

**CARBOGEN TREATMENT FOR pH-STAT
MANAGEMENT IN CARDIOPULMONARY BYPASS**

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**FACULTY OF SCIENCE
UNIVERSITY OF MALAYA
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UNIVERSITY OF MALAYA
ORIGINAL LITERARY WORK DECLARATION

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in Cardiopulmonary Bypass
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ABSTRACT

Hypocarbica commonly occurs in infants undergoing cardiopulmonary bypass causing respiratory alkalosis with pH-stat management. In this study, pCO₂ regulation was adjusted accordingly to sweep gas in control and treatment groups with gas-to-blood flow ratio of 0.5:1. Each extracorporeal membrane oxygenator (Capiiox[®] RX05 and Medtronic[®] Minimax Plus[®] Hollow Fiber Oxygenator) contained control and treatment groups to determine carbogen intervention is necessary for infants undergoing hypothermic bypass. Arterial blood gas was corrected according to actual temperature of the patients for both control (without carbogen) and treatment (with carbogen) groups. The carbogen treatment was introduced to overcome the problem of maintaining pH and pCO₂ for infants undergoing hypothermic bypass. One hundred and twenty (120) infants \leq 5 kg assigned for this study were single blinded assigned; with 60 infants in each group for Capiiox[®] RX05 and the Medtronic[®] Minimax oxygenators. Variables monitored included the type of operation performed; haematocrits; temperature; pCO₂; pH; carbogen 5% CO₂ usage; pump flow rate; bypass time; cross-clamp time; pre-operation, cooling, stable, re-warming and post-operative arterial blood gases (ABG). Arterial carbon dioxide tensions were measured using CDI™ 500 system, Cobas b 221 and capnograph systems. There is a significant difference between control and treatment groups in Capiiox RX05 oxygenator, in two variables: pCO₂ ($p < 0.0001$), and pH ($p = 0.0147$). There is a significant difference between control and treatment groups in Minimax Plus oxygenator for pCO₂ ($p < 0.0191$), however pH showed no significant difference ($p = 0.3138$). Overall survival to discharge was 97% (116 of 120 patients). From the present study, we concluded that carbogen usage improved the percentage of pCO₂ and pH level falling within the reference range as compared to control group.

ABSTRAK

Penurunan pCO₂ berlaku pada bayi yang menjalani pintasan jantung menyumbang kepada keadaan respirasi alkalosis dalam pengurusan pH-stat. Bagi penyelidikan ini nisbah aliran pCO₂ (alat kawalan gas) kepada pengaliran darah adalah 0.5:1. Setiap membran oksigenator (Capiox[®] RX05 dan Medtronic[®] Minimax Plus[®] Hollow Fiber Oksigenator) mempunyai kumpulan kawalan dan rawatan bagi mengenalpasti adakah penggunaan karbogen diperlukan atau tidak bagi bayi yang menjalani pintasan jantung pada suhu hipotermik. Ujian ABG diperbetulkan mengikut suhu badan pesakit dengan menggunakan prosedur pH-stat untuk kedua-dua kumpulan kawalan (tanpa karbogen) dan kumpulan rawatan (dengan karbogen). Rawatan ini diperkenalkan bagi mengatasi masalah mengekalkan pH dan pCO₂ dalam julat normal semasa bayi yang menjalani pintasan jantung pada suhu hipotermik. Sebanyak seratus dua puluh (120) bayi dipilih bagi menjalani penyelidikan yang hanya penyelidik mengetahui status pesakit menjalani rawatan atau tidak (single blind). Parameter yang diselidik adalah seperti berikut: jenis pembedahan, hematokrit, suhu, pCO₂, pH, penggunaan karbogen 5% CO₂, kelajuan pam jantung, masa pintasan jantung separa, masa pintasan jantung penuh, dan mengukur nilai ABG semasa penyejukan darah, penstabilan, pemanasan darah dan selepas tamat pintasan jantung. pCO₂ diukur menggunakan peralatan seperti: CDI[™] 500 system, Cobas b 221 system dan 'capnograph'. Secara perbandingan terdapat perbezaan signifikan diantara kumpulan kawalan dan rawatan (Capiox RX05 oksigenator) bagi parameter pCO₂ ($p < 0.0001$) dan pH ($p = 0.0147$). Terdapat juga perbezaan signifikan diantara kumpulan kawalan dan rawatan (Minimax Plus oksigenator) bagi pCO₂ ($p < 0.0191$), tetapi paras pH tidak menunjukkan perbezaan ketara ($p = 0.3138$). Peratusan keseluruhan yang hidup ialah 97% (116 daripada 120 pesakit). Daripada kajian ini kami simpulkan bahawa penggunaan karbogen meningkatkan peratusan paras pCO₂ dan pH dalam julat normal berbanding dengan kumpulan kawalan.

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LIST OF SYMBOLS AND ABBREVIATIONS

| | |
|-------------------------------------|---------------------------------------|
| ABG | Arterial Blood Gas |
| ABP | Arterial Blood Pressure |
| ACT | Activated clotting time |
| CBF | Cerebral blood flow |
| CO ₂ | Carbon dioxide |
| CPB | Cardiopulmonary Bypass |
| CrI | Control |
| CUF | Conventional ultrafiltration |
| ECC | Extracorporeal Circuit |
| ECMO | Extracorporeal membrane oxygenator |
| FIO ₂ | Fraction of inspired oxygen |
| GA | General Anaesthesia |
| LAR | Legally Authorized Representative |
| LPM | Litre per minute |
| <i>Outré</i> | Outside the bounds of reference range |
| pCO ₂ /paCO ₂ | Partial pressure of carbon dioxide |
| peCPBCO ₂ | Mean CPB pump expired carbon dioxide |
| Rx | Treatment |
| TEE/TOE | Transesophageal Echocardiogram |
| V/Q | Ventilation/perfusion |
| % | Percentage |
| °C | Celsius |
| mm/Hg | Millimetre mercury |