EDITORIAL

Special issue on medical bionics

To cite this article: Robert K Shepherd, PhD 2009 J. Neural Eng. 6 060201

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EDITORIAL

Special issue on medical bionics

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This special section of the Journal of Neural Engineering contains eight invited papers presented as part of the inaugural conference ‘Medical Bionics: A New Paradigm for Human Health’ held in the beautiful seaside village of Lorne, Victoria, Australia from 16–19 November 2008. This meeting formed part of the Sir Mark Oliphant International Conference Series (www.oliphant.org.au) and was generously supported by the Department of Innovation, Industry, Science and Research of the Australian Government, the Australian Academy of Science and the Australian Academy of Technological Sciences and Engineering.

This meeting was designed to bring experts from a variety of scientific, engineering and clinical disciplines together in a unique environment to discuss current progress in the field of medical bionics and to develop the concepts and techniques required to build the next generation of devices. The field is rapidly expanding, with new engineering solutions for neurological disorders being developed at an astonishing rate. Successful application of emerging engineering technologies into medical bionics devices requires a multidisciplinary research environment in order to deliver clinical solutions that are both safe and effective. Clinical success stories to date include spinal cord stimulators for the management of chronic neurological pain; auditory prostheses that allow the profoundly deaf to hear; and deep brain stimulation to negate movement disorders in Parkinson’s disease. Other research programs currently undergoing clinical trials include devices that allow paraplegics to stand and even walk; brain-machine interfaces that provide quadriplegic patients with rudimentary control of a computer but may ultimately provide control of wheel chairs and artificial limbs; devices that detect and suppress epileptic seizures using brief trains of electrical stimulation; and retinal prostheses that will provide vision to the blind. The future for medical bionics is indeed stimulating!

A key component to developing successful medical bionic solutions is a good understanding of the technological developments in the many enabling technologies that contribute to this field. Meetings such as this one are designed to provide that cross-discipline background. Conference themes included: smarter devices—the role of information and communication, and other enabling, technologies in medical bionics; smarter materials—in intelligent polymers and nanotechnology in medical bionics; neural interfaces for central nervous system and spinal cord stimulation; retinal and auditory prostheses; and cell-based therapies for neural generation and protection.

The eight articles arising from this meeting cover these broad research themes. Neural prostheses typically stimulate neural tissue that has undergone atrophic or pathological changes as a result of an underlying disease process, therefore technologies designed to minimise ongoing degenerative changes and improve the electrode-neural interface are important for improving device efficacy. Skinner and colleagues describe the use of cell-based therapies designed to deliver neurotrophic factors for long-term treatment of degenerative neurological disorders. A unique aspect of their research is the incorporation of neurotrophin releasing xenografts within alginate capsules designed to allow nutrients and neurotrophins to move freely across the alginate barrier while providing immunological isolation. Liu and colleagues describe the characterization of organic conducting polymers. These materials are attractive candidates for a number of biomedical applications including electrodes due to the inherent electrical conductivity, ease of fabrication and high surface area which facilitates...
ion exchange between the electrodes and surrounding tissues. These researchers demonstrate such materials can support and enhanced nerve cell differentiation via electrical stimulation in vitro. Shivdasani et al used sophisticated multichannel electrophysiological recordings of neurons within the ventral cochlear nucleus—part of the first relay centre within the auditory pathway—to demonstrate that neural synchrony in these neuron populations is predominantly a result of common excitatory input from the auditory nerve. Based on these studies the authors propose improved stimulation strategies for use in auditory brainstem implants. Ng and colleagues discuss various technologies needed to develop retinal prostheses with wireless power and data telemetry operation. They then describe the use of integrated circuits and microfabrication technologies for implementing these inductive links. Stieglitz summarizes the fundamental steps during the design and development of a micro-machined epiretinal vision prosthesis with emphasis on the electrode design, the cytotoxicity evaluation and hybrid assembly of the system. Seligman then uses the cochlear implant as a case study for the development of a commercial neural prosthesis. This overview considers issues of biocompatibility, extreme reliability, safety, patient fitting and surgical placement, and emphasises the importance of operating in a multidisciplinary environment. McDermott and Varsavsky applied perceptual models of acoustic and electric stimulation to estimate the loudness of sound signals when presented via a cochlear implant or hearing aid. The models’ outputs were compared with published data from relevant psychophysical experiments. The findings led to better fitting and sound processing, particularly in cases where cochlear implants and hearing aids are used simultaneously by individuals with some residual hearing. Finally, Fallon and colleagues review the evidence of plastic changes in the central auditory system that contribute to improved performance with a cochlear implant, and discuss how these changes relate to electrophysiological and functional imaging studies in humans. This review finishes by examining the role of brain plasticity in neural prostheses in general.

I would like to acknowledge our conference sponsors MiniFAB, National ICT Australia, School of Engineering University of Melbourne, Hearing CRC and the Bionic Ear Institute. Thanks to our conference participants, many of whom travelled great distances to be with us, the Scientific Advisory committee, the authors of the enclosed papers, the reviewers who ensured the publications were of high quality and the staff of IOP—particularly Jane Roscoe and Andrew Malloy—who supported this conference from its outset and were instrumental in bringing this special section to fruition. Finally, I look forward to welcoming you to our next meeting scheduled for late 2012.

Conference delegates.