INTRODUCTION

The COVID-19 pandemic has killed almost 5 million and infected more than 246 million people in the world as of 10/31/2021. Today the COVID-19 pandemic is still spreading worldwide and is still a major public health crisis. Studies show that the increasing evidence demonstrates a strong correlation between obesity (high body mass index (BMI)) and the COVID-19. Individuals with obesity are linked with large significant increases in morbidity and mortality from COVID-19. How to better prevent COVID-19, cardiac or cerebrovascular strokes and other obesity related diseases are becoming urgent issues in clinical research.

ABSTRACT

Backgrounds: The COVID-19 pandemic has killed almost 5 million and infected more than 246 million people in the world as of 10/31/2021. Today the COVID-19 pandemic is still spreading worldwide and is still a major public health crisis. Studies show that the increasing evidence demonstrates a strong correlation between obesity (high body mass index (BMI)) and the COVID-19. Individuals with obesity are linked with large significant increases in morbidity and mortality from COVID-19. How to better prevent COVID-19, cardiac or cerebrovascular strokes and other obesity related diseases are becoming urgent issues in clinical research. Methods and Results: In this study, based on the published data and theories of hemodynamics or hematology, we therefore propose modeling mechanisms of clinical hard breathing caused by excess fats, pulmonary hemorrhages, thrombosis, alveolar clots, scabs, edema, as well as air pollution and smoking. Our models qualitatively (formulatively) describe how human lungs (capillaries and alveoli) control diffusions and pressures of CO₂ and O₂; why some people, especially OHS (obesity hypoventilation syndrome) and obesity (overweight) asthma patients, are not mandatory to wear face masks to prevent COVID-19 and other respiratory diseases. Conclusion: To clinically prevent primary and secondary COVID-19 and other respiratory diseases without any side effect, we suggest people, especially for the patients with excess fats, to optimize the fatty amounts in the lower respiratory tracts by complete nutrition therapy. We think the body weight index (BWI) is a suitable daily measuring data for the fatty optimization because we have not found any data or method that the fats or lipids amount can be measured directly and daily between capillaries and alveoli in lungs.

Key words: capillaries, CO₂, O₂, diffusion, alveoli, fats, COVID-19, clinic, hemodynamics, hematology, pulmonary hemorrhages, thrombi, clots.

INTRODUCTION

The COVID-19 pandemic has killed almost 5 million and infected more than 246 million people in the world as of 10/31/2021.[1] Today the COVID-19 pandemic is still spreading worldwide and is still a major public health crisis.

Studies show that the increasing evidence demonstrates a strong correlation between obesity (high body mass index (BMI)) and the COVID-19. Individuals with obesity are linked with large significant increases in morbidity and mortality from COVID-19.[2-4]

Several articles report that obesity hypoventilation syndrome (OHS) is a condition in some obese people in whom poor breathing leads to lower oxygen (O₂) and higher carbon dioxide (CO₂) levels in the blood. Complications of obesity
hypoventilation syndrome include pulmonary hypertension; right heart failure, also known as cor pulmonale; and secondary erythrocytosis.[9] Overweight and hypertension patients have shortness of breath too,[6] i.e., overweight or obesity patients have a positive correlation with asthma.[7] OHS or overweight people have a high correlation with COVID-19.[2-4]

We proposed biomedical infophysical models of filtering ghost airflows of COVID-19 to defend our upper respiratory tracts and to decrease the related infection and death rates at a human society (country, territory or area) levels in our recently published two articles of preventing or treating (mild) COVID-19 by face mask-wearing.[8-9]

In our other previous studies, we also proposed models of complete nutrition therapy to prevent or cure cardiac or cerebrovascular strokes caused by obesity or overweight.[10-11]

To obtain higher efficiency to prevent COVID-19 and the other respiratory infection diseases, in late 2020, we published another paper for primary and secondary prevention of COVID-19 in clinic at an organ or tissue levels and suggested to often wash or clean our upper respiratory tracts to prevent all respiratory diseases as well as proposed hemodynamics models to maintain optimum transportation of all nutrients in blood flowing by drinking (boiled) warm water and complete nutrition fluids.[12]

How to better prevent COVID-19, cardiac or cerebrovascular strokes and other obesity related diseases are becoming urgent issues in clinical research. Therefore, in this article, we continue our previous studies[8-12] and propose models of CO2 and O2 diffusions across capillaries, alveoli and excess fats (an abnormally high concentration of fats or lipids between capillaries and alveoli in lungs) for primary and secondary preventions of COVID-19 in clinic in a perspective of hemodynamics or hematology.

METHODS

In this study, we develop our models using published data of hematology and theories of Fick’s diffusion law and hemodynamics; we assume a body weight index (BWI) indirectly indicates a fat or lipid amount between capillaries and alveoli in lungs because we have not found any direct method or data for the daily measuring.

MODELING RESULTS

The published data show that COVID-19 involves at least three human physiological systems: the respiratory, cardiovascular and urinary.

Maintaining the acid/base balance of blood is vital to human survival. The normal blood pH is set at 7.4, which is slightly alkaline or “basic”. Blood pH levels below 6.9 or above 7.9 are usually fatal if they last for more than a short time. There are three factors in the managements of pH: the lungs, the kidneys and buffers.[13] Lungs (capillaries and alveoli) control CO2 and kidneys control HCO3− (bicarbonate) or H+.[11-16]

Modeling CO2 and O2 Diffusions across Capillaries, Alveoli and Excess Fats in Lungs

A lung has two circulation (flow) systems: The hemodynamic for the blood flow and the aerodynamic for the air flow.[17-18] Our previous theoretical studies were mostly focused on the upper respiratory tracts and hemodynamic system.[8-9, 12] In this investigation, our major assignments are focused on the mechanisms of the air diffusions across the two circulation (flow) systems of the hemodynamics and aerodynamics in lungs (in the lower respiratory tracts).

A one dimensional (1D) diffusion of particles can be physically modeled using Fick’s first law of the pressure-driven flow:[14-15]

\[ J = \frac{dV}{(Adt)} = -D \frac{dP}{dx} = D \left[ (P_1 - P_2) / (x_2 - x_1) \right] \] (1)

Where J represents diffusion volume per unit time and area (flux),[15] d denotes the differentiation, V and A respectively represent diffusion volume and cross area, x and t respectively denote space and time coordinates, P denotes the pressure of diffusions, D denotes the diffusion coefficient or diffusivity, \( \nabla \) (nabla) and \( \Delta \) (delta) respectively denote gradient and variant operators; subscripts 1 and 2 respectively denote the two sides of the diffusion media. We omit Poiseuille’s and osmotic pressures because they are not applicable in this investigation.[14-15, 17] We also assume D and A are quasi constants in specific diffusion mediums and ignore the partition coefficient to simplify our modeling procedures.

Figure 1: Equivalent diffusion pathways: a, normal; b, abnormal OHS (excess fats). D represents the diffusion coefficient; [ ] denotes the concentration, \( \Delta x \) denotes the normal thickness of the combined wall, \( \delta_x \) denotes the increased thickness of the fat, subscripts a, c, f, i and n respectively denote the alveolus wall, capillary wall, excess fat, interstitial tissue and normal; superscripts a and c respectively denote alveoli and capillaries. See the text. The draw is not to the scale.
The meaning of equation 1 in physics is that a pressure gradient in a spatial domain produces (is equivalent to) a volume (quantity) flow (variant) in time domain.

Under normal (optimum) circumstances the transfers of CO$_2$ and O$_2$ across the capillaries and alveoli in lungs are perfusion (flow) limited, but under certain abnormal (excess fats or over fatty) pulmonary conditions the transfers may become diffusion limited, and when the gases are in chemical combination with hemoglobin, they no longer exert a partial pressure.\[14-15\]

Neglecting the interaction of different diffusion components, such as CO$_2$ and O$_2$,\[19\] based on equation 1, we define normal CO$_2$ diffusion from capillaries to alveoli as (Figure 1 a),

\[
J_n^{c-a}(CO_2)=\frac{dV_n^{c-a}}{d(t)}=-D_n^{c-a}(CO_2)\cdot [dP_n^{c-a}(CO_2)/dx]=D_n^{c-a}(CO_2)\cdot [P_n^{c-a}(CO_2)-P_n^{a}(CO_2)]/|x_2-x_1| \tag{2}
\]

where, $D$ and $\Delta x$ (> 0) respectively denote the equivalent diffusivity and thickness of the diffusion, subscript n means the normal, superscripts c, a and - respectively denote capillaries alveoli and to; others have the same meanings as that in equation 1.

For normal exercising people, the faster breathing frequencies increase CO$_2$ volumes and pressures in blood vessels, the increased pressures in the lung capillaries raise the pressure gradients between the capillaries and alveoli in space domain (right sides of the second equal sign in equation 2), the raised gradients enhance CO$_2$ diffusions from the capillaries to the alveoli in time domain (left sides of the second equal sign in equation 2). Note that, $P_n^{a}(CO_2)$ is roughly a constant, the only way to raise the gradient is to elevate $P_n^{c}(CO_2)$ usually. Therefore, our modeling equation 2 qualitatively (formulaically) explain how or why CO$_2$ pressure increasing in the blood vessels can elevate exhaling CO$_2$ rates in a perspective hemodynamics.

For the OHS or obesity (overweight) people, there is an abnormal excess fats (over fatty)$^{[27]}$ of alveolar-capillary barrier to limit the diffusion, see Figure 1 b. Based on equations 1 and 2, we define CO$_2$ diffusions across the capillaries, alveoli and excess fats as equation 3,

\[
J_f^{c-a}(CO_2)=-D_f^{c-a}(CO_2)\cdot [dP_f^{c-a}(CO_2)/dx]=D_f^{c-a}(CO_2)\cdot [P_f^{c-a}(CO_2)-P_f^{a}(CO_2)]/|x_2^*-x_1^*| \tag{3}
\]

Where subscript f means the excess fats, $\delta x$ (> 0) denotes the increased thickness of the excess fats (Figure 1b), others are the same as that in equation 2.

Comparing equations 2 and 3 of the normal and abnormal CO$_2$ diffusions, based on hemodynamic or physiological theories or data,$^{[13-16]}$ we assume the both diffusions (fluxes) are approximately equal because human physiological systems will do their best to provide almost constant (average) flow rates (equation 1) to maintain the lives, we also assume the (average) CO$_2$ air pressures do not change in the airways or alveoli, i.e.,

\[
J_n^{c-a}(CO_2) = J_f^{c-a}(CO_2) \tag{4}
\]

\[
P_n^{a}(CO_2) = P_f^{a}(CO_2) \tag{5}
\]

Therefore, from equations 2 - 5, we obtain,

\[
D_n^{c-a}(CO_2)\cdot [P_n^{c-a}(CO_2)-P_n^{a}(CO_2)]/|x_2-x_1|=-D_f^{c-a}(CO_2)\cdot [P_f^{c-a}(CO_2)-P_f^{a}(CO_2)]/|x_2^*-x_1^*| \tag{6}
\]

Because of the excess fats, we assume,

\[
D_n^{c-a}(CO_2) > D_f^{c-a}(CO_2) \tag{7}
\]

and

\[
|x_2^*-x_1^*| > |x_2-x_1| \tag{8}
\]

Therefore, to make the equation 6 valid, we must have,

\[
P_f^{a}(CO_2) > P_n^{a}(CO_2) \tag{9}
\]

In a perspective hemodynamics, our modeling (un)equations 2 - 9 qualitatively (formulaically) explain how or why CO$_2$ pressure increases in the blood vessels for OHS patients; and the thicker the abnormal fatty tissues or the lower the excess fatty diffusivity, the higher the CO$_2$ pressure in blood vessels and the more dangerous to human lives.
In the same way as that processing CO₂ diffusion from the capillaries to alveoli, we can obtain correspondent diffusion (un)equations of O₂ from alveoli (with and without excess fats) to the capillaries.

The (un)equations of O₂ and CO₂ have the same or similar forms. With the (un)equations of O₂, we can qualitatively (formulaically) explain how or why O₂ pressure decreasing in the blood vessels can enhance inhaling O₂ rates for OHS or obesity (overweight) and asthma patients as well as for normal exercising people; the thicker the excess fats or the lower the abnormal diffusivity, the lower the O₂ pressure in blood vessels and the more dangerous to human lives.

The mechanisms of that wearing face masks, air pollution and smoking make breathing difficult are the same as or similar to that of difficult breath for OHS or obesity (overweight) asthma patients. For OHS or obesity (overweight) asthma patients, the optimum treatment without any side effect is to reduce weight (excess fats)⁷ with the complete nutrition therapy.

We think, our modeling equations qualitatively (formulaically) explain how or why CO₂ and O₂ pressures respectively increase and decrease in the blood vessels for OHS and asthma patients as well as for normal exercising people; how or why the excess fats, air pollution and smoking make people breath hard; why some people, especially OHS and obesity (overweight) asthma patients, are not mandatory to wear face masks to prevent COVID-19 and other respiratory diseases; and how human lungs (capillaries and alveoli) control diffusions and pressures of CO₂ and O₂ in a perspective of hemodynamics or hematology.

If we assume the diffusion thickness of the excess fats as a negative value, we obtain modeling equations of lacking fats. Lack of the fats may be also harmful to people health by increasing risks of bleeding, thrombusis and (or) hemorrhage strokes.⁹,¹⁰ Therefore, we want the fats in our lungs as well as other organs (tissues) are neither excessive nor little, but optimum.

The CO₂ and O₂ Diffusions across Capillaries and Alveoli with Alveolar Clots, Fibrosis, Edema

COVID-19 invasion leads to immune cells, such as macrophages or neutrophils, injuring alveolus walls as well as killing the viruses.¹¹,¹² After containment of an injury, the tissue repair phase starts with removal of toxins and waste products. Clotting (coagulation) reduces blood loss from damaged blood vessels and forms a network of fibrin proteins that trap blood cells and bind the edges of the wound together. A scab forms when the clot dries, reducing the risk of infection. Sometimes a mixture of dead leukocytes and fluid called pus accumulates in the wound.¹⁶

The wounded alveolus walls may produce pulmonary hemorrhages, edema, clots, fibrosis, scabs and (or) thrombi. The fibrosis, scabs, edema or clots decrease the exchange of O₂ and CO₂ by decreasing the effective contact area between the alveoli and air, increasing the thickness or decreasing the diffusivity of the diffusion of O₂ and CO₂,¹² see (un)equations 1 - 9.

Additionally, thrombi, clots can increase the viscosity that can decrease flow rates of O₂ and CO₂ in blood vessels.¹² Therefore, it is more difficult for the patients to breathe because higher respiratory frequencies are required by the physiological systems to maintain their daily lives. All these dysfunctional factors can be reasons or answers how or why the death rates of COVID-19 patients with pulmonary blood clots or edema are so high.¹²,²³-²⁵

**PH, CO₂ and H₂O in Human Bicarbonate Buffer System and Kidney Functions**

Bicarbonate buffer system maintains our bodies’ homeostasis, the related chemical equation is,¹³

\[
\text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3 \rightleftharpoons \text{H}^+ + \text{HCO}_3^- \quad (10)
\]

The chemical equation 10 links the three human physiological systems: the respiratory, cardiovascular and urinary that are involved in COVID-19 directly. Lungs (capillaries and alveoli) control CO₂ and kidneys control HCO₃⁻ (bicarbonate) or H⁺.¹⁶ The chemical equation 10 also indicates a control of pH value in the blood.

• If pH is too high, carbonic acid will donate hydrogen ions (H⁺) and pH will drop.

• If pH is too low, bicarbonate will bond with hydrogen ions (H⁺) and pH will rise.

Too much CO₂ or too little HCO₃⁻ in human blood will cause acidosis.

Too much HCO₃⁻ or too little CO₂ in human blood will cause alkalosis. This condition is less common than acidosis. CO₂ can be lowered by hyperventilation.¹³

So, if you are going into respiratory acidosis chemical equation 10 will move to the right. The body’s H⁺ and CO₂ levels will rise and the pH will drop. To counteract this, the body will breathe more and release H⁺. In contrast, if you are going into respiratory alkalosis the equation will move to the left. The body’s H⁺ and CO₂ levels will fall and the pH will rise. So the body will try to breathe less to release HCO₃⁻¹.¹³
Therefore, our bodies have the negative feedback systems to manage our multiple physiological circulations.

Based on chemical equation 10, COVID-19, OHS or obesity (overweight) asthma patients are going into respiratory acidosis, i.e., they cannot normally transport CO₂ out as well as transport in O₂ of the bodies through human bloods. Therefore the concentration of body’s CO₂ or H⁺ goes high and the equation will move to the right to maintain their bodies’ homeostasis.

Also based on equation 10, H₂O plays a very important role in maintaining human bodies’ homeostasis with bicarbonate buffer system, because (many) H⁺, (little) HCO₃⁻ and other metabolic by-products or wastes dissolved in H₂O need to be excreted from kidney in the form of urine. The loss of H₂O in the urine or sweat has to be compensated enough, this is one of reasons why or how drinking more warm (boiled) water is very helpful to prevent or cure almost all of the (mild) respiratory diseases, such as COVID-19 and influenzas.

H₂O plays a very important role not only in the homeostasis maintain but also in the biological energy (ATP) metabolism and (or) OHS (overweight) preventions or treatments. Fats are storages of biological energies, to reduce weights (excess fats) means to reduce the stored energies, the chemical reaction equation is:

$$\text{ATP} + \text{H}_2\text{O} \rightarrow \text{ADP} + \text{P}$$

The equation 11 indicates drinking water is not only inhibiting hungry feelings but also enhancing the chemical reaction in nutrition therapy, i.e. speeding up weight loss by burning the excess fats.

Because SARS-CoV II (COVID-19) is correlated to multiple obesities or over weights related diseases, such as high blood pressure, heart disease, lung disease, diabetes and cancers, we strongly suggest to perform comprehensive (holistic) and systematic preventions of all of the diseases by maintaining normal body weight indexes with complete nutrition therapy without any side effect.

**DISCUSSIONS**

Increasing levels of CO₂ or decreasing levels of O₂ in the blood of asthma and OHS patients are similar to do exercise in a perspective view of hematological respiratory mechanism. This is one of reasons why we do not recommend patients with COVID-19 or any respiratory disease to do intensive exercises because of harder breathing.

The diffusion coefficients are proportional to the temperature, therefore, drinking (boiled) warm water, without side effects, can increase the gas diffusions, decrease the viscosity and dissolve the blood clots to increase the blood flow and transportations of all nutrients to prevent the diseases. Additionally, we felt drinking warm boiled water and (or) and keeping the laryngopharynx and larynx warm by wearing a scarf are very helpful to depress the coughing. The modeling results in this investigation are consistent to that in our previous study.

We believe, after OHS or obesity (overweight) asthma patients reduce their weights to normal ranges, they increase their willingness to correctly wear face masks.

**CONCLUSION**

To clinically prevent primary and secondary COVID-19 and other respiratory diseases without any side effect, we suggest people, especially for the patients with excess fats, to optimize the fatty amounts in the lower respiratory tracts by complete nutrition therapy. We think the body weight index (BWI) is a suitable daily measuring data for the fatty optimization because we have not found any data or method that the fats or lipids amount can be measured directly and daily between capillaries and alveoli in lungs.

To correctly wear face masks requires optimization of the status of the lower respiratory tracts too. To quit smoking and to reduce air and water pollutions are also key points of the comprehensive preventions of the respiratory diseases. If we systematically follow these guidelines to prevent the multiple diseases, we can get the maximum benefits with the minimum costs.

**ACKNOWLEDGEMENTS**

We thank Vivien Cheng (MPH Harvard School of Public Health) for her insights and advisory on paper comments; we thank Clinical Research in Hematology to invite us for publishing this research article. Submitted: 11/9/2021.

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