14.

Space medicine and life sciences in space

GERSTENBRAND F., M.D.; KOZLOVSKAYA I.B., M.D.; MAROSI M., M.D.

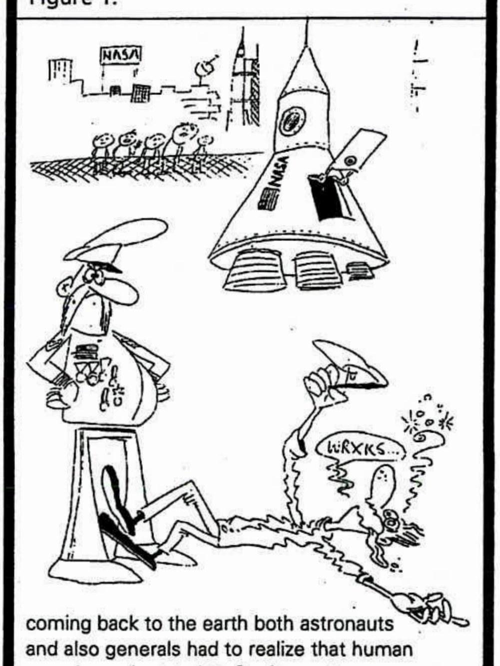
ASM / Institute of Space Neurology Innsbruck,
Ludwig Boltzman Institute Restorative Neurology Vienna. IBMP Moscow
Dept. of Neurorehabilitation Hochzirl /TILAK Innsbruck

SUMMARY: Grund based model. Conclusion. Literature

One goal of manned space mission was military reconnaissance. When astronauts returned to earth's gravity, even generals had to accept that the human neurophysiology had adapted to weightlessness. This was the birth of space neurology. (Figure 1)

Medical space research is concerned with the investigation of biological prerequisites, physiological adaptation processes, and pathophysiological problems during the preparation for and the realisation of manned space flight. The main objective of space neurology research is the gaining of new insights into the physiological function of the nervous system; not only per se, but also in order to integrate this knowledge in routine medicine.

Figure 1.



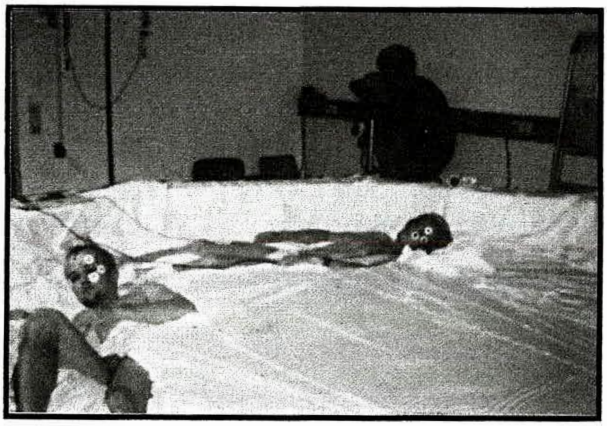
coming back to the earth both astronauts and also generals had to realize that human organism adaptated to G_0 circumstances

GROUND BASED MODEL

Only a relatively small percentage of medical space research must be carried out under conditions of antigravity. Most of the experiments can be done «on the ground», in simulated weightlessness. These investigations, however, require adequately equipped laboratories.

Within earth gravity real weightlessness (G_0) can be provoked for a few seconds by parabolic flights. Similar neurophysiological changes as observed in G_0 may be provoked by long period bedrest (BR) with 5° - 6°

head-down tilt [1,2] or by the dry water immersion model. The latter is a water filled pool which is covered with a thin foil; thus a volunteer in supine position cannot sink. Although he caves in, floating and movements are similar to those under water, but face and anterior parts of the body are outside. (Figure 2, below)



The healthy human body, with normal brain and spinal cord function and undisturbed peripheral nervous system, is subjected to the lack of gravitational influence in space. Our sensomotor system is bound to a constant inflow of information via the afferent part of an afferent / efferent neuron loop system; thus accurate motor function depends on an information inflow about the ad hoc position of joints, muscle tone, pressure distribution etc. Neurophysiologically the afferents are defined as lemniscal, which mediate information on localisation, time and intensity of stimuli (proprioceptive) and as extralemniscal, which mediate sensations of deep pressure, touch, pain, and temperature. Receptors in muscles, tendons, joints and skin mediate information about muscle tone, tendon stress, joint position (accuracy below 1°) etc. to spinal cord neurons via the pseudounipolar neurons of the dorsal root (primary afferents).

Proprioceptive input (lemniscal system) project directly to motoneurons (ipsilateral) or via the ipsilateral posterior funiculus to thalamus nuclei. The input then reaches (thalamocortical tract) the primary sensomotor cortex.

Extralemniscal information reaches the posterior and intralaminar nuclei thalami (VPL) via the posterior horn of the spinal cord, the contralateral ventral and lateral spinothalamic tract. Information also ascends via the spinoreticulothalamic tract to the reticular formation of the brainstem and then to the intralaminar nuclei thalami (generalized arousal reaction). Simultaneously this proprioceptive input is mediated to the spinocerebellum, nuclei thalami and vestibular nuclei (rapid reactions to maintain equilibrium).

Equilibrium as well as all motor functions are thus dependent on a combintion of labyrinthal, optic as well as lemniscal and extralemniscal input.

Sensomotorical physiology was from the beginning, and continues to be, one of the most important branches of space neurophysiology. Even before space flights began, scientists predicted that the condition of weightlessness would lead to the development of serious disturbances in the function of spatial perception, body image, as well as in the influence of changes in activity of the mechanoreceptors (otholites and proprioreceptors) on the organization of motion which are so important for the autoprogramming of movement. These assumptions were confirmed in practice. In the second space flight, Cosmonaut Titov demonstrated symptoms of seasickness as a result of anti-gravity[3-5].

Continuing disturbances in coordination and precision of movement were registered after the return to Earth following long space flights. Most scientists associate this phenomenon with the adaption process within the sensoric system. This complex of disturbances was defined as Space Adaption Syndrome, according to the proposal of an American scientist.

Table 1. Space Adaption Syndrome

➤ Vestibular disturbances (vertigo, nausea, vegetative problems)
➤ Motor disturbances (hypermetria, dysmetria, etc.)
➤ Optomotorical disturbances
➤ Proprioceptive disturbances
➤ Body image disturbances
➤ Pseudoapraxia

Table 2. Cosmonaut Syndrome

➤ Proprioceptive disturbances (joint position, vibration perception, hypo–areflexia, spinal ataxia)
➤ Preprogrammed motor disturbances (eye–head coordination)
➤ Cerebellar ataxia
➤ Body image disturbances
Decrease in vigilance
Vegetative disregulation
Polyneuropathy

The deficiencies which appear in actual weightlessness are classified in the initial stage as Space Adaption Syndrome[6-9] Stimulation and disinhibition of the vestibular apparatus[10] are the main factors. (Table 1)

Under longer exposure to conditions in actual G_0, the so-called «Cosmonaut Syndrome» became apparent, despite massive conditional training. The symptoms of this syndrome are also observed in simulated weightlessness. (Table 2)

The deficiencies of the Cosmonaut Syndrome[11] include changes in function of the peripheral nervous system with symptoms of polyneuropathy, atrophic changes in musculature[12], osteoporosis in bone, and failure of the motor feedback system and of the gravitational receptors, resulting in disturbances of positional and motor perception as well as motion sequences. The symptoms correspond to a Pseudo–Tabes Syndrome or a Pseudo–Friedreich Ataxia.

The symptoms of Cosmonaut Illness resemble those of Bedrest Syndrome in many details. Disturbance in proprioception is the main factor in Bedrest Syndrome, along with primary muscle atrophy.

Table 3. Bedrest syndrome

➤ Polyneuropathy
➤ Primary muscle atrophy with muscular changes and structural lesions
➤ Proprioceptive disturbances (spinal ataxia, deep sensation disturbances.)
➤ Decrease in vigilance
➤ Cognitive disturbances
➤ Body image disturbances
➤ Osteoporosis

Particularly in the study of reduced muscle activity and mobility, pioneer research was made possible through space medicine. Countless experiments, both model and in–flight, were undertaken by the space researchers, enabling them to describe the unfavorable effects of deafferentiation influences. This discovery of the mechanisms and resulting development of effective protective measures was an important contribution..

Accurate motor function, but also body posture are directly connected to the processing of sensory input, with a leading role of the proprioceptive information (lemniscal) originating from muscles, tendons, joints etc. This information has to be reprocessed within the central nervous system, compared with the actual program and adapted to the new environmental conditions. Since microgravity induces a modification of central interpretation of afferent input from the vestibular system and from proprioception[13], precise motor activities such as arm pointing, eye head coordination etc. are altered in microgravity (MONIMIR experiment). Similar changes are observed in simulated microgravity[14] and thus underline the role of proprioceptive input as etiology of the observed pathologies secondary to immobilisation.

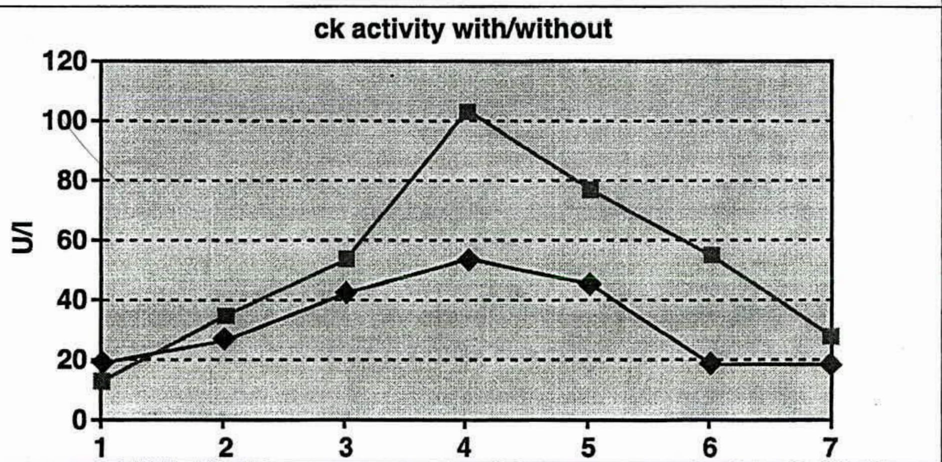
Several experiments documented a close relationship of clinical signs between the Cosmonaut syndrome and the Bed Rest syndrome. Both are characterized by altered reflex amplitudes, exteroceptive and proprioceptive afferences (afferent input), reduced muscle tone, signs of disintegrated cerebellar function as well as frontal signs[15,16]. The decrease of reflex amplitudes is interpreted to represent a change of afferent input, thus influencing the closed control loop of the motor system.

Long lasting immobilisation, e.g. in coma patients, leads to a diffuse muscle atrophy with an accentuation of antigravitational muscles, which can be documented by histological or muscle biochemical findings in these patients[17-20]. Changes of muscle morphology namely a proportional increase of II A fast fatigue resistant fibres in antigravitational muscles exposed to real G_0 conditions seems to be proven in rats. Similar changes are observed in antigravitational muscles of hind limb suspended rats, a model resembling bedrest. A similar neurophysiological adaptational process was demonstrated by biochemical changes of antigravitational muscles in volunteers exposed to long period bedrest versus simulated microgravity in dry water immersion. A countermeasure (Support Unloading Compensator – SUC) simulating standing or walking by stimulating plantar receptors was developed in order to reduce deafferentiation effect. In several experiments reduced levels of biochemical findings (CK–activity, – mass, Myoglobin, Myosin Heavy Chain fragments, Insulin like growth factor, Epithelian growth factor, cyclic Guanosine Monophosphate) documented a less diffuse lesioning of antigravitational muscles exposed to immobilisation.

CONCLUSION

The problem of adaption of the organism and its various systems to the conditions of antigravity is one of the central questions in space research. The complex of queries in this direction — what is adaption, etc. — are without a doubt very meaningful for all branches of medicine.

Figure 3. Mean values of serum ck activity for the stimulated group (blue / below) and the non stimulated group (red). Pattern of skeletal muscle proteins (creatine kinase enzyme activity) which were measured in the plasma of healthy volunteers. The concentrations are shown as percent increase from baseline values. Immobilization in dry water immersion (DWI) lasted for 120 hours followed by a standardized isometric muscle load. In group A standing was simulated (by SUC) during DWI exposure vs. group B without simulation.



The knowledge gained through medical space research concerning the influence of gravity and the development of Cosmonaut Syndrome or Bedrest Syndrome can be put to use today in the early rehabilitation of coma patients, especially in Apallic Syndrome (vegetative state), with good results. A positive influence on the course of illness of a long-term coma patient, and the benefits for his residual problems, is without a doubt a result of this research.

A further possibility is the use of this knowledge in Geriatric Medicine, in the avoidance of Bedrest Syndrome, a result of all illnesses which lead to immobilisation.

The results of research in simulated and actual weightlessness are further of use in the investigation of possibilities, development, and course of illness in different muscular diseases. Decisions in early diagnosis and development of new therapy strategies in medication and training are enhanced. Laboratories for simulated weightlessness can be used in the future for diagnosis and therapeutic surveillance in psychiatric illnesses such as Fear or Panic Syndrome, hormonal and vegetative psychological disturbances.

Other consequences for routine medicine will result from the high technology involved in medical space research. The development of new instruments for the compensation for interrupted spinal cord function can be expected. Instruments for treatment of muscle atrophy resulting from various etiologies can be developed out of the experience with the training apparatus of the cosmonauts.

Stimulators of the lemniscal system are being developed for the purpose of treating impairments of the peripheral nervous system, disturbances of spinal motor activity, as well as cerebellar misfunction.

These instruments could be used in prevention of Bedrest Syndrome in coma patients, elderly bedridden patients, and trauma patients. Medical space research is a completely new area which has led to new knowledge and will lead to much more. This knowledge is applicable in routine medicine, especially in geriatrics and in the treatment of coma patients. In conclusion, it should be emphasized that Space Medicine is not to be equated with the „organisational" concept of manned space travel. Space medicine represents only a small part of the overall goals of manned space travel, which is primarily involved with the realisation of industrial projects. Manned space travel is an indispensible part of the near future and beyond. The significance of the results of this research for terrestrial medicine cannot be overemphasized.

LITERATURE

1. **H. Sandler and J. Vernikos** (eds.) Inactivity: Physiologic effects, Academic Press, Orlando, FL, 1–202 (1986).
2. **A.E. Nicogossian, C.L. Huntoon and S.L. Pool** (eds.), Space Physiology and Medicine, Lea & Febiger, Philadelphia, PA, 1–380 (1989).
3. **C.M. Oman et al.**, Exp Brain Res., 64: 316–334 (1986).
4. **J.L. Homick et al.**, Aviat Space Med., 54: 994–1000 (1983).
5. **L.N. Cornilova et al.**, The Physiologist; 26 (6) suppl.: 35–36 (1983).
6. **Jennings T.** Med. Hypotheses 1990;32:289–291.
7. **Kennedy RS, Berbaum KS, Williams MC, Brannan J, Welch RB.** Ariat Space Environ Med 1987;58:A29–A33.
8. **Kozlovskaya IB, Ilyin EA, Sirota MG, Korolkov VI, Babyev BM, Beloozerova IN, Yakushin SB** «Cosmos-1887». Physiologist 1989;32:S45–S48.
9. **Ockels WJ, Furrer R, Messerschmid E.** Exp Brain Res 1990;79:661–663.
10. **Lessard CS, Wong WC:**. Aviat Space Environ Med 1987;58:A203–A206.
11. **Gerstenbrand F, Muigg A:** Spacemedicin. Ist workshop in space and underwater neurology, Messina (Taormina), Italy, 1987.
12. **Grigoriev AI, Egorov AD.** Kosm Biol Aviakosm Med 1988;22:4–17.

13. M. Berger et al., J Vest Res., 8(1): 1–15 (1998).
14. Berger M, Muigg A, Gerstenbrand F:Health from Space Research. Berlin–Heidelberg– New York–Tokyo, Springer, 1992.
15. Proceedings of the 1st Int. Symptosium on Inactivity and Health, Acta Phys Scand. 150 (616) suppl, (1994), (14 contributions).
16. G.A. Dudley et al., Aviat–Space–Environ–Med. Jul.; 60(7): 659–63 (1989).
17. H.E. Berg et al., J–Appl–Physiol Apr., 70(4): 1882–85 (1991).
18. E.A. Dworzak et al., J. of the Neurol. Sciences, Jun., 119–120 (1993).
19. K.W. Diederich et al., Human Genet., 81: 214–220 (1989).
20. A.J. Siegel, L.M. Silvermann and W.J. Evans, J. Am. Med. Assoc., 250: 2835 – 2837 (1983).

SOCIEDAD LATINOAMERICANA MOVIMIENTOS ANORMALES · SOLAMA

SOCIEDAD DE NEUROLOGIA DEL URUGUAY · SNU

INSTITUTO DE NEUROLOGIA PROF. A. RICALDONI · MONTEVIDEO

XVI WORLD CONGRESS OF NEUROLOGY

Buenos Aires • September 14–19, 1997

OFFICIAL SATELLITE SYMPOSIUM

Hotel San Rafael • Punta del Este • Uruguay • September 20 and 21, 1997

Biology of dopaminergic neuron: neurotoxicity and neuroprotection in chronic treatments

Honorary President
MELVIN D. YAHR (U.S.A.)

President
CARLOS CHOUZA (Uruguay)

Secretary
RUTH ALJANATI (Uruguay)

www.libreroonline.com/uruguay/libros/10229/si

libreroonline

0

Librero Online » Libros de Uruguay

0 (0 evaluaciones) | 0 búsquedas

BIOLOGY of dopaminergic neuron : neurotoxity and neuroprotection in chronic treatments. Offical satellite symposium dic. 20-21, 1997 Punta del Este

Chouza, Carlos (Ilustrador)
Yahr, Melvin D. (Prologuista)
Aljanati, Ruth (Ilustrador)

Soy Autor | Soy Editorial | Buscar

ISBN: 978-9974-648-03-6
editorial: Arena (Sello Dedos Productora)
categoría: Enfermedades del sistema nervioso y trastornos mentales
año de edición: 1998-01-01
idioma: Español
reseña: Agregar

categoría: Enfermedades del sistema nervioso y trastornos mentales
año de edición: 1998-01-01
idioma: Español
reseña: Agregar

Promoting Comittee:
Dr. Saúl Feres I Dr. Ricardo Buzo I Dra. Cristina Vázquez

Publications Comittee:
Dr. Alejandro Scaramelli I Dr. José Luis Caamaño I Dr. Álvaro Lista I Dr. Julio Valerio

Reception Comittee:
Dra. Susana Romero I Dra. Ofrenda De Medina I Dra. Cecilia Orellana I Dra. Diana Yorio

Financial Comittee:
Dra. Elena Diéguez I Dra. Nury Sánchez I Dr. Gustavo Emanuelli

Scientific Comittee:
Dra. Emilia Gatto (Argentina)
Dr. José Antonio Bueri (Argentina)
Dr. Rolando Giannaula (Argentina)
Dr. Ruben Femmenini (Argentina)
Dr. Manuel Rodríguez (Argentina)
Dra. Jeannette Laguna (Bolivia)
Dr. Aroldo Bacelar (Brasil)
Dr. Egberto Reis Barbosa (Brasil)
Dr. Francisco Cardozo (Brasil)
Dr. Jaderson Da Costa (Brasil)
Dr. Henrique Velloso (Brasil)
Dr. Felipe Pretelt Burgos (Colombia)
Dr. Esteban Michel (Cuba)
Dra. Paulina Arriagada (Chile)
Dr. Leopoldo Díaz (Chile)
Dr. Ariel Gómez Galera (Chile)
Dr. Claudio Martínez (Chile)
Dra. Mónica Troncoso (Chile)
Dr. Fernando Alarcón (Ecuador)
Dr. Enrique Otero (México)
Dr. Fernando Gracia (Panamá)
Dr. J. Corti Articawaba (Paraguay)
Dr. Carlos Cosentino (Perú)
Dr. Emilio Oribe (Uruguay – U.S.A.)
Dr. Roberto Weiser (Venezuela)

Montevideo, diciembre de 1998
Instituto de Neurología del Uruguay
Hospital de Clínicas «Dr. Manuel Quintela»
Avda. Italia 2870. CP 11600. Montevideo, Uruguay

Edición: **daniel pereira I ARENA ediciones**
Impreso en ICONOprint. Montevideo, Uruguay

ISBN: 9974-648-03-3