



PATHOPHYSIOLOGY OF HAPPY HYPOXIA IN COVID 19 PATIENTS: A REVIEW OF LITERATURE

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Article Received on 06/03/2021

Article Revised on 27/03/2021

Article Accepted on 16/04/2021

ABSTRACT

Viral contamination of the respiratory system regularly incites irritation and stimulation of tactile receptors, inducing transmission of afferent impulses to the respiratory centers. The nearness of dyspnea would be no physiological astonish in either circumstance. The surprise would emerge as it were in the event that sensory afferents or hypoxemia inspired critical stimulation of the respiratory centers and the persistent did not create dyspnea. COVID-19 patients show low oxygen levels without dyspnea. The clinical problem Happy Hypoxia, more accurately named Silent Hypoxia is particularly befuddling to doctors and is considered as opposing fundamental science. Due to lack of information regarding these components, doctors caring for hypoxemic patients free of dyspnea are working within the dark, setting helpless COVID-19 patients at significant risk. Thus the purpose of this article is to contribute to a growing body of research that will prove to be valuable for clinicians working in critical care wards; it explains a vivid picture about the patho-physiology, the mechanism involved which is mandatory before treating an extraordinarily contagious virus that is affecting millions of people worldwide.

KEYWORDS: COVID19, dyspnea. Happy Hypoxia.

INTRODUCTION

Suppose somebody would be sitting in an emergency room agreeable and ready to have a discussion, yet has an oxygen concentration around 80%, appears to be unbelievable?^[1] But this is a condition seen dominant in COVID19 patients usually around 5th to the 10th day of infection known as 'Happy Hypoxia' or 'silent hypoxia' at this stage the body has oxygen saturation underneath 90% and can hazardedly decay as low as 40%, but the individual can still breathe ordinarily.^[2] These coronavirus patients with hypoxia do not involve the trademark signs that their oxygen levels have dropped into a dangerous territory.^[1]

Dyspnea is commonly defined as, "A sensation of 'uncomfortable, difficult, or labored' breathing and occurs in common, when the demand for ventilation exceeds the proportion to the patient's ability to respond".^[3] Happy hypoxia happens in coronavirus patients when regions of the lung where ventilation is ordinary, but there's sufficient illness that leads to lower oxygen levels.^[3] These patients will still have sufficient

lung function in terms of how the lungs move that they're able to blow off their carbon dioxide well so they do not create the shortness of breath.^[4] As a result, within the starting stages of ailment, the COVID-19 quiet, on the exterior, shows up to be okay and "happy".^[5] It is harder to detect this form of oxygen deprivation than regular hypoxia because patients appear to be less in distress as compared to what is expected from them in their clinical presentation.^[6] A subjective symptom including repulsive breathing can be recognized as it were by a persistent; patients change broadly in behavioral reactions to inconvenience.^[7] As with torment, physical signs may overestimate or belittle understanding distress. The actual clinical presentations tend to explain that the arterial oxygen is about 75 to 100 millimeters of mercury (mm Hg). A Pulse Oximeter is a device that can be used to measure the oxygen level (oxygen saturation) of the blood.^[8-10] The device is used to measure the saturation of oxygen in red blood cells (RBCs).^[10-12] It is simple and effortless and the device can be reused or arranged off after using once, readings ordinarily extend from 95 to 100%. When levels drop underneath 90%, patients

may start encountering laziness, disarray or mental disturbances because of hypoxia within the brain tissues.^[13] When the reading falls below 80% it can cause vital organ damage. Patients suffering from COVID-19, who do not demonstrate symptoms necessary for dyspnea, are subjected to risks like Acute Respiratory Distress (ARDS), Transfusion Related Acute Lung Injury (TRALI) and organ failure.^[14] It is unlikely that TRALI can ever be entirely prevented, but its frequency may be reduced by diagnosing TRALI correctly and consistently.^[14]

There are no characteristics or criteria's that decide whether an individual is at a higher chance of happy hypoxia.^[15] It can be treated with a ventilator, but more often than not other methodologies come to begin with, such as a beat oximeter or a CPAP machine (persistent positive aviation route weight machine, which employments a hose and cover to provide consistent discuss weight) or altering the position of the body.^[16-18]

PATHOPHYSIOLOGY

When a region of the lungs encompasses a total blockage of air or blood stream, that exchange doesn't happen and oxygen levels drop.^[19] But carbon dioxide, which exchanges more promptly than oxygen, can still elude the lungs as long as the rest of the lung tissue is generally solid and not hardened by age or infection, like uncontrolled asthma or extreme pneumonia.^[20] That result in low oxygen levels and low carbon dioxide levels and individuals can really feel normal with low oxygen levels on the off chance that they are not exerting themselves.^[21]

Courtesy

With permission of Prof Eric Heffernan Consultant Radiologist, Department of Radiology, St Vincent's University Hospital Clinical Professor, School of Medicine, University College Dublin. Farkas J. PulmCrit - Understanding happy hypoxemia physiology: how COVID taught me to treat pneumococcus Internet. EMCrit Project. Available from: <https://emcrit.org/pulmcrit/happy-hypoxemia-physiology>.

To understand happy hypoxemia we must differentiate oxygenation vs. ventilation:

Status post left lower lobe resection

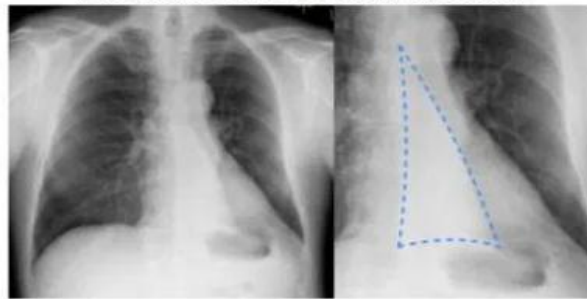


Oxygenation: Fine

CO₂ clearance: Fine

Work of breathing: Fine

**Complete left lower lobe atelectasis
(One potential example of happy hypoxemia)**



Oxygenation: Poor (shunt physiology)

CO₂ clearance: Fine

Work of breathing: Fine

Fig 1: The above comparative image shows that in both the lungs the work of breathing is fine, the CO₂ clearance is fine the lung tissue involved in receiving ventilation is normal. Thus their overall chest compliance is close to normal. Hence, both patients won't show symptoms of dyspnea causing the condition called Happy Hypoxia.

Currently, the mechanism is thought to be due to formation of micro-emboli, resembling pulmonary embolism.^[22] This would cause an increase in alveolar dead space and thus alveolar hypoventilation, if the minute volume remains unchanged. Impaired alveolar diffusion of oxygen will lead to 'silent hypoxia' and a consistent drop in oxygen saturation.^[23]

1. Oxygenation

Hypoxemia is said to be caused when blood without being fully oxygenated, passes from the right ventricle

into the left ventricle.^[24] The following ways through which it occurs are.

- **Ventilation-perfusion mismatch (V-Q mismatch):** The human lung consists of regions, and each region embarks its own effect on the proper functioning of the lung in terms of ventilation. Thus, some parts of the lung are adequately ventilated whereas others poorly ventilated.^[25] The blood which reaches these regions is distributed according with poorly ventilated regions being deprived of oxygen to those which are properly ventilated. Thus the net results in Hypoxia.^[25]

- **Shunt physiology:** Anatomical deficits like ventricular septal deformity or mucus plugging of one lobe of the lung causes the blood to flow from the right ventricle to the left ventricle without coming in contact with the oxygenated alveoli.^[26] Illustrations incorporate variation from the norm.^[26] The trademark sign of shunt physiology include its ineffective responsive to expanded oxygen level because of the shunt physiology.

MECHANISM

The exact mechanism behind the condition causing Happy Hypoxia is still obscure (since dissection studies ordinarily include patients who have been incubated for a limited amount of time, causing superimposed ventilator-induced lung harm) So far now only some assumptions

have been made which can be seen through Figure 2 involving the right mechanism like.^[26]

- The shunt physiology applies greatly as it leaves many regions in the lungs deprived of oxygen leading to no aeration. This might result to a great extent due to atelectasis (given that early APRV (Airway pressure release ventilation).
- Happy hypoxemia can occur when a combination of shunt physiology, poor ventilation occurs separately and a more severe form when it occurs together.^[27] Occurs usually because of an illness associated with Lungs e.g., lobar consolidation or atelectasis causing a constrained sum of shunt, protecting the leftover regions associated with the lung.

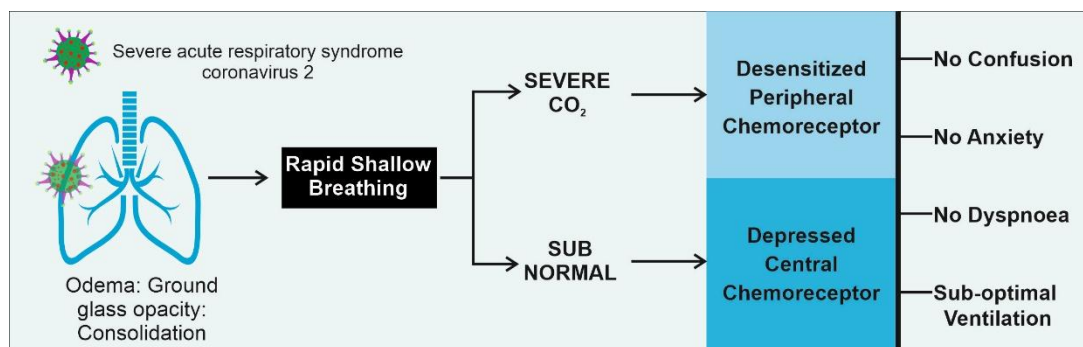


Fig 2: Putative mechanism that might explain the mechanism of Happy Hypoxia in COVID19 patients. Lungs showing edema, scans showing ground glass opacity. The desensitized peripheral chemoreceptor and depressed central chemoreceptors leads to no dyspnea, no anxiety and no confusion.

DIFFERENCE BETWEEN NORMAL HYPOXIA and HAPPY HYPOXIA

Coronavirus patients with Happy Hypoxia don't experience the hallmark signs that their oxygen levels have dropped into a dangerous territory. Whereas hypoxia could be a caution flag for imminent failure of crucial body organs just like the kidneys, brain, heart and is as a rule went with by conspicuous breathlessness, happy hypoxia does not provoke any such self-evident outside signs. As a result, within the starting stages of affliction, the COVID-19 patient, on the exterior, shows

up to be okay and "happy". Our brain power is to acknowledge carbon dioxide levels in blood not oxygen levels. Little changes in ventilation because it happened after PaO₂ starts to drop underneath 60 mm Hg. PaO₂ is the degree of degree of the pressure of oxygen within the blood within the arteries. The value significantly explains the proper flow of oxygen in the lungs and the blood vessels. The value of PaO₂ usually ranges between 75-100 mmHg. Thus, case of Happy Hypoxia where CO₂ level comparatively stays normal the hallmark signs are not clinically observed as in case of Normal Hypoxia.

NORMAL HYPOXIA	HAPPY HYPOXIA
"Normal Hypoxia is a condition or state in which there's a decrease in the partial pressure of oxygen in the blood. As blood oxygen levels begin to reduce, a person may experience shortness of breath." ^[3]	"Happy Hypoxia is a condition or state in which the supply of oxygen is insufficient for normal life functions. Despite low blood oxygen levels, some patients appear to be functioning without serious issues or even shortness of breath." ^[3]
Possible cause: CO ₂ level – Poor Oxygenation – Poor Work of breathing - Unwell	Possible cause: CO ₂ level – Normal Oxygenation – Poor Work of breathing - Fine
Symptoms: Shortness of breath, Rapid breathing, and Fast heart rate	Symptoms: No shortness of breath, No rapid breathing, and No fast heart rate

RADIOLOGICAL CHANGES SEEN AFTER THE EVENT OF HAPPY HYPOXIA

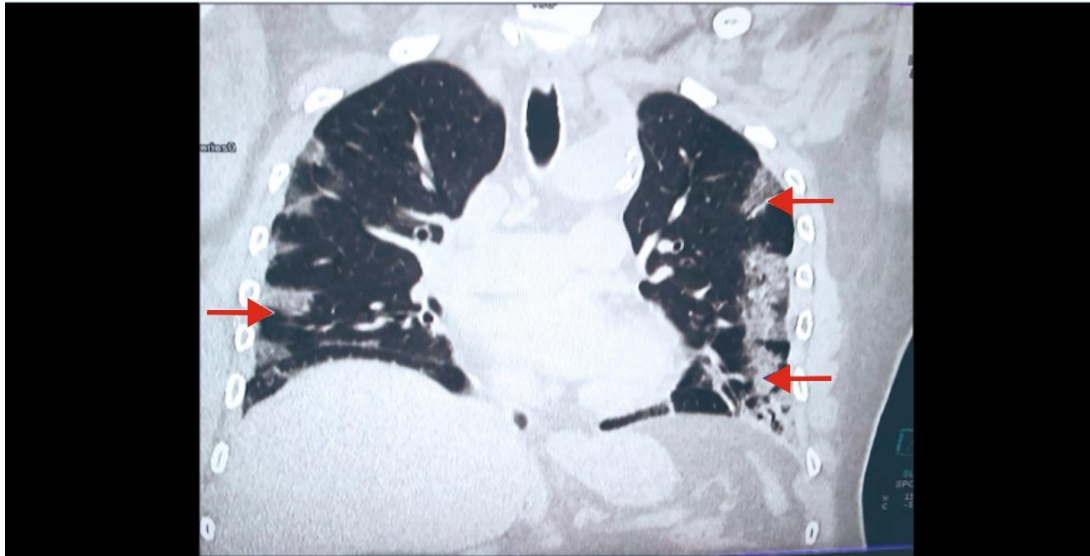


Fig:3. COVID Pneumonia with ground glass opacities. Coronal HRCT shows multifocal ground glass opacities in bilateral lung fields (white arrows) with peripheral predominance (black arrow).

Figure 3: The original Coronal HRCT shows lungs of a coronavirus disease (COVID-19) patient, suffering from Happy Hypoxia. The scan shows the hallmark signs of COVID-19 disease including Ground Glass Opacity (GGO) in bilateral lung fields with peripheral predominance.

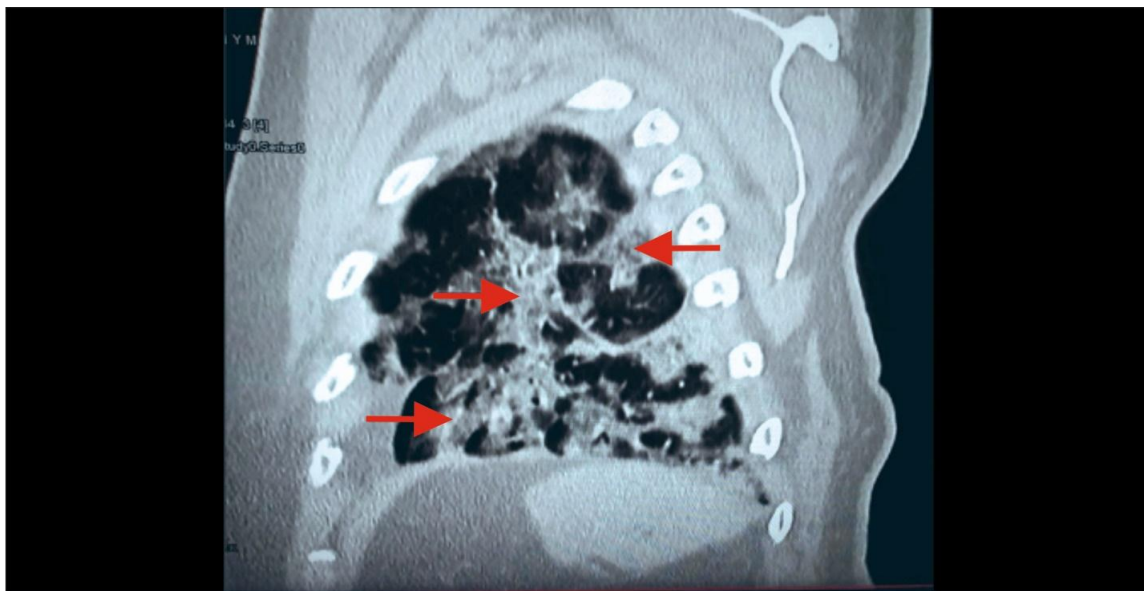


Fig:4. COVID Pneumonia with ground glass opacities. Sagittal HRCT shows multifocal ground glass opacities (black arrows) with air bronchogram (white arrow) in right lung field.

Figure 4: The original Sagittal HRCT shows multifocal ground glass opacity with air bronchogram in the right lung field.



Fig:5. COVID Pneumonia with ground glass opacities. Sagittal HRCT shows multifocal ground glass opacities (black arrows) in left lung field.

Figure 5: The original Sagittal HRCT shows multifocal ground glass opacity in the left lung field.

As the disease progresses, the pathological conditions cause the denuded basement membrane to be roofed with debris, consisting of dead cells, fibrin and complement activation products. The scan findings show, GGO, consolidations, crazy paving patterns, intra-lobular thickening, adjacent pleural thickening, linear opacities and much more. Patients with COVID-19 sometimes suggest the formation of blood clots due to the elevated levels of D-dimers.

CONCLUSION

The continued COVID-19 widespread holds numerous riddles. Among the most astounding has been the recurrence of silent hypoxemia.^[28] Happy hypoxia doesn't ordinarily go untreated for expanded periods in coronavirus patients since they as a rule create shortness of breath inevitably, which ought to incite them to look for therapeutic care.^[29] Moreover, numerous of these patients encounter other signs of the coronavirus before shortness of breath, which arrive them within the emergency room or a doctor's office.^[30] COVID-19's sudden development and fast spread gave researchers and clinicians small data to go on when deciding successful medicines.^[31, 32] Since most patients may have untreated hypoxia for fair many days, specialists push that poor oxygen levels by them does not cause a part of the harm, Long-term, if we're talking months to years, that's not something we expect to see with COVID is expected to cause major damage.

ACKNOWLEDGEMENT

The authors would like to thank Prof Eric Heffernan Consultant Radiologist, Department of Radiology, St Vincent's University Hospital Clinical Professor, School of Medicine, University College Dublin for granting permission to access the image mentioned as Figure 1.

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