

## **Precision pulse oximeter, medical device Type IIB with Bluetooth to estimate peripheral oxygen saturation continuously during physical exercise, valid on dark skin**

### **Brief description**

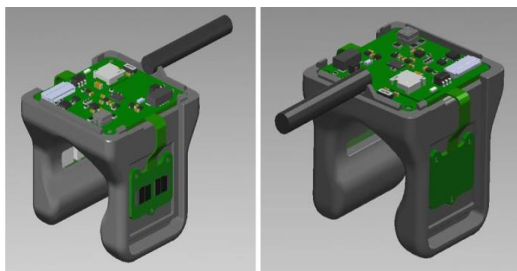
This technology based on pulse oximetry allows obtaining physiological parameters (heart rate and oxygen saturation) in real time and continuously, from the signals of the photoplethysmogram (PPG) obtained by the emission of several LEDs at different wavelengths.

The research group has developed a ring-shaped transmission pulse oximeter with Bluetooth, which is used to determine the heart rate and oxygen saturation continuously, from these photoplethysmographic signals (PPG) even in extreme situations, such as during continuous movements during physical exercise, in hypoxic situations, in people or athletes with darker skin color and in people with respiratory diseases with low oxygen saturation.



*Figure 1. Patient performing a stress test with an oximetric set.*

### **How does it work?**



*Figure 2. Finger pulse oximeter, design of the mechanical envelope and fit of the electronic hardware*

Pulse oximetry estimates continuous values of blood oxygen saturation (SpO<sub>2</sub>) and heart rate (HR) by analysing the photoplethysmogram (PPG), or pulse wave generated by each heartbeat. This technique analyses the pulsating signal generated by the variation in arterial blood flow with the pulse generated by each heartbeat. It is used continuously as a non-invasive technique in monitoring patients throughout the anesthesia and intensive care process, in the control of newborns, evaluation and follow-up of chronic and nocturnal pulmonary disorders, and in sports medicine.

Recent studies have shown that the use of classic red and infrared emitters underestimates the value of blood oxygen saturation, for levels below 70%, in movement and in people with high levels of melanin in the skin. The use of other wavelengths improves the measurement results at these levels as it allows these artefacts to be avoided. This problem is important in fetal monitoring, in sleep apnea studies, in people who perform physical effort, where these values are reached, and in dark-skinned people where commercial oximeters give underestimated values.

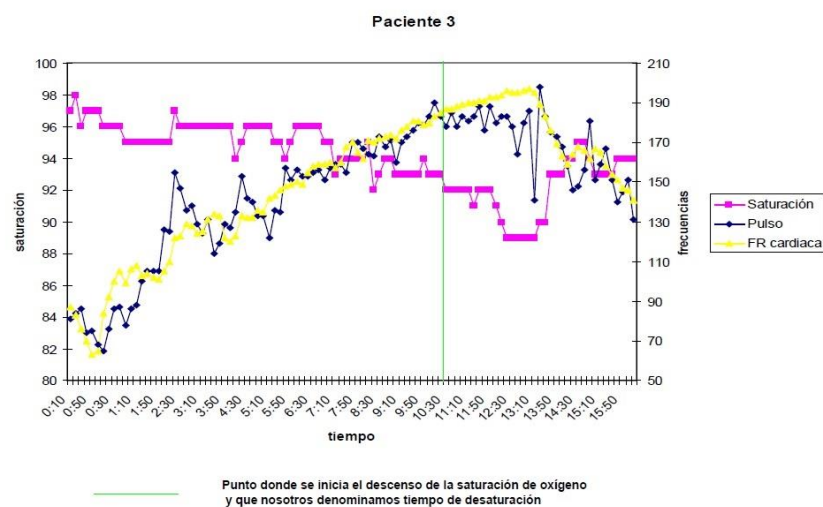
This technique, applied to the evaluation of the physical fitness of athletes and combined with ergometry, complements the stress test and constitutes an appropriate method for determining the limit of cardiopulmonary effort, characterized by a significant drop in arterial oxygen saturation. The study of the evolution of oxygen saturation at maximum effort using this type of oximeter together with the analysis of the correlation with ergo-spirometric variables in different sports allows the knowledge of the evolution of oxygen saturation during exercise as a parameter to improve sports performance. This can also be extrapolated and applied to the prescription of prescribed exercise in people with cardiopulmonary diseases.

## What problem does it solve?

Current marketed pulse oximetry products have many limitations and low accuracy because:

- They do not measure low oxygen saturation levels (<90%) generally observed in respiratory diseases.
- They do not measure well at high or higher heart rates (HR) (>150 bpm)
- They do not measure heart rate well during intense movements.
- Darker skin colors interfere with the accuracy of the measurement.
- Inability to continuously measure oxygen saturation: studies show that patients with respiratory diseases need continuous monitoring to monitor oxygen saturation values.

This system solves the accuracy problem of these commercial oximeters by obtaining data continuously and can be used during exercise and in respiratory and cardiovascular rehabilitation programs.



*Figure 3. Data obtained from the athlete performing the stress test and the oxygen saturation values obtained.*

## What future products will it develop?

This will be a new family of medical devices type IIb pulse oximeters, which will have as its main advantage the improvement of its precision and applicable to patients and people of any skin color, in movement and when they are in conditions of low hypoxia such as training in hypoxia, climbing high mountain climbs, training in fighter planes, etc.

## Competitive advantages compared to other research

1. Improved accuracy in measurements at low oxygen saturations.
2. Improved accuracy in measurements at high heart rates > 150 beats per minute (bpm).
3. Improved accuracy in measurements with intense movements, including with exercises performed by running at more than 16 km/h.
4. Improved accuracy in measurements with darker skin tones, where they clearly overestimate oxygen saturation values.
5. Continuous measurement during physical exercise to potentially detect sudden drops in oxygen saturation and useful in exercise prescription guidelines and to help in the rehabilitation of patients with lung and heart diseases.
6. Bluetooth connection avoiding movement limitations due to cable connections or other system of obtaining results (probes).



## **Where has it been developed?**

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This pulse oximeter is the result of many years of research carried out at the School of Medicine, Physical Education and Sport. Faculty of Medicine of the Complutense University of Madrid. The new pulse oximeter model designed to apply this methodology has been developed by a consolidated research group of the UCM 950056 - APPLICATION OF PULSE OXIMETRY IN SPORTS AND DIAGNOSTIC AID, this group has worked with Engineers and other researchers such as the Pulmonology Service of the San Carlos Clinical Hospital, the CSIC Microelectronics Institute, the Pontifical University of Comillas (ICA), and the Polytechnic University of Madrid. Currently, this research has led to the development of a technological start-up based in the Community of Madrid.

## **And moreover...**

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The potential clients could be segmented into three large groups:

### a.- Users who would use the device for medical purposes:

1. Exercise prescription for people with heart and respiratory problems (especially post-covid 19 sequelae). These people, once they have recovered from their illness, must exercise in a scheduled and precise manner and the use of these devices would be of great help, as a comprehensive follow-up of their subsequent rehabilitation, adaptation of the exercise to their pathology and as a tool to help with telemedicine.
2. Medical follow-up of patients with sleep apnea and other respiratory pathologies. It is increasingly necessary to have timely, precise monitoring in both resting and moving situations of people affected or suffering from respiratory processes that require special monitoring to choose a specific therapeutic option.

### b.- Users who would use the device for sports purposes:

1. Clients who can use the device for amateur and professional sports training, whose user volume has been increasing spectacularly in recent years.
2. Altitude training, Himalayan mountaineering. Hypoxia training. Monitoring the level of oxygenation (oxygen saturation) is extremely helpful for people or athletes who exercise at high altitudes above 5,000 meters. This monitoring of peripheral oxygen saturation helps us to know if oxygen supplementation is necessary at a certain altitude level or as a preventive element for the onset of altitude sickness.
3. Hypoxia training. More and more athletes are turning to this training system with the aim of improving their sports results. This training consists of training in hypoxic conditions in order to increase their red blood cells in a physiological way.

c.- Users who would use the device for professional purposes: In this case we are referring to its use in fighter planes where they need to implement precise oximeters that safeguard the safety of the pilot in fighter planes, having to fly in hypoxic conditions.

## **Researcher in charge**

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