

Ain Shams university
Faculty of medicine
Anaesthesia and Intensive care departmen

Carbon dioxide and Anaesthesia

Essay

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By:

Heba Alla Hassanian Refaee

M.B.B.Ch., Faculty of medicine Cairo University.
Supervised by:

Prof. Dr. / Fekry Foad A. Elbokl

Professor of anaesthesia and ICU,
Faculty Of Medicine, Ain Shams University.

Dr. / Waleed Abd Elmageed Eltahir

Assistant Professor of anaesthesia and ICU,
Faculty Of Medicine Ain Shams University.

Dr. / Ibrahim Mamdouh Esmat

Lecturer of anaesthesia and ICU,
Faculty Of Medicine, Ain Shams University.

Faculty Of Medicine

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الطبيبة/ هبة الله حسانين رفاعى

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تحت اشراف:

استاذ دكتور / فكرى فؤاد البكل

استاذ التخدير و الرعاية المركزة

كلية الطب ، جامعة عين شمس.

دكتور / وليد عبد المجيد الطاهر

استاذ مساعد التخدير و الرعاية المركزة

كلية الطب ، جامعة عين شمس.

دكتور / إبراهيم ممدوح عصمت

مدرس التخدير و الرعاية المركزة

كلية الطب ، جامعة عين شمس.

كلية الطب

جامعة عين شمس

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Carbon dioxide is colorless gas with physical properties that provide continuous gas exchange between inspired air and the blood in the pulmonary circulation, supplying oxygen and removing carbon dioxide which is then cleared from the lungs by subsequent expiration.

Breathing control in healthy people is by CO₂ concentrations in the brain and arterial blood. The breathing centre regulates our breathing movements through special chemoreceptors to measure CO₂ concentrations in the brain and arterial blood. The central chemoreceptors detect changes in the pH of the cerebro-spinal fluid and they are responsible for long term or slow changes in breathing. Since CO₂ dissolves in the blood and can penetrate through the blood-brain barrier, the main reason for pH variations in the brain are changes in CO₂ concentrations.

Peripheral chemoreceptors including the carotid and aortic bodies monitor immediate changes in CO₂, O₂ and pH concentrations of the blood and control our breathing in the short run.

carbon dioxide used in insufflation into fallopian tubes and abdominal cavities and in laparoscopic surgery.

Laparoscopy results in intra-operative cardio-respiratory changes during pneumoperitoneum. PaCO₂ increases due to CO₂ absorption from peritoneal cavity. Therefore pathophysiologic changes and complication of laparoscopy are first reviewed in compromised patients, cardio respiratory disturbance aggravate this increase in PaCO₂. Hemodynamic changes are accentuated in high risk cardiac patient.

Monitoring devices potentially increase the specificity and precision of clinical judgments. Our understanding of the physiologic effects of anesthesia and its inherent risks can be enhanced by the appropriate use of intra-operative physiologic monitoring. Capnometry is the measurement and numeric representation of the CO₂ concentration during inspiration and expiration. Carbon dioxide monitoring the partial pressure of expiratory CO₂ has evolved as an important physiologic and safety monitor. CO₂ is usually sampled near the endotracheal–gas delivery interface. Alterations in ventilation, cardiac output (CO), distribution of pulmonary blood flow and metabolic activity influence end tidal CO₂ concentration and the capnograph display obtained during quantitative expired gas analysis.

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List of Abbreviations

Co₂	Carbone di oxide
(-NH ₂)	amino
NH.COO ⁻	(carbamino)
O ₂	oxygen
mm Hg	Millimeter mercry
PaCO ₂	The partial pressure of carbon dioxide in the arterial blood
(MAC)	monitored anaesthesia care
TcCO ₂	Transcutaneous measurement of carbon dioxide
H ₂ O	water
H ₂ CO ₃	Carbonic acid

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Introduction:

Carbon dioxide Co₂ is an odorless and colorless gas

CO₂ is resulting from oxidation of carbon and formed in tissues and eliminated by the lungs Co₂ is used in some pump oxygenators to maintain blood carbon dioxide (Co₂) tension.

The solid form of Co₂ is carbon dioxide snow **(BOCMedical, June, 1994)**

There are many uses of Co₂ the most common practice is abdominal insufflations in laparoscopic surgery.

The hallmark of laparoscopy is the creation of apneumo peritoneum with pressurized co₂. the resulting increase in intra-abdominal pressure displaces the diaphragm cephalad, causing a decrease in lung compliance and increase in peak inspiratory pressure. Atelectasis, diminished FRC, ventilation/perfusion mismatch, and pulmonary shunting contribute to a decrease in arterial oxygenation. These changes should be exaggerated in this obese patient with a long history of tobacco use. **(Lumb A et.al., Nunn JF et.al., 2000). (Evers AS et.al., Maze M et.al. Churchill Livingstone, 2004).**

Side effect of Co₂ insuffilation

1. CO₂ is not an inert gas. It causes direct peritoneal irritation and pain by forming carbonic acid. Post operatively it remains intraperitoneal and causes referred shoulder pain.
2. It causes hypercarbia and respiratory acidosis.
3. It causes sympathetic stimulation which leads to tachycardia, hypertension, and arrhythmias.

(Malley Cet.al., Cunningham AJ et.al., 2001), (Joshi Gp et.al., 2001)

Co₂ disorders

Hypocapnia

Produced by passive hyperventilation

Hypocapnia may cause a decrease in T wave by three separate mechanism

- First, if it is present, an increase in intrathoracic pressure will decrease cardiac output.
- Second, hypocapnia is associated with withdrawal of sympathetic nervous system activity, and such withdrawal can decrease the inotropic state of the heart
- . Third, hypocapnia can increase pH, and the increased pH can decrease ionized calcium, which may in turn decrease the inotropic state of the heart. **(Wang T et.al, El Kebir D et.al., Blaise G et.al., 2003)**

Hypercapnia

is generally defined as a blood gas carbon dioxide level over 45 mmHg.

Causes

- Increased CO₂ production, as Increased temperature including malignant hyperthermia
- Decreased CO₂ excretion, as inadequate ventilator settings
- Increased CO₂ delivery to the lungs, as Increased cardiac output, R to L shunt

Management

Ensure adequate oxygenation,adequate ventilation, Check FiO₂,sample Blood gases to confirm capnography, Consider secondary causes, Treat complications of hypercapnia

(Rowan Thomas et.al.,2009)

Contents:

Chapter 1: Introduction.

Chapter 2: Co₂ manufacture, physiological properties

Chapter3: laparoscopic surgery, indications & complications

Chapter 3: Monitoring & measurements.

Chapter 1

ANATOMY AND PHYSIOLOGY OF THE RESPIRATORY SYSTEM