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Center of Excellence in Basic, Clinical and Translational Neuroscience (ZCI-NEURO)

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The ZCI-Neuro is one of ten Croatian centers of excellence in all research fields (and the only one in neuroscience). It represents a network of 13 institutions and has been funded by European Regional Development Fund (Operational Program Competitiveness and Cohesions, grant agreement No. KK.01.1.1.01.0007, CoRE-Neuro). The core research problem and task is to develop innovative, systematic and integrated approach to early detection, treatment, and assessment of neurodevelopmental outcome and rehabilitation of patients (both children and adults) with hypoxic-ischaemic and haemorrhagic brain damage. This is a continuation of our long-term research programme (normal and disturbed human brain development) with combined use of histological, histochemical, immunocytochemical, molecular biological, genomic-genetic, clinical and radiological methods to analyse the structure and function of the developing brain and to develop new approaches for analysing cell cultures and stem cells. Accordingly, the entire program is subdivided in 6 main sub-programs (led by 6 research groups), as follows. Group1: The developmental origin of neuropediatric disorders after perinatal hypoxic/ischaemic brain lesion; Group2: New biomarkers of ageing, Alzheimer39;s disease, vascular dementia and insulin resistant brain state; Group3: Clinical and experimental studies of cerebral hypoxic/ischaemic and haemorrhagic lesions and their relation to alterations in movement and pressure of intracranial fluids; Group4: Preclinical studies of hypoxic/ischaemic lesions in experimental rodent model; Group5: Cognitive and linguistic analysis of language changes and recovery after stroke; Group6: Innovative markers of therapeutic response in mental disorders.

For functional testing of adults and children, we use 4 main approaches: 1) Functional testing of brain activity (fMRI, DTI/DWI, MRI-spectroscopy, resting-state fMRI) in adult patients with stroke or subarachnoid haemorrhage, in children with verified perinatal brain damage, as well as in healthy controls; 2) Cognitive (psychology, psychiatry, linguistics, speech therapy, rehabilitation) testing of diseased children and adults, and healthy controls; 3) Developing a system for follow-up and rehabilitation of children with perinatal brain damage; 4) Analyzing biomarkers of changes in neuronal signalling molecules and mechanisms, in two groups of chronic and progressive hypoxic-ischaemic damage of human brain microcirculation (vascular and related dementias; brain hypoperfusion in patients with depression), in contrast to acute hypoxic-ischaemic brain damage (stroke, subarachnoidal haemorrhage, perinatal lesion).

We also work on developing new experimental in vivo and in vitro models, in three ways: 1) Development of new experimental in vivo models (pigs, rodents) to study pathogenesis of hypoxic-ischaemic brain damage, its consequences and potentials of recovery/functional rehabilitation post lesion; 2) Development of new experimental in vitro models (cells, cell cultures, stem cells, single-neuron activity recordings) to study selective and specific changes in signalling molecules and mechanisms of neurons, glia and blood vessels after the hypoxic-ischaemic brain lesion; 3) development of new experimental models (rodent brain, cell culture) of implementing nanoparticles in stem cells, for potential diagnostic and therapeutic post-lesional application. So far, the main results and outcomes of this programme are: 1) 86 engaged researchers plus 26 doctoral students; 9 completed PhD theses; almost 400 publications (more than 250 in Q1, Q2 journals -almost 100 in journals with IF 4- 43); over 2.500 WoS citations.

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