WICH 2019
7th World Intracranial Hemorrhage Conference
Granada, Spain | May 19-21 2019

Abstract E-Book

www.worldich.org
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Dear Friends and Colleagues,

We would like to invite you to the 7th World Intracranial Hemorrhage (WICH) Conference that will take place in Granada from 19th to 21st of May 2019.

This Conference provides a great opportunity for specialists with interest in intracranial hemorrhage and head injury management.

Neurologists and neurosurgeons work closely on this topic in the hospital environment and this conference will not only allow interaction between both of them but also with professionals from other related specialities such as neuroradiology, intensive care and basic sciences, joining in a multidisciplinary academic approach to intracranial hemorrhage.

We hope we can see each other in the spring of 2019 in the beautiful and ancient city of Granada.

With warmest regards.

Yours sincerely,

Dr. Jesus Lafuente
Dr. David Rodriguez
Presidents of the 7th WICH Conference
Managing DOAC-related life-threatening bleeds?

VISIT BOOTH 3–4
Committees

Executive Committee
Dr. Magdy Selim
Dr. Daniel Hanley
Dr. Jesús Lafuente
Dr. Richard Frederick Keep
Dr. David Rodríguez

Organizing Committee
Dr. Magdy Selim
Dr. Daniel Hanley
Dr. Alexander David Mendelow
Dr. Thorsten Steiner
Dr. Jesús Lafuente
Dr. David Rodríguez
Dr. Joan Martí Fabregas
Dr. Ricardo Rivera
Dr. Encarnación Castillo
Dr. Javier Gómez

Scientific Committee
Prof. Peter Hutchinson, United Kingdom
Prof. Alexander David Mendelow, United Kingdom
Dr. Craig Anderson, Australia
Dr. Jaroslaw Aronowski, United States of America
Dr. Antonio Belli, United Kingdom
Dr. Eivind Berge, Norway
Dr. Joseph Broderick, United States of America
Dr. Charlotte Cordonnier, France
Dr. David Gaist, Denmark
Dr. Barbara Gregson, United Kingdom
Dr. Daniel Hanley, United States of America
Dr. Richard Frederick Keep, United States of America
Dr. Karin Kljcin, Netherlands
Dr. Alfonso Lagares, Spain
Dr. Joan Martí Fabregas, Spain
Dr. Rustam Salman, United Kingdom
Dr. Magdy Selim, United States of America
Dr. Nikola Sprigg, United Kingdom
Dr. Thorsten Steiner, Germany
Dr. Katharina Sunnerhagen, Sweden
Dr. Daniel Woo, United States of America
Dr. Chao You, China
Dr. Mario Zuccarello, United States of America
We thank the below sponsors and exhibitors for their valuable support of the 7th World Intracranial Hemorrhage (WICH) Conference.

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EXHIBITOR(S)

NICO CORPORATION

STORZ KARL STORZ – ENDOSCOPE
Artemis
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88.2% average clot evacuation
n=47 | SD=20.8


Product availability varies by country. Prior to use, please refer to the Instructions for Use (IFU) for complete product indications, contraindications, warnings, precautions, potential adverse events, and detailed instructions for use. Please click here for additional risk information. Rendering for illustrative purposes only. Individual results may vary depending on a variety of patient-specific attributes. Please contact your local Penumbra representative for more information.

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Artemis Device Symposium

New Perspectives: Minimally Invasive Hematoma Evacuation

20 May 2019 | 18:40 – 19:50
Granada Exhibition and Conference Centre | Hall B

Moderator
Dr. Jesús Lafuente
Hospital del Mar, Barcelona, Spain

Speakers
Prof. Karin Klijn
Radboud UMC, Nijmegen, Netherlands

Dr. Nils Hecht
Charité Universitätsmedizin, Berlin, Germany

Product availability varies by country. Prior to use, please refer to the Instructions for Use (IFU) for complete product indications, contraindications, warnings, precautions, potential adverse events, and detailed instructions for use. Please click here for additional risk information. Please contact your local Penumbra representative for more information.

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<tr>
<th>Time</th>
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<tbody>
<tr>
<td>15:00-15:05</td>
<td>Opening</td>
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<tr>
<td>15:05-17:05</td>
<td>SCIENTIFIC SESSION 1</td>
</tr>
<tr>
<td></td>
<td>EPIDEMIOLOGY &amp; GENETICS</td>
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<tr>
<td></td>
<td>Moderators: Rustam Al-Shahi Salman, UK and Daniel Woo, USA</td>
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<tr>
<td>15:05-15:20</td>
<td>The changing epidemiological pattern of ICH in the XXI century</td>
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<td></td>
<td>Adnan Qureshi, University of Missouri, USA</td>
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<tr>
<td>15:20-15:27</td>
<td>O-001 Nationwide Prevalence for Opioid Abuse among</td>
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<td>Hemorrhagic Stroke Patients in the United States</td>
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<tr>
<td></td>
<td>Farhaan Shaheer Vahidy, McGovern Medical School at</td>
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<td>UTHHealth Houston, USA</td>
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<tr>
<td>15:27-15:34</td>
<td>O-002 Global Burden of Intracerebral Hemorrhage</td>
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<tr>
<td></td>
<td>Alexander Yacob, Tulane University School of Medicine, USA;</td>
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<td>Ochsner Clinic Foundation, USA</td>
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<tr>
<td>15:34-15:49</td>
<td>Genetic, racial and environmental risk factors for intracerebral</td>
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<td>hemorrhage</td>
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<td></td>
<td>Daniel Woo, University of Cincinnati, USA</td>
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<tr>
<td>15:49-15:56</td>
<td>O-003 Global Burden of Subarachnoid Hemorrhage</td>
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<td>Christopher Carr, Tulane University School of Medicine, USA;</td>
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<td>Ochsner Clinic Foundation, USA</td>
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<tr>
<td>15:56-16:03</td>
<td>Sex-differences in ICH</td>
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<td>Hanne Krarup Christensen, University of Copenhagen, Denmark</td>
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<tr>
<td>16:03-16:18</td>
<td>O-005 Risk of Intracerebral Hemorrhage in Pregnancy and the</td>
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<td>Postpartum Period: A Population Based Analysis using a</td>
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<td>Cohort-Crossover Design</td>
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<td></td>
<td>Jennifer R Meeks, McGovern Medical School at UTHHealth, USA</td>
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<tr>
<td>16:18-16:25</td>
<td>O-006 Gender and age differences and its relation to outcome</td>
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<td>in a large multicenter cohort of patients with intracranial</td>
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<td>hemorrhage</td>
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<td>Daniel Vázquez Justes, Hospital Arnau de Vilanova, Spain</td>
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<tr>
<td>16:25-16:32</td>
<td>The underlying cerebral small vessel diseases</td>
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<td>Rustam Al-Shahi Salman, University of Edinburgh, United Kingdom</td>
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<tr>
<td>16:32-16:47</td>
<td>O-007 Estimates and Temporal Trend for Nationwide 30-day Hospital</td>
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<td></td>
<td>Readmission Among Patients with Hemorrhagic Stroke: A Contemporary</td>
</tr>
<tr>
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<td>Population Based Analysis of 6-Year Nationwide Data</td>
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<td></td>
<td>Farhaan Shaheer Vahidy, University of Texas Health Science Center, USA</td>
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<tr>
<td>16:47-16:54</td>
<td>COFFEE BREAK</td>
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<td>Time</td>
<td>Hall A</td>
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<td>------------------------------------------------------------------------</td>
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</table>
| 17:30-19:30  | **SCIENTIFIC SESSION 2**  
PATHOPHYSIOLOGY & BASIC SCIENCES  
Moderators: Richard Frederick Keep, USA and Daniel Hanley, USA |
| 17:30-17:45  | Protecting brain from ICH: Nrf2 and other cell factors  
*Jaroslaw Aronowski, The University of Texas Health Science Center, USA* |
| 17:45-17:52  | O-010 Investigating the role of SAMHD1 and hypocholesterolaemia in intracerebral haemorrhage  
*Sarah Withers, The University of Manchester, United Kingdom* |
| 17:52-17:59  | O-011 Hemin has a Different Toxicity Pattern than Iron: Why Chelation Alone May Not be Sufficient to Treat Intracerebral Hemorrhage  
*Thomas A Kent, Houston Methodist Hospital, USA; Rice University, USA* |
| 17:59-18:14  | Coagulopathy in Traumatic Brain Injury  
*Marc Maegel, Cologne-Merheim Medical Center - University Witten-Herdecke, Germany* |
| 18:14-18:21  | O-090 Feasibility of Improving Cerebral Autoregulation in Acute Intracerebral Haemorrhage (BREATHE-ICH) Study: Results from an Experimental Interventional Study  
*Jatinder S Minhas, University of Leicester, United Kingdom* |
| 18:21-18:28  | O-013 Using zebrafish larval models of brain haemorrhage to measure brain injury, locomotor and neuroinflammatory outcomes in a drug screen  
*Siobhan Crilly, The University of Manchester, United Kingdom* |
| 18:28-18:43  | New experimental animal models in ICH and SAH  
*Richard Frederick Keep, University of Michigan, USA* |
| 18:43-18:50  | O-014 Assessment of early brainstem injury progression in a collagenase-induced rat brainstem hemorrhage model using multi-sequence magnetic resonance imaging combined with histopathology  
*Xi Guo, West China Hospital, China; Sichuan University, China* |
| 18:50-18:57  | O-015 Specific Gene Expression Networks Define the Peripheral Immune Response following Intracerebral Hemorrhage in Human  
*Boryana Stamova, University of California, USA* |
| 18:57-19:12  | Potential targets for SAH / vasospasm  
*John Zhang, Loma Linda University School of Medicine, USA* |
| 19:12-19:19  | O-016 Investigating the role of neuroinflammation and cholesterol metabolism in the progression of brain injury following ICH  
*Paul Kasher, The University of Manchester, United Kingdom* |
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<thead>
<tr>
<th>Time</th>
<th>Scientific Session 3: Diagnosing &amp; Imaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:00-08:15</td>
<td>Diagnosing ICH using biomarkers</td>
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<tr>
<td>08:15-08:22</td>
<td>O-017 New and Expanding Ventricular Hemorrhage Predicts Poor Outcome in Acute Intracerebral Hemorrhage</td>
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<tr>
<td>08:22-08:29</td>
<td>O-018 Incorporating Intraventricular Hemorrhage Assessment to the Current Definitions of Hematoma Expansion Improves Clinical Outcome Prediction</td>
</tr>
<tr>
<td>08:29-08:44</td>
<td>Diagnosing the cause of ICH using imaging</td>
</tr>
<tr>
<td>09:13-09:20</td>
<td>O-021 Clinical Predictors of Withdrawal of Life-Sustaining Treatment for Critically Ill Patients with Intracerebral Hemorrhage and Intraventricular Hemorrhage</td>
</tr>
<tr>
<td>09:20-09:27</td>
<td>O-022 Predicting Intracerebral Hemorrhage Expansion with CT perfusion</td>
</tr>
<tr>
<td>09:27-09:42</td>
<td>Cognition after ICH</td>
</tr>
<tr>
<td>09:42-09:49</td>
<td>O-023 Low Perihematolal Edema Volumes Associated with Improved Functional Outcome and Lower Mortality in the MISTIE III Trial</td>
</tr>
<tr>
<td>09:49-09:56</td>
<td>O-024 Clinical and pathophysiological properties of peak edema extension distance in intracerebral hemorrhage</td>
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<td>10:00-10:30</td>
<td>COFFEE BREAK</td>
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<tr>
<td>10:30-10:45</td>
<td>Reversal of oral anticoagulants in SAH, SDH and IVH&lt;br&gt;<strong>Hanno Riess, Charité - Universitätsmedizin Berlin, Germany</strong></td>
</tr>
<tr>
<td>10:45-10:52</td>
<td>O-026 Histotripsy clot liquefaction in a porcine intracerebral hemorrhage model&lt;br&gt;<strong>Aditya S Pandey, University of Michigan, USA</strong></td>
</tr>
<tr>
<td>10:59-11:14</td>
<td>Measurements of inflammation in ICH in humans&lt;br&gt;<strong>Adrian Parry-Jones, The University of Manchester, United Kingdom</strong></td>
</tr>
<tr>
<td>11:14-11:21</td>
<td>O-027 Blood pressure variability within first 24 hours after admission predicts poor in-hospital outcome in spontaneous intracerebral hemorrhage&lt;br&gt;<strong>Wendy Ziai, Johns Hopkins University School of Medicine, USA</strong></td>
</tr>
<tr>
<td>11:21-11:28</td>
<td>Anti-inflammatory treatments after ICH&lt;br&gt;<strong>Magdy Selim, Harvard University, USA</strong></td>
</tr>
<tr>
<td>11:43-11:50</td>
<td>Management of blood pressure after ICH&lt;br&gt;<strong>Craig Anderson, The University of Sydney and the Institute of Neurosciences of Royal Prince Alfred Hospital, Australia</strong></td>
</tr>
<tr>
<td>12:12-12:27</td>
<td>Innovations for the management of spontaneous ICH&lt;br&gt;<strong>Dariush Dowlatshahi, Canada</strong></td>
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<tr>
<td>12:27-12:35</td>
<td>O-031 Intracranial pressure and cerebral perfusion pressure trajectories: A novel approach to informing outcomes in spontaneous intracerebral hemorrhage with large intraventricular extension&lt;br&gt;<strong>Wendy Ziai, Johns Hopkins University School of Medicine, USA</strong></td>
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<tr>
<td>12:35-13:30</td>
<td>The Hoff Awards&lt;br&gt;Presented by Richard Frederick Keep, USA</td>
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<tr>
<td>13:30-15:00</td>
<td>Networking Event - Lunch Reception</td>
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<tr>
<td>13:45-14:45</td>
<td>Industry Sponsored Luncheon Symposium</td>
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# Scientific Program

## WICH - 20th May, Monday, 2019

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<tr>
<th>Time</th>
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<tr>
<td>15:00-17:00</td>
<td>SCIENTIFIC SESSION 5</td>
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<tr>
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<td>ORAL ANTICOAGULANTS AND REVERSAL AGENTS</td>
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<td>Moderators: Joan Martí Fabregas, Spain and Thorsten Steiner, Germany</td>
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<tr>
<td>15:00-15:15</td>
<td>Anticoagulant resumption vs. LAAO in patients with anticoagulation-related ICH</td>
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<td><em>Eivind Berge, Oslo University Hospital, Norway-University of Tromsø, Norway</em></td>
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<tr>
<td>15:15-15:22</td>
<td>O-032 A multicenter registration study for nontraumatic intracerebral hemorrhage in the DOAC era</td>
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<td><em>Joji Tokugawa, Juntendo University Nerima Hospital, Japan</em></td>
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<tr>
<td>15:22-15:29</td>
<td>O-033 Hemocoagulase atrox is not associated with Hematoma expansion prevention in intracerebral hemorrhage patients: a retrospective study</td>
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<td><em>Yunke Li, West China Hospital of Sichuan University, China</em></td>
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<tr>
<td>15:29-15:44</td>
<td>Antithrombotic drugs and the risk of ICH</td>
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<td><em>David Gaist, Odense University Hospital - University of Southern Denmark, Denmark</em></td>
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<tr>
<td>15:44-15:51</td>
<td>O-034 Prognosis for intracerebral hemorrhage during ongoing anticoagulant treatment A Swedish stroke register study</td>
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<td><em>Trine Apostolaki Hansson, Lund University, Sweden</em></td>
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<tr>
<td>15:51-15:58</td>
<td>O-035 Simulating an Adaptive, Randomized, Clinical Trial of Dose-Response from Time to Anticoagulant Reinitiation (Restart) after Intracranial Hemorrhage</td>
</tr>
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<td><em>Truman J Milling Jr, University of Texas at Austin, USA</em></td>
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<tr>
<td>15:58-16:13</td>
<td>Reversal of new oral anticoagulants</td>
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<td><em>Thorsten Steiner, University of Heidelberg, Germany</em></td>
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<td>16:13-16:20</td>
<td>O-036 rFVIIa for Acute hemorrhagic Stroke</td>
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<td>Administered at Earliest Time (FASTEST) Trial</td>
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<td><em>Thorsten Steiner, University of Heidelberg, Germany</em></td>
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<tr>
<td>16:20-16:27</td>
<td>O-037 Comparing Pharmacological Venous Thromboembolism Prophylaxis to Intermittent Pneumatic Compression in Acute Intracerebral Hemorrhage: Systematic Review and Network Meta-Analysis</td>
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<td><em>Vignan Yogendrakumar, University of Ottawa, Canada</em></td>
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<tr>
<td>16:27-16:42</td>
<td>Safety and usefulness of haemostatic drugs for acute ICH</td>
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<td><em>Nikola Sprigg, University of Nottingham, United Kingdom</em></td>
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<tr>
<td>16:42-16:49</td>
<td>O-038 Direct Assessment of Health Utilities among Patients with Intracerebral Hemorrhage using the Standard Gamble Method</td>
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<td><em>Farhaan Shaheer Vahidy, UTHealth Houston, USA</em></td>
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<tr>
<td>16:49-16:56</td>
<td>O-039 Longitudinal prevalence of Cognitive Impairment after Intracerebral Haemorrhage using data from the Tranexamic acid for hyperacute primary Intracerebral Haemorrhage (TICH-2) trial</td>
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<td><em>Andrew Belcher, University of Nottingham, United Kingdom</em></td>
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<td>17:00-17:30</td>
<td>COFFEE BREAK</td>
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<tr>
<td>17:30-19:30</td>
<td>SCIENTIFIC SESSION 6</td>
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<td>FUNCTIONAL RECOVERY &amp; PROGNOSIS</td>
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<td>Moderators: Yolanda Silva Blas, Spain</td>
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<tr>
<td>17:30-17:45</td>
<td>Predictors of intracerebral hemorrhage in ischemic stroke treated with fibrinolysis</td>
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<td><em>Joan Martí Fabregas, Hospital de la Santa Creu i Sant Pau, Spain</em></td>
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<tr>
<td>17:45-17:52</td>
<td>O-042 Epileptic seizures as a complication in cerebral hemorrhage surgically treated in ICU patients</td>
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<td><em>Maria Del Carmen Molina De La Torre, Hospital Universitario de Jaén, Spain</em></td>
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<tr>
<td>17:59-18:14</td>
<td>Prognosis for serious vascular events after ICH</td>
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<td><em>Karin Klijn, Radboud University Medical Center, The Netherlands</em></td>
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<tr>
<td>18:14-18:21</td>
<td>O-043 A Delayed Modified-ICH Score Outperforms Baseline Scoring in Acute Intracerebral Hemorrhage</td>
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<td><em>Ronda Lun, University of Ottawa, Canada</em></td>
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<td>18:21-18:28</td>
<td>O-044 Stroke nurse plays a key role in the fast, intensive and sustained blood pressure reduction in acute intracerebral hemorrhage</td>
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<td><em>Olalla Pancorbo, Vall d’Hebron University Hospital, Spain</em></td>
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<tr>
<td>18:28-18:43</td>
<td>Rehabilitation after hemorrhagic stroke: stroke-subtype specific recovery therapies</td>
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<td><em>Katharina Stibrant Sunnerhagen, University of Gothenburg, Sweden</em></td>
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<tr>
<td>18:43-18:50</td>
<td>O-045 Nationwide Trends and Disparities in Utilization of In-Patient Rehabilitation for Patients with Hemorrhagic Stroke</td>
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<td><em>Farhaan Shaheer Vahidy, University of Texas Health Science Center, USA</em></td>
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<tr>
<td>18:50-18:57</td>
<td>O-046 Spontaneous Intracerebral Hemorrhage in a Plateau Area: A Study Based on the Tibetan Population</td>
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<td><em>Lu Ma, West China Hospital, Sichuan University, China</em></td>
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<tr>
<td>18:57-19:12</td>
<td>Minimally invasive surgery with thrombolysis for intracerebral hemorrhage in China</td>
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<td><em>Zhou-ping Tang, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology, China</em></td>
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<td>19:12-19:19</td>
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### Scientific Program

#### WICH - 20th May, Monday, 2019

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<tr>
<td>08:00-10:00</td>
<td>Short Oral Presentations Session&lt;br&gt;Moderators: Daniel Hanley, USA and David Rodriguez-Rubio, Spain</td>
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<tr>
<td>08:00-08:03</td>
<td>SO-001 Study update: INTERACT3 - a stepped-wedge cluster randomized trial&lt;br&gt;&lt;br&gt;<strong>Guojuan Cheng, The George Institute for Global Health (Australia)</strong>&lt;br&gt;<strong>Beijing Representative Office, China</strong></td>
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<tr>
<td>08:03-08:06</td>
<td>SO-002 Neurosurgical intervention for supratentorial spontaneous intracerebral haemorrhage: A systematic review and meta-analysis of randomised controlled trials&lt;br&gt;&lt;br&gt;<strong>Lotte Sondag, Radboud University Medical Center, The Netherlands</strong></td>
</tr>
<tr>
<td>08:06-08:09</td>
<td>SO-003 Initial experience with minimally invasive parafascicular surgical approach for evacuation of supratentorial intracerebral hemorrhage&lt;br&gt;&lt;br&gt;<strong>Nicolas Kon Kam King, National Neuroscience Institute, Singapore</strong></td>
</tr>
<tr>
<td>08:09-08:12</td>
<td>SO-004 Neuroendoscopic Evacuation of Intraventricular Hemorrhage in the Preterm Newborns Using Ventriculoport&lt;br&gt;&lt;br&gt;<strong>Hakan Simsek, Sultan Abdulhamid Han Teaching Hospital, Turkey</strong></td>
</tr>
<tr>
<td>08:12-08:15</td>
<td>SO-005 Stereotactic Aspiration with Thrombolysis for Spontaneous Intracerebral Hemorrhage: A Meta-Analysis and Systematic Review of Randomized Controlled Trials&lt;br&gt;&lt;br&gt;<strong>W. Andrew Mould, Johns Hopkins University School of Medicine, USA</strong></td>
</tr>
<tr>
<td>08:15-08:18</td>
<td>SO-007 Evaluating outcomes from brainstem evacuation: An algorithm for selection and timing of intervention in patients with hypertensive brainstem haemorrhages&lt;br&gt;&lt;br&gt;<strong>Swati Jain, National University Health System, Singapore</strong></td>
</tr>
<tr>
<td>08:18-08:21</td>
<td>SO-008 Risk Factors for Early Hemorrhagic Progression after Traumatic Brain Injury: A Focus on Lipid Profile&lt;br&gt;&lt;br&gt;<strong>Kwangwook Jo, The Catholic University of Korea, South Korea</strong></td>
</tr>
<tr>
<td>08:21-08:24</td>
<td>SO-009 Regimented start-up programs lead to faster site activation&lt;br&gt;&lt;br&gt;<strong>Karen Lane, Johns Hopkins University, USA</strong></td>
</tr>
<tr>
<td>08:24-08:27</td>
<td>SO-010 Systematic Review of Reliability of Perihaematomal Oedema Volume Segmentation and in Patients with Spontaneous Intracerebral Haemorrhage&lt;br&gt;&lt;br&gt;<strong>Nikola Sprigg, University of Nottingham, United Kingdom</strong></td>
</tr>
<tr>
<td>08:30-08:33</td>
<td>SO-011 Single IRB review timelines slower than standard IRB processes for site start-up, but improved for changes in research&lt;br&gt;&lt;br&gt;<strong>W. Andrew Mould, Johns Hopkins University, USA</strong></td>
</tr>
<tr>
<td>08:33-08:36</td>
<td>SO-012 Limitation of therapeutic effort in acute intracerebral hemorrhage: Do we apply it correctly?&lt;br&gt;&lt;br&gt;<strong>Tomàs Xuclà Ferrarons, Hospital de la Santa Creu i Sant Pau, Spain</strong></td>
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| 08:36-08:39 | SO-013 Prognosis determinants of severe traumatic brain injury. A hospital based study in one sub saharan african country  
**Bello Figuim, Central Hospital, Cameroon** |
| 08:39-08:42 | SO-014 Evaluation of functional situation of patients who had undergone surgery for intraventricular hemorrhage after 5 years of their admission into ICU  
**Maria Del Carmen Molina De La Torre, Hospital Universitario de Jaén, Spain** |
| 08:42-08:45 | SO-015 An elderly lady with multiloculated bilateral subdural hematomas  
**Bella Richard, United Kingdom** |
| 08:45-08:48 | SO-016 The application of Willis covered stent in the treatment of Blood Blister aneurysms: a single center experience and systematic literature review  
**Lun Xin Liu, West China Hospital of Sichuan University, China** |
| 08:48-08:51 | SO-017 Association between good modified Rankin Scale and cognition impairment status among hemorrhage stroke survivor patients: Results from CLEAR III and MISTIE III trials  
**Radhika Avadhani, Johns Hopkins University, USA** |
| 08:51-08:54 | SO-058 Family Presence and Intracerebral Hemorrhage Characteristics: Role in Predicting Length of Stay and Outcomes after Minimally Invasive Evacuation  
**Natalia Romano Spica, Icahn School of Medicine at Mount Sinai, USA** |
| 08:54-08:57 | SO-019 Dual antiplatelet therapy associated with reduced risk of clinical vasospasm in aneurysmal subarachnoid hemorrhage  
**Dae Won Kim, Wonkwang University Hospital, South Korea** |
| 08:57-09:00 | SO-020 The prevalence of dynamic CT angiography spot sign and its predictability of clinical outcome in acute intracerebral hemorrhage: a prospective cohort study  
**Hee Sahng Chung, University of Ottawa, Canada** |
| 09:00-09:03 | SO-021 Differential Risk factor profile for intracerebral hemorrhage according to location: A nested case-control analysis in the Framingham Heart Study  
**Vasileios Arsenios Lioutas, Harvard Medical School, USA;  
Boston University School of Medicine, USA** |
| 09:03-09:06 | SO-022 Recovery of Visual Function after Occipital Hemorrhage Evacuation by Minimally Invasive Neurosurgery (MIN)  
**Susanna Anital, LKHF Neurosurgery, Teaching Hospital University, Austria** |
| 09:06-09:09 | SO-023 Study of Antithrombotic Treatment after IntraCerebral Haemorrhage (STATICH)  
**Kristin Tveitan Larsen, Oslo University Hospital, Norway; Akershus University Hospital, Norway; University of Oslo, Norway** |
| 09:09-09:12 | SO-024 Endovascular management of Hemorrhagic Dural Arteriovenous Fistulas  
**Jose Angel Larrea, Donostia University Hospital, Spain** |
| 09:12-09:15 | SO-025 Endovascular treatment in comparison with surgery for Aneurismatic Subarachnoid Hemorrhage: Analysis of results and costs  
**Ángel Horcajadas, Hospital Universitario Virgen de las Nieves, Spain** |
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| 09:15-09:18  | SO-026 High In-Hospital Systolic Blood Pressure Variability and Poor Functional Outcome in Primary Intracerebral Hemorrhage Patients  
*Jennifer R Meeks, McGovern Medical School at UTHealth, USA* |
| 09:18-09:21  | SO-027 Novel clinical trial design: INTERACT4, an ambulance-delivered PROBE trial of intensive BP lowering  
*Lili Song, The George Institute China, Peking University Health Science Center, China* |
| 09:21-09:24  | SO-044 Minimally Invasive Endoscopic Evacuation of Intracerebral Hemorrhage is Safe with the NICO Myriad  
*Rui Song, Icahn School of Medicine at Mount Sinai, USA* |
| 09:24-09:27  | SO-029 The Impact of Inter-hospital Transfers versus In-Hospital Emergency Department Admissions on Intracerebral Hemorrhage Patients Undergoing Minimally Invasive Evacuation  
*Julianne Kleitsch, Icahn School of Medicine at Mount Sinai, USA* |
| 09:27-09:30  | SO-031 Case report: A patient with hemorrhagic subtype of moyamoya disease  
*Jana Kenda, UMC, Slovenia* |
| 09:30-09:33  | SO-033 Blockage of glymphatic system contribute to enhanced neuroinflammation in intraventricular hemorrhage  
*Si Zhang, West China Hospital, China* |
| 09:36-09:39  |                                                                 |
| 09:39-09:42  | SO-037 A retrospective audit of 96 patients with spontaneous intracerebral hemorrhage admitted to West Suffolk Hospital, UK, between May 2017 and October 2018 considering the severity and the outcomes and DOAC use vs Warfarin and the outcomes  
*Dominika Danuta Raciborska, University of Cambridge, United Kingdom* |
| 09:42-09:45  | SO-038 The efficacy and mechanisms of adipose-derived stem cells on the treatment of intracerebral hemorrhage  
*Gaigai Li, Huazhong University of Science and Technology, China* |
| 09:45-09:48  | SO-039 Increasing mortality rates of intracerebral hemorrhage associated with direct oral anticoagulants in Japan  
*Tomohide Adachi, Tokyo Saiseikai Central Hospital, Japan* |
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| 10:00-12:30  | **PARALLEL SESSION 1**  
TRAUMATIC INTRACEREBRAL HEMORRHAGE  
Moderators: Jesús Lafuente, Spain and Mario Zuccarello, USA |
| 10:00-10:15  | Risk factors associated with progression of traumatic intracerebral hemorrhage  
Alfonso Lagares, Universidad Complutense de Madrid, Spain |
| 10:15-10:22  | O-048 Burr-hole drainage for treatment of chronic subdural hematomas: experience with 328 cases  
Lun Xin Liu, West China Hospital, Sichuan University, China |
| 10:22-10:29  | O-049 Subdural haematoma management in newborns: a case series  
Tomaz Velnar, University Medical Centre Ljubljana, Slovenia |
| 10:29-10:36  | Decompressive craniectomy for acute subdural hematomas  
Antonio Belli, University of Birmingham, United Kingdom |
| 10:36-10:51  | O-053 Efficacy and Safety of Four Interventions for Spontaneous Supratentorial Intracerebral Hemorrhage: a Network Meta-Analysis of Randomized Controlled Trials  
Chao Pan, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology, China |
| 10:51-10:58  | O-054 Clinical and Radiological Predictors of Cognitive Impairment after Intracerebral Haemorrhage at Day 90 and Day 365 using data from the Tranexamic acid for hyperacute primary IntraCerebral Haemorrhage (TICH-2) trial  
Andrew Belcher, University of Nottingham, United Kingdom |
| 11:05-11:12  | O-055 Specific Intraventricular Hemorrhage Severity Associated with Subsequent Incontinence and Gait Dysfunction  
Tyler P Behymer, University of Cincinnati College of Medicine, USA |
| 11:12-11:27  | Post-traumatic cognitive impairment: strategies to support function recovery  
Michael Nilsson, The University of Newcastle, Australia |
| 11:27-11:34  | O-056 Clinical Predictors of Health-Related Quality of Life for Patients with Intracerebral Hemorrhage and Intraventricular Hemorrhage  
Lourdes Carhuapoma, Johns Hopkins Hospital, USA |
| 11:34-11:41  | O-057 Vitamin D – a new perspective in treatment of cerebral vasospasm  
Sepide Kashefiolasi, University Hospital Frankfurt, Germany |
| 11:41-11:48  | O-058 Unraveling mechanisms of axonal degeneration and endothelial cell damage in intracerebral hemorrhage  
Marietta Zille, Fraunhofer Research Institution for Marine Biotechnology and Cell Technology, Germany; University of Luebeck, Germany |
| 11:48-12:03  | Surgical and Medical Management of Contusions  
Marc Maegle, Cologne-Merheim Medical Center - University Witten-Herdecke, Germany |
T Forcht Dagi, Boston Neurosciences, USA |
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<td>13:30-15:00</td>
<td>Networking Event - Lunch Reception</td>
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| 14:53-15:55  | Oral Presentations Session  
Moderators: Ramón Navarro, UAE and Sujoy K Sanyal, India |
| 14:53-15:00  | O-108 Stereotactic Intracerebral Hemorrhage Underwater Blood Aspiration (SCUBA) improves mortality after intracerebral hemorrhage  
*Rui Song, Icahn School of Medicine at Mount Sinai, USA* |
| 15:00-15:07  | O-060 Determining the optimal shape-related indicator on non-contrast computed tomography for predicting hematoma expansion in spontaneous intracerebral hemorrhage  
*Jun Zheng, West China Hospital, Sichuan University, China* |
| 15:07-15:14  | O-061 The Capacity of Blend Sign on Noncontrast Computed Tomography in Predicting Poor Outcome of Patients with Intracerebral Hemorrhage  
*Fan Xia, West China Hospital, China* |
| 15:14-15:21  | O-062 Regional differences in BP management in INTERACT2  
*Xia Wang, The George Institute for Global Health, Australia* |
| 15:21-15:28  | O-063 Brain Tissue Iron Quantification by MRI at Periphery of Hematoma in Patients with Intracerebral Hemorrhage: Preliminary Translational Evidence in First 10 Patients  
*Neeraj Chaudhary, Michigan Medicine, USA* |
| 15:28-15:35  | O-064 Regional Patterns of Care for Patients with Primary Intracerebral Hemorrhage in the Greater Cincinnati Northern Kentucky Stroke Study  
*Farhaan Shaheer Vahidy, UTHealth Houston, USA* |
|               |                         |
| 15:35-15:42  |                         |
| 15:49-15:56  | O-101 Sensitivity of non-enhanced computed tomography in identifying the location of a ruptured cerebral aneurysm in patients with aneurysmal subarachnoid hemorrhage  
*Marcin Sawicki, Pomeranian Medical University in Szczecin, Poland* |
| 16:00-18:30  | PARALLEL SESSION 2  
ANEURYSMS, AVMs and CAVERNOUS MALFORMATIONS  
Moderators: David Rodriguez-Rubio, Spain and Chao You, China |
| 16:00-16:15  | Endovascular Does Not Always Equal Minimally Invasive: Decision making on Coiling or Clipping for everyday Aneurysms: the perspective of a Dual-trained Neurosurgeon  
*Sujoy K Sanyal, Rabindranath Tagore Hospital and Armenian Church Trauma Center, India* |
| 16:15-16:22  | O-068 Safety and efficiency of flow diveters for treating small intracranial aneurysms: A systematic review and meta-analysis  
*Xiyang Yao, The First Affiliated Hospital of Soochow University, China* |
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| 16:22-16:29  | O-069 Entire Orifice Blocking-Assisted Microsurgical Treatment: Clipping of Intracranial Giant Wide-Neck Paraclinoid Aneurysms  
               *Lu Ma, West China Hospital, Sichuan University, China*          |
| 16:29-16:36  | O-070 Prediction of postoperative stroke after intracranial aneurysm surgery using changes in intraoperative evoked potential monitoring  
               *Jungjae Lee, The Catholic University of Korea, South Korea*     |
| 16:36-16:51  | Timing for treatment in ruptured AVMs: the neuroradiologist point of view  
               *Pedro Pablo Alcázar, Hospital Universitario Virgen de las Nieves, Spain* |
| 16:51-16:58  | O-071 Emergent microsurgical treatment of arteriovenous malformation-related intracranial hemorrhage  
               *Qiao Zhang, West China Hospital, Sichuan University, China*     |
| 16:58-17:05  | O-073 In-hospital Delirium and Long-Term Cognitive Outcomes among Patients with Intracerebral Hemorrhage and Subarachnoid Hemorrhage: A population-based cohort analysis  
               *Jennifer R Meeks, McGovern Medical School at UTHealth, USA*    |
| 17:05-17:12  | O-074 Scale up of the ‘ABC’ care bundle for acute intracerebral haemorrhage in a UK urban region: 1-year post-launch quantitative evaluation and development of an app to support acute stroke teams  
               *Emily Birleson, Salford Royal Foundation Trust, United Kingdom* |
| 17:12-17:27  | Surgical management strategy for complex AVMS  
               *Francisco González-Llanos, Hospital Virgen de la Salud, Spain* |
| 17:27-17:34  | O-075 Deep Learning for Automated Segmentation of Hematoma and Perihematomal Edema Volumes in Supratentorial Intracerebral Hemorrhage  
               *Rajat Dhar, Washington University School of Medicine, USA*      |
| 17:34-17:41  | O-076 Andexanet alfa for Treatment of Factor Xa inhibitor-related Acute Major Bleeding  
               *Truman John Milling Jr., Seton Dell Medical School Stroke Institute, USA* |
| 17:41-17:48  | O-077 Gamma Knife Radiosurgery for Brainstem Cavernous Malformations  
               *Jing Chen, West China hospital, Sichuan University, China*      |
| 17:48-18:03  | Endovascular strategy in AVM  
               *Ramón Navarro, Cleveland Clinic, Abu Dhabi, UAE*               |
| 18:03-18:18  | Cavernous malformations of the brain stem  
               *Miguel Ángel Arráez, Carlos Haya University Hospital, Spain*   |
| 18:18-18:25  | O-078 The association between long-term oral antithrombotic drug use and intracerebral haemorrhage for patients with cerebral cavernous malformations: a population-based cohort study, systematic review, and meta-analysis  
               *Susanna M Zuurbier, Amsterdam University Medical Centers, The Netherlands* |
| 18:25-18:32  | O-079 Confirmation of the Utility of Modeling Intracerebral Hemorrhage Outcomes to Predict Effectiveness of Treatment: Update with Phase 3 Results  
               *Thomas A Kent, Texas A&M Health Science Center, USA*            |
| 18:40- 20:10 | Industry Sponsored Symposium                                           |
## Scientific Program

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<td>08:00-10:00</td>
<td><strong>SCIENTIFIC SESSION 7</strong>&lt;br&gt;SURGICAL TREATMENT&lt;br&gt;Moderators: Jesus Lafuente, Spain and Pedro Pablo Alcazar, Spain</td>
</tr>
<tr>
<td>08:00-08:15</td>
<td>A comprehensive analysis of the STICH trials: identifying those patients who would benefit from craniotomy&lt;br&gt;<strong>Alexander David Mendelow, Newcastle University, United Kingdom</strong></td>
</tr>
<tr>
<td>08:15-08:22</td>
<td>O-080 New meta-analysis of Surgery for ICH&lt;br&gt;<strong>Alexander David Mendelow, Newcastle University, United Kingdom</strong></td>
</tr>
<tr>
<td>08:22-08:29</td>
<td>O-081 Brain tissue donation after ICH-Maximising the potential&lt;br&gt;<strong>Christine Elizabeth Lerpiere, Edinburgh University, United Kingdom</strong></td>
</tr>
<tr>
<td>08:29-08:44</td>
<td>The CLEAR Trial: Current Status of Research&lt;br&gt;<strong>Daniel Hanley, Johns Hopkins University, USA</strong></td>
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<td>08:44-08:51</td>
<td>O-082 Navigated endoscopy-assisted ICH evacuation with the Apollo® device and intraoperative CT or robotic cone-beam CT imaging&lt;br&gt;<strong>Nils Hecht, Universitätsmedizin Berlin, Germany</strong></td>
</tr>
<tr>
<td>08:51-08:58</td>
<td>O-083 Prognostic significance of ultraearly hematoma growth in spontaneous intracerebral hemorrhage patients receiving hematoma evacuation&lt;br&gt;<strong>Zhiyuan Yu, West China Hospital, Sichuan University, China</strong></td>
</tr>
<tr>
<td>08:58-09:13</td>
<td>Current Status of the endoscopic hematoma evacuation and surgical innovations for the intracerebral hemorrhage&lt;br&gt;<strong>Takuji Yamamoto, Juntendo University Shizuoka Hospital Japan</strong></td>
</tr>
<tr>
<td>09:13-09:20</td>
<td>O-084 Initial Experiences on Minimally Invasive Trans-Sulcal Endoscopic Surgery of Spontaneous Basal Ganglia Intracerebral Hemorrhage&lt;br&gt;<strong>Juan Manuel L Mariano, St. Luke’s Medical Center, Philippines</strong></td>
</tr>
<tr>
<td>09:20-09:27</td>
<td>O-085 Application of Two Novel Techniques of Minimally Invasive Image Guided Inter-Fascicular Evacuation (MIS) of Spontaneous Basal Ganglia Hemorrhages (SC-ICH)&lt;br&gt;<strong>Jean Louis Caron, UT Health San Antonio, USA</strong></td>
</tr>
<tr>
<td>09:27-09:42</td>
<td>The MISTIE Trial: Current Status of Research&lt;br&gt;<strong>Mario Zuccarello, Mayfield Brain and Spine Clinic, USA</strong></td>
</tr>
<tr>
<td>09:42-09:49</td>
<td>O-086 Microsurgical versus Endovascular Treatments for Blood-Blister Aneurysms of the Internal Carotid Artery: A Retrospective Study of 83 Patients in a Single Center&lt;br&gt;<strong>Yanming Ren, West China Hospital, Sichuan University, China</strong></td>
</tr>
<tr>
<td>09:49-09:56</td>
<td>O-087 Midline shift distance and early mortality in MISTIE 3 patients&lt;br&gt;<strong>Yunke Li, Johns Hopkins University, USA</strong></td>
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<td>10:15-10:45</td>
<td><strong>COFFEE BREAK</strong></td>
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<td>10:45-13:30</td>
<td><strong>SCIENTIFIC SESSION 8</strong> <strong>RANDOMISED CONTROL TRIALS</strong></td>
<td><strong>Moderators:</strong> Alexander David Mendelow, UK and David Rodríguez-Rubio, Spain</td>
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<td>10:45-11:00</td>
<td>STICH 3: Improving craniotomies</td>
<td>Chao You, West China Hospital, Sichuan University, China</td>
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<tr>
<td>11:00-11:07</td>
<td>O-088 Screen failure rates in MISTIE III</td>
<td>Radhika Avadhani, Johns Hopkins University, USA</td>
</tr>
<tr>
<td>11:07-11:14</td>
<td>O-089 Intensive Blood Pressure Lowering in Patients with Moderate to Severe Grade Acute Cerebral Hemorrhage: Post Hoc Analysis of Antihypertensive Treatment of acute Cerebral Hemorrhage (ATACH)-2 Trial</td>
<td>Adnan Qureshi, University of Missouri, USA</td>
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<tr>
<td>11:14-11:29</td>
<td>RCTs for traumatic ICH</td>
<td>Peter Hutchinson, University of Cambridge, United Kingdom SYKPE PRESENTATION</td>
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<tr>
<td>11:36-11:43</td>
<td>O-092 Survey Results from the MISTIE III Mobile Application’s Use</td>
<td>Lindsay M Eyzaguirre, Johns Hopkins University, USA</td>
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<tr>
<td>11:43-11:58</td>
<td>Meta-analysis of surgical trials for spontaneous ICH</td>
<td>Barbara Gregson, Newcastle University, United Kingdom</td>
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<tr>
<td>11:58-12:05</td>
<td>O-094 INTERACT3 update: feasibility of an implementation cluster clinical trial</td>
<td>Chao You, West China Hospital, Sichuan University, China</td>
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<tr>
<td>12:05-12:12</td>
<td>O-095 Identification and Application of Radiographic Characterization of Spontaneous ICH-Mediated Encephalomalacia (IME) in the MISTIE-III Cohort</td>
<td>Ayushi Gautam, Johns Hopkins School of Medicine, USA</td>
</tr>
<tr>
<td>12:12-12:27</td>
<td>Designing RCTs for ICH in the new century: The good, the bad and the ugly</td>
<td>Daniel Hanley, Johns Hopkins University, USA</td>
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<td>12:30-12:45</td>
<td>Closing Remarks &amp; Highlights</td>
<td>Presented by Magdy Selim, USA</td>
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<td>12:45-13:00</td>
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<td>08:00-10:00</td>
<td><strong>Short Oral Presentations Session</strong></td>
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<td>Moderators: David Rodriguez, Spain and Bello Figuim, Cameroon</td>
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<td>08:00-08:03</td>
<td>SO-041 Radiologic features of intracerebral hemorrhage as predictors of</td>
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<td>intrahospital mortality and functional outcome at discharge</td>
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<td><em>Ane Ugarte Nuño, Hospital Universitario Donostia, Spain</em></td>
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<td>08:03-08:06</td>
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<td>08:06-08:09</td>
<td>SO-043 A survey of usual care of physiological variables in ICH Patients -</td>
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<td>INTERACT3 Trial</td>
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<td><em>Lili Song, The George Institute China, Peking University Health Science Center, China</em></td>
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<td>08:09-08:12</td>
<td>SO-045 Establishing Criteria for Triage of Primary Intracerebral Hemorrhage Patients to Higher Level of Care</td>
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<td><em>Jennifer R Meeks, McGovern Medical School at UTH, USA</em></td>
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<td>08:12-08:15</td>
<td>SO-046 A Case of Subdural Hematoma After Epidural Blood Patch in a Spontaneous Intracerebral Hypotensive Patient With Multi-Level Cerebrospinal Fluid Leakage</td>
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<td><em>Young Joo, Department of Anesthesiology and Pain Medicine, South Korea</em></td>
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<td>08:18-08:21</td>
<td>SO-057 Predictors of early in-hospital mortality in patients with spontaneous intracerebral hemorrhage</td>
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<td><em>David Campo Caballero, Donostia University Hospital, Spain</em></td>
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<td>08:21-08:24</td>
<td>SO-049 Initial Experiences on Early Surgery for Spontaneous Basal Ganglia Intracerebral Hemorrhage</td>
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<td><em>Giannina Krishna Chua Go, St. Luke's Medical Center Global City, Philippines</em></td>
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<td>08:24-08:27</td>
<td>SO-050 Neuromonitoring Further Role for ICH Management - A Pilot Study</td>
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<td><em>Ana V. Ferreira, Centro Hospitalar Universitário de São João, Portugal</em></td>
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<td>08:27-08:30</td>
<td>SO-051 Admitting Patients with Small Intracerebral Hemorrhage and Minor Deficits to a Neurologic Step-Down Unit rather than Intensive Care Unit is Safe and Results in Shorter Total Length of Stay</td>
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<td><em>Flavia Lee, Saint Louis University, USA</em></td>
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<td>08:42-08:45</td>
<td>SO-056 The Role of Ultrasound in ICH Evacuation</td>
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<td><em>Klaus D M Resch, Teaching hospital University, Austria</em></td>
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<td>08:51-08:54</td>
<td>SO-061 Association of Various Perihematomal Edema Metrics to Primary</td>
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<td>Intracerebral Hemorrhage Clinical Outcomes</td>
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<td><em>Patrick Matic Yalung, St. Luke’s Medical Center, Philippines</em></td>
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<td>08:54-08:57</td>
<td>SO-062 Spontaneous intracranial hemorrhage associated with novel oral</td>
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<td><em>Han Lin Yen, Tainan Municipal Hospital, Taiwan</em></td>
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<td>08:57-09:00</td>
<td>SO-064 Radiologic characteristics and high risk of seizures in infants</td>
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<td>with ruptured intracranial aneurysms: case report and review of the literature</td>
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<td><em>Yi Liu, West China Hospital, Sichuan University, China</em></td>
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<td>09:00-09:03</td>
<td>SO-065 Hemicraniectomy with minimally invasive evacuation for intracranial</td>
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<td>hematoma: a novel hybrid technique</td>
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<td><em>Leonard H Verhey, Michigan State University, USA</em></td>
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<td>09:03-09:06</td>
<td>SO-066 Evacuation of Traumatic Intracranial Haemorrhage by MIN Techniques</td>
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<td><em>Klaus D M Resch, Teaching Hospital University, Austria</em></td>
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<td>09:06-09:09</td>
<td>SO-067 The risk of Hemorrhagic Transformation after intravenous thrombolysis</td>
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<td>in cardioembolic Ischemic stroke</td>
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<td><em>Lina Carazo Barrios, Hospital Clinico Universitario Virgen de la Victoria, Spain</em></td>
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<td>09:09-09:12</td>
<td>SO-068 MRI findings of primary hypertensive intracerebral hemorrhage at</td>
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<td><em>A Hyun Cho, Catholic University of Korea, South Korea</em></td>
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<td>09:12-09:15</td>
<td>SO-069 Intracerebral haematoma evacuation with minimally invasive technique: a case study</td>
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<td><em>Tomaz Velnar, University medical Centre Ljubljana, Slovenia</em></td>
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<td>09:15-09:18</td>
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<td>09:18-09:21</td>
<td>SO-071 Register-based research of intracerebral haemorrhage in Denmark:</td>
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<td>Possibilities and challenges</td>
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<td><em>Stine Munk Hald, University of Southern Denmark; Odense University Hospital, Denmark</em></td>
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<td>SO-073 How Do We Organize a Clinical Trial?</td>
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<td><em>Xi Li, West China Hospital, Sichuan University, China</em></td>
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<td>09:27-09:30</td>
<td>SO-074 A New Risk Factor for lung infection in spontaneous intracerebral</td>
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<td><em>Xiaoyu Wang, West China Hospital, Sichuan University, China</em></td>
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| 09:36-09:39 | SO-077 Safety indicators in patients with subarachnoid hemorrhage and its relationship with results of medical attention  
Pamela Rodriguez Salgado, ABC Medical Center, Campus Observatorio, Mexico |
| 09:39-09:42 | SO-078 Immediate reversal of anticoagulation effect of dabigatran in hemorrhagic stroke  
Krisztian Pozsegovits, Dr. Keressey Albert Hospital, Balassagyarmat, Hungary |
| 09:42-09:45 | SO-079 Primary intracerebral haematoma evacuation through external ventricular drainage  
Tomaz Velnar, University Medical Centre Ljubljana, Slovenia |
| 09:45-09:48 |                                                                 |
| 09:48-09:51 |                                                                 |
| 09:51-09:54 | SO-082 Neurological Impact of Renal Stenosis  
Lina Carazo Barrios, Hospital Clinico Universitario Virgen de la Victoria, Spain |
| 09:54-09:57 | SO-083 Intracerebral hemorrhage in very elderly patients: medical and ethical aspects  
Baltateanu Doru, S.U.U. Elias, Romania |
| 09:57-10:00 |                                                                 |
| 10:00-10:03 | SO-085 Epidemiology and risk factor profile of Primary intracerebral hemorrhage in sea coast population of South India- an observational study  
Sangamithra Gandra, Narayana Medical College and Hospital, India |
### WICH - 21st MAY, TUESDAY, 2019

<table>
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<tr>
<th>Time</th>
<th>PARALLEL SESSION 3: INTRACEREBRAL HEMORRHAGE IN THE NON-INTRAPARENQUIMATOUS SPACES: SAH, SDH and IVH</th>
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<td>10:15-13:00</td>
<td>Moderators: Jesús Lafuente, Spain and Alfonso Lagares, Spain</td>
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#### 10:15-10:30
- Safety and efficacy of thrombolysis in intraventricular hemorrhage  
  - **Daniel Hanley, Johns Hopkins University, USA**

#### 10:30-10:37
- O-096 Endoscopic Evacuation of Thalamic Hemorrhage with Intraventricular Extension  
  - **Erickson Fernando Torio, St. Luke’s Medical Center, Philippines**

#### 10:37-10:44
- O-098 Delayed Calculation of Multiple Intracerebral Hemorrhage Scores Outperform Baseline Scoring in Acute Intracerebral Hemorrhage  
  - **Ronda Lun, University of Ottawa, Canada**

#### 10:44-10:51
- O-100 Intraventricular Hemorrhage Growth: Definition, Prevalence and Association with Parenchymal Hematoma Growth and Prognosis  
  - **Qi Li, The First Affiliated Hospital of Chongqing Medical University, China**

#### 10:51-10:58
- O-102 Intraventricular Hemorrhage Growth: Definition, Prevalence and Association with Parenchymal Hematoma Growth and Prognosis  
  - **Qi Li, The First Affiliated Hospital of Chongqing Medical University, China**

#### 10:58-11:05
- O-103 A practical 3D-printed model for training of endoscopic and exoscopic intracerebral hematoma surgery with a tubular retractor  
  - **Junhao Zhu, Jinling Hospital, School of Medicine, Nanjing University, China**

#### 11:05-11:20
- New therapeutic targets in early neurological deterioration after SAH  
  - **John Zhang, Loma Linda University School of Medicine, USA**

#### 11:20-11:27
- O-104 Intracerebral hemorrhage with tentorial herniation: conventional open surgery or emergency stereotactic craniopuncture aspiration surgery?  
  - **Guofeng Wu, Affiliated Hospital of Guizhou Medical University, China**

#### 11:27-11:34
- O-105 Diffusion Tensor Imaging of the Cortical Spinal Tract in Minimally Invasive Surgical Endoscopic Evacuation of Intracerebral Hemorrhage  
  - **Christopher P Kellner, Icahn School of Medicine at Mount Sinai, USA**

#### 11:34-11:41
- O-106 Targeting Spot Sign in Intracerebral Hemorrhage with NICO BrainPath Minimally Invasive Parafascicular Surgery to Prevent Hematoma Expansion  
  - **Gustavo Pradilla, Emory University, USA**

#### 11:41-11:56
- Technical challenges in surgical treatment of ruptured aneurysms presenting as intracerebral hematoma  
  - **Isabel Maria Ortiz, Hospital Universitario Virgen de las Nieves, Spain**

#### 11:56-12:11
- Dissecting sulci to access ICH: Minimally invasive surgery, the EnrICH Trial and BrainPath device  
  - **Gustavo Pradilla, Emory University, USA**

#### 12:11-12:18
- O-107 Novel Technique of Minimally Invasive Image Guided Catheter Inter-Fascicular Evacuation of Spontaneous Basal Ganglia Hemorrhages Results in Successful Hemorrhage Evacuation and Improved Short-term Outcomes  
  - **Jean Louis Caron, UT Health San Antonio, USA**

#### 12:18-12:25
- O-109 Minimally invasive parafascicular surgery for supratentorial intracerebral hemorrhage  
  - **Nicolas Kon Kam King, National Neuroscience Institute, Singapore**
Abstracts of Invited Speakers
Sex-differences in ICH

Hanne Christensen

University of Copenhagen, Denmark

There is increasing evidence that sex-differences are present in stroke, as in e.g. ischaemic heart disease. However, our knowledge is still fragmented especially as to ICH. This lecture aims to give an overview of existing data and present gaps in the knowledge on similarities and differences in ICH between men and women.

In spite of the higher incidence of stroke in men, the actual number of female stroke victims is higher due to larger numbers of old women in comparison to the numbers of older men. Some risk factors including hypertension are more frequent in women than in men, others have different impact. An example is diabetes which has more impact on the risk of stroke in women. As to presentations, deep hematomas may be more frequent in men, while lobar locations are more frequent in women. However, data is not completely consistent and interactions with age and ethnicity are present. Perihematomal oedema appears more pronounced in men than women, and it has been suggested that the observed relation between blood pressure decline and mortality is only present in men. There is conflicting evidence as to outcome after ICH in men and women. Women are underrepresented in trials and sex-disaggregated analyses are still only rarely presented.

Conclusion: There is a need to increase female representation in trials (external validity) and sex-disaggregated analyses should be attempted consistently.
The underlying cerebral small vessel diseases

Rustam Al-Shahi Salman

The University of Edinburgh and the Edinburgh Royal Infirmary, Edinburgh, UK

Abstract: About 85% of spontaneous intracerebral haemorrhages have no underlying macrovascular, neoplastic, or infectious cause and are attributed to small vessel disease, mostly arteriolosclerosis with or without cerebral amyloid angiopathy (CAA). Cerebral amyloid angiopathy affects cortical and leptomeningeal vessels and is only associated with lobar intracerebral haemorrhage, whereas arteriolosclerosis can cause intracerebral haemorrhage anywhere in the brain. When cerebral small vessel disease is thought to underlie non-lobar intracerebral haemorrhage, arteriosclerosis is found at autopsy in almost every case. In our population-based spontaneous intracerebral haemorrhage brain bank (Lancet Neurol 2018;17:232-40), we found a broader spectrum of cerebral small vessel diseases underlay lobar intracerebral haemorrhage: in 42% there was arteriolosclerosis and CAA, in 39% there was arteriolosclerosis alone, 16% had CAA alone, and 3% had no clear underlying cause. Diagnosing these underlying diseases using brain imaging or blood tests may help better stratify patients according to their prognosis or response to treatment.
Coagulopathy in traumatic brain injury

Marc Maegele (M.D., Ph.D.)

Institute for Research in Operative Medicine (IFOM)
University of Witten/Herdecke
Cologne-Merheim Medical Center (CMMC)

Coagulopathy after traumatic brain injury (TBI) is frequent and represents a powerful predictor related to outcome and prognosis. Almost any disorder of coagulation apart from the reference range appears to be associated with worse outcomes and therefore resembles a clinically important target for therapeutic intervention. When severe TBI is coincided with coagulopathy mortality is extremely high. The complex pathophysiological mechanisms of the coagulopathy of TBI are multifactorial and remain still undefined. The nature of the coagulation abnormalities differs between severe TBI and non-TBI with somatic injuries. The current hypothesis for the development of coagulopathy after TBI includes combinations of both hypo- and hypercoagulable states promoted by the magnitude and the extent of the injury resulting in a variable degree of secondary injury via subsequent ischemic and haemorrhagic lesioning. The proposed underlying mechanisms to date may comprise the release of tissue factor (TF) and TF-bearing microparticles, platelet hyperactivity/dysfunction, shock and hypoperfusion thus triggering the protein C pathway and hyperfibrinolysis. Haemocoagulative disorders after TBI may be amenable to treatment, and adequate and timely management may protect from secondary injury and poor outcomes.
New experimental animal models in ICH and SAH

Richard F. Keep, Ya Hua, Guohua Xi

Department of Neurosurgery, University of Michigan, Ann Arbor, MI, USA.

Experimental research on intracerebral hemorrhage (ICH) has generally focused on targets within perihematoma tissue. This includes mechanisms causing parenchymal cell death, those underlying vascular disruption and bleeding, and, recently, there has been considerable interest in targeting perihematoma macrophages/microglia-mediated phagocytosis to regulate hematoma resolution. Less attention has focused on potential therapeutic targets within the hematoma itself. The MISTIE and CLEAR trials have targeted fibrin within the hematoma with tissue plasminogen activator to aid in clot evacuation, but there is evidence of other potential targets.

The removal of the red blood cell (RBC) component of the hematoma may occur via phagocytosis or erythrolysis. RBC phagocytosis by macrophages/microglia is regulated by eat-me/don’t-eat-me signals on RBCs, with the plasma membrane protein CD47 acting as a don’t-eat-me signal. RBC expression of CD47 decreases with time after ICH which may permit normal phagocytosis. Reducing CD47 genetically (using blood for hematoma from CD47 KO mice) or blocking CD47 with a neutralizing antibody, both speed clot resolution and reduce ICH-induced brain injury.

The mechanisms underlying erythrolysis within the hematoma have not been well studied. There is evidence that some erythrolysis occurs early (within first day) after an ICH (in rodents and humans) and participates in ICH-induced brain injury via the release of hemoglobin and its degradation to iron. One mechanism that can cause systemic erythrolysis in complement activation and insertion of the membrane attack complex (MAC) in the RBC plasma membrane. Inhibiting complement activation with N-acetylheparin, or MAC with aurin tricarboxylic acid, reduces erythrolysis within the hematoma in rats at day 1 and 3 after ICH and reduces ICH-induced brain injury and neurological deficits.

Thus, there are potential therapeutic targets within the hematoma. There may be advantages and disadvantages to targeting the hematoma versus perihematoma events, including questions of drug delivery. Targeting the hematoma may be particularly useful in combination with clot evacuation which allows direct drug administration to the hematoma. Identification of the mechanisms within the clot that regulate normal clot resolution, including RBC phagocytosis and lysis, as well as fibrin breakdown may help identify further therapeutic targets.
Non-traumatic intracerebral haemorrhage (ICH) results from bleeding into the brain parenchyma arising from the rupture of an arterial vessel, most often (>80%) a small arteriole affected by cerebral small vessel diseases (SVD). Deep perforator arteriopathy (also termed hypertensive arteriopathy or arteriolosclerosis) and cerebral amyloid angiopathy (CAA) are the most common forms of sporadic SVD causing ICH. A minority of ICH (less than about 20%) is caused by macrovascular bleeding sources such as arteriovenous malformations, cavernomas or fistulas.

The prognosis of intracerebral haemorrhage differs depending on the underlying cause, and in some cases (such as intracranial vascular malformations) early treatment can reduce the risk of future intracerebral haemorrhage; thus, accurate and rapid diagnosis is clinically important.

Acute ICH can be readily diagnosed on plain CT. Although older age, deep location of intracerebral haemorrhage and history of high blood pressure are considered markers of hypertensive arteriopathy, these are not sufficiently reliable indicators. Thus, further imaging beyond plain CT is warranted in most cases of ICH, regardless of clinical and radiological features. This imaging can be classified as: vascular (angiographic) imaging of the arterial tree and venous drainage—useful for excluding intracranial vascular malformations, aneurysms (“macrovascular” causes) and venous sinus thrombosis; and structural imaging (with CT or MRI)—useful for excluding tumours, cavernomas, haemorrhagic transformation of infarcts, and for identifying markers of SVD.

Recent data suggest that identifying markers of SVD can be useful in predicting the likelihood of identifying a macrovascular cause, thus helping to guide further investigations, including intra-arterial digital subtraction angiography (IADSA). Diagnostic markers for CAA are also available, based on MRI findings of lobar cerebral microbleeds (CMBs) or cortical superficial siderosis. Recent data suggest that acute CT findings and genetic biomarkers (APOE genotype) might also be helpful in predicting the likelihood of the presence of CAA.

This talk will discuss a rational approach to the diagnosis of ICH using vascular and structural neuroimaging, based on the available evidence and current practice.
Predicting intracerebral hemorrhage expansion

Dariush Dowlatshahi MD PhD FRCPC

University of Ottawa & Ottawa Hospital Research Institute, Ottawa, Canada

Early hematoma expansion occurs in approximately one third of patients with intracerebral hemorrhage; it is a major predictor of clinical outcome. Therapies targeting hematoma expansion may be most effective when directed to those patients at highest risk of expansion. However, identifying these patients can be challenging. This lecture will review promising predictive markers of hematoma expansion, including important clinical variables, non-contract CT findings, and the CT-angiography spot sign. We will compare the predictive performance of the various markers, and discuss the role of emerging clinical prediction rules.
Measurements of inflammation in ICH in humans

Adrian Parry-Jones

The University of Manchester, UK

ICH accounts for at least 10% of strokes and has an incidence of around 25 new cases per 100,000 per year. Around 40% of ICH patients die before one month and over half of survivors remain dependent on others for day-to-day care. Despite the considerable and persistent health, social and economic burden of ICH, it has received little attention in comparison to ischaemic stroke, and has no proven acute therapy, aside from modest benefits from intensive blood pressure lowering7 and stroke unit care. ICH thus represents a considerable unmet health need worldwide. Regardless of the cause, extravasation of blood into the brain parenchyma leads to rapid physical tissue injury and may lead to mass effect, brain herniation syndromes and early death. ICH can be further complicated by early haematoma expansion (in up to a third of patients within 4 h of onset) which worsens prognosis. For survivors of the acute phase, secondary brain injury contributes to tissue damage over the subsequent hours to days and is driven by a cascade of cellular and molecular events including the toxic effects of blood components (thrombin, haem, iron) and inflammation. Partly driven by these processes, cerebral oedema increases rapidly over 3 days with a further slow increase up to 1-2 weeks after onset. Preclinical studies have demonstrated that local inflammation occurs in response to diverse acute brain injuries (including ICH), exacerbating early damage and playing an important role in later repair and recovery. Within hours of an acute brain injury, a sterile inflammatory response is initiated where activated microglia take on a pro-inflammatory phenotype, releasing cytokines and chemokines that activate astrocytes and endothelial cells and lead to recruitment of neutrophils to the site of injury. This early inflammatory response profoundly exacerbates tissue injury but over subsequent days, factors released by circulating blood monocytes recruited to the site of injury limit damage by switching the resident microglia to a predominantly anti-inflammatory phenotype. Previous clinical studies in ICH have largely focused on peripheral inflammatory markers and shown associations between fever, elevated white blood cell count, IL-6, CRP, fibrinogen, and c-fibronectin on admission and worse short term outcomes (haematoma expansion and neurological decline at 48 h). Elevated CRP, fibrinogen and matrix metalloproteinases (MMPs) on admission are associated with poor functional outcomes and survival at 1-3 months. These clinical studies demonstrate the importance of the systemic inflammatory response. Animal models have taught us much about the central nervous system (CNS) inflammatory response to ICH, but current ICH models have limited relevance to the clinical disease and research in ischaemic stroke has been blighted by the failure to translate promising preclinical findings to effective therapies. In order to effectively target inflammation for patient benefit, a greater understanding of the nature, distribution and progression of the inflammatory response within the brain after clinical ICH is required.
Anti-inflammatory Treatments After ICH

Magdy Selim, MD, PhD.

Harvard Medical School/Beth Israel Deaconess Medical Center. Boston, MA. USA

BACKGROUND: The role of inflammation, both central and peripheral, in the pathophysiology of secondary injury after ICH has been increasingly recognized in recent years. Hemoglobin degradation products, in particular iron, released from the hemolyzed red blood cells within the hematoma illicit specific inflammatory process involving activation of resident microglia, infiltration of systemic immune cells, and production of pro-inflammatory cytokines, chemokines, and reactive oxygen species. Targeting peripheral inflammation and upstream events in the inflammatory cascade to quell the neuroinflammatory response after ICH represents a promising therapeutic strategy and is the subject of ongoing investigations.

OBJECTIVE: To briefly review important targets in the inflammatory cascade after ICH, and to discuss relevant ongoing therapeutic investigations, including the results of the Deferoxamine in ICH (iDEF) Trial.
Elevated blood pressure (BP) is a common response in patients with acute intracerebral hemorrhage (ICH) and predicts a poor outcome, in part by promoting growth of the underlying hematoma. However, two large randomized controlled trials that evaluated the efficacy and safety of early intensive BP lowering – INTERACT2 and ATACH-II – produced apparent conflicting results: INTERACT2 (n=2,829) fell short of showing a clearly significant effect on the primary outcome of death or dependency (mRS scores 3-6) but did show a significant effect on the key secondary outcome of functional recovery (ordinal shift analysis of mRS scores) and across several parameters of health-related quality of life at the end of follow-up, without raising any safety concerns; while ATACH-II (n=1,000) showed no effect of a more intensive BP lowering regime on death or severe disability (mRS scores 4-6) and an increase in renal adverse events. Furthermore, the recently completed pre-hospital ambulance-delivered trial (RIGHT-2) has shown in subgroup analysis of adverse clinical outcomes, including increased hematoma growth, from hyper-acute (<2 hours) administration of the transdermal glyceryl trinitrate patch (compared to placebo patch). Consequently, there remains ongoing uncertainty over the balance of benefit and harms of BP lowering in ICH, and in particular with regard to the optimum agent, timing, intensity and duration of treatment. A recently completed individual patient data pooling analysis of INTERACT2 and ATACH-II will shed light on the associations of early systolic BP lowering parameters and outcome, and ongoing clinical trials that involve (i) care bundles including intensive BP lowering (INTERACT3, cluster design) and (ii) pre-hospital BP lowering (INTERACT4), will provide further randomised evidence to this important topic. BP control provides the most practical, low-cost and widely applicable treatment for this serious illness that can potentially be administered without requirement of CT scanning. This presentation provides a contemporaneous overview of the topic, future directions and recommendations for practice.
Innovations for the Management of Spontaneous ICH

Joseph P. Broderick

University of Cincinnati, USA

Intracerebral hemorrhage (ICH) remains the only major stroke subtype without a scientifically proven treatment as demonstrated by the predefined primary endpoint in a Phase III Trial. Prior trials do provide clues about the innovations that are required for demonstrating an effective therapy for acute ICH. The fundamentally most important factor to consider in the next trials is the time-dependent pathophysiology of ICH. Most ongoing bleeding in spontaneous ICH not associated with anticoagulants is completed within 2-3 hours. Thus, medical therapies including hemostatic agents must be given within this time window if they are to have a chance to be effective. Innovative methods to decrease the time to treatment in future trials are treatment within mobile stroke units, use of exception from informed consent or emergency consent, and streamlining of processes in the emergency department. There may be synergy between acute blood pressure management and hemostatic agents. Inclusion of subjects in medical trials with large ICHs that are associated with very high mortality is not advisable. The NINDS FASTEST Trial contains several of these innovative features and will be presented in more detail during the conference. Once bleeding is completed, damage to surrounding brain has a strong mechanical component that is unrelated to chemical toxicity of blood on surrounding brain and appears to have a narrow therapeutic time window. This would suggest that hyper-early and substantial removal of ICH (as suggested by MISTIE 3 trial) and methods to halt ongoing bleeding in the surgical bed could improve outcome, even in patients with larger ICH. Use of t-PA in these settings require stabilization of bleeding but minimally invasive methods that are strictly mechanical may allow for rapid surgical removal. Standardization of surgical approach for such a hyperacute trial will be important. We have learned a lot from prior large ICH trials and hopefully are poised to find the first treatment for ICH.
Antithrombotic drugs and the risk of ICH

David Gaist

Department of Neurology, Odense University Hospital &
Department of Clinical Research, Faculty of Health Sciences, University of Southern Denmark, Odense, Denmark

The interest in the relationship between intracerebral haemorrhage (ICH), the stroke type with the most dismal prognosis, and use of antithrombotic drugs has been re-kindled in recent years. This is in part due to the major changes in use of antiplatelet drugs and oral anticoagulants (antithrombotics) observed in developed countries in recent years. First, use of antithrombotics has increased substantially, mirroring changes in population demographics; this increase is expected to further burgeon in future years owing to steadily growing numbers of older persons in need of secondary cardio- and cerebrovascular disease prevention. Second, patterns of antithrombotic drug use have also changed due to the introduction of new drugs (e.g. direct oral anticoagulant drugs [DOACs]), and due to a higher prevalence of more aggressive therapy regimens (e.g. dual and triple antithrombotics). Third, in the near future, new antithrombotic agents are expected to enter the market and new patterns of antithrombotic drug may emerge as the result of numerous ongoing trials in the field. Finally, the recent advent of agents that can reverse the anticoagulating effects of DOACs will probably also have an impact on the use of antithrombotics.

Thus, the landscape of antithrombotic drug use has not only undergone considerable changes, but will in all probability continue to do so in years to come. These changes necessitate the collection of data on drug safety that can supplement the evidence provided by randomized clinical trials; data that may better reflect the everyday clinical use of antithrombotics. Large observational studies with timely collection of data from unselected populations may provide the necessary information, and may be particularly pertinent regarding the risk of ICH, given the relative rarity of this type of stroke.

In this talk, results from recent studies that illustrate some of the points made above will be presented with emphasis on provisional data from a recently initiated large Danish observational study. In this nationwide case-control study, use of antithrombotic drugs among more than 17,000 incident hospitalized cases of ICH was compared with that of approximately 700,000 general population controls. Information on drug use, co-morbidity and other potential confounders was based entirely on nationwide registries. The large sample allowed exploration of the association between use of antithrombotics with risk of ICH. This approach may provide a useful model for future analyses based on regularly updated data from Danish registries and may provide a framework for studies in other countries with similar settings.
Safety and usefulness of haemostatic drugs for acute ICH

Nikola Sprigg

University of Nottingham, United Kingdom

Background
Outcome after spontaneous intracerebral hemorrhage (ICH) is related to hematoma expansion, which occurs in up to one-third of patients. Early use of haemostatic drugs might limit haematoma growth and thus improve outcome.

Objectives
This talk will review the evidence for different classes of haemostatic drugs in adults with acute ICH, including tranexamic acid, desmopressin and rFVIIa. Focus will be on data from recently completed studies and an over view of on-going and planned studies will be presented.

Results
Tranexamic acid was safe in 2325 participants in TICH-2 but had no significant effect on functional outcome despite modest reductions on haematoma expansion and early death. Other RCTs of tranexamic acid in ICH are on-going; STOP AUST NCT01702636, TRIAGE NCT02625948 and the recently commenced ambulance based STOP MSU NCT03385928.

Desmopressin is used in a number of inherited bleeding conditions to treat or prevent bleeding and recommended for the reversal of antiplatelet drugs in guidelines from the USA. A small RCT in patients with ICH is on-going, Desmopressin for reversal of Antiplatelet drugs in Stroke due to Haemorrhage DASH ISRCTN67038373.

In small studies rFVIIa decreased ICH growth but had no benefit on clinical outcomes, perhaps due to increased vaso-occlusive events. The planned Recombinant Factor VIIa (rFVIIa) for Hemorrhagic Stroke Trial FASTEST NCT03496883 will test the hypothesis that treatment with rFVIIa within two hours of onset in appropriately selected patients with spontaneous ICH improves outcome.

Conclusion
More RCT data is needed to determine if haemostatic drugs are safe and effective at improving outcome after ICH. Studies need to focus on enrolling participants at greatest risk of HE – hence enrollment and study procedures must be rapid.
Predictors of intracerebral hemorrhage in ischemic stroke treated with fibrinolysis

Joan Martí-Fàbregas

Hospital de la Santa Creu i Sant Pau, Spain

Like all antithrombotic drugs, the use of rt-PA is associated with a risk of intracerebral haemorrhage (ICH), a complication with high mortality. Although the actual risk depends on the definition of ICH that we use, symptomatic ICH occurs in 2-7% of treated patients. In order to analyze the variables associated with the risk of symptomatic ICH, various methodological aspects must be considered due to the heterogeneity and inconsistency of the available studies. There are many risk factors associated with this complication, including age, stroke severity (NIHSS scale), hyperglucemia and early signs of cerebral ischemia. The detection of microbleeds and severe leukoaraiosis has been reported to increase the risk. With the exception of hyperglucemia and high blood pressure, most risk factors are not treatable. In one clinical trial, intensive blood-pressure lowering therapy did not decrease the rate of symptomatic ICH compared to non-intensive therapy. Also, various risk scores models have been developed to predict intracerebral bleeding and the prediction performance (C statistics) ranges between 0.55 and 0.86. However, no factor or group of factors is important enough to deny the benefit provided by this drug.
Rehabilitation after hemorrhagic stroke: stroke-subtype specific recovery therapies

Katharina Stibrant Sunnerhagen
University of Gothenburg, Sweden

Rehabilitation after stroke are overall dependent on impairments. However, when it comes to hemorrhagic stroke and specifically if neurosurgery has been needed, the possible impact of elevated blood pressure needs to be considered. Activation and mobilization of a sedated patient in the neurointensive care is beneficial for the pulmonary system and reduces the risk of contractures. This leads to increase in heart rate and blood pressure as well as increased pressure in the ventricular system. Later on, the discussion sometime arises regarding how much the brain is allowed to pulsate when the skull bone has been removed and whether a helmet should be used.

Being in bed leads to de-conditioning and reduction of bone mass, muscle mass and increases the risk of complications. The important thing is to realize that there is a need for mobilization and activation since the patient otherwise will become even more de-conditioned. Activation and mobilization always lead to increased blood pressure. There will be no RCT on how the safe increase in blood pressure. For good care and rehabilitation, discussions regarding possible limits should take place in the team.
Minimally invasive surgery with thrombolysis for intracerebral hemorrhage in China

Chao Pan, Zhouping Tang

Department of Neurology, Tongji Hospital of Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China.

Spontaneous intracerebral hemorrhage (ICH) is a devastating disease due to intracranial hematoma formation. It has an annual incidence of 20 per 100,000, accounting for 10%–15% of all strokes in the Western countries and up to 30%–50% in China. Removal of hematoma is regarded as the key to successful treatment. Rapid and substantial hematoma reduction can be achieved utilizing minimally invasive surgery with thrombolysis (MIST) which was widely used in China (More than 10,000 patients a year received this therapy). Here, we introduced the development of MIST in China including the surgical instruments and stereotaxic technique. A considerable portion of ICH patients (even infratentorial hemorrhage) received MIST and benefited from successful removal of hematoma and less brain disruption. Researchers in China also studied the possible protective mechanism of MIST therapy using ICH animal model and neuroimaging. The disruption of the internal capsule due to mechanical compression and toxic effect of hematoma can be relieved by MIST.

In conclusion, minimally invasive surgery with thrombolysis therapy was widely used in China and worthy for further evaluation and may be a promising treatment option.

KEY WORDS: Intracerebral hemorrhage; hematoma evacuation; minimally invasive
Risk factors associated with progression of traumatic intracerebral hemorrhage


Department of Neurosurgery, Hospital 12 de Octubre, imas12, Universidad Complutense de Madrid

Traumatic intracerebral hematomas (TICH) appear in about 13-35% of patients suffering a traumatic brain injury. The hemorrhagic progression of TICH is the cause of surgery for about 20% of patients and is a cause of further deterioration and poorer outcomes. Therefore it is critical to early identify which patients are in risk of hemorrhagic progression of TICH and to know which factors are associated to this phenomenon.

We review the pathophysiology of hemorrhagic progression of TICH and the risk factors associated to progression in a large cohort of patients. We focus on the biomechanics of TICH and its association to hemorrhagic progression as well as its relation to a common surgical procedure for traumatic brain injury, decompressive craniectomy.

The hemorrhagic progression of the TICH occurs in a higher percentage of patients (63%) in our case series most probably due to the fact that it is a moderate and severe TBI database. Risk factor for hemorrhagic progression include acute subdural hematoma, older age, hypoxia, falls as the mechanism of trauma and treatment by decompressive craniectomy. There is an association of hemorrhagic progression with impact location and contrecoup mechanism. Decompressive craniectomy for traumatic lesions is a risk factor for hemorrhagic progression, and the degree of decompression obtained, i.e. size of craniectomy and herniation of brain parenchyma, is related to the change in TICH volume.
The acute, subacute and chronic phases after brain injury are heterogeneous demonstrating components of both recovery and of further deterioration of brain tissue integrity and function. Tissue death was historically considered to be confined to the first few weeks following traumatic brain injury (TBI) or stroke, but it has now become apparent that CNS tissue continues to be lost for many months after the initial injury. This delayed tissue loss occurs not primarily at the initial site of injury, but rather within regions and projection areas quite distant from this site. This process is known as secondary neurodegeneration (SND). It has consistently been identified in humans following stroke and TBA as well as after injury in experimental rodent models. SND is characterized not only by loss of CNS tissue but also with the later emergence of cognitive deterioration and dementia-like symptomatology. We have in a recent suite of experimental work shown that psychological stress further exacerbates deterioration and slows down recovery after brain injury. Stress negatively impacts cellular repair and is correlated with functional impairment. Stress also impacts on those psychological domains that underpin activities known to be essential to the rehabilitation process, including pain, fatigue, and cognition, and is therefore likely to compromise the recovery trajectory and any rehabilitation attempts. Epidemiological studies suggest that stress-related disorders are experienced at greater rates in stroke survivors than in the general population. However, it is not routinely monitored in the clinic. Stress management programs have not been specifically trialed in stroke survivors. Where they have been used in other chronic diseases, whilst some interventions alleviate subjective ratings of perceived stress in the short term, effects on clinically relevant endpoints such as disease progression, risk of subsequent events, and/or risk of stress-related disorders has not yet been shown. Environmental enrichment (EE), a multimodal approach comprising physical, social and cognitive activity, is a very promising strategy to reduce stress that also is broadly deployable. A multitude of cellular reactions is underpinning the beneficial effects of EE on functional recovery after stroke and TBI. Novel translational opportunities to influence plasticity, recovery and degeneration in patients will be discussed at the seminar.
Surgical and Medical Management of Contusions

Marc Maegele (M.D., Ph.D.)

Professor for Trauma Surgery
Department of Trauma and Orthopedic Surgery
Institute for Research in Operative Medicine (IFOM)
University of Witten/Herdecke
Cologne-Merheim Medical Center (CMMC)

Cerebral contusions are fairly common, found in 8% of all TBI cases and in 13% to 35% of severe injuries. There is a spectrum of severity associated with cerebral contusions from tiny punctate contusions in mild TBI with little or no clinical significance carrying the same prognosis as normal findings on CT onto large contusions with significant mass effect in severe TBI that can be life-threatening. Brain contusions can be classified as coup or contrecoup injuries. Coup contusions occur at the site of impact, whereas contrecoup contusions occur on the opposite side or distant from the impact. Contusions may be present in any part of the brain but are most commonly found in the frontal and temporal lobes. They may often enlarge during the first week after injury. Temporal lobe contusions are particularly ominous due to their proximity to the brainstem and risk of herniation. Repeated CT should be considered in cases of clinical deterioration. The current BTF guidelines recommend that patients with parenchymal mass lesions and signs of progressive neurologic deterioration related to the lesion, refractory intracranial hypertension, or signs of significant mass effect on CT should be treated operatively. Also patients with GCS scores of 6 to 8 with frontal or temporal contusion greater than 20 cm3 with midline shift greater than 5 mm or cisternal compression on CT scan and patients with any lesion greater than 50 cm3 in volume should be surgically treated. Management of severe TBI patients using information from ICP monitoring is recommended to reduce in-hospital and 2-week post-injury mortality. Treating ICP >22 mm Hg is recommended because values above have been associated with increased mortality. Early (within 2.5 h), short-term (48 h post-injury), prophylactic hypothermia is not recommended to improve outcomes in patients with diffuse injury. Mannitol is effective for control of raised ICP at doses of 0.25 to 1 g/kg body weight. Arterial hypotension (systolic blood pressure < 90 mm Hg) should be avoided; the recommended target CPP value for survival and favorable outcomes is suggested between 60 and 70 mm Hg. The use of steroids is not recommended for improving outcome or reducing ICP. In patients with severe TBI, high-dose methylprednisolone was associated with increased mortality and is contraindicated. Point-of-care functional coagulation assays (TEG or ROTEM) may inform and trigger individualized protocols and algorithms to rapidly correct accompanying haemostatic defects.
Endovascular does not always equal Minimally Invasive: Deciding on Coiling/Clipping for Everyday Aneurysms: Perspective of a Dual-Trained Neurosurgeon

Sujoy K. Sanyal
Senior Consultant Neurosurgeon,
Director, Vascular-cum-Endovascular Neurosurgery,
NH Institute of Neurosciences, Rabindranath Tagore Hospital, Calcutta, India

The author as a Vascular-cum-Endovascular Neurosurgeon does not feel that the absence of an incision makes Endovascular necessarily always Minimally Invasive. Placement of a stent in a small vessel such as the ACA/MCA with possibilities of in-stent stenosis is by no stretch of imagination minimally invasive because in order to treat a pathology outside a vessel, the vessel itself is now exposed to long-term risk. Moreover, putting a patient on antiplatelets is invasion of a patient’s homoeostatic mechanisms. Increasing numbers of catheters in the vessel lumen increases thromboembolic risks. Therefore, the author prefers not to use stents in reasonable-to-clip wide-necked Acom/MCA/DACA aneurysms. This is not to say that the author would hesitate to use stents or even flow-diverters in difficult-to-clip aneurysms.

The authors’ contention is that the debate between Coiling and Clipping, dictated by statistics, needs to be replaced by a more patient-specific approach. The only reasonable consensus is that posterior circulation aneurysms with the exception of distal PICA aneurysms and cavernous ICA aneurysms are preferably treated by Endovascular means.

The decision on all other aneurysms hinges on many factors, including aneurysm architecture, location, parent vessel anatomy from the arch of the aorta to beyond the aneurysm, presence of vasospasm, presence of ICH/IVH, age and grade. Based on these factors, some aneurysms are better off clipped and some are better off coiled. Only in the ones, which are suitable for both, does the debate of statistics arise. The author, being a Vascular-cum-Endovascular Neurosurgeon, will try to illustrate this approach, by a series of 210 cases from the last 9 years of his combined practice. He will illustrate that after having adopted Endovascular Therapy, he has coiled aneurysms, which he would have tried to clip before. And he will also illustrate that, even after having adopted Endovascular Therapy, he still would not think of coiling many aneurysms. He will also illustrate a couple of Endovascular mishaps and the lessons thereof. The preferences which have arisen out of this Dual Vascular-cum-Endovascular practice will be discussed. The author chooses What is Easiest for him and What is Safest for the patient. The author prefers Clipping for Small aneurysms, Wide-necked Acom/MCA/DACA aneurysms, aneurysms with unfavorable cervical vessel anatomy or aneurysms with large ICH. The author prefers Coiling for aneurysms with spasm because spasm can be treated by Endovascular means and surgery can only aggravate spasm. The author prefers Coiling for aneurysms with vessels arising from the neck. As about ICA aneurysms, the author uses both modalities in almost equal proportions. Since most Acom/MCA aneurysms are wide-based, most of Acom/MCA aneurysms get clipped in his practice. Obviously, most posterior circulation aneurysms except distal PICA aneurysms get coiled.
Timing for treatment in ruptured AVMs: the neuroradiologist point of view

Pedro Pablo Alcázar


ABSTRACT: Embolization is an important tool in the multidisciplinary treatment of brain AVMs. It can be used in different clinical scenarios in the treatment of ruptured brain AVMs: presurgical embolization, curative embolization, preradiosurgical embolization, targeted embolization and palliative embolization. The timing of definite management of ruptured brain AVM in not standardized in the cerebrovascular community. Emergent treatment aims to reduce rebleeding rates but complex invasive treatments can compromise neurological recovery due to acute bleeding. To the contrary, delayed, elective treatment may avoid the risk of exacerbating the deficits had brought the patient to medical attention. Embolization is a minimally invasive therapeutic modality that can be applied even in critically ill patients without compromising its stability but in most scenarios it should be integrated in a coordinated multidisciplinary sequence of treatments. The timing of embolization in those scenarios is discussed and illustrated by several cases of the author personal experience.
Cavernous Malformation of the Brain Stem

Miguel A. Arraez

Chairman, Dept of Neurosurgery, Carlos Haya University Hospital
Professor of Neurosurgery, University of Malaga
Malaga. Spain

The anatomy of the brainstem is one of the most challenging of the Central Nervous System. The brainstem can harbor different tumors, among them cavernomas and tumors from glial origin. The first consideration is about the indication for surgery. Young patients with cavernomatous lesions that have bled are amenable for surgery. Regarding tumors of glial origin, bulky/exophytic lesions can be resected. The surgical approach must be tailored for every case, trying to incorporate the concept of “safe entry zone” (some specific areas of the brainstem surface/IV ventricle that can entered without neurological injury). It may need skull base osteotomies to improve the access.

The ventral medullary region can be approached through the retrolivary sulcus (between C1-XII nerve root exit). The far lateral approach can be really useful for that purpose. The posterior medullary region can be entered through the posterior median, paramedian and lateral sulcus. The pons can be approach through the forth ventricle: median sulcus and periculstatic area (supra-infrafacial triangle). The cerebral peduncles can be reached sometimes through the fourth ventricle and also through a supratenorsular route or retrosigmoid craniotomy. The ventral pons can be reached through a retrosigmoid, presigmoid or transpteral approach (safe entry zone: the peritrigeminal -anterolaterally placed- area). There is also another entrance between the exit of V and VII nerves. The subtemporal approach or a cranio-zygomatic approach can lead to the mesencephalic median sulcus, the safe entry zone of the ventral mesencephalon. The dorsal mesencephalon can be reached through a supracerebellar-infratentorial approach.

The surgery of brainstem tumors must be done in the context of a perfect knowledge of the anatomical neurovascular structures. Some skull base approaches can be really helpful to enter the safe entry zones, along with intraoperative neurophysiological monitoring.

Miguel A. Arraez
Carlos Haya University Hospital
Malaga. Spain
A Comprehensive analysis of the STICH trials: identifying those patients who would benefit from craniotomy.

Alexander David Mendelow, Barbara A Gregson, Patrick Mitchell

Newcastle University, Newcastle Upon Tyne, United Kingdom

The STICH Trials randomised patients with spontaneous intracerebral haemorrhage (ICH) to early surgery or initial conservative treatment. The STITCH(TRAUMA) Trial randomised patients with traumatic ICH in an identical fashion. All 3 trials had neutral results, although there was a significant reduction in mortality in the craniotomy group from the STITCH(TRAUMA) Trial. This may be because surgery has a minimal effect on recovery, or because surgery has benefit in some cases and detriment in others. We compare these competing explanations for the neutral results, introduce a new non-parametric method of analysis and apply the indication from this method back to the data.

Methods: Data from 1541 patients from the 2 STICH trials and 167 from the STITCH(TRAUMA) Trial were analysed using

1. Standard meta-analysis of prognosis-based dichotomised outcome and pre-specified standard subgroups of Glasgow Coma Score (GCS): 3-8, 9-12, 13-15;
2. New non-parametric regression of ranked Extended Glasgow Outcome Scale (GOSE) against ranked GCS and ranked volume.
3. Repeat standard meta-analysis using the subgroup coding identified by 2)

Results: Standard meta-analysis of STICH I and II showed more favourable outcomes, although non-significant, with surgery if the presenting GCS was 9-12 (OR 0.70, 95% CI 0.48, 1.03; p = 0.07). In the STITCH(TRAUMA) Trial there were also more favourable outcomes, although non-significant, with surgery if the presenting GCS was 9-12 (OR 0.48, 95% CI 0.18, 1.26; NS). The ranked analysis suggested that initial conservative treatment was better for patients at the extreme ends of the GCS and that surgery was better if the presenting GCS was 10-13. Surgery was harmful for small lesions but showed increasing benefit for larger volume lesions.

Meta-analysis from the 2 STICH Trials with GCS 10-13 confirmed that surgery was beneficial with OR of 0.71 (95% CI 0.51, 1.00; p=0.05). The effect in the GCS 10 to 13 subset was even greater and more significant for the STITCH(TRAUMA) Trial with an OR of 0.16 (95% CI 0.05, 0.51; P=0.002).

Conclusions: The null results observed in the STICH trials are due to mixing patients who benefit from surgery with those who are harmed. Patients with a GCS 10-13 and a large ICH are likely to benefit from surgery. This categorisation also appears to apply to traumatic ICH.
Current Status of the Endoscopic Hematoma Evacuation and Surgical Innovations for the Intra-Cerebral Hemorrhage

Professor, Takuji Yamamoto, M.D.

Chair of Neurosurgery
Chief of Stroke Center
Department of Neurosurgery
Juntendo University Shizuoka Hospital, Japan

According to the reliable study in Japan, so call “Hisayama Study”, putaminal hemorrhage have significantly decreased, and thalamic hemorrhage have remarkably increased, particularly among subjects aged over 70’s. Several factors might be considered as risk in this trend such as hypertension, alcohol intake, and more. The influence of hypertension has declined since 1970. On the other hand, the aging rate is rapidly progressing. This elevation may contribute to the increasing of thalamic hemorrhage which is likely to occur in the elderly patient. Moreover, Asian population has higher risk of ICH than another race. Under that social situation, to take advantage of the surgical modality might be one of important clinical subjects. In Japan, the endoscopic hematoma evacuation had been spreading as one of the surgical options. Hematoma clot can be removed by the suction tube under the endoscopic view through the small sheath. I will present our surgical procedure with some illustrative cases. In our study, putaminal hemorrhage in patient with improvement outcome should be within 30 to 60ml as volume. And their GCS should be between 9 and 12 points. Moderate severity would be optimal surgical indication for putamen. The cerebellar hemorrhage might also be good indication for the endoscope. The Endoscopic surgery took for 74 minutes as average. It is significantly shorter than suboccipital approach, even the evacuation rate was almost same degree. The endoscopic surgery can also be applied to intra-ventricular hemorrhage which cause by various diagnosis; thalamic hemorrhage, subarachnoid hemorrhage, AVMs and more. We can approach to bi-lateral ventricle with an endoscopic septostomy by unilateral single burr. It could make the patient management with hydrocephalus to be simplified, and could be reduction the rate of the permanent shunt insertion.

We believe that the minimally invasive endoscopic surgery might be one of the treatment options for aging Japanese patients with ICH. In Japan, the registry study is ongoing to establish the clinical evidence in future.
There is equipoise regarding the surgical management of traumatic intracranial haematomas, particularly acute subdural haematomas and intracerebral haematomas / contusions. There are three multicentre randomised studies that address this topic: STITCH, RESCUEicp and RESCUEasdh.

The status of these clinical trials is summarised as follows:

**STITCH.** The STITCH trial addressed the role of early surgery for traumatic intracerebral haematoma compared to initial medical management. The study randomized 170 patients between early surgery and medical management. The results showed that early surgery reduces mortality with a trend towards an increase in favourable outcome.

**RESCUEicp.** The RESCUEicp trial addressed the role of secondary decompressive craniectomy for diffuse injury and mass lesions in patients with raised and refractory intracranial hypertension with an intracranial pressure threshold CP of 25mmHg for 1-12 hours. The study randomized 408 patients between secondary decompressive craniectomy and ongoing medical management. The results showed that surgery reduces mortality, increases vegetative state (VS), lower severe disability (LSD), and upper severe disability (USD) with similar rates of moderate disability and good recovery. There is an improvement in outcome in the surgical patients between 6 and 12 months. For every 100 patients undergoing the procedure decompressive craniectomy resulted in saving 22 more patients with 5 VS, 4 LSD and 13 USD or better (independent at home for at least 8 hours).

**RESCUEasdh.** The RESCUEasdh trial is addressing the role of primary decompressive craniectomy for acute subdural haematoma. The aim is to randomize 440 patients during surgery between bone flap replacement (craniotomy) versus bone flap removal (craniectomy) following evacuation of an acute subdural haematoma.

This presentation will give an update on the results and interpretation of these studies in terms of assisting with clinical decision making.

References


Meta-analysis of surgical trials for spontaneous ICH

Barbara Gregson¹, David Mendelow¹, Daniel Hanley²

¹Newcastle University, United Kingdom
²Johns Hopkins University, USA

Randomised controlled trials are the gold standard method of obtaining evidence for the beneficial effect of one treatment over another. There have now been over 30 trials of different surgical treatments for spontaneous intracerebral haemorrhage (ICH). Amongst surgeons there has been a strongly held belief that evacuation of the haematoma is important to achieve recovery by preventing secondary injury whether this is due to toxic effects of blood or to the mass effect of the haematoma. The first trial in the sixties was negative possibly because of the lack of CTs to confirm presence of ICH or because of less well developed clinical medical care and it was some years before scientific advances led to the belief that this was a treatment that could be revisited. So through the latter years of the 20th century and the beginning of this there has been a desire to investigate this further. There have been a large number of single centre trials but very few well conducted multicentre trials. These have failed to find a significant benefit but combining their results might lead to an answer. Meta-analysis is the method used to combine the results but it is essential to ensure that the studies included are scientifically rigorous and that the values extracted from them are accurate.

To date there have only been three large (> 500 patients) multicentre trials of treatments to evacuate the hematoma: STICH (2005; 1033 patients), STICH II (2013: 601 patients) and MISTIE III (2019: 506 patients). While each of these were in themselves neutral. Further information may be obtained by combining them and by looking at subgroups of patients in particular by examining the effect of initial severity in terms of the Glasgow Coma Scale and the effect on the outcome as defined by the Glasgow Outcome Scale.
Technical challenges in surgical treatment of ruptured aneurysms presenting as intracerebral hematoma

Angel Horcajadas MN Ph D.
Virgen de las Nieves and Vithas Hospitals. Granada (SPAIN)

Brain aneurysms are an uncommon cause of intracerebral hematoma. The most common presentation of brain aneurysms is subarachnoid hemorrhage and only around 20-40% of the aneurysms present with intracerebral hemorrhage. Hemorrhage associated with brain aneurysms is more common in distal ones, especially in MCA aneurysms. The simple presence of clot in an SAH increases the Fisher grade, turning it into grade IV, implying a worse prognosis.

Most of the time clot is not enough to threaten by itself the patient life but sometimes bleeding is profuse and the hematoma can cause mass effect and brain herniation. These cases are emergent and need urgent surgery to avoid death and to improve the prognosis.

The surgery of intracerebral hematomas associated with brain aneurysms is one of the most difficult situation than a neurosurgeon can face. It usually happens in an unearthly time, with the unappropiate surgical team and sometimes with incomplete presurgical studies. From the surgical point of view, the status of the brain use to be bad, with severe hypertension and the risk of intraoperative rupture of the aneurysms is very high.

All these drawbacks makes this surgery one of the most challenging surgeries for a neurosurgeon, even for the more skilled ones.

There are some technical points we have to take into account when facing this pathology:
- Preoperative studies. It is important to perform a good angioCT to identify the aneurysm, its shape, the relationship with the distal branches and with the hematoma. Angiography is not necessary if a good angioCT is available unless the situation of the patient allows it and endovascular treatment is planned.
- Anesthesiology. Brain relaxation depends on anesthesiologist to a great extent.
- Surgical planification. Positioning, craniotomy size and location
Abstracts of Oral Presentations
O-001

Nationwide Prevalence for Opioid Abuse among Hemorrhagic Stroke Patients in the United States

Farhaan Shaheer Vahidy, Hari K Indupuru, Jennifer R Meeks, Arvind B Bambhroliya, Louise D McCullough, Sean I Savitz

Department of Neurology, McGovern Medical School at UTHHealth Houston TX, USA

INTRODUCTION: Substance abuse (SA) is a risk factor for hemorrhagic stroke (HS) and has been associated with poor outcomes among HS patients. Opioid abuse (OA) can be a precursor for SA and is considered to be the new gateway mechanism to SA. National prevalence and outcomes associated with OA particularly in young hemorrhagic stroke patients (YHSP) has not been described. We report nationally representative prevalence and factors associated with OA among YHSP in the US. We further explored association of OA and SA with poor in-hospital outcomes HS patients.

METHODS: We identified intracerebral hemorrhage (ICH) and sub-arachnoid hemorrhage (SAH) patients coded for Opioid, Cocaine, Alcohol, Cannabis, Amphetamine and Hallucinogen abuse using previously validated ICD-9 codes, from the National Inpatient Sample (NIS) for the years 2006 – 2011. The NIS represents 90% of all US hospitalizations. Patients aged 18 - 45 were categorized as YHSP. Survey design logistic regression methods are used and nationally representative estimates are reported as Odds ratios (OR) and 95% Confidence Intervals (CI).

RESULTS: A total of 551,312 HS patients (53.5% female) were identified; of whom, 11.0% were ≤ 45 (YHSP). The proportion of OA among YHSP was 1.4%. YHSP had a significantly higher proportion of SA as compared to non-YHSP for all substance types. Among OA YHSP, 63.3% patients also abused at least one additional substance, with up to a maximum of 4 substances. Males were more likely to be opioid abusers (OA) as compared to females (OR: 1.33, CI: 1.12 – 1.59) and higher likelihood of OA was associated with lower household income (OR: 1.41, CI: 1.27 – 1.56). The odds of OA among African Americans and Hispanics were higher as compared to White HS patients (OR, CI: 3.55, 2.89 – 4.35 and 1.57, 1.15 – 2.14). OA was also associated with higher disease severity and mortality risk, likelihood of being on ventilator support, and longer length of hospital stay. Higher proportion of OA was treated at urban and teaching hospitals, and in the Northeast as compared to other national regions. The adjusted odds for death or poor discharge disposition were not statistically different between OA and non-OA HS patients; however, YHSP with SA had a higher likelihood of in-hospital death as compared to those without SA (OR: 1.26, CI: 1.11 – 1.44). This effect however did not remain statistical significance after co-variate adjustment.

CONCLUSIONS: Nationwide prevalence of OA is significantly higher among hospitalized YHSP, and about two-thirds of OA patients were also coded for at least one additional substance abuse. OA was associated with lower income, minority race, and higher disease severity. Although OA has not been independently identified as a risk factor for HS, OA is frequently accompanied by or is a precursor to SA. Routine screening and counselling is required in YHSP to prevent recurrence and poor outcomes associated with OA and SA.

Keywords: Intracerebral Hemorrhage, Subarachnoid Hemorrhage, Opioid Abuse, Substance Abuse, Outcomes
O-002

Global Burden of Intracerebral Hemorrhage

Christopher Carr, Alexander Yacob, Brendan Huang, Aaron Sean Dumont

Department of Neurosurgery, Tulane University School of Medicine /Ochsner Clinic Foundation, New Orleans, LA, United States

Background - Intracerebral hemorrhage (ICH) can occur spontaneously or secondary to traumatic brain injury and carries a particularly large disease burden worldwide. Despite the best efforts of researchers and clinicians, ICH remains fatal in close to 50% of patients and results in permanent disability in approximately one third of survivors. The Global Burden of Disease (GBD) is an international collaboration and the largest comprehensive investigation of global health disease burden ever conducted. It has been particularly insightful for understanding disease demographics in middle-income nations undergoing rapid development. We hypothesized that rapidly modernizing, middle-income nations would have a particularly high burden of ICH. We also investigated whether there would be a difference between deaths attributable to ICH and years lived with disability (YLD) for ICH survivors depending on national income, as this may reflect the overall effectiveness of higher-cost interventions aimed at reducing ICH mortality.

Methods - Using GBD data, we abstracted data for death by cause and YLD for ICH for every nation in the world. Using data from the Global Health Data Exchange, we determined GDP per capita for each nation. We constructed histograms to visually correlate the global burden of ICH with national income. We looked at additional characteristics of nations with particularly large and small disease burden, including region.

Results - 16 of the 20 (80%) nations with the highest burden of ICH deaths were in the middle 50% for national income. Likewise, 18 of the top 20 (90%) nations with the highest YLD were in the middle 50% for national income. 11 of the top 20 (55%) nations in terms of death attributable to ICH were Eastern European nations, and 10 of the top 20 (50%) nations in terms of YLD were Eastern European. East Asian nations, such as China, North Korea, and Taiwan, also had disproportionately high rates of both ICH death and YLD when controlling for national income.

Discussion - Some specific interventions for ICH, including blood pressure reduction and medical and surgical techniques for management of increased intracranial pressure, have been associated with modest decreases in ICH mortality, although some data are equivocal, and much remains to be studied of the effects of specific treatments on specific ICH subtypes. Our results show that ICH disproportionately affects middle income nations, both in terms of deaths and YLD. This trend is concerning and suggests a need for greater understanding of ICH in middle-income and developing nations especially, as well as a need for focus on international cooperation and investment in design and implementation of cost-effective interventions for ICH.

Keywords: neurosurgery, Global Burden of Disease, stroke, intracerebral hemorrhage
O-003
Global Burden of Subarachnoid Hemorrhage

Christopher Carr, Alexander Yacob, Brendan Huang, Aaron Sean Dumont

Department of Neurosurgery, Tulane University School of Medicine /Ochsner Clinic Foundation, New Orleans, LA, United States

Background - Approximately 85% of cases of spontaneous subarachnoid hemorrhage (SAH) are caused by rupture of intracranial aneurysms, which are outpouchings of the vasculature that tend to occur at arterial branch points. Despite the best efforts of researchers and clinicians and significant advances in treatment, SAH remains fatal in up to 65% of patients and results in permanent disability in over 50% of survivors. As such, SAH imposes a particularly large burden of disease on healthcare systems throughout the world. The Global Burden of Disease (GBD) is an international collaboration and the largest comprehensive investigation of global health disease burden ever conducted. It has been particularly insightful for understanding disease demographics in middle-income nations undergoing rapid development. We hypothesized that rapidly modernizing, middle-income nations would have a particularly high burden of SAH.

Methods - Using GBD data, we abstracted data for death by cause and prevalence of years lived with disability (YLD) for SAH for every nation in the world. Using data from the Global Health Data Exchange, we determined GDP per capita for each nation. We constructed histograms to visually correlate the global burden of SAH with national income. We looked at additional characteristics of nations with particularly large and small disease burden, including region.

Results - 16 of the 20 (80%) nations with the highest burden of SAH deaths were in the middle 50% for national income, and 2 of the top 20 (10%) were in the top quartile in terms of national income. Nevertheless, only 9 of the top 20 (45%) nations in terms of YLD were in the middle 50% for national income, and 2 of the top 20 (10%) were in the top quartile in terms of national income. Nevertheless, only 9 of the top 20 (45%) nations in terms of YLD were in the middle 50% for national income, and 11 of the top 20 (55%) nations in terms of YLD were in the top quartile. 10 of the top 20 (50%) nations in terms of deaths from SAH were Eastern European, and 12 of the top 20 (60%) nations in terms of YLD was Eastern European.

Discussion - Optimal treatment of SAH is expensive and requires prolonged ICU stay for best outcomes. Best practice is a highly protocolized regimen including advanced diagnostics such as digital subtraction angiography with early aneurysm coiling to prevent rebleeding, along with careful postbleed monitoring for complications such as vasospasm and cardiac dysfunction. The discrepancy between deaths and years lived with disability in terms of national income likely reflects differential access to this advanced, protocolized level of care. This is concerning, and suggests a need for greater international cooperation, focus, and investment in developing such resources in middle-income and developing nations especially.

Keywords: neurosurgery, Global Burden of Disease, stroke, intracranial aneurysm, subarachnoid hemorrhage
O-005
Risk of Intracerebral Hemorrhage in Pregnancy and the Postpartum Period: A Population Based Analysis using a Cohort-Crossover Design

Jennifer R Meeks1, Arvind B Bambholiya1, Jon E Tyson2, Charles C Miller2, Sunil A Sheth1, Louise D McCullough1, Sean I Savitz1, Farhaan S Vahidy1

1Department of Neurology, McGovern Medical School at UTHealth, Houston, USA
2Center for Clinical Research and Evidence Based Medicine, McGovern Medical School at UTHealth, Houston, USA

INTRODUCTION: While there is a well-documented increased risk of thrombotic events; little is known regarding the risk of intracerebral hemorrhage (ICH) during pregnancy / postpartum period (PP), particularly during the extended postpartum beyond the traditional 6-week duration. Prior cross-sectional studies also do not account for potential confounding by differences in risk factor profiles between pregnant females with and without ICH. We explore the risk of ICH in PP utilizing a novel cohort crossover design in which patients serve as their own control.

METHODS: We utilized State Inpatient Databases for NY (2005 – 2014), FL (2005 – 2014) and CA (2005 – 2011) and identified patients with labor/delivery diagnoses using validated ICD-9 codes. The cohort crossover design included a 64-week case period (40 weeks pregnancy/labor/delivery, 24 weeks postpartum), followed by a 52-week interim period, and a 64-week crossover period. We excluded patients who were ≤ 12 years of age, missing linkage information, admitted for false labor, or had a prior ICH diagnosis. Subsequent pregnancies were not included. In both case and crossover periods, we identified nontraumatic ICH using ICD-9 codes specific to ICH and ICD-9 codes recommended by the Center for Disease Control and Prevention for identifying head trauma. We compared the rate of nontraumatic ICH during the case and crossover periods and report risk difference and risk ratio with 95% confidence interval (CI) estimated using conditional Poisson regression.

RESULTS: Over 3.3 million deliveries were identified, with 238 patients experiencing ICH during the case period. Those who died during the case / interim period or were in PP during the crossover period were removed from analyses. The overall rate of ICH during case vs. crossover period was 7.2 vs 2.5 per 100,000 deliveries / patients, resulting in a risk difference and risk ratio (CI) of 5.6 (4.3 – 6.8) and 3.2 (2.4 – 4.3) respectively. The relative risk of ICH is significantly increased during the 3rd trimester and the 12-week postpartum period (Figure). Patients experiencing ICH during PP were more likely to be Black or Asian (compared to White), and had a history of hypertension, diabetes, coagulopathy, thrombocytopenia, or substance abuse (Table).

CONCLUSION: Assuming that the risk factor profile remained unchanged over the period of investigation, our analyses uniquely demonstrate that pregnancy confers a significantly higher risk of ICH that peaks during the 3rd trimester and continues into early postpartum. Further investigation is warranted to characterize females at a greater risk of ICH during PP.

Keywords: Intracerebral Hemorrhage, Risk Factor, Pregnancy, Postpartum
Gender and age differences and its relation to outcome in a large multicenter cohort of patients with intracranial hemorrhage

Daniel Vázquez Justes¹, Joaquin Serena², Ikram Benabdelhak¹, Ana Vena¹, Ana María Arce³, Gerard Mauri Capdevila¹, Jordi Sanahuja¹, Blanca Fuentes⁴, Mónica Millán⁵, Juan Francisco Arenillas⁶, Joan Martí Fábregas⁷, Francisco Purroy¹

¹Hospital Arnau de Vilanova, Stroke Unit, Lleida, Spain
²Hospital Dr. Josep Trueta., Stroke Unit, Girona, Spain
³Hospital San Sebastián, Stroke Unit, San Sebastián, Spain
⁴Hospital de la Paz, Stroke Unit, Madrid, Spain
⁵Hospital Trias i Pujol, Stroke Unit, Badalona, Spain
⁶Hospital Clínico, Stroke Unit, Valladolid, Spain
⁷Hospital de la Santa Creu i Sant Pau, Stroke Unit, Barcelona, Spain

BACKGROUND: Little and confounding information is available about sex and age differences in Intracranial Hemorrhage (ICH) characteristics and its relationship to outcome. We aimed to determine the age and sex related patterns and predictors of the poor functional outcome in a large multi-center registry (from Spain’s nationwide hospital-based stroke registry, RENISEN) of patients with ICH.

METHODS: We studied 2,573 ICH patients extracted from a database of 19 university hospitals. Post traumatic intracranial hemorrhage, post-fybrinolisis hemorrhage, subdural and subarachnoid hemorrhage were excluded. Primary ICH were those presumably due to hypertensive or amyloid angiopathy. Secondary causes of HS included those categorized as due to oral anticoagulants, arteriovenous malformation, coagulopathy and tumor. Location of the bleeding was classified as deep, lobar, cerebellar or intraventricular. Data were analysed by age groups: 18 to 39, 40 to 49, 50 to 59, 60 to 69, 70 to 79, 80 to 89 and ≥ 90 years) and by sex groups. Poor outcome was defined as a modified Rankin score (mRS) at discharge>2.

RESULTS: The mean (SD) age was 71.2 (13.2) years. 964 (39.1%) subjects were women. 80.1% of cases occurred among patients aged above 60 years. Hypertension was the most frequent risk factor even at young ages. Alcoholism, hypertension and ischemic heart disease were more frequent in men, whereas atrial fibrillation was among females. Older patients were more likely to be females. There was no significant difference in the prevalence of primary etiologies between men and women. Young patients showed high levels of hypertensive etiology, with 58.7% of patients below 50 years. No cases of amyloid etiology were detected below 50 years. Secondary ICH were more common in the younger than in the olders, representing 43.9% of cases in the group between 18-39 years. Secondary ICH prevalence decreases steeply with age, being the lowest rate in the group of ≥ 90 years, with 9 patients (11.5%) that were all due to oral anticoagulants. In the multivariate analysis: age, female sex, diabetes mellitus, NIHSS at admission and febrile syndrome were predictors of poor outcome.

CONCLUSIONS: ICH has a poor functional prognosis. Baseline characteristics, etiology, management and outcomes differed with respect to age group and sex. Hypertension was a frequent cause of ICH at young people. Etiologies of secondary should be pursued in young patients. Oral anticoagulants should be used with caution in oldest patients. Age, female sex, diabetes mellitus, NIHSS at admission and febrile syndrome were predictors of poor outcome. Reasons underlying sex differences in outcome remains unclear and require further investigation.

Keywords: Intracranial Hemorrhage, ICH, etiology, outcome, risk factors
Estimates and Temporal Trend for Nationwide 30-day Hospital Readmission Among Patients with Hemorrhagic Stroke: A Contemporary Population Based Analysis of 6-Year Nationwide Data

Farhaan Shaheer Vahidy, Arvind B Bambahdriya, John P Donnelly, Jennifer R Meeks, Eric J Thomas, Jon E Tyson, Charles C Miller, Louise D McCullough, Sean I Savitz

1 Department Of Neurology, University of Texas Health Science Center, Houston TX, USA
2 Department of Epidemiology, University of Alabama School of Public Health, Birmingham AL, USA
3 Department of Internal Medicine, University of Texas Health Science Center, Houston TX, USA
4 Center for Clinical Research and Evidence Based Medicine, University of Texas Health Science Center, Houston TX, USA

INTRODUCTION: Early readmission (RA) reduction is linked with improved quality of care, saves cost, and is a desirable patient-centered outcome. Though the Centers for Medicare and Medicaid (CMS) in the US provide 30-day RA rates for patients with ischemic stroke (IS); contemporary data on nationally representative RA metrics for hemorrhagic stroke (HS) patients are unavailable. We sought to provide nationwide estimates and a temporal trend for overall, planned, and potentially-preventable 30-day-RA among HS patients and compare these with IS patients. We highlight the causes of 30-day-RA and describe comparative costs and outcomes associated with 30-day-RA among patients with Intracerebral Hemorrhage (ICH) and Subarachnoid Hemorrhage (SAH).

METHODS: We performed a year-wise cohort analysis of the national readmission database (NRD) from January 2010 to September 2015. The NRD represents 50% of all US hospitalizations from 25 states. Adult (≥ 18 years) patients with primary discharge diagnosis of ICH or SAH were tagged using validated ICD-9 codes. We defined RA as any admission within 30 days of index hospitalization discharge. Using CMS defined algorithms, events were classified as unplanned and/or potentially-preventable. Survey design analytical methods were used to account for sampling weights and nationally representative estimates are reported. Costs were obtained using AHRQ ratios of cost to charge and were inflation adjusted for 2014.

RESULTS: Based on our criteria, 192,212 ICH and 79,920 SAH patients were included. Mean (SE) age: 65.6 (0.14), and 52.7% female. The overall proportion (95% CI) of 30-day-RA for ICH and SAH patients was 13.7% (13.4–14.0) and 11.5% (11.0–12.0) respectively. Of these 94.2% (ICH) and 90.6% (SAH) were planned and 13.6% (ICH) and 9.3% (SAH) were potentially preventable. The proportion of patients RA (for any cause) within 30-day of index hospitalization discharge declined among all stroke subtypes, however ICH patients consistently had higher RA rates as compared to IS patients (Figure). The all cause 30-day RA rates among ICH and SAH patients pre vs. post implementation of the Hospital Readmission Reduction Program in the US (October 1, 2012) were also significantly different (Figure). However, RA with same primary diagnosis as that of index admission did not show similar decline for either ICH or SAH patients (data will be presented). The top 2 leading causes of RA were acute cerebrovascular disease and septicemia. Index hospitalization and RA for ICH and SAH were associated with higher cost and mortality as compared to IS patients (data will be presented).

CONCLUSION: RA burden of HS remains high particularly for events with same diagnosis as that of index event, highlighting the need for focus on secondary prevention. Nationally representative RA metrics can be used to benchmark individual hospitals’ performance, and a temporal trend may be used to evaluate effectiveness of RA reduction strategies.

Keywords: Intracerebral Hemorrhage, Subarachnoid Hemorrhage, Readmission, Costs
Investigating the role of SAMHD1 and hypocholesterolaemia in intracerebral haemorrhage

Sarah Withers¹, Joseph Morgan¹, Siobhan Crilly¹, James Cooper¹, Ioana Emilia Mosneag¹, Gillian Rice¹, Stuart Allan¹, Tracy Briggs¹, Yanick Crow², Paul Kasher¹

¹Faulty of Biology Medicine and Health, School of biological sciences, AV Hill Building, The University of Manchester, Oxford Road, Manchester, M13 9PT, United Kingdom
²UKMRC Institute of Genetics and Molecular Medicine, Centre for Genomic and Experimental Medicine, University of Edinburgh, Edinburgh, UK

Currently, most basic intracerebral haemorrhage (ICH) research is targeted towards understanding the secondary injury phase. However, understanding the biological basis of cerebral vessel rupture is of equal importance. We are currently investigating the mechanisms underlying neurovascular impairment in a model of Aicardi-Goutières syndrome subtype 5 (AGS5) – a rare monogenic form of childhood-onset ICH that is associated with upregulation of type I interferon (IFN) signalling and caused by mutation of the SAMHD1 gene. SAMHD1 is a viral restriction factor that also plays a vital role in self-non-self-discrimination, a function which may help explain the inflammatory basis of the disease. However, how SAMHD1 mutations cause ICH is not clear, suggesting an unknown function of this protein relating to neurovascular integrity, which, if established could also help explain the pathology of more common forms of ICH. Using CRISPR/cas9, we have generated a mutant samhd1 zebrafish model which recapitulates aspects of the AGS5 phenotypes as seen clinically. In an attempt to identify a link between SAMHD1 function and ICH observed in AGS5, we performed RNA sequencing analysis and quantitative PCR on the zebrafish mutants, which highlighted a reduction in a number of cholesterol biosynthesis genes. Furthermore, samhd1 homozygous mutants are vulnerable to ICH following treatment with subthreshold doses of the cholesterol lowering drug atorvastatin, providing evidence for a potential association between SAMHD1, cholesterol biosynthesis and ICH. Hypcholesterolemia has already been acknowledged as a risk factor for ICH, potentially due to the important role cholesterol plays in maintaining the integrity of cell membranes. Interestingly, a reduction in cholesterol has also been attributed to IFN signalling in vitro, alluding to a role of increased IFN signalling and regulation of the cholesterol biosynthesis pathway in AGS5. Through further experimentation we aim to identify a novel function of the SAMHD1 protein, making the relationship between AGS5, ICH and hypocholesterolaemia much clearer and enabling translatability to understanding other forms of ICH.

Keywords: Intracerebral haemorrhage, SAMHD1, Cholesterol, Zebrafish,
O-011
Hemin has a Different Toxicity Pattern than Iron: Why Chelation Alone May Not be Sufficient to Treat Intracerebral Hemorrhage

Thomas A Kent1, Girish Talakatta3, Joy Mitra3, Paul J Derry2, Emily A Mchugh4, James M Tour4, Muralidhar Hegde3

1Institute of Biosciences and Technology, Texas A&M Health Science Center, USA; Department of Neurology, Houston Methodist Hospital, USA; Department of Chemistry, Rice University, USA
2Institute of Biosciences and Technology, Texas A&M Health Science Center, USA
3Department of Radiation Oncology, Houston Methodist Hospital, USA
4Department of Chemistry, Rice University, USA

BACKGROUND: The Phase III deferoxamine (DEF) trial in intracranial hemorrhage (ICH) demonstrated lack of efficacy although a positive trend was noted. While free iron (Fe) plays a major role in ICH, we previously showed that hemin, a breakdown product of hemoglobin, rapidly induced reactive oxygen species (ROS) and genomic damage in culture and in vivo mouse brain. Here, we compare Fe to hemin and differential effect of DEF.

METHODS: Human induced pluripotent cells (iPSCs) derived neurons, differentiated SHY5Y cells and adult mouse injected ICV with hemolyzed blood were used. ROS (pHyPer™), cell viability (MTT assay), DNA integrity (long amplicon PCR) in nuclei and mitochondria were assessed. Single cell gel electrophoresis alkaline and neutral comet assays were used to detect single (SSB) and double (DSB) strand DNA breaks in the nuclear genome. Alkaline comets include SSBs and DSBs while neutral detects mostly DSBs. Fe chelation was assessed using UV-vis spectroscopy.

RESULTS: The IC50 for hemin was 5µM, while FeSO₄ or Fe-nitrilotriacetate showed only 30% cell death at 100µM. pHyPer assays demonstrated ROS induction by hemin within minutes in mitochondria followed by appearance in cytoplasm and then nucleus. Comet assays indicated hemin rapidly induced equal amounts of both alkaline and neutral comets, indicating preponderance of DSBs. Fe chelation was assessed using UV-vis spectroscopy. RESULTS: The IC50 for hemin was 5µM, while FeSO₄ or Fe-nitrilotriacetate showed only 30% cell death at 100µM. pHyPer assays demonstrated ROS induction by hemin within minutes in mitochondria followed by appearance in cytoplasm and then nucleus. Comet assays indicated hemin rapidly induced equal amounts of both alkaline and neutral comets, indicating preponderance of DSBs. The viability of hemin-treated cells was assessed after DEF alone and a potent carbon nano-antioxidant, PEGylated-hydrophilic carbon clusters (PEG-HCCs) with or without the chelator DEF covalently bonded (DEF-HCC-PEG). While PEG-HCCs and DEF separately reduced cell death by 30%, the combination drug maximally reduced death (>75%). DEF-HCC-PEG also dramatically improved (>90%) DNA integrity in mouse brain when administered 30 mins. ICV hemolyzed blood and sampled 12 hours later. The 430 nm peak associated with DEF-Fe complex observed with Fe and DEF solution was not visible with a solution of hemin and DEF (Fig).

CONCLUSION: We report an unexpected robust DNA DSB effect of hemin not typical of an agent that solely releases ROS. Hemin can be rapidly transported to the nucleus, where the DSBs occurred prior to ROS generation. Because hemin appears to have a unique mechanism of action, and because we failed to chelate Fe from hemin, we suspect that chelation alone will not be sufficient to improve outcome following ICH. We suggest that a combination of both chelation and ROS scavenging may be a better approach.

Keywords: hemin, deferoxamine, chelation, antioxidant, ROS
O-013
Using zebrafish larval models of brain haemorrhage to measure brain injury, locomotor and neuroinflammatory outcomes in a drug screen

Siobhan Crilly1, Adrian Parry Jones2, Stuart Allan1, Paul Kasher1

1The Division of Neuroscience and Experimental Psychology, School of Biological Sciences, Faculty of Biology, Medicine and Health, Manchester Academic Health Science Centre, The University of Manchester, Oxford Road, Manchester, M139PT
2The Division of Cardiovascular Sciences, School of Medical Sciences, Faculty of Biology, Medicine and Health, Manchester Academic Health Science Centre, The University of Manchester, Oxford Road, Manchester, M139PT

Intracerebral haemorrhage (ICH) is a devastating condition with limited treatment options and accounts for 49% of 6.5 million annual stroke deaths worldwide, and over half disability adjusted life years lost to stroke. Current understanding of pathophysiology is incomplete partly due to limitations of pre-clinical models of spontaneous disease. We have shown that zebrafish larvae exhibit comparable pathological outcomes to human condition in response to spontaneous brain bleeding and therefore offer an alternative model for pre-clinical study for ICH. The aim of this study was to investigate the use of these models in a drug screen for a potential therapeutic. Zebrafish larvae are frequently used as vertebrate disease models and are associated with several practical advantages including high fecundity, optical translucency and non-protected status prior to 5 days post fertilisation. Through live, non-invasive imaging of transgenic fluorescent reporter lines and behavioural assessment we can quantify brain injury, locomotor function and neuroinflammation following ICH. Here we used these assessable outcomes to screen 2000 compounds from the Spectrum Collection for a drug that improves disease phenotypes after a haemorrhage has already occurred, as a translatable approach to validate potential therapeutics for clinical application. Larvae exhibiting brain haemorrhage at 48 hours post fertilisation were incubated (n=3) in the compounds for 24 hours and assayed at 72 hours post fertilisation for brain injury phenotype using fluorescent microscopy. Following a positive reduction in the brain injury, larvae treated with potential drug hits were assayed for locomotor function and an exacerbated neuroinflammatory response. Drugs with significant results, comparable with non-haemorrhaged sibling controls, were investigated further for mechanistic understanding. We show that the zebrafish larval model can be used for medium/high-throughput screening of drug compounds to reduce the number of protected animals used in pre-clinical ICH study and to support the advancement of the stroke field with practical translatable outcomes to directly benefit patients in the clinic.

Keywords: intracerebral haemorrhage, pre-clinical, zebrafish, drug screen
**O-014**  
**Assessment of early brainstem injury progression in a collagenase-induced rat brainstem hemorrhage model using multi-sequence magnetic resonance imaging combined with histopathology**

Xi Guo, Tong Sun, Lu Ma, Hao Li, Chao You, Meng Tian

Department of Neurosurgery, West China Hospital, Sichuan University, Chengdu, Sichuan, China; West China Brain Research Centre, West China Hospital, Sichuan University, Chengdu, Sichuan, China

AIMS: Brainstem hemorrhage (BSH) is a deadly subtype of intracerebral hemorrhage and pathology of which in clinic was little studied. Our aim is to investigate the early brainstem injury progression after BSH through multi-sequence magnetic resonance imaging (MRI) combined with histopathology using a collagenase induced brainstem hemorrhage model of rats.

METHODS: Male Sprague–Dawley rats received the infusion of type VII collagenase into the right besotegmental pontine to build BSH model. The neurobehavior scores were recorded. 7.0 tesla MRI was used to the temporal assessment of hematoma lesion by T2 weighted imaging, brain edema by diffusion weighted imaging, and white matter injury by diffuse tensor imaging. Hematoxylin-eosin staining, Luxol fast blue staining and Fluoro-Jade C immunofluorescence were used for hematoma and perihematomal edema observation, iron deposition, myelin integrity and neuron degeneration measurements, respectively.

RESULTS: The BSH model was successfully made featured with typical neurobehavior deficit of rats (Fig. 1). The mortality rates of the BSH groups were respectively 21.4, 33.3 and 56.3% on day 1, 3, and 7 which were similar to the high mortality of human research. Hematoma lesion volume decreased from day 1 to day 7, while a rapidly formed vasogenic perihematomal edema was observed on day 1, peaked on day 3 then slightly recovered on day 7 (Fig. 2 and 3). A decline trend of fractional anisotropy value and Luxol fast blue staining indicated that the integrity and continuity of neuro fibers deteriorated within first 7 days (Fig. 4). And neuron degeneration was distinctly observed after 3 days following modeling (Fig. 5).

CONCLUSION: Our study revealed the progression of hematoma lesion change, perihematomal edema evolution, white matter injury and neuron degeneration of brainstem in early period after BSH on a collagenase induced BSH model of rats.

**Keywords:** Brainstem hemorrhage; Collagenase; Multi-sequence MRI; Perihematomal edema; White matter injury; Neuron degeneration
O-015
Specific Gene Expression Networks Define the Peripheral Immune Response following Intracerebral Hemorrhage in Human

Boryana Stamova¹, Marc Durocher¹, Bradley P Ander¹, Glen Jickling², Farah Hamade¹, Bodie Knepp¹, Dazhi Liu¹, Xinhua Zhan¹, Heather Hull¹, Alan Yee¹, Kwan Ng¹, Frank R Sharp¹

¹Department of Neurology, University of California, Davis, School of Medicine, Davis, California, USA
²University of Alberta, Edmonton, AB, Canada

BACKGROUND: The peripheral immune system is involved in the damage and repair following ischemic stroke (IS) and intracerebral hemorrhage (ICH). Studies have shown distinct blood gene expression signatures following IS. However, little is known about the transcriptional response following human ICH and how it differs from IS. Thus, we aimed to define the gene co-expression networks in ICH compared to matched controls, and the ones associated with ICH volume and peri-hematoma edema (PHE) volume.

METHODS: We performed transcriptomic analysis on 66 human peripheral whole-blood samples (33 ICH, 33 vascular risk factor controls) using GeneChip® HTA 2.0 arrays. Weighted gene co-expression network analysis (WGCNA) of ICH compared to matched controls identified groups of co-expressed genes (modules) associated with ICH and their most interconnected genes (hubs). We also performed WGCNA for association with PHE and ICH volumes on a subset of the ICH subjects (n=20).

RESULTS: WGCNA revealed modules enriched with cell-specific genes including one neutrophil module, one neutrophil plus monocyte module, one T-cell module, one natural killer cell module and two erythroblast modules. Inflammatory / immune pathways dominated the neutrophil / monocyte modules, while T-cell receptor and other T-cell signaling genes - the T-cell module. A NK-cell-enriched module was dominated by alternative splicing, and epigenetic regulation. One erythro¬blast module was enriched in autophagy pathways implicated in experimental ICH, and in NRF2 signaling implicated in hematoma clearance. Many of the hub and module genes have been implicated in neuro-inflammation, gene regulation, cell death, and some as experimental ICH therapeutic targets. In addition, additional WGCNA analysis revealed four modules positively correlated to PHE volume and three modules - with ICH volume – two positively and one negatively. Two volume-associated modules were significant for both ICH and PHE volumes and were dominated by multiple inflammatory pathways. This included TLR signaling, which has been implicated in peripheral leukocyte infiltrating brain tissue following ICH-related brain injury and has been associated with poor clinical outcomes. Key immune response pathway, the Inflammasome Pathway, NFAT Regulation of Immune Response, IL-17, NF-kB, p38MAPK and ERK5 Signaling and FCγ-receptor mediated monocyte/macrophage phagocytosis were also enriched in PHE and ICH-associated modules. Scavenger mechanisms involving FCγ-receptor mediated monocyte/macrophage phagocytosis have been implicated in hematoma resolution.

CONCLUSION: This study delineated coordinately expressed modules of genes in the peripheral immune response and associated with PHE and ICH volumes underlying ICH pathophysiology. The identified hub genes and their networks provide data on human ICH, which may help guide the search for novel therapeutic targets.

Keywords: ICH, gene expression, gene networks, ICH volume, peri-hematoma volume, peripheral immune response
O-016
Investigating the role of neuroinflammation and cholesterol metabolism in the progression of brain injury following ICH

Siobhan Crilly, Annabel Chadwick, Jack Barrington, Stuart Allan, Adrian Parry Jones, Paul Kasher

Faculty of Biology, Medicine & Health, The University of Manchester, UK

The toxic influx of blood into the brain initiates an immune response that induces activation of microglia, infiltration of peripheral leukocytes and the production of inflammatory cytokines, including interleukin-1β (IL-1β). Such processes are thought to drive the progression and potential recovery of brain injury following ICH, and represent a realistic therapeutic target. An increasing body of evidence exists to support a role for cross-talk between cholesterol metabolism and the immune system. Cholesterol 25-hydroxylase (CH25H) is an enzyme that can be upregulated following inflammatory stimulation that catalyses the conversion of cholesterol into 25-hydroxycholesterol (25-HC). Subsequently, 25-HC can inhibit inflammation, and IL-1β has been shown to be one of its targets. Given the known pro-inflammatory function of IL-1β in the pathogenesis of brain injury, the aim of this study is to determine whether CH25H plays a role in the resolution of the post-ICH immune response. We have recently described the use of zebrafish larvae for studying brain injury and neuroinflammation following ICH (Crilly et al, 2018, F1000Research). At 1 day post-haemorrhage (dph), haemorrhaged animals (ICH+) exhibit significant brain cell death accompanied by increased recruitment and activation of brain immune cells, which begins to recede from 2 dph. Following RNA-sequencing analysis, we identified a reduction in expression of the zebrafish orthologue, ch25h, in ICH+ in comparison to ICH- siblings at 1 dph. A significant reduction in ch25h gene expression in ICH+ larvae was subsequently confirmed at 1 dph by quantitative PCR. At this same time point, we observed a significant increase in il-1β expression. Interestingly, at 2 dph, we observed a decrease in il-1β expression, whilst ch25h expression increases in ICH+ larvae in comparison to ICH- siblings. To determine the translational relevance of this observation, we next performed immunohistochemistry using anti-CH25H and anti- IL-1β antibodies in acute (1-7 days post-onset) and subacute (~1 month post-onset) ICH patient and age/region-matched control brain sections. Low CH25H expression was observed in acute sections. However, strong CH25H expression was observed in subacute sections, occurring in immune cells that surround the glial scar. Comparable to the zebrafish model, IL-1β expression was strong in acute sections, but this receded in subacute sections. To the best of our knowledge, this is the first time CH25H has been implicated in human ICH pathogenesis. Taken together these data suggest an inverse relationship exists between CH25H and inflammation in the ICH brain. Given the clinical observation that ICH patients with higher LDL cholesterol levels exhibit improved haematoma expansion and survival rates (Chang et al, 2017, Atherosclerosis), we hypothesise that cholesterol metabolism may play an important role in the resolution of neuroinflammation following ICH-induced brain injury.

Keywords: ICH, cholesterol, neuroinflammation, zebrafish, patient material
**O-017**

**New and Expanding Ventricular Hemorrhage Predicts Poor Outcome in Acute Intracerebral Hemorrhage**

Vignan Yogendrakumar\(^1\), Tim Ramsay\(^2\), Dean Fergusson\(^3\), Andrew M Demchuk\(^4\), Richard I Aviv\(^5\), Chris D Anderson\(^6\), Mahmut E Gurol\(^6\), Steve M Greenberg\(^6\), Anand Viswanathan\(^6\), Jonathan Rosand\(^7\), Joshua N Goldstein\(^8\), Dar Dowlatshahi\(^1\)

\(^1\)Ottawa Stroke Program, Department of Medicine (Neurology), University of Ottawa, Ottawa, Canada
\(^2\)Ottawa Methods Center, University of Ottawa, Ottawa, Canada
\(^3\)Ottawa Hospital Research Institute, University of Ottawa, Ottawa, Canada
\(^4\)Calgary Stroke Program, Department of Clinical Neurosciences, University of Calgary, Calgary, Canada
\(^5\)Division of Neuroradiology and Department of Medical Imaging, Sunnybrook Health Sciences Centre, University of Toronto, Toronto, Canada
\(^6\)Department of Neurology, Massachusetts General Hospital, Boston, USA
\(^7\)Henry and Allison McCance Center for Brain Health, Massachusetts General Hospital, Boston, USA
\(^8\)Department of Emergency Medicine, Massachusetts General Hospital, Boston, USA

**INTRODUCTION:** Intraventricular hemorrhage (IVH) is a predictor of poor outcome in patients with intracerebral hemorrhage (ICH). However, the effect of IVH expansion or delayed IVH development on outcome is unclear.

**OBJECTIVE:** To describe the relationship between IVH expansion and long-term outcome and use this relationship to select and validate clinically relevant thresholds of IVH expansion.

**METHODS:** We used fractional polynomial analysis to test linear and non-linear models of 24-hour IVH volume change and clinical outcome with data from the PREDICT-ICH study. The primary outcome was poor outcome (mRS 4-6) at 90 days. We derived dichotomous thresholds from the selected model and calculated diagnostic accuracy measures. We validated all thresholds in an independent cohort (Massachusetts General Hospital).

**RESULTS:** Of the 256 patients from PREDICT, 127 (49.6%) had a mRS of 4-6. IVH volume change and poor outcome fit a non-linear relationship, where minimal increases in IVH were associated with mRS 4-6 (Figure 1). IVH expansion ≥ 1 mL (n=53, Sensitivity 33%, Specificity 92%, aOR 2.68 [95% CI: 1.11-6.46]) and development of any new IVH (n= 74, Sensitivity 43%, Specificity 85%, aOR 2.53 [95% CI: 1.22-5.26]) strongly predicted poor outcome at 90 days. The dichotomous thresholds reproduced well in a validation cohort of 169 patients (IVH expansion ≥ 1 mL: n=16, Sensitivity 16%, Specificity 94%; Any new IVH: n=24, Sensitivity 24%, Specificity 90%).

**CONCLUSION:** IVH expansion, as small as 1 mL, or any new IVH is strongly predictive of poor outcome. This suggests that the prevention of IVH growth could be a novel target for ICH therapy and that IVH growth could be incorporated into future definitions of hematoma expansion to better inform future ICH treatment trials.

**Keywords:** Intracerebral hemorrhage, Cohort studies, CT; expansion, intraventricular hemorrhage
O-018
Incorporating Intraventricular Hemorrhage Assessment to the Current Definitions of Hematoma Expansion Improves Clinical Outcome Prediction

Vignan Yogendrakumar¹, Tim Ramsay², Dean A Fergusson³, Andrew M Demchuck⁴, Richard I Aviv⁵, Dar Dowlatshahi¹

¹Ottawa Stroke Program, Department of Medicine (Neurology), University of Ottawa, Ottawa, Canada
²Ottawa Methods Center, University of Ottawa, Ottawa, Canada
³Ottawa Hospital Research Institute, University of Ottawa, Ottawa, Canada
⁴Calgary Stroke Program, Department of Clinical Neurosciences, University of Calgary, Calgary, Canada
⁵Division of Neuroradiology and Department of Medical Imaging, University of Toronto, Toronto, Canada

INTRODUCTION: In acute intracerebral hemorrhage, several definitions of significant hematoma expansion (>6mL, >12.5mL, >33%) are currently in use. At present, these definitions only assess changes in intraparenchymal volume. The presence of intraventricular hemorrhage is a well-known predictor of poor outcome, but no current definition of hematoma expansion (HE) includes intraventricular hemorrhage expansion.

OBJECTIVE: To determine whether including changes in intraventricular hemorrhage volumes to current definitions of hematoma expansion improves the ability to predict 90-day outcome.

METHODS: Using data from the PREDICT-ICH study, we compared a standard definition of hematoma expansion (≥6mL or ≥33%) to a new definition that includes new intraventricular hemorrhage development or expansion (≥6mL or ≥33% or any IVH expansion). The primary outcome was poor clinical outcome (mRS 4-6) at 90 days. Diagnostic accuracy measures were calculated for each definition. Receiver operating characteristic curves for each definition were compared using non-parametric methods.

RESULTS: Of the 256 patients from PREDICT, 127 (49.6%) had a mRS of 4-6. Sensitives and specificities for the standard definition were 0.457 (95% CI: 0.368-0.547) and 0.829 (95% CI: 0.753-0.889), respectively. The new definition of hematoma expansion possessed a higher sensitivity (0.638 [95% CI: 0.548-0.721]) with no significant differences in the specificity (0.752 [95% CI: 0.668-0.824]). Overall accuracy was improved in the new definition (AUC: 0.69 vs. 0.64, p=0.0129). Adjusting for relevant co-variates, the new definition was associated with a 2.58x increased odds of poor outcome at 90 days.

CONCLUSIONS: Including intraventricular hemorrhage expansion in our traditional definitions of hematoma expansion improves its sensitivity without significant decreases to specificity. A refined version of hematoma expansion that includes intraventricular hemorrhage measurement could be considered for use in future intracerebral hemorrhage treatment trials.

Keywords: total blood volume, hematoma expansion, intraventricular hemorrhage
**O-021**

**Clinical Predictors of Withdrawal of Life-Sustaining Treatment for Critically Ill Patients with Intracerebral Hemorrhage and Intraventricular Hemorrhage**

Lourdes Carhuapoma\(^1\), Radhika Avadhani\(^2\), Noeleen Ostapkovich\(^2\), Karen Lane\(^2\), Nichol Mcbee\(^2\), Juan Ricardo Carhuapoma\(^3\), Wendy Ziai\(^3\), Daniel F Hanley\(^2\)

\(^1\)Department of Anesthesia and Critical Care Medicine, The Johns Hopkins Hospital, Baltimore, USA  
\(^2\)Department of Neurology, Johns Hopkins University, Baltimore, USA  
\(^3\)Departments of Anesthesia and Critical Care Medicine and Neurology, Johns Hopkins University, Baltimore, USA

**OBJECTIVES:** Withdrawal of life-sustaining treatment (WoLST) is a common cause of immediate death in critically ill patients with intracerebral hemorrhage (ICH) and intraventricular hemorrhage (IVH). In a large, contemporary cohort of ICH/IVH patients, we aimed to determine if previously described clinical predictors of poor outcome continue to influence the decision to withdraw life-sustaining treatment, leading to self-fulfilling prophecies in the ICH/IVH patient population.

**METHODOLOGY:** We retrospectively compared no WoLST patients (N=861) to WoLST patients (N=118) enrolled in the MISTIE III and CLEAR III trials. Multivariable logistic regression (MLR) was used to estimate the influence of clinical factors, such as age (years), Glasgow Coma Scale (GCS), ICH location (deep or lobar), and total blood burden (<= 30 mL, >30 to <= 40 mL, >40 to <= 55 mL, >55 mL), defined by adding ICH and IVH volumes at stability, for WoLST patients.

**RESULTS:** In the MLR model, age at consent (AOR [95% CI]=1.04 [1.02, 1.06], p<0.0001), GCS 9 to 12 (AOR [95% CI]=2.16 [1.07, 4.36], p=0.033), GCS 3 to 8 (AOR [95% CI]=4.15 [2.09, 8.22], p<0.0001), total blood burden of >40 to <= 55 mL (AOR [95% CI]=2.81 [1.36, 5.80], p=0.005), and total blood burden of >55 mL (AOR [95% CI]=4.72 [2.34, 9.53], p<0.0001) were all significantly associated with WoLST. ICH deep location (AOR [95% CI]=0.86 [0.55, 1.36], p=0.261) and total blood burden of >30 to <= 40 mL (AOR [95% CI]=0.55 [0.20, 1.55], p=0.261) were statistically insignificant.

**CONCLUSION:** After nearly 20 years following the description of the “self-fulfilling prophecies” paradigm and more than 10 years following the European Stroke Organization and American Heart Association guidelines which discourage early WoLST for spontaneous ICH, the same clinical predictors of poor outcome appear to still influence the decision to withdraw life-sustaining treatment in the critically ill ICH/IVH patient population.

**Keywords:** Withdrawal of Life-Sustaining Treatment, Prognosis, Intracerebral Hemorrhage, Intraventricular Hemorrhage
O-022
Predicting Intracerebral Hemorrhage Expansion with CT perfusion

Andrea Morotti1, Giorgio Busto2, Andrea Bernardoni3, Carmine Tamborino4, Enrico Fainardi2

1 Stroke Unit, IRCCS Mondino Foundation, Pavia, Italy
2 Università di Firenze, Neuroradiology Unit- Department of Experimental and Clinical Biomedical Sciences, Firenze, Italy
3 Arcispedale S. Anna, Neuroradiology Unit, Department of Radiology, Ferrara, Italy
4 Azienda Ulss 3 Serenissima, Neurology Unit, Ospedale dell’Angelo, Mestre, Italy.

Background and AIMS: We investigated whether CT perfusion (CTP) can identify intracerebral hemorrhage (ICH) patients at high risk of hematoma expansion.

METHODS: We studied subjects with primary spontaneous ICH undergoing CTP within 24 hours from symptom onset/time last seen well. Cerebral blood flow (CBF), cerebral blood volume (CBV) and mean transit time (MTT) levels were measured in four regions of interest: (1) hemorrhagic core; (2) perihematomal rim; (3) 1 cm rim of normal-appearing brain tissue surrounding the perilesional area; and (4) a mirrored area, including the clot and the perihematomal region, located in the contralateral hemisphere. Predictors of log-transformed absolute hematoma growth were explored with univariable and multivariable linear regression. In a secondary analysis we studied predictors of ICH expansion defined as ICH growth>33% or >6 mL, using logistic regression.

RESULTS: A total of 155 patients were included (median age 68, 47.1% males). After adjustment in multivariable analysis, perihematomal CBV was inversely associated with ICH growth (B= - 0.20, p<0.001), independently from systolic blood pressure, baseline ICH volume and other potential confounders. This association was not dose-dependent and only very low CBV (<1.4 mL/100g) was significantly associated with increased ICH growth (B= 0.24, p<0.001). Logistic regression confirmed the inverse relationship between perihematomal CBV and risk of ICH expansion (odds ratio: 0.69, p=0.032).

CONCLUSIONS: The risk of hematoma expansion is increased in patients with low perihematomal CBV. This finding provides further insights into the pathophysiology of ICH expansion and suggests a potential role of the brain region surrounding the hemorrhage.

Keywords: Intracerebral Hemorrhage; CT Perfusion; Hematoma Expansion
O-023
Low Perihematomal Edema Volumes Associated with Improved Functional Outcome and Lower Mortality in the MISTIE III Trial

W. Andrew Mould¹, John Muschelli², Richard Thompson², Nataly Montano¹, Christina Grabarits¹, Meghan Hildreth¹, Hasan Ali¹, Nichol Mcbee¹, Karen Lane¹, Issam Awad³, Dan Hanley¹

¹Department of Neurology, Johns Hopkins University, Baltimore, MD
²Department of Biostatistics, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD
³Department of Neurosurgery, University of Chicago, Chicago, IL

INTRODUCTION: Intracerebral hemorrhage (ICH) is a stroke subtype with high mortality and poor functional outcome. No successful treatments or therapies exist. Secondary injury to ICH, perihematomal edema (PHE), contributes to poor outcomes and is a potential therapeutic target. We hypothesized that minimally invasive surgery (MIS) plus rt-PA would reduce ICH and PHE volumes and that this reduction would lead to improved clinical outcomes.

METHODS: MISTIE III is a multi-center, prospective, randomized, phase III trial testing the efficacy of standardized hematoma evacuation after spontaneous ICH. We conducted a semi-automated, computerized, volumetric analysis on CT imaging assessing the effect of hematoma removal on PHE at baseline (BL) and end-of-treatment (EOT).

RESULTS: Of 500 randomized, 240 surgical and 232 medical patients were analyzed. There was no significant difference between the two cohorts in age, GCS, ICH location, BL ICH or BL PHE volumes. Surgical patients experienced a significant reduction in ICH volumes: mean EOT ICH 14.9(12.2)mL vs medical patients, 46.8(17.4)mL; p<0.001. Moreover, surgical patients had a positive reduction in PHE, 4.7(13.8)mL, compared with medical patients -11.8(15.1)mL; p<0.001. Subdividing the cohort into pre-specified subgroups of ICH removal >65%, 20-65%, and <20% clot removal, (Med 0.5:227, Surg 167:66:7) all patients achieving <20% reduction experienced a PHE increase, while reductions of 2.1mL and 6.6mL occurred in the surgical groups achieving 20-65% and >65%, respectively; p<0.001. A continuous analysis confirmed that greater ICH removal leads to greater PHE reduction (Spearman coefficient: 0.55(0.48-0.61), p<0.001). Logistic regression was used to look at effect of PHE volume on mortality and for every 10 mL increase in PHE volume, patients in both groups were 25% more likely to die [OR=1.25 (1.11-1.41)] at 30 days and 15% more likely at 180 days [OR=1.15 (1.03-1.27)]. Moreover, patients with low levels of edema at EOT (< 25 mL) were 10% less likely to have a poor outcome (mRS 4-6) at 365 days with every 1 mL PHE volume reduction from BL to EOT after accounting for age, baseline GCS, ICH location, baseline ICH volume, baseline IVH volume, and CVD [OR=.90 (0.82-0.99) p=0.049].

CONCLUSIONS: The MISTIE procedure has a demonstrated capability to substantially reduce ICH volumes while also mitigating PHE formation. This combined effect leads to low volumes of ICH and PHE at EOT in patients treated successfully with the MISTIE procedure which in turn is independently associated with a benefit in both functional outcome and mortality at 365 days. These results suggest that edema mitigation plays an important role in recovery of these ICH patients and should be considered in conjunction with blood volumes when gauging therapeutic success.

Keywords: ICH, intervention, edema, stroke, imaging
O-024
Clinical and pathophysiological properties of peak edema extension distance in intracerebral hemorrhage

Antje Giede Jeppe1, Joji B. Kuramatsu1, Hagen B. Huttner1, Maximilian Sprügel1, Hannes Lücking2, Stefan Lang2, Christian Fung5, David Bervini4, Urs Fischer3, Bastian Volbers1

1Department of Neurology, University of Erlangen-Nuremberg, Erlangen, Germany
2Department of Neuroradiology, University of Erlangen-Nuremberg, Erlangen, Germany
3Department of Neurology, Inselspital, Bern University Hospital, University of Bern, Bern, Switzerland
4Department of Neurosurgery, Inselspital, Bern University Hospital, University of Bern, Bern, Switzerland
5Department of Neurosurgery, University of Freiburg, Freiburg, Germany

INTRODUCTION: Edema extension distance (EED) is a novel perihemorrhagic edema (PHE) measure corresponding to an approximation to the radius of PHE volume. It could be shown, that EED may be less dependent on hematoma volume than absolute PHE volume. Thus, it is suggested as a promising surrogate outcome parameter in early phase clinical trials of anti-edematous treatments possibly requiring a smaller sample size compared to absolute PHE volume. However, peak EED has not been analyzed so far and its association with outcome remains to be elucidated.

METHODS: Patients with spontaneous intracerebral hemorrhage and at least 2 CT scans over a period of 12 days were included. We assessed PHE volume using a semiautomatic threshold based algorithm. The radius of ICH volume was calculated assuming a spheroid shape including correction for retraction and subtracted from the radius of the total mass lesion (hematoma + PHE) to obtain EED. We correlated EED with hematoma volume and outcome using dichotomized modified Rankin scale (0-3 = favorable, 4-6 = poor) on day 90.

RESULTS: 292 patients (median age 70 years [interquartile range (IQR) 62-78], median ICH volume on admission 17.7 mL [IQR 7.9-40.2], 131 female [45%]) were included. There was a trend towards a weak association of peak EED with hematoma volume ($R^2=0.007$, $p=0.084$). Peak EED differed between patients with favorable and poor outcome (0.59 cm [IQR 0.45-0.78] and 0.7 cm [IQR 0.53-0.89], $p=0.002$). Multivariable logistic regression adjusted for NIHSS on admission, intraventricular hemorrhage, age and hematoma volume by location revealed an independent negative association of peak EED with favorable outcome (OR 0.174 [95% CI 0.058-0.527], $p=0.002$). ROC-Analysis showed a moderate prognostic value compared to absolute PHE volume (AUC peak EED 0.608 [95% CI 0.54-0.676], $p=0.002$, AUC peak PHE 0.695 [95% CI 0.632-0.759], $p<0.0001$).

CONCLUSION: Peak EED is independently associated with outcome in the present cohort while there was only a trend towards a weak correlation with hematoma volume. Further studies should focus on the correlation between absolute PHE volume, EED, hematoma volume and outcome also accounting for the shape of edema formation to further assess the value of EED as an outcome parameter in clinical trials.

Keywords: Intracerebral Hemorrhage, Perihemorrhagic Edema, Edema Extension Distance, Outcome
**O-026**

**Histotripsy clot liquefaction in a porcine intracerebral hemorrhage model**

Tyler Gerhardson\(^1\), Jonathan R Sukovich\(^1\), Neeraj Chaudhary\(^3\), Tom Chenevert\(^3\), Kim Ives\(^1\), Tim L Hall\(^1\), Sandra Camelo Piragua\(^4\), Zhen Xu\(^1\), Aditya S Pandey\(^2\)

\(^1\)Department of Biomedical Engineering, University of Michigan, Ann Arbor, MI, USA
\(^2\)Department of Neurosurgery, University of Michigan, Ann Arbor, MI, USA
\(^3\)Department of Radiology, University of Michigan, Ann Arbor, MI, USA
\(^4\)Department of Pathology, University of Michigan, Ann Arbor, MI, USA

**BACKGROUND:** Intracerebral hemorrhage (ICH) is characterized by a 30-day mortality rate of 40% and significant disability for those who survive.

**OBJECTIVE:** Histotripsy is a non-invasive focused ultrasound treatment modality that uses externally applied ultrasound pulses to generate cavitation to mechanically fractionate tissue. Histotripsy has the potential to liquefy clot in the brain without damaging the cerebral tissue, and thus is being investigated as a potential non-invasive step to facilitate a minimally invasive aspiration treatment option for intracerebral hemorrhage (ICH). The purpose of the current study was to investigate the safety of histotripsy mediated clot liquefaction and aspiration of the resultant liquefied clot products in a porcine ICH model.

**METHODS:** After performing a craniotomy to provide an acoustic window, 1.75 mL clots were formed in the left frontal lobe of the cerebral white matter. 18 pigs were placed into three groups of (\(n = 6\) per group): a control group and two treatment groups. In two treatment groups central cores of the clots were liquefied with histotripsy 48 hours after formation and the liquefied content was either evacuated via needle and syringe or left within the brain. Pigs underwent MRI 7 – 8 days post clot formation and were subsequently euthanized. Histological analysis was performed on harvested brains. A subset of pigs underwent acute analysis (\(\leq 6\) hr). Neurological behavior was assessed throughout the study.

**RESULTS:** Histotripsy was able to liquefy the center of clots without direct damage to the perihematomal brain tissue (Fig. 1). An average volume of 0.9±0.5 mL was drained after histotripsy treatment (Fig. 2). All groups showed mild ischemia and gliosis in the perihematomal region, however, there were no deaths or signs of neurological dysfunction in any groups.

**CONCLUSIONS:** This study presents the first analysis of histotripsy-based liquefaction of ICH in-vivo. Histotripsy safely liquefy clots without significant additional damage to the perihematomal region. The liquefied content of the clot can be easily evacuated and the undrained clot has no effect on pig survival or neurological behavior.

**Keywords:** focused ultrasound, histotripsy, thrombolysis, intracerebral hemorrhage, neurosurgery
Blood pressure variability within first 24 hours after admission predicts poor in-hospital outcome in spontaneous intracerebral hemorrhage

Afshin Andre Divani\(^1\), Xi Liu\(^2\), Mario Di Napoli\(^3\), Simona Lattanzi\(^4\), Wendy Ziai\(^5\), Jeffrey L. Saver\(^6\), J. Claude Hemphill\(^7\), Mostafa Jafari\(^1\), Paul M. Vespa\(^6\), Stephan A. Mayer\(^8\)

\(^1\)Department of Neurology, University of Minnesota, Minneapolis, MN, USA
\(^2\)Department of Statistics and Applied Probability, University of California, Santa Barbara, California, USA
\(^3\)Department of Neurology, San Camillo de Lellis District General Hospital, Rieti, Italy
\(^4\)Neurological Clinic, Department of Experimental and Clinical Medicine, Marche Polytechnic University, Ancona, Italy
\(^5\)Department of Neurology, Neurosurgery, and Anesthesia/Critical Care Medicine, Johns Hopkins, Baltimore, USA
\(^6\)Department of Neurology, Ronald Reagan UCLA Medical Center, CA, USA
\(^7\)Department of Neurology, University of California San Francisco, CA, USA
\(^8\)Department of Neurology, Henry Ford Health System, Detroit, MI, United States

BACKGROUND: Recent literature suggests that increased systolic blood pressure variability (SBPV) may influence spontaneous intracerebral hemorrhage (ICH) outcomes. The aim of this study was to clarify the association between SBPV in the first 24 hours of admission and in-hospital ICH outcome.

MATERIALS-METHODS: We used a 10-year consecutive admission data of spontaneous ICH patients between January 2008 and December 2017 from the two healthcare systems in the Twin Cities area in Minnesota, USA. The primary outcome was the modified Rankin scale score (mRS) at discharge. Patients were classified according to either a dichotomous division (mRS 0-3 vs 4-6) or trichotomous one (mRS 0-2, 3-4, 5-6). SBPV was quantified using standard deviation, coefficient of variation, successive variation, range of systolic blood pressure (SBP), and functional successive variation (FSV). The association of each SBPV measure with outcome was estimated with multivariate logistic and ordinal regression models reported as adjusted odds ratio (AOR) with 95% CI. All models were adjusted for mean SBP for the first 24 hours of admission, demographics, clinical, and radiological variables as determined by a prescreening univariate analysis followed by stepwise model selection. The association between history of hypertension (HTN) and acute SBPV was tested through permutation tests.

RESULTS: After excluding the subjects with more than 10 missing BP recording and those who died with the first 24 hours of admission, we had 725 subjects in our cohort with a mean age ± SD of 66.1 ± 15.6 years old. There were 410 men (age = 66.1 ± 15.6 years) and 315 women (age = 69.8 ± 14.7 years). The logistic regression models demonstrated the significance of all the five BPV measures in determining the probability of poor (mRS 4-6) functional outcome, after accounting for mean SBP levels and other covariates (FSV: AOR=1.03, CI = [1.01,1.05]; SD: AOR=1.03, CI = [1.01,1.06]; CV: AOR = 1.05, CI = [1.01,1.09]; SV: AOR = 1.04, CI = [1.01,1.07]; Range: AOR = 1.01, CI = [1.00,1.02]). Similarly, ordinal regression models concluded that four BPV indices (FSV, SD, CV, and Range) were significantly associated with the trichotomized functional outcome. Mean SBP was not significant in any model. Average BPV was significantly different between normotensive and untreated-HTN subjects for all five BPV indices (all p-values <0.02), between normotensive and treated-HTN for four BPV indices (FSV, SD, CV, and Range: all p-values <0.05), and between untreated- and treated-HTN for FSV (p=0.03) only.

CONCLUSIONS: Our data revealed that the higher the SBPV in the acute phase of ICH, the larger was the probability of poor outcome at discharge. SBPV, but not mean BP, significantly influenced the mRS at discharge. Further, our results suggest an association between history of HTN and SBPV postICH. These findings warrant the need for a prospective study to better assess the role of BPV on ICH outcome.

Keywords: intracerebral hemorrhage; blood pressure control; blood pressure variability; outcomes; hematoma volume; computed tomography
O-031
Intracranial pressure and cerebral perfusion pressure trajectories: A novel approach to informing outcomes in spontaneous intracerebral hemorrhage with large intraventricular extension

Wendy Ziai1, Gayane Yenokyan2, Issam Awad3, Daniel Hanley4

1Department of Neurology, Division of Neurocritical Care, Johns Hopkins University School of Medicine, Baltimore, USA
2Department of Biostatistics, Johns Hopkins Bloomberg School of Public Health, Baltimore, USA
3Department of Neurosurgery, University of Chicago, Chicago, USA
4Department of Neurology, Division of Brain Injury Outcomes, Johns Hopkins University School of Medicine, Baltimore, USA

BACKGROUND: Intracranial pressure (ICP) and cerebral perfusion pressure (CPP) in monitored patients with spontaneous intracerebral hemorrhage (ICH) with large intraventricular hemorrhage (IVH) is dynamic and associated with variables such as hematoma volumes, midline shift, and patient-factors including Glasgow Coma Scale (GCS) and age. Summary ICP and CPP measures potentially lose important information about temporal trends. We aimed to identify longitudinal ICP and CPP trajectories in severe spontaneous IVH requiring external ventricular drainage (EVD) and to evaluate whether they predicted mortality and functional outcomes.

METHODS: We used group-based trajectory modeling to identify ICP and CPP trajectories over 10 and 7 days respectively after ICH onset and enrollment in the CLEAR III trial which evaluated intraventricular alteplase vs. saline for removal of IVH volume. Models incorporated risk-factor adjustment using demographics, presentation and treatment variables. We modelled 30 and 180-day outcomes (mortality and modified Rankin scale (mRS)) with age, GCS, ICH and IVH volumes, and thalamic ICH location and determined whether estimated trajectory-groups were associated with outcome in multivariable logistic regression models.

RESULTS: For ICP (N=464 patients), a four trajectory-group model best fit the data, identifying cohorts that differed by type of trajectory (constant vs. cubic function). Age at baseline was the only variable associated with ICP group membership; it was negatively associated with membership in the group with highest ICP levels (p<0.001). ICP trajectories and group variances differed across groups (p<0.001). The highest ICP trajectory group was associated with significantly higher odds of 30 day mortality compared with the lowest ICP trajectory (Odds Ratio, 95% Confidence Interval) (3.94, 1.12-13.89; p=0.03). For CPP (N=413), a three-group membership model performed best. For day 30 mortality, the highest group was significantly associated with lower mortality compared to the lowest (OR, 95%CI: 0.33, 0.13-0.87; p=0.03). Favorable mRS (0-3) was not predicted by ICP but was predicted positively by both high CPP-trajectories compared with lowest CPP trajectory (highest group: OR, 95%CI: 4.61, 1.74-12.23; p=0.002; 2nd highest group: 4.30, 1.77-10.50; p=0.001). Day 180 results will also be presented.

CONCLUSIONS: We employed a novel approach investigating longitudinal ICP and CPP patterns in ICH with large IVH requiring pragmatic EVD and ICP monitoring. Four ICP and three CPP groups were identified and predicted early mortality for ICP and both mortality and functional outcome for CPP. ICP and CPP phenotyping may be an important consideration in evaluating intracranial elastance/compliance and may provide insight into optimal ICP and CPP thresholds for this population.

Keywords: intracerebral hemorrhage, intracranial pressure, cerebral perfusion pressure, outcomes
O-032

A multicenter registration study for nontraumatic intracerebral hemorrhage in the DOAC era

Joji Tokugawa1, Ryota Tanaka5, Hideaki Ueno2, Kensaku Yoshida8, Rikizo Saito7, Munetaka Yamamoto4, Satoshi Tsutsumi6, Takuji Yamamoto2, Takao Urabe5, Nobutaka Hattori3, Arai Hajime4

1Department of Neurosurgery, Juntendo University Nerima Hospital, Tokyo
2Department of Neurosurgery, Juntendo University Shizuoka Hospital, Tokyo
3Department of Neurology, Juntendo University Hospital, Tokyo
4Department of Neurosurgery, Juntendo University Hospital, Tokyo
5Department of Neurology, Juntendo University Urayasu Hospital, Chiba
6Department of Neurosurgery, Juntendo University Urayasu Hospital, Chiba
7Department of Neurosurgery, Koshigaya Municipal Hospital, Saitama
8Department of Neurosurgery, Tokyo Metropolitan Hiroo Hospital, Tokyo

<Objective> To investigate the clinical evidence and clarify the risk factors and associated problems of nontraumatic intracerebral hemorrhage (ICH) in the Japanese population in the direct oral anticoagulant (DOAC) era.

<Patients and methods> This was a multicenter, prospective registration trial involving eight institutes in six hospitals of the Juntendo group. From July 1st, 2016, every patient with nontraumatic intracerebral hemorrhage admitted to each hospital was registered online. We collected comprehensive data from the patients on admission such as the patient’s basic demography, present illness, past medical history, family history, medication, habits, and radiographical findings as well as changes during hospitalization in consciousness, symptoms, vital signs, and the neurological status at discharge. After the rehabilitation period, the patients’ status was checked in 3-6 months after onset. We aimed to collect data on 1000 patients.

<Results> A total of 480 patients were registered and 267 patients were analyzed to date. The average patient age was 69.5 years and the average body mass index was 22.9%. One quarter of the patients had untreated hypertension and nearly half had been treated already. Dyslipidemia, diabetic mellitus, renal failure, and atrial fibrillation were recognized in 38.6%, 17.2%, 7.5%, and 7.1%, respectively. Habitual drinkers and smokers were 32.2% and 23.5%, respectively. Antithrombotic drugs were being taken by 22.4%, antiplatelet drugs by 14.6%, and anticoagulants by 7.9% of the patients. In the 7.9% of patients taking anticoagulants, vitamin K antagonists were being taken by 38.1% and DOAC by 61.9%. The average score of the National Institutes of Health Stroke Scale on admission was 11.0 ± 9.3 and that at discharge was 7.6 ± 8.4. The average volume of hematoma was 24.2 ml, and 26.6% of the patients underwent surgery. The etiology of the hemorrhage was hypertensive in 85.5%, amyloid angiopathy in 11.2%, drug-induced in 4.5%, the others in 0.7%. Although the mortality was 1.5%, the modified Rankin Scale 3-5 (poor outcome) was 66.7%.

<Discussion> In Japan, we are entering a period of a “super aging society”. The etiology, demography, and outcome of patients with ICH are different from what they were 10 years ago. It is important to investigate the current evidence surrounding patients with ICH to improve their treatment and outcomes.

Keywords: Multicenter registration study, intracerebral hemorrhage, DOAC, risk factor, evidence
Hemocoagulase atrox is not associated with Hematoma expansion prevention in intracerebral hemorrhage patients: a retrospective study

Yunke Li1, Xin Hu1, Fan Xia1, Hao Li1, Daniel F. Hanley2, Wendy Ziai2, Chao You1

1Department of Neurosurgery, West China Hospital of Sichuan University
2Department of Neurology, Division of Brain Injury Outcomes, Johns Hopkins University, Baltimore, MD, USA

OBJECTIVE: Hematoma expansion (HE) has confirmed related to poor outcome in intracerebral patients (ICH). To evaluate whether hemocoagulase atrox treatment is associated with HE prevention in ICH patients.

METHODS: We retrospectively evaluated 157 ICH patients on admission to West China Hospital from July 2011 to January 2015. We asked the question does HA (give the full name fo HA) alter hematoma expansion (HE). All patients had an ICH onset time within 6 hours, were confirmed by computed tomography (CT) and received a follow-up CT at 24 hours. We assessed the baseline data including demographics, admission blood pressure, Glasgow coma score (GCS), anticoagulant use, smoking, alcohol use, past medical history and lab results. Administration was treated 2 units of hemocoagulase atrox by either intramuscular or intravenous injection every 12 or 24 hours. The hematoma volume was measured by ABC/2 method and we also evaluated non-contrast CT sign. We defined HE as increased volume more than 6mL or 33% compared with baseline volume.

RESULTS: Of 157 patients, 109 (69%) received 2 units of hemocoagulase atrox. No significant difference was found in baseline data between the two groups of patients. Average ICH volume was 12.4mL±12.3 in HA-treated patients and 13.7mL±12.4 in controls (p=0.54). HE occurred in 30 patients (19.1%) on follow-up CT; 20 (18.3%) in HA-treatment group and 10 (20.8%) in control group (p=0.83). The Barras Scale was found in 64 patients and 20 (31.3%) has HE (p<0.01), bland sign was found in 33 patients and 12 (36.4%) has HE (p=0.01) and island sign was found in 17 patients 8 (47.1%) has HE (p<0.01) was found related to HE. Besides, we compared 4 subgroups by route of treatment. There were 19 (17%) patients in intramuscular vs 90 (83%) intravenous injection subgroups; and 60 (55%) patients in per-12 hours group vs 49 (45%) patients in per-24 hours group. No association with HE was found in any subgroup analysis.

CONCLUSION: We found that HA treatment in the acute phase of ICH was not associated with HE prevention. There was no significant difference between subgroups to suggest that route or frequency of administration was an important factor in this pilot study.

Keywords: Intracerebral Hemorrhage, Hematoma expansion, Hemocoagulase Atrox
Objective: Intracerebral hemorrhage (ICH) is the most serious adverse effect of treatment with oral anticoagulants. Prognostic data after ICH associated with Non-Vitamin K Antagonist oral anticoagulants (NOAC) compared to vitamin-K antagonists (VKA) are sparse. We compared 90-day survival and functional outcome following NOAC-ICH versus VKA-ICH using data from the Swedish Stroke Register (Riksstroke).

Methods: Using data from Riksstroke and the Swedish Causes of Death Register between 2012 and 2016, we compared all-cause 90-day mortality for patients with NOAC-ICH versus VKA-ICH using Kaplan-Meier survival analysis and Log-rank test. Cox regression, with adjustment for age, sex, previous stroke and level of consciousness (LOC) on admission, was used to estimate hazard ratios (HR) for 90-day mortality. Estimated functional outcome at 90 days, based on the modified Rankin Scale (mRS), was compared between VKA and NOAC-associated ICH using Chi-squared test.

Results: We included 2483 patients; 300 with NOAC-ICH and 2183 with VKA-ICH. In both groups, mean age was 79 years, and 58% were male. No significant difference between NOAC-ICH and VKA-ICH was found for all-cause 90-day mortality (44.3% NOAC-ICH versus 42.6% VKA-ICH; p=0.54, HR=0.93; 95% confidence interval (CI): 0.78–1.12) or 90-day estimated functional outcome (mRS 0–2: 13.7% and 15.3%; mRS 3–5: 27.3% and 28.9%, respectively (p=0.52)). Factors predicting death were increased age (HR=1.03; 95%CI: 1.02–1.04) and reduced LOC (drowsy: HR=3.48; 95%CI: 2.86–4.23; comatose: HR=12.27; 95%CI: 10.13–14.87).

Conclusion: In this large study on anticoagulant-associated ICH, we found no significant difference in mortality and functional outcome at 90 days between NOAC-ICH versus VKA-ICH.

Keywords: Intracerebral hemorrhage, prognosis, anticoagulant, mortality, functional outcome
Simulating an Adaptive, Randomized, Clinical Trial of Dose-Response from Time to Anticoagulant Reinitiation (Restart) after Intracranial Hemorrhage

Ben King¹, Corrine Elliott², Truman J Milling Jr³

¹University of Texas at Austin, Dell Medical School, Department of Neurology
²Berry Consultants
³University of Texas at Austin, Dell Medical School, Division of Emergency Medicine

BACKGROUND: Oral anticoagulation therapy (OAT) reduces the rates of thromboembolic (TE) events, but introduces the risk of hemorrhage. The optimal timing for reinitiation of OAT after a major hemorrhage to mitigate the risk of either event type is still uncertain. RESTART is an adaptive, randomized clinical trial being designed to resolve this uncertainty. Trial simulations are a critical step in designing and establishing a sample size in trial designs with an adaptive allocation mechanism. Estimation of the outcome event rate(s) in multiple scenarios demonstrates the ability of the trial to accurately detect a range of “true” conditions so that the trial can be both flexible and accurate.

METHOD: The survival functions used to estimate study conditions included four hypothetical scenarios, constructed by combining monotonic probabilities of both TE and hemorrhagic events. Additionally, unpublished data from a recent trial was used to generate a fifth scenario based on the event rates seen in the absence of controlled, randomized assignment of time to reinitiation. The intervals from medication discontinuation to reinitiation were divided to mirror the planned arms of the Restart trial and the observed survival functions were imputed. Hemorrhagic risk was adjusted in the model to reflect rates seen in successful anticoagulation control or reversal immediately after hemorrhage and a low risk of hemorrhagic event associated with OAT beginning after restart. The simulated trial scenarios included an adaptive algorithm for adjusting allocation ratios to three sequential time-to-reinitiation intervals, at predetermined interim analysis points. Utility-weighted, joint event rates were used to drive the adaptive algorithm. The trial outcome is a significant difference between any two of the three restart-interval arms. Thus, the probability of detecting any difference between arms is the primary parameter output.

RESULTS: Scenarios 1-4 modeled trial performance under the following “true” conditions: 1) first interval optimal; 2) second interval optimal; 3) third interval optimal; or 4) null trial. These scenarios resulted in a range of probabilities for detecting a difference between arms. A final sample size for the Restart trial has not yet been determined, but it will need to balance Type I error, Type II error, and the overall ability to successfully detect differences. CONCLUSION: This approach to estimating the outcome event rates for simulation of the Restart trial more accurately reflects the assignment of risk based on the extended delays in treatment restart that affect observational study designs. However, the influence of selection bias from the timing of the restart decision is still present. The randomized, clinical trial of delay to reinitiation for which these simulations are intended, is the only definitive way to determine the relative rates.

Keywords: Clinical Trial, Anticoagulation, Major Hemorrhage, Adaptive Design, Trial Simulation,
O-036
rFVIIa for Acute hemorrhagic Stroke Administered at Earliest Time (FASTEST) Trial

Joseph Broderick¹, James Grotta², Andrew Naidech³, Jordan Elm⁴

¹University of Cincinnati
²Memorial Hermann Hospital Texas Medical Center
³Northwestern University
⁴Medical University of South Carolina

Recombinant Factor VIIa (rFVIIa) for Acute hemorrhagic Stroke Administered at Earliest Time (FASTEST) Trial is a randomized, double-blind, controlled global trial of rFVIIa plus best standard therapy vs. best standard therapy alone for patients with intracerebral hemorrhage (ICH). Our central hypothesis is that treatment with rFVIIa within two hours of onset in appropriately selected patients with spontaneous ICH improves outcome as measured by the ordinal distribution of the modified Rankin Scale (mRS) at 90 days, as compared to placebo. We will test our hypothesis in 860 patients recruited at 100 hospital sites and at least 15 mobile stroke units (MSUs) within the NINDS StrokeNet (70 sites) and key global institutions (30 sites) with large volumes of patients with ICH and ability to treat within 2 hours of onset. Participating countries include the U.S., Canada, United Kingdom, Germany, Spain, Japan, and Australia. We will include subjects with a volume of ICH < 60 cc, no intraventricular hemorrhage (IVH) or a small volume of IVH (IVH score ≤ 7), age ≤ 80, GCS ≥ 8, and treated within 120 minutes from last known normal. To minimize time-to-treatment, the study will use exception from informed consent and MSUs with a goal of 4 of patients treated within 90 minutes as accomplished in the NINDS t-PA trials. We will recruit the 860 patients over 3 1/2 years and randomize them in a double-blinded fashion to rFVIIa 80 micrograms/kg dose (maximum 8mg dose) or placebo. Subjects in both arms will receive best medical therapy as per published AHA Guidelines for ICH, including a target blood pressure of 140 mm Hg. The primary efficacy outcome measure is the ordinal distribution of the mRS at 180 days (Steps 0-2, 3, 4-6). Primary safety outcomes will include ischemic events (cerebral infarction, myocardial infarction, and pulmonary embolus) within 4 days of study medication. To measure growth of ICH and IVH, all subjects will have baseline non-contrast CT and at 24 hours. CT angiograms at baseline as part of standard of care will be collected and analyzed but not required. Centralized volumetric measurements of ICH, IVH, and edema will be done for both time-points. The overall principal investigators (PIs) for the Trial include Joseph Broderick, James Grotta, Andrew Naidech, and Jordan Elm (primary statistical PI) as well as PIs for each participating non-U.S. country. In summary, the goal of FAST is to find the first scientifically proven treatment for acute ICH.

Keywords: Intracerebral hemorrhage, recombinant factor VIIa
Comparing Pharmacological Venous Thromboembolism Prophylaxis to Intermittent Pneumatic Compression in Acute Intracerebral Hemorrhage: Systematic Review and Network Meta-Analysis

Vignan Yogendrakumar¹, Ronda Lun¹, Faizan Khan², Karine Lacut³, Brian Hutton², Philip S Wells⁴, Dean A Fergusson², Dar Dowlatshahi¹

¹Ottawa Stroke Program. Department of Medicine (Neurology), University of Ottawa, Ottawa, Canada
²Ottawa Hospital Research Institute, Clinical Epidemiology Program. University of Ottawa
³EA3878, Université de Bretagne Occidentale, Brest, France
⁴Division of Thrombosis, Department of Medicine, University of Ottawa

INTRODUCTION: Patients with an acute intracerebral hemorrhage are at an increased risk of developing venous thromboembolism. Pharmacological methods and pneumatic compression devices have been shown to prevent venous thromboembolism but there have been no head to head comparisons assessing effectiveness and safety.

OBJECTIVE: To examine the comparative effectiveness of pharmacological prophylaxis with pneumatic compression devices in the context of intracerebral hemorrhage through a systematic review of the literature and a bayesian network meta-analysis.

DATA SOURCES and STUDY SELECTION: The databases of MEDLINE, PUBMED, EMBASE, CENTRAL, ClinicalTrials.gov, and the Internet Stroke Trials Registry were searched from inception until March 1, 2018. Our patient population was adults presenting acutely with spontaneous intracerebral hemorrhage. We selected studies that compared each intervention directly against each other or against a control (compression stockings or placebo). Both randomized and non-randomized studies were included.

DATA EXTRACTION AND SYNTHESIS: Data was extracted by two reviewers independently. A bayesian network meta-analysis was performed to compare the two interventions. Study quality was assessed using either the Cochrane Risk of Bias Tool or the Robins-I tool.

MAIN OUTCOME(S) AND MEASURE(S): Occurrence of new venous thromboembolism (asymptomatic/symptomatic deep vein thrombosis or pulmonary embolism) in the first thirty days.

RESULTS: 7,482 articles were screened with four articles, all randomized control trials, meeting eligibility criteria. 615 patients were included in the network analysis. Pneumatic compression devices were associated with a significantly decreased odds of venous thromboembolism compared to control (OR: 0.34, 95% Credible Limits [Crl]: 0.18-0.59, Fixed effects model). No difference between pharmacological therapy and control was observed (OR: 0.76, 95% Crl: 0.13-4.00, Fixed effected model). Pneumatic compression devices were clinically, but not statistically, more protective than pharmacological therapy (OR: 0.26, 95% Crl: 0.04-1.48, Fixed effects model).

CONCLUSION AND RELEVANCE: Pneumatic compression devices appear to be more protective than pharmacological therapy in the prevention of venous thromboembolism. With ongoing clinical equipoise, a large comparative effectiveness clinical trial is warranted.

Keywords: deep vein thrombosis, pulmonary embolism, intracerebral hemorrhage, pneumatic compression devices, heparin, enoxaparin
O-038

Direct Assessment of Health Utilities among Patients with Intracerebral Hemorrhage using the Standard Gamble Method

Farhaan Shaheer Vahidy1, Kristen B Slaughter1, Arvind B Bambhroliya1, Jennifer R Meeks1, Wamda O Ahmed2, Ritvij Bowry2, Reza Behrouz3, Osman Mir4, Jon E Tyson5, Charles C Miller5, Steven J Warach6, Sean I Savitz1

1Institute of Stroke and Cerebrovascular Disease and Department of Neurology at UTHealth Houston TX, USA
2Department of Neurosurgery, McGovern Medical School at UTHealth Houston TX, USA
3Department of Neurology, UTHealth San Antonio TX, USA
4Department of Neurology, Baylor Scott and White Dallas TX, USA
5Center for Clinical Research and Evidence Based Medicine, McGovern Medical School at UTHealth Houston TX, USA
6Department of Neurology, Dell Medical School, UTHealth Austin TX, USA

INTRODUCTION: EuroQol-5 Dimension (EQ-5D) is a validated albeit indirect method to derive health utilities (HU). Conversely, Standard Gamble (SG) directly measures patients’ valuation of their health state. We compare in-hospital and day-90 SG Utilities (SGU) among intracerebral hemorrhage (ICH) patients and report a three-way association between SGU, EQ-5D and mRS at day-90.

METHODS: Primary ICH patients were enrolled in a multisite cohort and underwent in-hospital and day-90 assessments for the mRS, EQ-5D, and SG. SG entails providing patients a choice between their current health state and a hypothetical treatment (a pill) with varying chances of either perfect health or a painless death. Higher SGU (scale 0 - 1) indicates a lower risk-tolerance for death; thus, a higher valuation of one’s health state. Median and interquartile range (IQR) are reported. Logistic regression was used to estimate the likelihood of low SGU (≤ 0.6) and Wilcoxon paired signed rank test compared in-hospital and day-90 SGU. RESULTS: In-hospital and day-90 SG was obtained from 381 and 280 patients respectively (including 236 paired observations). Median (IQR) in-hospital and day-90 SGU were 0.85 (0.40-0.98) and 0.98 (0.75-1.00) (p < 0.001). In-hospital SGU were lower with advancing age (p = 0.007), with higher NIHSS and ICH scores (p < 0.001), and with greater treatment intensity. Proxies evaluated lower SGU (p < 0.001). In the adjusted model, higher NIHSS and proxy assessments were independently associated with lower SGU, along with an interaction between age and SGU by race (white vs. black) (p value for interaction 0.05) (Figure 1a). Day-90 SGU and mRS were correlated (p < 0.001), however SGU were increasingly higher than the EQ-5D HU at higher mRS scores (Figure 1b). Data of feasibility of SGU among ICH patients will also be presented.

CONCLUSION: Direct assessment of HU via SG may be feasible in selected ICH patients. Divergence between directly and in-directly assessed HU at high levels of functional disability warrant careful prognostication of ICH outcomes, and should be considered in designing early end-of-life care discussions with families and patients.

Keywords: Intracerebral Hemorrhage, Quality of Life, EQ-5D, Standard Gamble, Patient-Reported Outcomes
Longitudinal prevalence of Cognitive Impairment after Intracerebral Haemorrhage using data from the Tranexamic acid for hyperacute primary IntraCerebral Haemorrhage (TICH-2) trial

Andrew Belcher, Lisa Woodhouse, Philip Bath, Nikola Sprigg

INTRODUCTION: Cognitive impairment is common following an Intracerebral Haemorrhage (ICH), yet the natural history and optimal time point for assessment is unclear. In this study, we investigated the longitudinal prevalence of post stroke cognitive impairment (PSCI) and its decline in a large cohort of ICH survivors.

METHOD: Patients were adults with an ICH that were recruited into the Tranexamic acid for hyperacute Intracerebral Haemorrhage (TICH 2) trial. The Telephone Interview for Cognitive Status-Modified (TICS-M) was performed at Day 90 and 365 post-ICH. PSCI includes mild cognitive impairment (MCI, defined as TICS-M <25) and severe cognitive impairment (SCI, defined as TICS-M <21).

RESULTS: Of 2243 patients enrolled into TICH-2 (with an ICH), at Day 90, 33.0% (n=741) had cognition data, 45.5% (n=1020) did not and 21.5% (n=482) were dead. At Day 90, 44.1% (n=327) of patients were cognitively preserved (CP), 29.7% had MCI (n=220) and 26.2% had SCI (n=194). Of the 1020 patients without cognition data at day 90, 15.4% (n=157) were able to complete the cognitive assessment at day 365. Meanwhile, of the 741 patients with cognition data at day 90, 49.3% (n=365) completed the Day 365 follow up. At Day 365, 23.3% (n=522) patients had cognition data, 50.6% (n=1134) did not and 26.2% (n=587) were dead (105 patients died between Day 90 and Day 365). At Day 365, 52.9% (n=193) of patients were CP, 28.2% (n=103) had MCI and 18.9% (n=69) had SCI. Of the 327 patients that were CP at Day 90, 52.3% (n=171) completed the Day 365 follow up. Of these patients, 77.2% (n=132) remained CP, whereas, 19.3% (n=33) and 3.5% (n=6) of patients developed MCI and SCI, respectively. Of the 220 patients that had MCI at Day 90, 50.9% (n=112) completed the Day 365 follow up. Of these patients, 44.6% (n=50) recovered, 46.4% (n=52) had persistent MCI and 8.9% (n=10) developed SCI. Of the 194 patients that had SCI at Day 90, 42.3% (n=82) completed the Day 365 follow up, and while 13.4% (n=11) recovered to CP and 22.0% (n=18) recovered to MCI, 64.6% (n=53) had persistent SCI.

CONCLUSION: Both MCI and SCI were common over time, with an accumulative 55.9% of patients suffering from PSCI at Day 90, which decreased to 47.1% at Day 365. Cognitively preserved patients at Day 90 were less likely to suffer from cognitive decline at Day 365, whereas patients with MCI were equally likely to recover as decline. SCI was more likely to persist in the long term. This suggests that, 3 months post-ICH may be too early to assess for MCI, and instead 1-year may be better suited for cognition assessment after ICH. Further longitudinal study in a similarly large cohort over a longer period assessing both MCI and SCI, are required to confirm this finding.

Keywords: Stroke, Post-Stroke Cognitive Impairment, IntraCerebral Haemorrhage, Natural History, Longitudinal
O-042
Epileptic seizures as a complication in cerebral hemorrhage surgically treated in ICU patients

Maria Del Carmen Molina De La Torre¹, Maria Marina Gordillo Resina¹, María Dolores Arias Verdú², Esteban Pérez Mesa¹, Encarnación Castillo Lorente³, Juan Mora Ordoñez², Ricardo Rivera Fernández¹, Miguel Angel Arraez Sánchez²

¹Hospital Universitario de Jaén, Spain
²Hospital Regional de Málaga, Spain.
³Hospital Virgen de las Nieves de Granada, Spain

OBJECTIVE: To evaluate the presence of epileptic seizures and surgical treatment in patients with supratentorial spontaneous non-traumatic intracerebral hemorrhage (ICH) and intraventricular hemorrhage (IVH).

MATERIAL-METHODS: During the years 2009 to 2012, ICU admitted patients from three Spanish hospitals with Neurosurgery Services with the diagnosis of supratentorial ICH and IVH were studied. The effect of the surgical intervention over these patients was studied. Using a propensity index, 26 patients who underwent surgery were paired with the same number of non-operated patients.

RESULTS: 163 patients with supratentorial and intraventricular ICH were admitted. These patients presented in the admission a Glasgow 8 + 4, APACHE-II 21.42 + 7.55 and an ICH score of 2.75 + 0.9 with a predicted mortality (30 days) of 65% and with a mortality of 59.5%. At admission, 13.5% had bilateral arreactive mydriasis. 23.3% (n=38) of patients underwent surgery. Mortality of those who underwent surgery was 34.2% and of the non-operated patients it was 67.2% (p <0.001). In the multivariate analysis, OR for surgical intervention was 0.14 (0.05-0.41). Subsequently, 26 surgically operated patients were matched with further 26 non-surgically treated patients, based on a propensity index. This index was calculated based on: age, presence of pupillary anomalies, size and location of the hematoma and Glasgow on admission. The surgical and non-surgical patients presented similar characteristics (age, Glasgow, ICH score, APACHE II, volume and location of the hematoma) and none presented bilateral mydriasis at admission. The hospital mortality of the 26 operated was 30.8% and of the 26 not operated was 65.4%, (p = 0.001) and OR 0.23; CI: 95%: 0.07-0.75. Afterwards, these 52 paired by propensity index patients were tracked for 6-9 years and mortality was 57.7% in those operated, and 73.1% in those not operated on. Of the 26 patients non-surgically treated, 6 were alive and none had epileptic seizures, and of the 26 who were surgically treated 11 were alive and had epilepsy 6 of them (54.5%), (p = 0.017).

CONCLUSION: Patients admitted to the ICU for non-traumatic cerebral hemorrhage open to ventricle who undergo surgery have lower mortality than those who have not undergone surgery, but have epileptic disorders with a frequency much higher than those who have not undergone surgery.

Keywords: Epileptic seizures, supratentorial spontaneous non-traumatic intracerebral hemorrhage, intraventricular hemorrhage
A Delayed Modified-ICH Score Outperforms Baseline Scoring in Acute Intracerebral Hemorrhage

Ronda Lun¹, Vignan Yogendrakumar¹, Dylan Blacquiere¹, Michel Shamy¹, Grant Stotts¹, On Behalf Of Vista Ich Collaboration²

¹Ottawa Stroke Program. Department of Medicine (Neurology), University of Ottawa, Ottawa, Canada
²University of Glasgow, Scotland, UK

Background and PURPOSE: The Modified-Intracerebral Hemorrhage (MICH) Score is a simple tool created to provide prognostication in basal ganglia (BG) hemorrhages, which are associated with increased risk for intraventricular extension and clinical deterioration. All current prognostic scores, including the MICH, are based on the assessment of baseline patient characteristics, failing to account for these increased risks. The MICH Score is calculated using only three components: GCS, IVH extension, and ICH volume. Given its easy applicability, we propose to validate the MICH Score in all hemorrhage locations, and hypothesize that its delayed calculation will have better predictive value for mortality and long-term functional outcome than its baseline counterpart.

METHODS: We performed a retrospective analysis of collated clinical stroke trial data from the Virtual International Stroke Trials Archive (VISTA) database. Primary outcome was mortality at 90 days. Secondary outcome was poor outcome (modified Rankin Scale [mRS] of 4-6) at 90 days. Receiver operating characteristic (ROC) curves were generated looking at the predictive ability of the MICH Score for mortality and poor outcome, at baseline and at 72 hours. Competing curves were assessed with non-parametric methods.

RESULTS: We included 226 patients, with a 90-day mortality of 22.5% (51/226). MICH scores calculated at 72 hours were more predictive of mortality as compared to baseline (Area under the curve [AUC]: 0.89 [95%CI: 0.83-0.94] vs 0.78 [95%CI: 0.70-0.85]), p<0.01. MICH scores at 72-hours similarly better predicted poor outcome vs baseline (AUC: 0.78 [95%CI: 0.72-0.84] vs AUC: 0.72 [95%CI: 0.66-0.78]), p=0.047.

CONCLUSION: The MICH Score has positive prognostic value for mortality and poor functional outcome in all hemorrhage locations. The delayed calculation of the score led to more accurate prognostication, possibly because it accounts for changes in hematoma volume and neurological deterioration.

Keywords: Modified ICH Score, Prognostication, acute ICH, withdrawal of care, mortality, functional outcome
O-044

Stroke nurse plays a key role in the fast, intensive and sustained blood pressure reduction in acute intracerebral hemorrhage

Olalla Pancorbo, Estela Sanjuan, Katherine Santana, Victoria Sala, Álvaro García Tornel, Noelia Rodríguez Villatoro, Jesús María Juega, Sandra Boned, María Angeles Muchada, Marta Rubiera, Carlos Molina, David Rodriguez Luna

Stroke Unit, Department of Neurology, Vall d’Hebron University Hospital and Stroke Research Group, Vall d’Hebron Research Institute.

Background and PURPOSE: Time metrics and blood pressure (BP) stability influence on potential benefit of BP reduction on attenuating intracerebral hemorrhage (ICH) expansion. We aimed to compare two different BP managements to determine the stroke nursing practice influence in acute ICH.

METHODS: Consecutive ICH patients <6h and systolic BP (SBP) >150 mmHg under an early (antihypertensive IV bolus at CT scan), intensive (target SBP <140mmHg), and sustained (antihypertensive continuous infusion after IV bolus) BP protocol within a 4-year period (2013-2017) were 1:1 matched with a prospectively collected control group (2009-2013) under a non-early (IV bolus at Stroke Unit), non-intensive (target SBP <180 mmHg), and non-sustained (repeated IV bolus) BP protocol. All patients underwent a bedside non-invasive BP monitoring at 15 min intervals over the first 24h. Time to SBP target achievement and SBP variability were prospectively recorded in both groups.

RESULTS: 103 cases were matched with 103 controls. Mean age was 71.3±13.5 years, 133 (64.6%) were men, and mean SBP was 182.6±24.6 mmHg. Median time from initial CT scan to antihypertensive treatment initiation (23[6-52] vs. 196[40-605] minutes, P<0.001), from CT scan to SBP target achievement (82[46-157] vs. 169[50-579] minutes, P<0.001), and from symptom onset to SBP target achievement [256[180-360] vs. 334[207-635] minutes, P=0.006] was lower in cases than controls, respectively. Over the first hours of follow up attention, the mean SBP was lower in early/intensive/sustained SBP group as compared with the non-early/non-intensive/non-sustained group, including first 6 hours (136.3±19.0 vs. 169.8±20.7 mmHg, P<0.001) and first 24 hours (135.5±14.0 versus 169.2±17.3 mmHg, P<0.001), respectively. Cases group maintained the SBP below the target more frequently than control group at different time points, including 120 minutes (39.8% vs. 32.8%, P<0.001), 18 hours (30.6% vs. 23.4%, P<0.001), and 24 hours (32.7% vs. 9.4%, P<0.001), respectively.

CONCLUSIONS: An early and continued stroke nursing care allows a fast and sustained BP reduction in acute ICH patients under an intensive BP reduction protocol.

Keywords: acute intracerebral hemorrhage, blood pressure, stroke nursing
INTRODUCTION: There are no proven therapies for patients with hemorrhagic stroke (HS). Transfer to an inpatient rehabilitation (IR) facility (IRF) potentially provides multiple benefits to HS patients including improvements in functional independence measures, neurological impairments, stroke related medical complications, and reduction in re-admissions. Nationwide estimates for IRF utilization among HS patients are unknown. We report nationwide trends and disparities in post HS IR utilization.

METHODS: We analyzed the National Inpatient Sample representing 90% of all US hospitalizations for years 2006 – 2011 and used ICD-9 diagnosis codes to identify adult patients with intracerebral hemorrhage (ICH) and sub-arachnoid hemorrhage (SAH). Patients receiving IRF were identified by the Centers for Medicare & Medicaid (CMS) and the National Uniform Billing Committee approved UB-04 claims form. Institutionalized care (IC) included transfer to either a skilled nursing facility or a long-term care facility. We fit survey design multivariable logistic regression models to determine nationally representative trends in IR utilization and report crude and adjusted odds ratios (aOR) and 95% confidence intervals (CI) for factors associated with IR utilization as compared to IC, including level of care (LOC) as defined by the teaching status of the hospital.

RESULTS: Based on our criteria 494,826 HS patients were included in analyses between 2006 – 2011; of whom only 14.7% utilized IR. However, there was a significantly increasing trend in post-HS IR utilization over the period of investigation (OR: 1.07, 95% CI: 1.04 – 1.10), with 19.9% and 18.0% patients discharged to IRF in 2010 and 2011 respectively (Figure). After controlling for various demographic, disease severity, clinical and comorbidity factors, older age and female gender were significantly associated with decreased likelihood of IR utilization (aOR, 95% CI for each year increase in age: 0.95, 0.95 – 0.96 and for females vs males: 0.79, 0.73 – 0.85). Furthermore, the gender effect was significantly modified by age; whereby older (> 65 years) females were more likely to not utilize post-HS IR as compared to males with comparable ages (p value for interaction < 0.001) (Figure). Patients utilizing IR had significantly greater odds of being discharged from a teaching hospital, after controlling for various demographic, clinical, disease severity, and comorbidity factors (aOR 1.31, 95% CI 1.10 – 1.55).

CONCLUSION: Our analyses indicates an overall low nationwide IR utilization rate in the US for patients with HS. However, we demonstrate an increasing trend in utilization of IR, albeit with significant age, gender, and LOC disparities. Further studies should focus on barriers and closing the disparities gap in IR utilization for HS patients.

Keywords: Intracerebral Hemorrhage, Sub Arachnoid Hemorrhage, In-patient Rehabilitation, Recovery, Disparities
O-046
Spontaneous Intracerebral Hemorrhage in a Plateau Area: A Study Based on the Tibetan Population

Lu Ma
Department of Neurosurgery, West China Hospital, Sichuan University

OBJECTIVE: To reveal the characteristics of spontaneous intracerebral hemorrhage (sICH) in a plateau area based on the Tibetan population.

METHODS: Data of Tibetan and Han patients (control group) with sICH treated at our center from January 2013 to April 2017 were retrospectively reviewed.

RESULTS: A total of 122 Tibetan and 927 Han patients were included. Compared with Han patients, Tibetan patients were older (54.7 ± 11.2 vs. 50.9 ± 18.3 years, P < 0.027), exhibited higher male-to-female ratios (73.8% vs. 55.0%, P < 0.001), were more overweight (22.1% vs. 13.1%, P < 0.007) had more smokers (36.9% vs. 20.5%, P < 0.001), had a higher concentration of hemoglobin (163.7 ± 17.6 vs. 134.8 ± 20.2 g/L, P < 0.001), and included a higher number of patients with hypertension (83.6% vs. 60.5%, P < 0.001), diabetes mellitus (19.2% vs. 9.3%, P < 0.002), and prior hemorrhagic stroke (9.0% vs. 2.0%, P < 0.001). Tibetan patients also experienced more brainstem hemorrhage (11.5% vs. 5.1%, P < 0.039) in the infratentorial region and had a higher risk of in-hospital complications resulting from hematoma enlargement (20.5% vs. 10.4%, P < 0.002) and cerebral infarction (59.0% vs. 9.7%, P < 0.001). During a 6-month follow-up period, they had higher rates of unfavorable outcomes and case mortality (P < 0.05). A multivariable analysis adjusted for confounding factors revealed that the Tibetan race was positively associated with unfavorable clinical outcomes in sICH patients (P < 0.05).

CONCLUSIONS: Tibetan sICH patients from the plateau area presented unique characteristics in their baseline measurements, incidence of comorbidities, hematoma location, risk of in-hospital complications, and clinical outcomes compared with Han patients. The Tibetan race was positively associated with unfavorable 6-month outcomes in ICH patients.

Keywords: - Han - Plateau area - Spontaneous intracerebral hemorrhage - Tibetan
OBJECTIVE: This study aimed to evaluate the effect of burr-hole drainage on chronic subdural hematomas (CSDH).

METHODS: We retrospectively reviewed the medical records of patients with CSDH who underwent surgical treatment in West China Hospital between Jan. 2012 and June 2018. The patients' age, gender, the history of injury, Markwalder grading, computed tomography (CT) findings, surgical methods, and outcomes were analyzed.

RESULTS: A total of 328 patients with male 281 and female 47 were included. The patients ranged in age from 22-93 years, with a mean age of 65.1 years. There were 170 patients (51.8%) with a history of minor head injury. According to Markwalder grading, 311 patients were Grade 1, 14 patients Grade 2, 1 patient Grade 3, and 2 patients Grade 4. The CSDH was left-sided in 147 patients, right-sided in 120, and bilateral in 61. In terms of CT findings on admission, 136 patients were mixed density hematoma, 140 iso-density, 34 high density, and 18 low density. Midline shift had an average of 4.7 mm (0-15 mm). The thickness of hematoma ranged from 7 to 40 mm, with a mean of 18.2 mm. Three hundred and twenty-two patients underwent burr hole craniostomy with irrigation and closed-system drainage. Six patients underwent craniotomy when organized hematoma was found in burr hole. Recurrence was found in 8 patients, of which 7 patients were mix density hematoma, and 1 iso-density. Mix density hematoma was associated with recurrence (P<0.05). Six patients underwent craniotomy and the inner membrane was found thick and resected. Two patients performed burr hole drainage again. Overall, the mortality was 0.30% (1/328), and the recurrence rate was 2.44% (8/328). Three hundred and twenty-seven patients were classified as Markwalder Grade 0 at 6 months post-operation.

CONCLUSIONS: Burr hole craniostomy with irrigation and closed-system drainage is an effective method for the surgical treatment of CSDH. Mix density hematoma is a risk factor for recurrence. Moreover, the presence of thick inner membranes might be a main cause of recurrence. Organized CSDH should be treated by craniotomy.

Keywords: chronic subdural hematomas, burr-hole drainage
O-049
Subdural haematoma management in newborns: a case series

Tomaz Velnar, Roman Bosnjak, Peter Spazzapan
University medical centre Ljubljana, Department of neurosurgery

Introduction: Subdural haematomas may be frequently encountered in newborns and young children, resulting as a consequence of various pathology, such as trauma, child abuse, metabolic diseases, forced delivery, coagulopathies, prematurity or vascular pathology. Surgery is necessary in case of neurological symptoms and brain compression. We describe the symptoms, surgical outcome and prognosis of children with subdural haemorrhage of various aetiologies.

Methods: A retrospective analysis of clinical data was performed from 2015 to 2017. The children treated at our centre due to various subdural haematomas were evaluated. Clinical condition, neurological condition, mode of treatment and outcome were taken into account.

Results: Eight children were treated at our department. The median age was 1 year. Seven were operated on under emergency conditions due to brain oedema and herniation. In one child, a spontaneous resolution of bleeding was observed. Six children had symptoms of elevated intracranial pressure within the first 24 hours of life, in one the neurological deterioration occurred after 24 hours. Each patient had a cranial ultrasound followed by MR that confirmed the bleeding. The result of bleeding was in two respective cases birth trauma and child abuse, in four prematurity, in one coagulopathy and in one fall trauma. With a mean follow-up of 6 months, one patient died and one had mild developmental delay. In other, a normal development was observed.

Conclusion: In neonates and small children with subdural bleeding, surgery can be safely performed in cases of clinical deterioration and radiological signs of brain oedema or compression. Because of a good long-term neurological outcome, surgical and supportive treatment should be carried out in these cases.

Keywords: Subdural haematoma, newborns, operation
O-053
Efficacy and Safety of Four Interventions for Spontaneous Supratentorial Intracerebral Hemorrhage: a Network Meta-Analysis of Randomized Controlled Trials

Chao Pan, Guangyu Guo, Suiqiang Zhu, Zhoupeng Tang

Department of Neurology, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, People’s Republic of China

OBJECTIVE: To perform a systematic review and network meta-analysis of four main interventions for spontaneous supratentorial intracerebral hemorrhage (SICH).

METHODS: PubMed, EmBase, Web of Science and Cochrane Central Register of Controlled Trials (CENTRAL) were searched for original randomized controlled trials investigating endoscopic surgery (ES), minimally invasive puncture surgery (MIPS), conventional craniotomy (CC) and/or conservative medical treatment (CMT). Significant functional impairment of ADL, and mortality and hemorrhage recurrence rates were evaluated by a random-effects network meta-analysis.

RESULTS: Eighteen RCTs with 2528 patients were included. Compared with CMT, lower risk of death or significant functional impairment of ADL was found after MIPS (RR=0.58, 95%CI 0.48-0.70) and CC (RR=0.73, 95%CI 0.59-0.91), while ES strongly reduced mortality compared with CMT (RR=0.63, 95%CI 0.46-0.87), with a similar trend for MIPS (RR=0.77, 95%CI 0.60-0.98). Higher risk of hemorrhage recurrence was found after CC (RR=4.39, 95%CI 2.17-8.84) and MIPS (RR=2.20, 95%CI 1.23-3.91) compared with CMT, with no significant difference with ES. ES and MIPS were comparable in efficacy and safety. For the efficacy outcome (death or significant functional impairment of ADL), P-scores ranked from high to low for CMT, CC, ES and MIPS. P-scores for mortality ranked from high to low for CC, CMT, MIPS and ES. Ranking probability for hemorrhage recurrence from high to low was CC, MIPS, ES and CMT.

CONCLUSIONS: Minimally invasive puncture surgery is most effective in improving neurological function. SICH treatment by endoscopic surgery results in lowest mortality. All hematoma removal surgeries increase the risk of hemorrhage recurrence compared with conservative treatment.

Keywords: intracerebral hemorrhage, Network Meta-Analysis, Randomized Controlled Trials
Clinical and Radiological Predictors of Cognitive Impairment after Intracerebral Haemorrhage at Day 90 and Day 365 using data from the Tranexamic acid for hyperacute primary IntraCerebral Haemorrhage (TICH-2) trial

Andrew Belcher, Lisa Woodhouse, Philip Bath, Nikola Sprigg

Stroke Trials Unit, Division of Clinical Neuroscience, University of Nottingham, Nottingham, United Kingdom

INTRODUCTION: Cognitive impairment is common following an intracerebral haemorrhage (ICH), however, its predictors remain unclear. This study investigated the predictors of post-stroke cognitive impairment (PSCI) in ICH survivors.

METHOD: Patients were adults with an ICH that were recruited into the TICH 2 trial. The Telephone Interview for Cognitive Status-Modified (TICS-M) was performed at Day 90 and Day 365 post-ICH. PSCI includes mild cognitive impairment (MCI, defined as TICS-M <25) and severe cognitive impairment (SCI, defined as TICS-M <21). A multivariate backward binary logistic regression was used to determine the independent predictors of PSCI and SCI at Day 90 and Day 365.

RESULTS: The independent predictors of PSCI at Day 90 (n=685, R²=0.23) were age (odds ratio [OR] 1.06, 95% confidence intervals [CI] 1.04-1.08; p=<0.001), non-Caucasian ethnicity (OR 2.77, 95% CI 1.56-4.92; p=<0.001), stroke severity (OR 1.04, 95% CI 1.00-1.08; p=0.016), a history of hypertension (OR 1.59, 95% CI 1.11-2.26; p=0.011), a history of smoking (OR 1.83, 95% CI 1.29-2.58; p=0.001), a left-sided stroke (OR 2.03, 95% CI 1.44-2.87; p=<0.001), ICH volume (OR 1.03, 95% CI 1.01-1.04; p=0.001), and the degree of leukoaraiosis (OR 1.21, 95% CI 1.01-1.46; p=0.036). At Day 365 (n=475, R²=0.19), age (p=<0.001), non-Caucasian ethnicity (p=<0.001), stroke severity (p=0.022), and a history of hypertension (p=0.042) remained significant predictors of PSCI, along with Glasgow Coma Scale (GCS) score (OR 0.76, 95% CI 0.61-0.95; p=0.016). The independent predictors of SCI at Day 90 (n=685, R²=0.24) were age (OR 1.07, 95% CI 1.05-1.09; p=<0.001), non-Caucasian ethnicity (OR 5.01, 95% CI 2.67-9.41; p=<0.001), stroke severity (OR 1.06, 95% CI 1.02-1.11; p=0.004), a history of smoking (OR 1.65, 95% CI 1.12-2.43; p=0.011), a left-sided stroke (OR 1.86, 95% CI 1.26-2.74; p=0.002), an intraventricular haemorrhage (IVH) (OR 1.84, 95% CI 1.13-3.01; p=0.014), and a lobar hematoma (OR 2.12, 95% CI 1.35-3.31; p=0.001). At Day 365 (n=475, R²=0.30), age (p=0.001), non-Caucasian ethnicity (p=<0.001), a history of smoking (p=0.018) and lobar hematoma (p=0.003) remained significant predictors of SCI, along with GCS score (OR 0.74, 95% CI 0.60-0.91; p=0.006), and socioeconomic status (OR 0.90, 95% CI 0.82-0.98; p=0.022).

CONCLUSION: The baseline volume of ICH was predictive of the presence but not severity of cognitive impairment at Day 90. Instead, the location of the hematoma was associated with SCI at both time points. Interestingly, non-Caucasian ethnicity, a history of smoking and socioeconomic status was also associated with long term SCI. However, additional research is required to confirm these associations.

Keywords: Stroke, Intracerebral Haemorrhage, Cognition, Post-stroke Cognitive Impairment
Specific Intraventricular Hemorrhage Severity Associated with Subsequent Incontinence and Gait Dysfunction

Tyler Paul Behymer¹, Simone Uniken Venema², Padmini Sekar¹, Ashby C Turner¹, Elisheva R Coleman¹, Russell Sawyer¹, Robert Stanton¹, Matthew L Flaherty¹, Christopher D Anderson², Alessandro Biffi², Jonathan Rosand², Daniel Woo¹

¹Department of Neurology, University of Cincinnati College of Medicine, Cincinnati, USA
²Department of Neurology, Massachusetts General Hospital, Boston, USA; Center for Genomic Medicine Massachusetts General Hospital, Boston, USA

INTRODUCTION: Intracerebral hemorrhage (ICH) is the most severe subtype of stroke with 80% of survivors having disability. We previously reported that intraventricular hemorrhage (IVH) complicating ICH was an independent predictor of urinary incontinence and gait disturbance at 3-months post stroke. To identify a target population for intervention, specific IVH characteristics that are predictive of these outcomes need to be identified. We hypothesized that IVH affecting the III and IV ventricle would be the key criteria leading to urinary incontinence and gait disturbance at 3-months. METHODS: Between 2008-2016, the Genetic and Environmental Risk Factors for Hemorrhagic Stroke (GERFHS) and the Ethnic/Racial Variations of Intracerebral Hemorrhage (ERICH) studies prospectively recruited spontaneous ICH cases. Baseline CT scans were analyzed for ICH location, volume, and IVH severity (Graeb Score). ICH volumes were log transformed to minimize extreme influence on models. The functional outcomes urinary incontinence and gait disturbance were obtained by Barthel Index at follow-up and multivariate logistic regression models were performed to determine the independent risk of long-term urinary incontinence and gait disturbance after ICH. RESULTS: Among 3543 ICH cases, 708 died by 3-month follow-up and 722 were missing follow-up or Graeb Score. Of the remaining 2113 cases, 762 had IVH (age 61.7; 40.6% female) and by 3-months 592 had urinary incontinence and 881 had gait disturbance. Multivariate risk factors for incontinence and dysmobility are presented (Figure). Involvement of the III or IV ventricle alone without lateral ventricle involvement was not associated with long-term urinary incontinence or gait disturbance. A Graeb Score in lateral ventricles more than trace, however, was associated with long-term urinary incontinence and gait disturbance independent of other factors including ICH volume and location. CONCLUSION: Contrary to our hypothesis, IVH involvement of the III or IV ventricle alone was not sufficient to cause long-term urinary incontinence or gait disturbance. We identified that ‘more than trace IVH in the lateral ventricles alone’ is independently associated with long-term urinary incontinence and gait disturbance. Further studies are needed to identify the precise proportion of IVH that increases risk along with a score that includes all variables associated with long-term urinary incontinence or gait disturbance. Keywords: Intracerebral Hemorrhage, Intraventricular Hemorrhage, Neuroimaging, Functional Outcomes, Stroke
O-056

Clinical Predictors of Health-Related Quality of Life for Patients with Intracerebral Hemorrhage and Intraventricular Hemorrhage

Lourdes Carhuapoma¹, Radhika Avadhani², Noeleen Ostapkovich², Karen Lane², Nichol Mcbee², Juan Ricardo Carhuapoma³, Wendy Ziai³, Daniel F Hanley²

¹Department of Anesthesia and Critical Care Medicine, The Johns Hopkins Hospital, Baltimore, USA
²Department of Neurology, Johns Hopkins University, Baltimore, USA
³Departments of Anesthesia and Critical Care Medicine and Neurology, Johns Hopkins University, Baltimore, USA

OBJECTIVES: Clinical predictors of functional recovery have been described for patients with Intracerebral Hemorrhage (ICH) and Intraventricular Hemorrhage (IVH); yet little is known regarding clinical predictors of health-related quality of life (HRQoL).

METHODOLOGY: We studied HRQoL, measured by the EuroQoL Visual Analog Scale (EQ-VAS), in patients (N=979) enrolled in the MISTIE III and CLEAR III trials at days 30 (D30), 180 (D180) and 365 (D365). Multivariable linear regression (MLR) was used to estimate each timepoint relationship between EQ-VAS and disease severity characteristics, such as age (years), Glasgow Coma Scale (GCS), ICH location (deep or lobar), and total blood burden (TBB) (<= 30 mL, >30 to <= 40 mL, >40 to <= 55 mL, >55 mL), defined by adding ICH and IVH volumes at stability. MLR model includes adjusted coefficients and 95% confidence interval for each covariate (Beta [95% CI]).

RESULTS: In D30 EQ-VAS MLR model, age (-0.5 [-0.6, -0.3], p<0.0001), GCS 9-12 (-6.5 [-10.8, -2.2], p<0.0001), GCS 3-8 (-14.7 [-19.8, -9.7], p=0.003), TBB >40 to <= 55 mL (-9.4 [-14.3, -4.5], p<0.0001), TBB >55 mL (-14.6 [-19.7, -9.5], p<0.0001) and deep ICH location (-12.2 [-16.2, -8.2], p<0.0001) were significantly associated with lower EQ-VAS, while TBB >30 to <=40 mL (-3.0 [-8.3, 2.3], p=0.271) was not statistically significant. In D180, age (-0.4 [-0.5, -0.3], p<0.0001), GCS 3-8 (-9.0 [-13.8, -4.2], p<0.0001), TBB >40 to <= 55 mL (-7.1 [-11.7, -2.5], p=0.002), TBB >55 mL (-12.9 [-18.0, -7.7], p<0.0001) and deep ICH location (-11.7 [-15.3, -8.1], p<0.0001) were significantly associated with lower EQ-VAS, while GCS 9-12 (2.0 [5.8, 1.9], p=0.315) and TBB >30 to <=40 mL (2.4 [6.9, 2.1], p=0.301) were not statistically significant. In D365, age (-0.4 [-0.5, -0.2], p<0.0001), TBB >30 to <=40 mL (6.8 [-11.0, -2.5], p=0.002), TBB >40 to <= 55 mL (-7.3 [-11.7, -2.9], p<0.001), TBB >55 mL (8.0 [-12.9, -3.1], p=0.002) and deep ICH location (-11.7 [-15.2, -8.1], p<0.0001) were significantly associated with lower EQ-VAS, while GCS 3-8 (-4.0 [-8.3, 0.3], p=0.068) and GCS 9-12 (1.0 [-4.7, 2.8], p=0.614) were not statistically significant. The median increase in EQ-VAS from D30 to D180 is 17 points, while the median increase in EQ-VAS from D180 to D365 is 4 points.

CONCLUSION: A poorer HRQoL is associated with an increase in age, larger TBB and deep ICH location at all timepoints. The highest increase in EQ-VAS scores occurred between D30 and D180.

Keywords: Health-related Quality of Life, Intracerebral Hemorrhage, Intraventricular Hemorrhage
OBJECTIVE: Cerebral vasospasm (CVS) is a severe complication after subarachnoid hemorrhage (SAH). We explored vitamin D (VitD) as a possible therapeutic option for CVS in SAH patients. METHODS: The translational study was composed of an experimental and a clinical arm. 25-vitaminD3 (VitD3) levels tested between 2007-2015 and data of SAH patients admitted during the months with a peak versus nadir of VitD3-values were analyzed, retrospectively. Furthermore, we prospectively correlated VitD3 and vasospasm/outcome data in SAH patients admitted in 2017 after written informed consent. An experimental mice SAH model and cell culture model using 1,25-dihydroxy-vitaminD3 (1,25-VitD3) or not were used to investigate the pathophysiological differences. Additionally, the mediators acting in the VitD mechanism were researched and detected. RESULTS: In SAH patients an increased frequency of severe vasospasm during the low VitD period was observed (p<0.05, OR1.7).

Active 1,25-VitD3 attenuated CVS development, as determined by vessel diameter and endothelial function measurements of the basilar artery (BA) as well as reduced neurological deficit. An attenuated inflammation of the BA was detected under 1,25-VitD3-treatment, additionally. Deletion of the myeloid or endothelial VitD-receptor decreased the protective effect.

Co-culture experiments of myeloid and endothelial cells with blood confirmed the anti-inflammatory effect of 1,25-VitD3 but also revealed a selective induction of SDF1α, VEGF and eNOS. In mice, SDF1α mimicked the protective effect of 1,25-VitD3.

Also, in the prospective study of 23 patients high VitD3 levels were associated with a significant higher chance for favorable outcome (p<0.05, OR18). CVS severity was inversely correlated with the VitD level (r=-0.63, p<0.001). Patients with severe CVS exhibited attenuated expression of SDF1α and VitD-responsive genes on circulating myeloid cells.

CONCLUSIONS: Patients with VitD-deficiency have a higher rate of severe CVS and worse outcome. 1,25-VitD3, by inducing SDF1α, attenuates CVS after subarachnoid hemorrhage. VitD administration should be tested as potential treatment option to prevent CVS after SAH.

Keywords: Vitamin D, subarachnoid hemorrhage, cerebral vasospasm, translational study
Unraveling mechanisms of axonal degeneration and endothelial cell damage in intracerebral hemorrhage

Marietta Zille
Fraunhofer Research Institution for Marine Biotechnology and Cell Technology, Luebeck, Germany; University of Luebeck, Institute for Medical and Marine Biotechnology, Luebeck, Germany, University of Luebeck, Institute for Experimental and Clinical Pharmacology and Toxicology, Luebeck, Germany

OBJECTIVES: It is established that adverse outcomes after intracerebral hemorrhage (ICH) result from irreversible damage to neurons resulting from primary and secondary injury. Secondary injury has been attributed to hemoglobin and its oxidized product hemin from lysed red blood cells. However, our advances in understanding neuronal demise after ICH have not translated into effective therapeutic approaches. There are many possible explanations for the lack of success of current therapeutics at the bedside. One reason may be that they primarily focus on neurons and, more specifically, on neuronal cell bodies. We here hypothesize that the molecular mechanisms underlying cell death and degeneration may be different in different cell types as well as compartments of the cells, such as the axon in comparison to the soma.

METHODS: We investigated cell death mechanisms in cultured primary neurons, isolated axons, and primary endothelial cells exposed to hemin. We systematically screened pharmacological inhibitors of different known cell death pathways (apoptosis, necroptosis, ferroptosis, parthanatos) to identify the underlying molecular signaling pathways involved in the different cell types or compartments.

RESULTS: We developed a quantitative method to analyze axonal degeneration in vitro based on deep learning/convolutional networks. We show that different cell death pathways are activated in primary endothelial cells versus primary neurons and that the mechanisms are different between neuronal cell body demise and axonal degeneration.

CONCLUSIONS: Our results indicate that different therapeutic approaches addressing the numerous types of brain cells are needed to effectively treat patients with ICH and, potentially, other neurological diseases.

Keywords: cell death, deep learning, ferroptosis, necroptosis, apoptosis, parthanatos
We report preliminary results from clinical trials with a self-calibrating, non-invasive, Doppler-ultrasound based intracranial pressure (ICP) measuring instrument, which may help optimize the management of patients with intracranial haemorrhage (ICH) and, through timely intervention, lead to improvement in functional recovery. The role of elevated ICP in causing secondary injury is well understood. The deployment of standard surgically implanted devices for measuring ICP in ICH is often constrained by coagulopathy. Rapid reversal of anticoagulation, however, may carry its own risks. Thus a non-invasive device could be useful in guiding the timing of surgical interventions, ranging from external ventricular drainage to decompressive craniotomy. While there have been other attempts to develop non-invasive intracranial pressure monitoring instruments, the devices to date have suffered from the need for calibration, from inaccuracy, and from difficulty of use. That has made studies around the optimal timing of intervention very difficult.

We report results from preliminary clinical trials in patients with trauma, ICH, SAH and normal and low pressure glaucoma, where alterations in the gradient of ICP and intraocular pressure across the lamina cribrosa have been aetologically implicated. The ophthalmic artery (OA) serves as a “natural” ICP sensor. The instrument (the BNS 301, Boston Neurosciences, Waltham, MA) utilises transcranial Doppler ultrasound to intermittently compare flow parameters in the intracranial and orbital segments of the OA. The OA originates from the intracranial internal carotid artery at or shortly after its exit from the cavernous sinus, travels through the optic canal, and courses through the orbit to the retina. It is subject to ICP intracranially but not in the orbit. As a result, blood flow parameters in the two arterial segments, reflected in the blood flow waveforms displayed by instrument simultaneously, differ measurably. A computer controlled inflatable cushion gently compresses the orbit to equalize the pressure in the two segments while the waveforms are compared. The ICP is calculated automatically from the pressure required to achieve equilibrium.

Because this system relies entirely on a closed physiological system, it is self-calibrating and requires no external zero point. Multicenter clinical trials have commenced in the EU and the USA. Over 350 patients have been studied to date. Comparison of noninvasive vs. invasive measurements across 78 paired data points using a “Gold Standard” intraventricular probe (Silverline 8FS®, Spiegelberg, Germany) revealed an accuracy of 0.10 mmHg and precision of 1.88 mmHg. SD is <2.5 mmHg, with R of >0.8. There have been no significant adverse events. The results exceed of standard parenchymally implanted devices.

We believe this instrument may prove useful in further studies around the timing and extent of intervention and improvement of functional recovery.

Keywords: Intracranial pressure, non-invasive measurement, timing of intervention, image guided measurement
Determi

Determining the optimal shape-related indicator on non-contrast computed tomography for predicting hematoma expansion in spontaneous intracerebral hemorrhage

Jun Zheng, Zhiyuan Yu, Hao Li

Department of Neurosurgery, West China Hospital, Sichuan University

OBJECTIVE: Among several novel predictors on non-contrast computed tomography (CT) for hematoma expansion in spontaneous intracerebral hemorrhage (sICH), shape irregularity grade, satellite sign and island sign are all related to irregular shape of hematoma. This study is aimed to compare the accuracy of these imaging markers for predicting hematoma expansion in the same cohort of sICH patients.

METHODS: This retrospective study enrolled sICH patients who had diagnostic CT scan within 6 hours after onset and another follow-up CT scan within 24 hours after initial CT scan. Shape irregularity grade, satellite sign and island sign were assessed following the definitions in previous studies. The accuracy of these imaging indicators for predicting hematoma expansion was analyzed using receiver-operator analysis.

RESULTS: Finally, a total of 196 patients were included. Shape irregularity grade ≥3 was found in 87 (44.39%) patients, satellite sign was identified in 76 (38.78%) patients and island sign was only shown in 41 (20.92%) patients. Only island sign remained an independent predictor for hematoma expansion in multivariate logistic regression. The sensitivity values of shape irregularity grade ≥3, satellite sign and island sign were 0.52, 0.63 and 0.48, respectively. In contrast, the specificity values of these three predictors were 0.58, 0.69 and 0.85, respectively. Shape irregularity grade ≥3 had the smallest AUC (0.597) and island sign had the largest one (0.676).

CONCLUSIONS: Island sign seems to be the optimal shape-related predictor for hematoma expansion in sICH patients and could be included in the future predictive model for hematoma expansion.

Keywords: Hematoma expansion; Island sign; Satellite sign; Shape irregularity; Spontaneous intracerebral hemorrhage
O-061
The Capacity of Blend Sign on Noncontrast Computed Tomography in Predicting Poor Outcome of Patients with Intracerebral Hemorrhage

Fan Xia, Zhiyuan Yu, Jun Zheng, Chao You

Department of Neurosurgery, West China Hospital, Sichuan University, Chengdu, China; West China Brain Research Center, West China Hospital, Sichuan University, Chengdu, China

Background and purpose: Blend sign on noncontrast computed tomographic (NCCT) have been shown to be associated with hematoma enlargement in intracerebral hemorrhage (ICH), but the impact on clinical outcome is yet to be determined. We systematically assessed whether blend sign on baseline NCCT is associated with poor clinical outcome.

Methods: We performed a retrospective study of patients with primary ICH presenting to a single academic medical center between 2013 and 2018. The presence of NCCT blend sign was assessed by 2 independent observers on the baseline NCCT. Unfavorable outcome was defined as a modified Rankin score ≥3 on discharge. The associations between NCCT blend sign and unfavorable outcome were investigated using uni- and multivariable logistic regression models. A systematic literature search was conducted based on our findings and other 4 original studies reported the associations between blend sign and poor clinical outcome in ICH patients.

Results: A total of 178 patients were included in the final analysis. Forty-two (23.6%) patients showed blend sign on NCCT, and 138 (77.5%) patients experienced unfavorable outcome. Patients with blend sign were more likely to have history of alcohol consumption and smoking (21 versus 42, P=0.038; 26 versus 40, P<0.001, respectively), as well as to have hematoma expansion (21 versus 23, P<0.001). Potential outcome related parameters such as baseline hemorrhage volumes, admission GCS score, and intraventricular hemorrhage were not statistically different between blend sign positive patients and those without blend sign (P>0.05). Incorporating our findings with other 4 related studies, five studies was included in meta-analysis. Two studies indicated that the presence of blend sign was an independent predictor of unfavorable clinical outcome. Two studies showed that the occurrence of blend sign was significantly higher in patients with poor clinical outcome compared with those without poor clinical outcome (pooled odds ratio, 1.30; 95% confidence interval, 1.02-1.66).

Conclusion: There was a potential association between blend sign and unfavorable clinical outcome. Further studies with larger sample size are still needed to be conducted to explore the association between blend sign and ICH patients’ ominous prognosis.

Keywords: blend sign, intracerebral hemorrhage, poor outcome
Abstracts of Oral Presentations

O-062
Regional differences in BP management in INTERACT2

Xia Wang¹, Candice Delcourt¹, Lily Song¹, Chalmers John¹, Tom Robinson², Craig Anderson¹

¹The George Institute for Global Health
²The University of Leicester

Background and AIMS: Results from large-scale epidemiological studies show significant variations in hypertension management at the country level and variations in management within countries. Given that an elevated blood pressure (BP) accounts for about two-thirds of strokes worldwide, it is of great importance to understand the regional differences in BP management after acute intracerebral hemorrhage (ICH) in the hospital setting.

METHODS: INTERACT2 was an international, multicentre, randomised controlled trial of 2829 patients with spontaneous ICH (<6 hrs) with elevated systolic BP (SBP) randomised to intensive treatment (target SBP <140 mmHg) or guideline-recommended (target SBP <180 mmHg) treatment. BP management were compared between four regions; China (China and Hong-Kong); Western countries (Europe, Australia, and United States); India (India and Pakistan); and South America (Argentina, Chile, and Brazil).

RESULTS: Of the 2829 patients included in the analysis, 1049(37%) were women, and the mean (SD) age was 63(13) years. Mean SBP at admission was 178, 179, 183, 185 for the 4 regions, respectively. Among patients with history of hypertension, patients from China were significantly less treated (51%, 64%, 80%, 84% respectively). The mean achieved SBP within 1 and 24 hours were lower in Western countries compared with other regions, but similar from day 2 to day 7. Compared with other regions, China was less likely to use intravenous medication within the 1 hours after randomization, prescribe BP lowering drugs until 90 days, and use more than 1 type of drugs.

CONCLUSION: In INTERACT2, there were regional variations in SBP at symptoms onset and in the management of BP over the 3 months follow-up. This led to variations in achieved BP between regions.

Keywords: acute intercerebral hemorrhage, blood pressure
Introduction: Intracerebral hemorrhage (ICH) has devastating consequences in the human population. No specific outcome modifying treatment or objective risk stratifying measure currently exists in ICH patients. The goal of our study is to validate an MRI based algorithm to reliably quantify the iron levels in the periphery of the hematoma.

Methods: Institutional IRB was obtained for the study. We recruited 10 patients based on inclusion and exclusion criteria established for the study. The study protocol was to obtain MRI at day 3, 14 and 30 following ICH. The sequences performed were T1, T2 plus a multi-echo T2* sequence. 1/T2* – R2* maps were created utilizing the multi-echo sequence in Matlab. Two consecutive volumes of interest (VOI) 1 & 2 were drawn around the periphery of the hematoma, on all the axial slices demonstrating the hematoma, on all available date points in each individual patient. Identical contralateral brain VOI (Normal Control - NC) was also drawn at each corresponding MRI axial image slice. The average measurement values were then tabulated at pre-specified time points over a period of one month following the ICH. The R2* value was then extrapolated to an iron concentration (IC) measured from an iron phantom MRI with identical sequences.

Results: 10 eligible patients with ICH and two controls were recruited to the study. The Mean R2* value Day 3: VOI 1; 53.59 (SD: 6.01) – IC 0.16 SD 0.02, VOI 2: 28.35 (SD:5.17) – IC 0.08 SD 0.02, NC: 19.47 (SD:2.85) – IC 0.05 SD 0.01. Day 14: VOI 1; 47.97 (SD:5.43) – IC 0.14 SD 0.02, VOI 2: 27.19 (SD: 2.19) – IC 0.08 SD 0.01, NC: 18.94 (SD: 1.62) – IC 0.05 SD 0.01. Day 30: VOI 1; 49.14 (SD: 6.44) – IC 0.15 SD 0.02, VOI 2: 30.10 (SD: 3.41) – IC 0.09 SD 0.01, NC: 19.93 (SD: 2.82) – IC 0.05 SD 0.01.

Discussion: The MISTIE III trial did not show benefit from hematoma evacuation in ICH patients correlating with functional outcome. The iDEF trial showed good dose tolerance of Desferroxamine by the patients with ICH. It showed that future trials of iron chelate agents should assess patients for a period of 6 months. Our study demonstrates a reliable method to assess peri-hematoma tissue iron over a period of 1 month following ICH. Our study shows that the IC immediately adjacent to the periphery of the hematoma has higher levels of iron compared to control levels at day 3 & 14, getting closer to the normal control levels by day 30.

Conclusion: Our study, the first translational study of its kind, shows relatively reliable iron concentration measurements by MRI at the periphery of the hematoma over a period of 1 month following the ICH, showing good correlation with previous animal study data over a similar duration. Larger study is needed with extended 180 day follow up to further validate the measurement algorithm with a view to potentially becoming an MRI based risk stratification strategy in ICH patients. In addition, the algorithm may be utilized for monitoring iron chelate therapy in ICH.

Keywords: ICH, MRI, Iron, Quantification
Regional Patterns of Care for Patients with Primary Intracerebral Hemorrhage in the Greater Cincinnati Northern Kentucky Stroke Study

Farhaan Shaheer Vahidy1, Jane C Khoury2, Charles J Moomaw2, Kathleen S Alwell2, Brett M Kissela2, Opeolu M Adeoye2, Pooja Khatri2, Jason S Mackey2, Daniel S Woo2, Matthew L Flaherty2, Sean I Savitz1, Dawn O Kleindorfer2

1Institute for Stroke and Cerebrovascular Disease and Department of Neurology at UTHealth Houston TX, USA
2Department of Neurology, University of Cincinnati, Cincinnati OH, USA

INTRODUCTION: AHA guidelines recommend that acute management of all ICH patients take place at hospitals with neurocritical and neurosurgical care expertise. We describe the distribution of ICH patients at two levels of care (LOC) in the Greater Cincinnati Northern Kentucky (GCNK) region, explore the change in care pattern across cross sectional study periods, and report the factors associated with management at higher level of care (HLOC).

METHODS: We conducted retrospective analyses for two study periods (2005 and 2010) of the GCNK Stroke Study. All adult (≥ 20 years) primary ICH patients admitted upon acute presentation to the emergency department of any of the thirteen regional hospitals were included. Two hospitals with neocritical/neurosurgical expertise were considered HLOC. We used logistic regression to estimate odds ratios (OR) and 95% confidence intervals (CI) for association between LOC and study time period.

RESULTS: Based on our criteria, 560 ICH patients were included. Of these, 300 (53.6%) were managed at HLOC. The proportion of both directly presenting and transferred to HLOC patients was higher in 2010 as compared to 2005, with direct presenters being significantly different (29.6% vs. 19.2%, p < 0.01). The overall proportion of patients at HLOC was significantly higher in 2010 (59.5%), compared with 2005 (47.9%) [OR: 1.60, 95% CI: 1.14 – 2.23], (Figure). Smaller proportions of patients treated at HLOC had history of diabetes (p = 0.03), atrial fibrillation (p = 0.01), and coronary heart disease (p < 0.01). HLOC patients were also younger [median (IQR) age: 66(53,78) vs. 76(63,84)], and a significantly higher proportion of the patients managed at HLOC were African American (32% vs. 12%) (p < 0.01 for both).

CONCLUSION: Our data show an increasing trend of management of ICH patients at HLOC in the GCNK region, driven primarily by direct presentation at HLOC. Further investigation is needed into selection of ICH patients who would optimally benefit from HLOC.

Keywords: Intracerebral Hemorrhage, Transfer, Regional Care
Endogenous plasminogen activators are associated with haematoma progression in spontaneous intracerebral haemorrhage: findings from the TICH-2 plasma biomarkers sub-study

Zhe Kang Law, Michael Desborough, Kamini Rakkar, Philip Bath, Ulvi Bayraktutan, Nikola Sprigg, Zhe Kang Law

1 Stroke, Division of Clinical Neuroscience, University of Nottingham, Nottingham, United Kingdom
2 Oxford Haemophilia and Thrombosis Centre, Oxford University Hospitals NHS Foundation Trust, NIHR Oxford Biomedical Resource, Oxford, United Kingdom

Background: Endogenous activation of fibrinolysis leads to persistent bleeding in traumatic causes of intracerebral haemorrhage. We explore the hypothesis that endogenous fibrinolysis may lead to haematoma growth in spontaneous intracerebral haemorrhage.

Methods: This is a single-centre sub-study of the Tranexamic acid for IntraCerebral Haemorrhage-2 (TICH-2) trial, which is a randomised controlled trial that tested the efficacy and safety of tranexamic acid in spontaneous intracerebral haemorrhage within 8 hours of onset. Urokinase-type plasminogen activator (uPA), tissue-type plasminogen activator (tPA), D-dimer, fibrinogen, plasminogen, plasmin-alpha-2-antiplasmin complexes, thrombin-antithrombin, matrix metalloproteinases-2 and 9 (MMP-2, and -9) levels were measured using specific ELISA assays at baseline, 24 hours and day 7. Plasma biomarker levels in patients with intracerebral haemorrhage were compared with those in healthy controls. Levels in patients with and without haematoma progression, which is a composite of haematoma expansion at 24 hours (>33% growth or 6mL increase), early neurological deterioration (National Institute of Health Stroke Scale increase of ≥4 or Glasgow Coma Scale decrease ≥ 2 in the first week) and death, were compared using Mann-Whitney U test.

Results: Twenty-two patients were recruited into this sub-study. Seven patients (31.8%) had haematoma progression. Patients with haematoma progression had higher baseline plasma uPA (median [interquartile range, IQR] 555.6 [205.1, 706.4] pg/mL vs 203.8 [93.6, 430.6] pg/mL, p=0.053) and tPA (median 6234.2 [4229, 9251] vs 2801 [2398, 4351] pg/mL; p=0.01) and lower plasminogen levels (199 [176.7, 208] vs 218.2 [202.6, 317.6] µg/mL, p=0.032). 24-hour MMP-9 was significantly increased in patients with haematoma progression (270.8 [200.5, 322.6] vs 97.3 [60.3, 207.7] ng/mL, p=0.012) with further increase on day 7 (656.6 vs 131.8 ng/mL, p<0.001). There were no significant differences in plasma biomarker levels between patients treated with tranexamic acid (n=9) and placebo (n=13).

Conclusion: Increased levels of baseline uPA and tPA and 24-hour MMP-9 levels are associated with haematoma progression. Larger studies are needed to confirm these findings.

Keywords: intracerebral haemorrhage, tissue-type plasminogen activator, urokinase-type plasminogen activator, matrix metalloproteinase, tranexamic acid, haematoma growth
O-068
Safety and efficiency of flow diverters for treating small intracranial aneurysms: A systematic review and meta-analysis

Xiyang Yao¹, Junwei Ma¹, Haiying Li¹, Haitao Shen¹, Xiaojun Lu², Gang Chen
¹Department of Neurosurgery & Brain and Nerve Research Laboratory, The First Affiliated Hospital of Soochow University, Suzhou, Jiangsu Province, China
²Department of Neurosurgery, Taicang First People’s Hospital, Taicang, Jiangsu Province, China

BACKGROUND: We evaluated the safety and efficiency of flow diverters (FDs) in treating small intracranial aneurysms (IAs).

MATERIALS-METHODS: We reviewed the literature published in PubMed and EMBASE. R for Project software was used to calculate the complete aneurysm occlusion rates, procedure-related neurologic mortality, procedure-related neurologic morbidity and procedure-related permanent morbidity.

RESULTS: Ten observational studies were included in this analysis. The complete aneurysm occlusion rate was 84.23% (80.34%-87.76%), the procedure-related neurologic mortality was 0.87% (0.29%-1.74%), the procedure-related neurologic morbidity rate was 5.22% (3.62%-7.1%), the intracerebral haemorrhage rate was 1.42% (0.64%-2.49%), the ischemic rate was 2.35% (1.31%-3.68%), the subarachnoid haemorrhage rate was 0.03% (0%-0.32%) and the procedure-related permanent morbidity was 2.41% (0.81%-4.83%).

CONCLUSIONS: Treatment of small IAs with FDs may be correlated with high complete occlusion rates and low complication rates. Future long-term follow-up randomized trials will determine the optimal treatment for small IAs.

Keywords: flow diverters, small intracranial aneurysms, pipeline, SILK, systematic review, meta-analysis
O-069

Entire Orifice Blocking-Assisted Microsurgical Treatment: Clipping of Intracranial Giant Wide-Neck Paraclinoid Aneurysms

Lu Ma

Department of Neurosurgery, West China Hospital, Sichuan University

OBJECTIVE: Giant wide-neck paraclinoid aneurysms remain a formidable challenge for neurosurgeons due to the brisk retrograde blood flow during surgical clipping. Theoretically, Entire orifice blockade (EOB) by placing a longitudinal intracarotid balloon catheter across the aneurysm neck could achieve a good vascular control in treating cerebral aneurysms, but related studies have been scarce. The aim of this study was to evaluate the safety and efficiency of the EOB-assisted microsurgical technique for treating giant wide-neck paraclinoid aneurysms.

METHODS: Clinical data and treatment summaries of patients with giant wide-neck paraclinoid aneurysms who underwent EOB-assisted microsurgical clipping were retrospectively reviewed.

RESULTS: A total of 26 patients were analyzed. All but 3 patients harbored unruptured aneurysms. The mean largest diameter of the aneurysms was 26.8 ± 2.0 mm, and the mean neck size was 12.5 ± 2.4 mm. All lesions were successfully clipped without residual aneurysms. Post-operative images revealed no major branch occlusion due to thromboembolic complications. Four patients presented neurologic deficits caused by vasospasm, 3 of which were completely resolved by postoperative treatment. At a mean follow-up time of 1.86 ± 0.95 years (range, 0.5 to 3.5 years), none of the patients died, and 96.2% (n = 25) of the patients had favorable clinical outcomes with modified Rankin Scale values of 0 to 2.

CONCLUSIONS: For patients with giant wide-neck paraclinoid aneurysms, EOB-assisted microsurgical clipping is a safe and useful procedure for obtaining vascular control, for softening and shrinking the aneurysm sac and for providing a wide and clean operative field that allows the clip to be effectively placed.

Keywords: - Endovascular assisted microsurgical clipping - Entire orifice blocking - Giant wide-neck paraclinoid aneurysms
O-070

Prediction of postoperative stroke after intracranial aneurysm surgery using changes in intraoperative evoked potential monitoring

Jungjae Lee, Jihye Park, Youngjin Ko

Department of Rehabilitation Medicine, Seoul St. Mary’s hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea

OBJECTIVE: To evaluate the sensitivity, specificity, and predictive value of intraoperative somatosensory evoked potential (SSEP) and motor evoked potential (MEP) monitoring for predicting postoperative stroke after intracranial aneurysm surgery.

METHODS: We retrospectively analyzed the results of intraoperative SSEP and MEP monitoring in 728 patients who underwent intracranial aneurysm neck clipping. All patients underwent computed tomography (CT) or magnetic resonance imaging (MRI) within 72 hours after surgery to confirm the occurrence of stroke. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of SSEP and MEP were calculated.

RESULTS: The mean age of the 728 patients was 59.71±9.64 years and consisted of 485 women (66.6%). The most common aneurysms were anterior choroidal arteries (367 cases, 50.4%), and anterior communicating arteries (148 cases, 20.3%). Subarachnoid hemorrhage were 42 cases and non-ruptured aneurysm were 686 cases.

The changes of SSEP occurred in 10 out of 728 cases (1.37%): 9 out of 10 cases (90%) were reversible. The changes of MEP occurred in 14 out of 728 cases (1.92%): 11 out of 14 (78.6%) were reversible. 23 patients (3.16%) were diagnosed with postoperative stroke by CT or MRI findings. The sensitivity, specificity, PPV and NPV were 22.7%, 99.3%, 50.0% and 97.6%, respectively when there was only SEP change, and 9.1%, 98.3%, 14.3%, 97.2%, respectively when there was only MEP change.

CONCLUSION: Intraoperative SSEP monitoring can provide a higher sensitivity for postoperative stroke than MEP monitoring. Intraoperative SSEP and MEP showed high specificity and NPV, which can also be helpful in interpreting the results of intraoperative monitoring.

Keywords: intraoperative evoked potential; postoperative stroke; intracranial aneurysm surgery; SSEP; MEP
O-071
Emergent microsurgical treatment of arteriovenous malformation-related intracranial hemorrhage

Qiao Zhang¹, Hong Sun²

¹Department of Neurosurgery, West China Hospital, Sichuan University, Chengdu, China; Department of Neurosurgery, Shang Jin Nan Fu Hospital, Chengdu, China
²Department of Neurosurgery, West China Hospital, Sichuan University, Chengdu, China

BACKGROUND: Because of low re-bleeding rate, most neurosurgeons usually prefer performing elective surgery for patients with arteriovenous malformation-related intracranial hemorrhage, while emergent operation was usually lack of imaging data and with additional difficulty caused by swelling brain tissue. However, for life-threatening hemorrhage, neurosurgeons usually have no choice but to perform emergent surgical treatment. The present study aims to investigate safety and effect of emergent microsurgical treatment for AVM associated with mass effect of intracranial hemorrhage.

METHODS: A total of eighteen consecutive patients who were diagnosed with intracranial hematoma due to AVM rupture were retrospectively recruited. All patients showed intracranial AVM on computed tomography angiography (CTA). In 13 cases, the site of the hematoma was in supratentorial, while it was in the posterior cranial fossa in the other 5 cases. After experiencing neurological deterioration, mydriasis and respiratory arrest, patients were relatively given tracheal intubation, hyperventilation and osmotic diuresis. All patients underwent emergency microsurgical procedures to evacuate the hematoma, and excise the AVMs at the same time. Postoperatively, cerebral angiography was performed to assess the extent of resection. Neurological outcome was assessed by Glasgow Outcome Scale during an average of 16 months follow-up.

RESULT: According to the Glasgow Outcome Scale, 14 patients got good recovery, 3 were in moderate disability and 1 died. Poor prognosis occurred in patients with posterior fossa AVM and massive cerebellar hematoma due to mydriasis and respiratory arrest.

CONCLUSIONS: There is no time for neurosurgeons to hesitate in the management of patients with AVM associated with life-threatening intracranial hemorrhage. CTA guided emergent microsurgical treatment was necessary for hematoma evacuation and AVM resection, meanwhile, perioperative aggressive medical therapy, such as intubation, hyperventilation and intracranial pressure control, may also be essential for good prognosis.

Keywords: AVM; life-threatening hemorrhage; CTA; emergent microsurgical treatment
O-073
In-hospital Delirium and Long-Term Cognitive Outcomes among Patients with Intracerebral Hemorrhage and Subarachnoid Hemorrhage: A population-based cohort analysis

Jennifer R Meeks1, Arvind B Bambhroliya1, Jon E Tyson2, Charles C Miller2, Babar Khan3, Sunil A Sheth1, Louise D McCullough1, James C Grotta4, Jaroslaw Aronowski1, Sean I Savitz1, Farhaan S Vahidy1

1Department of Neurology, McGovern Medical School at UTHealth, Houston, USA
2Center for Clinical Research and Evidence Based Medicine, McGovern Medical School at UTHealth, Houston, USA
3Department of Critical Care Medicine, Indiana University, Indianapolis, USA
4Mobile Stroke Unit and Institute for Research and Innovation, Memorial Hermann Hospital Texas Medical Center, Houston, USA

INTRODUCTION: Cognitive impairment significantly contributes to morbidity associated with hemorrhagic stroke. Patients with HS are frequently managed in intensive care environment and undergo invasive procedures. Prevalence of in-hospital delirium is reported to be high among critically ill patients and delirium has been linked to long-term cognitive decline in general medical and surgical patients. However, little is known regarding the association between acute in-hospital delirium and long-term cognitive outcomes among patients with intracerebral hemorrhage (ICH) and subarachnoid hemorrhage (SAH). We sought to explore the risk of mild cognitive impairment or dementia (MCID) among ICH and SAH patients who experienced in-hospital delirium.

METHODS: We utilized State Inpatient and Emergency Department Databases for NY (2006 – 2014), CA (2005 – 2011), and FL (2005 – 2014), and established a cohort by selecting MCID free patients with a primary diagnosis of ICH or SAH. Patients with concurrent diagnoses of head trauma or missing linkage information were excluded. Delirium during the initial ICH/SAH event was tagged using a validated algorithm with high specificity and positive predictive value for the confusion assessment method. The cohort was followed for MCID diagnoses. Patients that died within 90 days of ICH/SAH were excluded. We conducted time-to-event analyses and report incidence rate (per 1,000 person-years), 95% confidence interval (CI) and adjusted hazard ratios (aHR) for risk of MCID among ICH and SAH patients with and without delirium. Final models were adjusted for demographics, comorbidities, disease severity, and in-hospital complications (ARDS, pneumonia, sepsis, seizures, UTI).

RESULTS: A total of 44,734 ICH patients (mean age: 67.7, female: 47.1%, white: 57.9%) and 18,855 SAH patients (mean age: 57.7, female: 61.3%, white: 55.9%) were included and were followed for up to 8yrs, resulting in 87,010 and 38,428 person-years, respectively. Patients who experienced delirium had a significantly higher comorbidity index and intensity of in-hospital treatment. Final models were adjusted for demographics, comorbidities, disease severity, and in-hospital complications (ARDS, pneumonia, sepsis, seizures, UTI). Development of MCID was significantly higher among delirium patients (ICH: 65.82, 59.25 - 73.11; SAH: 40.1, 32.93 - 48.83) as compared to non-delirium patients (ICH: 42.83, 41.43 - 44.27; SAH: 20.8, 19.36 - 22.35). Likewise, the aHR for MCID among delirium patients was statistically significant (ICH: 1.38, 1.22 - 1.55; SAH: 1.44, 1.15 - 1.81) in the fully adjusted Cox proportional model (Figure 1 and Figure 2).

CONCLUSION: ICH and SAH patients with in-hospital delirium are at a significantly higher risk of developing MCID. Further investigation is warranted to understand the biological mechanism for cognitive decline among ICH/SAH patients who experience in-hospital delirium.

Keywords: Intracerebral Hemorrhage, Subarachnoid Hemorrhage, Cognitive Impairment, Outcome
O-074
Scale up of the ‘ABC’ care bundle for acute intracerebral haemorrhage in a UK urban region: 1-year post-launch quantitative evaluation and development of an app to support acute stroke teams

Emily Birleson¹, Lisa Brunton², Appukuttan Suman⁴, Khalil Kawafi³, Clare Mcquaker⁴, Natalie Greaves⁵, Stephen Cross⁴, Matthew Machin⁵, Hiren Patel¹, Adrian Parry Jones⁶

¹Department of Neurosciences, Salford Royal Foundation Trust, Manchester, UK
²Department of Alliance Manchester Business School, Manchester University, Manchester, UK
³Department of Neurosciences, Pennine Acute Hospitals, NHS Trust, Manchester, UK
⁴Department of Neurosciences, Stockport Foundation Trust, Manchester, UK
⁵Department of Health Sciences, Manchester University, Manchester, UK
⁶Department of Medical Sciences, Manchester University, Manchester, UK; Department of Neurosciences, Salford Royal Foundation Trust, Manchester, UK

INTRODUCTION: The ‘ABC’ care bundle for intracerebral haemorrhage (ICH) was developed and implemented at Salford Royal Hospital and reduced 30-day case fatality in 2015-2016 by 35%. The care bundle consists of rapid Anticoagulant reversal, intensive Blood pressure lowering and a Care pathway for emergency referral to neurosurgery. Implementation of the bundle was scaled out across the two other hyperacute stroke units (HASUs) in Greater Manchester from April 2017. To aid bundle delivery, we developed an ‘ABC-ICH app’, which entered clinical use in late 2018. The app is intended to guide bundle delivery in real-time and capture key process data for display in an automated, web-based dashboard and includes visual aids for recognition of DOAC packaging/tablets and identification of key brain imaging features.

METHODS: A harmonised quality improvement register at each HASU captured consecutive ICH patients from 1/10/2016 and is continuing prospectively. Here we present data from 01/10/2016-30/03/2017 (6 months pre-launch) and 01/04/2017-30/03/2018 (1 year post-launch). Data are presented as median and interquartile range. Data collection and a process evaluation are continuing to assess the ABC-ICH app and these results will also be presented.

RESULTS: HASU1 significantly reduced anticoagulant reversal door-to-needle time (134 min [120–392; n=14] pre-launch vs 72 min [63–108; n=21] post-launch; p<0.001) and intensive BP lowering door-to-target time 336.5 min [199-856, n=22] pre-launch vs 83.5 min [59.5-114.5, n=30] post-launch; p<0.001). 30-day case fatality at HASU1 fell from 34.3% (n=70) to 26.8% (n=97, 21.9% relative reduction), but was not statistically significant. No statistically significant changes in care process/ case fatality occurred at HASU2.

CONCLUSION: Findings will be used to support an implementation strategy to launch the ABC bundle in 3 other UK regions in 2019. We will present results of ongoing evaluation of the ABC-ICH app which we will use to develop an enhanced version 2. The ABC-ICH app will be used to support launch of the ABC care bundle in additional regions in 2019.

Keywords: Intracerebral haemorrhage, blood pressure, anticoagulants, neurosurgery
Deep Learning for Automated Segmentation of Hematoma and Perihematomal Edema Volumes in Supratentorial Intracerebral Hemorrhage

Rajat Dhar\textsuperscript{1}, Yasheng Chen\textsuperscript{1}, Rommell Noche\textsuperscript{2}, Elayna Kirsch\textsuperscript{2}, Julian Acosta\textsuperscript{3}, Zachary King\textsuperscript{2}, Thomas Gill\textsuperscript{4}, Ali Hamzehloo\textsuperscript{1}, Andres Ruiz\textsuperscript{1}, Jin-Moo Lee\textsuperscript{1}, Kevin Sheth\textsuperscript{2}, Guido Falcone\textsuperscript{2}

\textsuperscript{1}Department of Neurology, Washington University School of Medicine, Saint Louis, USA
\textsuperscript{2}Department of Neurology, Yale School of Medicine, New Haven, USA
\textsuperscript{3}Department of Neurology, F.E.N.I., Buenos Aires, Argentina
\textsuperscript{4}Department of Internal Medicine, Yale School of Medicine, New Haven, USA

OBJECTIVE: Hematoma volume (HV) and perihematomal edema (PHE) are well-established neuroimaging biomarkers of primary and secondary injury, respectively, in intracerebral hemorrhage (ICH). The ability to rapidly and accurately quantify these in large-scale data-sets will enable the identification of the biological mechanisms that mediate their presence, evolution, and effect on outcome after ICH. METHODS: Regions of HV and PHE were manually delineated on serial head CT scans of patients with supratentorial ICH enrolled in the Yale Longitudinal Study of ICH. These ground-truth masks were then used to train a U-Net convolutional neural network (CNN) to segment CT image pixels into HV, PHE, or unaffected brain. Results from this training were assessed using 3-fold cross-validation, with accuracy quantified by Dice similarity coefficient (DSC) and Pearson correlation between manual ground-truth and automated volumetric results. RESULTS: 191 scans from 108 patients (age 67±15 years, female sex 50\(46\%\)) were used for training. ICH location was deep (56) vs. lobar (52), with median HV of 19ml (IQR 8-39) and PHE volume of 12ml (IQR 5-27). Automated segmentation using CNN yielded median DSC of 0.88 for HV (IQR 0.80-0.92) and 0.46 for PHE (IQR 0.29-0.57). Correlations of automated to manual volumes were excellent for HV (Figure 1, \(r=0.97\)) and good for PHE (Figure 2, \(r=0.72,\) both \(p<0.001\)). Follow-up scans were available for 51 subjects (47\%). There was strong agreement between both absolute and relative measurement of change in HV between baseline and follow-up scans (\(r=0.89\) and 0.94 respectively). Furthermore, automated measurements of HV and PHE were both associated with 3-month functional outcome, dichotomized as mRS 3-6 vs. 0-2 (HV: 35±25 ml vs. 15±16 ml; PHE: 20.5±15 ml vs. 10.5±11 ml, both \(p<0.001\)). CONCLUSIONS: It is feasible to leverage deep learning with CNN to develop an automated means of measuring meaningful neuroimaging biomarkers of primary and secondary injury after ICH. This method will now be applied to larger cohorts of ICH patients to facilitate studies of disease biology. Keywords: artificial intelligence, deep learning, perihematomal edema, imaging, biomarkers, big data
O-076
Andexanet alfa for Treatment of Factor Xa inhibitor-related Acute Major Bleeding

Truman John Milling Jr.1, Stuart J Connolly2, John Eikelboom2, C. Michael Gibson3, John T Curnutte4, Deborah M Siegal2, Elena Zotova2, Brandi Meeks2, Juliet Nakamya2, Todd Fralich4, Andrew Demchuk5, Mark Crowther2

1Seton Dell Medical School Stroke Institute, TX, USA
2McMaster University, Hamilton, Canada
3Harvard Medical School, Boston, MA, USA
4Portola Pharmaceuticals, Inc., South San Francisco, CA, USA
5University of Calgary, Calgary, Canada

BACKGROUND: Andexanet alfa (coagulation factor Xa (recombinant), inactivated-zhzo) is a modified, recombinant form of Factor Xa (FXa) designed to rapidly neutralize the anticoagulant effects of FXa inhibitors at time of acute bleeding. We evaluated andexanet in patients with acute major bleeding while on a FXa inhibitor.

METHODS: We evaluated 352 patients who had acute major bleeding within 18 hours after administration of a factor Xa inhibitor (apixaban, edoxaban, enoxaparin, or rivaroxaban). The patients received a bolus of andexanet, followed by a 2-hour infusion. The co-primary outcomes were 1) Percent change from baseline in anti-fXa activity and 2) Percentage of patients with excellent or good hemostatic efficacy at 12 hours after the end of the infusion, with hemostatic efficacy adjudicated on the basis of prespecified criteria. Efficacy was assessed in the subgroup of patients with confirmed major bleeding and baseline anti-fXa activity ≥75 ng/mL (≥0.25 IU/mL for enoxaparin patients). Safety outcomes (including mortality and thrombotic events) were assessed at 30 days post-andexanet.

RESULTS: The mean time from last FXa inhibitor dose to andexanet administration was 12 hours. The location of bleeding was intracranial in 227 patients (64%); of which 60%, 33%, and 25% had intraparenchymal, subdural, and subarachnoid involvement, respectively. There were 194 patients on apixaban, 128 on rivaroxaban, 20 on enoxaparin and 10 on edoxaban. In patients who had received apixaban, the median anti-fXa activity decreased from 149.7 ng/mL at baseline to 11.1 ng/mL after the andexanet bolus (92% reduction; 95% CI: 91-93); in patients who had received rivaroxaban, the median value decreased from 211.8 ng/mL to 14.2 ng/mL (92% reduction; 95% CI: 88-94). Excellent or good hemostasis occurred in 204 of 249 patients (82%) who could be evaluated; hemostatic efficacy was observed in 80% of patients with intracranial bleeding. Within 30 days, death occurred in 49 patients (13.9%) and a thrombotic event in 34 (9.7%), although no thrombotic events occurred in patients after restarting anticoagulation. In patients with intracranial bleeding, the mortality rate was 15.0%.

CONCLUSION: In patients with acute major bleeding associated with the use of a factor Xa inhibitor, treatment with andexanet markedly reduced anti–FXa activity, and 82% of patients had excellent or good hemostatic efficacy at 12 hours, as adjudicated according to prespecified criteria.

On behalf of the ANNEXA-4 Investigators

Keywords: Factor Xa, bleeding, coagulation
O-077
 Gamma Knife Radiosurgery for Brainstem Cavernous Malformations

Jing Chen, Fujun Liu
Department of Neurosurgery, West China hospital, Sichuan University, Chengdu, China

OBJECTIVES: The purpose of this study was to evaluate the efficacy and safety of Gamma Knife Radiosurgery (GKRS) for patients with brainstem cavernous malformations (BCMs), and to further investigate the factors influencing clinical efficacies of GKRS.

METHODS: From January 2009 to June 2017, 97 patients with BCMs were treated with GKRS at our center. The mean age was 44.0 years. The mean lesions volumes were (0.99±1.20) cm³ (0.076–5.49 cm³), and the mean dose of radiation was 11.05 Gy (6.0–13.0 Gy). After the GKRS, all patients participated in a scheduled clinical follow-up and the results of the latest follow-up were used as the evaluation criteria to compare with before treatment. The possible factors influencing the GKRS efficacies were explored by conducting statistical analysis.

RESULT: The mean clinical follow-up was 49.25±26.62 months (8-120 months). Neurologic status improved in 72 patients (74.2%), and stationary in 15 (15.5%). 10 patients (10.3%) experienced the exacerbation of symptoms at the last follow-up. By analysis and comparison of factors related to worsening of symptom after GKRS, we found that patients with the poorly control of symptoms was correlated to the postoperative rebleeding and the number of preoperative hemorrhages (P<0.05). The mean MRI follow-up was 31.79±22.14 months (4-99 months). During this period, lesions shrinkage was documented in 31 (32%) patients, stabilization in 54 (55.7%), and enlargement in other 12 (12.3%). Overall, the control rate of lesions’ volume after GKRS was either stable or improved in 87.7% of the patients. 11 of 12 patients had rebleeding after GKRS. One patient occurred perilesional edema after GKRS. Four of the 9 symptomatic rebleeding patients underwent craniotomy, 4 patients underwent the GKRS again and one patient clinical symptoms was relieved after observation. Postoperative rebleeding was associated with increased lesion volume (P<0.05). The annual hemorrhage rate (AHR) was 31% before treatment. The AHR was 4.5% within first 2 years after GKRS, and 1.4% beyond 2 years after GKRS.

CONCLUSION: GKRS can be used as an important method to treat symptomatic BCMs that had bleeding history, which is safe and effective. The safety dose directed to the lesion margin was approximately 11.0 Gy (6-13 Gy). Additionally, GKRS can reduce the AHR of BCMs. The number of preoperative hemorrhage and postoperative rebleeding were correlated with the poorly control of symptoms after GKRS.

Keywords: Annual hemorrhage rate Brainstem cavernous malformations Gamma Knife Radiosurgery
The association between long-term oral antithrombotic drug use and intracerebral haemorrhage for patients with cerebral cavernous malformations: a population-based cohort study, systematic review, and meta-analysis

Susanna M Zuurbier¹, Christos Tolias², Kelly D Flemming³, David Bervini⁴, Giuseppe Lanzino⁵, Robert J Wityk⁶, Rustam Al Shahi Salman²

¹Department of Neurology, Amsterdam University Medical Centers, Amsterdam, The Netherlands
²Centre for Clinical Brain Sciences, University of Edinburgh, Scotland
³Department of Neurology, Mayo Clinic, Rochester, Minnesota, USA
⁴Department of Neurosurgery, Inselspital, Bern University Hospital, Switzerland
⁵Department of Neurosurgery, Mayo Clinic, Rochester, Minnesota, USA
⁶Department of Neurology, Johns Hopkins Hospital, Baltimore, USA

BACKGROUND: The effects of oral antithrombotic (anticoagulant or antiplatelet) agents (ATA) on the risk of symptomatic intracerebral haemorrhage (ICH) from cerebral cavernous malformations (CCM) are unknown.

METHODS: The population-based Scottish Intracranial Vascular Malformation Study (SIVMS) prospectively identified adults resident in Scotland who were first diagnosed with CCM during 1999-2003 or 2006-2010. We recorded use of ATA after diagnosis and the occurrence of new ICH during up to 12 years of prospective follow-up via annual questionnaires sent to primary care practitioners and patients, and medical records surveillance. We compared the association between ever versus never ATA use and ICH using survival analysis with multivariable adjustment for sex, ICH at presentation and brainstem CCM location if hazards were proportional. We also did a systematic review of published studies of ATA use with CCM in Pubmed, Embase, and Cochrane Library Central Register of Controlled Trials from the earliest available date until February 1, 2019. We included SIVMS and another ongoing prospective population-based cohort study including CCM patients from the USA and other cohort studies of CCM that reported ICH and person-years of follow-up according to ATA use, calculated the incidence rate ratio in each study, and generated a pooled estimate using the inverse variance method and a random effects model with Review Manager 5.3.

RESULTS: Of 301 adults in SIVMS, 253 never used ATA and 48 used ATA during follow-up. At baseline, adults using ATA were older than adults who never used ATA during follow-up (median age 58 versus 40 years, p<0.0001), but the proportions with ICH at diagnosis (27% versus 28%) and brainstem CCM location (10% versus 11%) did not differ. During 12 years of follow-up, there was a non-significant association between ever-use of ATA and a lower rate of ICH or focal neurologic deficit (adjusted hazard ratio 0.52, 95% CI 0.16 to 1.71). The meta-analysis of SIVMS and five studies (1381 patients, 245 on ATA, 8 with ICH during follow-up) found a significant association between ATA use and a lower risk of ICH (incidence rate ratio 0.17, 95% CI 0.09-0.34) with no inconsistency between studies (I² 0%).

DISCUSSION: ATA use was associated with a lower risk of ICH from CCM. ATA do not seem to be harmful, and might be beneficial for the prevention of ICH from CCM. A randomised controlled trial of ATA for CCM appears justified and is being designed.

Keywords: antithrombotic drug, cerebral cavernous malformation, intracerebral haemorrhage
O-079

Confirmation of the Utility of Modeling Intracerebral Hemorrhage Outcomes to Predict Effectiveness of Treatment: Update with Phase 3 Results

Pitchaiah Mandava¹, Daniel F Hanley², Issam A Awad³, Thomas A Kent⁴

¹Department of Neurology, Baylor College of Medicine, Houston, USA
²Department of Neurology, Johns Hopkins University, Baltimore, USA
³Department of Neurosurgery, University of Chicago, Chicago, USA
⁴Department of Neurology, Engineering Medicine (EnMed), Texas A&M Health Science Center, Houston, USA

BACKGROUND: We previously presented an outcome model developed from baseline factors from the control arms of 14 RCT ICH Trials representing 3386 subjects (pPREDICTS-ICH, Mandava et al, WICH 2017; Neurology 2019 in press). Our approach adds statistical intervals to see if an early phase trial exceeds the expected variance of a larger control population. Of the interventions tested, only the catheter-facilitated clot removal trials exceeded expected outcomes at the p=0.1 screening level suggesting potential positive Phase 3 results. Here we compare the model predictions to those recently presented at the 2019 International Stroke Conference.

METHODS: pPREDICTS-ICH is a method that utilizes data abstracted from published Phase 1 and 2 trials to generate a “pseudo-control arm”, a best fit outcome model to compare studies at their baseline factors. The method provides a statistical interval around the model to indicate whether the outcomes seen in the early phase exceed what can be expected from a control population in a larger trial. Early phase trial predictions of phase 3 trials of deferoxamine, blood pressure intervention and hematoma evacuation were compared with the final results presented.

RESULTS: A model based on baseline NIHSS, age and hematoma volume captured approximately 85% of outcome variance (p=.001) with Modified Rankin Scale 0-3 and mortality as the dependent variables. Deferoxamine (hi-DEF) and blood pressure intervention trials showed outcomes within the control arm variance and were predicted to be ineffective. Consistent with this prediction, final results presented of i-DEF and a reanalysis of ATACH 2 based on hematoma location were also negative, at least for 90 day outcomes. By contrast for MISTIE-III, while the intention to treat arm was negative, those patients in which sufficient ICH blood was removed had an improved outcome.

CONCLUSION: It is possible to utilize a multi-factorial outcome model to test whether efficacy data presented in early trials can be used to prioritize resources for future trials. Our model is only useful if the methods for the Phase 3 trial are not significantly altered. In the case of MISTIE-III, it is possible that including less experienced sites or changing the threshold for hematoma removal influenced the intention to treat result. Nevertheless, our model suggests that further pursuit of this approach appears worthwhile.

Keywords: Intracerebral Hemorrhage, Hematoma Evacuation, Outcome Modeling
We have previously shown with meta-analysis that there were more favourable outcomes with surgery (albeit not significant) if the presenting Glasgow Coma Score was between 9-12 (odds ratio (OR) of 0.70, 95 percent CI 0.48, 1.03; P = 0.07). More detailed post-hoc ranked analysis showed that surgery produced an even better outcome if the presenting Glasgow Coma Score was between 10 and 13. By contrast, initial conservative treatment was better than surgery for patients at the extreme ends of the Glasgow Coma Score (3 to 8 and 14 to 15). Surgery was also harmful for small lesions but showed an increase in benefit for patients with larger volume lesions. The benefit for patients with a Glasgow Coma Score of between 10 and 13 was with an OR of 0.71 (95 percent CI 0.51, 1.00; P=0.05). This new non-parametric analysis was not prespecified but does indicate that greater benefit for surgery occurred when patients presented with coma scores of between 10 and 13. Because the Glasgow Coma Score is heavily dependent upon the verbal response, we have separately analysed patients with left and right hemisphere lesions to see if this slight shift in the maximum beneficial effect was different between the left and right hemispheres. This analysis has shown that patients with dominant (left) hemisphere lesions were more likely to benefit when the presenting Glasgow Coma Score was lower (9-12). By contrast, patients with right hemisphere lesions were more likely to benefit when the Glasgow Coma Score was 10-13 (P<0.05). This effect of dominance of the hemisphere on measurement of consciousness by the Glasgow Coma Score has not previously been shown in patients undergoing surgery for ICH. When pre-specifying outcomes in future trials, we hypothesise that the surgical benefit will be greater in left hemisphere ICH patients with a slightly lower Glasgow Coma Score than those with a non-dominant hemisphere lesion.

Keywords: Surgery, Trials, Glasgow Coma Score, Dominance, Meta-analysis.
Brain tissue donation after ICH-Maximising the potential

Christine Elizabeth Lerpiniere, Tracey Millar, Neshika Samarasekera, Rustam Al Shahi Salman, Colin Smith

Background: Obtaining brain tissue following intracerebral haemorrhage may help to understand its causes and consequences. In 2010, we established an intracerebral haemorrhage brain bank. 49 % of those approached consented to autopsy. But despite giving consent, some participants do not become tissue donors. We sought to determine the reasons why.

Methods: We used multiple overlapping sources of case ascertainment to identify every adult diagnosed with intracerebral haemorrhage between June 2010-October 2016, whilst resident in the Lothian region of Scotland. We sought consent from patients with intracerebral haemorrhage (or their nearest relative if the patient lacked mental capacity) to conduct a research autopsy limited to the brain.

Results: Of 249 participants who consented, 81 (33%) are alive, 137 (55%) died and became donors, but 31 (12%) died but did not become donors. These 31 consenters did not donate brain tissue because: the research team was not informed of the participant’s death (n=9, 29%), the family withdrew consent (n=8, 26%), the autopsy was not possible because of the funeral arrangements (n=2, 6%), a neuropathologist was not available (n=8, 26%), the body had been embalmed already (n=2, 6%) or the case was referred to the coroner (n=2, 6%).

Conclusion: More than half of patients who consented to research autopsy after intracerebral haemorrhage did not donate because the research team was not made aware of their death or their family withdrew consent. We have addressed these missed opportunities by: placing alerts in primary and secondary care medical records, sending participants an annual newsletter, contacting nursing homes so they have copies of consent forms. How to prevent families overturning the wishes of their deceased relatives requires careful consideration.

Keywords: autopsy, tissue donation, withdrawing consent
O-082
Navigated endoscopy-assisted ICH evacuation with the Apollo® device and intraoperative CT or robotic cone-beam CT imaging

Nils Hecht1, Marcus Czabanka1, Georg Bohner2, Peter Vajkoczy1

1Department of Neurosurgery and Center for Stroke Research Berlin (CSB), Charité - Universitätsmedizin Berlin
2Department of Neuroradiology, Charité - Universitätsmedizin Berlin

OBJECTIVE: Randomized trials on surgical evacuation of spontaneous intracerebral hemorrhage (ICH) have failed to show efficacy. One reason for this could be the invasiveness of an open microsurgical approach, particularly in deep-seated ICH. Against this background, the present study describes our first experience with the minimally invasive Apollo® device in combination with intraoperative computed tomography (iCT) or robotic cone-beam CT (CBCT) imaging for navigated, endoscopy-assisted evacuation of spontaneous ICH.

METHODS: This pilot study includes 12 consecutive patients with deep seated (n=7), lobar (n=4) or intraventricular (n=1) spontaneous ICH who underwent navigated, endoscopy-assisted ICH evacuation with the Apollo® device and iCT / CBCT imaging in a 12-month period. Eligibility for Apollo® surgery required (a) spontaneous lobar, deep or intraventricular ICH with exclusion of a structural vascular lesion, (b) availability of intraoperative imaging (i.e. AIRO® iCT or Zeego® CBCT), (c) ICH volume between 20-80 cm³, (d) preoperative baseline mRS ≤ 1, and (e) preoperative reduction of alertness to a GCS score between 5 and 14.

RESULTS: Eight female and 4 male patients with a median age of 77 years (range 51-85) presented with a median ICH score of 3 (range 2-4), GCS of 10 (range 6-14) and mean ICH volume of 49±24cm³. The median time to surgery was 36 hours (range: 6-76) with a surgery duration of 95 minutes (range 54-168). Intraoperative imaging revealed a mean hematoma removal of 68±27% and the postoperative GCS was determined at 11 (range 6-14).

CONCLUSION: Minimally invasive evacuation of spontaneous ICH with the Apollo® device appears to be feasible and safe. Importantly, iCT or CBCT imaging is helpful to decide, whether a desired degree of hematoma removal is reached or if immediate re-evacuation is required, which may reduce the need for secondary revision surgery. Clinical effectiveness of the procedure will be evaluated in a prospective trial.

Keywords: spontaneous intracerebral hemorrhage, intraoperative imaging, minimally invasive surgery, endoscopy, image guidance
O-083
Prognostic significance of ultraearly hematoma growth in spontaneous intracerebral hemorrhage patients receiving hematoma evacuation

Zhiyuan Yu, Jun Zheng, Rui Guo, Lu Ma, Hao Li, Chao You

Department of Neurosurgery, West China Hospital, Sichuan University

OBJECTIVE: To investigate the association between ultraearly hematoma growth (uHG) and clinical outcome in patients with spontaneous intracerebral hemorrhage (sICH) receiving hematoma evacuation.

METHODS: Supratentorial sICH patients receiving hematoma evacuation within 24 hours after ictus were enrolled in this study. uHG was defined as baseline hematoma volume/onset-to-computed tomography (CT) time (ml/h). The outcome was assessed using modified Rankin Scale (mRS) score at 3 months. Unfavorable outcome was defined as mRS >2.

RESULTS: A total of 93 patients were enrolled in this study. The mean uHG was 10.3±5.5 ml/h. 69 (74.2%) patients had unfavorable outcome at 3 months. The uHG in patients with unfavorable outcome were significantly higher than those with favorable outcome (11.0±6.1 ml/h vs. 8.3±2.5 ml/h, P=0.003). The optimal cutoff of uHG for predicting unfavorable outcome was 8.7 ml/h. The sensitivity, specificity, positive predict value and negative predict value of uHG>8.7 ml/h for predicting unfavorable outcome were 56.5%, 75.0%, 86.7%, and 37.5%, respectively.

CONCLUSIONS: uHG is a helpful predictor of unfavorable outcome in sICH patients treated with hematoma evacuation. The optimal cutoff of uHG to assist in predicting unfavorable outcome in sICH patients receiving hematoma evacuation is 8.7 ml/h.

Keywords: Hematoma evacuation; Prognosis; Spontaneous intracerebral hemorrhage; Ultraearly hematoma growth
O-084
Initial Experiences on Minimally Invasive Trans-Sulcal Endoscopic Surgery of Spontaneous Basal Ganglia Intracerebral Hemorrhage

Juan Manuel L Mariano¹, Giannina Krishna C Go¹, Erickson F Torio¹, Marian Irene C Escasura², Von Edward S Salcedo², Maurice V Bayhon¹, Manuel M Mariano¹

¹St. Luke’s Medical Center
²East Avenue Medical Center

BACKGROUND: We conducted a retrospective case control study to describe our initial experiences and outcomes of Minimally Invasive Trans-Sulcal Endoscopic Evacuation (MITSEE) for spontaneous basal ganglia intracerebral hemorrhage (ICH) in the Philippine setting.

METHODS: We evaluated consecutive patients with acute basal ganglia ICH in two Tertiary medical centers over a 25-month period. Patients received either best medical management according to established guidelines (controls) and MITSEE (cases). The MITSEE procedure was described in two Tertiary Medical Centers. The cases were described and compared to standard surgical approaches for ICH using variables such as time from ictus to surgery, length of surgery, blood loss, materials needed, hematoma volume, mortality, complications, and postoperative status. The following outcomes were compared for best medical management versus MITSEE: in-hospital mortality rate, length of hospital stay, Glasgow Coma Scores, and complications.

RESULTS: The procedure, materials and equipment required to perform the procedure was described in detail. The patient was placed supine with the head in neutral position and slightly extended. A supraorbital or curvilinear incision was performed over a craniotomy less than 4cm. A modified 5cc syringe attached to a Leyla retractor system or Kelly forceps was used as a trocar. The trocar was inserted trans-sulcally after dissection of the pia and sulcal vessels. A zero degree 5mm diameter endoscope and a Frazier suction tip was used to evacuate the hematoma. A total of 23 patients underwent MITSEE. The mean age of patients was 50.1 ± 11.5. Among the patients, 26.1% were female. Hematomas greater than 30 to 50cc were evacuated. Operative times were reduced to approximately half (2.1 ± 0.4 hours) and intraoperative blood loss (125 ± 60 ml) was reduced by 75% compared to standard procedures for hematoma evacuation. Near total evacuation (less than 5% residual hematoma) was achieved in 85.7%. Postoperative improvement in GCS as noted in 80.9% of patients. Patients succumbed to severe pneumonia in 39.1% and acute kidney injury in 17.4%. Patients succumbed to brain herniation, severe pneumonia, and acute kidney injury in more than 70% of cases. Average length of hospital stay of patients who survive is 3 weeks.

CONCLUSIONS: Minimally Invasive Trans-sulcal Endoscopic Surgery was associated with shorter operation times, less intraoperative blood loss, good evacuation, and improved GCS scores postoperatively.

Keywords: minimally-invasive, trans-sulcal, endoscopy, hemorrhage
O-085
Application of Two Novel Techniques of Minimally Invasive Image Guided Inter-Fascicular Evacuation (MIS) of Spontaneous Basal Ganglia Hemorrhages (SC-ICH)

Jean Louis Caron, Shane Hawksworth, John Floyd, Esther Nanez, Sherley White, Luis Llamas

UT Health San Antonio

BACKGROUND: We describe 2 innovative MIS, combining fascicular anatomy and advanced imaging. Hypothesis is MIS results in decreased clot burden, restoration fascicular anatomy and improved survival.

METHODS: 53 subjects, ICH 20cc-90cc, age <80, and admission GCS >5 selected from 855 consecutive SC-ICH. Cohort of 32 ICH 20cc-60cc, a modified 14Fr urethral rubber catheter (Bard Inc.) was image guided (StealthStation® AxiEM™) along the long axis of the ICH and evacuated by manual aspiration followed rtPA lysis and drainage. Second cohort of 21 ICH 40cc-90cc: 12mm port (VBAS™, Vycor Medical Inc.) image guided for microsurgical evacuation. Cohorts followed with CT/MRI.

RESULTS: First cohort: mean surgical reduction of 26cc (p<0.05). At 24 hours, mean 13cc after rtPA lysis (p<0.05). 30 day mortality 10.5% (40% by predicted ICH scores). Admission GCS of 9.8 and 12.1 at discharge (p=0.0053).

Second cohort: 80% reduction (pre 82.6cc +/- 21.8, post 16.9cc +/- 12.9). Mortality: 50% (expected 50.5 +/- 28.3%). T2-FLAIR: minimal injury to longitudinal tracts. Effect on cortico-spinal tract anatomy will be demonstrated by DTI. Will discuss operative nuances to achieve maximal evacuation.

CONCLUSIONS: Innovative MIS for SC-ICH is feasible, effective, without significant disruption of subcortical tracts. DTI demonstrates trend towards preservation of cortico-spinal tract.

Keywords: hypertensive subcortical cerebral hemorrhage, minimally invasive surgery, surgical technique
O-086
Microsurgical versus Endovascular Treatments for Blood-Blister Aneurysms of the Internal Carotid Artery: A Retrospective Study of 83 Patients in a Single Center

Yanming Ren, Hong Sun, Yi Liu, Hao Li, Lu Ma, Chang Wei Zhang, Chao Hua Wang, Xiao Dong Xie, Min He, Jin Li, Chao You

Department of Neurosurgery, West China Hospital, Sichuan University, Chengdu, Sichuan, PR China

BACKGROUND: Blood-blister aneurysms (BBAs) of the internal carotid artery (ICA) are challenging lesions with high morbidity and mortality. Both surgical and endovascular approaches have been used to treat BBAs; however, little is known about their safety and efficacy.

OBJECTIVE: To review our experience with the treatment of BBAs and explore the optimal treatment strategy.

METHODS: A total of 83 patients with BBAs were reviewed retrospectively. The characteristics of the patients and the aneurysms, treatment results, and follow-up outcomes were analyzed.

RESULTS: The cohort comprised 52 females and 31 males with a mean age of 46.6 years; 33 patients were assigned to the microsurgical therapy. Subsequently, 27/33 patients underwent surgical clipping, 4/33 underwent trapping without bypass, 2/33 underwent wrapping, and 50 patients underwent endovascular therapy, including stent-assisted coiling (49 patients) and coiling (1 patient). Intraoperative rupture occurred in 14 and 4 patients in the microsurgical and endovascular groups, respectively. Ischemic events occurred in 16 and 8 patients in the microsurgical and endovascular groups, respectively. At 1-year follow-up, a favorable clinical outcome was achieved in 18 (54.5%) and 38 (76.0%) patients in the microsurgical and endovascular groups, respectively. The multivariate regression model showed that the treatment strategies, Fisher grade, and vasospasm contributed significantly to the prediction of outcome for 1 year.

CONCLUSIONS: BBAs are challenging vascular lesions with poor prognosis. Endovascular treatment may be more effective and safer with better outcomes than surgical approaches.

Keywords: Blood-blister aneurysms; internal carotid artery; Endovascular treatment; microsurgery
O-087

Midline shift distance and early mortality in MISTIE 3 patients

Yunke Li1, Wendy Ziai1, W. Andrew Mould1, Issam Awad2, Daniel F. Hanley1, Mistie Trial Investigators1

1Department of Neurology, Division of Brain Injury Outcomes, Johns Hopkins University, Baltimore, MD, USA
2Department of Neurosurgery, University of Chicago Medicine and Biological Sciences, Chicago, IL, USA

OBJECTIVE: We evaluated early mortality and midline shift (MLS) of pineal gland (PG) and septum pellucidum (SP) on CT scans of intracerebral hemorrhage (ICH) patients at onset and the last scan available prior to discharge (scan-2) to assess impact of minimally invasive surgery (MIS) compared with best medical management.

METHOD: MIS plus alteplase in ICH evacuation (MISTIE) III trial is a multi-center, randomized, clinical trial. We evaluated 499 patients’ CT scans and calculated ICH and IVH volume, MLS at PG and SP and change at admission and the scan-2. We compared variables between MIS and medical groups, by early mortality status (within 30 days) and by scan-2 hematoma volume.

RESULT: Of 498 patients with CT imaging (250 in MIS group, 248 in medical group), 1 patient has only 1 CT scan after randomization due to protocol deviations. Time interval between admission and scan-2 (median [IQR]) was 8[6-9] days vs 7[6-9] days, respectively. 30-day mortality was not different between groups (9% vs 15%, p=0.06). Mean baseline volume between two group has no significant different (46.5±21.2 vs 46.1±20.0, p=0.84). Mean hematoma volume in scan-2 was 20.3mL±20.5 (MIS) vs 37.7mL±21.7 (medical; p<0.01). Mean MLS at admission for PG and SP were not different between groups. At scan-2 assessment, MLS was significantly different between groups at both PG (2.3mm±2.3 vs 3.0mm±2.7, p<0.01) and SP (3.3mm±3.0 vs 5.1mm±3.7, p<0.01). Difference in MLS was also significant at PG (0.3mm±2.6 vs 1.1mm±2.8 p<0.01) and SP (-0.1mm±3.7 vs 1.8mm±4.2, p<0.01). We compared 138 (55%) MIS patients who have a scan-2 volume less than 15mL with all medical patients. Scan-2 hematoma volume was significantly lower sub group MIS vs. medical patients (7.3mL±4.3 vs 37.7mL±21.7 p<0.01), as was sub group MLS changes at PG (0.2mm±2.4 vs 1.1mm±2.8, p<0.01) and SP (-0.7mm±3.2 vs 1.8mm±4.2, p<0.01), and also mortality (6% vs 15%, p<0.01). CONCLUSION: Hematoma volume reduction secondary to MIS is associated with significant reduction in MLS at scan-2 compared with medical treatment. Patients with scan-2 volume <15mL in MIS group had less MLS and lower mortality compared with medical patients at same volume threshold.

Keywords: Intracerebral Hemorrhage, Minimally Invasive Surgery, Midline Shift, Early Mortality
O-088
Screen failure rates in MISTIE III

Radhika Avadhani1, Karen Lane2, Nichol Mcbee3, Steve Mayo4, Andrew Mould5, Lourdes Carhuapoma6, Noeleen Ostapkovich7, Daniel F. Hanley8

1Radhika Avadhani, Johns Hopkins University - School of Medicine
2Karen Lane, Nichol Mcbee, Johns Hopkins University - School of Medicine
3Nichol Mcbee, Johns Hopkins University - School of Medicine
4Steve Mayo, Johns Hopkins University - School of Medicine
5Andrew Mould, Johns Hopkins University - School of Medicine
6Lourdes Carhuapoma, Johns Hopkins University - School of Medicine
7Noeleen Ostapkovich, Johns Hopkins University - School of Medicine
8Daniel F. Hanley, Johns Hopkins University - School of Medicine

BACKGROUND Screen failure data can provide numbers of intracerebral hemorrhage patients available and reasons for exclusion; both could clarify available populations for trial enrollment and intervention use. We investigated MISTIE III reasons for screen failure to develop international assumptions for ICH trial enrollment and treatment.

METHODS A training module specified the process for screening potential subjects; investigators were instructed to give active consideration for all patients admitted with the ICD 9/10 diagnosis of intracerebral hemorrhage. Potential subjects screened but not randomized were classified as screen failures (n=19,436). An EDC system allowed one primary exclusion selection. In addition to I/E, EDC selections included operational impediments to enrollment, i.e., staff availability, consent refusal, and “unknown.” An embedded algorithm prospectively standardized all exclusions into four categories.

RESULTS Distributions for Protocol and Other exclusions were dissimilar across regions. End of Window (operational) exclusions occurred similarly and more often outside of North America. Radiographic exclusions were more similar across all three regions.

Four Exclusion Categories Australasia % (CI) Europe % (CI) North America % (CI)
 Protocol 33.4% (29.3%-37.5%) 44.9% (42.8%-47.0%) 48.9% (48.1%-49.7%)
 End of window 30.2% (26.2%-34.2%) 30.8% (28.9%-32.7%) 25.3% (24.5%-26.0%)
 Radiographic 25.4% (21.6%-29.2%) 20.0% (18.4%-21.7%) 23.2% (22.5%-23.8%)
 Other 11.0% (8.2%-13.8%) 4.3% (3.4%-5.1%) 2.6% (2.4%-2.9%)

CONCLUSION MISTIE III screening data suggests radiographic data could be of value in developing a generalized predictor for enrollment potential in similar ICH surgical trials as well as eventual intervention use. Greater standardization of definitions, methods, and reporting are needed to better understand screen failure rates.

Keywords: Screen failure rates
O-089
Intensive Blood Pressure Lowering in Patients with Moderate to Severe Grade Acute Cerebral Hemorrhage: Post Hoc Analysis of Antihypertensive Treatment of acute Cerebral Hemorrhage (ATACH)-2 Trial

Adnan I Qureshi¹, Yuko Y Palesch², Lydia Foster², Mushtaq H Qureshi¹

¹Zeenat Qureshi Stroke Institute, University of Minnesota, Minneapolis MN, USA
²University of South Carolina, Charleston, USA

OBJECTIVE: To evaluate the effect of intensive (goal 110-139 mmHg) over standard (goal 140-179 mmHg) SBP reduction within 4.5 hours of symptom onset in moderate to severe grade subjects with intracerebral hemorrhage (ICH). The benefit may have been obscured due to relatively high proportion of good grade patients (ceiling effect) in previous intent to treat analysis.

METHODS: Moderate to severe grade was defined by Glasgow coma scale score <13 or baseline National Institutes of Health Stroke Scale score ≥10 or baseline intraparenchymal hemorrhage volume ≥30 cm³ or presence of intraventricular hemorrhage. The primary outcome was death or disability (score 4-6 on modified Rankin scale) at 3-months post-randomization ascertained by a blinded investigator.

RESULTS: The primary endpoint of death or disability was observed in 52.5% (170/324) of subjects receiving intensive treatment and 48.9% (163/333) subjects receiving standard treatment (relative risk: 1.07; 95% confidence interval: 0.86 to 1.32) among those who met the definition of moderate to severe grade. Serious adverse events were significantly higher (relative risk: 1.38; 95% confidence interval: 1.03 to 1.83), among patients randomized to intensive treatment (32.7% and 23.7% for intensive and standard treatment groups, respectively). In a multivariate model including all randomized subjects (n=1000), the interaction between treatment effect and moderate to severe grade was not significant (p=0.4646).

CONCLUSIONS: A non-significantly higher rate of death or disability and higher rates of serious adverse events in subjects randomized to intensive SBP reduction did not support any greater benefit among subjects with moderate to severe grade ICH.

Keywords: Intracerebral Hemorrhage; Blood pressure reduction; Hemorrhage volume; death or disability; modified rankin scale; clinical trial
Feasibility of Improving Cerebral Autoregulation in Acute Intracerebral Haemorrhage (BREATHE-ICH) Study: Results from an Experimental Intervventional Study

Jatinder S Minhas¹, Ronney B Panerai², David Swienton³, Thompson G Robinson²

¹Cerebral Haemodynamics in Ageing and Stroke Medicine (CHIASM) Research Group, Department of Cardiovascular Sciences, University of Leicester, Leicester, United Kingdom
²Cerebral Haemodynamics in Ageing and Stroke Medicine (CHIASM) Research Group, Department of Cardiovascular Sciences, University of Leicester, Leicester, United Kingdom; National Institute for Health Research Leicester Biomedical Research Centre, University of Leicester, Leicester, United Kingdom
³Department of Radiology, University Hospitals of Leicester NHS Trust, Leicester, United Kingdom

BACKGROUND: Cerebral autoregulation (CA) is impaired in a multitude of neurological conditions. Increasingly, clinical studies are correlating the nature of this impairment with prognostic markers. In acute intracerebral haemorrhage (ICH), impairment of CA has been associated with worsening clinical outcomes including poorer Glasgow Coma Score and larger haematoma volume. Hypocapnia has been shown to improve CA despite concerns over hypoperfusion and consequent ischaemic risks, and it is therefore hypothesised that hypocapnia (via hyperventilation) in acute ICH may improve CA and consequently clinical outcome. BREATHE-ICH is the first CA-targeted interventional study in acute ICH utilising a simple bedside hyperventilatory manoeuvre.

METHODS: Twelve patients with acute ICH within 48 hours of onset were enrolled. The experimental set-up measured CBF velocity (CBFV, transcranial Doppler), blood pressure (BP, Finometer) and end-tidal CO₂ (EtCO₂, capnography) at baseline, and in response to hypocapnia (-5mm Hg below baseline) achieved via a 90-second hyperventilatory manoeuvre. Autoregulation was evaluated with transfer function analysis and autoregulatory index (ARI) calculations. Important classical endpoints associated with this before and after interventional study included death and disability at 14 days and the proportion of recruited individuals able to comply with the full measurement protocol.

RESULTS: We observed tolerance to the protocol in a cohort of mild (NIHSS 4) supratentorial ICH patients with small volume haematomas without intraventricular extension. Significant increases in ARI were seen, reflecting improved CA, though a dose-dependent effect of PaCO₂ on ARI was not observed. Importantly, a significant difference was noted between ipsilateral ARI at baseline 4.8 (1.7) and ARI during hypocapnic intervention 7.0 (0.8) (p=0.0004) (Figure). The expected physiological response of lower CBFV and higher ARI was seen in 11/12 (92%) of patients.

CONCLUSIONS: In this small study, no significant reduction in 14-day death and disability was observed. Therefore, further studies are required to examine the effect on clinical outcomes, as well as the assessment of alternative methods in a more severe ICH population that would be less able to comply with a hyperventilatory technique. This is the first report of improvement of CA following acute ICH using a non-invasive interventional manoeuvre, though induction of hypocapnia via hyperventilation. (ClinicalTrials.gov Identifier: NCT03324321).

Keywords: Haemorrhage, Carbon Dioxide, Cerebral Circulation, Haemodynamics, Blood Pressure, Intervention
O-091
The Triple therapy prevention of Recurrent Intracerebral Disease EveNts Trial (TRIDENT): safety and tolerability of the “Triple Pill” after 2 week active run-in

Ruth Freed1, Joyce Y Lim1, Clara Chow2, Karin Klijn3, Rustam Al Shahi Salman4, Tsong Hai Lee5, H. Asita De Silva6, B. Senanayake7, Wan Asyraf Wan Zaidi8, John Chalmers9, Craig S Anderson10

1The George Institute for Global Health, Academic Project Operations, Sydney, Australia
2The George Institute for Global Health, Cardiovascular Division, Sydney, Australia
3Radboud University Nijmegen Medical Centre, Neurology, Nijmegen, Netherlands Antilles
4University of Edinburgh, Clinical Brain Sciences, Edinburgh, United Kingdom
5Linkou Chang Gung Memorial Hospital, Neurology, Taipei, Taiwan R.O.C
6University of Kelaniya, Pharmacology, Colombo, Sri Lanka
7National Hospital of Sri Lanka, Neurology, Colombo, Sri Lanka
8Universiti Kebangsaan Malaysia Medical Centre, Department of Internal Medicines, Kuala Lumpur, Malaysia
9The George Institute for Global Health, Professorial Unit, Sydney, Australia
10The George Institute for Global Health, Neurology, Sydney, Australia; The George Institute China at Peking University, Health Science Centre, Beijing, China

Background and Aims: The incidence and prognosis of acute intracerebral haemorrhage (ICH) is strongly linked to blood pressure (BP) levels. Intensive BP lowering is beneficial in the prevention of recurrent ICH. Many patients require two or more BP lowering agents to improve BP control and adherence. TRIDENT is evaluating a simple fixed, low-dose combination “Triple pill” BP lowering regimen (telmisartan 20 mg, amlodipine 2.5 mg and indapamide 1.25 mg) on top of standard care in ICH patients to determine the effectiveness of more intensive long term BP lowering on time to first occurrence of recurrent stroke.

Method: An international, multi-centre, double blind, placebo controlled parallel group, randomised, controlled trial involving 4200 patients from 100+ sites globally. Single-blind initial active run-in period, followed by double blind randomisation to active or placebo treatment with 6-monthly follow-up for an average of 3 years. Vital signs, BP, Na+, K+, serum creatinine, liver function and adverse events are collected at baseline, end of run-in, 6 weeks and at completion of study

Results: Recruitment commenced in September 2017 and has been slow but increasing, with participation from 40 hospitals across Australia, Netherlands, UK, Sri Lanka, Malaysia, and Taiwan so far with more expected to join from Brazil, China, Singapore and others. BP and adverse event data will be presented in the first 200 participants following the initial active run-in phase.

Conclusion: Two weeks’ treatment with the Triple Pill in patients following acute ICH is safe and well tolerated. Long-term effect of treatment will be reported in due course.

Keywords: intracerebral haemorrhage, blood pressure lowering, Triple Pill, safety, tolerability
INTRODUCTION: There has been an explosion in the development of medical mobile applications for smartphone platforms (iOS and Android). Most are geared toward health care professionals; few are geared toward clinical trial staff. A MISTIE III Mobile Application (MISTIE APP) was developed in 2014 for the MISTIE III (Minimally Invasive Surgery Plus rt-PA for Intracerebral Hemorrhage Evacuation) clinical trial. METHODS: The MISTIE APP contained modules that linked to randomization, summarized the protocol, listed inclusion/exclusion criteria and the schedule of events, trained on how to measure CT volumes, itemized permitted/prohibited medications, and contained an instructional dosing video, all of which could be viewed at the bedside or remotely. To determine the mobile application’s use and its impact, a 3-minute questionnaire (18 questions) was developed using SurveyMonkey and circulated to the MISTIE III sites. If respondents said they used the MISTIE APP, they were asked to identify their site and role; how frequently it was used and in what phases of the trial; as well as its usefulness; and what aspects of trial performance were improved by the MISTIE APP. RESULTS: Of 180 responses, 72 represented the MISTIE APP’s target audience, used the MISTIE APP and completed the survey. From 72 users, 51% used it more than once per patient during the randomization/screening; 42% used it more than once per subject during the acute phase of the trial; and 90% found the MISTIE APP useful. When asked which module was the most useful, 60% of the respondents selected the inclusion/exclusion criteria module. Respondents were also asked what aspects of the trial operation they believed were improved by the use of the MISTIE APP; 68% responded that it enhanced self-efficacy/self-confidence; 61% said it increased overall efficiency. Unexpectedly, 24% reported having used the MISTIE APP for other trials or general clinical practice. CONCLUSION: In the literature, there are some data on the use of medical mobile applications by physicians and patients; however, there is little to no data on the mobile application’s utility in clinical trial implementation. Self-reported data from MISTIE APP users confirm that it was useful and enhanced self-confidence and increased perceived efficiency. Keywords: Mobile application, clinical trial, survey, innovation
O-094
INTERACT3 update: feasibility of an implementation cluster clinical trial

Chao You¹, Lili Song³, Lu Ma¹, Xin Hu¹, Menglu Ouyang², Chunmiao Zhang⁴, Xi Li¹, Jun Zheng¹, Craig S Anderson⁵

¹Department of Neurosurgery West China Hospital, Sichuan University, Chengdu, Sichuan, People’s Republic of China
²The George Institute China, Peking University Health Science Center, Beijing, China
³The George Institute for Global Health, Faculty of Medicine, UNSW, Sydney, Australia
⁴Department of Neurology, Royal Prince Alfred Hospital, Sydney, Australia
⁵Sydney Medical School, University of Sydney, Sydney, Australia

BACKGROUND: The ongoing trial INTERACT3 (NCT03209258) aims to determine the effectiveness of a goal-directed care bundle of early intensive blood pressure (BP) lowering, glycemic control, treatment of pyrexia, and reversal of anticoagulation in patients with acute intracerebral hemorrhage (ICH).

METHODS: An international, multicenter, stepped-wedge (4 phases/3 steps, av 29 patients per phase), cluster randomized trial to assess the effectiveness of a multifaceted care package in 8621 patients across 75+ sites. After a variable background ‘usual care’ control period, hospitals are randomized for immediate implementation of the intervention (BP control, SBP target <140mmHg; glucose control by diabetes status, target 6.1-7.8/7.8-10.0 mmol/L; body temperature ≤37.5 °C; reversal of anticoagulation, INR <1.5).

Primary outcome is ordinal analysis of mRS scores at 6 months.

RESULTS: To date, 1774 ICH patients (mead age 62 yr; 37% female) were enrolled at 45 Chinese hospitals during December 2017 to December 2018. Mean baseline clinical characteristics include SBP 174 mmHg, blood glucose 8.1 mmol/L, NIHSS 14, and hematoma volume 21.5 mL. Medical history of hypertension (71.2%) diabetes 9.4%, smoker 22.8% and current drinker 21.9%. 21 sites has crossed over to intervention for 550 patients.

CONCLUSION: INTERACT3 is the first large-scale pragmatic complex system of care interventional clinical trial to determine the effectiveness of a widely applicable goal-directed care bundle in acute ICH. Rapid activation of sites, recruitment and baseline data support the feasibility of the study.

Keywords: cluster; care bundle; management; intracerebral hemorrhage; stroke
Identification and Application of Radiographic Characterization of Spontaneous ICH-Mediated Encephalomacia (IME) in the MISTIE-III Cohort

Ayushi Gautam, Hasan Ali, Radhika Avadhani, W Andrew Mould, Daniel F Hanley
Neurology, Division of Brain Injury Outcomes, Johns Hopkins School of Medicine

INTRODUCTION: Intra-cerebral hemorrhage (ICH) accounts for 2 million of 15 million strokes annually, and is associated with high mortality rates and poor patient outcomes. Common radiological findings on follow-up neuroimaging include edema and encephalomalacia, which refers to loss of parenchymal tissue. While ICH and edema have been extensively studied, radiographic features and clinical importance of ICH–mediated encephalomalacia (IME) are yet to be determined.

METHODS: MISTIE III was an international phase-3 trial testing the efficacy of minimally invasive surgery combined with alteplase compared to standard medical management. Exploratory analysis was conducted by randomly choosing D180 CTs of 99 participants with hemorrhagic stroke enrolled in the trial (50 surgical, 49 medical). With image-processing software OsiriXMD, free-hand segmentation was used to measure the volumes of IME and the associated Hounsfield Unit values of the regions segmented. We examined whether D180 IME volumes were associated with good functional outcomes, defined as modified Rankin Scale (mRS) score of 0-3 at days 180 (D180) and 365 (D365) post-stroke. Multivariate logistic regression (MLR) was used to determine the association between D180 IME volume and functional outcome at D180 and D365.

RESULTS: There was a significance difference in the average IME volume for medical (mean=14.6 mL, SD=12.1) and surgical (mean=20.6 mL, SD=14.0) arms, p=0.011. Similarly, there was a significant difference between the two cohorts in mean HU values, medical (mean=14.4 HUs, SD=3.6) surgical (mean=12.8 HUs, SD=4.02) p=0.037. We then ran a linear regression to determine the effect of IME on functional outcome. For each mL increase in D180 IME volume, there was a 3% decrease in odds of good D180 mRS. In univariate analysis, D180 IME volume (p<0.0001), age (p<0.0001), and deep ICH location (p<0.0001) were statistically significant and therefore added to the MLR model. The results of the MLR were for each mL increase in D180 IME volume, the model predicted a 3% decrease in odds of good D365 [0.97 (0.94, 1.00), p=0.073] with only a trend toward significance.

CONCLUSIONS: Through free-hand segmentation analysis of MISTIE-III patients, we radiographically characterized IME via volumetric and HU value measures. The results of our analyses suggests that there may be a meaningful association between IME volume and patient outcomes and thus represents a potential radiographic marker as a novel predictor of poor functional outcome post-stroke.

Keywords: intra-cerebral hemorrhage, edema, encephalomalacia, mRS scores, functional outcomes
Endoscopic Evacuation of Thalamic Hemorrhage with Intraventricular Extension

Erickson Fernando Torio, Juan Manuel Luis Mariano, Carlo Garcia Barredo, Giannina Krishna Chua Go, Maurice V Bayhon, Jonna Maala, Manuel Mendoza Mariano

St. Luke’s Medical Center, Philippines

Thalamic hemorrhages with intraventricular extension are conventionally treated conservatively by insertion of an external ventricular drain, ventriculoperitoneal shunt or by medical decompression. The length of hospital stay and recovery are usually prolonged. Furthermore, about 45% of patients will need a permanent VP shunt to control the intracranial pressure. The use of the endoscope to clear the intraventricular hemorrhage and remove the parenchymal hemorrhage within the thalamus is deemed safe and effective.

The objective of this study is to determine the technique and outcomes of patients treated by endoscopic evacuation of thalamic and intraventricular hemorrhage. This is a retrospective study of all patients with thalamic hemorrhages with intraventricular extension. Patients included are those with thalamic hemorrhages with intraventricular extension due to hypertension, GCS below 12, and surgery performed within 24 hours. Exclusion criteria included patients on antiplatelet/anticoagulants, and severe medical co-morbidities. Intracranial pressure monitoring through a ventricular catheter was inserted in all patients and removed once the pressure is normal. The duration of hospital stay and neurological status were evaluated and compared with historical control of previous patients treated conservatively by simple external ventricular drainage. Patients in this study had a GCS of 9 to 12 in 11 patients and GCS 6 to 8 in 4 patients. The surgical technique was described. Good intracranial pressure was immediately achieved postoperatively. The external ventricular drain was removed day 3 postoperatively. Fourteen out of 15 had improved level of consciousness, 1 got worse due to a rebleed, and there was no mortality. The hospital stay was 30% shorter and recovery was faster than our previously treated patients (range 1 to 4 weeks). CT scan was done within 24 hours of surgery to determine extent of hematoma evacuation. There was no surgical mortality and only one out of the 15 needed a ventriculoperitoneal shunt to control the hydrocephalus.

CONCLUSION: We conclude that the endoscopic technique to remove the intraventricular and thalamic hemorrhages is a useful and effective technique. It is safe, cost-effective, and minimally invasive. The endoscopic technique to remove the hematoma is feasible, useful, and effective in the management of hypertensive thalamic hemorrhage with intraventricular extension. Rapid and lasting control of intracranial pressure by early removal of blood that obstruct cerebrospinal fluid pathways and prevention inflammation induced by blood products which may obviate the need to insert a permanent VP shunt. This procedure removes the mass effect on the midbrain or diencephalon to produce immediate improvement in the level of consciousness.

Keywords: endoscopy
O-098  
Delayed Calculation of Multiple Intracerebral Hemorrhage Scores Outperform Baseline Scoring in Acute Intracerebral Hemorrhage

Ronda Lun1, Vignan Yogendrakumar1, Andrew M. Demchuk2, Richard I. Aviv3, Dar Dowlatshahi1, On Behalf Of The Predict Collaboration4

1Ottawa Stroke Program. Department of Medicine (Neurology), University of Ottawa, Ottawa, Canada  
2Calgary Stroke Program, Department of Clinical Neurosciences, Hotchkiss Brain Institute, University of Calgary, Calgary, Alberta, Canada.  
3Division of Neuroradiology and Department of Medical Imaging, Sunnybrook Health Sciences Centre, University of Toronto, Toronto, ON, Canada  
4PREDICT/Sunnybrook ICH CTA study group

Background and PURPOSE: Patients with intracerebral hemorrhage (ICH) are at risk of early hematoma expansion and clinical deterioration. Prognostic scores are largely based on baseline patient characteristics, which may not account for these rapid changes. We proposed that delayed calculation of ICH prognostic scores will have better predictive value for mortality than their baseline counterparts.

METHODS: We analyzed data from 280 consecutive patients presenting with ICH within 6 hours of onset from the observational PREDICT study (Prediction of Hematoma Growth and Outcome in Patients with Intracerebral Hemorrhage Using the CT-Angiography Spot Sign). ICH Score, FUNC Score, and modified-ICH (MICH) Score were calculated using both baseline and 24-hour characteristics. The primary outcome was mortality at 90 days. We generated receiver operating characteristic (ROC) curves looking at the predictive ability of all three scores for mortality. Baseline and 24-hour curves were compared with non-parametric methods.

RESULTS: Two hundred eighty patients were included in analysis, with a 90-day mortality of 25.3% (71/280). All three prognostic scores calculated at 24 hours were more predictive of mortality as compared to baseline calculations (see Figure 1), with their respective p-values calculated to be 0.046, 0.0052, and 0.0008 for ICH Score, FUNC, and MICH respectively.

CONCLUSION: Delayed 24-hour calculation of the ICH Score, FUNC Score and MICH Score demonstrated better prognostic value in predicting 90-day mortality compared to scores calculated at presentation. This could help improve prognostication and supports delaying discussions around withdrawal of care in ICH patients.

Keywords: prognostication, ICH Score, FUNC Score, acute intracerebral hemorrhage, MICH Score
O-100
Intraventricular Hemorrhage Growth: Definition, Prevalence and Association with Parenchymal Hematoma Growth and Prognosis

Qi Li¹, Xiao Wei², Wen Song Yang¹, Rui Li¹, Lan Deng¹, Xin Ni Lv¹, Peng Xie¹

¹Department of Neurology, The First Affiliated Hospital of Chongqing Medical University; Chongqing, China
²Department of Medical Technology, Chongqing Medical and Pharmaceutical College; Chongqing, China

Background and Purpose Intraventricular hemorrhage (IVH) occurs in up to 50% of patients with ICH and is an independent predictor of 30-day mortality. Many authors have examined early hematoma expansion after ICH, referring specifically to expansion of the parenchymal component, and have found this associated with poor outcome. However, few have studied whether the ventricular component (IVH) expands as well. The aim of our study was to propose a new definition of intraventricular hemorrhage (IVH) growth and to investigate whether IVH growth is associated with ICH expansion and functional outcome.

Methods We performed a prospective observational study of ICH patients between July 2011 and May 2017 in a tertiary hospital. Patients were included if they had a baseline CT scan within 6 hours after onset of symptoms and a follow-up CT within 36 hours. In our study, we have defined hematoma growth as an increase in hematoma volume of >33% or > 6 ml at follow-up CT scan. Two experienced neurologists independently reviewed all images in a blinded manner. IVH growth was defined as either any newly occurring intraventricular bleeding on follow up CT scan in patients without baseline IVH or an increase of IVH volume > 2 ml on follow-up CT scan in patients with initial IVH. Poor outcome was defined as modified Rankin Scale score of 3-6 at 90 days. The association between IVH growth and poor outcome were assessed by using multivariable logistic regression analysis. Results IVH growth was observed in 58 (19.1%) of 314 patients. Patients with IVH growth had larger baseline hematoma volume, higher NIHSS score and lower GCS score than those without. Of 46 patients who had concurrent IVH growth and hematoma growth, 43 (93.5%) had poor functional outcome at 3-month follow-up. Further analysis of the 90-day ordinal mRS scores demonstrates that IVH growth was associated with a significant shift towards poor outcomes and increased mortality. After adjusting for age, admission hematoma volume, NIHSS score, time from onset to CT, and presence of IVH at baseline CT, IVH growth was an independent predictor of poor functional outcome (OR=7.56, 95%CI=2.66-21.49; P <0.001). Conclusions IVH growth is not uncommon and independently predicts poor outcome in ICH patients. IVH growth appears to be associated with early hematoma growth in most cases. It may serve as a promising therapeutic target for intervention.

Keywords: intracerebral hemorrhage, intraventricular hemorrhage, hematoma expansion, outcome
O-101
Sensitivity of non-enhanced computed tomography in identifying the location of a ruptured cerebral aneurysm in patients with aneurysmal subarachnoid hemorrhage

Marcin Sawicki¹, Krzysztof Kościukiewicz¹, Dariusz Jeżewski², Kornek Chetstowski³, Michał GęBA¹, Leszek Sagan², Wojciech Poncyljusz¹

¹Department of diagnostic Imaging and Interventional Radiology, Pomeranian Medical University in Szczecin, Rybacka 1, 70204 Szczecin, Poland
²Department of Neurosurgery, Pomeranian Medical University in Szczecin, Rybacka 1, 70204 Szczecin, Poland
³Department of Laboratory Diagnostics, Pomeranian Medical University in Szczecin, Rybacka 1, 70204 Szczecin, Poland

BACKGROUND: In patients with aneurysmal SAH and multiple aneurysms the ruptured lesion should be identified to prevent recurrent bleeding.

PURPOSE: To assess the sensitivity of non-enhanced computed tomography (NECT) for identifying the rupture site in patients with aneurysmal subarachnoid hemorrhage (SAH) and multiple aneurysms. Predicted location was verified by surgery as the reference standard.

MATERIAL-METHODS: We included patients with SAH revealed by NECT and multiple aneurysms detected on computed tomography angiography (CTA) in whom the ruptured aneurysm was identified during neurosurgical treatment. Two radiologists predicted the location of the ruptured aneurysm based on the distribution of the SAH and location of intracerebral hematoma (ICH) by NECT.

RESULTS: Eighty-three patients with a mean age of 55.7±14.4 years were included. Ruptured aneurysms were significantly larger (mean size 7.7±4.7 mm) than unruptured aneurysms (mean size 5.9±4.5 mm; p=0.014). Interobserver agreement was 0.86 (p<0.001). Overall sensitivity of radiological prediction was 78.3% (95%CI, 68.6%-87.1%). The sensitivity for aneurysms in the anterior circulation (anterior communicating artery, anterior and middle cerebral artery) appeared to be significantly higher than in other locations: 92.3% (95%CI, 80.6%-97.5%) vs. 56.7% (95%CI, 37.7%-74.0%; p<0.001); see Figures 1 and 2. Analysis of independent predictive factors of correct radiological diagnosis revealed that only ICH predisposes to correct radiological diagnosis with odds ratio of 1.99 (95% CI, 1.33-2.98; p=0.006).

CONCLUSIONS: NECT has high sensitivity in identification the source of bleeding in patients with multiple aneurysms for anterior circulation aneurysms. The presence of ICH increases the sensitivity of NECT. For other locations NECT is not sensitive enough for making treatment decisions.

Keywords: multislice computed tomography, intracranial aneurysm, aneurysmal subarachnoid hemorrhage, aneurysmal rupture
O-103
A practical 3D-printed model for training of endoscopic and exoscopic intracerebral hematoma surgery with a tubular retractor

Junhao Zhu¹, Guodao Wen², Chao Tang¹, Chunyu Zhong¹, Jin Yang¹, Zixiang Cong¹, Chiyuan Ma¹

¹Department of Neurosurgery, Jinling Hospital, School of Medicine, Nanjing University
²Department of Neurosurgery, Dongguan Tungwah Hospital, School of Medicine, Sun Yat-sen University

OBJECTIVES: A 3D-printed model that simulated endoscopic and exoscopic intracerebral hematoma (ICH) surgery with a tubular retractor was presented.

METHODS: We utilized 3D printing technology to develop the model. The model consisted of the skull frame and the replaceable inserted module. Edible gelatin and animal blood were placed into the module to mimic the brain tissue and the hematoma. Twenty neurosurgeons were recruited to participate in our training program, which required the use of an endoscope and an exoscope to aspirate the hematoma with a tubular retractor. Five post-graduates were asked to finish the whole training with endoscope for five times. Questionnaires were distributed for feedback, after the training program.

RESULTS: We found that (1) the more experienced surgeons performed obviously better than the rather inexperienced surgeons which verified that our model could reflect the ability of the trainees; (2) as the training progressed, the scores of the post-graduates increased and the fifth training average score was obviously higher than their first training average score; (3) There were no significant differences in the trainees’ performance with the endoscope and the exoscope. The feedback questionnaires showed the average score for value of the simulator as a training tool was a 3.65 (on a 4-point scale). Our model received better comments regarding the bone texture (mean=3.20), the brain tissue texture (mean=3.20), and the experience in aspiration of hematoma (mean=3.10). The surgical position (mean=2.95), the surgical approach (mean=2.90), and the reality of the brain tissue (mean=2.85) should be improved.

CONCLUSION: Our model was practical for endoscopic and exoscopic ICH surgery training. The results of our program showed that prior surgical experience benefited the mastery of both the endoscopic and the exoscopic ICH surgery in 3D-printed model and our model could make it more efficient to master basic skills.

Keywords: endoscope, exoscope, tubular retractor, the 3D printed simulator, intracerebral hematoma model
Intracerebral hemorrhage with tentorial herniation: conventional open surgery or emergency stereotactic craniopuncture aspiration surgery

Guofeng Wu, Jing Shi, Xiaohua Zou, Ke Jiang, Li Tan, Shujie Sun
Affiliated Hospital of Guizhou Medical University

Abstract
BACKGROUND: To observe the therapeutic effect of conventional decompressive craniectomy with hematoma evacuation and frame-based stereotactic minimally invasive surgery (MIS) for tentorial intracranial hematoma with herniation.

METHODS: One hundred forty-nine patients with hypertensive ICH complicated with tentorial herniation were reviewed and analyzed in the present study. The intracranial hematoma was evacuated by emergency surgery within 6 hours after admission. According to the authorized representatives’ wishes and consent, 74 of the 149 patients were treated by conventional decompressive craniectomy followed by hematoma removal, defined as the CDC group, and the remaining 75 patients underwent frame-based stereotactic minimally invasive surgery for ICH evacuation, defined as the MIS group. The intervals between the admission to surgery, the duration of surgery, the amount of iatrogenic bleeding, the occurrence of postoperative rebleeding and the recovery of neurological functions were compared between the two groups. All patients were followed up for 3 months. Secondary epilepsy, survival in a vegetative state, severe pulmonary complications, mortality, and activities of daily living (ADL) classification were also recorded and compared.

RESULTS: The interval between admission and surgery, the duration of surgery and intraoperative blood loss in the MIS group were significantly decreased compared to the CDC group. The mortality rate, the rate of rebleeding, prevalence of vegetative state, and severe pulmonary complications in the MIS group were remarkably decreased compared to the CDC group. In the MIS group, the survivors’ (ADL) grade also showed advantages.

CONCLUSIONS: In the surgical treatment of hypertensive ICH complicated with tentorial herniation, frame-based stereotactic MIS for ICH showed advantages compared to conventional open surgery.

Keywords: Hypertensive ICH; tentorial herniation, stereotactic minimally invasive surgery, conventional craniotomy, secondary epilepsy.
INTRODUCTION: Intracerebral hemorrhage (ICH) is the most devastating type of stroke with one-year mortality rate approaching 38%. Over the past 5 years, a number of novel minimally invasive techniques have been developed for the surgical evacuation of ICH leading to large randomized controlled clinical trials, including MISTIE and ENRICH. Diffusion tensor imaging (DTI) is commonly used for neuronavigation during these procedures, however little is understood on how the evacuation of the hemorrhage alters tractography characteristics over time.

METHODS: Twenty-one patients who experienced spontaneous ICH and underwent minimally invasive endoscopic hematoma evacuation were retrospectively reviewed. DTI scans were reviewed at three time-points, preoperatively, one-week postoperatively, and at six-months postoperatively. Automatic segmentation and computational whole brain tractography were performed using Slicer DMRI (http://dmri.slicer.org/). Fractional anisotropy (FA), mean diffusivity (MD), axial diffusivity (AD), and radial diffusivity (RD) of the corticospinal tract (CST) were calculated and compared across imaging timepoints.

RESULTS: The average hematoma volume across the population was 42.9 ± 24.0mL, ranging from 14.6 - 104.9mL. Preoperative values of FA, MD, AD, and RD on the affected side were 0.44 ± 0.036, 0.00085 ± 6.03E-5, 0.0013 ± 9.3E-5, 0.00062 ± 5.4E-5 respectively. One-week postoperative values on the affected side were 0.42 ± 0.047, 0.00083 ± 6.1E-5, 0.0013 ± 0.00012, 0.00061 ± 5.5E-5, respectively. Lastly, six-month postoperative values for the criteria listed above were 0.39 ± 0.071, 0.00094 ± 0.00011, 0.0014 ± 8.3E-5, 0.00072 ± 0.00013, respectively. Upon comparison between all three timepoints, MD and RD increased over time (p=0.0021, 0.0026, respectively). FA decreased from the preoperative to six-month timepoint, although non-significant (p=0.11). FA of the CST in the affected hemisphere is less than that of the contralateral unaffected hemisphere at all three time points (p= 0.0007, 0.00041, 0.028). At the six-month timepoint, FA has continued to decrease postoperatively (0.39 ± 0.071) compared to preoperatively (0.435 ± 0.036), although non-significant (p=0.19).

CONCLUSION: Minimally invasive evacuation of the hematoma could potentially reduce both primary mass effect and secondary cytotoxic effects on the corticospinal tract allowing for preservation and restoration of motor function in patients with intracerebral hemorrhage. To our knowledge, this is the largest case series assessing and quantifying CST tractography in patients who have undergone minimally invasive endoscopic evacuation of ICH by using DTI tractography. A larger case series with more comprehensive long-term follow-up is necessary.

Keywords: Intracerebral Hemorrhage, Endoscopic, Diffusion Tensor Imaging, Corticospinal Tract, Minimally Invasive Evacuation
Targeting Spot Sign in Intracerebral Hemorrhage with NICO BrainPath Minimally Invasive Parafascicular Surgery to Prevent Hematoma Expansion

Mark D Bain¹, Alex Witek¹, Nina Moore¹, Gustavo Pradilla²

¹Cerebrovascular Center, Cleveland Clinic, Cleveland, Ohio, United States
²Emory University, USA

Intracerebral hemorrhage is a significant cause of morbidity and mortality in neurologic patients with vascular disease. There has been a renewed interest in minimally invasive intracerebral hemorrhage evacuation since 2013. Successful trials in the ischemic stroke realm have raised the question of whether these outcomes can be translated to hemorrhagic stroke, specifically intracerebral hemorrhage (ICH). New minimally invasive technology has created a novel approach to evacuate intracerebral hemorrhage. One of these technologies aides in evacuation of ICH, the BrainPath endoport made by NICO Corporation (Indianapolis, Indiana), is being compared to medical management in a randomized controlled trial called ENRICH. One of the hallmarks of the BrainPath System is that it provides access to the hematoma using a transulcal parafascicular trajectory preserving white matter tracks thereby eliminating collateral trauma to the surrounding tissue. BrainPath also allows for bimanual surgical technique once the port is placed into the hematoma. The surgeon can effectively operate and use instruments such as suction and bipolar cautery to control bleeding. It is well understood that spot sign is a sensitive and specific predictor of hematoma expansion and overall poor outcome. Up until this point physicians have been hesitant to target a spot sign in an acute ICH especially with minimally invasive access for fear that uncontrollable arterial bleeding would be encountered. In this abstract we report a case of targeting a spot sign with BrainPath in order to coagulate the offending vessel and limit hematoma expansion. An operative video showing the spot sign and offending vessel is presented as well for proof of concept.

A 75 year old male presented to our hospital with a 35 cc left anterior basal ganglia hemorrhage under 8 hours from symptom onset. A CTA with a 90 second delayed fine cut CT through the hematoma was obtained and a definite spot sign was discovered at the medial aspect of the lesion. Given the patients symptoms of hemiplegia and aphasia and the worry for hematoma expansion he was emergently taken to the operating room. Using stereotactic guidance, a 75 mm Brain Path Tube was navigated through a frontal sulcus into the long access of the hematoma. We specifically targeted the spot sign. After the obturator was removed we encountered active arterial bleeding. Suction and bipolar were used to remove some of the old hematoma and the actively bleeding vessel was encountered. This vessel was successfully coagulated and the remainder of the hematoma evacuated. The patient was taken to the ICU and was discharged 12 days later. 98% of the hematoma was evacuated and no reaccumulation was seen. Prevention of hematoma expansion is of utmost importance for good patient outcomes. This case demonstrates that current minimal access technology like BrainPath can effectively control bleeding from an active spot sign thereby preventing hematoma expansion.

Keywords: ICH, Spot Sign, BrainPath
Novel Technique of Minimally Invasive Image Guided Catheter Inter-Fascicular Evacuation of Spontaneous Basal Ganglia Hemorrhages Results in Successful Hemorrhage Evacuation and Improved Short-term Outcomes

Jean Louis Caron, Shane Hawksworth, John Floyd, Esther Nanez, Luis Llamas

Department of Neurosurgery, UT Health San Antonio, San Antonio, Texas, USA

Introduction: Minimally invasive surgical (MIS) therapies demonstrate promising results in the treatment of intracerebral hemorrhages (ICH). We applied a novel technique of image guided catheter placement and evacuation, followed by recombinant tissue plasminogen activator (rtPA) lysis, to treat spontaneous basal ganglia hemorrhages. We hypothesized that MIS ICH evacuation would result in decreased clot size, improved survival, and improved functional outcome. We predicted that the corticospinal tracts would be preserved, as quantified with diffusion tensor imaging (DTI).

Methods: We reviewed a prospective series of 50 subjects selected out of 855 ICHs evaluated from 2015-2018. We chose patients with an ICH volume of 20 to 80cc, age <80, and admission GCS >5 for this procedure. Patients with aneurysms, malformations, or traumatic hemorrhages were excluded. Using frameless stereotaxy (StealthStation® AxiEM™) a 14 French, urethral rubber catheter (Bard Inc.) was guided to the clot and it was evacuated. A drainage catheter placed in the hemorrhage allowed for rtPA lysis and drainage post-operatively.

Results: Reduction in hematoma volume from 44 to 26cc was achieved at surgery (p<0.05). This volume was reduced to 13cc after rtPA lysis and drainage (p<0.05). 30 day mortality was 10.5%, better than the 40% mortality predicted by the calculated individual ICH scores. The discharge GCS of 12.1 improved from the admission GCS of 9.8 (p=0.0053). We are completing long term follow up. DTI of 13 patients before and after surgical evacuation demonstrated less of a decrease in the fractional anisotropy ratio of the ipsilateral over the contralateral corticospinal tract to the hemorrhage for those patients with GCS>12 (-0.09 vs. -0.40, p=0.083). This trend did not correlate with a significant improvement with the contralateral upper extremity NIH motor score from admission to discharge for these patients (+0.6 vs. -0.40, p=0.10).

Conclusions: Our innovative MIS technique for ICH evacuation is safe and effective, achieving the desired post-therapeutic ICH volume target of 15cc or less. DTI demonstrates a trend towards preservation of the corticospinal tract, which may contribute to the benefits of MIS techniques over traditional craniotomy.

Keywords: Minimally invasive surgery, deep cerebral hemorrhage, novel surgical technique
OBJECTIVE: Spontaneous intracerebral hemorrhage (ICH) is associated with high rates of mortality. We previously reported on the Stereotactic Intracerebral Hemorrhage Underwater Blood Aspiration (SCUBA) technique for ICH evacuation. The primary hypothesis of this study was that 30-day mortality in SCUBA patients would be significantly less than predicted using the commonly used ICH score.

METHODS: We performed a retrospective observational cohort study of consecutive nontraumatic spontaneous ICH patients treated at a single, tertiary care, academic center from December 2015 to June 2018. Patients qualified for SCUBA with hematoma volume >15cc, National Institute of Health Stroke Scale ≥6, Glasgow Coma Scale (GCS) ≥4, and baseline modified Rankin Score ≤2. We used Wilcoxon-Mann-Whitney U-test (2-sided, non-parametric) to assess statistical significance.

RESULTS: A total of 158 ICH patients were included; 56 (35.4%) had SCUBA procedure. The patients in the SCUBA group, compared to those that were not, had larger hematoma volume (median 35.9cc vs 21.8cc; p=0.0023), but were similar in age (60.9 years vs 62.9 years, p= 0.28) and initial GCS (10 vs 10.6, p= 0.21). Based on the ICH score prediction, the expected overall 30-day mortality was similar among SCUBA and non-SCUBA patients (35.6% vs 35.8%). The observed mortality among SCUBA patients was substantially lower at 5.4%, absolute average difference 30.2% (95% confidence interval 24.5% - 35.9%).

CONCLUSIONS: Patients undergoing SCUBA patients have substantially lower observed mortality than predicted by the ICH score and when compared to non-SCUBA patients despite larger initial hematoma volumes. Further investigation is needed to evaluate this finding.

Keywords: intracerebral hemorrhage; hemorrhagic stroke; minimally invasive; endoscopic; stability scan
O-109
Minimally invasive parafascicular surgery for supratentorial intracerebral hemorrhage

Nicolas Kon Kam King, Angela An Qi See, Jai Prashanth Rao, Wan Tew Seow
Department of Neurosurgery, National Neuroscience Institute, Singapore

BACKGROUND: Decompressive craniectomy (DC) followed by delayed cranioplasty has been performed as a standard surgical procedure for patients with intracerebral hemorrhage (ICH). DC has been found to significantly reduce mortality by 18% compared to medical management in our patient cohort, although benefit for functional outcomes with DC was not observed. A recent meta-analysis of randomized controlled trials demonstrated that select patients with supratentorial ICH benefited from minimally invasive surgery over medical treatment and conventional craniotomy.

OBJECTIVE: We aimed to assess the impact of minimally invasive parafascicular surgery (MIPS) approach for hematoma evacuation of supratentorial ICH on the length of acute hospital stay and model its economic impact.

METHOD: Historical cohorts of patients with supratentorial ICH who underwent surgery with clot evacuation were analyzed as three groups, namely DC (N=11), DC with delayed cranioplasty (N=5), and MIPS (N=12). All groups had comparable baseline ICH-GS score, which has been validated as a prognostic model for ICH in our patient cohort. The median ICH-GS score in all three groups was 9, corresponding to a predicted mortality of 57% in hospital and 71% at 30 days. Patients’ mean length of stay in neurointensive care unit, high dependency and intermediate care units as well as the total acute hospital stay were reviewed. The actual costs of the procedures were calculated based on the estimated costs normalized to hospital rates for the year 2018.

RESULTS: The mean operating time was significantly reduced with MIPS (19% shorter than DC). The mean length of stay was significantly reduced with MIPS in the neurointensive care unit (50% shorter than DC alone) and total acute hospital stay (52% shorter than DC alone, 61% shorter than DC with delayed cranioplasty). The shorter length of stay with MIPS resulted in a smaller room bill in the acute hospital stay (42% lower than DC alone, 51% lower than DC with delayed cranioplasty).

CONCLUSION: Based on our initial experience, compared to DC with delayed cranioplasty, the adoption of MIPS has resulted in shorter operation time, neurointensive care unit length of stay, and total acute hospital length of stay, leading to cost savings.

Keywords: Minimally invasive parafascicular surgery, intracerebral hemorrhage, health economics
Abstracts of Short Oral Presentation
SO-001

Study update: INTERACT3 - a stepped-wedge cluster randomized trial

Guojuan Cheng¹, Chunmiao Zhang¹, Lili Song², Lu Ma³, Xin Hu³, Xi Li³, Chao You³, Menglu Ouyang¹, Craig S Anderson⁴

¹The George Institute for Global Health (Australia) Beijing Representative Office, Beijing, China
²The George Institute for Global Health (Australia) Beijing Representative Office, Beijing, China; Department of Neurology, 85 Hospital of People’s Liberation Army, Shanghai, China
³Department of Neurosurgery, West China Hospital, Sichuan University, Chengdu, China
⁴The George Institute for Global Health (Australia) Beijing Representative Office, Beijing, China; The George Institute for Global Health, and University of Sydney, Sydney, Australia

BACKGROUND: Continued uncertainty exists over benefits of early intensive blood pressure (BP) lowering in acute intracerebral hemorrhage (ICH), related to the non-significant primary outcomes, patient selection, and discordant results of INTERACT2 and ATACH-II. We designed INTERACT3 to determine the effectiveness of a goal-directed care bundle of ‘early intensive physiological control’ (intensive BP lowering, glycemic control, and treatment of pyrexia) and reversal of anticoagulation vs. usual care in ICH.

METHODS: INTERACT3 is an international, multicenter, stepped-wedge (4 phases/3 steps), cluster randomized. After a variable background control period, each hospital will implement the intervention (intensive BP lowering - systolic target <140mmHg; glucose control - target 6.1-7.8 mmol/l for non-diabetic, 7.8-10.0 mmol/l for diabetic patients; treatment to a target body temperature ≤37.5 °C; reversal of anticoagulation - target INR <1.5 within 1 hour). After collection of in-hospital clinical/management data and 7-day outcomes, central trained blinded assessors conduct telephone disability assessments (mRS) at 6 months. Primary outcome is an ordinal shift analysis of 6-month mRS scores. Assuming ICC 0.03, the sample size of 75 hospitals, 8661 patients provides 90% power (p=0.05) to detect a 5.6% absolute improvement (shift) in the primary outcome of the intervention.

CONCLUSION: INTERACT3 has been approved by West China Hospital Ethics Committee on 27th September 2017 and passed the annual review. To the end of 2018, 1774 ICH patients have been enrolled from 45 Chinese hospitals and 21 sites has shifted into intervention phases with 550 patients undertaking intensive care bundle.

Keywords: stepped-wedge cluster; care bundle; management; intracerebral hemorrhage; stroke
SO-002

Neurosurgical intervention for supratentorial spontaneous intracerebral haemorrhage: A systematic review and meta-analysis of randomised controlled trials

Lotte Sondag¹, Floris H B M Schreuder¹, Jeroen D Boogaarts², Maroeska M Rovers³, Peter Vandertop⁴, Ruben Dammers⁵, Catharina J M Klijn¹

¹Department of Neurology, Donders Institute for Brain, Cognition and Behaviour, Radboud University Medical Center, Nijmegen, The Netherlands
²Department of Neurosurgery, Radboud University Medical Center, Nijmegen, The Netherlands
³Departments of Operating Rooms and Health Evidence, Radboud University Medical Center, Nijmegen, The Netherlands
⁴Neurosurgical Center Amsterdam, Amsterdam University Medical Centers, VU University Medical Center and Academic Medical Center, Amsterdam, The Netherlands
⁵Department of Neurosurgery, Erasmus Medical Center, Erasmus MC Stroke Center, Rotterdam, the Netherlands

BACKGROUND: The effect of surgical treatment for supratentorial spontaneous intracerebral haemorrhage (sICH) and whether it is modified by key baseline characteristics and timing remains undefined.

METHODS: We performed a systematic review and meta-analysis of randomised controlled trials of surgical treatment of supratentorial sICH aimed at clot removal. We searched MEDLINE, Embase, and Cochrane databases up to February 7th 2019. Primary outcome was good functional outcome at follow-up; secondary outcomes were death and serious adverse events. We analysed all types of surgery combined and minimally-invasive approaches separately. We pooled risk ratios (RRs) with 95% CIs and assessed the modifying effect of age, Glasgow Coma Scale (GCS), haematoma volume, and timing of surgery with meta-regression analysis.

FINDINGS: We included 21 studies with 4,135 patients; four (20%) were of the highest quality. The RR of good functional outcome after any type of surgery was 1.40 (95% CI 1.22-1.60; I² 46%; 20 studies) and after minimally-invasive surgery 1.47 (1.26-1.72; I² 47%; 12 studies). For death the RR for any type of surgery was 0.78 (0.69-0.88; I² 21%; 21 studies), and for minimally-invasive surgery 0.69 (0.57-0.85; I² 15%; 13 studies). Serious adverse events were reported infrequently. Surgery was more effective when performed sooner after symptom onset (p=0.04; 12 studies). Age, GCS, and ICH volume did not modify the effect of surgery.

Interpretation: Surgical treatment of supratentorial sICH may be beneficial, in particular with minimally-invasive procedures and when performed early after symptom onset.

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(PROSPERO: CRD42018098864)

Keywords: Intracerebral hemorrhage, neurosurgery, minimally-invasive procedures, review, meta-analysis
SO-003
Initial experience with minimally invasive parafascicular surgical approach for evacuation of supratentorial intracerebral hemorrhage

Angela An Qi See, Nicolas Kon Kam King
National Neuroscience Institute, Singapore

BACKGROUND: Minimally disruptive hematoma evacuation has shown promising results as a safe and effective treatment to reduce the high mortality and morbidity associated with intracerebral hemorrhage (ICH).

OBJECTIVE: We report the three-months survival and functional outcomes of patients with supratentorial ICH who underwent hematoma evacuation using minimally invasive parafascicular surgical approach.

METHODS: Seventeen patients (11 men, mean age 66±12 years) with radiologically confirmed acute primary spontaneous ICH between 25ml to 100ml underwent minimally disruptive hematoma evacuation at the National Neuroscience Institute, Singapore from December 2017 to January 2019. Functional outcome at three months was assessed using the modified Rankin Scale (mRS).

RESULTS: Satisfactory hematoma evacuation (>95%) was achieved in all patients, with a median surgical time of 185 minutes (IQR 153–244). The median length of stay in neuro-intensive care unit was 3.6 days (IQR 2.3–6.0). One patient (6%) died at post-op day 15 due to myocardial infarction. Out of the remaining 16 surviving patients, 5 (31%) patients had good functional recovery (mRS 0–2) at 3 months after surgery. Nine (56%) patients had moderate disabilities (mRS 3–4) while two (12.5%) had severe disabilities (mRS 5).

CONCLUSIONS: Satisfactory hematoma evacuation was achieved using minimally invasive parafascicular approach, with one-third of patients showing good functional recovery at three months.

Keywords: Intracerebral hemorrhage, minimally invasive parafascicular surgical approach, hematoma evacuation
SO-004

Neuroendoscopic Evacuation of Intraventricular Hemorrhage in the Preterm Newborns Using Ventriculoport

Hakan Simsek, Murat Atar

Department of Neurosurgery, University of Health Sciences, Sultan Abdulhamid Han Teaching Hospital, Istanbul, Turkey

BACKGROUND: We report the use of neuroendoscopic evacuation of intraventricular hematoma (IVH) in 12 premature patients through a ventriculoport with minimal invasive fashion. We discuss the impact of early surgical hematoma evacuation on clinical recovery.

METHODS: Retrospective search of the medical records of the patients hospitalized and treated in the neonatal intensive care unit in our institution because of intraventricular hematomas and related hydrocephalus were analyzed. In the years 2018, during a period of six months, 12 patients underwent surgeries for intraventricular hemorrhages. They were either primary intraventricular hemorrhages or extension of subependymal hemorrhages into the lateral ventricles. Hematoma degradation products were evacuated and ventricles were rinsed with clear liquid. Endoscopic third ventriculostomy was performed in all patients and aqueductoplasty was also added to the procedure when needed. Regular head diameters were measured before and after the surgery. Minimum follow-up time was 6 months after surgery.

RESULTS: Postoperative course of the patients were favorable. Significant immediate progress in the neurological conditions and feeding was recorded as intended. Mean hospital stay was 12 days. None of the patients needed ventriculo-peritoneal shunting in the follow-up period of at least six months.

CONCLUSION: Evacuation of the intraventricular hemorrhage early after incident in a minimally invasive fashion provided significant progress in the clinical outcome of the patients. Early intervention seems to have prevented need for shunting. Prospective studies with larger series are needed to yield more evidence.

Keywords: Intraventricular hematoma, endoscopy, newborn, ventriculostomy, aqueductoplasty, posthemorrhagic hydrocephalus
SO-005
Stereotactic Aspiration with Thrombolysis for Spontaneous Intracerebral Hemorrhage: A Meta-Analysis and Systematic Review of Randomized Controlled Trials

Christina M. Grabarits¹, Meghan M. Hildreth¹, Nataly Montano Vargas¹, Joshua B. Gruber¹, Yunke Li¹, Yi Hao¹, W. Andrew Mould¹, Issam A. Awad², Daniel F. Hanley¹, Wendy Ziai¹

¹Division of Brain Injury Outcomes, Johns Hopkins University School of Medicine, Baltimore, MD, USA
²University of Chicago, Chicago, IL, USA

BACKGROUND: Meta-analyses of minimally invasive surgery (MIS) for ICH have not considered stereotactic aspiration with thrombolysis (SAT) separately from other types of MIS and common treatments. The efficacy and safety of SAT is controversial compared to conservative medical treatment (MT) and conventional craniotomy (CC). The addition of the MISTIE III dataset affords a larger sample size than previous meta-analyses. Our objective was to assess mortality, functional outcomes, and rebleeding of the SAT group compared with both MT and CC groups.

METHODS: We searched PubMed, CENTRAL, CNKI, VIP and Wanfang from 1987 to February 7, 2019, using the Cochrane systematic approach and the PRISMA guidelines to collect all pertinent literature on spontaneous ICH treatment that met our inclusion and exclusion criteria. We used the outcome measures from the original studies, while taking into account the heterogeneity of the scales assessed at varying time points. We conducted sub-analyses using forest plots to compare functional outcomes, mortality and rebleeding in the SAT group with the other groups at different time points. Functional outcomes were assessed using pooled mRS and Barthel Index data.

RESULTS: We included 11 randomized controlled trials with 2,586 participants. There was a significant difference in mortality favoring SAT to MT (95% CI 0.50-0.93; p=0.015), but no significant difference between SAT and CC. Combined data at Days 90 and 180 demonstrated a significant difference in functional outcomes favoring SAT to MT (95% CI 0.31-0.82; p=0.006), and when comparing SAT to CC, sub-analysis demonstrated a weak association (95% CI 0.21-1.06; p=0.068). At Day 90, there was no significant difference between SAT and MT, or between SAT and CC. At Day 180, there was no significant difference between SAT and MT; no data exist for an analysis between SAT and CC. There was no significant difference in rebleeding between SAT and MT or SAT and CC. CONCLUSION: ICH treatment using stereotactic aspiration with thrombolysis may improve functional outcomes compared to medical treatment and to conventional craniotomy as early as 90 days, and may reduce mortality compared to medical treatment. Of note, scarce long-term follow-up and rebleeding data limits the impact of these results. This meta-analysis identifies areas of further stroke treatment research.

Keywords: Intracerebral hemorrhage, Meta-analysis, Minimally Invasive Surgery, Stereotactic Aspiration with Thrombolysis, Medical Treatment, Conventional Craniotomy
SO-007
Evaluating outcomes from brainstem evacuation: An algorithm for selection and timing of intervention in patients with hypertensive brainstem haemorrhages

Swati Jain1, Boon Chuan Pang2, Eugene, Weiren Yang2, Sein Lwin1, Kejia Teo1, Tseng Tsai Yeo1, Zhi Xu Ng2, Ning Chou1

1Division of Neurosurgery, University Surgical Cluster, National University Health System, Singapore
2Division of Neurosurgery, Department of Surgery, Khoo Teck Puat Hospital, Singapore

BACKGROUND: Primary brainstem haematomas are associated with catastrophic and poor outcomes. It is still debated whether surgical evacuation of brainstem haemorrhages can improve neurological outcomes. Majority of patients present in a comatose or severely depressed state. Whether surgical intervention would improve outcomes remains questionable.

CASES: We reviewed the cases published in literature so far as well as our own experience with surgical evacuation of brainstem haemorrhages. We present 3 cases with hypertensive haemorrhages and outcomes after surgical evacuation. 2 of the 3 patients showed gradual deterioration after their initial presentation. Surgical evacuation via suboccipital approach as well as subtemporal approach was performed after clinical deterioration. Both these patients showed remarkable improvement at time of discharge. 1 patient who underwent immediate evacuation at time of presentation did not show any improvement in neurology and eventually demised from pneumonia.

DISCUSSION AND CONCLUSIONS: Multiple case reports and case series have been published looking at the potential of surgical evacuation improving outcomes in patients with brainstem haemorrhages. While some centres have shown improvement with immediate evacuation, others have recommended an observational period before intervention. However, no clear indications are available to select the subgroup of patients who may potentially improve from surgical evacuation of haematomas. We suggest a simplistic algorithm for intervening in patients with brainstem haemorrhages. We believe that patients who present with relatively good Glasgow coma scale at presentation and deteriorate over time in their neurology, will benefit from removing the mass effect caused by the haematoma. Further multicentric trials are required to prove the efficacy of this approach of management of brainstem haemorrhages.

Keywords: Hypertension, Brainstem Haemorrhages, Haemorrhagic Stroke
The purpose of this study was to identify the risk factors related to the hemorrhagic progression (HP) of brain contusion in patients after traumatic brain injury (TBI). Recently, many studies have reported abnormal lipid levels associated with hemorrhagic stroke. Unlike hemorrhage stroke, however, the lipid profiles in patients with TBI have not been examined. Therefore, we evaluated the risk factors of HP in patients with TBI and focused on lipid profiles. 121 patients with TBI with mild to moderate injuries (Glasgow Coma Scale ≥ 9) who initially did not need surgical intervention were enrolled in this study. Patients underwent repeated computed tomography (CT) scans at 4 h and 24 h after injury. Magnetic resonance imaging (MRI) was performed 7 days after the initial injury. In each noncontrast CT scan, the hemorrhage volume was quantified using the ABC/2 technique. Clinical features, previous medical history, initial CT, and microbleeding on follow-up MRI were analyzed retrospectively. There were 63 (52%) patients in whom significant HP developed (volume > 30%). Current smoking (p = 0.044), higher initial systolic blood pressure (p = 0.030), and lower triglyceride levels (p = 0.035) were significantly associated with HP. Current smoking and a triglyceride (TG) level < 150 mg/dL were the only statistically significant predictors of HP in the multivariate analysis (p = 0.029, p = 0.021, respectively). HP with TBI is common in patients who currently smoke and have lower TG levels (150 mg/dL). However lower LDL and statin use were not associated with HP. These patients should be monitored closely, and surgery may be considered before deterioration occurs.

Keywords: brain contusion; hemorrhagic progression; smoking; traumatic brain injury; triglyceride
Regimented start-up programs lead to faster site activation

Shannon Hillery, Ryan Majkowski, Ying Wang, Yi Hao, Radhika Avadhani, Karina Loyo, Karen Lane, Dan Hanley

Department of Brain Injury Outcomes, Johns Hopkins University, Baltimore, USA

BACKGROUND: Site start-up in multi-center clinical trials is unnecessarily prolonged due to factors that can be harnessed for improvement. The Brain Injury OutcomeS Research Center (BIOS) at the Johns Hopkins University (Baltimore, MD) developed an accelerated, interactive start-up program between sites and coordinating centers to achieve quicker site activation. We implemented this program in two ongoing multi-center trials, TREAT-MS (2018-present; 34 activated sites) and VICTAS (2018-present; 22 activated sites), using MISTIE III (2013-2018; 92 sites), an intracerebral hemorrhage trial recently completed, as the benchmark for comparison.

METHODS: BIOS and Tufts University CSDD (Boston, MA), as one NIH-awarded Trial Innovation Center, performed a retrospective analysis of the MISTIE III (2013-2018; 92 active sites) start-up metrics associated with and predictive of site performance. The analysis provided evidence that MISTIE III start-up metrics were comparable to industry performance and therefore useable as a benchmark of site activation timelines with which to test our new system. To service the accelerated start-up program we built an automated, electronic platform with interactive functionality designed to increase awareness of deliverables, missed deadlines, upcoming tasks, and to provide effortless access to pertinent start-up information for all stakeholders. We implemented this start-up program in the TREAT-MS and VICTAS trials and measured site performance against the MISTIE III benchmark.

RESULTS: Within the MISTIE III trial, the mean site start-up duration was 323.48 days (SD±155.49) from the time of protocol receipt at the site to enrollment activation. In comparison, sites in the TREAT-MS and VICTAS trials activated in a mean of 163.89 days (SD±45.30) and 171.27 days (SD±37.50), respectively. Both results are statistically significant in achieving faster site activation at p values of less than 0.0001.

CONCLUSION: The accelerated, interactive start-up program achieved a significant decrease in time spent in start-up and quicker site activation. We plan to use the newly available start-up metrics as a benchmark for improvement in future trials, and to explore the potential connection between metrics gathered from regimented start-up programs, such as ours, as possible predictors of site performance within a trial, such as enrollment speed.

Keywords: clinical trials, site start-up, metrics, innovation, process improvement
SO-010
Systematic Review of Reliability of Perihaematomal Oedema Volume Segmentation and in Patients with Spontaneous Intracerebral Haemorrhage

Azlinawati Ali¹, Zhe Kang Law², Philip M Bath¹, Nikola Sprigg¹, Robert Dineen³

¹Stroke, Division of Clinical Neuroscience, University of Nottingham, United Kingdom
²Stroke, Division of Clinical Neuroscience, University of Nottingham, United Kingdom; Department of Medicine, National University of Malaysia, Kuala Lumpur, Malaysia
³Radiological Sciences, Division of Clinical Neuroscience, University of Nottingham, United Kingdom

Background: Perihaematomal oedema (PHE) is a marker of secondary injury in patients with spontaneous intracerebral haemorrhage (ICH) and is of interest in clinical trials aiming to minimise the tissue injury in ICH. PHE segmentation on computed tomography (CT) is quite challenging because of indistinct margins and common co-occurrence of adjacent leukoariosis. We systematically review the available literature to establish definitions and observer reliability for PHE volume measurement, and add our own novel reliability data from the Tranexamic Acid for Spontaneous Intracerebral Haemorrhage (TICH-2) Trial.

Methods: A systematic review to identify studies reporting PHE segmentation methodology with intra- and inter-observer reliability measures for PHE volume measurement. Potential studies were identified from search via electronic database. Reference lists, related articles and citation lists of each papers identified were screened to identify further relevant papers. Initial screening of study titles excluded non-relevant topics and remaining studies were further screened by reading abstracts. We additionally performed an intra- and inter-observer reliability analysis on 20 CT scans using manual tracing method with ITK SNAP software.

Results: 20 studies were included reporting results from 1899 patients. Semi-automated segmentation (SAS) was used in 9 studies, a combination of ABC/2 and modified SAS in 4 studies, a combination of ABC/2 and modified ABC/2 in 2 studies, manual segmentation in 2 studies and 1 study used a combination of fully automated and manual quantification. PHE was commonly defined as a hypodense area around the haematoma region and represented with a threshold of Hounsfield Unit of 5 – 33 HU. For studies reporting reliability measures, average intra-observer reliability for the SAS technique was 0.90 (range 0.73-0.99, 7 studies), for manual segmentation was 0.93 (range 0.9-0.95, 2 studies) and for ABC/2 was 0.959 (single study). Inter-observer reliability for SAS and manual PHE quantification were 0.8746 (range 0.74-0.98, 5 studies) and 0.89 (single study) respectively. Our novel analysis gave intra-observer reliabilities of 0.997 and 0.834 for observers 1 and 2 respectively, and inter-observer reliability of 0.987.

Conclusions: Despite the difficulties in delineation of PHE on CT images, manual segmentation, SAS and combined methods using the ABC/2 method show an overall high inter- and intra-observer reliability for measurement of PHE volume.

Keywords: perihaematomal oedema, intracerebral haemorrhage, semi-automated segmentation, tranexamic acid, computed tomography, inter-observer reliability
SO-011
Single IRB review timelines slower than standard IRB processes for site start-up, but improved for changes in research

Ryan Walter Majkowski, Shannon Hillery, Ying Wang, Yi Hao, Radhika Avadhani, Karina Loyo, Megan Singleton, Cindy MacInnis, Janelle Maddox Regis, Karen Lane, Daniel Hanley

Johns Hopkins Medical Institutions

BACKGROUND: During the clinical trial site start-up process, one of the most time intensive steps is IRB review. Multiple rounds of communication regarding consent form edits, protocol clarifications, and local policies and legal considerations can delay approvals. To streamline and enhance the IRB review process, the NIH mandated that single IRBs (sIRB) be used in all federally funded clinical trials. The Brain Injury OutcomeS Research Center (BIOS) at the Johns Hopkins University (Baltimore, MD) and the Johns Hopkins Medicine IRB are working under one NIH Trial Innovation Center (TIC) award to improve and innovate the sIRB review process.

METHODS: We performed a retrospective analysis of the MISTIE III (2013-2018; 105 sites with available IRB data) start-up metrics associated with and predictive of site performance. A key metric analyzed was the IRB submission to approval timeline. The analysis provided evidence that MISTIE III start-up metrics were comparable to industry performance and therefore useable as a benchmark against which to test the new sIRB process for two new trials: TREAT-MS (2018-ongoing; 41 sites with sIRB approval) and VICTAS (2018-ongoing; 34 sites with sIRB approval). We measured site performance against the MISTIE III benchmark through the use of an automated, electronic platform designed by BIOS to increase awareness of deliverables, missed deadlines, and upcoming tasks within the start-up process.

RESULTS: This analysis shows that the sIRB process in both TREAT-MS (Mean = 136.00 days, SD±54.36) and VICTAS (Mean = 124.32 days, SD±33.6) was significantly slower than MISTIE III (Mean = 86.49 days, SD±72.36) at p values of 0.0001 and 0.0023, respectively. However, study-wide changes requiring full board review, such as protocol revisions, were significantly faster (p = 0.0046) in comparison to per-site IRB review. Protocol revision events (5 across TREAT-MS and VICTAS) submitted to the sIRB were approved in a mean of 28.6 days (SD±7.2) compared to MISTIE III per-site approvals, which averaged 167.2 days (SD±107.84) to complete.

CONCLUSION: The new sIRB process is a complex and time-consuming component of site activation and does not hasten start-up yet. However, study-wide changes, such as protocol revisions, are rapid and need only happen once, eliminating large parallel workloads across sites. We plan to use our newly acquired sIRB metrics as benchmarks to improve this process in future trials.

Keywords: Clinical Trials, Single IRB, Start-Up, Metrics, Process Improvement, Innovation
SO-012
Limitation of therapeutic effort in acute intracerebral hemorrhage: Do we apply it correctly?

Tomàs Xuclà Ferrarons, Luís Prats Sánchez, Marina Guasch Jimenez, Marta Caballero Ávila, Artur Izquierdo Tapiz, Alejandro Martínez Domeño, Raquel Delgado Mederos, Pol Camps Renom, Joan Martí Fàbregas

Neurology department, Hospital de la Santa Creu i Sant Pau, Barcelona

INTRODUCTION: Intracerebral hemorrhage (ICH) has a high mortality. ICH score estimates mortality based on Glasgow Coma Score (GCS), age and CT findings and may help to identify candidates to limitation of therapeutic effort (LTE). We assessed whether LTE measures in patients with ICH were correctly applied in a single Comprehensive Stroke Center.

METHODS: A retrospective and observational study of consecutive patients admitted to a single comprehensive stroke center between 2013 and 2018. We included patients ≥18 years with spontaneous ICH. All patients were treated according to National guidelines of ICH. The decision to apply LTE was taken by the attending physician (neurologist, neurosurgeon, intensive care or a physician from the emergency department). During the course of the study, there was no LTE guide at our institution. We defined that LTE was correctly applied when: 1) Prior Rankin scale score ≥4 and ICH score ≥3, irrespective of evolution time; or 2) Prior Rankin scale score <4 and ICH score ≥3 with LET decided after 48 hours. We prospectively collected age, sex, GCS, ICH volume, presence of intraventricular hemorrhage (IVH). In addition were registered which physician indicated LTE measures.

RESULTS: We included 450 patients (mean age: 73.5 ± 14 y) and 68 (15.1%) of them underwent LTE. Compared to patients without LTE, patients in whom LTE were applied were significantly (p<0.05) older (80 vs 72.3 y), had larger ICH volumes (60.3 vs 25.2 cc), lower GCS score (8.5 vs 15 points), and higher frequency of IVH (72.7% vs 44.3%). In LTE patients, LTE was correctly applied in 10 and wrongly applied in 58 patients. In 6 patients, LTE was not applied although criteria were met. LTE decisions were taken within the first 24 hours in 77.9% of patients and from 24 to 48 hours in 22.1%.

CONCLUSIONS: The LTE decision was made inaccurately in most patients. The main reason was to make the decision too soon. Our results indicate the need to unify LTE criteria in the Emergency Room according to accepted guidelines.

Keywords: limitation of therapeutic effort (LTE), Intracerebral hemorrhage (ICH), Glasgow Coma Scales (GCS), Intraventricular Hemorrhage (IVH)
SO-013
Prognosis determinants of severe traumatic brain injury. A hospital based study in one sub saharan african country

Bello Figuim¹, Bamatota Zogo Marie Dominique², Nchufor Roland Ndouh¹, Tsafack Lekane Arielle¹, Mbele Messanga Ghislain¹, Eloundou Ngah Joseph¹

¹Department of neurosurgery, Central Hospital, Yaounde, Cameroon
²Faculty of Health Sciences, Buea University, Buea, Cameroon

INTRODUCTION: Severe traumatic brain injury (TBI) is a devastating condition with tremendous public health implications. Patients with severe TBI usually have bad outcomes in our setting with mortality rates between 60 and 80%. OBJECTIVES: we aimed at describing patient characteristics and 6 months outcome, and to identify prognostic determinants for patients with severe TBI. Patients and METHOD: This was a retrospective descriptive study conducted in the neurosurgical unit of the Yaounde Central Hospital (Cameroon) over a period of 10 years from January 2007 to December 2017. We included all patients admitted for severe TBI. RESULTS: A total of 62 patients were included. Males were predominant (90.3%) and the average age was 33.6 years. 71% of patients were admitted with a Glasgow Coma scale between 8 and 7. The most frequent intracerebral lesions on head CT scan were acute subdural hematoma (38.2%), epidural hematoma (16.4%), diffuse axonal injury (14.5%) and subarachnoid hemorrhage (12.7%). 6 months after injury, 11.3% of patients had good recovery, 8.1% had moderate disability, 48.4% had severe disability and 30.6% died from their head injury. Behavioral impairments and cognitive deficits were the most common post traumatic sequelae occurring in 62.9% and 59.7% respectively. The prognostic determinants for outcome were age, low GCS, subdural hematoma and late decision for surgical management.

Keywords: Prognostic, brain injury, outcome
Evaluation of functional situation of patients who had undergone surgery for intraventricular hemorrhage after 5 years of their admission into ICU

Maria Del Carmen Molina De La Torre1, Maria Marina Gordillo Resina1, Maria Dolores Arias Verdú2, Juan Mora Ordoñez2, Encarnación Castillo Lorente3, Miguel Angel Arraez Sanchez2, Ricardo Rivera Fernández1, Francisco Guerrero Lopez3

1Hospital Universitario de Jaén, Spain
2Hospital Regional de Málaga, Spain.
3Hospital Virgen de las Nieves de Granada, Spain

AIM: To evaluate patients admitted to ICU diagnosed with spontaneous supratentorial intracerebral hemorrhage and intraventricular hemorrhage, in terms of functional situation and its relation to surgical intervention.

MATERIAL AND METHODS: Patients with spontaneous supratentorial intracerebral hemorrhage who were admitted to ICU during 2009-2012 in three different Spanish hospitals with Neurosurgery Services, had been studied. Effect of surgical intervention in patients with intraventricular hemorrhage had been studied. Using a propensity index, 26 patients who had undergone surgery were paired with 26 who had not.

RESULTS: 163 patients were admitted with spontaneous supratentorial intracerebral hemorrhage and intraventricular hemorrhage. This patients presented at admission a 8+4 in Glasgow, 21.42+7.55 points in APACHE-II, and 2.75+0.9 score in ICH with a 65% predicting mortality (30 days) and a 59.5% mortality (30 days). 13.5% presented non-reactive bilateral midriasis. 23.3% of patients (N=38) were surgically intervened. Mortality of patients intervened was 34.2% and 67.2% (p<0.001) for patients who were not intervened. In the multifactorial analysis OR for surgical intervention was 0.14 (0.05-0.41). Afterwards a pairing of 26 surgically intervened patients with other 26 non-intervened in relation to a propensity index had been done. This index was calculated in relation to age, presence of pupillary abnormalities, hemorrhage size and location, and Glasgow at admission. Patients intervened and not intervened presented similar characteristics (age, Glasgow, ICH score, APACHE II, hemorrhage volume and location) and none of them presented non-reactive bilateral midriasis at admission. Hospital mortality of patients surgically intervened was 30.8% and 65.4% for patients not intervened (p=0.001) and OR 0.23; CI: 95%: 0.07-0.75. After 5 years of admission from the 52 paired patients, 20 of them were still alive, 29 no survived and 3 were missing (1 was surgically intervened and 2 of them were not). From the 25 who were intervened, 14 were still alive (56%) and from the 24 not intervened 6 were still alive (25%) (p=0.027) OR =0.26 (0.08-0.89). For the 14 patients intervened who were still alive, the functional situation evaluated with Barthel index was 38+38 points; and for the 6 patients who were not intervened presented a 54+39 puntos, (p=0.403) in the Barthel index. For he 25 patients surgically intervened, 5 (20%) were still alive and presented a slight dependence (Barthel >60) and for the 24 non intervened, only 2 (8.3%) were still alive and presented a slight disfunction (p=0.245).

CONCLUSION: Patients admitted into ICU with spontaneous intracerebral hemorrhage with ventricular involucration who were surgically intervened presented less mortality after five years in comparison to the ones who were not intervened. In the other hand, survivors presented a poor functional situation with a high dependence degree.

Keywords: spontaneous supratentorial intracerebral hemorrhage, functional situation, dependence
SO-015
An elderly lady with multiloculated bilateral subdural hematomas

Bella Richard¹, Ed Caple²

¹Bella Richard
²Ed Caple

INTRODUCTION: 76 year old lady admitted to the acute medical take with symptoms and signs of left leg Deep vein thrombosis (DVT).

CASE PRESENTATION: The patient had a background of Congestive cardiac failure, cognitive impairment and previous left leg DVT in 2016. She had an NSTEMI in 2017 and was on dual anti-platelet therapy (DAPT). 4 weeks prior to her DVT she had a upper gastrointestinal bleed (GI) and her DAPT was discontinued. She also had a 3 month history of rapid weight loss, diarrhoea and general decline. A lower gastrointestinal malignancy was suspected but she was felt not fit enough for invasive investigations in light of her heart failure and frailty.

Her health was gradually declining and she was treated in the community by the Frailty team until admission. There was no history of a fall from the patient or the family.

Left lower limb Doppler showed a residual thrombus in the common femoral, superficial femoral and popliteal veins. In light of previous GI bleed she was admitted for anticoagulation. No focal neurological findings on admission except cognitive impairment.

She was anticoagulated with subcutaneous Dalteparin. She weighed 68kgs and hence a weight adjusted dose of 12500 units was administered once daily. Her serum creatinine was 128 µmol/li and eGFR was 35ml/min. She received the dose for 7 days during which she was alert and mobilising short distances. On day 8 she was found unresponsive by the nursing staff. GCSwas6, shewasneglectfulofherrightside and had bilateral upgoing plantars. Pupils were equal and reactive. Intracranial haemorrhage was suspected and she underwent a CT head scan.

CT head scan showed extensive bilateral loculated subdural hematomas. She was given Protamine Sulphate with no effect. Unfortunately she was not well enough for neurosurgical intervention and she passed away.

CONCLUSION: This patient had multiple loculated subdural hematomas with a very unusual appearance. The possibility of leptomeningeal metastasis with bleeding into the lesions was raised. The absence of perilesional oedema was against this diagnosis. The patients’ gradual decline, frailty and heart failure made her unsuitable for further investigations and neurosurgery. There was no history of trauma prior to admission and no previous brain imaging for comparison. The loculation and multilayering of the blood on scanning indicates the bleeding at multiple times and respectively found in 13.2% and 13.6%. It is also more common in patients more than 75 years. The loculated appearance may represent acute on chronic subdural bleeding. It is important to consider baseline brain scans in the elderly prior to anticoagulation, as the history of trauma is often unreliable.

Keywords: bilateral subdural hematoma loculated subdural hematoma
SO-016
The application of Willis covered stent in the treatment of Blood Blister aneurysms: a single center experience and systematic literature review

Lun Xin Liu, Chao Hua Wang, Chang Wei Zhang, Xiao Dong Xie

WestChina Hospital of Sichuan University

Purpose: The purpose of this study is to introduce our initial experience with the evaluation and feasibility of using Willis covered stent (WCS) in the treatment of blood blister aneurysms (BBAs) and to present a systematic review of the literature on the covered stent treating BBAs.

Methods: 14 consecutive patients with BBAs were treated by WCS (Microport, Shanghai, China) in West China Hospital from January 2015 to August 2017. Medical records, angiography, and endovascular treatment reports were reviewed by interventional neuroradiologists and neurosurgeons to obtain relevant clinical and angiographic information. We conducted a systematic review of all reports of BBAs treated with the covered stent. We searched the literature using PubMed, Embase, the CNKI, Wanfang databases, and commercial Internet search engines. We included BBAs located at nonbranching portions of the ICA.

Results: The current study included nine men and five women, with a mean age of 54.5 years (range, 30-79 years). All patients had complete occlusion after immediate postoperative angiography. Ophthalmic artery (OA) was occluded in two patients (case 5, case 10). No mortality and morbidity occurred during the procedure. Two patient (case 5, case 6) experienced mild recurrence. One patient (case 1) found mild in-stent stenosis. The clinical follow-up of 6 to 15 months in all patients was evaluated. The mRS score at follow-up was 0 in eleven patients and 1 in two patients. One patient (case 7) experienced subarachnoid hemorrhage (SAH) and death 7,10 days later postoperatively, respectively. None of the patients experienced visual defects. All patients (except case 7) survived this report by the outpatient department or telephone interview. A total of 8 articles meet our criteria, which includes 38 patients. 37 patients (97.3%) have successful delivery to the diseased ICA. 34 patients experienced complete occlusion in their follow-up. The overall rate of complete occlusion is 83.0% (95%CI, 68%-91%).

Conclusion: Patients with ruptured BBAs treated with WCS achieved satisfactory clinical results. Therefore, for BBAs, the implementation of WCS may be safe and feasible. This strategy may be a promising option for this type of high-risk aneurysm. However, patients with tortuous ICA or aneurysms close to essential branch arteries should be seriously evaluated before using the WCS.

Keywords: BBA, Willis Covered Stent, Endovascular, Intracranial Aneurysm, Review
SO-017
Association between good modified Rankin Scale and cognition impairment status among hemorrhage stroke survivor patients: Results from CLEAR III and MISTIE III trials

Radhika Avadhani¹, Richard E. Thompson², Gayane Yenokyan³, Nichol Mcbee⁴, Karen Lane⁵, Wendy Ziai⁶, Issam A. Awad⁷, Daniel F Hanley⁸

¹Radhika Avadhani, Johns Hopkins University - School of Medicine
²Richard E. Thompson, Johns Hopkins University - School of Public Health
³Gayane Yenokyan, Johns Hopkins University - School of Public Health
⁴Nichol Mcbee, Johns Hopkins University - School of Medicine
⁵Karen Lane, Johns Hopkins University - School of Medicine
⁶Wendy Ziai, Johns Hopkins University - School of Medicine
⁷Issam A. Awad, University of Chicago
⁸Daniel F. Hanley, Johns Hopkins University - School of Medicine

BACKGROUND: We examined whether screening Mini-Mental State Examination (MMSE) scores, assessed at days 30 and/or 180, could predict good functional outcome, measured by modified Rankin Scale (mRS) scores at days 180 and 365 post-stroke.

METHODOLOGY: Intracerebral hemorrhage (ICH) patients in the MISTIE-III and CLEAR-III clinical trials were followed for 1 year, with MMSE and mRS collected at days 30 (D30), 180 (D180) and 365 (D365). Good functional outcome was defined as mRS 0-3. Five hundred patients were randomized in CLEAR III and 499 for MISTIE III; 732 survivors were analyzed. Multi-variable logistic regression (MLR) was used to estimate the relationship between D30 MMSE and good D180 and D365 mRS, adjusting for age, diabetes, ICH location, ICH hemisphere and total blood burden (stability ICH plus IVH).

RESULTS: For each unit increase in D30 MMSE, the model predicted a 10% increase in the odds of good D180 mRS (OR [95% CI]=1.10 [1.08, 1.12], p<0.001). A score of MMSE of 16 or higher was associated with good D180 mRS with 69% sensitivity, 69% specificity, and 69% correctly classified cases (AUC=0.8). Similarly, for each unit increase in D30 MMSE, the model predicted 9% increase in the odds of good D365 mRS (OR [95% CI]=1.09 [1.07, 1.11], p<0.001). A score of MMSE of 16 or higher was associated with good D180 mRS with 69% sensitivity, 69% specificity, and 69% correctly classified cases (AUC=0.8).

CONCLUSION: Cognition measurements at D30, such as MMSE, maybe helpful in predicting good functional outcomes at D180 and D365 post-stroke.

Keywords: good functional recovery; cognition status; modified rankin scale
SO-019
Dual antiplatelet therapy associated with reduced risk of clinical vasospasm in aneurysmal subarachnoid hemorrhage

Dae Won Kim

Department of Neurosurgery, Wonkwang University Hospital

OBJECTIVE Clinical vasospasm is one of serious complication of aneurysmal subarachnoid hemorrhage (aSAH). Several theories involving platelet activation have been postulated as potential explanations of the development of clinical vasospasm. However, the effects of dual antiplatelet therapy (DAPT; aspirin and clopidogrel) on clinical vasospasm have not been widely investigated. The objective of this study was to evaluate the effects of DAPT on clinical vasospasm in aSAH patients. METHODS Analysis of patients treated for aSAH during the period from 2009 to 2018 was performed in a single-institution retrospective study. Patients were divided into 2 groups: patients who underwent stent-assisted coiling requiring DAPT (DAPT group) and patients who underwent coiling or clipping only without DAPT (control group). The frequency of symptomatic clinical vasospasm was compared between the 2 groups. RESULTS Total 744 patients were included in the analysis (68 patients in the DAPT group, 676 patients in the control group; clipping – 569, coiling - 107). In the 3 different treatment modality (clipping, coiling, DAPT) groups, the incidence of clinical vasospasm was 8.6, 10.3 and 1.5%, respectively. The risks of clinical vasospasm was significantly lower in patients receiving DAPT (p = 0.001). CONCLUSIONS The use of DAPT was associated with a lower risk of clinical vasospasm in patients treated for aSAH.

Keywords: aspirin, clopidogrel, vasospasm, subarachnoid hemorrhage
SO-020
The prevalence of dynamic CT angiography “spot sign” and its predictability of clinical outcome in acute intracerebral hemorrhage: a prospective cohort study

Hee Sahng Chung1, Dariush Dowlatshahi2, Franco Momoli3, Grant Stotts4, Richard Avis5, Matthew Hogan6, Andrew Demchuk7, Santanu Chakraborty8

1Faculty of Medicine, University of Ottawa, ON, Canada
2Department of Medicine, Division of Neurology, The Ottawa Hospital, Ottawa, ON, Canada; Department of Epidemiology and Community Medicine, Ottawa Hospital Research Institute and University of Ottawa, ON, Canada; Department of Medicine, Ottawa Hospital Research Institute and University of Ottawa, ON, Canada
3Department of Epidemiology and Community Medicine, Ottawa Hospital Research Institute and University of Ottawa, ON, Canada; Department of Medicine, Ottawa Hospital Research Institute and University of Ottawa, ON, Canada; Children’s Hospital of Eastern Ontario Research Institute, Ottawa, ON, Canada
4Department of Medicine, Division of Neurology, The Ottawa Hospital, Ottawa, ON, Canada
5Department of Medical Imaging, Sunnybrook Health Sciences Centre, University of Toronto, ON, Canada
6Department of Medicine, Division of Neurology, The Ottawa Hospital, Ottawa, ON, Canada; Department of Medicine, Ottawa Hospital Research Institute and University of Ottawa, ON, Canada
7Department of Clinical Neurosciences, Alberta Stroke Program, University of Calgary, AB, Canada
8Division of Neuroradiology, Department of Medical Imaging, Ottawa Hospital Research Institute and University of Ottawa, ON, Canada

Introduction: Hematoma expansion (HE) is a predictor of poor clinical outcome in intracerebral hemorrhage (ICH). The spot sign on conventional CT angiography (CTA) is a validated predictor of HE and clinical outcome following ICH. However, conventional “static” CTA can miss delayed spot signs, depending on the timing of image acquisition. Dynamic CTA (dCTA) can detect delayed spot signs, however, the predictive performance of a delayed “dynamic spot” is not known.

Objectives: 1) To determine the prevalence of the dCTA spot sign 2) To explore its predictive performance for clinical outcome in ICH

Methods: In this prospective cohort study, we enrolled 78 patients who presented with ICH and underwent dCTA within 6 hours from onset. Secondary ICH were excluded. Spot sign status and hematoma volumes were determined on dCTA and CT, respectively. The primary outcome was the prevalence of the dCTA spot sign. The secondary outcome was significant hematoma expansion (HE) defined as an increase in hematoma volume by 6mL or 33% from baseline. The temporal distribution of spot signs was explored. Fisher’s exact and Mann-Whitney U tests were used for statistical analyses.

Results: The prevalence of the dCTA spot sign was 44.9% (95% CI, 33.7-56.5%). Significant HE was seen in 56.7% (17/30) of spot-positive patients versus 29.0% (9/31) of spot-negative patients (P=0.04). 60.9% (14/23) and 42.9% (3/7) of patients with spot signs in the arterial and venous phases revealed significant HE, respectively (P=0.67). The sensitivity and specificity of the dCTA spot sign in predicting significant HE were 65% and 63%, respectively.

Conclusion: Dynamic CTA captured higher spot sign prevalence than conventional CTA. The dCTA spot sign was associated with significant HE. While the sensitivity in predicting significant HE was higher with dCTA than with conventional CTA, the specificity was lower. This may be due to a lower risk of HE with delayed spot signs; further studies are warranted to examine the relationship between the temporal phase of the spot sign and clinical outcome.

Keywords: Intracerebral hemorrhage, dynamic CT angiography, spot sign, prevalence, significant hematoma expansion
Differential Risk factor profile for intracerebral hemorrhage according to location: A nested case-control analysis in the Framingham Heart Study

Vasileios Arsenios Lioutas1, Alexa Beiser2, Jayandra J. Himali2, Ayesha Chowhan4, Hugo J. Aparicio3, Jose Rafael Romero3, Sudha Seshadri5

1Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, USA; Framingham Heart Study, Boston University School of Medicine, Boston, USA
2Department of Biostatistics, Boston University School of Medicine, Boston USA; Framingham Heart Study, Boston University School of Medicine, Boston, USA
3Department of Neurology, Boston Medical Center, Boston USA; Framingham Heart Study, Boston University School of Medicine, Boston, USA
4Framingham Heart Study, Boston University School of Medicine, Boston, USA
5Glenn Biggs Institute for Alzheimer’s & Neurodegenerative Diseases, University of Texas Health Sciences Center, San Antonio, USA; Framingham Heart Study, Boston University School of Medicine, Boston, USA

BACKGROUND: Lobar and deep intracerebral hemorrhage (ICH) are thought to represent different pathophysiologic processes with different sets of predisposing factors. Some studies provide evidence for distinct risk factors while others suggest overlapping risk factor profile regardless of location. We addressed this question by examining baseline risk factor profiles of incident ICH cases in the Framingham Heart Study.

METHODS: We included FHS participants with a first-ever ICH between cohort inception in 1948 and 2015 and available clinical examination data within 10 years before ictus. We matched each case on sex and age to 4 ICH-free controls. Given the central role of hypertension we included systolic and diastolic blood pressure (SBP and DBP) as continuous variables and additionally computed pulse pressure (PP, expressed as [SBP-DBP]). We used conditional logistic regression adjusting for age and time from clinical assessment and ICH or matching.

RESULTS: We identified 34 deep (mean age 78±12 years, 50% male) and 50 lobar (76±13 years, 40% male) incident ICH cases. Compared to controls, deep ICH cases had slightly higher hypertension prevalence (82% vs 70%, OR 2.05 95% CI [0.70-6.01], p=0.191), significantly higher SBP (155±27 vs 139±23mmHg, OR 1.03, 95%CI [1.01-1.05]; p=0.001), DBP (82±17 vs 73±13mmHg, OR 1.06; 95%CI [1.02-1.10], p=0.001) and PP (74±23 vs 66±19mmHg, OR 1.02; 95% CI [1.00-1.04], p=0.04). Lobar ICH cases had higher proportion of ApoE ε4 allele carrier status (38% vs 21%, OR 2.98; 95% CI [1.07-8.28]; p=0.037). This association was stronger among homozygous ε4 carriers (OR 4.38; 95% CI [1.35-14.19]; p=0.014). No association between cholesterol levels, smoking, diabetes and any of the ICH subtypes was observed. Both subtypes had significantly higher long-term mortality compared to controls: HR=4.00 [2.55-6.27], p<0.001 for deep and HR=4.94 [3.35-7.30], p<0.001 for lobar.

CONCLUSION: Our study lends support to the notion that deep and lobar ICH have distinct risk factor profiles suggesting disparate underlying pathophysiologic processes. ApoE ε4 genotype was specifically associated with lobar hemorrhage. Higher SBP and DBP rather than history of hypertension were associated with incident deep but not lobar ICH. In addition, PP, a marker of arterial stiffness, is also associated with deep ICH. This finding could help refine antihypertensive agent choices in patients at higher ICH risk.

Keywords: intracerebral hemorrhage; lobar intracerebral hemorrhage; deep intracerebral hemorrhage; pulse pressure; apoE and ICH
SO-022
Recovery of Visual Function after Occipital Hemorrhage Evacuation by Minimally Invasive Neurosurgery (MIN)

Susanna M Antal¹, Klaus D M Resch²

¹LKHF Ophthalmology, Teaching hospital Univ. Innsbruck; Austria
²LKHF Neurosurgery, Teaching hospital Univ. Innsbruck; Austria

INTRODUCTION: In a recent series of 56 cases of ICH evacuation there were 9 cases with occipital/parieto-occipital location causing disturbance of visual function. We analyzed the ophthalmological outcome to prove the effect of functional recovery by this procedure.

MATERIALS-METHODS: This MIN concept combined 5 MIN-key techniques to assist microneurosurgery: high-end neuro-sonography with small probes (burr-hole-probe 8x8mm, ALOKA/ Hitachi) and mouth-tracking of the microscope, both mandatory. Additionally we added endoscopy (Wolf, Aesculap, Storz) and LASER (Th-YAG Revolix). Sealing technique (Tachosil/ Takeda) is always used. Ophthalmological standard techniques were peri-operatively used to meticulously document ophthalmological functions. Visual acuity, 30° visual field, RNFL and fundoscopy were examined as soon as the patients condition did allow so.

RESULTS: There were five male (73, 71, 67, 61, 42 y), three female (52, 76, 82 y) and one child (2mth) with occipital/parieto-occipital ICHs. The volume was 20 – 125 ml, 0 – 1,5 cm depth from the cortex, sono-assisted and mouth-tracked microsurgery through 7 MIN approaches (1 – 3 cm) and 2 burr-holes (1 cm) were used. Reasons of bleeding were 3 angiopathia, 1 cavernoma, 1 infarction and 4 unknown. In all angiopathia cases anticoagulants were involved. All patients recovered completely, only the 82y lady underwent during rehabilitation a TEP and was mobilized slowly and went finally home to her family. In all cases visual function recovery could be documented ophthalmologically.

CONCLUSIONS: - Cooperation of neurosurgery and ophthalmology can preserve visual functions.
- Ophthalmological techniques may support an outcome analysis as an excellent model to show functional recovery after ICH-evacuation.
- The superior results of MIN in ICH-evacuation can be objectively measured by ophthalmological methods.
- The most sensitive parameter for indication to evacuate the hemorrhage was the visual field disturbance.
- Because of the few cases, the temporal ICHs should be examined also by ophthalmological techniques to document the functional outcomes after evacuation of ICHs.

Keywords: evacuation occipital hemorrhage; visual recovery; ophthalmological outcome measurement; minimally invasive neurosurgery; interdisciplinary cooperation
SO-023
STudy of Antithrombotic Treatment after IntraCerebral Haemorrhage (STATICH)

Kristin Tveitan Larsen¹, Johanna Pennlert², Eva Lotta Glader³, Christina Kruuse⁴, Per Wester⁴, Elisabeth Forfang⁵, Hege Ihle Hansen⁵, Maria Carlsson⁶, Ole Morten Rønning⁷, Eivind Berge⁵

¹Department of Geriatric Medicine, Oslo University Hospital, Oslo, Norway; Department of Neurology, Akershus University Hospital, Lørenskog, Norway; Institute of Clinical Medicine, University of Oslo, Oslo, Norway
²Department of Public Health and Clinical Medicine, Umeå University Hospital, Umeå, Sweden
³Herlev Gentofte Hospital and University of Copenhagen, Herlev, Denmark
⁴Department of Public Health and Clinical Medicine, Umeå University Hospital, Umeå, Sweden; Department of Clinical Sciences, Karolinska Institute, Stockholm, Sweden
⁵Department of Geriatric Medicine, Oslo University Hospital, Oslo, Norway
⁶Department of Clinical Medicine, UiT The Arctic University of Norway, Tromsø, Norway; Department of Neurology, Nordland Hospital Trust, Bodø, Norway
⁷Department of Neurology, Akershus University Hospital, Lørenskog, Norway; Institute of Clinical Medicine, University of Oslo, Oslo, Norway

BACKGROUND AND AIMS: Patients with prior intracerebral haemorrhage (ICH) often have indication for antithrombotic treatment (antiplatelet or anticoagulant agents) for prevention of ischaemic events, but it is uncertain whether this is beneficial. STATICH will assess the effects of antithrombotic treatment on the risk of ischaemic and haemorrhagic events after ICH.

METHODS: STATICH is a Scandinavian, multicentre, randomised controlled, open trial of antithrombotic treatment in patients who have had a primary ICH during the last six months and who have indication for antithrombotic treatment. Participants with indication for antiplatelet treatment are allocated to antiplatelet treatment or no antithrombotic treatment. Participants with atrial fibrillation and indication for anticoagulant treatment are allocated to anticoagulant or no anticoagulant treatment. Cerebral MRI is performed before randomisation (if possible) and repeated at two years. Assessment of clinical outcomes is performed blinded to treatment allocation. Target recruitment is 500 participants, and duration of follow-up is at least two years. The primary outcome variable is recurrent ICH. Secondary outcome variables include other haemorrhagic events, ischaemic events, death, and functional and cognitive status.

STATUS: Recruitment of centres is on-going, and interested centres are welcome to participate. As per February 2019, 19 centres have been initiated and 9 participants enrolled. The primary analysis will assess the effects of antithrombotic treatment on clinical events. Secondary analyses will examine the importance of MRI findings, like cerebral microbleeds and white matter lesions, for the effects of antithrombotic treatment on the risk of recurrent ICH.

CONCLUSION: Randomised controlled trials like STATICH are needed to evaluate the net effects of antithrombotic treatment after ICH. An individual patient data meta-analysis is planned with other ongoing trials within the COCROACH collaboration.

Keywords: intracerebral haemorrhage; antithrombotic treatment; secondary prevention; ischaemic events; randomised controlled trial; antiplatelet therapy; anticoagulant therapy; atrial fibrillation; stroke
INTRODUCTION: Dural arteriovenous fistulas (DAVF) are an uncommon acquired pathology that establish an abnormal communication between arteries and veins. They can affect any territory of the central nervous system and normally occur between dural arteries and venous sinuses. Depending on their location DAVF can produce different symptoms such as tinnitus, exophthalmos, diplopia, headache, progressive neurological deficit, etc. The venous congestion produced by the fistulous communication causes an increase in pressure that, according to anatomical conditions, can be transmitted to a greater or lesser degree towards the drainage veins of the neural tissue reaching the capillary system, whose rupture can finally trigger a hemorrhagic event of serious consequences. In these cases it is of vital importance to occlude the fistulous communication in the fastest and most complete way possible in order to avoid new hemorrhagic incidents. The development of new materials and treatment techniques make endovascular therapy the most effective and safe option for this purpose. In this revision, we present the experience of our institution in the endovascular management of DAVF with hemorrhagic presentation.

MATERIAL AND METHODS: We reviewed the patients with DAVF treated endovascularly in our institution in a period of 5 years between 2014 and 2019. Of 35 patients treated 6/35 presented with acute neurological deterioration produced by a hemorrhagic event associated with the DAVF. All patients were treated early electively in the first days of admission. In 5/6 patients, a selective catheterization of the afferent arteries to the fistula was performed through a femoral access. In 1/6 patient the tortuosity of the arterial route forced access through direct puncture of a transcranial arterial afferent. In all cases liquid material (Onyx) or a combination of liquid material and coils was used.

RESULTS: In all cases complete closure of the DAVF was achieved in the first treatment. There was a technique complication associated with the microcatheter entrapment that required urgent surgical intervention at the cervical carotid without neurological consequences. No patient presented new hemorrhagic episodes and I did not appreciate recurrence of the fistula in the subsequent angiographic controls.

CONCLUSION: Cerebral hemorrhage is a rare but dangerous form of presentation of DAVF that requires a rapid intervention to prevent its recurrence. The modern techniques and materials developed for the endovascular treatment of cerebrovascular pathologies allow a safe, effective and rapid healing approach to DAVF even in its hemorrhagic form of presentation.

Keywords: dAVF, dural arteriovenous fistula, embolization, hemorrhage, endovascular therapy, vascular malformation
SO-025

Endovascular treatment in comparison with surgery for Aneurismatic Subarachnoid Hemorrhage: Analysis of results and costs

Angel Horcajadas, Isabel María Ortiz, Ana María Jorques, Majed Jouma Katati

Department of Neurosurgery, Hospital Universitario Virgen de las Nieves, Granada, Spain.

Object: To evaluate the clinical and angiographic results as well as the costs of surgical treatment against endo-vascular treatment in a SAH in a paired series of patients.

METHODS: A retrospective study of a series of 78 SAH patients treated endovascularly (EV) or surgically (SC) and paired according to age, Hunt-Hess scale at admission, Fischer grade, aneurysm localization and follow-up time. A descriptive study was performed, as well as clinical results (Glasgow Outcome Scale, GOS, at 6 months), angiographic data (occlusion classification) and economic costs in each of the groups.

RESULTS: The mean age was 51.4 years (25-82) with a female predominance (7:10). The mean follow-up time was 37.3 months. Glasgow Outcome Scale (GOS) at 6 months was favorable (4-5) in 69.7% of the cases (better in the SC group). The average length of stay (ALOS) was 36.3 days (slightly higher in the EV group). Complete occlusion of the aneurysm was obtained in 80.0% of the patients in SC series and 47.3% in the EV series. 18.4% of the EV patients required retreatment. Costs of the SC treatment were slightly higher than the EV costs for the first admission (0.2% higher) but EV costs are considerably higher when the costs of follow-up and retreatment were added (13.4% more). The factors that made EV treatment more expensive were the costs of embolization material and retreatment.

CONCLUSIONS: SC and EV treatment have similar clinical results; however SC treatment has greater stability and lower costs. Adequate selection of patients for treatment modality could save costs.

Keywords: Brain aneurysm, Coil, Cost effectiveness, Subarachnoid hemorrhage
High In-Hospital Systolic Blood Pressure Variability and Poor Functional Outcome in Primary Intracerebral Hemorrhage Patients

Jennifer R Meeks, Arvind B Bambhroliya, Louise D McCullough, Sean I Savitz, Farhaan S Vahidy

Department of Neurology, McGovern Medical School at UTHealth, Houston, USA

INTRODUCTION: High in-hospital SBP variability (HSBPV) is an emerging marker for poor outcomes among Intracerebral Hemorrhage (ICH) patients. We aimed to determine the risk of severe disability or death (SDD) at day-90 among ICH patients with HSBPV and explore pre-hospital factors associated with HSBPV.

METHODS: Adult, radiologically confirmed primary ICH patients were prospectively enrolled and followed-up until day-90. All routinely collected SBP values were recorded for the inpatient stay. Inter and intra-patient SBPV was quantified using generalized estimating equations. Modified Rankin Scale (mRS) Score of 4 – 6 was defined as SDD. Poisson and logistic regression models were fit to determine the risk of day-90 SDD, and the association of pre-hospital characteristics with HSBPV. As a sensitivity analysis, we performed propensity-score based matched comparison of HSBPV and non-HSBPV patients for 90-day SDD. A sub-sample was matched 1:1 on important clinical and statistical variables by defining a caliper of 0.05 for the propensity scores. Post-match reduction in standardized bias was quantified and the matched sample was analyzed by fitting a multilevel mixed effect logistic regression model.

RESULTS: A total of 566 patients [mean age: 63.5, females 36.6% (207 of 566)] were included. Total in-hospital follow-up period was 4,908 days [median (IQR) per patient = 8.7 (3-11)]. Over 120,500 SBP readings were analyzed. Inter and intra-patient mean SBP standard deviation (SD) was 11.1 and 13.2, respectively. A SD of 13.0 was parameterized as a cut-off for HSBPV. HSBPV patients had a 17% higher adjusted risk of day-90 SDD (Relative Risk, 95% CI: 1.17, 1.02-1.35) (Table). Older age and female sex were independently associated with HSBPV after controlling for hemorrhage volume, pre-morbid mRS, and Glasgow Coma Scale (Figure). 420 patients were matched 1:1 on the basis of age, NIHSS Score, GCS, hemorrhage volume, and pre-morbid mRS. The matching adequacy was statistically tested and the pairs were balanced on all matched covariates. The multilevel mixed effect logistic regression model showed a statistically significant association between HSBPV and SDD at day 90 in the matched sample (OR, 95% CI: 1.78, 1.07 – 2.97, p = 0.027).

CONCLUSION: Quantification of HSBPV is feasible utilizing routinely collected SBP readings. HSBPV is associated with poor outcomes. Elderly and female patients may be more likely to demonstrate HSBPV during hospitalization.

Keywords: Intracerebral Hemorrhage, Hypertension, Blood Pressure Variability, Outcomes
SO-027
Novel clinical trial design: INTERACT4, an ambulance-delivered PROBE trial of intensive BP lowering

Lili Song\textsuperscript{1}, Jie Yang\textsuperscript{2}, Gang Li\textsuperscript{3}, Xiaoying Chen\textsuperscript{1}, Chen Chen\textsuperscript{3}, Feifeng Liu\textsuperscript{3}, Yaping Lin\textsuperscript{2}, Yijia Guo\textsuperscript{2}, Hisatomi Arima\textsuperscript{4}, Craig S Anderson\textsuperscript{1}

\textsuperscript{1}The George Institute China, Peking University Health Science Center, Beijing, China
\textsuperscript{2}Department of Neurology, The First Affiliated Hospital of Chengdu Medical College, China
\textsuperscript{3}Department of Neurology, Shanghai Eastern Hospital, Tongji University, China
\textsuperscript{4}Department of Preventive Medicine and Public Health, Faculty of Medicine, Fukuoka University, Fukuoka, Japan

BACKGROUND: Uncertainty persists over benefits of early intensive blood pressure (BP) lowering both in acute intracerebral hemorrhage (ICH) and acute ischemic stroke (AIS), with speed and choice of treatment being potentially critical factors. The INTERACT4 (ClinicalTrials.gov: NCT03790800) aims to determine if hyperacute ambulance-delivered intensive BP control improves functional outcome after stroke.

METHODS: A region-based clustered multicenter, prospective, open, randomized, blinded endpoint trial of pre-hospital BP lowering in 3116 hypertensive presumed acute stroke patients in China. Up to two bolus doses of intravenous Urapidil will be used to treat patients assigned to intensive group (systolic BP target <140mmHg within 30 mins) via a mobile-APP-based randomization system. Control BP management is according to guidelines after admission to hospital. Data are collected in-hospital over 7-days, and at 90-days through central blind telephone follow-up assessment. Sample size allows 90\% power to detect 22\% relative odds improvement in functional recovery among 2072 cases of definite stroke (30\% mimics) and 30\% absolute reduction in 24 hr hematoma growth in ICH patients (30\% of definite strokes).

CONCLUSION: INTERACT4 will provide reliable evidence on the effectiveness and safety of ambulance-delivered intensive BP lowering with a standard intravenous regime in patients with presumed acute stroke.

Keywords: Stroke; Pre-hospital; Blood pressure
SO-029
The Impact of Inter-hospital Transfers versus In-Hospital Emergency Department Admissions on Intracerebral Hemorrhage Patients Undergoing Minimally Invasive Evacuation

Julianne Kleitsch, Dominic A Nistal, Natalia Romano Spica, Trevor Hardigan, Rui Song, J. Mocco, Neha Dangayach, Christopher P Kellner

Icahn School of Medicine at Mount Sinai, Department of Neurosurgery, New York, NY 10029

Introduction: With the increasing number of large health care systems, many hospitals rely on a centralized inter-hospital transfer system to provide time-sensitive interventions for neuroemergencies. Treatment of intracerebral hemorrhage (ICH) at high-volume hospitals is associated with better outcomes, however inter-hospital transfer of such patients requires quick and effective multi-disciplinary coordination, and mismanagement or delays in treatment can lead to worse outcomes. In this study we tried to ascertain the impact of different clinical factors on outcomes of ICH patients who underwent minimally-invasive evacuation, who were either transferred to or admitted from an emergency room to a comprehensive stroke center.

Methods: Ninety-seven patients with ICH who underwent minimally invasive hematoma evacuation from December 2015 through August 2018 were retrospectively reviewed. The patients were then classified into two groups: inter-hospital transfer and in-hospital ED admissions. Primary outcome was good functional outcome defined as mRS 0-3 at 6-months and secondary outcomes included NSICU length of stay, hospital length of stay and mortality. Univariate and multivariate regression models were constructed using clinical and statistical inferences to predict primary and secondary outcomes. Clinical variables included in the models were age, admission status, NIHSS, location lesion, intraventricular hemorrhage (IVH), hematoma volume, percent of hematoma evacuation, and time to evacuation of hematoma.

Results: Of 97 patients, 33.0% (n=32) were female, 88.7% (n=86) were transferred, and 11.3% (n=11) were directly admitted through the ED. Upon univariate linear regression analysis, higher NIHSS, deeper lesions, and the presence of IVH positively predicted longer lengths of stay in the NSICU (Table 1). After multivariate analysis, higher NIHSS and presence of IVH remained significant (p=0.0077 and 0.0011, respectively), and admission status became significant. Patients who underwent inter-hospital transfer were more likely to have a shorter stay in the NSICU (β=-6.13 p=0.0252*). Admission status did not significantly predict mRS at 6-months, mortality, or hospital LOS.

Conclusion: In this cohort of subjects, patients who underwent inter-hospital transfer were predicted to have a shorter stay in the NSICU compared to those directly admitted through the ED. With the development of new minimally invasive evacuation techniques, a single center of excellence for the treatment of hemorrhagic stroke patients may improve outcomes for this unique group of patients. Longer NSICU stay results in greater resource utilization, increasing cost of care and decreasing bed availability for other patients. A limitation of our study is the small number (n=11) of in-hospital ED admissions compared to inter-hospital transfer patients (n=86). A large prospective cohort study is needed to better elicit the effect of inter-hospital transfers on patient outcomes.

Keywords: ICH, inter-hospital transfer, minimally invasive evacuation, intracerebral hemorrhage
Case report: A patient with hemorrhagic subtype of moyamoya disease

Jana Kenda¹, Barbara Smrke², Anita Resman Gaspersic¹

¹Department of vascular neurology and intensive care unit, UMC Ljubljana, Slovenia
²Department of neurosurgery, UMC Ljubljana, Slovenia

Moyamoya disease (MMD) is a rare cerebral vasculopathy characterized by development of small collateral vessel networks at the base of the brain due to progressive stenosis and occlusion of the distal carotid (ICA), proximal middle (MCA) and anterior cerebral arteries (ACA). Majority of MMD patients have ischemic presentation, while 20% manifest with intracerebral hemorrhage (ICH). Hemorrhagic subtype (hMMD) is associated with a poor clinical course. No definitive treatment method has been recognized as effective for preventing recurrent bleeding, however recent studies show that cerebral revascularisation could be favorable. Herein we present a patient with hMMD treated with revascularisation surgery. 46-years old female without classical vascular risk factors suffered first ICH at age of 25. ICH was located in the left basal ganglia and thalamic region. CT angiography revealed stenosis of the left distal ICA and left MCA with typical pattern of collaterals for MMD. 13 years later she had another ICH in left putamen and centrum semiovale. After both ICH she recovered completely. No specific treatment was introduced at that time. At the age of 45 she suffered another ICH located in left temporoparietal region, urgent surgical evacuation of hematoma was needed. Afterwards motor dysphasia and mild right sided hemiparesis persisted. Control digital subtraction angiography showed occlusion of proximal left MCA, absent left A1 and stenosis of the right A1 segment of ACA. The brain MRI showed only hemorrhagic lesions. In keeping with recent reports about hMMD treatment we referred her to surgery and direct revascularisation. MCA - superficial temporal artery anastomosis was performed. The procedure was successful and so far she did not suffer a recurrent ICH. According to the literature direct revascularisation seems to be beneficial in preventing recurrent ICH in MMD. Surgical treatment should be offered to patients with hMMD. Due to rarity of the disease referral to highly experienced surgical team is reasonable.

Keywords: moyamoya disease, revascularisation surgery
SO-033
Blockage of glymphatic system contribute to enhanced neuroinflammation in intraventricular hemorrhage

Si Zhang, Chao You, Chuanyuan Tao, Xin Hu
Department of Neurosurgery, West China Hospital, Chengdu, China

Object The aim of our study is to investigate the pathogenesis of enhanced neuroinflammation caused by extensive glymphatic dysfunction.

Methods After intraventricular injection of autologous blood, the distribution of blood components was observed in vivo. Then, patency of glymphatic drainage and paravascular expression of neuroinflammational factors were examined via histopathological and molecular biological methods.

Results After intraventricular hemorrhage, blood components could spread into the paravascular space of contralateral cortex. In vivo two-photo imaging showed that, after intraventricular injection of TR-d70 labeled blood, this red fluorescent dye spread into the paravascular space in a short time. However, one day after intraventricular hemorrhage, intraventricular injection of TR-d70 labeled saline, the pathway of paravascular-glymphatic system was blocked. Meanwhile, accumulation of fibrin was detected in paravascular space. After the blockage of glymphatic drainage, the expression of IBA-1, GFAP and MMP-9 was progressively elevated in the contralateral cortex remote to ventricular system and showed a tendency of accumulating around the vessels.

Conclusion After intraventricular hemorrhage, blood component including fibrin could spread into the subarachnoid space and paravascular space. The accumulation of fibrin in paravascular space may lead to dysfunction of paravascular pathway-glymphatic system which in turn cause enhanced neuroinflammations.

Keywords: Intraventricular Hemorrhage, Glympathic system, Neuroinflammation
INTRODUCTION: 15% of all strokes in the UK are haemorrhagic. As the impact of stroke on society and economy is massive, it is important to understand the correlation between patient’s NIHSS and GCS at presentation and prognosis.

Design: A retrospective audit of 96 patients with spontaneous intracerebral haemorrhage(IH), as evidenced by a CT scan, admitted to West Suffolk Hospital between May 2017 and October 2018 was conducted.

AIMS: 1. To establish correlation between severity of stroke at presentation (NIHSS and GCS scores) and the outcomes.
2. To establish whether there is any difference between the patients being on DOACs and Warfarin and the outcomes.

RESULTS: Out of 96 patients 30 (31%) died, 28 (29%) were discharged home, 21 (22%) received palliative treatment within 72 hours of admission.

- 40(42%) presented with GCS of 15, 45 (46.9%) had GCS of 9-14, 11 GCS ≤ 8(11.5%). Out of patients with GCS 15(n=40), 16(40%) were discharged home, 14 (35%) with ESD, 3 (7.5%) died, 5 (12.5%) were discharged to a care home, 2 (5%) to another hospital. Out of cohort with GCS 9≤14, 16 patients died (40%), 7 were discharged with ESD (17.5%), 6 to a care home (15%), 4(10%) to another hospital, 4(10%) were discharged home.

- Out of the whole cohort 21(22%) were on anticoagulants: 7(33.3%) on Warfarin, 9(43%) on Apixaban, 4(19%) on Rivaroxaban, 1 patient (5%) on Dabigatran.

- Warfarin cohort: 1 (14.3%) died in the hospital, 2 were discharged (28.6%) to care home, 2 were transferred with ESD.
- Apixaban cohort (n=9) 6 died (66.7%), 1 (11.1%) was discharged home, 1 (11.1%) was discharged to care home.
- Rivaroxaban cohort (n=4), 2 (50%) patients discharged with ESD, 2 (50%) died. 1 on Dabigatran was transferred with ESD.

- 22 patients (23%) had severe stroke (NIHSS>21), 9 (9.4%) had moderate to severe stroke (NIHSS 16-20), 11(11.5%) moderate stroke(NIHSS 11-15) and 49(71%) mild stroke (NIHSS 0-10)

Severe stroke: 18 died (82%), the rest were discharged to a care home.
Moderate to severe stroke: 6 died (67%), 2 were discharged home (22.2%), 1 to a care home (11.1%)
Moderate stroke: 3(27.3) died, 2 (18%) were discharged home, 2 discharged with ESD≤(18%), 4(36.4%) were discharged to a care home.
Mild stroke: 16(33%) patients were discharged home, 18(36.7%) discharged with ESD, 8(16.3%) patients died, 4(8.1%) were transferred to another team and 3(6.1%) were discharged to care home.

Conclusions: The audit showed clear correlation between poor NIHSS score at presentation and poor outcome as well as clear link between decreased GCS and mortality. This might help guide clinician’s decision about initiating palliative treatment. Interesting correlation was shown between the high mortality rate and the use of DOACs but the cohort size is too small to establish causality. It also established that our mortality rates are within acceptable variation range of published data.

Keywords: DOACs, warfarin, GCS, NIHSS, epidemiology, outcomes
SO-038
The efficacy and mechanisms of adipose-derived stem cells on the treatment of intracerebral hemorrhage

Gaigai Li¹, Yang Hu¹, Ye Zhang², Qian Wu³, Zhouping Tang¹

¹Department of Neurology, Tongji Hospital, Tongji Medical college Huazhong University of Science and Technology, Wuhan, 430030, China
²Department of Endocrinology, Tongji Hospital, Tongji Medical college Huazhong University of Science and Technology, Wuhan, 430030, China
³Department of Neurosurgery, Zhongnan Hospital of Wuhan University, Wuhan,430030, China

Intracerebral hemorrhage (ICH) is one of the most common neurological diseases with high morbidity and mortality. Current treatment options for ICH mainly include medical and surgical therapies of symptomatic lesions. Stem cell therapy has emerged as a new promising therapeutic strategy for various neurological disorders. Adipose Derived Stem Cells (ADSCs) is a kind of mesenchymal stem cell with the advantages of high yield, low immunogenicity and avoidance of ethical issues. We tried to examine the protective effects of ADSCs on ICH and study its mechanisms of action. We isolated ADSCs from the subcutaneous inguinal adipose tissues of Sprague-Dawley rats, and found that ADSCs can be induced to generate neurospheres that have NSC-like properties and may thus constitute a potential source of cells in stem cell therapy for neurological disorders. ICH model was induced in SD rats by injecting collagenase to the basal ganglion region. We found significantly improved functional recovery, reduced apoptosis of neurons and increased angiogenesis after transplantation of ADSCs through lateral ventricle in rats with ICH. In addition, we locally injected ADSCs around the lesion of brain of mice with ICH, similar results were observed. Transplanted ADSCs could reduce neuroinflammatory reaction and maintain the integrity of blood-brain barrier. To examine the mechanisms of ADSCs, FeSO₄ and neurons, Hemin and astrocytes, LPS and microglia were co-cultured respectively in vitro to simulate ICH. It was found that ADSCs could protect neurons and astrocytes form damage by inhibiting the expression and secretion of IL-1β, IL-6, TNF-α, MDA, NOS and iNOS, etal. In addition, ADSCs could significantly reduce the expression of aquaporin 4 and 9 on the surface of astrocytes after cerebral hemorrhage, which might be closely related to the reduction of cerebral edema and maintenance of BBB integrity after ADSCs transplantation. Through SiRNA interference technology, we found that ADSCs could weaken immune response in microglia cells by up-regulating TSG6 protein expression. In summary, we concluded that ADSCs could play a neuroprotective role in cerebral hemorrhage through multiple mechanisms such as anti-neuroinflammation, immune regulation and edema alleviation. Thus, ADSCs might be taken as a promising therapeutic strategy for the treatment of ICH in the future.

Keywords: Intracerebral hemorrhage, Adipose Derived Stem Cells, transplantation
SO-039
Increasing mortality rates of intracerebral hemorrhage associated with direct oral anticoagulants in Japan

Tomohide Adachi1, Haruhiko Hoshino1, Makoto Takagi1, Shodo Fujioka2, Chiaki Arakawa1, Satoshi Yamada1, Koichi Oki1

1Department of Neurology, Tokyo Saiseikai Central Hospital, Tokyo, Japan
2Department of Neurosurgery, Saiseikai Misumi Hospital, Uki, Japan
3Saiseikai Stroke Research Group

Background and PURPOSE: Several studies reported that the hematoma volume of intracerebral hemorrhage (ICH) with direct oral anticoagulants (DOACs) was smaller than that of ICH with warfarin. Moreover, we previously reported mortality rate in ICH with DOACs was lower than ICH with warfarin. However, mortality rates and functional prognosis were similar for ICH with DOACs and ICH with warfarin in phase III trials. In this study, we evaluated the change in mortality rates and functional prognosis of cerebral hemorrhage following treatment with antithrombotic agents, including DOACs, warfarin, and antiplatelets.

METHODS: The participants were 2,084 patients with acute cerebral hemorrhage, selected from two years in our stroke database; 1,193 in the first year and 891 in the second year. Risk factors of stroke, cerebral hemorrhage type, antithrombotic agents, mortality rate, and functional prognosis, determined by the modified Rankin score (mRS), were recorded. The mortality rate and good functional prognosis at discharge (mRS 0-1) were compared for patients treated with DOACs, warfarin, antiplatelets, anticoagulants and antiplatelets, and no antithrombotic agents in each of the two years.

RESULTS: In the first year, patients were treated with DOACs (n = 18), warfarin (n = 79), antiplatelets (n = 234), anticoagulants and antiplatelets (n = 7), or no antithrombics (n = 862); in the second year, the patients were treated with DOACs (n = 51), warfarin (n = 38), antiplatelets (n = 123), anticoagulants and antiplatelets (n = 17), or no antithrombics (n = 662). The mortality rates and functional prognosis are shown in the table. The mortality rate of was significantly lower for DOAC-treated patients than for those treated with other antithrombotic agents in the first year; however, in the second year, the mortality rate of the DOAC-treated patients increased and was similar to that for patients treated with warfarin and other antithrombotics. The mRS 0-1 at discharge was comparable among all groups in the first year, but it was lower for the anticoagulants and antiplatelets group in the second year.

CONCLUSION: The mortality rate of ICH with DOACs increased over time in Japan. Further studies are needed to verify this result.

Keywords: DOACs, warfarin, intracerebral hemorrhage, mortality
SO-041
Radiologic features of intracerebral hemorrhage as predictors of intrahospital mortality and functional outcome at discharge

Ane Ugarte Nuño, Virginia Gómez Usabiaga, Gorka Arenaza Choperena, Jose Ángel Larrea Peña, David Campo Caballero, Maria Teresa Martínez Zabaleta, Maialen Ganzarain Oyarbide, Arantza Murguialday Iturrioz, Nicolás Sampron Lebed, Arantza Aguirre Arrizabalaga, Javier Basterrechea Peña, Ana De Arce
Department of Radiology, Hospital Universitario Donostia, San Sebastian, Spain

INTRODUCTION: Spontaneous intracerebral hemorrhage (ICH) has a high intrahospital mortality rate. It would be useful to identify severity factors to help decide on the aggressiveness of treatment from the emergency room (ER). We hypothesize that shape and clot density of intracerebral hemorrhage evaluated in baseline CT may predict intrahospital mortality and functional outcome of patients at discharge.

METHODS: Retrospective observational study of a prospective registry of patients admitted in a tertiary hospital with hemorrhagic stroke during 2018. Variable in the study include neuroimagine features on initial sub-6 hour CT (volume, lesion shape and clot density, presence of intraventricular blood) and other clinical variables that have been demonstrated to be negative predictors, such as age, INR and NIH stroke severity scale. Lesion shape and clot density in baseline CT were evaluated based on the Barras 5-point Scale. Univariate and multivariate regression tests were conducted.

RESULTS: The study included 90 patients with ICH and a sub-6 hour baseline CT (mean age 72.2 years and 58.7% were male). Median NIHss score was 14.10 (0-30). Median hemorrhage volume was 23.04 (IQR 5-52). A crosstable study was performed to evaluate the relation between hemorrhage shape and patient death. There is a discrete association between them with a Pearson chi square of 0.051. More significant results were obtained when other statistical dependence tests were applied (likelihood ratio test 0.034 and linear by linear association 0.031). A decision tree with a QUEST algorithm was applied to analyse the relation between hemorrhage margins and death. The results showed that patients with a Barras Scale I-V have a death probability of 32%, whilst patients with a Barras V have a death probability of 51% (Table 1).

When multivariate regression test were conducted, none of the results were statistically significant for hemorrhage shape. Hemorrhage density showed no significant correlation with patient mortality or functional outcome.

CONCLUSION: According to these results, there is only a weak correlation between hemorrhage shape and mortality, mainly in those patients with Barras Scale V. No significant correlation was shown between shape and functional outcome nor density and mortality/functional outcome.

Keywords: CT, Intracerebral hemorrhage, mortality, functional outcome
SO-043
A survey of usual care of physiological variables in ICH Patients - INTERACT3 Trial

Lili Song¹, Lingli Sun¹, Lu Ma², Xin Hu², Menglu Ouyang¹, Chunmiao Zhang¹, Xi Li², Guojuan Cheng¹, Chao You², Craig S Anderson¹

¹The George Institute China, Peking University Health Science Center, Beijing, China
²Department of Neurosurgery, West China Hospital, Sichuan University, Chengdu, China

BACKGROUND: The ongoing trial - INTERACT3 aims to determine the effectiveness of a goal-directed care bundle of intensive blood pressure [BP] lowering, glycemia control, treatment of pyrexia and reversal of anticoagulation in patients with acute intracranial haemorrhage (ICH).

METHODS: A multicentre, hospital-based survey was conducted among INTERACT3 investigators from November 2017 to October 2018. Data on usual management of BP, glucose, pyrexia and elevated INR were collected using a pre-tested, structured questionnaire.

RESULTS: A total of 106 hospitals across 24 provinces in China were included, with 80 (75.5%) are from low-income regions based on World Bank Classification. Intensive BP control with a target of systolic BP (SBP) <140 mmHg was administrated in 28 (%) hospitals, but only % hospital would lower SBP to this target within one hour. A moderate target of SBP reduction (140-160 mmHg) was given in 75 (%) hospitals. Comparing to low-economic regions, hospitals at high-income regions had a higher application of intensive BP control (38.5% vs. 23.4%). 40.6% hospitals and % will control glycemia with a target of 7.8-10 mmol/L for diabetic patients and <7.8 mmol/L for non-diabetic patients, respectively. Only 12 hospitals will treat pyrexia, and 7.1% hospitals will reverse anticoagulation-related ICH with a INR target < 1.5. Prothrombin complex concentrates (PCCs) was available in 37 hospitals.

CONCLUSION: Acute ICH management varies across regions in China. Implementation of evidence-based care bundle through high quality RCTs may translate evidence-bases recommendations to clinical practice, and provide broader evidence to policy makers.

Keywords: Stroke; Intracerebral Hemorrhage; survey; Blood pressure; care bundle
SO-044
Minimally Invasive Endoscopic Evacuation of Intracerebral Hemorrhage is Safe with the NICO Myriad

Rui Song, Dominic A Nistal, Jonathan S Pan, J. Mocco, Christopher P Kellner
Icahn School of Medicine at Mount Sinai

Introduction: Intracerebral hemorrhage (ICH) is a devastating form of stroke for which traditionally there have been few therapeutic options. While open surgical craniotomy has been thoroughly explored as a treatment option, multiple minimally invasive techniques are currently being tested. These include the MISTIE technique, a semi-passive approach combining aspiration with alteplase irrigation, as well as endoscopic approaches including the SCUBA technique. The current ENRICH trial tests a minimally invasive hematoma evacuation technique utilizing the NICO BrainPath for a trans-sulcal hematoma approach and the NICO Myriad for aspiration, a system that has been long used for tumor resection. While this approach is actively being investigated, the Myriad device has yet to be used in with an endoscope for ICH evacuation. In this early report, we report that the endoscopic ICH evacuation with the SCUBA technique is safe and effective with the NICO Myriad aspiration device.

Methods: Retrospective analysis was performed on thalamic ICH patients who were treated with MIS endoscopic evacuation in the Mount Sinai Health System from December 2018 to January 2019, a total of 4 patients. Cases were performed exclusively in the angiography suite NICO Myriad device (NICO Corporation, Indianapolis, IN). Hemorrhage volumes were calculated using the ABC/2 method.

Results: Clinical data was available for all four patients (1 male; mean age 67.7 ± 18.3 years). All patients presented with initial ICH score of 2 or less; all patients had baseline mRS 0. Mean hematoma size was 55.4 ± 77.2 cc. No patients presented with concurrent IVH. Average evacuation percentage was 88.8% ± 13.8%; average SCUBA and total operative time were 1.7 ± 1.2 and 2.5 ± 1.2 hours respectively. Average NSICU 11 ± 8 days and average hospital length of stay was 17 ± 4 days. There were no procedural complications, rebleeding, or readmissions within 30 days.

Conclusions: These preliminary data suggest minimally invasive endoscopic ICH evacuation with the NICO Myriad aspiration device is safe and can achieve high evacuation rates. More experience with this device will be needed to further test its effectiveness and efficacy compared to other endoscopic aspiration tools.

Keywords: intracerebral hemorrhage; hemorrhagic stroke; minimally invasive; endoscopic
SO-045
Establishing Criteria for Triage of Primary Intracerebral Hemorrhage Patients to Higher Level of Care

Jennifer R Meeks, Katie M Alex, Arvind B Bambhroliya, Sunil A Sheth, Sean I Savitz, Farhaan S Vahidy
Department of Neurology, McGovern Medical School at UTHealth, Houston, USA

INTRODUCTION: Patients with Intracerebral hemorrhage (ICH) are routinely transferred to Comprehensive Stroke Centers (CSCs) for neurosurgical and neurocritical care. However, evidence for utility and criteria of such transfers is lacking. Therefore we sought to explore factors associated with non-utilization of CSC Services (non-CSC) among patients with primary ICH and provide preliminary criteria for early identification and triage of non-CSC patients.

METHODS: Primary ICH patients admitted between 01/01/2016 and 03/31/2017 were identified from our stroke registry. Patients who did not stay in the neurocritical care unit, did not get an extra-ventricular drain, or did not undergo a neurosurgical procedure were categorized as non-CSC patients. Logistic regression models were utilized to compare demographics, disease severity, and outcomes between CSC utilizers and non-CSC patients. Odds ratios (OR) and 95% confidence intervals (CI) are reported. Receiver operative curve (ROC) analyses were used to determine the discriminatory potential of routinely used severity scales in identifying non-CSC patients.

RESULTS: A total of 958 patients were included, among whom 33.7% were non-CSC. Transferred patients were more like to be non-CSC as compared to those who directly presented to CSC (OR, CI: 1.60, 1.18-2.16). Non-CSC patients had a significantly lower median NIH Stroke Scale (NIHSS) (Median, IQR Non-CSC vs. CSC: 4, 2-10 vs. 19, 9-26) and ICH scores (Median, IQR Non-CSC vs. CSC: 0, 0-1 vs. 2, 1-3), and higher median Glasgow Coma Scale (GCS) score (Median, IQR Non-CSC vs. CSC: 15, 14-15 vs. 10, 5-14) on presentation. All three scales had a fair to good individual discrimination for classifying non-CSC patients (c-statistic for GCS, NIHSS, ICH Score: 0.71, 0.77, and 0.80 respectively). After combining ICH score with dichotomized GCS at 10 and categorized NIHSS at 0-5 / 6-15 / 16+, the combined c-statistic for all three scales was 0.84.

CONCLUSION: A third of ICH patients presenting at CSC do not utilize neurosurgical / neurocritical care. Identification and triage of these patients may help optimize ICH care and provide criteria for randomization of ICH patients across various levels of care in a healthcare system. Further validation in external cohorts is needed.

Keywords: Intracerebral Hemorrhage, Resource Utilization, Transfer, Level of Care
A Case of Subdural Hematoma After Epidural Blood Patch in a Spontaneous Intracranial Hypotensive Patient With Multi-Level Cerebrospinal Fluid Leakage

Young Joo
Department of Anesthesiology and Pain Medicine

CASE REPORT: A 42-year-old male visited the department of Neurosurgery due to severe headache. The onset was about one month before admission to hospital, and his headache was gradually getting worse. No aura, photophobia was noted and no lumbar puncture or recent trauma history could be investigated. He was sent to our clinic with brain magnetic resonance imaging (MRI) showing that diffuse dural thickening with enhancement and subdural effusion.

The patient had a chief complaint of a headache in whole head area, which were aggravated by standing and relieved by lying down. On the day he was admitted, he experienced pain of 10/10 on the VAS. But, there was no nausea or vomiting, and neurological examinations and laboratory studies were all normal. Spinal tap was performed and showed an low pressure of 6cmH2O in the sitting position, increased protein 90mg/dl (normal range 20-50mg/dl) and glucose level was 61mg/dl (normal range 45-70mg/dl), RBC 0 mm3, WBC 5 mm3. A cytologic examination of the CSF and a bacterial culture test showed no strange findings. On day 6 of admission, a MR myelogram was taken, but not demonstrated CSF leakage site. Although CSF leakage site was not found, patient’s symptoms could all explained by spontaneous intracranial hypotension, so he was referred to the pain clinic for EBP. We performed the EBP at L level under fluoroscopic guidance by injecting 8 mL of autologous blood for 2 times in two days apart. But he headache was not relieved.

For accurate diagnosis and treatment, radionuclide cisternography (RNC) was performed, and showed that the CSF leaked to the left at the upper thoracic level (T1-2) and to the right at the lumbar level (L2). On the day 13 of admission autologous blood was injected under fluoroscopic guidance between T1-T2. A 18G Touhy needle was employed using hanging drop method after loss of resistance with saline in the left interlaminar approach. Using a sterile technique, 6 mL of autologous blood was injected into the epidural space. Next day, his pain was 4/10 on VAS at head up position. After 1 week EPB was performed using similar technique at L2-3 in right interlaminar space with 12mL autologous blood. The patient’s headache was resolved gradually, but still complaining of mild residual orthostatic headache. On day 20 of admission we performed fifth EBP at Left T1-2 level again. After EBP, the patient felt even better when he was in the upright position. But next day, headache was exacerbated and 10/10 on VAS, even lying down did not relieve the pain. Physical and neurologic examinations were normal, but brain CT was done because of constant headache.

Brain CT indicated a bilateral SDH, next day subdural hematoma were drained through left burr hole. Five days later, brain CT showed re-enlargement of the left subdural hematoma, and the patient was undergone craniotomy at the 39th day of admission.

**Keywords:** subdural hematoma, spontaneous intracranial hemorrhage, Multi-level cerebrospinal fluid leakage, Epidural blood patch
SO-049

Initial Experiences on Early Surgery for Spontaneous Basal Ganglia Intracerebral Hemorrhage

Giannina Krishna Chua Go, Erickson Fernando Torio, Juan Manuel Luis Mariano, Maurice Villaflors Bayhon, Jonna Mae De Sagun Maala, Manuel Mendoza Mariano

Institute for Neurosciences, St. Luke’s Medical Center Global City, Philippines

BACKGROUND: Spontaneous intracerebral hemorrhage (ICH) is a leading cause of death and disability secondary to stroke. The negative effects of ICH include (1) vasogenic edema from clot retraction, drops in hydrostatic pressure and plasma proteins, (2) cytotoxic edema from inflammation secondary to thrombin activation, hemoglobin toxicity and red blood cell lysis and (3) tension hematoma from capsule-like granulation formation. These effects occur as early as an hour, peaks after 3 to 7 days and persists up to a month after ICH. This review of the pathophysiology of ICH has led our institution to adapt early surgery for ICH.

OBJECTIVES: The purpose of this study is to describe our institution’s technique and initial experiences in early evacuation of ICH.

METHODS: This is a case series of patients describing our experiences in institutionalizing early evacuation of intracerebral hemorrhage. The rationale for early evacuation of ICH was presented at our institution last August 2017. Neurosurgeons at our institution were invited to adapt the strategy. Data on patient demographics, time from ictus to surgery, pre- and post-operative Glasgow Coma Scale (GCS), length of hospital stay, and mortality were collected. Initial results were compared to data before institutionalizing early evacuation ICH.

RESULTS: Neurosurgeons at our institution agreed to adapt to early evacuation of intracerebral hemorrhage. Thirty four patients had ICH over a 17-month period. Eleven patients with hematoma volumes greater than 30 to 50cc were evacuated using various techniques. Mean patient age was 48.6 ± 13.8 years. Females comprised 37.5% of the sample. Average time from ictus to surgery was 12.5 ± 14.7 hours. 42.9% of patients underwent surgery 6 hours and less after hemorrhage. 71.4% had improvement in GCS postoperatively. The average length of hospital stay was 30.1 days (range 17 to 60 days). A patient died due to pneumonia 37 days after surgery. More neurosurgeons have adapted early surgery and minimally-invasive techniques such as endoscopic evacuation of ICH and thalamic hemorrhage with intraventricular extension.

CONCLUSIONS: Initial experiences on early evacuation of ICH (less than 4 to 6 hours post-ictus) were described. Institutionalizing early evacuation was acceptable at our institution. Clinical outcome based on pre- and post-operative GCS, length of hospital stay, and mortality show the benefits of early evacuation of ICH.

Keywords: early surgery, intracerebral hemorrhage, institutionalized
INTRODUCTION: Intracranial hemorrhage (ICH) is the second most common cerebrovascular event, and its morbidity is exceptionally high. Given the patient’s characteristics, clinical presentation may range from a few symptoms to critical states with the need for intensive care and surgery. Mortality may affect as much as 60% of patients per year, and only 20% will have functional independence at six months after the event. Our goal, besides describing the main characteristics of spontaneous ICH patients admitted to the Neurocritical Care Unit (NCCU), was to characterize their invasive neuromonitoring signaling.

METHODS: We retrospectively analyzed a cohort of patients, with spontaneous ICH as the primary diagnosis, admitted to NCCU of a tertiary hospital between 2016 and 2018. We described the main characteristics of admission, the need for surgery and EVD and functional status at NCCU discharge. For the subgroup analysis, we identified patients submitted to invasive neuromonitoring and selected the ones with good quality records defined as continuous signal records for at least 48 hours.

RESULTS: One hundred and forty-three patients admitted to the NCCU between 2016 and 2018 with a mean age of 61.7±15.1 years old and a mean length of stay at NCCU of 17.0±18.0 days. 59% had invasive mechanical ventilation, 43% were submitted to surgery (HIC drainage or decompressive craniectomy), and 25% need EVD. Comparing to admission, at the time of NCCU discharge, 80% of patients improved functional status, 3% worsened, and 17% died. From the 36 patients with intracranial ICP monitoring, 13 had good quality records. It was possible to observe that the ones who died had significantly higher ICP. Even though with no statistically significant difference these patients showed a tendency to higher PRx and more notable difference from CPP to the calculated optimal CPP as compared to the ones who lived.

CONCLUSION: This pilot study aimed to observe if there was any identifiable pattern of the neuromonitoring signal related to outcome for spontaneous ICH patients. For the 13 patients with good quality records, the analysis raised the question, as in TBI, that vascular autoregulation mechanisms might be involved as seen by a trend for higher PRx and more notable difference of CPP to optimal CPP in worse outcome patients. This relation is going to be pursued with a larger sample size and prospectively collected neuromonitoring records of spontaneous ICH patients.

Keywords: Spontaneous ICH, Neurocritical Care, Neuromonitoring
Admitting Patients with Small Intracerebral Hemorrhage and Minor Deficits to a Neurologic Step-Down Unit rather than Intensive Care Unit is Safe and Results in Shorter Total Length of Stay

Rajat Dhar¹, Lindsay Laws¹, Flavia Lee², Abhay Kumar³

¹Department of Neurology, Washington University School of Medicine, Saint Louis, USA
²Department of Neurology, Saint Louis University, Saint Louis, USA
³Department of Neurosurgery, UT Health Sciences Center/McGovern School of Medicine, Houston, USA

OBJECTIVE: Patients suffering acute intracerebral hemorrhage (ICH) are at risk for early neurologic deterioration and are often admitted to intensive care units (ICU) for observation. There is limited data on the safety of admitting a low-risk subset of ICH patients to a non-ICU setting (such as a step-down or stroke unit). We compared cohorts of ICH patients at two partner institutions: at one, all ICH patients are admitted to the ICU and at the other, patients with small ICH and mild deficits may be admitted to a neurologic step-down unit (SDU). To determine if admitting such patients to a SDU is safe and less resource-intensive, we compared rates of early neurologic deterioration and total hospital length of stay between the groups.

METHODS: Patients with supratentorial ICH without significant IVH or uncorrected coagulopathy could be admitted to the neuro-SDU at one center if Glasgow Coma Scale (GCS) was 13-15 and NIHSS was below 10. We compared this group to a comparable cohort (using the above criteria) at the institution where all patients with ICH are admitted to the ICU. ICH volumes were 15ml or less in both groups. We collected all instances of neurologic deterioration requiring repeat brain imaging as well as whether patients were (re)admitted to the ICU from the SDU or floor. Primary endpoint analysis between the two populations was admission (or re-admission) to the ICU and overall hospital length of stay. Group medians (interquartile range) were compared using Mann-Whitney tests.

RESULTS: The two cohorts (SDU n=74 vs. ICU n=58) were comparable: ICH volume 1.6 (0.5-3.25) vs. 2.1-ml (0.6-8.0), NIHSS 2 (1-4) vs. 2.5 (1-5). Of those admitted to the neuro-SDU, there were five (7%) who required ICU admission but only one for neurologic deterioration related to hematoma expansion (HE). Overall rates of HE were similar (3 vs. 5, p=0.28). No patients in either group required ventriculostomy, craniotomy, or osmotic therapy. Median ICU days were 0 vs. 1 (1-2, p<0.001). Hospital length of stay was one day shorter in the SDU group (3 vs. 4 days, p=0.05).

CONCLUSIONS: Patients with small ICH and good clinical status can be safely admitted to a neurologic step-down unit. This may result in shorter overall length of hospital stay with less ICU utilization and lower healthcare costs.

Keywords: intensive care unit; hospital care; intracerebral hemorrhage; hematoma expansion
SO-056
The Role of Ultrasound in ICH Evacuation

Klaus D M Resch

LKHF, Neurosurgery, Teaching hospital Univ. Innsbruck; Austria

BACKGROUND: About 3000 neurosonography cases and 260 ICH evacuation cases are the background to define the role of ultrasound in surgery of intracranial hemorrhages.

MATERIAL-METHODS: Several high-end ultrasound equipments have been used peri-operatively during the last 22 years. The recent 56 cases of ICH evacuations were analyzed according to the contribution the ultrasound had for performing the procedures minimal invasively. Cases were presented to show the key points of the application.

RESULTS: Ultrasound came out to be one of the key-techniques to performing this kind of surgery in ICH evacuation. The indication borders were enlarged to so called inoperable cases with excellent outcome. Ultrasound detected dangerous bleeding causes to avoid uncontrollable situations. Evacuation control made fast and precise visible when the goal is reached. Imaging the brain tissue, vascularity and pathophysiology changes was accomplished in real-time.

CONCLUSION: Without ultrasound the presented results were impossible. High-end equipment is mandatory. Ultrasound is a peri-operative concept. Several characteristics of ultrasound technique are un substitutable. It has excellent ergonomics, supporting microsurgery without impairment of the procedure. An indispensable learning time is necessary.

Keywords: Intra-operative Imaging; ICH evacuation; Neuro-sonography; Minimally Invasive Neurosurgery; Key-technique for MIN
SO-057

Predictors of early in-hospital mortality in patients with spontaneous intracerebral hemorrhage

Maialen Ganzarain Oyarbide¹, David Campo Caballero², Arantza Murguialdhay Iturrioz¹, Patricia De La Riva Juez², M. Teresa Martínez Zabaleta², Alejandro Elua Pinín⁴, Nicolas Sampron Lebed⁴, Ane Ugarte Nuño³, Jose Angel Larrea Peña³, M. Aranzazu Aguirre Arrizabalaga⁵, Javier Basterrechea Peña⁶, Ana De Arce Borda²

INTRODUCTION: Spontaneous intracerebral hemorrhage (ICH) has high in-hospital mortality rate. It would be useful to identify severity factors to help decide on the aggressiveness of the treatment from the emergency room. The aim of this study is to identify predictors of early in-hospital mortality in ICH patients upon admission.

MATERIAL-METHODS: Retrospective observational study of a prospective registry of patients admitted in a tertiary hospital with ICH between January and October 2018. Variables in the study include: age, sex, hypertension, diabetes, dyslipidemia, atrial fibrillation, ischemic cardiomyopathy, active smoking, alcohol abuse, previous ICH, previous antiplatelet therapy, previous anticoagulation, use of statins, Charlson comorbidity index, Rankin scale, cancer, renal failure, cognitive impairment, NIH stroke severity scale, Glasgow coma scale, arterial pressure on admission, INR and neuroimaging features on initial CT: mean volume, lesion shape, clot density variation and intraventricular blood. Univariate and multivariate regression analysis were conducted to identify independent predictors of mortality within the first 7 days of admission.

RESULTS: The study included 131 patients with ICH (mean age 73.6 years and 50% were female). 24.4% were admitted to the ICU and 71% to the Stroke Unit. Median NIHss score was 25 (IQR 15-30) and 4.5 (IQR 2-9) for dead and living patients respectively. Median volume was 40 (IQR 20-90) and 9.64 (IQR 3.92-26.06) for dead and living patients respectively. 87% of deaths were related to ICH and 2.1% to respiratory complications. Mortality in the first seven days was 34.4%, 45% of the survivors were autonomous at three months. Independent predictors of ICH early in-hospital mortality include age (OR 1.11 (1.04 -1.18) p=0.001), NIHss on admission (OR 1.15 (1.07-1.24) p=0.001), volume of the hematoma (OR 1.01 (0.99-1.03) p=0.058) and existence of intraventricular blood (OR 5.45 (1.50-19.8) p=0.01). Mortality at three months was 38.1% and 45% of the survivors were autonomous at three months.

CONCLUSIONS: According to these results, age, stroke severity, ICH volume and the presence of intraventricular discharge arise as independent predictors of ICH early in-hospital mortality. Therefore, it seems reasonable to take these features into consideration when assessing ICH patients at the emergency room.

Keywords: Mortality predictors, Spontaneous intracerebral hemorrhage
INTRODUCTION: While management of intracerebral hemorrhage (ICH) is well studied, additional insight is needed into the clinical and multidisciplinary factors affecting patient hospital course and outcomes. In this study, we determined whether the presence of family at the bedside of patients with ICH in the Neurosurgical Intensive Care Unit (NSICU) after undergoing minimally invasive evacuation predicted a change in length of stay (LOS), mortality, and improvement in functional outcomes at 6 months after discharge from the hospital.

METHODS: Ninety-seven patients diagnosed with ICH were retrospectively reviewed from December 2015 through August 2018. Patients were then classified into two groups: having family present at the bedside at some point during their admission and family was never present at the bedside. Primary outcome of the study was good functional outcome at 6-months, defined as mRS 0-3. The secondary outcomes included both hospital and NSICU length of stays (LOS), and mortality. Univariate and multivariate regression models were constructed using clinical and statistical inferences to predict primary and secondary outcomes. Clinical variables included in the models were age, admission status, NIHSS, location of lesion, intraventricular hemorrhage (IVH), hematoma volume, percent of hematoma evacuation, and time to evacuation of hematoma.

RESULTS: Of 97 patients, 33.0% (n=32) were female, 74% (n=72) had family present at the bedside, and 26% (n=25) did not have family present. Upon univariate linear regression analysis, higher NIHSS, deep lesions, and the presence of IVH positively predicted poor functional outcome (mRS 4-6) (p=0.000011, p=0.0004, p=0.0002, respectively), while the absence of family did not significantly predict poor functional outcome (OR= 0.42, p=0.09). After multivariate analysis, higher NIHSS, deep lesions, and presence of IVH remained significant (Table 1), and age and evacuation percentage reached significance (Table 1). Having family at the bedside was predictive of survival (OR=0.19, p=0.05, reference: mortality within 6-months). Family at the bedside did not significantly predict mRS at 90 days, NSICU LOS, or hospital LOS when controlling for all other clinical variables.

CONCLUSIONS: The rehabilitation process in stroke is multidisciplinary, often involving both detailed clinical knowledge and the involvement of patients’ support systems. This study provided insight into the ICH clinical variables affecting a patient’s length of stay and functional outcomes. The presence of family at the bedside was shown to improve the odds for reduced mortality within six months. While additional research is necessary to further describe the effects of family presence, this study may point to the importance of encouraging early family involvement during hospital stay and after discharge.

Keywords: Intracerebral hemorrhage, family presence, functional outcomes, minimally invasive evacuation
SO-061
Association of Various Perihematomal Edema Metrics to Primary Intracerebral Hemorrhage Clinical Outcomes

Patrick Matic Yalung1, Charlotte Seongeun Yoon5, Bernard Kean Mappala Capinpin5, Danielle Kei Alzaga Pua5, Shane Del Rosario Chug5, Erickson Fernando Torio2, Maritoni Lao Rosales4, Maria Cristina Zarsadias San Jose1, Mercedes De Leon Dizon3, Ibet Marie Yap Sih2, Geraldine Siena Largoza Mariano1, Joven Racpan Cuanang1

1Section of Adult Neurology, Institute for Neurosciences, St. Luke’s Medical Center, Metro Manila, Philippines
2Section of Neurosurgery, Institute for Neurosciences, St. Luke’s Medical Center, Metro Manila, Philippines
3Institute of Radiology, St. Luke’s Medical Center, Metro Manila, Philippines
4Neurocritical Care Unit, St. Luke’s Medical Center, Metro Manila, Philippines
5St. Luke’s Medical Center, College of Medicine, Metro Manila, Philippines

Background—Perihematomal edema is being focused on in research as a possible independent predictor for intracerebral hemorrhage outcomes, but there is limited and inconsistent data. Analysis of association of perihematomal edema metrics with clinical outcomes and other factors will be of great use in prognostication and in medical and neurosurgical pre-emptive decision making. Objective—To determine association between various perihematomal edema metrics with clinical outcomes

Methods—This is a retrospective, analytical, cohort study involving 54 patients with primary intracerebral hemorrhage enrolled in the stroke databank from January 2013 to August 2018. Inclusion criteria were ≥18 years of age with acute supratentorial primary intracerebral hemorrhage with at least two cranial computed tomography scans. Exclusion criteria were patients with secondary intracerebral hemorrhage, intraventricular extension, and ventriculostomy tube placement. Chart review and scan measurements were performed. Univariate and multivariate analyses were done. Results—For every unit increase in perihematomal edema volume, the odds of poor outcome, severe disability, and prolonged hospital stay is increased by 1.108 times (p=<0.001), 1.071 times (p=<0.001), and 1.074 times (p=<0.001) respectively. Likewise, for every unit increase in perihematomal edema absolute area, the odds of poor outcome, severe disability, and prolonged hospital stay is increased by 1.15 times (p=0.001), 1.072 times (p=0.023) and 1.127 times (p=<0.001) respectively.

Conclusion—There is indeed association between perihematomal edema volume and perihematomal edema absolute area with higher odds of developing poor Modified Rankin Scale and severe National Institute of Health Stroke Scale scores and prolonged hospital stay. Hence we should consider measuring these metrics for prognostication. This study also reiterates the need for aggressive control of fever and hyperglycemia which were found to significantly worsen perihematomal edema metrics.

Keywords: intracerebral hemorrhage, edema, metrics, outcomes, CT scan
Spontaneous intracranial hemorrhage associated with novel oral anticoagulants

Han Lin Yen, Shih Chung Tsai, Hsien Tzung Cheng

Department of Neurosurgery, Tainan Municipal Hospital (Managed by Show Chwan Medical Care Corporation), Tainan, Taiwan

Introduction: The emergence of novel oral anticoagulants (NOACs) has changed the approach to anticoagulation for patients worldwide. The absolute incidence of spontaneous intracranial hemorrhage (ICH) associated with NOACs has increased with the greater use of these anticoagulants. Therefore, to gain further insight into the clinical characteristics and outcome after the management of NOAC-related ICH, we present our experience in nine patients with NOACs-related ICH.

Methods: We retrospectively analyzed the characteristics of symptomatic ICH patients receiving NOACs between April 2013 and March 2018 in a single center in southern Taiwan.

Results: ICH occurred in 9 patients (7 men, 2 women; mean ± SD age, 75.6 ± 8.7 years). The mean CHA2DS2-VASc score was 3.4 and the mean HAS-BLED score was 2.9. Mean time to onset was 440 days after starting NOACs. Five patients received rivaroxaban, 2 patients received dabigatran and 2 patients received apixaban. Two patients (22%) had a favorable outcome with a modified Rankin Scale score ≤2 and 6 deaths leading to a mortality rate of 67% (6/9). The hematoma expansion was noted in 2 patients who received rivaroxaban. One patient received antidote (Idarucizumab) to reverse the anticoagulation effect of dabigatran and no expansion in the size of the hematoma.

CONCLUSION: The mortality of NOACs-related ICH was high at our institution. While there is good-quality evidence that the incidence of ICH is reduced with the use of NOACs compared with warfarin. However, the absolute incidence of ICH associated with NOACs has increased with greater use of these anticoagulants. This comes with a greater risk for hematoma expansion and death if suitable reversal strategies are not found. Understanding the potential salvaging reversal strategies and knowledge of the outcome following ICH in patients receiving NOAC is importance.

Keywords: Intracranial hemorrhage, novel oral anticoagulants
SO-064
Radiologic characteristics and high risk of seizures in infants with ruptured intracranial aneurysms: case report and review of the literature

Yi Liu, Ruiqi Chen, Yanming Ren, Si Zhang, Chao You
West China Hospital, Sichuan University

OBJECTIVE: To evaluate the parameters related to the high risk of preoperative seizures in infants (1 year or younger) with ruptured intracranial aneurysms.

METHODS: Infants with ruptured intracranial aneurysms treated at our institution from January 2012 to January 2018 were retrospectively analyzed. Seventeen similar cases of infant patients with seizures reported in published studies were reviewed.

RESULTS: The mean age of the 7 infant patients treated at our institution was 4.1 ± 3.3 months (range, 28 days to 11 months), with 2 male and 5 female subjects. One patient (14.3%) had an internal carotid artery aneurysm with subarachnoid hemorrhage, and the remaining 6 patients (85.7%) had middle cerebral artery (MCA) aneurysms in the distal arterial region with lobe hemorrhage. Five of the 7 infants (71.4%) had seizures, 4 of whom (4/5, 80.0%) had MCA distal arterial aneurysms with lobe hemorrhage. Management was successful for all patients with aneurysm clipping or resection surgery, and one patient experienced postoperative seizures. Of the 17 reviewed cases of infant patients with seizures, 10 patients (58.8%) exhibited the typical distal arterial aneurysm with lobe hemorrhaging, and 6 (60%) of them had aneurysms in MCA.

CONCLUSIONS: Infant patients with ruptured intracranial aneurysms have a high risk of preoperative seizures. The typical radiologic finding of distal arterial aneurysm with lobe hemorrhage was frequently observed in the MCA, and it might be related to the high risk of preoperative seizures in this population. Microsurgical techniques effectively control postoperative seizures in infants with ruptured intracranial aneurysms.

Keywords: Radiologic Characteristics; Seizures; Infants; Ruptured Intracranial Aneurysms
SO-065

Hemicraniectomy with minimally invasive evacuation for intracranial hematoma: a novel hybrid technique

Leonard H Verhey¹, Leah Lyons¹, Paul Mazaris¹, Joseph Zachariah², Justin A Singer¹

¹Division of Neurological Surgery, Spectrum Health, Michigan State University, Grand Rapids, MI, USA
²Division of Neurology, Department of Clinical Neurosciences, Spectrum Health, Grand Rapids, MI, USA

PURPOSE: Spontaneous intracerebral hemorrhage (ICH) accounts for 10-20% of all strokes,¹ and is associated with a 50% one-year mortality rate.² Minimally invasive hematoma evacuation techniques may have a benefit over conventional medical and surgical treatments.³,⁴ We describe a case in which a novel hybrid technique of emergent hemicraniectomy with minimally invasive parafascicular surgery was used to evacuate a large subcortical supratentorial ICH with lobar extension.

CASE: A 61-year-old female developed sudden onset headache, right-sided weakness and facial droop, aphasia, and vomiting while exercising. Initially recorded blood pressure was 176/82. She was emergently intubated in the CT scanner due to obtundation, with a GCS of 7 and an enlarged minimally reactive left pupil. Head CT demonstrated a 10x4x8 cm left hemispheric ICH with intraventricular dissection, brain compression, and 14 mm of rightward midline shift. (Figure 1A) ICH score was 3. She was given mannitol and hypertonic saline, placed on a nicardipine drip, hyperventilated, and taken emergently to the operating room for a left hemicraniectomy and ICH evacuation. A large left trauma flap was turned in standard fashion, and a stellate durotomy was performed. A 75 mm trocar was inserted into the frontal lobe along the long axis of the hematoma, and upon removal of the obturator, significant hematoma products were encountered. The hematoma was resected with gentle dissection, suction and irrigation. Hemostasis was obtained, the endoport was removed, and the flap was closed. Repeat head CT revealed minimal residual hematoma and decreased mass effect and midline shift. (Figure 1B) Following an unremarkable neurocritical care course, the patient was transferred to inpatient rehabilitation. At a recent five month follow-up, the patient is progressing well, speaking in short phrases, has residual right sided weakness, and is ambulating with maximal assistance.

CONCLUSION: Early follow-up of our patient suggests promising clinical functional recovery. This novel hybrid technique of hemicraniectomy with endoport ICH evacuation offers a unique window of intervention for patients requiring emergent decompression.

REFERENCES


Keywords: intracerebral hemorrhage, minimally invasive parafascicular surgery, endoport, hematoma evacuation
SO-066
Evacuation of Traumatic Intracranial Haemorrhage by MIN Techniques

Klaus D M Resch
LKHF, Neurosurgery, Teaching hospital Univ. Innsbruck; Austria

INTRODUCTION: The disadvantages of craniectomy are not well examined and published. Craniectomy for TBI did not come out to be of benefit for the patients. Analysis of 56 recent hematoma cases showed 12 trauma cases. To prevent craniectomy, evacuation of the hematoma by MIN techniques was preferred.

MATERIAL-METHODS: This MIN concept combined 5 MIN-key techniques to assist microneurosurgery: high-end neurosonography with small probes („burr-hole-probe 8x8mm, ALOKA/Hitachi) and mouth tracking of the microscope, both mandatory. Additionally we added endoscopy (Wolf, Aesculap, Storz) and LASER (Th-YAG Revolix). Sealing technique (Tachosil/Takeda) is always used. We found in a recent analysed series of 84 intracranial hematomas 12 trauma cases. There were 5 subdural bleedings, 6 ICH cases and 1 bullet injury case, 8 male and 4 female.

RESULTS: In all cases we saw a much better course of recovery than in craniectomy cases. The patient were not disabled additionally by stigmata like craniectomy defect, big scarf, loss of hair and psychological trauma. We did not see the typical malignant hyperperfusion in TCD, the perifocal edema was minimal and the ICP was always decreased to normal levels. The beginning of rehabilitation therapy could start within one week only, the wound of 3 cm was hardly visible and during rehabilitation there was no fear by the rehabilitation clinics to soon start the full training program. We did not see any complications due to the MIN strategy.

CONCLUSION: To avoid additional trauma by craniectomy MIN techniques are effective to decrease ICP level. Pathophysiologically it seems logical to release ICP by evacuation of traumatic bleeding rather than craniectomy.

Keywords: Evacuation of Traumatic ICH; Minimally invasive Neurosurgery; Preservation of Function; ICP Release; Avoiding Craniectomy by MIN; Fast Rehabilitation without additional Trauma
SO-067
The risk of Hemorrhagic Transformation after intravenous thrombolysis in cardioembolic Ischemic stroke

Lina Carazo Barrios¹, Blanca Sanchez Mesa², Alejandro Gallardo Tur¹, Carlos De La Cruz Cosme¹

¹Department of Neurology. Hospital Clínico Universitario Virgen de la Victoria, Málaga, Spain
²Department of Internal Medicine. Hospital Costa del Sol. Marbella, Spain

BACKGROUND: Arteriosclerosis and atrial fibrillation are the most common causes of acute ischemic stroke (AIS). The risk of Hemorrhagic Transformation (HT) is known to be higher in patients treated with intravenous thrombolysis (IT) and those with cardioembolic stroke (CES). The aim of this study is to evaluate the risk of HT in CES and non-CES patients with IT.

METHODS: A prospective observational study was performed between 2013 to 2017. Patients with AIS treated with IT were included. Data was collected as age, gender, NIHSS score, ASPECTS score, and TOAST etiology, divided in CES and non-CES. HT were classified in Hemorrhage infarction type 1 and 2 (HI1/2), Parrenchymal Hematoma 1 (PH1), Parenchymal Hematoma 2 (PH2). Remote Parenchymal Hemorrhage 1 and 2.

RESULTS: N=204 patients with AIS treated with IT, all were caucasian people, 85 females (41,7%). Mean age 67,6 ± 12 years. Mean NIHSS score 14,6 ± 5,4. Mean ASPECTS score 9,6 ± 0,8. No Hemorrhagic Transformation were observed in 151 patients (74,8%); IH1/2 in 30 patients, PH1 in 13 (9,4%), PH2 in 6 (3%), HPR1/2 2, lost information in 2. CES etiology was observed in 76 (37,3%); 28 of 74 CES patients presented some HT (all types) and 25 of 108 non-CES patients presented some HT (all types). Odds Ratio= 2,3 CI95% (1,21-4,462).

CONCLUSIONS: The risk of presenting any type of hemorrhagic transformation after intravenous thrombolysis is approximately doubled in case of cardioembolic etiology compared to other etiologies. Cardioembolic etiology is a risk factor for the presentation of Hemorrhagic Transformations in Acute Ischemic Stroke patients treated with intravenous thrombolysis.

Keywords: Hemorrhagical Transformation, Stroke, Cardioembolic, Thrombolysis.
SO-068

MRI findings of primary hypertensive intracerebral hemorrhage at chronic stage

A Hyun Cho¹, Eun Ye Lim¹, Yoon Sang Oh¹, Seong Hoon Cho², Hae Kwan Park²

¹Department of Neurology, Catholic University of Korea, College of Medicine
²Department of Neurosurgery, Catholic University of Korea, College of Medicine

BACKGROUND: Dark signals on gradient-echo MRI (GRE) which suggest old hemorrhagic sequelae are often found incidentally. It is difficult to distinguish if it is the sequelae of hemorrhagic infarct or primary intracerebral hemorrhage particularly when the clinical history is uncertain. Therefore, we aimed to determine the radiological findings of primary intracerebral hemorrhage at the chronic stage.

METHODS: We consecutively enrolled patients with hypertensive intracerebral hemorrhage more than six months ago. Follow-up MRI was prospectively performed with informed consent. MRI protocols included FLAIR or T2-weighted image and gradient-echo MRI. Lesion shape, size, locations and GRE signals were interpreted. The radiological findings were compared to the initial exam.

RESULTS: Total 10 cases were included. 8 were male. Mean age was 66.7. Lesion locations were basal ganglia in 1, putamen & corona radiata in 3, external capsule & corona radiata in 2, pons in 1, thalamus in 2, and occipital lobe in 1. The time interval from the initial exam to follow-MR scan was 4.4 years (mean). Lesions involving corona radiata showed slit shape after severe shrinkage (n=3). Lesions involving thalamus, basal ganglia showed cavitation after encephalomalatic change rather than slit like shrinkage. Dark signal on GRE was present as three patterns (whole dark signal, partial dark rim, total dark rim). Whole dark signal was present in one patient with small pontine lesion, partial dark rim in 4, total dark rim in 5. Mean initial hematoma volume was 13.67±13.19 ml. Mean follow-up volume was 4.22±5.47 ml. The proportion of hematoma reduction was 34% (mean).

CONCLUSION: GRE MRI at chronic stage of intracerebral hemorrhage shows variable shape, size reduction according to their location. Dark signal on GRE was present particularly in the edge of hematoma with central cavitory change. Slit shape shrinkage was observed in the hematoma located at mainly white matter rather than gray matter.

Keywords: intracerebral hemorrhage, gradient-echo MRI
SO-069
Intracerebral haematoma evacuation with minimally invasive technique: a case study

Tomaz Velnar, Peter Spazzapan, Roman Bosnjak

University medical centre Ljubljana, Department of neurosurgery

Introduction: Spontaneous intracerebral hemorrhage (ICH) is one of the most devastating types of stroke with a high disability and mortality rate. In cases, when surgery is needed, minimally invasive approach is recommended. Besides blood pressure reduction and intensive medical and surgical treatment, immediate coagulopathy reversal is vital. On the other hand, the haemostatic disturbances may occasionally contribute to improve the recovery.

Methods: In the prospective study, 10 patients with ICH treated by nonendoscopic minimally invasive evacuation were included so far. All of them were treated with anticoagulant theory because of concomitant diseases. The coagulopathy was reversed when possible. After coagulopathy reversal, a minimally invasive approach was chosen for the ICH removal. A burr hole of 1cm in diameter was made over the location of ICH. Under the microscope, the liquefied blood was evacuated with aspirator and bipolar.

Results: The control CT scan showed successfully evacuated haematomas in all operated patients. Various degrees of neurological disability was observed as a result of bleeding. Of 10 patients, 3 died within a week after surgery because of fulminant oedema, recurrent bleeding and pneumonia, respectively. In 7 patients, the outcome was favourable. The GCS varied from 9 to 15 after the discontinuation of the sedation. On the discharge, the outcome was favourable in 4 patients and 3 remained in a long-term care.

Conclusions: In case of patient with numerous risk factors and imminent operation, minimally invasive surgery for intracerebral haematoma is warranted and represents a safe and efficient treatment option even though the coagulation cannot be normalised.

Keywords: Intracerebral haematoma, minimally invasive technique, oedema
Register-based research of intracerebral haemorrhage in Denmark: Possibilities and challenges

Stine Munk Hald¹, Rustam Al Shahi Salman², Hanne Christensen³, Luis Alberto García Rodríguez⁴, Jesper Hallas⁵, Sören Möller⁶, Anton Pottegård⁵, David Gaist¹

¹Department of Clinical Research, University of Southern Denmark, Odense, Denmark; Department of Neurology, Odense University Hospital, Odense, Denmark
²Centre for Clinical Brain Sciences, University of Edinburgh, Edinburgh, United Kingdom
³University of Copenhagen, Copenhagen, Denmark; Department of Neurology, Bispebjerg Hospital, Copenhagen, Denmark
⁴Spanish Centre of Pharmacoepidemiology, CEIFE, Madrid, Spain
⁵Clinical Pharmacology and Pharmacy, University of Southern Denmark, Odense, Denmark
⁶Odense Patient data Explorative Network (OPEN), Odense University Hospital, Odense, Denmark

Denmark (population 5.7 million) provides a unique setting for epidemiological research with focus on intracerebral haemorrhage (ICH). In Denmark, cases suspected of stroke are treated as medical emergencies, and there is easy access to medical evaluation, including brain imaging. Healthcare is tax-based, free of charge and independent of income, and the majority of medicines are substantially subsidized by the state. Information on Danish citizens’ health (e.g., hospitalisations, blood test results, and use of medicines), income, education, and a plethora of other data is prospectively collected at the level of the individual in several nationwide medical and administrative registries. Furthermore, a number of nationwide clinical databases have been established in Denmark with the purpose to monitor and improve the quality of care, e.g., the Danish Stroke Registry. A permanent and unique civil registration number allotted to all residents of the country is recorded in the registries and databases and this enables simple and correct retrieval and linkage of data. Authorised researchers can be provided remote access to predefined data sets, retrieved from the nationwide registries, and held at secure environments provided by Statistics Denmark or the National Health Data Board. Such data sets can be enriched with external data, e.g., from clinical databases. Conversely, a number of registries can provide data to researchers that include information on the civil registration number and enable, e.g., retrieval of medical records and brain scan results in ICH. Similar options are also available to researchers at a regional level, where a large number of registries hosted by local authorities and research groups exist. The Danish setting provides the possibility to perform studies based entirely on cross-linkage of registries, or studies more rich in clinical detail, where register-based information is combined with “ad hoc” collected data. We will present key registries and illustrate opportunities and potential challenges of research based on these data sources by outlining two ongoing studies of drug-related ICH.

Keywords: Intracerebral haemorrhage, Register-based research, Danish registries, Epidemiology
One purpose for us of doing clinical trials is to help solving the problems that blocked clinical works, as well as revealing the myths that confused us. We notice that it is necessary and urgent to find out the solutions of the issue of blood pressure reduction in acute ICH. A team of experts in the fields of neurology, neurosurgery, hypertension, cardiovascular disease, epidemiology and clinical trials neurologists discussing what we would like to find out and how it could help the clinic work. A check list of what to do will be necessary and significant. A draft protocol, the content and a signature page with discussing and revising for several times, is the basement of the research. The study need to be registered. Documents will be submitted to the ethics committee of the general coordinating agency. Researchers meeting will be held, to recruit hospitals/sites. Cooperation agreement will be signed between the head unit and each site. Insurances need to be purchased for each site. Each participating site declares the ethical approval at the hospital. One kick-off meeting is held for every sub-center. The CRA works on the documents, The PI and CRA may answer the questions by the researchers in the meeting. The CRA completes the start-up report. After patients being included, CRA visits each site at least once a month, checking if the data of the patients has been entered correctly on time. The imaging information should be uploaded within one week. Feedbacks and corrections must be made timely. A conventional visit and a research progress report will be necessary for each site every three months. An intervention training visit needs to be paid to each site, checking out of 10% of the CRF and every SAE form. The SAE should be reported to the ethics committee every 6 months. Data safety management board checks the data every half a year, reporting to the ethic committee. All subject files need to be checked, and queries reports submitted to the ethics committee before sites closing.

**Keywords:** organize; multi-sites; clinical trails
SO-074
A New Risk Factor for lung infection in spontaneous intracerebral heamorrhage patients

Xiaoyu Wang, Wei Chen, Jing Chen
Department of Neurosurgery, West China hospital, Sichuan University, Chengdu, China

Background and Purpose—Air pollution is known to be associated with cardiovascular disease, but little is known about the occurrence of lung infection in spontaneous intracerebral heamorrhage patients. We investigated the association between lung infection in spontaneous intracerebral heamorrhage patients and air pollution over a 7-year period (January 2011 through December 2018) in Chengdu, China. Methods—A generalized additive model was used to regress daily lung infection counts for each air pollutant, controlling for time trends, day of the week, and meteorological influences such as temperature, relative humidity, and atmospheric pressure. Results—There were 3838 spontaneous intracerebral heamorrhage patients in our study and 1129 patients had lung infection. The effects of air pollutants on lung infection in spontaneous intracerebral heamorrhage patients were statistically significant. We observed estimated relative risks of 1.03 (95% CI, 1.00 to 1.06) and 1.04 (95% CI, 1.01 to 1.08) for lung infection for each interquartile range increase in total suspended particulates and sulfur dioxide concentrations on the same day. Conclusions—We find that air pollutants are significantly associated with lung infection in spontaneous intracerebral heamorrhage patients. These findings have public health implications for lung infection prevention in spontaneous intracerebral heamorrhage.

Keywords: Air pollution, lung infection, spontaneous intracerebral heamorrhage
SO-077
Safety indicators in patients with subarachnoid hemorrhage and its relationship with results of medical attention

Francisco Rafael Revilla Pacheco, Tenoch Herrada Pineda, Pamela Rodriguez Salgado, Arantxa Anton Alonso

Department of Neurosurgery, ABC Medical Center, Campus Observatorio, Mexico City, Mexico.

Objective: To determine the association that exists between the appearance of adverse events called Patient Safety Indicators, length of stay (measured as days of hospital stay), and Neurological Status at discharge (measured with the Glasgow Outcome Scale), in two groups of patients: a control group of 35 patients selected through a simple randomization process, with a diagnosis of subarachnoid hemorrhage in whom the appearance of Patient Safety Indicators was registered and an experimental group of 35 patients with subarachnoid hemorrhage in whom a quality process in Health Care was applied to prevent the emergence of Patient Safety Indicators.

Background: In-hospital complications are reported between 3 and 22% of patients admitted to a hospital. It is considered that 50% of the complications attributable to the medical care process are preventable, and that preventing or avoiding them can reduce morbidity and improve treatment outcomes. The Agency for Healthcare Research and Quality (AHRQ) has defined as Patient Safety indicators (ISP) a group of measurements that evaluate the appearance of adverse events likely to occur in patients as a result of their exposure to health care systems.

Design/Methods: The design of the study uses a randomized clinical trial methodology, design of non-equivalent groups only-post test, comparative study of two variables, which analyzes and studies the differences in two groups of patients with aneurysmal subarachnoid hemorrhage.

Results: In group 1, more than two thirds were received in grade II and III of Hunt and Hess scale, and the majority were treated surgically (69%). 80% of the patients had a score of 4 and 5 on the Glasgow Outcome Scale. They were hospitalized on average 28.6 days, and the presence of any of the Patient Safety Indicators was recorded in 57 occasions, in 23 patients; 12 patients (34.3%) did not present any event. In group 2, 80% of the patients had a score of 4 and 5 on the Glasgow Outcome Scale. They were hospitalized on average 20.6 days, and the presence of any of the Patient Safety Indicators was recorded 25 times, in 10 patients; 25 patients (71.4%) did not present any event.

Conclusions: This study has confirmed Patient Safety Indicators are events that can influence the outcome of medical care and are preventable. Its prevention, under specific medical conditions, can be part of the planned goals that contribute to improving the quality of medical care.

Keywords: Glasgow Outcome Scale, Intracranial aneurysm, Patient Safety Indicator, Subarachnoid Hemorrhage.
Immediate reversal of anticoagulation effect of dabigatran in hemorrhagic stroke

Krisztian Pozsegovits

Dr. Kenessey Albert Hospital, Balassagyarmat, Hungary

Introduction—Intracranial hemorrhage (ICH) is the most devastating complication of oral anticoagulation (OAC). Most frequent type of ICH is the basal ganglia hemorrhage, hematoma expansion happens in more than 50% within 3-6 hours. Dabigatran has a specific antidote, idarucizumab which is available in bolus and it has fast mechanism of action. In everyday practice the effect of dabigatran can be detected with the measurement of activated partial thromboplastin time (APTT) and thrombin time (TT), but international normalized ratio (INR) is not informative. Dabigatran has a half life of 13 hours.

Methods—We present a patient who was on dabigatran and suffered basal ganglia hemorrhage. The size of the hematoma was small and we could revert the effect of dabigatran promptly.

The case—Our patient was a 67-year-old man with a history of atrial fibrillation. He cancelled his medicine intake before, including acenocumarol. Later he was given full dose dabigatran (2x150 mg daily). He was admitted to the ER 60 minutes after stroke symptom onset. On arrival he had blurred speech, right-sided flaccid hemiplegia. Brain CT imaging revealed 1 cubic centimeter-sized hemorrhage in the left internal capsule. Blood test verified normal values except coagulogram, we verified actual dabigatran intake as both APTT and TT values were elevated while INR remained normal. Last OAC intake was 7 hours before onset. Patient was given 5 grammes of idarucizumab 120 minutes after onset. Two hours and 12,5 hours later his coagulogram was normal. Hematoma volume was unchanged on follow-up CT images. Symptoms improved with rehabilitation, patient could walk with aid, mRS was 3 point at 3 month.

Conclusion—Our patient suffered hemorrhagic stroke under verified full dose dabigatran treatment. Hematoma expansion and fatal outcome was at considerable risk. Immediately after idarucizumab treatment the patient’s coagulogram normalized fully, follow-up imaging did not show hematoma expansion. There was no complication of the idarucizumab treatment. With the prompt use of the specific antidote catastrophic outcome could be prevented.

Keywords: stroke, hemorrhage, anticoagulation, antidote
SO-079
Primary intracerebral haematoma evacuation through external ventricular drainage

Tomaz Velnar
University medical centre Ljubljana, Department of neurosurgery

Introduction: Spontaneous intracerebral hemorrhage is one of the most devastating types of stroke. Besides blood pressure reduction and intensive medical and surgical treatment, immediate coagulopathy reversal is vital. On the other hand, the haemostatic disturbances may occasionally contribute to improve the recovery.

Patient description: A 64-year old lady was admitted due to headache, nausea and progressive left sided arm and leg weakness. The international normalised ratio (INR) and protrombine time (PT) were lowered, 2.08 and 0.3 respectively. The platelet count was reduced to 57 and the platelet function tests were entirely disturbed. Computed tomography (CT) showed an ICH with haematocephalus and developing brain shift due to cerebral oedema. The CT angiography was negative, classifying the haematoma as a primary one.

As a result of rapid consciousness decline, urgent intubation was necessary. The coagulopathy was corrected. Control haemostasis test were even worse. This prevented surgical method of haematoma treatment. The EVD and ICP probe were insertion. Liquefied blood and CSF, which were under pressure, were evacuated. The ICP values, initially 35mmHg, have fallen to 10mmHg and remained normal during the course of treatment. The control CT scan showed evacuated haematoma and normal ventricles with residual haematocephalus. In clinical status, a moderate left sided haemiparesis persisted, the GCS was rated at 12.

Conclusions: The outcomes of spontaneous intracerebral haematomas are usually poor. Especially with the newer anticoagulant agents, the treatment is aggravated, as there is no effective antidote. In these cases, minimally invasive evacuation of haematoma is warranted.

Keywords: intracerebral haematoma, ventricular drainage, haematoma evacuation
SO-082
Neurological Impact of Renal Stenosis

Lina Carazo Barrios¹, Blanca Sánchez Mesa², Alejandro Gallardo Tur¹, Carlos De La Cruz Cosme¹

¹Department of Neurology. Hospital Clinico Universitaria Virgen de la Victoria, Málaga, Spain
²Department of Internal Medicine. Hospital Costa del Sol. Marbella, Spain

47 year old woman, ex-smoker since 6 years 54 packs / year, high blood pressure (hypertension) diagnosed six weeks ago and treated with enalapril 10 mg every 24 hours. No family history of hypertension or cerebrovascular disease are known. She went to emergency room for sudden weakness in right hemibody, language disorder and headache. Her blood pressure (BP) was 180/100 mmHg and she was afebrile. General and neurological examination showed confusion and motor aphasia, right central facial paralysis, right hemiparesis (3/5 in the Medical Research Council scale), and hemisensory loss, right Babinski’s reflex. National Institutes of Health Stroke Scale (NIHSS) score at presentation was 11. Cardiorespiratory auscultation and abdominal examination were normal. Supplementary test showed brain hematoma on the computer tomography (CT) in the left underlying lymph with intraventricular haemorrhage, perilesional edema and minimal midline deviation. It was necessary to administer several types of antihypertensive drugs to control BP. Different combinations of antihypertensive drugs at high doses in the early days (mannitol, labetalol, urapidil, amlodipine, captopril and nitroglycerin) with partial control of the PA in the next administration of the drug and subsequent elevations next few hours were administered after decreasing effect. Nitroglycerin was introduced after, being removed by hypotension. Mannitol was administered initially, decreasing the dose until his retirement in the early days. Propofol sedation and endotracheal intubation twice the persistence of hypertensive crisis said. At 10 days after admission he presented clinical and BP control, although with occasional tension elevations improvement. At 15 days, oral medication losartan, carvedilol and amlodipine-started high BP observed on days 15, 17 and 19 despite clinical and neurological stability needs of rescue medication (captopril). Secondary hypertension was suspected because of the difficulty controlling BP, recent diagnosis with hypertension and severe organ damage. Cortisol, catecholamines and metanephrines in 24 hour urine were normal. Doppler ultrasound and CT angiography showed a critical proximal right renal artery stenosis without fibromuscular dysplasia. A stent was placed by right renal angioplasty procedure. BP improved in the following weeks. The stenting procedure was done because of the difficulty controlling BP. Currently, renal arterial stenosis angioplasty is still under discussion. Hypertension is one of the most common causes of intracranial hemorrhage in essential and secondary hypertension. This case shows the neurological impact of a vasculo-renal pathology.

Keywords: Intracranial hemorrhage; secondary hypertension; renal stenosis
SO-083
Intracerebral hemorrhage in very elderly patients: medical and ethical aspects

Baltateanu Doru, Sandu Catalin

Department of Neurosurgery, S.U.U. Elias, Bucharest, Romania

According to statistics on life expectancy and life duration in developed countries, the percentage of people over 80 years of age is steadily increasing. This situation generates problems that require active medical and social involvement for the patients suffering sudden acute brain events that complicate pre-existing medical conditions.

In this paper, we try to review the particularities of intracerebral hemorrhage in patients over 80 years presenting our experience, taking into account the associated pathology, the chronic treatments imposed by it, the individual living conditions, the diagnosis modalities and the medical and ethical aspects of medical staff attitude after diagnosis.

A standardized conduct is difficult to be established in such situations, but developing medical guidelines would lead to the adoption of medical and social principles to facilitate decision-making in such cases.

Keywords: Very old patients, intracerebral hemorrhage, medical and ethical aspects
SO-085
Epidemiology and risk factor profile of Primary intracerebral hemorrhage in sea coast population of South India- an observational study

Sangamithra Gandra, Sampath Kumar Ns

Department of Neurology, Narayana medical college and hospital, Nellore, AP, India

Stroke is categorized into two major subtypes i.e., ischemic and hemorrhagic and is one of the major causes of morbidity and mortality worldwide. Primary intracerebral hemorrhage (ICH), i.e. spontaneous extravasation of blood into the brain parenchyma, sudden in onset and is a medical catastrophe. The incidence of ICH varies geographically, ranging from 10 to 15/100,000 persons per year. The incidence is highest in Asians (120 per 100 000 persons in Japan), intermediate in blacks (17.5 per 100 000 persons for blacks) and lowest in whites (13.5 per 100 000 persons for whites) respectively.

Aim of the Study
1) To Study the Clinical presentation of Primary Intracerebral hemorrhage (PICH).
2) To Study the Aetiology & Risk factors of PICH.

Materials and Methods
The present study was done at Narayana medical college, Nellore for a period of 1 year 6 months from January 2016 to June 2017. The current study is a prospective, observational, hospital based study and approved by the Institutional Ethical committee. The study was done on the patients attending Neurology OPD, Emergency and patients admitted in Neurology Department. Sample size: A total of 100 patients who fulfilled the inclusion and exclusion criteria are included in the present study.

Inclusion Criteria: Patients who presented with primary intracerebral hemorrhage
Exclusion Criteria:
1. Head injury, antecedent trauma(subdural hematoma/epidural hematoma/brain contusion)
2. Space occupying lesions,
3. Vascular malformation
4. Sub Arachnoid Hemorrhage,
5. Cerebral Venous Thrombosis,
7. Coagulation abnormalities.

Observation and Results SUPRATENTORIAL ICH
Age: The age group of the present study population in supratentorial ICH group (88 patients) was divided into 4 age groups (<40, 40-59, 60-79 and ≥80 years). Majority of the patients [n=40 (45%)] are in between the age range of 60-79 years. (Table 1). The mean age of the total study population was 59.06±1.29.
Sex: Out of 88 patients 53 (60.22%) were male and 35 (39.77%) were female (Table 1).

Risk factors: The most common risk factor in the current study for supratentorial ICH was hypertension(HTN) which was seen in 81(92%) patients. Among which 20 patients had admission BP>200/100. Table 1.

INFRATENTORIAL ICH
12 patients out of 100 patients had infratentorial hemorrhage.
Age: The age group of the present study population in infratentorial ICH group (12 patients) was divided into 4 age groups (<40, 40-59, 60-79 and ≥80 years). Majority of the patients [n=6 (50%)] are in between the age range of 60-79 years. (Table 2). The mean age of the total study population(12) was 64±1.39 years.
Sex: Out of 12 patients 8 (66.66%) were male and 4 (33.33%) were female (Table 2).

Risk factors: The most common risk factor in the current study for infratentorial ICH was hypertension (HTN) which was seen in 12(100%) patients. Table 2.

Keywords: intracerebral hemorrhage, stroke, risk factors, hypertension, diabetes, dyslipidemia.
Industry Satellite Symposia
PORTOLA Satellite Symposium

ADDRESSING THE CHALLENGE OF FACTOR XA INHIBITOR-RELATED CRITICAL BLEEDING

20th May, 2019 13:45-14:45
Chairs: Pr. David Werring (London, UK) & Pr. Marc Maegele (Cologne, Germany)

13:45-14:01 DOAC-related Major Bleeding – Pivotal Clinical Trials/ Registries Informing ICH Management Needs.
Pr. Marc Maegele (Cologne, Germany)

14:01-14:17 Novel Target FXa Inhibitor Antidote Therapeutic Options – Lessons from Phase-3 and ANNEXA-4
Dr Mauricio Concha (Sarasota, FL, USA)

14:17-14:33 Case-Based Learning: Review of Challenging Patient Presentations
Pr. Saskia Middeldorp (Amsterdam, NL)

14:33-14:45 Q&A Roundtable / Concluding Remarks

PENUMBRA - Artemis Device Symposium

NEW PERSPECTIVES: MINIMALLY INVASIVE HEMATOMA EVACUATION

20th May, 2019 18:40-19:50
Moderator: Dr. Jesús Lafuente, Hospital del Mar Barcelona, Spain

18:40-19:10 The Rationale behind the Minimally Invasive Evacuation
Prof. Karin Klijn, Radboud UMC, Nijmegen, Netherlands

19:10-19:40 What Does the Surgical Evacuation with the Artemis Device Offer?
Dr. Nils Hecht, Charité Universitätsmedizin, Berlin

19:40-19:50 Questions and Answers
Company Profile
Company Profile

BAXTER

Address: Avenida de Castilla 2 Madrid
Phone: +34 91 678 9300
E-mail: pablo_martin_granados@baxter.com
Web: https://www.baxter.es/es
Contact person: Martin Granados, Pablo

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DAIICHI SANKYO SPAIN

Address: Acanto 22 I Madrid, 28045
Phone: (+34) 91 539 99 11
E-mail: info@daiichi-sankyo.es
Web: www.daiichi-sankyo.es/
Contact person: Jorge Muñoz

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- **Adres**: 250 E. 96th Street, Suite 125
- **Telefon**: 317-660-7118
- **E-mail**: info@niconeuro.com
- **Web**: www.niconeuro.com
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- **Adres**: Am Borsigplatz 44, 13507 Berlin
- **Telefon**: +49(0)30-20056760
- **Fax**: +49(0)30-69088045
- **E-mail**: acornil@penumbrainc.com
- **Web**: https://www.penumbrainc.com
- **Yetkili kişi**: Mr. Alain CORNIL

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- **Adres**: 270 E Grand Ave South San Francisco CA 94080
- **Telefon**: 650 246 7000
- **E-mail**: mbeard@portola.com
- **Web**: www.portola.com

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