METHODS

**SDC 1**. MultiModality Monitoring in University of Pennsylvania NeuroICU patients.

Many figures are provided from the UPenn neuroICU database to provide clinical examples of many of the ICP subsets presented in the text. These data were collected with approval of the biomedical review board of the University of Pennsylvania (Protocol # 819681 and Protocol # 831352). There were specific methods for the multimodality monitoring and the optical neurometabolic brain monitoring which was employed in these patients. These methods follow:

Invasive multimodality monitoring 1 employed brain tissue partial pressure of O2 monitors (*PbO2* ;Licox, Integra LifeSciences, Plainsboro, NJ, USA), intracranial pressure (*ICP* ; Camino, Integra LifeSciences), thermodilution cerebral blood flow (*TDF* *CBF*; Bowman Perfusion Monitor, Hemedex)*,* and cerebral microdialysis (M Dialysis Inc, North Chelmsford, MA, USA). Regional monitors were inserted into the frontal lobe white matter via a quad-lumen bolt (Hemedex, Cambridge, MA, USA) placed above Kocher’s point.

Noninvasive CBF measurements were made using diffuse correlation spectroscopy (DCS).2, 3 The optical sensor was secured on the scalp over the frontal cortex area on the same hemisphere as the bolt, if also used for concurrent invasive neurophysiologic monitors. Full details can be found in a recent publication by Busch eta.l4

1. Sinha S, Hudgins E, Schuster J, et al. Unraveling the complexities of invasive multimodality neuromonitoring. *Neurosurgical Focus* 2017;43: E4.

2. Yodh AG, Greenberg JG, Yu G, et al. Optical Measurement of Tissue Blood Flow, Hemodynamics and Oxygenation, ,, . In: Office USP, ed. United States, 2011.

3. Durduran T, Yodh AG. Diffuse correlation spectroscopy for non-invasive, micro-vascular cerebral blood flow measurement. *NeuroImage* 2014;85: 51-63.

4. Busch DR, Balu R, Baker WB, et al. Detection of Brain Hypoxia Based on Noninvasive Optical Monitoring of Cerebral Blood Flow with Diffuse Correlation Spectroscopy. *Neurocritical Care* 2018.