Background Hypoxic-ischaemic encephalopathy (HIE) is associated with high mortality and morbidity rates worldwide. Aims To investigate brain haemodynamic, cytochrome-c-oxidase (CCO) and energy-resource changes during transient hypoxia-ischaemia (HI) and recovery using simultaneous broadband near-infrared spectroscopy (NIRS) and phosphorus (31P) magnetic resonance spectroscopy (MRS).

Methods Nine healthy piglets (aged <24 hr) were anaesthetised and physiologically monitored. Transient cerebral HI (duration 20 min-utes) was induced by reducing the inspired oxygenation and reversibly inflating bilateral carotid artery occluders. Using 31P MRS we measured inorganic phosphate (Pi)/epp, phosphocreatine (PCr)/epp, and nucleotide triphosphate (NTP)/epp where epp=exchangeable phosphate pool=Pi+PCr+3NTP. NIRS measured cerebral concentration changes of oxy-haemoglobin (HbO2) and deoxy-haemoglobin (HHb), and cytochrome-c-oxidase oxidation state changes (Δ[oxCCO]).

Results Simultaneous 31P-MRS and NIRS results are shown. HI rapidly reduced brain oxygenation as shown by changes in haemoglobin difference (ΔHbO2diff=Δ[HbO2]-Δ[HHb]) closely followed by a fall in Δ[oxCCO]. PCr/epp fell, and Pi/epp rose, quickly while NTP/epp was buffered initially and only declined when Δ[oxCCO] was significantly lowered.

Discussion During transient HI, CCO becomes reduced due to oxygen depletion; adenosine triphosphate levels are initially preserved by the creatine kinase reaction leading to PCr decline whereas energy utilisation without oxidative phosphorylation leads to increased Pi. Complementary MRS and NIRS enable better understanding of the cerebral metabolic response to HI and can help evaluate early interventional therapies.