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Bioelectronics for traumatic brain injury monitoring

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Traumatic Brain Injury (TBI) can be defined as brain trauma due to an acute external mechanical force. TBI is a major cause of death and disability in all age groups, the leading cause of death and disability in working people and among young adults.TBI was recently recognized as a 'silent epidemic' in the UK and worldwide by the Lancet Neurology Editorial.A third of all injury-incurred deaths in the US relates to TBI with the TBI-related healthcare cost exceeding $3bn. Around 1,000,000 hospital admissions each year in the European Union alone are due to TBI. Central to TBI's devastation is a delayed "secondary" injury that occurs in 30-40% of TBI patients in the Intensive Care Unit each year. Secondary injuries include ischemic, ionic, neurochemical and immunological insults, intracranial haematomas, delayed traumatic oedemas around the lesion (often in need of neurosurgical intervention) or vasospasms that are often associated with traumatic subarachnoid haemorraghes. Secondary injuries reduce survival rate and usually occur within ten days post-injury - a clear treatment window.

Current patient management strategies aim at optimizing the physiological environment of the injured tissue by reducing the energy demands of the brain by sedation, followed by CT scans (and other techniques) to document the damage done. A better approach is on-line, measurement of intracranial parameters to enable detection of harmful events prior to the development of irreversible tissue damage. The collection of such dynamic pathophysiological data allows for patient-specific, dynamic treatments to be offered.

In this presentation we will detail tailor-made bioelectronics suitable for the robust interfacing with real-time brain monitoring modalities including electrocorticography (EcoG) and rapid sampling microdialysis (rsMD) which allow for the detection of spreading depolarization (SD) waves, mass depolarisations of all neurons and astrocytes propagating through the injured brain.The SD waves spread out from the initial site of injury into the surrounding brain tissue 'at risk' of secondary brain injury.We will explain the design of our application-specific ampero-potentiometric instrumentation, we will stress its role in enabling real-time neuro-electro-chemical monitoring of the injured human brain, we will comment on its high-performance monitoring abilities and we will highlight how its operation in the ICU environment constitutes an improvement over current practice.

Biography

E M Drakakis is an academic member of staff of the Department of Bioengineering at Imperial College London, where he joined in October 2001. He has studied Physics (4-year degree) at Aristotle University of Thessaloniki (AUT) - Macedonia - Hellas, Electronic Physics and Radioelectrology (2.5-year MPhil degree) at the same university, and earned his PhD in Analog IC design under the supervision of Dr. Alison Payne from the Department of EEE-Imperial in May 2000 where he also conducted EPSRC-sponsored post-doctoral research. He has founded the Bioinspired VLSI Circuits and Systems Group whose research activities revolve around two axes: a) \"Circuits for Biology\" (inspiration drawn by the need for innovative instrumentation as dictated by a specific biological problem or application) and b) \"Circuits from Biology\" (inspiration drawn by operational, architectural and/or anatomical characteristics encountered in natural information processing systems).

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