ReOxy®

Innovative Solution for Sports Medicine
SRT® Technology
SRT® uses advanced software that reads and analyses information from a built-in pulse oximeter to adjust the supplied air mixture composition and session timing individually for each patient in response to changes in vital indicators, i.e. blood oxygen saturation (SpO2) and heart rate.

SRT®-technology relies upon the principle of biological feedback, where patients bodily reactions define therapeutic parameters and control them throughout the whole treatment session.

The main objectives to be achieved using the ReOxy® device are short and long-term adaptive responses at the whole body, system, tissue and cellular levels. These compensatory adaptive mechanisms have been scientifically proven to effectively treat cardiovascular and metabolic diseases. ReOxy® uses Self Regulated Treatment (SRT®) technology.

ReOxy® is CE-marked, approved and intended for improvement of physical exercise capacity in coronary artery disease patients.

ReOxy® is... innovative breathing therapy medical device which treats a patient with individually selected reduced-oxygen (hypoxic) gas mixtures adjusted in real time during the procedure.

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ReOxy® purpose
- Interval Hypoxic Treatment in the “Hypoxia - Hyperoxia” mode (IHHT®) based on SRT® technology
- Hypoxic Preconditioning
- Hypoxic Functional Test

Interval Hypoxic Treatment
Interval Hypoxic Treatment (IHT) consists of repeated short-term hypoxia (9-15% O2), interrupted by brief periods of recovery. These periods of recovery could be either normoxic (21% O2, Hypoxia-Normoxia mode), or hyperoxic (30-35% O2, Hypoxia-Hyperoxia mode). Typical treatment course comprises 10-15 sessions.

The Advantages of Unique IHHT® Modality
- increase in the amplitude of the treatment factor, without more intense hypoxia (higher efficacy)
- shortening recovery periods and the procedure and total course duration

Hypoxic preconditioning
Hypoxic preconditioning refers to exposure of the body, its systems, organs, tissues and cells to moderate hypoxia resulting in increased resistance to disease-related episodes of severe hypoxia. It mobilizes evolutionary acquired, genetically determined stress defense mechanisms.

This process involves activation of multiple intracellular components including receptors, mitochondrial respiratory chain, key intracellular regulatory systems, early genes, superfamilies of the inducible and constitutively active transcription factors.
IHHT® benefits

• a method based on more than 10 years of research and clinical trials
• a non-pharmaceutical treatment with minimal side-effects
• a unique solution for elderly/senior patients and patients with reduced physical abilities

IHHT application for Sports Medicine and Rehabilitation

• Rehabilitation of athletes with overtraining syndrome [5]
• Recovery after injury [1, 8, 15]
• Cardioprotection from physical overloads, acute ischemia [2, 5, 6]
• Increase in professional longevity (prevention of stress-associated diseases such as arterial hypertension, ischemic heart disease, myocardial infarction, stroke)[2, 6, 11, 13, 18]
• Adaptation to altitude training due to shortened acclimatization period [19]
• Adaptation to intensive physical loads [5, 16]
• Improved resistance to different stress types including emotional loads and competitive stress [5, 16, 17, 20]

IHHT mechanisms:

• Direct influence of Hypoxia Inducible Factors (HIFs) on O2 transportation and utilization mechanisms (hypoxic component)
• Indirect influence of Reactive Oxygen Species produced in reoxygenation phase (stress component)
• Phenomenon of hypoxic preconditioning (adaptation component)

Physiological effects:

• Improves physical exercise capacity [2, 3, 4, 6, 10, 22]
• Improves microcirculation [6, 9, 16, 17, 18, 19]
• Reduces endothelial dysfunction [16, 17, 19]
• Decreases blood pressure [6, 18]
• Increases myocardium and brain resistance to acute ischemia [16, 17, 19]
• Reduces negative consequences of systemic oxidative stress [5, 11, 16, 17, 19, 20]
• Improves respiratory function, increases ventilatory response [1, 8, 13, 19, 20]
• Reduces metabolic markers, such as cholesterol and low density lipids [7, 11, 13]
• Modulates somatic motor function [1, 8, 15]

ReOxy® Treatment

• Interval Hypoxic Hyperoxic Treatment parameters are determined after a preliminary assessment of patient’s ability to adapt to hypoxic gas mixtures, by doing the hypoxic test.
• Built-in intelligent software automatically identifies and suggests key treatment parameters for individual treatment programme, initially based on the results of the hypoxic test. Intensity of treatment parameters varies within the pre-set safety limits throughout every procedure.
• At the end of each test, procedure and treatment course ReOxy generates a summary report in pdf.
Blending and supply of gas mixtures
- gas mixtures supplied:
  - hypoxic (10-14% O2)
  - hyperoxic (30-40% O2)
- automatic switching of gas flows (SRT-Technology)
- automatic flow volume regulation

Multi-level safety system
- automatic identification of the maximal treatment efficiency zone
- automatic switch between gas flows when reaching maximal and minimal threshold values
- manual gas flows switch
- integrated safety valve (automatic supply of ambient air)
- alarm signals (acoustic and visual warnings)

Built-in Pre-Treatment Test
- hypoxic test
  Evaluates individual tolerance to hypoxia and determines individual parameters for further treatment procedures
- automatic analysis of test results
- automatic calculation of individual feedback parameters

Intelligent Control System
- individually-programmed operating modes
- monitoring of heart rate and blood oxygen saturation
- maintenance of patient database for data export and further statistical analysis
- possibilities for updating built-in software

Colour Control Display
- wide viewing angle and high contrast
- mode indication (hyperoxic / hypoxic)

ReOxy® Button
- manual gas flow switch

ReOxy benefits
- More than 10 years of research in IHT clinical applications
- SRT-technology: Individual Treatment Programme and Control
- Unique patented built-in software algorithms
- Hypoxia-Hyperoxia mode: improved treatment factor amplitude with reduced possible side effects
- Fully automated procedure, easy to operate
- Built-in pulse oximeter for real-time treatment parameters control
- Patient safety (multi-level controls, physiological and technical alarms)
- Compact, mobile, autonomous (no need for a specially equipped room)
Select or add a patient to the patient & procedure database management system.

Confirm the calculated procedure parameters and alarm limits. Put on the sensor and mask.

During the procedure, ReOxy® monitors SpO2, PR and O2.
The procedure lasts for 30-60 min.

Remove the mask and sensor. Evaluate the automatically generated procedure report.

- Sensory Multifunctional Display
  - simple, user-friendly interface

- On-screen Multi-language Keyboard

- USB Port
  - data export: medical and technical reports

- Hinge Joint
  - reliable fixation in the most convenient position

- Pulse Oximetry Sensor
  - reliable reading and fast signal processing

- Antibacterial Filter

- Breathing Circuit

Procedure Report PDF

Trends

- cO2 - Oxygen concentration supplied to a patient via mask
- SpO2 - Individual SpO2 reaction to O2 concentration changes
- PR - Individual pulse rate reaction to O2 concentration changes
Compensatory mechanisms of adaptive responses to interval hypoxia

Adaptation to low oxygen tension (hypoxia) in cells and tissues leads to the transcriptional induction of a series of genes that participate in angiogenesis, iron metabolism, glucose metabolism, and cell proliferation/survival. The primary factor mediating this response is the hypoxia-inducible factor-1 (HIF-1), an oxygen-sensitive transcriptional activator [17]. Ischemic diseases such as stroke and heart attack are caused by localized hypoxia manifested as cerebral and myocardial ischemia, respectively. Increase of the VEGF expression by HIF-1 or HIF-2 could induce formation of new blood vessels of the target area in the brain and heart, thereby providing increased blood flow and oxygen supply, and reducing harmful effects of ischemia [20].

Restoration of endothelial function and increase in nitric oxide synthesis [18], as well as development of HIF-1 mediated hypoxia tolerance of myocardium are the most likely mechanisms behind beneficial IHHT effects in CAD. Together with the heart rate decrease reported in both patient and healthy elderly populations, and the relevant metabolic effects (such as lowering LDL, triglycerides and cholesterol) [2, 22], these changes are likely to contribute to lowering frequency of angina attacks.

Anti-hypertensive IHT mechanisms include hypoxic stimulation of endothelial NO production, which causes vasodilation and opening of reserve capillaries [19].

Repeated intermittent systemic exposure to hypoxia, a treatment known as intermittent hypoxic training (IHT), has been shown to enhance exercise capacity and performance in endurance athletes [4], by trigerring hematological and non-hematological adaptations [9], and to improve cardiopulmonary efficiency and running economy in athletes [10, 3]. Also, exposure to hypoxia alternated with periods of exposure to normoxia (IHT) has been found to be efficacious in coronary artery disease and chronic obstructive pulmonary disease in patients by increasing their tolerance to physical exertion without exercising [2] and improving autonomic cardiovascular control [14]. Based on this findings, a new form of hypoxia exposure (Intermittent Hypoxia-Hyperoxia Training, IHHT), featuring recovery periods consisting of breathing a hyperoxic gas mixture, has been recently introduced and tested in a study aimed at enhancing exercise tolerance and re-balancing ANS in patients with coronary artery disease [6]. This new approach has been designed taking into consideration that breathing a hyperoxic gas mixture allows quicker oxygen saturation after being exposed to hypoxia, potentially reducing the time of the hypoxic–hyperoxic exposure cycle. At the same time, animal model studies demonstrated that replacing normoxia by hyperoxia within a cycle of hypoxia exposure creates a stronger stimulus to enhance reactive oxygen species signalling, so this form of exposure results in higher resistance of membrane structures and improved antioxidant capacity [20]; this aspect could be relevant in OTS athletes in the light of a recently published study showing that oxidative stress resistance and antioxidant capacity are critical for these athletes.
Safety

To our knowledge, there weren’t a single case of a patient abandoning IHHT trials due to side effects development. Minor side effects observed during IHHT studies, such as dizziness, mild sedation, shortness of breath, or brief limited blood pressure rise, were noted in a few patients only. These negative sensations and adverse effects quickly disappeared after a small increase in the supplied O2 concentration.

Short-term hypoxic exposures did not provoke angina attacks in CAD patients with myocardial infarction in the past, and were well tolerated even by senior (65 to 75-year-old) individuals [22].

No significant side effects specific to hypoxia-hyperoxia combination have been reported so far [5, 6].

It should be noted that all hypoxia-hyperoxia mode studies reviewed have been done employing ReOxy.

Risk analysis performed for patients with CVD has not revealed any reported serious ReOxy device-related adverse effects. The following non-serious ReOxy-related side effects have been reported:

- 6 cases of chest discomfort during the procedure which have resolved on their own and with no ECG deviations observed out of 584 procedures performed [5],
- 4 cases of mild headache and 2 of mild dizziness which have resolved on their own out of 584 procedures [5],
- transient mild blood pressure elevation above patient’s normal levels have been reported in 1 out of 35 patients in a single published studyy [22],
- Transient moderate heart rate elevation from the initial baseline level during the IHT procedure as a common adaptational reaction to hypoxia.

References:


## Technical data

<table>
<thead>
<tr>
<th>Model</th>
<th>60-1001</th>
<th>60-2001</th>
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<tbody>
<tr>
<td><strong>O₂ concentration, hypoxic gas mixture</strong></td>
<td>10-14%</td>
<td>10-14%</td>
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<tr>
<td><strong>O₂ concentration, hyperoxic gas mixture</strong></td>
<td>30-40%</td>
<td>30-40%</td>
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<tr>
<td><strong>Capacity</strong></td>
<td>not less than 25 litres/minute</td>
<td>not less than 25 litres/minute</td>
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<tr>
<td><strong>Gas flows switching</strong></td>
<td>- automatic mode SRT&lt;br&gt;- manual mode</td>
<td>- automatic mode SRT&lt;br&gt;- manual mode</td>
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<tr>
<td><strong>Length of treatment</strong></td>
<td>30-60 minutes</td>
<td>30-60 minutes</td>
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<td><strong>Monitored parameters</strong></td>
<td>Pulse, SpO₂, O₂</td>
<td>Pulse, SpO₂, O₂</td>
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<tr>
<td><strong>SpO₂ measurement range</strong></td>
<td>1-100%</td>
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<tr>
<td><strong>SpO₂ accuracy of measurement</strong></td>
<td>70-100% +/-2%, 0-69% +/-3%</td>
<td>70-100% +/-2%, 0-69% +/-3%</td>
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<tr>
<td><strong>HR measurement range and accuracy</strong></td>
<td>25-240 +/-3%</td>
<td>25-240 +/-3%</td>
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<td><strong>EU pulse oximeter standards</strong></td>
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<td>EN 60601-1, EN 60601-1-4, EN 865, EN 475</td>
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<tr>
<td><strong>Alarm signals</strong></td>
<td>SpO₂, HR, sensor, power (acoustic and visual warnings)</td>
<td>SpO₂, HR, sensor, power (acoustic and visual warnings)</td>
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<tr>
<td><strong>Data interface</strong></td>
<td>- 6” built-in colour multifunctional display</td>
<td>- 6” built-in colour multifunctional display&lt;br&gt;- 15” touch-screen colour display</td>
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<tr>
<td><strong>Saving and exporting data</strong></td>
<td>n/a</td>
<td>- internal memory&lt;br&gt;- USB port</td>
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<td><strong>Output pressure</strong></td>
<td>&lt; 2 kPa</td>
<td>&lt; 2 kPa</td>
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<td><strong>Noise level</strong></td>
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<td>&lt; 50 dB</td>
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<tr>
<td><strong>Dimensions (H x L x W)</strong></td>
<td>90 x 70 x 50 cm</td>
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<td><strong>Weight</strong></td>
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<tr>
<td><strong>Manufacturer’s warranty</strong></td>
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<td><strong>Dedicated patient kits</strong></td>
<td>Single-patient breathing circuit (2 sizes)</td>
<td>Single-patient breathing circuit (2 sizes)</td>
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<td>ReOxy 60-1001, patient kits, pulse oximetry sensor</td>
<td>ReOxy 60-2001, patient kits, pulse oximetry sensor</td>
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### Design

**Designed by**

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