A Potential Therapy for SARS-Cov-2 Virus Deactivation: Carbon Dioxide Management

Yehya Elsayed[1], Rania Shebair[2]

1 American University of Sharjah
2 Al Manara Pharmacy Group, Delta Medical Est.

Funding: The author(s) received no specific funding for this work.

Potential competing interests: The author(s) declared that no potential competing interests exist.

Abstract

On March 12, 2020, WHO has announced COVID-19 as a pandemic due to the uncontrolled spread of SARS-Cov-2 virus, which cause severe acute respiratory tract infections. The virus penetrates the human's body through the droplets of infected person to other person, and binds to certain receptors located on the surface of the human cells. Many challenges appeared when suggesting medicines for the treatment of Covid-19, in addition to several unanswered questions related to the vaccines' accessibility and long-term consequences. In this paper, we would like to suggest a potential treatment for COVID-19 disease based on existing knowledge in the medical field, whether the case is mild, moderate or severe. The therapy is based on the use of carbon dioxide (CO_2) either alone or as a carrier of other medication as bronchodilator, antibiotic, antiviral or anti-cytokine. The investigation shows that administration of warmed, humidified form of CO_2 gas to COVID-19 patient would deactivate the viral process. Therefore, CO_2 has an antimicrobial effect or can act as disinfectant.

COVID-19, a severe acute respiratory syndrome caused by SARS-CoV-2 virus, requires long-term multi-variant strategic plans especially with the increase in the number of impacted cases. As of February 12th, 2021, more than 108 million coronavirus cases were reported with about 25.5 million of currently infected patients[1]. The associated death toll is on the rise exceeding 2.4 million cases[1]. With the positive news on the effectiveness of several vaccines towards SARS-COV-2 control directed toward minimizing illness and death, we may be far from ending COVID-19 pandemic as a public health issue. We should expect several associated challenges in the future[2]. Although the vaccines are expected to be effective at reducing the risk of severe Covid-19 cases, the vaccinated people may still be infected and transmit the virus without showing the symptoms[2]. The coverage levels, which is essential step to achieve a herd immunity by vaccination, may also be a challenge in many countries due to economical or cultural factors[2]. Another challenge is associated with the lack of information on the long-term side effects of such vaccines. The effectiveness of these vaccines in protecting people may be time limited especially with the observed mutations in the virus; therefore, there may be a need for repeated vaccinations in order to control this pandemic[2]. The vaccine manufacturer will be required to provide answers and continue to improve the effectiveness of the currently licensed COVID-19 vaccines beyond the emergency use authorization[2]. At the same time, the scientific community should continue their research on alternative medicines for treatment and prevention. In this letter, we are proposing a potential treatment method.

In many cases of COVID-19, patients develop different symptoms range from mild to severe, including sore throat, body aches, coughing, fever, and may escalate to reach respiratory failures. In critically ill patients, when the lung get infected with SARS-Cov-2 virus, a respiratory response in form of hyperventilation is developed where the amount of CO_2 exhaled is more than the amount of O_2 inhaled. This will lead to increase in the breathing rate with less O_2 and CO_2 supply in the blood stream to organs[3]. This may become an issue among elderly COVID-19 patients with other comorbidities as hypertension or diabetes. In those cases, the infection is associated with severe respiratory illness termed as Acute Respiratory Distress Syndrome (ARDS), which imposes hypoxia and hypocapnia (hypocapnea) similar to the ones observed in hyperventilation cases[4][5]. Those cases require prolonged period of recovery and admission to ICU. The Estimated Oxygen Saturation (SpO_2) in these cases are low.

Hypoxia is a major indicator of the illness severity, which is defined as lower levels of oxygen circulated in the blood to body tissues. This is measured by SpO_2 using the pulse oximeter. Healthy level of SpO_2 should exceed 95% in order to maintain normal metabolic functions in the body, while a reading of less than 90% indicates a serious illness in these functions including breathing problems. The symptoms of hypoxia depend on the severity of the case and may include shortness of breath, rapid breathing, and tachycardia in acute cases. In severe cases, the symptoms are confusion, inability to communicate and possibility of coma and death[6]. Cerebral hypoxia attacks brain tissues and may lead to brain damage and death. The severity of cerebral hypoxia is measured by monitoring CBF status, which is measured by cerebrovascular reactivity (CVR-CO_2)[7]. CO_2 has a reversible effect on cerebral blood flow (CBF), and its stability is highly sensitive to changes in $PaCO_2$ [8].

In patients with COVID-19, a cytokine storm takes place, where cytokine bodies increase in the blood serum. It has been found that a similarity in the inflammatory response in the cases reported for both of COVID-19 and in patients with unstable CBF (vasculitis, stroke, traumatic brain injury, seizures and cognitive decline), where a reaction of cytokine storm leads to the release of interleukins IL-1, Il-6, IL-2r and,IL-8 [7][9][10]. Maintaining healthy level of CBF during CO_2 fluctuation in COVID-19 patients would maintain stable breathing process in the body; hence, it will provide a chemo reflex control of breathing. Normal CBF in adults is maintained at ~ 50ml/100g of brain tissue/ min. As reported, there is a linear relationship between CO_2 and CBF demonstrated in humans where inhalation of 5% CO_2 will increase the CBF by 50 %. On the other hand, inhalation of 7% CO_2 is expected to increase CBF by 100%[11]. Therefore, the use of CO_2 may have potential for treating moderate to severe cases of Covid-19, especially when breathing difficulties and hypoxia are present. By elevating the partial pressure of arterial CO_2 ($PaCO_2$), CBF increases resulting in the stabilization of the breath by increasing the oxygen supply in the body tissues. This will help in stabilizing the release of interleukins and in suppressing the cytokine storm reaction where the CO_2 gas is diffused in body tissues about 20 times more than O_2 [12]. In patients admitted to ICU with severe symptoms of COVID-19, severe hypoxia was found to trigger the respiratory response for hypocapnia (low $PaCO_2$) [3][13]; hence, leading to a favorable environment for bacterial and viral growth. Inhalation of CO_2 gas would reduce the release of interleukins by lowering the pH to 5.5, as CO_2 gas possess anti-inflammatory, antimicrobial and anti-cytokine features.

CO_2 plays a vital role in improving oxygenation of blood and body organs. Based on the above discussions, we suggest administering a heated warmed and humidified CO_2 in order to lower PH to around 4.2. This acidic medium increases the cell membrane permeability to CO_2 leading to a decrease in the viral growth rate inside the cell and ultimately the deactivation of the viral process. This suggestion aligns with a recent article, which showed the inactivation of viruses and bacteria by CO_2 bubbles in solution[13]. In addition, Dense Phase Carbon Dioxide (DPCD) treatment may be applied for the deactivation of the virus. This high density of warmed CO_2 molecules enter the virus capsid and binds to the protein sites to form CO_2-protein binding complex which results in the deactivation of the virus action as well.

References

1. a, b *COVID-19 Coronavirus Pandemic. Worldometer, https://www.worldometers.info/coronavirus/ (Accessed on Feb 12, 2021).*
2. a, b, c, d, e *Anderson M, Vegvari C, Truscott J and Collyer BS. Challenges in creating herd immunity to SARS-CoV-2 infection by mass vaccination. The Lancet 2020; 396(10263):1614-1616.*
3. a, b *El-Betany AMM, Behiry EM, Gumbleton M, Harding KG. Humidified Warmed CO2 Treatment Therapy Strategies Can Save Lives With Mitigation and Suppression of SARS-CoV-2 Infection: An Evidence Review. Front Med (Lausanne) 2020; 7:594295.*
4. ^ *Robba C, Bali L and Pelosi, P. Between hypoxia or hyperoxia: not perfect but more physiologic. J Thorac Dis 2018; S2052-S2054.*
5. ^ *Kashani KB. Hypoxia in COVID-19: Sign of Severity or Cause for Poor Outcomes. Mayo Clin Proc. 2020; 95(6):1094-1096.*
6. ^ *Davi CP. Hypoxia and Hypoxemia (Low Blood Oxygen). MedicineNet, https://www.medicinenet.com/hypoxia_and_hypoxemia/article.htm#hypoxia_and_hypoxemia_facts (Accessed on Feb 12, 2021).*
7. a, b *Duffin J and Ainslie PN. Integration of cerebrovascular CO2 reactivity and chemoreflex control of breathing: mechanism of regulation, measurement, and interpretation. Am J Physiol Regul Integr Comp Physiol 2009; 296(5): R1473-R1795.*
8. ^ *Cipolla MJ. The Cerebral Circulation. San Rafael (CA): Morgan & Claypool Life Sciences, 2009. Available from: https://www.ncbi.nlm.nih.gov/books/NBK53081/*
9. ^ *Gur A, Karakoc M, Erdogan S, Nas K, Cevik R and Sarac AJ. Regional cerebral blood flow and cytokines in young females with fibromyalgia. Clin Exp Rheumatol. 2002; 20(6):753-760.*
10. ^ *Spano VR, Mandell DM, Poublanc J, Sam K, Battisi-Charbonney A, Pucci O, Han JS, Crawley AP, Fisher JA and Mikulis DJ. CO2 Blood Oxygen Level-dependent MR Mapping of cerebrovascular Reserve in a Clinical Population: Safety, Tolerability, and Technical Feasibility. Radiol. 2013; 266(2): 592-598.*
11. ^ *Bailey JE, Argyropoulos SV, Kendrick AH and Nutt DJ. Behavioral and cardiovascular effects of 7.5% CO2 in human volunteers. Depress Anxiety 2005; 21(1):18-25*

12. [^]*Ottestad W, Søvik S. COVID-19 patients with respiratory failure: what can we learn from aviation medicine?. Br J Anaesth 2020;125(3):e280-e281.*
13. [a, b]*Sanchis AG, Pashley R and Ninham B. Virus and bacteria inactivation by CO2 bubbles in solution. npj Clean Water 2019; 2.*