability</th>
<th>ROP3 tcPCO₂ mean</th>
<th>ROP3 tcPCO₂ variability</th>
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**Figure 1.** The comparison of transcutaneous and simultaneous arterial PCO₂. These data are displayed as a Bland-Altman plot. 85.8% of transcutaneous values were within 1.5 kPa of the simultaneous arterial value (1.5 kPa or less difference between tcPCO₂ and PCO₂ was accepted in this study as a satisfactory agreement.) Difference = difference between PCO₂ and tcPCO₂ (kPa) at time of each arterial blood gas measurement. Average = mean of PCO₂ and tcPCO₂ (kPa) at time of each arterial blood gas measurement.

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**Discussion**

The present study does not support the view that either increased variability of blood carbon dioxide or a particular duration of hypercarbia or hypocarbia in the first 2 weeks of life is related to the development or severity of ROP.
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