Intracranial Dynamics and Shunt Technology

MIC Theme 4

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Background

Intracranial Dynamics & Shunt Technology

Intracranial dynamics focuses on the mechanisms and models of the blood supply to the brain and its buoyancy mechanisms. How do changes in cerebral blood flow (CBF) and the cerebrospinal fluid (CSF) circulation interact in time and in space and how may stable flows and fluxes be preserved over a wide range of compartmental pressures within the brain? How do such control systems change with brain injury and how may such disturbances be ameliorated?

Cerebral autoregulation (CA) controls and adapts cerebral blood flow (CBF) over a range of cerebral perfusion pressures (arterial blood pressure minus intracranial pressure) thereby ensuring adequate perfusion and oxygenation of the brain. This crucial neuroprotective mechanism provides the haemodynamic reserve to cope with various insults is variably impaired following acute brain injury in newborn infants, children and adults, and is an independent predictor of poor outcome.

Significant advances in TBI outcome have been achieved over the last 20 years by basing our management of systemic and cerebrovascular physiology on targets derived from population studies. However, this approach takes no account of interpatient heterogeneity as reflected by varying degrees of autoregulatory reserve in different patients and its time-variability. There is mounting evidence that including cerebral autoregulation in the ICU management of patients after severe TBI is beneficial to patients' survival and generally better outcome.

Autoregulation based individualisation of therapy thresholds has been included in the recent brain trauma guidelines. However there are still no clinically approved monitors of cerebral autoregulation available.

Crucial to such studies has been the development of techniques for the continuous monitoring of cerebrovascular reactivity [Czosnyka M, Stroke 1996] and cerebral autoregulation [Czosnyka M, Neurosurgery 1997]. These novel methods, based on computer-supported time-series analysis were introduced in 1996-1997 and have demonstrated such methods can be beneficial in the acute stage of management of TBI patients for the individual optimization of management strategies. This work led to the development of the concept of defining an individual patient’s ‘Optimal Cerebral Perfusion Pressure’ using continuous monitoring of a dynamic index of cerebral autoregulation [Steiner L Critical Care Medicine 1997] – until this work, patients were assumed to require the same cerebral perfusion pressure.
A new method based on combined measurements of optic nerve sheath diameter and venous Doppler blood flow velocity will be validated against invasive monitoring of ICP.
Computing tools for targeted management of CPP in TBI patients will be developed for ICM+ software.
Cambridge Shunt Evaluation Laboratory - assessment of the Certas 2 valve.
A monitoring cart will be designed for non-invasive brain monitoring, containing TCD ultrasonograph, plethysmographic arterial blood pressure monitor and profiled custom version of ICM+ to assess multiple parameters of brain circulation, including autoregulation, critical closing pressure, diastolic closing margin, and baroreflex sensitivity.

Near infrared Spectroscopy will be added to the cart to facilitate assessment of 'optimal' arterial blood pressure target.
A multicenter RCT is planned to assess the efficacy of the ‘optimal CPP’ approach to management of TBI.

Creation of a comprehensive multimedia support to improve dissemination of the knowledgebase pertaining to the CSF dynamics investigative suite of tools implemented in ICM+. This will be made available on-line via a new, redesigned ICM+ web portal.
Diffuse Correlation Spectroscopy is a new technique using near infrared light, able to monitor CBF in absolute units (ml/min/100g). We plan to add and validate DCS using the non-invasive brain monitoring platform.
Continuation of ‘optimal CPP’ trial.
Sub-themes
Intracranial Dynamics & Shunt Technology


2. Development of new methods of non-invasive ICP monitoring

3. Noninvasive techniques for continuous monitoring of cerebral blood flow by using a combination of TCD, NIRS and Diffuse Correlation Spectroscopy

4. Creation of tools for trials of CPPopt methodology

FIND
Identify areas of unmet need throughout the brain injury pathway that might be amenable to a technology-based innovation.

FACILITATE
Promote the generation of innovative solutions through the facilitation of interdisciplinary communication and collaboration between the NHS, academia, industry and public organisations.

FOSTER
Support the translational pathway of viable solutions from initial concept to successful market adoption and sustainable clinical impact.

CORE ACTIVITIES: Patient & Public Involvement, MedTech Regulation & Developmental Support, Clinical Informatics, Health Economics

NIHR Brain Injury MedTech Co-operative

What we do

Handover, dissemination & early adoption
1. NICE evaluation
2. Revision of clinical pathway
3. Publications and presentations
4. Wider innovation landscape
5. Industrial development

Evaluation
1. Brain Injury Den (BID)
2. Brain Injury Technologies Think tank (BITT)
3. Expert review

Growth
1. Linkages to funding initiatives
2. Crowd sourcing
3. Source investment
4. Support grant applications
5. Experimental clinical research (phase 0 to II)
6. Inform Randomized Controlled Trial Design (phase III)

NETWORKS & COLLABORATIONS

NIHR Brain Injury MedTech Co-operative

PREVENTION
Reintegration into the Community

BRAIN INJURY PATIENT PATHWAY
Neurodevelopment/Paediatrics
Old Age
Regenerative Neuroscience

CORE ACTIVITIES
NIHR Brain Injury MedTech Co-operative

Identification of unmet need

Prehospital Care

Brain Injury Den (BID)

Handover, dissemination & early adoption

Triage

Neurocritical Care
Multimodality Bedside Monitoring
Intracranial Dynamics
Functional Neuroimaging / Neurophysiology
Neuro-Oncology

Catalyse early Proof of Concept
1. Inform competitions
2. Pump priming
3. Team building
4. Identification of networks
5. Prototype
6. CE marking
7. Grant application
8. Industrial partnership

CATALYST

Catalyse early R&D
1. Inform validation
2. Market analysis/Health economics
3. Technology screening
4. Intellectual Property
5. Regulatory issues
6. Peer review

Proactive
1. Horizon scanning
2. Road mapping
3. Gap analysis
4. Competition

Reactive
1. NIHR clinical research infrastructure (NOCR)
2. National Institute for Health and Care Excellence (NICE)
3. Surgical Technology Evaluation Portal (STEP)

NIHR Brain Injury MedTech Co-operative
Clinical Themes

The NIHR Brain Injury Healthcare Technology Co-operative (HTC) in numbers

FUNDING COMPETITIONS 2013-2017
- The NIHR Brain Injury HTC Innovations Small Funding Competition 2014-15 and the ‘Seedcorn Funding Competition 2016-17’ have seed funded 38 national projects that address the unmet needs that have been identified.

External Funding Leveraged with partners

200 expressions of interest
75 applications
38 projects have been awarded for a total of £330,335
with a return of £7,890,803

The NIHR Brain Injury HTC ran 8 strategic roadmapping workshops and 10 patient and carer workshops

Since 2014, the NIHR Brain Injury HTC ran 8 strategic roadmapping workshops and 10 patient and carer workshops

70 unmet needs have been prioritised through the various structured initiatives facilitated by the HTC to create an ‘Unmet Needs Directory’

7031 participants recruited to NIHR HTC studies

The Register for Healthcare Involvement and Technology Evaluation (RHITE) has transitioned to an online platform, and has noted a 100% increase since its launch

SUPPORTED PROJECTS & BRAIN INJURY DEN

101 peer reviews have been conducted
30 projects have received feedback from experts and leaders in healthcare innovation as part of the Brain Injury Den

Over 5 years,

Supported-projects generated 272 publications

BRAIN INJURY TECHNOLOGIES THINK (BITT) TANK

Over 4 years, the HTC ran 5 BITT tanks, which have been attended by 103 companies

54 SMEs, start-ups and project teams showcased technological innovations to a panel of patients, carers, clinical and academic experts

49 new collaborations formed following the BITT tanks

Since 2013, the HTC has worked with 182 SMEs

UNMET NEEDS

PATIENT CENTRED

£59,562,367
Brain network visualisation and assessment at the bedside in disorders of consciousness

Dr Srivas Chennu

ICM+
Dr Peter Smielewski, Brain Physics, University of Cambridge
https://icmplus.neurosurg.cam.ac.uk

NIHR Brain Injury MedTech Co-operative
The Next Generation

Launch Event

Wednesday 25 April 2018: Homerton College, CB2