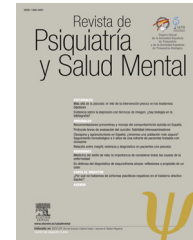




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## ORIGINAL ARTICLE

# Hypocapnia and hyperoxia induction using a hyperventilation protocol in electroconvulsive therapy<sup>☆</sup>

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### KEYWORDS

Electroconvulsive therapy;  
Hyperventilation;  
Hypocapnia;  
Seizures;  
Capnography

### Abstract

**Introduction:** Hyperventilation in electroconvulsive therapy sessions has been associated with seizure threshold, seizure characteristics, and cognitive effects. There is no consensus on the optimal procedure of applying hyperventilation manoeuvres during electroconvulsive therapy.

**Material and methods:** Prospective evaluation of the effects of systematic use of hyperventilation manoeuvres with facial mask and capnography (protocolised hyperventilation [pHV]), on ventilation parameters and on seizures. The study included a sample of 130 sessions (65 performed according to hyperventilation standard practice and 65 successive sessions, with pHV) of 35 patients over a period of 10 weeks.

**Results:** The pHV manoeuvres reduced exhaled CO<sub>2</sub> and increased O<sub>2</sub> saturation significantly ( $p < 0.001$ ). The average CO<sub>2</sub> reduction achieved was  $6.52 \pm 4.75$  mmHg (95% CI  $-7.7$  to  $-5.3$ ). The CO<sub>2</sub> values after pHV correlated significantly with seizure duration and O<sub>2</sub> values, with other electroencephalographic quality indices. In pHV sessions, compared with sessions performed according to hyperventilation standard practice, the average lengthening of the motor and electroencephalographic seizure was  $3.86 \pm 14.62$  and  $4.73 \pm 13.95$  s, respectively. No differences were identified in other ictal quality parameters.

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**PALABRAS CLAVE**

Terapia electroconvulsiva;  
Hiperventilación;  
Hipocapnia;  
Convulsiones;  
Capnografía

**Conclusions:** The proposed pHV manoeuvres significantly modify ventilation parameters. The hypocapnia and hyperoxia obtained by applying these manoeuvres lengthen the duration of seizures without worsening the quality of the electroencephalographic trace. The use of pHV is generalisable and might improve electroconvulsive therapy procedure without adding costs. © 2016 SEP y SEPB. Published by Elsevier España, S.L.U. All rights reserved.

## Inducción de hipocapnia e hiperoxia con maniobras de hiperventilación reglada en la terapia electroconvulsiva

**Resumen**

**Introducción:** La hiperventilación en las sesiones de terapia electroconvulsiva se ha relacionado con el umbral convulsivo, las características de la convulsión y los efectos cognitivos. No existe consenso sobre el procedimiento óptimo de aplicación de las maniobras de hiperventilación durante la terapia electroconvulsiva.

**Material y métodos:** Evaluación prospectiva de los efectos del uso sistematizado de maniobras de hiperventilación con mascarilla facial y capnografía (hiperventilación reglada [HVR]) en los parámetros ventilatorios y de la convulsión. Muestra de 130 sesiones (65 realizadas con hiperventilación según la práctica habitual y 65 sucesivas con HVR) de 35 pacientes en un periodo de 10 semanas.

**Resultados:** Las maniobras de HVR disminuyeron el CO<sub>2</sub> espirado e incrementaron la saturación de O<sub>2</sub> significativamente ( $p < 0,001$ ). La disminución media de CO<sub>2</sub> alcanzada fue de  $6,52 \pm 4,75$  mmHg (IC 95%  $-7,7$  a  $-5,3$ ). Los valores de CO<sub>2</sub> tras la HVR correlacionaron significativamente con la duración de la convulsión, y los de O<sub>2</sub>, con otros índices electroencefalográficos de calidad. En las sesiones con HVR, en comparación con las sesiones realizadas con hiperventilación según la práctica habitual, el alargamiento medio de la convulsión motora y electroencefalográfica fue de  $3,86 \pm 14,62$  y de  $4,73 \pm 13,95$  s, respectivamente, sin diferencias en los demás parámetros ictales.

**Conclusiones:** Las maniobras de HVR propuestas modifican de forma relevante los parámetros ventilatorios. La hipocapnia y la hiperoxia obtenidas al aplicar estas maniobras alargan la duración de las convulsiones sin empeorar la calidad del trazado electroencefalográfico. El uso de protocolos de HVR es generalizable y puede mejorar el procedimiento de la terapia electroconvulsiva sin añadir costes.

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**Introduction**

The conditions for providing electroconvulsive therapy (ECT) influence the outcome of treatment and its side effects. Along these lines, we have studied the parameters related to electrical stimulation such as the charge, the pulse amplitude, the location of the electrodes and the influence of different anaesthetics. Available evidence of the ideal characteristics for ventilatory support during ECT is scarce. In the literature on the ECT procedure and current clinical practice guidelines,<sup>1-5</sup> pre-oxygenation with elevated oxygen levels (O<sub>2</sub>) is recommended for monitoring and to provide ventilatory assistance with slight hyperventilation to promote seizure and avoid the risk of hypoxia during the procedure. There has been no consensus as to specific protocols for the application of hyperventilation, including duration, type of manoeuvres, and optimum carbon dioxide (CO<sub>2</sub>) values required. In usual clinical practice, hyperventilation is usually at the discretion of the anaesthesiologist who runs the ECT session. Hyperventilation has been

proposed as a method for optimising seizure,<sup>2,6,7</sup> since this is associated with a need for smaller charges<sup>8-10</sup> and longer crises obtained.<sup>8,10-13</sup> In addition, hyperventilation has been associated with an improvement in the cognitive effects associated with ECT, since it produces shortened reorientation time<sup>13</sup> and a decrease in the incidence of postictal delirium.<sup>8</sup>

Capnography consists of the non-invasive measurement of partial CO<sub>2</sub> pressure and, through end-tidal CO<sub>2</sub> (EtCO<sub>2</sub>), or maximum CO<sub>2</sub> concentration at the end of each exhalation, provides instantaneous ventilation, perfusion and metabolism of CO<sub>2</sub>. EtCO<sub>2</sub> measurements correlate closely with arterial CO<sub>2</sub> values in patients with no lung disease<sup>14</sup> and are an early sign of potential respiratory adverse effects, such as airway obstruction, respiratory failure, hypoventilation, or apnea.<sup>15-19</sup> Monitoring EtCO<sub>2</sub> with capnography during ECT has been associated with maintenance of lower CO<sub>2</sub> values during the procedure and more adequate control of haemodynamic parameters.<sup>20</sup>

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