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Edited by
K. R. H von Wild
In Cooperation with G. A. Brunelli

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Preface

Re-Engineering of the Damaged Brain and Spinal Cord
is dedicated to Tetsuo Kanno, M.D.
Professor of Neurosurgery

By presenting the original papers that make up this third supplement we wish to make a further contribution to the issue of functional rehabilitation, this so important and fascinating modern area of research in the field of neurosciences. The congress papers we have selected constitute a good reflection of the transdisciplinary objectives. The literature references are designed as a guide to lead the interested reader to a deeper and more detailed understanding of the individual issues.

Functional rehabilitation has been an original task of neurosurgery from the very outset. The 1990s have entered the annals of brain research as the ''Decade of the Brain''. Since then there has been an ever stronger growth of neuroscientific interest worldwide, accompanied by substantial financial engagement. This has primarily resulted in advances in basic neurobiological and neurophysiological research and also in the growth of neuroscientific knowledge about basic mechanisms for motor control, pain control, awareness, cognition, learning and memory. The consequence must be to ensure that the advances made in the neuroscientific research area are adequately expanded into practical neurosurgical care and re-engineering of brain and spinal cord lesions and to ensure upon new approaches. Following this a fundamental path will result in an improved and more efficient prevention in the future, the measures that stand right at the forefront of all rehabilitation principles, meaning that conventional concepts must be modified to keep pace with the more task-specific, intensive, and progressive demands. In this connection a series of guidelines, recommendations, and expert opinions and also algorithms have been elaborated by national and international expert panels and multidisciplinary associations for the acute medical care of patients. Experience has shown that these guidelines and recommendations must not be infrequently modified to the features of the local medical landscape in the regions where they are enacted. What is more, progressive new findings must be also subjected to a frequent revision. On top of this, it should not be forgotten that even when committal therapy guidelines are consistently applied, there are considerable variations in the range of potential complications and in the outcome of prospective controlled multi-centre and multinational studies on the issue of quality management.

The demand for ''evidence-based medicine'' is well justified; however, it rapidly comes up against the limits of feasibility, especially where controlled therapeutic studies are concerned. The Cochran collection of high-quality evidence-based healthcare databases has thus far been of no help to us in drawing up therapeutic recommendations for the re-engineering of brain and spinal-cord lesions. Today as ever, the opinion of experts and empirically based medical treatment and posttraumatic neurorehabilitation continue to occupy an indispensable position for the everyday clinical practice of neurosurgical and neurotraumatological therapies. Promising adjunct approaches include neuropharmacology, for cascades of molecular interactions are known to be underlying activity-dependent plasticity and skills learning, as many of these processes involve the major transmitters. Furthermore, biological interventions by using endogenous neurons and glia as well as exogenous stem cells, bone-marrow cells, macrophages, and other types may promote the regeneration of nerve cells, tissue, and neural circuitry. Class one studies have been made, and now class two studies have been initiated, for example in connection with acute spinal cord injury (SCI). The clinical application of functional electrical stimulation (FES), the use of Neuroprosthesis, recently brain-mind interface technology, and robotic devices are still at the experimental stage;

however, in the near future these may become helpful adjuncts in restoring impaired and even lost motor and sensory functions in connection with brain and spinal cord lesions. Clinicians working in the fields of post-traumatic rehabilitation and re-engineering may now design and test novel therapies that have shown their potential value in animal experiments and preliminary human studies in manipulating the central nervous system to less impairment, disabilities, and functional limitations. Brunelli's paradigm of the CNS-PNS connection in SCI is one such characteristic example of the novel opportunities for neural repair. This opens up an entirely new challenge for all neurosurgeons and neurotraumatologists interested in multidisciplinary cooperation working at developing new strategies for the re-engineering of brain and spinal-cord lesions.

In this connection, studies into the assurance of the quality of our medical action in acute care and holistic rehabilitation are an urgent necessity. What will be the functional outcome of the patient? Which treatment strategy promises the most favourable health-related quality of life (HRQOL) for the patient? It is precisely issues such as these that place us before a major task, one that we can successfully approach only in cooperation, in a common team consisting of neuropsychologists, neurologists, neurosurgeons, neuropaediatric specialists, gerontologists, traumatologists, orthopaedic experts, epidemiologists, and social-medicine specialists. After five years of preparation, an assessment of HRQOL in persons after TBI has now matured for clinical application. A prospective study into the quality management of acute TBI in Germany, with a response rate of 64% after just one year, for the first time ever, gives a reliable indication of the outcome after standardized acute treatment. The definition of specific measures for outcome assessment following tumour surgery, functional neurosurgery, and neurosurgical re-engineering of brain and spinal-cord lesions is one of the challenges facing the delegates of the Committee for Neurorehabilitation and indeed all neurosurgeons and rehabilitation scientists.

This volume is the third in the series of proceedings covering the official biennial conferences of the Neurorehabilitation Committee of the WFNS in connection with two other international scientific congresses on aspects of basic research and clinical issues in neurotraumatology, namely the 5th Symposium on Experimental Spinal Cord Repair and the 1st Conference of the Academy for Multidisciplinary Neurotraumatology (AMN) in Brescia in March 2004. The first volume (Volume 79/2001) on functional rehabilitation in neurosurgery and neurotraumatology highlighted the important role played by neurosurgeons in neurorehabilitation beginning at an early period after the occurrence of the brain and spinal cord lesion and the important role of neuropsychology, as it was presented at the first meeting of the WFNS Committee in Münster, Germany 2000 under my auspices, as well as selected papers from another two meetings, the 5th Annual Meeting of the Euroacademy for Multidisciplinary Neurotraumatology in Paris, September 2000, and the Workshop on Early Neuropsychological Rehabilitation, Maribor, March 2001. The second supplement (Volume 87, 2003), edited by Professor Yoichi Katayama, contains the most important manuscripts that were presented at the second conference of our WFNS committee in Tokyo in 2002, which was organized and chaired by him. The central topic of this conference was the re-engineering of brain and spinal-cord lesions. Accordingly, it presents a wide variety of neurosurgical techniques, indications, and functional results that are described in detail. The conference was run as a joint meeting with the Japan Coma Society and gave the attending experts the opportunity to visit the nearby Chiba Ryogo Centre, which is one of the best equipped institutes specializing in the neurorehabilitation of the severest cases of TBI (vegetative state) in Japan.

In continuing our endeavours to promote close multidisciplinary cooperation in functional neurosurgery, neurotraumatology, and functional neurosurgical rehabilitation and the re-engineering of brain and spinal-cord lesions, it can indeed be called a stroke of luck that Giorgio A. Brunelli, Emeritus Professor at the Orthopaedics Medical Faculty of Brescia, Italy, organized the 5th Symposium on Experimental Spinal Cord Repair in Brescia, with a joint chair in conjunction with the third conference of our WFNS committee from March 27–29, 2004. Guest of Honour of the 5th Symposium was Professa Rita LEVI-MONTALCINI, Rome, Nobel Prize Laureate in Medicine 1986, who once again inspired the audience with her unique expertise, brilliant new ideas and her critical remarks and future visions regarding both experimental and clinical spinal cord repair (Fig. 1).

Professor Brunelli, in his capacity as Vice-President and Congress President of the World Academy for Multidisciplinary Neurotraumatology (AMN), founded in 2003, he also invited the 17 founding members and guest speakers for March 29

Fig. 1. Guest of Honour, Professa Rita LEVI-MONTALCINI, Rome, Nobel Prize Laureate in Medicine 1986, for her discoveries of growth factors, sitting between Professor Giorgio A. Brunelli, Brescia, Congress President (right side) and Professor Klaus R. H. von Wild, Münster on occasion of the of the 5th Symposium on experimental spinal cord repair, Brescia, Italy, in conjunction with the 3rd Conference of the WFNS Committee on Neurorehabilitation, March 28th, 2004

and 30, so that all congress participants had ample opportunity to exchange information and experience and to hold informal discussions. It was thus an obvious option to publish the most important papers presented at these three jointly held scientific conferences covering many aspects of the re-engineering of brain and spinal-cord lesions in a third supplement and thus to make them accessible for a larger circle of interested scientists. The 42 scientific papers that have been included in this supplement reflect the current status of neuroscientific research and the clinical knowledge in this field.

First and foremost I wish to express my sincere and cordial thanks to my friend and colleague, Giorgio A. Brunelli, for his hospitality and cooperation. Not only did he manage to organize a wonderful congress with a stimulating scientific programme in Brescia, but thanks to his considerable personal experience, his recognition as an expert the world over and his many personal contacts, he was also able to create yet again just in the right atmosphere, an extraordinarily intensive scientific exchange of opinions and ideas, giving me welcome support in my endeavours.

I should also like to thank all the authors and co-authors for sending me their original papers for inclusion into this third supplement in good time, the time pressure that was placed upon them notwithstanding.

Without the careful review and the first correction of the manuscripts by Dr. Matej Lipovšek, Maribor, Slovenia, the secretary of the WFNS Committee of many years' standing, I would never have succeeded in publishing this volume. My most special thanks for this renewed demonstration of our friendship.

I also wish to say a special thank-you to Professor Dr. Hans-Jakob Steiger, the editor of Acta Neurochirurgica Supplements, for his support in the realization of this project and his attentive and constructive handling of the individual papers. My thanks also go to Mrs. S. Schilgerius from the Springer Verlag in Vienna, who yet again applied her renowned diligence and expert eye to enable the proceedings to be published in such a short time and especially in the quality that is the hallmark of her work.

Acknowledgments

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Klaus R. H. von Wild
Münster, Germany

Forewords

The subject of neurorehabilitation and the enhancement of recovery from brain and spinal cord injury is of great importance to people in every part of the world and to neurosurgeons and allied physicians who care for injured patients. Based on the remarkable advances that are occurring in molecular biology and basic neuroscience, there is every reason to believe that great strides can be made in helping patients recover from injury to the central nervous system. It is clear that these efforts will be multidisciplinary in nature, and a review such as this one emphasizes that important aspect of our endeavors.

Hopefully this is only a beginning of a new era in rehabilitation and we must admire the wisdom and the energy of all of the contributors to this outstanding effort.

Edward R. Laws
President of the WFNS
Charlottesville, Virginia, USA

The question of paraplegic and quadriplegic patients is one of the main challenges of the next decade. In Europe, there are around 300.000 paralyzed people. In France, every year, 1000 new cases are coming in addition to the 6500 patients waiting for a miracle therapy. In the clinical context of poor spontaneous regeneration in spinal cord, the difficulties to transfer in human beings the promising results obtained in animals are huge and the path to repair human injured spinal cord may be unfortunately long. However, in acute stage, there is a study going on with autologous activated macrophages whose primary results in phase I gave, for the first time, a hope for stimulating repair processes in paralyzed people. We wish that the phase II study will confirm the exciting results of phase I and that other studies will arrive for those chronic patients who are waiting with great hope from all the researches which are going on animals.

Jacques Brotchi
President-Elect and
Coordinator Scientific Committees WFNS
Professor & Chairman
Department of Neurosurgery
Erasme Academic Hospital
Brussels, Belgium

I am delighted to be holding and scrutinizing this book, the third volume in a new series of proceedings, which covers the official scientific meetings of the Neurorehabilitation Committee of the World Federation of Neurosurgical Societies (WFNS). Recent advances in functional neurosurgery have opened up an important new area in which neurosurgeons can collaborate with specialists in the multi-disciplinary aspects of neurorehabilitation, involving a wide range of neurosurgical techniques. These procedures provide benefits for the control of a wide variety of disabilities. It was for these reasons that the Neurorehabilitation Committee was founded within the WFNS.

The first scientific meeting of the WFNS Neurorehabilitation Committee was held in Munster, Germany, in 2000 under the auspices of Professor Klaus R. H. von Wild. The second scientific meeting of the WFNS Neurorehabilitation Committee was held in Tokyo, Japan, in 2002 and it was hosted by me. The second meeting placed emphasis on identifying and defining the role of neurosurgeons within the broad multi-disciplinary spectrum of neurorehabilitation. The tasks carried out through collaboration between neurosurgeons and specialists in neurorehabilitation cannot be viewed simply as a restoration of function or reconstruction of structure, since they involve extensive functional and structural reorganization of neural networks within the brain and spinal cord. On this basis, we ascribed such activities as re-engineering of the damaged brain and spinal cord, and designated the second scientific meeting as the International Symposium on Neurosurgical Re-Engineering of the Damaged Brain and Spinal Cord.

It was clear to us from these two initial meetings that this field of endeavor had undergone rapid development in close cooperation and association with relevant areas of the basic neurosciences. The third scientific meeting, on which this volume is based, was held in Brescia, Italy, on March 28–30, 2004. In order to facilitate communication and cooperation among neurosurgeons, specialists in neurorehabilitation and basic neuroscientists, the meeting was held as a joint meeting with the Academy of Multidisciplinary Neurotraumatology (AMN) just after the 5th International Symposium on Experimental Spinal Cord Repair, and the participation of a wide range of basic neuroscientists was thus encouraged. As expected, this third scientific meeting provided an excellent opportunity to share skills and knowledge among neurosurgeons and specialists in neurorehabilitation, as well as basic neuroscientists. The meeting also aroused attention and interest among neurosurgeons regarding recent progress in the basic neurosciences, and helped basic neuroscientists to discuss their achievements in the context of a clearer understanding of neurosurgical techniques. As a result, the third scientific meeting was a great success.

I congratulate Professor Giorgio A. Brunelli, the Congress President and Vice-President of AMN, and Professor George P. Prigatano, the President of AMN, for organizing the joint meeting of AMN and WFNS so successfully. I extend my thanks to Professor Klaus R. H. von Wild, the Honorary Chair and Founder of the WFNS Neurorehabilitation Committee, for his energetic efforts to arrange the third scientific meeting in Brescia. I would like to express my gratitude to them for providing us all with an excellent opportunity to interact with other specialists and investigators in different fields. I also gratefully acknowledge support from Professor Edward R. Laws, the President of the WFNS, for his unfailing assistance so generously given to the Neurorehabilitation Committee.

Yoichi Katayama
Chair of the Neurorehabilitation Committee of the
World Federation of Neurosurgical Societies

On behalf of the Academy of Multidisciplinary Neurotrauamtology (AMN), we are most pleased to have *Acta Neurochirurgica* publish as a Supplement the scientific proceedings of the first meeting of the AMN in Brescia, Italy.

It is readily apparent that the papers present a broad coverage of topics important to the neurotraumatologist. It is the expressed purpose of the AMN to foster such multidisciplinary discussion and dissemination of information between disciplines.

Patients with neurotrauma require specialist care at all levels. When specialists communicate with one another about their work and ideas, the probability of patients receiving various specialists' care increases. Such dialogue also provides the hope that multiple disciplines will collaborate in their research activities to answer clinically meaningful questions. This research obviously must be done in a scientifically robust fashion.

We are most gratified with the response to the AMN and invite our colleagues to consider joining this active, international group of individuals. Presently, the AMN represents physicians and surgeons in many disciplines, as well as a variety of healthcare providers. Our hope is that the organization will continue to foster this type of diverse membership. Our yearly meetings will attempt to focus on specific topics relevant to the neurotraumatologist. We are hopeful that those meetings will produce new insights and reinforce the enthusiasm necessary in caring for patients who have trauma to the central nervous system. For those interested in learning more about our organization, please go to our web site, www.worldamn.org.

George P. Prigatano, Ph.D.
President of the AMN
Phoenix, Arizona, USA

The International Symposium on Experimental Spinal Cord Repair and Regeneration is held every two years in Brescia on behalf of the foundation for research on spinal cord lesions.

All the branches of Medicine in any way connected to spinal cord lesions represented, with special attention to research: Basic Science, Neurology, Molecular Biology, Biochemistry, Bio-Technologies, Immunology, Experimental Surgery, Clinical Surgery, Urology, Reconstructive Surgery and rehabilitation.

Scientists from all over the world have presented their research and results obtained in the last years.

This year the 5th International symposium on experimental spinal cord repair and regeneration, thank to the active and enthusiastic cooperation of Prof. Klaus von Wild, took place together with the 1st AMN World Congress. The founder members of the Academy for Multidisciplinary Neurotraumatology presented their results in research and treatment of trauma of the central nervous system (brain and spinal cord).

The 3rd Conference of the WFNS Committee took place at the same time, as there is a combination of different scientific activities that are more or less of special interest for the same group of participants regarding neurotrauma and functional neurohabilitation with reconstructive neurosurgery.

The combination of the 3 events was certainly a great occasion to share the ideas of so many participants and was indeed a great success.

A hundred and four authors from all over the world were able to present their papers and to discuss them with the audience.

An attractive social program gave the participants the opportunity to spend some time together in a relaxed atmosphere.

Unfortunately the reserved manner which is necessary for any research before its publication in special journals prevented the possibility to publish the most recent and probably interesting works in this book.

Giorgio A. Brunelli
Congress President 5th International Symposium on Experimental Spinal-Cord Repair and Regeneration and 1st AMN World Congress, Brescia, Italy

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