Hypercapnia

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.

Avalanche patients who are completely buried but still able to breathe are exposed to hypothermia, hypoxia and hypercapnia (triple H syndrome). Little is known about how these pathologic changes affect brain physiology. A study aimed to investigate the effect of hypothermia, hypoxia and hypercapnia on brain oxygenation and systemic and Cerebral hemodynamics. Anaesthetised pigs were surface-cooled to 28°C. Inspiratory oxygen (FiO2) was reduced to17% and hypercapnia induced. Haemodynamic parameters and blood gas values were monitored. Cerebral measurements included cerebral perfusion pressure (CPP), brain tissue oxygen tension (PbtO2), cerebral venous oxygen saturation (ScvO2) and regional cerebral oxygenation saturation (rSO2). Tests were interrupted when haemodynamic instability occurred or 60 min after hypercapnia induction. ANOVA for repeated measures was used to compare values across phases. There was no clinically relevant reduction in cerebral oxygenation (PbtO2, ScvO2, rSO2) during hypothermia and initial FiO2 reduction. Hypercapnia was associated with an increase in pulmonary resistance followed by a decrease in cardiac output and CPP, resulting in haemodynamic instability and cerebral desaturation (decrease in PbtO2, ScvO2, rSO2). Hypercapnia may be the main cause of cardiovascular instability, which seems to be the major trigger for a decrease in brain oxygenation in triple H syndrome despite severe hypothermia [1)].

The cranial cavity is a closed compartment and any breach to this confined space secondary to neurosurgery or trauma cause an imbalance between atmospheric pressure and intracranial pressure. As the altitude increases, the atmospheric pressure decreases and hypoxia with hypercarbia is a well-known fact. In children, there is an argument to suggest that hypoxia can contribute to mild increase in intracranial pressure during commercial flights [2)].

1)
Strapazzon G, Putzer G, Dal Cappello T, Falla M, Braun P, Falk M, Glodny B, Pinggera D, Helbok R, Brugger H. Effects of hypothermia, hypoxia and hypercapnia on brain oxygenation and haemodynamic parameters during simulated avalanche burial - a porcine study. J Appl Physiol (1985). 2020 Nov 5. doi: 10.1152/japplphysiol.00498.2020. Epub ahead of print. PMID: 33151777.
2)
Lo Presti A, Weil AG, Ragheb J. Flying with a shunt. J Neurosurg Pediatr. 2015;15(2):223-224.