


**Karl Landsteiner Institute**  
 for Neurorehabilitation  
 and Space Neurology

Austrian Society for  
 Aerospace Medicine  
 Life Sciences in  
 Space



**Space Neurology and its benefit for  
 Neurorehabilitation**

F. Gerstenbrand<sup>1),2),3)</sup>, Vienna  
 W. Struhal<sup>4)</sup>, Linz,

<sup>1)</sup> Department for Neurology, University of Innsbruck  
<sup>2)</sup> President Austrian Society for Aerospace Medicine, Vienna  
<sup>3)</sup> Karl Landsteiner Institute for Neurorehabilitation and Space Neurology, Vienna  
<sup>4)</sup> Department for Neurology, General Hospital of Linz

9<sup>th</sup> MHAA Conference  
 Neurological Workshop

November 21-24, 2009  
 Yangon, Myanmar

### Research in Space, Real Microgravity Basic Factors

- Influence of microgravity on human beings, animals, plants and biological material
- Radiation effects in space on biological and technological material
- Influence to psychosocial factors
- Technological development of equipment for human beings during space flight
- Communication system between control center and crew

### Construction of a Control System for the Orbit Station

*„Our job is not only to  
 make sure astronauts  
 can function  
 adequately in space,  
 but also that they can  
 function on their return  
 to earth.”*

(Frank Sulzmann)



Source: G. Gerstenbrand

### Space Medicine Influence of Microgravity

- Research in biomedical problems
  - space neurology
  - cardio-vascular alterations
  - immunology, infection and hematology
  - human performance factors, sleep and chronobiology
  - nutrition and digestion
- Development of new medical devices for counter measure during space missions

### History of Space Medicine 1

- Take-over of experiences in aviation medicine
- Research in training centrifuge
- Research in rocket sledge
- First Department for Space Medicine in Randolphville, TX, USA
- Institute for Biomedical Problems (IBMP), Moscow, Russia
- Animal experiments in the orbit (IBMP Moscow – Laika, first dog in space)



Laika, Nov 3<sup>rd</sup>, 1957



„Ham the Astrochimp“, Jan 31<sup>st</sup>, 1962

## History of Space Medicine 2

- April 12<sup>th</sup>, 1961 - Yuri A. Gagarin  
first manned space flight, space capsule Wostok 1
- May 5<sup>th</sup>, 1961- A. Shepard  
first American in space,
- March 18<sup>th</sup>, 1965 - Alexei Leonov  
first space walk
- July 16<sup>th</sup>, 1969 - first moon landing
- July 20<sup>th</sup>, 1969 - Neil Armstrong,  
first moon walk
- Feb 20<sup>nd</sup>, 1986 - start of space station MIR (base module)
- Nov 20<sup>nd</sup>, 1989 - start of construction of ISS - first module SARJA
- Manned Mission to Mars, in preparation



MIR in space,  
destroyed March 23<sup>rd</sup> 2001

Launch of Soyuz TMA-5



011407200

International Space Station (ISS) used by Americans, Russians, Europeans

## Surface of Mars



Northpole of Mars, ice on polar cap, NASA

Twinpeaks, photographed by  
Pathfinder Lander, 1997,  
NASA



## Space life at MIR



Austrian cosmonaut Franz Viehböck with  
Russian crew at MIR

## Space life at MIR



Cosmonauts at MIR in  
free time



"Lunch-time"

### Counter Measures in Real Microgravity

- Treadmill exercises
  - Daily fixed program
- Special exercises legs and arms
- Adaptation of fine motor skills
  - Target training
- Adaptation training of cognitive functions
- Electrode trousers
- Penguin suit

### Counter Measures in Real Microgravity



Cosmonauts at MIR in training

### Counter Measures Real Microgravity



Cosmonauts counter measure: Electrode trousers: stimulation of muscle receptors



Penguin-Suit, carried over hours per day. Every movement has to be carried against resistance of the suit.

### Research in Microgravity

- Real microgravity
- Parable flight
- Simulated microgravity
  - Ground based laboratory

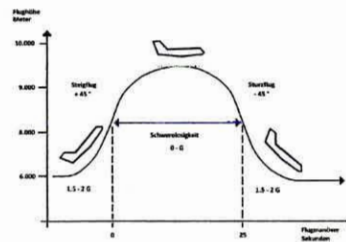
### Research Experiment in Space Real Microgravity



Motor exercises, recording with EMG

Source: <http://images.jsc.nasa.gov/images/pao/STS44>

### Transient Microgravity - Parable Flight



Microgravity only for few seconds. Diminishes research program.

**Simulated microgravity**  
Ground based laboratory  
Special equipment necessary

- **Methods**
  - Bedrest system
    - Head down tilt-system – HDT
  - Body weight discharge
  - Dry water immersion model – DWI-method

**Simulated microgravity**



Head down tilt position (HDT),  
bedrest method



Unilateral body  
weight discharge

**Simulated microgravity**

**Dry water immersion model – DWI-method**



Healthy volunteer, experiment 72 hours, consequent neurological control.

**Simulated microgravity**

**Dry water immersion model – DWI-method**



DWI institution, Innsbruck,  
Neurospace Institute, 2 healthy  
volunteers, 48 hours experiment



DWI experiment, healthy  
volunteer lift out for showering

**Simulated microgravity**

**Dry water immersion model – DWI-method**



Optomotoric examination



Examination of the positional reflexes

Neurological examination, healthy volunteer  
Ground based laboratory IBMP, Moscow

**Space Neurology**

- **Research aim: influence of microgravity**
  - Real microgravity
    - Influence on the proprioceptive system
    - Influence on the vestibular system (otolith system)
  - Simulated microgravity, ground based laboratory
    - Influence on the proprioceptive system
- **Use of the research results in neurology**
  - Neurodiagnosis
  - Neurorehabilitation
- **Development of new methods and new devices**
  - Acute neurology
  - Neuro-rehabilitation

### Neurological Disturbances in Real Microgravity

- Adaptation phase to real microgravity
  - disturbances during start phase
    - Space Adaptation Syndrome
- Neurological disturbances during space mission
  - Cosmonaut syndrome

### Cosmonaut Syndrome Real Microgravity

- Primary muscle atrophy (changing of muscle enzymes)
- Polyneuropathy
- Proprioceptive disturbances (joint position recognition, vibration perception, hypo-/areflexia, spinal ataxia)
- Thalamic disturbances
- Programmed motor disturbances (eye-head-coordination, etc.)
- Cerebellar ataxia
- Body scheme disturbances
- Decrease in vigilance
- Vegetative dysregulation
- Osteoporosis

### Bedrest Syndrome Developed in Simulated Microgravity

- Primary muscle atrophy with muscular changes and structural lesions
- Changing in muscle enzymes
- Polyneuropathy
- Proprioceptive disturbances (spinal ataxia, deep sensation disturbances)
- Thalamic symptoms
- Decrease in vigilance
- Cognitive disturbances
- Body scheme disturbances
- Osteoporosis

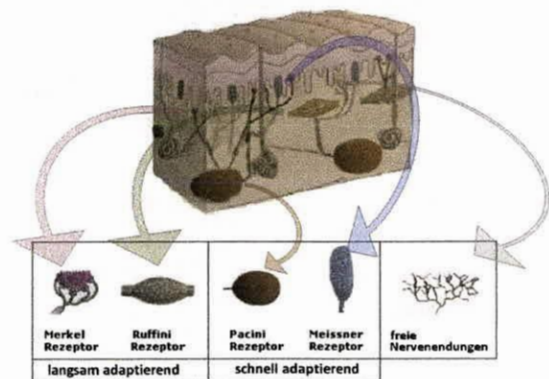
### Bedrest Syndrome in simulated and partial simulated microgravity conditions, Etiology

- Experimental induced
- Pathogenic origin
  - Long-lasting coma states, apallic syndrome, etc.
  - Cardio-vascular disturbances, long bed stay
  - Post-traumatic states, severe bone fractures, etc.
  - Parkinson Syndrome
  - Spasticity
  - Dementia
- Psychiatric patients, reduced motion, drug induced
- Elderly people, reduced motion

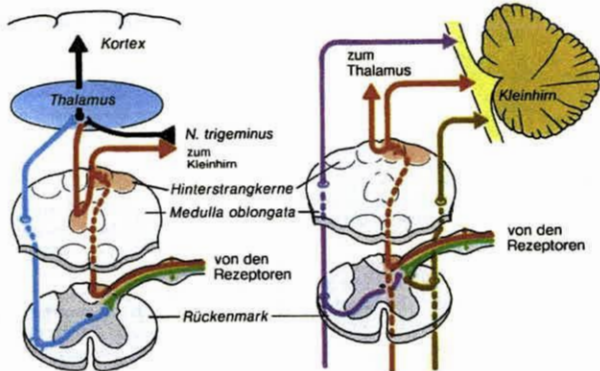
### Pathophysiology of Cosmonaut and Bedrest Syndrome (real and simulated microgravity)

- Microgravity: diminished influence to the gravity receptors, disturbances of the proprioceptive system
  - Disturbances of motoric system, body movement
  - Disturbances of the upright position
  - Disturbances of the sensory system, refference
  - Disturbances of the thalamic function
  - Disturbances of frontal lobe functions, cognitive abilities (psycho-motoric coordination, associativity, critics, emotional control)
  - Disturbances of vigilance

### Scheme of Mechano-Receptors



### The Proprioceptive System Responsible for the perception of gravity



### Experimental Verification Influence of foot sole vibrostimulation

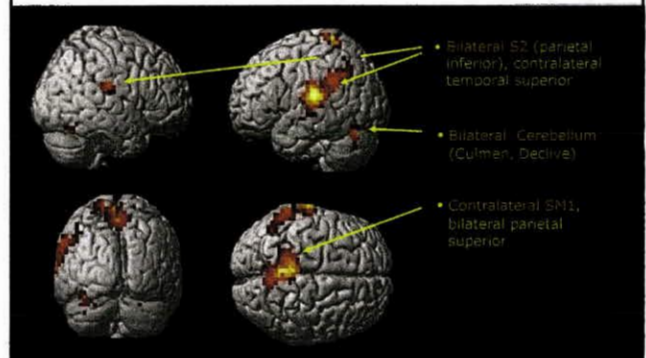
- **Functional MRI (fMRI) in healthy volunteers**
  - BOLD-effect (Blood oxygenation level-dependent), main focus in centers of the postural system (motoric, proprioceptive, epicritic, cerebellar centers)
  - BOLD effect in other foci like frontal lobe, temporal lobe, thalamus, cingulate gyrus, inferior part of parietal lobe

### Vibrotactile Stimulation of the Foot Sole, Moving Magnet Actuator System



Vibration frequency 50 Hz  
Stimulation of muscle spindles and Paccini-corporcles

### Result of vibrostimulation of the foot sole in healthy volunteers



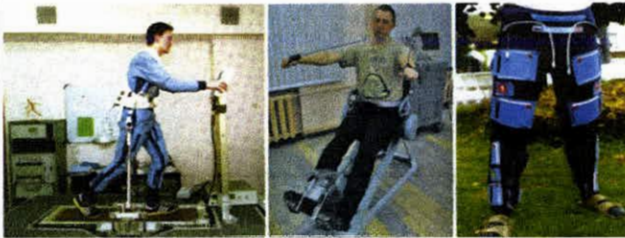
### Use of Research Results in Neurology and Neuro-Rehabilitation

- **Bedrest examinations, acute results**
  - manifestation of minimal brain lesions during examination phase
- **Use of research results in real and simulated microgravity**
  - Different methods in neuro-rehabilitation
    - Motoric disturbances (Parkinson Syndrome, spasticity, cerebellar disturbances, disturbances of the peripheral nerve system)
    - Apallic syndrome, Locked-in syndrome
    - Severe conditions after stroke
    - Severe conditions after traumatic brain injury
    - Prevention of bedrest syndrome
    - Dementia
  - Geriatrics
  - Psychiatric disorders
  - Methods in wellness

### Different Devices as a Spin-off effect of Space Neurology

- Prevention tools for space missions (treadmill, weight trainer, trousers with electro stimulator)
- Pressure shoe – Austrian model
- Pressure shoe – Russian model
- Korvit System – Foot loading imitator
- Regent – treatment suit
- Penguin System
- ADELI System

## New Neurorehabilitation Methods



Treadmill

Weight trainer

Electromyostimulator

### Prevention tools for space missions

Used in:  
minimal neurological disturbances (spasticity, cerebellar disturbances, Parkinson Disease, polyneuropathy, early dementia state)  
Geriatrics, wellness training

Source: Manned Mission to Mars, Russian Academy of Cosmonautics, 2006

## New Neuro-Rehabilitation Methods

### Pressure shoe Austrian model



Used in:

long-lasting coma states  
(intensive care units),  
Prevention of bedrest  
syndrome

Apallic syndrome  
Locked-in syndrome

Severe stroke defects

Severe states after  
traumatic brain injury

Planned: Dementia,  
Geriatric institutions

## New Neuro-Rehabilitation Methods



### Mechanical Stimulator, „Artificial Foot“ Russian model

Used in:  
Prevention for bedrest syndrome (ICU)  
Parkinson's Disease (mild form), spasticity (mild form), cerebellar  
symptoms, etc.

Source: Manned Mission to Mars, Russian Academy of Cosmonautics, 2006

## New Neuro-Rehabilitation Methods

### Korvit - Foot loading imitator



Used in:  
Gait disturbances; Parkinson's disease;  
spasticity, different origin; spinal cord  
lesions; polyneuropathy

Planned: Dementia, geriatric institutions



## New Neurorehabilitation Methods

### Regent Treatment Suit



Used in:  
Spasticity  
Spinal cord lesions  
Parkinson's Disease  
Polyneuropathy  
Stroke, severe defects

Planned In:  
Cerebellar ataxia, Dementia,  
Geriatric institutions

## New Neurorehabilitation Methods



### Penguin Suit

Used in:  
Cerebral palsy  
Spastic spinal  
paralysis

Planned: Parkinson's  
Disease, Dementia



## ADELI SYSTEM



Source: ADELI Flyer

Used in:

Cerebral palsy  
Spastic spinal  
paralysis  
Stroke  
Vertebral spine  
decompensation

Planned:

M. Parkinson  
Dementia



Source: ADELI Flyer

## Scuba Diving – A New Neurorehabilitation method

(limited depth 4 – 5 m)

Partial microgravity, influence to proprioceptive system

- Relaxation of vertebral spine system
- Indications:
  - minimal spinal cord lesions (traumatic, MS, etc.)
  - vertebral spine disturbances
    - cervical myelopathy
    - lumbago with radicular/pseudo-radicular symptoms
- Additional method in neuro-rehabilitation
  - Mild Parkinson Syndrome
  - Mild spasticity (after stroke, TBI, etc.)
  - Mild form of cerebellar ataxia

## Scuba Diving in depth 4 - 5 m



Precondition:

Always in pairs  
with special  
trained physio-  
therapist

## Space Neurology and Neurorehabilitation in Future

- Scientific programs focused on simulated microgravity methods
  - Detailed results in knowledge of the proprioceptive system and its influence to the highest and higher brain functions
  - New methods in neurodiagnoses
  - New methods in neurorehabilitation
- Scientific program in real microgravity based on orbit flights, ISS
- Scientific program in partial microgravity in underwater conditions
- Combined programs with neuropharmacological methods



Established 1914

# The NEW LIGHT OF MYANMAR

Volume XVII, Number 220

6<sup>th</sup> Waxing of Nadaw 1371 ME Sunday, 22 November, 2009

## 9<sup>th</sup> Conference of MHAA held

YANGON, 21 Nov—  
The opening of 9<sup>th</sup>  
Conference of Myanmar  
Health Assistants  
Association was held at  
University of Nursing here  
this morning.

Patron U Win Kyi of  
MHAA and Chairman U  
Aung Khin made speeches  
and wellwishers made  
donations. The officials  
later viewed the  
documentary photos and  
booths displayed at the hall  
and paid respects to the  
senior health assistants.

At the paper reading  
session of the conference's  
first day, retired health



*Patron U Win Kyi of Myanmar Health Assistants Association making  
speech at the opening of 9th MHAA Conference.—MNA*

assistant U Than Win  
extended greetings. Next,  
the activities—reading the  
minutes of 8<sup>th</sup> Conference,

submitting the work done  
in 2007-2009 fiscal year of  
CEC members, giving  
educative talks, displaying

clinics and sample  
medicines, presenting  
advice on reports of CEC  
— took place.—MNA

Neurology workshops Prof. Gerstenbrand

- Nov. 21, 09 Posttraumatic mental disturbances
- Nov. 21, 09 Neurorehabilitation – an obligation in the treatment  
of every neurological patient
- Nov. 22, 09 Space neurology and its benefit for neurorehabilitation