Carbon dioxide

Carbon dioxide (chemical formula CO2) is a colorless and odorless gas vital to life on Earth. This naturally occurring chemical compound is composed of a carbon atom covalently double bonded to two oxygen atoms. Carbon dioxide exists in Earth's atmosphere as a trace gas at a concentration of about 0.04 percent (400 ppm) by volume.

Natural sources include volcanoes, hot springs and geysers, and it is freed from carbonate rocks by dissolution in water and acids. Because carbon dioxide is soluble in water, it occurs naturally in groundwater, rivers and lakes, in ice caps and glaciers and also in seawater. It is present in deposits of petroleum and natural gas.

Hypercapnia or hypercapnea (from the Greek hyper = “above” or “too much” and kapnos = “smoke”), also known as hypercarbia, is a condition of abnormally elevated carbon dioxide (CO2) levels in the blood. Carbon dioxide is a gaseous product of the body's metabolism and is normally expelled through the lungs.

Carbon dioxide is a potent cerebral vasodilator that may influence outcomes after ischemic stroke.

Current guidelines suggests a target of partial pressure of carbon dioxide (PaCO2) of 32-35 mmHg (mild hypocapnia) as tier 2 for the intracranial hypertension management. However, the effects of mild hyperventilation on cerebrovascular dynamics are not completely elucidated. This study aims to evaluate the changes in intracranial pressure (ICP), cerebral autoregulation (measured through pressure reactivity index, PRx), and regional cerebral oxygenation (rSO2) parameters before and after induction of mild hyperventilation. A single-center, observational study including patients with acute brain injury (ABI) admitted to the intensive care unit undergoing multimodal neuromonitoring and requiring titration of PaCO2 values to mild hypocapnia as tier 2 for the management of intracranial hypertension. Twenty-five patients were included in this study (40% female), with a median age of 64.7 years (Interquartile Range, IQR = 45.9-73.2). Median Glasgow Coma Scale was 6 (IQR = 3-11). After mild hyperventilation, PaCO2 values decreased (from 42 (39-44) to 34 (32-34) mmHg, $p < 0.0001$), ICP and PRx significantly decreased (from 25.4 (24.1-26.4) to 17.5 (16-21.2) mmHg, $p < 0.0001$, and from 0.32 (0.1-0.52) to 0.12 (-0.03-0.23), $p < 0.0001$). rSO2 was statistically but not clinically significantly reduced (from 60% (56-64) to 59% (54-61), $p < 0.0001$), but the arterial component of rSO2 (ΔO2Hbi, changes in concentration of oxygenated hemoglobin of the total rSO2) decreased from 3.83 (3-6.2) µM.cm to 1.6 (0.5-3.1) µM.cm, $p = 0.0001$. Mild hyperventilation can reduce ICP and improve cerebral autoregulation, with minimal clinical effects on cerebral oxygenation. However, the arterial component of rSO2 was significantly reduced. Multimodal neuromonitoring is essential when titrating PaCO2 values for ICP management [1)].

1)

Cardim D, Giardina A, Ciliberti P, Battaglini D, Berardino A, Uccelli A, Czosnyka M, Roccatagliata L, Matta B, Patroniti N, Rocco PRM, Robba C. Short-term mild hyperventilation on intracranial pressure, cerebral autoregulation, and oxygenation in acute brain injury patients: a prospective observational study. J Clin Monit Comput. 2024 Feb 4. doi: 10.1007/s10877-023-01121-2. Epub ahead of print. PMID:

38310592.