Pulse oximetry and 2 chair test in covid-19

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Monitoring a contact and a patient of covid-19 has turned a new challenge. These patients are often asymptomatic with low oxygen saturation in peripheral blood. The low SpO2 means low concentration of oxygen in the blood (hypoxemia) and it is derived from the underlying lung involvement by covid-19. The monitoring of the oxygen status is commonly done by a small instrument called pulse oximeter that has become almost a household article today. The instrument, measures the pulse rate and the peripheral arterial oxygen saturation or SpO2. Thanks to the media and social media to popularise this small instrument. Let us deal discuss a little the understanding of the application of pulse oximeter in relation to covid-19.

Pulse oximeter does not measure the oxygen content of blood:

Oxygen is transported from lungs via the left side of the heart through the arteries to the corners of the body where different tissues survive on the supply of oxygen. The oxygen been carried so far is unloaded there. This oxygen is used up in the tissues to form carbon-di-oxide which is loaded on the haemoglobin simultaneous to its unloading of oxygen. This CO2 carrying deoxygenated blood returns from the tissue to the lungs via venous system through the right side of the heart. In the lungs, the things happen just opposite to what occurs in the tissues. Here the CO2 is unloaded and is exhaled out. The free haemoglobin in the red blood cells picks up oxygen from inhaled air. Although a small part of the oxygen is dissolved in blood, the major share taken up by haemoglobin

The actual oxygen content of arterial blood (the actual load) depends on several things and the most important is the haemoglobin content. SaO2 or the oxygen saturation of arterial blood means the percent of haemoglobin saturated with oxygen. The percentage of saturation cannot predict the content. Let me explain it. Normally, the haemoglobin concentration in blood is 14 grams per 100 ml. If the haemoglobin level is halved (dropped by 50% to 7 gram/ 100ml), the content of oxygen carried to the tissue will also be reduced to half. But sSpO2 in both the cases will be same (say, 98 %). This is why an anaemic feels out of breath on a little exercise. There are other twists in the story too. The body regulates the unloading and loading in a very sophisticated way. The content of oxygen in blood is not linearly related to SpO2. So, a SpO2 of 90% or even above does not mean that there is no deficiency of oxygen at the tissues. Moreover, in chronic deficiency the body learns to manage with relatively low oxygen content in blood in real life. Hence, a 90 % SpO2 may not mean the same for two different persons; one may be very sick while the other may even greet the doctor “good morning sir”. Arterial blood gas (ABG) measurement can give a better idea of the status.

Lung disease, desaturation, and post exercise response in SpO2:

In lung diseases, the job of loading of haemoglobin with oxygen is affected and the SpO2 is influenced. The degree of lung affection and the demand of oxygen delivery influence the degree of loading. With more and more affection of the lungs, the effective units of lungs will be dysfunctional. So, they cannot load the haemoglobin fully with oxygen. So, there is reduction in oxygen content in the blood that comes out of lungs. Such blood with low oxygen content reaches the left heart and ejected through the arterial system. This arterial blood with partially saturated haemoglobin will show a reading of low SpO2 by pulse oximeter. If such a patient exercises a little, more oxygen than resting state will be extracted and the

venous blood will contain even lesser oxygen and more CO2 than resting state. The venous blood that returns from the tissue will carry more carbon-di-oxide and far less oxygen now. The diseases lung cannot compensate for this change well with its already reduced loading capacity. This will make the arterial oxygen even lower than before and the SpO2 or oxygen saturation will fall further especially immediately after exercise. So, immediate (a minute or two) post exercise SpO2 may reflect the degree of lung affection to some extent. The body will try to adjust it as best as possible depending on its capacity. This correction may take a longer time than normal. Thus, in covid-19 lung affection, the post exercise oxygen saturation will fall. This degree of reduction and the post exercise recovery pattern is a new area of research to understand the normal and different disease states.

We have evolved a new exercise test and published it last year. This simple test is known as 2-chair test and on performing the test on hundreds of patients we have got some idea how both the normal and the diseased persons behave in post exercise change as regards the SpO2 and pulse rates are concerned. The degree and duration of the fall of SpO2 (desaturation) that occurs immediately after exercise appears important and interesting to us. We think that the test may come in use greatly for the patients and suspects of covid-19.

How to perform the 2-chair test:

The 2-chair test was made with an intention to substitute 6 minutes walk test (6MWT). The 6MWT is a well established test where a person needs to walk up and down a 100 feet long corridor and we measure the distance walked and the SpO2 especially after exercise. This simple test is more popular in research than in clinical practice possibly because of the logistic issues concerned. The 2-chair test is far simple than 6MWT and it needs a little space, two chairs, and a pulse oximeter. First, the chairs ate placed face to face at distance of five feet (from front to front edges). The person to be tested sits on any of the chairs and his or her SpO2 is noted after a bit of rest when it stabilizes. The person now gets up to move to the other chair, sits on it to get up and return to the initial chair and sit again. This is regarded as one movement and the person needs to perform five such movements between the chairs continuously in his or her own pace. After five such movements the pulse rate and SpO2 are noted immediately on cessation of exercise and at every 10 seconds for 2 minutes. The minimum saturation and the maximum pulse rates give an idea of the degree of deviation from the baseline. The maximum fall of SpO2 is marked by “desat- max” and the maximum change in pulse rate is named “PR-difference max”. The desat-max in 2 Chair test can mean a lot for covid-19 patients. If unable the patient may stop in between or even stop the exercise. There contraindications to the test are almost the same as that applies to 6MWT.

Some use of 2-chair test in covid-19:

Let us now see how the desat-max can be useful in covid-19.

a) Normal SpO2 is variable from 95 to 99 % in adults and variability of 2 % between two different pulse oximeters is acceptable. So, a Spo2 of 95% at the first instance may be misinterpreted as abnormal. This, in covid-situation can lead to unnecessary tension and panic. The confusion may be settled by doing 2-chair test with the same pulse oximeter. The SpO2 will remain unchanged or may turn even a little better by one or two percent in normal health while a person with diseased lungs with show desaturation. Here, none needs to note that a covid-19 patient may be absolutely symptom free with a SpO2 of 95% or even a much lower SpO2. Doctors call them “happy

hypoxemic" although the gravity of the situation is same as symptomatic hypoxemia or lowering of SpO2.

b) The desat-max can act as a marker of severity and can guide the course of action in a particular patient by integrating the findings in the judgement algorithm of the treating physician. We are placing our own proposal here that needs modification through field research. This is meant for people without any existing lung disease

Resting saturation (SpO2)	**Desat-max in 2-chair test**	**Interpretation**	**Course of action**
≥95 %	None	Normal	Monitor daily with 2-chair test
	≥2%	Possible abnormality	* repeat the test after a few hours * Test RTPCR for SARS-COV-2 if there is history of contact
	≥3%	mild abnormally	*Contact your doctor and start whatever treatment is advised *A HRCT chest may be planned by your doctor *Monitor with 2-CT twice daily * be mentally prepared for worsening
≤95 % but ≥90%	≥3%	Mild abnormality	*Consult a doctor: start treatment *Get HRCT chest done, if RTPCR for covid-19 is negative / not available *Monitor with 2-CT twice / thrice daily *Practice prone positioning
	≥5%	Moderate abnormality	*Add oxygen on demand (during and after taking bath and alike, add nocturnal oxygen supplementation) *Inform your doctor for guidance for tests and treatment *Continue monitoring 2-CT twice/thrice daily *need closer observation and prepare for hospitalization *Practice prone positioning
	≥10%	Moderate or severe abnormality	* Consider hospitalization *Add continuous oxygen supplementation *Practice prone positioning
≤90 %	Do not test with out supervision and stand by oxygen support	Moderate or severe abnormality	*Check for degree of de-saturation on movemer of a few steps * continue oxygen supplementation to keep it above 90 % *practice prone position as far as possible *Consider hospitalization if beds available

c) This simple test has helped us a lot to assess the course of patients on recovery from lung involvement from covid-19. We are keeping that part out of our per-view of discussion now.

Saturation measurement is a part of the holistic assessment of covid-19. We have given an empirical scheme considering the real world situation of bed availability and oxygen supply. It needs to be modified with field research and also individualized for each particular by the treating physicians. The scheme applies to people with a presumed normal pre-morbid (before the attack of covid-19) state. Patients with lung diseases like COPD, long standing asthma, interstitial lung diseases, or any other fairly extensive lung or pleural abnormality (bronchiectasis, fibrosis, etc) will show variable but abnormal desaturation in 2-chair test. If such patients get lung involvement from covid-19, the effect on SpO2 will be aggravated. In covid-19, the change in the status needs to be followed over a length of time and the pace of the change varies widely depending on many known and unknown factors. People should act rationally and making panic will possibly make things more difficult to manage.

Referene:

Bhattacharyya P, Saha D, Paul M, et al. Two chair test: a substitute of 6 min walk test appear cardiopulmonary reserve specific. BMJ Open Resp Res 2020;7:e000447. doi:10.1136/ bmjresp-2019-000447

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