

Hyperbaric Oxygenation Therapy (HBOT)
*A good possibility in Neurorehabilitation
but not accepted enough and generally used*

F. Gerstenbrand¹⁾, M. Banikova²⁾, St. Golaszewski^{1),3)}, A. Kunz³⁾
¹⁾ Karl Landsteiner Institut für Neurorehabilitation und Raumfahrtneurologie, Wien
²⁾ Adeli Medical Center, Piastany, Slowakei
³⁾ Neurological Department of Christian Doppler University, Salzburg

Danube Lecture

11th Danube Teaching Course
Kazimierz Dolny, May 13 – 15, 2015

Neurorehabilitation, basic program
Restoration of the disturbed brain functions

- Rebuilding of the damaged neural network (post acute phase)
- Activation of the rebuilt neural network (HBOT)
- Reactivation of the neural network, rehabilitation program, (stimulation of proprioception)
- Special reactivation of neural network, (individual neurorehabilitation program)

Activation of cortical network
pressurized oxygen

- Reactivating of idling neurons
- Improving of oxygen cell respiration
- Restoring of blood brain barrier and cell membranes
- Promotion of neovascularization
- Acting as scavenger of free radicals
- Stimulation of the adaptive immune system

Neuro-Rehabilitation Methods
stimulation of the proprioception



ADELI SYSTEM

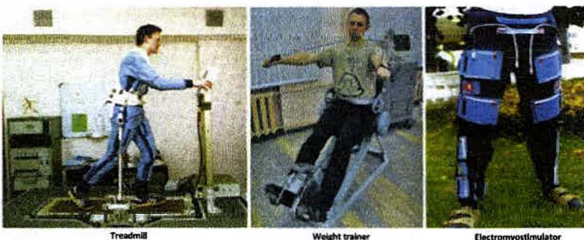
- Cerebral palsy
- Traumatic Brain Deficits
- Stroke
- Apallic Syndrome
- Vertebral Spine Decompensation Syndrome
- Parkinson's Syndrome
- Dementia



Source: ADELI Flyer

Source: ADELI Flyer

Reactivation of specialized cortical network
Stimulation with proprioceptive methods
Prevention methods during space flights



Treadmill

Weight trainer

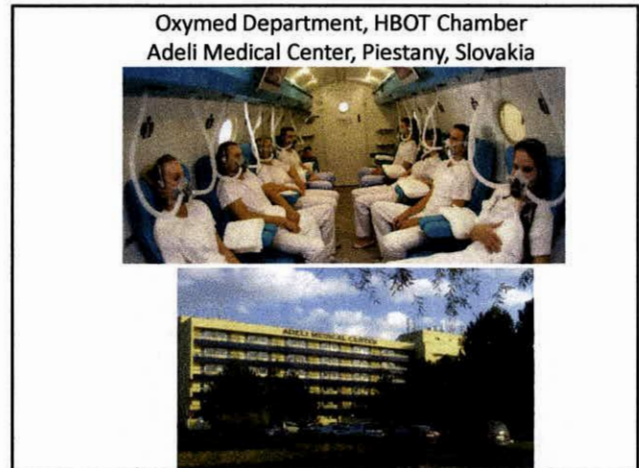
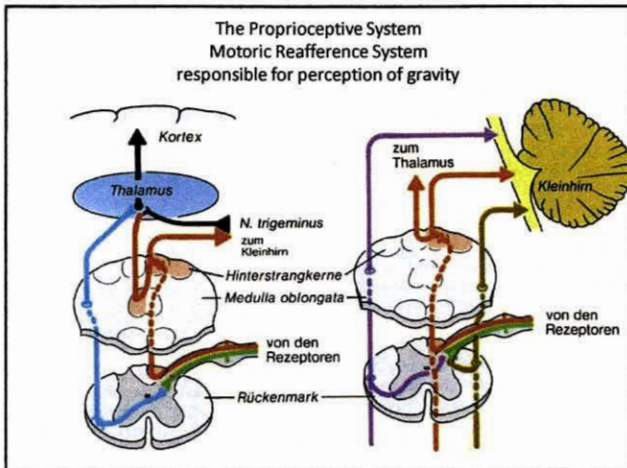
Electromyostimulator

Methods transferred to neurorehabilitation in:

Spasticity, Cerebellar Disturbances, Parkinson's Disease, Polyneuropathy,
Dementia, Geriatrics,
Wellness training

**Combination program of stimulation of proprioception
and HBOT in cerebral palsy**
Adeli Medical Center Piastany





The pressurized environment
is not new

The first recorded use in history was
a diving bell Alexander the Great
used in the siege of Tyrus in 332 BC.

Oxygen was discovered
by Priestly 1774

- He warned that increased pressure may be toxic
- This held the field back for many years

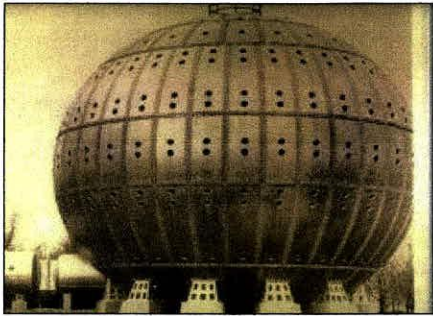
1920s – 30s

Remarkable clinical results
were obtained by
Orville Cunningham,
Professor of Anesthesia,
University of Kansas

1928

The six stories stainless steel
Domicilium
was erected for Cunningham by
Timken Ball Bearing Company
in Cleveland

Cunningham's Domicilium



Pressurized O₂ adheres to all gas laws of physics

Henry's Law states there is a direct relationship between pressure and the amount of gas dissolved in solutes

Under hyperbaric condition oxygen is increased in:

- bone
- urine
- plasma
- lymph
- and most importantly in the cerebrospinal fluid

Under pressure free molecular oxygen is delivered directly to the cell for immediate metabolic use without energy exchange.

Edward Teller, Ph.D.

Dose equals

- Strength of pressure
- Time (length) of exposure
- Frequency
- Total number of treatments

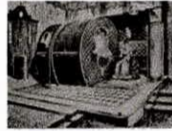
How is it administered - Pressure Vessel

- Multiplace chamber
- Monoplace chamber
- Low pressure portable chamber

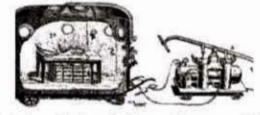
Types of pressure chamber

- Multiplace Chamber
- Monoplace Chamber
- Low Pressure Portable Chamber

History of Hyperbaric Oxygenation Chamber Oxymed Department Adeli Center Piestany



"The Domicilium" from 1862



Fontaine's mobile hyperbaric operating room - 1879

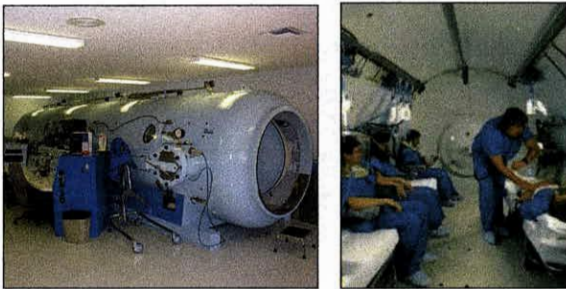


Cunningham's hyperbaric chamber
In Cleveland - 1928



12-seat hyperbaric chamber
HAUX STARMED 2200 / 5.5 / XL -
2014 Oxymed Center, Piestany

Multiplace Chamber



Monoplace Chamber



Hyperbaric Oxygenation Treatment Administration

- Hyperbaric Oxygen Therapy is using 100% Oxygen at a greater pressure than in atmosphere
- 20 – 60 sessions are recommended (for insurance)
- Some patients are needing 100 sessions and more depending from the diagnosis
- Duration of one session 60 to 90 minutes

Effects of Pressurized Oxygen in Acute Brain Insult - 1

- Reduces adhesion of WBCs (white blood cells) to endothelium
- Perfuses all tissue spaces
- Life sustaining O₂ available via retrograde perfusion in absence of a trickle phenomena
- Delivers metabolically available O₂ without chemical energy transfer – *enough to sustain life without blood*

Effects of Pressurized Oxygen in Acute Brain Insult - 2

- Under pressure, O₂ adheres to all the gas laws of physics
- Displaces all other gases in the body:
 - N₂, CO
- Follows the law of mass action
- Completely saturates hemoglobin
- Increases plasma O₂ by 2000%
- Dissolves in cerebrospinal fluid, lymph, bone and urine

Effects of Pressurized Oxygen in Acute Brain Insult - 3

- Reduces cerebral edema & ICP
- Limits the ischemic cascade
- Reduces CNS lactate peak in hypoxia
- Neutralizes toxic amines
- Disaggregation of platelets
- Increases Phagocytic activity of PMN cells (white blood cells)

Effects of Pressurized Oxygen in Chronic Brain Insult - 1

- Reactivates idling neurons
- Enhances plasticity
- Efficiently elevates diffusional driving force for O₂, thereby increasing tissue oxygen availability
- Promotes phagocytosis (internal debridement)
- Ameliorates multiple biochemical changes

Effects of Pressurized Oxygen in Chronic Brain Insult - 2

- Restores the integrity of the blood brain barrier and cell membranes
- Improves cell respiration, reduces cell byproducts – cytokines
- Promotes neovascularization
- Promotes epithelization

Effects of Pressurized Oxygen in Chronic Brain Insult - 3

- Acts as scavenger of free radicals
- Bacteriostatic effects, synergizes with certain antibiotics
- Neutralizes certain toxins: clostridium, anaerobes
- Stimulates the adaptive immune system, especially in elderly (mice)

Influence on certain drugs

HBOT may enhance the effectiveness of certain drugs and extend the longevity of the product

Application in Neurology (1)

Acute neurological conditions:

Stroke, traumatic brain injury (TBI), encephalitis, spinal cord injury

Progredient neurological diseases:

Alzheimer dementia, ALS, MS, vascular dementia

Chronic neurological conditions:

CP, apallic syndrome, traumatic brain deficit, spinal cord lesion

Application in Neurology (2)

- Acute Intoxication:
CO-intoxication
- Decompression:
diving accidents, air embolism
- Radiation accident

Cochrane Recommendations for HBOT

- Traumatic Brain Injury – Artru (1976), Holbach (1974), Rockswold (1992), Ren (2001)
- Neonatal hypoxic encephalopathy – Hutchinson (1966), Liu (2006)
- Cerebral Palsy – Machado (1989), Montgomery (1999), Packard (2000), Collet (2001), Mathai (2005)

Own experiences in Apallic Syndrome

Common project with HBOT Center

Fort Lauderdale (USA)

Dr. Richard Neubauer

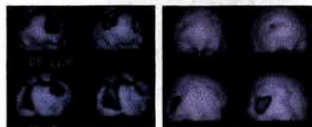
Case M. J.

MJ, 31^a, male, AS, CO-intoxication, attempted suicide, remission state II-III during 12 years

HBOT: 60 sessions
HBO home treatment: 350 sessions
1,5 ATA

Additional:
physiotherapy
logopedics

Significant improvement
minimal cognitive defects,
spastic signs



Case J. N.

JN, 21^a, male, AS, traumatic remission stage II-III
HBOT: 64 sessions
1.5 – 1.75 ATA

Additional treatment:
physiotherapy

Significant improvement
Light defect symptoms:
cerebellar, spastic symptoms,
speech disturbances (pseudo-bulbar), cognitive deficits



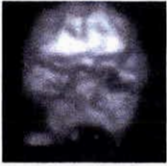
SPECT:
Significant improvement
of perfusion

Case M. A. B.



MAB, 89a, female, AS, traumatic, full stage

HBOT: 38 sessions,
1.1 ATA (1 hour each session)
Treatment stopped because disallowed



One week after start improvement:
spasticity and encephalopathy reduced,
mobilization possible, walking with help,
speech understandable

SPECT

Significant improvement
of perfusion

Improvement to significant amelioration
of quality of life with good contact to
surrounding and less demand of nursing
care.
Mild encephalopathy as rest state.

HBOT in Apallic Syndrome

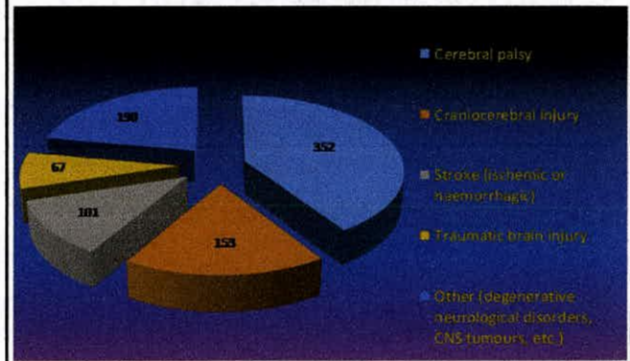
- in full stage
→ as early as possible
- in remission stage with temporary interruption state II-III
→ after 3 months
- in later remission stages and in defect stage without
sufficient result of running rehabilitation
→ in any case

Continuation of classic treatment and consequent
neurorehabilitation program

Clinical effects Apallic Syndrome and HBO-treatment:

Full stage:	reorganization of cortical connections to brain stem centers supported by the activation of reticular system
Remission stage:	Revitalization of the cortical network (idling neurons) Revitalization of damaged axons
Defect stage:	Reactivation of dendrite system

Presentation of patients treated at Adeli Medical Center Piestany 2011-2013



Future aspects of HBOT in Neurology

- **Acute conditions:**
 - traumatic brain injury, stroke, encephalitis, spinal cord injury, neonatal hypoxic encephalopathy
- **Progredient conditions:**
 - MS, progredient dementia of different origin, ALS
- **Chronic states:**
 - Cerebral palsy
 - Apallic syndrome
 - Hypoxic encephalopathy
 - Vascular dementia, mixed dementia
 - Alzheimer dementia
 - Traumatic spinal cord lesions

3. Summary of the 11th International Danube Teaching Course in Kazimierz (by Professor Konrad Rejdak, MD, PhD)

11th International Danube Teaching Course took place on 13-15 May 2015 in Kazimierz Dolny – historical centre of medieval culture of Poland.

The meeting was organised under the auspices of the International Danube Symposium for Continuing Education in Neurological Sciences, Department of Neurology Medical University of Lublin (Head: Prof dr K. Rejdak) and Lublin Branch of Polish Neurological Society (Prof dr Z. Stelmasiak).

The scientific programme focused on the newest aspects of multiple sclerosis, epilepsy, headache and child neurology but also included the special session on stem cell therapy. The highest educative and scientific level of this conference was guaranteed by the attendance of many internationally recognised experts and scientists from the country and abroad including prof. F. Gerstenbrandt, prof. A. Korczyn, prof. G. Bauer, prof. P. Sorensen, prof. I. Blatt, prof M. Brazdil and others.

There were 7 Danube Lectures: by

Prof. F. Gerstenbrandt – Hyperbaric Oxygenation Therapy - a good possibility in neurorehabilitation, but not enough accepted and generally used

Prof. A. Korczyn – Medically unexplained symptoms

Prof. A. Słowik – Asymptomatic Carotid Artery Disease Update: Surgery, Stent or Watchful Waiting?

Prof. K. Selmaj – Future trend in MS therapy – the rule of generic drugs

Prof. P. S. Sørensen – Neutralizing antibodies to biological MS therapies

Prof. G. Bauer – Locked-in syndrome and related conditions

Prof. I. Blatt – Status Epilepticus

Prof. M. Brázdil – Epileptic seizures arising from the anterior cingulate cortex

Moreover the program included 6 scientific sessions: neuroprotection (3 lectures), multiple sclerosis (6 lectures), stroke and ultrasound examination (5 lectures), child neurology (3 lectures) and epilepsy (9 lectures).

The meeting was very successful with around 450 participants including students and residents who were given a free admission to the scientific part of the meeting.



Photo: (from left) dr Szczepanska-Szerej, prof. K. Rejdak, prof. F. Gerstenbrandt, prof A. Korczyn, prof. Z. Stelmasiak, prof. P. Nowacki, prof. K. Mitosek-Szewczyk



International Danube Symposium
for Neurological Sciences and Continuing Education

Lublin Branch of Polish Neurological Society

Department of Neurology
Medical University of Lublin

XI Międzynarodowe Warsztaty Szkoleniowo-Naukowe

PROGRAM
FINAL PROGRAMME



11th Danube Teaching Course

13 - 15 czerwca 2015, Kazimierz Dolny

www.danube2015.skolamed.pl