Discussion
13: DISCUSSION

Patients with COPD develop high ventilatory and metabolic output when they perform simple household activity in routine base. Impaired exercise tolerance is a prominent complaint of patients with obstructive lung disease. Unlike healthy subjects, patients with obstructive lung disease are often limited in their exercise tolerance by the level of ventilation they are able to sustain. Improving physical performance is an important therapeutic goal in COPD. Recent evidence suggests that muscle mitochondrial (oxidative) capacity is reduced and that may be the reason for the exercise intolerance in this population (104) (110) (101). One of the important factors that have an effect on exercise ventilation is CO2 production which is generated by aerobic metabolism and buffering of lactic acid, which is formed anaerobically when oxygen demand exceeds supply to exercising muscles (110).

Lactate production is a natural process and it is produced even at rest and it is removed also, but when the production rate is increased more than removal it accumulates. The removal of lactate is done by the heart, kidney, and liver and non-exercising muscle.

The increase in blood lactate level during the progressive exercise is the interest of many physician, clinician, sport trainers and many researchers in today new era. Lactate is the marker of peripheral muscle anaerobic metabolism and fatigue (111). The blood lactate response to exercise has interested physiologists for over many years, but has more recently become as routine a variable to measure in many exercise laboratories as is heart rate. This rising popularity is probably due to: a) the ease of sampling and improved accuracy afforded by recently developed micro-assay methods and/or automated lactate analyzers; and b) the predictive and evaluative power associated with the lactate response to exercise. Several studies suggest that the strong relationship between exercise performance and lactate-related variables can be
attributed to a reflection by lactate during exercise of not only the functional capacity but also the peripheral capacity of the musculature to utilize this oxygen\(^{(112)}\).

The precise mechanism by which blood-lactate accumulation occurs during exercise comprises many factors like the mass of exercising muscle, supply of oxygen to that muscle in blood, diffusion into cells, and the efficiency of utilization by those muscle cells\(^{(106)}\).

The production of more lactate is one of the primary factors for the limitation of the exercise performance in the COPD patients. Our result confirms that lactic acid production is increased as the level and stress of exercise is increasing, but there is no significant difference in increment level between COPD and control group with respect to the production and recovery of the lactate.

This study has some limitation like sample size which was limited due to nonavailability of co-operative patients, we have not categorized the severity of COPD patients and we did not compare the lactate production and recovery in different group of the COPD patients due to the smaller sample size. We did not measure the lactate production at the maximal cardiopulmonary exercise level as it was not the purpose of this study and could have resulted in discomfort to patients as this was pointed out by the ethical committee. In the current study the other parameters like blood pressure is measured only at rest and not immediately after exercise, after 15 and 30 minutes of an exercise as the primary concern was just to measure the rate of production and recovery of lactate with least discomfort to patients.

In present study the lactate production is more in the COPD patients, as in COPD patients the oxygen supply to the body is limited or reduced as compared to the other normal individual. During exercise as the oxygen supply is reduced the exercise shift towards the anaerobic metabolism and the end product of anaerobic metabolism is pyruvate.
which is converted into lactate and this is the reason of increase in the level of lactate in COPD patients compared to the normal individual. Glycogen breakdown during anaerobic metabolism leads to an accumulation of inorganic acid that is lactic acid, as lactic acid is a very strong acid it immediately gets converted into lactate and hydrogen ion which indirectly causes fatigue in many COPD patients and our findings are corroborating the study done by Hakan Westerblad in 2002 (113).

In COPD patients the increment in respiratory rate is more which leads to less time for the expiration and causes dynamic hyperinflation which is the main cause of respiratory discomfort and exercise limitation (114).

Katz and Sahlin postulate that lactate production is O₂ dependent. In fact they said that when O₂ supply is less or limited then mitochondrial respiration shifts by decreased ATP, Pi (inorganic phosphate) and the reduced form of NADH (nicotinamide adenine dinucleotide). This favors the stimulation of glycolysis, which will increases cytosolic NADH formation and shift the lactate dehydrogenase (LDH) equilibrium toward increase lactate production. They proposed that oxygen supply plays the most important factor in lactate production (115).

In 1996 F Maltais et al studied COPD subjects in which each subject performed a stepwise exercise test on an ergo cycle up to their maximum limit and they concluded that lactic acid rises steeply in COPD group and suggested that the activity of the oxidative enzymes (citrate synthase CS, and 3-hydroxyacyl CoA dehydrogenase HADH) was significantly lower in COPD than in control group so this study also supports our study results (13).
F Maltais et al in 1996 suggested that in COPD group compared to the normal group, the increment in lactate production is steep in COPD group; they said that reason for this is the activity of the oxidative enzymes is significantly lower in COPD groups than the control subjects. They did not find any difference in glycolytic enzymes. They concluded that oxidative capacity of the skeletal muscle is reduced, and increase in arterial lactate during exercise is excessive, and these both results are interrelated (13). This is also supporting our findings.

In present study the increase in heart rate, respiratory rate, and systolic blood pressure is the response of exercise in both the group. But resting heart rate and respiratory rate in COPD group is significantly higher than the control group. The reason for this is that the impairment in COPD brings to the pulmonary mechanism which can lead to the decreased venous return and ultimately leading to increased heart rate at rest, and because of this there is higher blood pressure at rest compared to the normal individuals. In this way COPD can affect the heart rate at rest also and this is a very important factor as it decreases the reserve heart rate available for any kind of exercise/efforts (103).

In present study results suggest that lactate is increasing in both the group significantly when they perform sub maximal level of exercise but the increment of lactate is more in the COPD group which suggests that COPD patient gets fatigue early and easily as lactate production is increased more than in the control group at sub maximal exercise level, this is very interesting as well as important as our routine day to day activity involves sub maximal exercise and that might be the reason that COPD patient either do not perform the routine activity or if they perform these activity they get fatigue very easily, which turns them into avoidance of these activity leading into deteriorations of their functional ability and capacity to perform the routine task.
The respiratory rate is more at rest in the COPD group than the control group, because the hydrogen ion which is produced by the dissociation of the lactic acid into lactate and hydrogen ion with the help of bicarbonate, and converts to produce CO₂ and this increases the load onto patient. Moreover the hydrogen ion itself is the stimulus for the ventilatory drive. Both the increased in CO₂ generated by buffering and the respiratory stimulation by the hydrogen ion are perceived by the patient as breathing stimuli which increases the respiratory rate (11).

The occurrence of metabolic acidosis in patients with COPD during exercise may be crucial for the designing the proper rehabilitation protocol. For example in patents who develop the metabolic acidosis, exercise training has the some potential to improve exercise tolerance. Reduction of metabolic acidosis translates into lesser ventilatory requirements and the same amounts of exercise can be performed with less ventilation, reducing the dyspnoea.

Immediately after an exercise there is more increment of heart rate in the COPD group than the control group which suggests that mild to moderate activity like in present study (sub maximal exercise). The explanation for this is as like how heart rate is more in COPD group at rest, same way the heart rate immediately after an exercise is more in COPD group. As the level of exercise increases the oxygen and other nutrient material are more required to the working muscle and in COPD group the oxygen supply is less because of the obstruction which is compensated by more increment in the heart rate compared to the control group after a sub maximal exercise.

The lactate level is not significantly different in both the group at resting level. The lactate level is increasing in both the group immediately after an exercise, 15 and 30 minutes of an exercise but the level of increment is higher in COPD group compared to the control group at the sub maximal level of exercise. We have not allowed any
person from both the group to reach at the maximal level of exercise as explained earlier. The level or stress of the exercise was measured by the PRE at each minute of the exercise and at end of 5 minutes the PRE of both the group was somewhat hard or a bit higher hard.

The reason why the sub maximal level of exercise was chosen is that routine activity (day to day activity) mostly occurs in the sub maximal level of stress and that is the reason to finding out the lactate level during sub maximal level of an exercise.

So the finding of lactate production in patients with COPD may prove to be useful in deciding whether to include exercise training as part of an individual’s rehabilitation program.