Continuous Assessment of Cerebral Blood Flow Autoregulation Following Aneurysmal Subarachnoid Hemorrhage: An Important Variable that is Now Clinically Accessible

Mark Krasberg PhD; Brittany Mead BSc; Bobby Sena; Suguna Pappu MD; Kim Olin; Edwin Nemoto PhD; Martina Stippler MD; Marc Malkoff; Howard Yonas MD

UNM SCHOOL of MEDICINE

Introduction

Access to information about the integrity of autoregulation should be relevant to directing the care of patients following aneurysmal subarachnoid hemorrhage (SAH), especially if they are suspected of having delayed neurological deficits. By integrating continuous data streams such as cerebral blood flow (CBF) and mean arterial pressure we have gained access to potentially useful autoregulation information.

Methods

Aneurysmal SAH patients are candidates for the placement of a Hummingbird Monitoring system (Innerspace Medical) that in addition to tissue and ventricular ICP measurements provide access to thermal diffusion CBF (Hemedex) placed within the adjacent deep white matter. All data including continuous blood pressure measurements are acquired via the Component Neuromonitoring System (CNS) (Moberg Technologies). The fusion of data streams is an essential step that then permits advanced analysis of data.

Results

The thermal diffusion probe provides reliable access to high frequency quantitative CBF changes. Continuous recording of CBF data in excess of 10 days has been possible in many patients. In patients with good outcomes, mean CBF has not fluctuated with either subtle or dramatic changes of mean blood pressure. The most severely injured patients have demonstrated changes in CBF that correlate exactly with instantaneous changes of blood pressure indicating a loss of autoregulation.

Conclusions

Direct access to continuous thermal diffusion CBF information is a powerful clinical tool especially when integrated with other vital measurements such as mean blood pressure. Integrating these measurements makes information about the integrity of autoregulation readily accessible. Our experience demonstrates that cerebral autoregulation is not static and that patients may gain or lose control of this relationship following an aneurysm. With access to this continuously monitored information new strategies for altering patient management to improve outcome should become apparent...

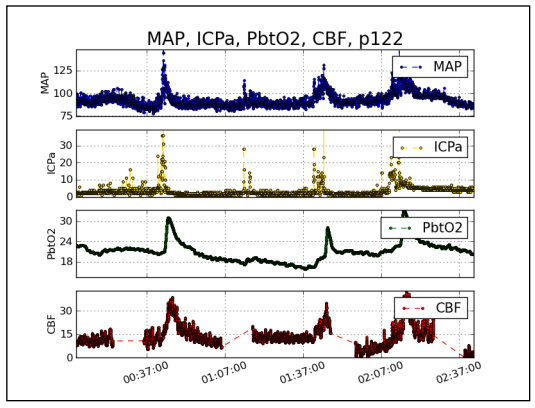


Fig. 1 Multimodal data stream illustraton of patient exhibiting loss of autoregulation

Fig 2. Changes in Mean Arterial Pressure (MAP) precede changes in Cerebral Blood Flow (CBF).

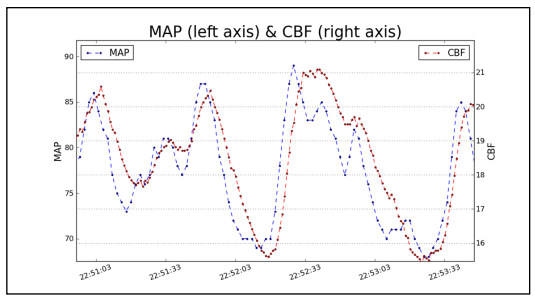
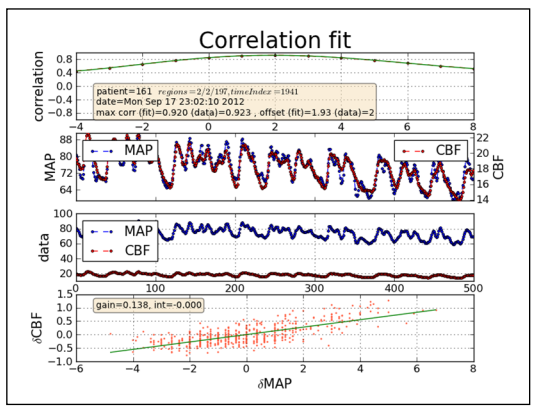


Fig 3. Phase Shift is determined by detrmining the offset where the correlation between the curves is maximized



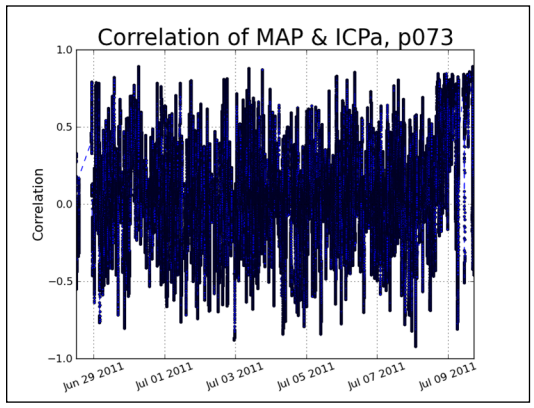


Fig 4. MAP vs. ICPa correlation curve over a period of 2 weeks. the corrleation factor (a high corelation indicates loss of autoregulation) can be seen increasing at the far right.

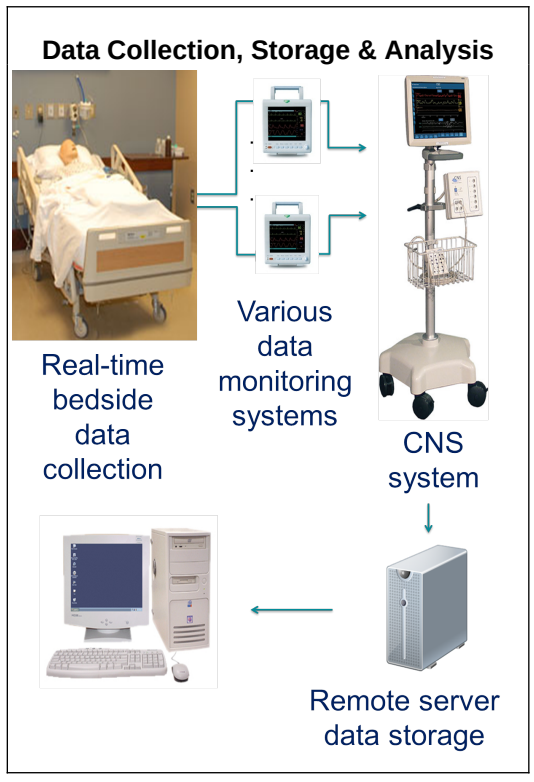


Fig 5. Same patient/timeline as in figure 4.MAP Vs CBF correlation curve indicates that patient lost and then regained MAP/CBF autoregulation over the first few days of the patients's stay, something which would not have been recognized using the variables in Fig 4.

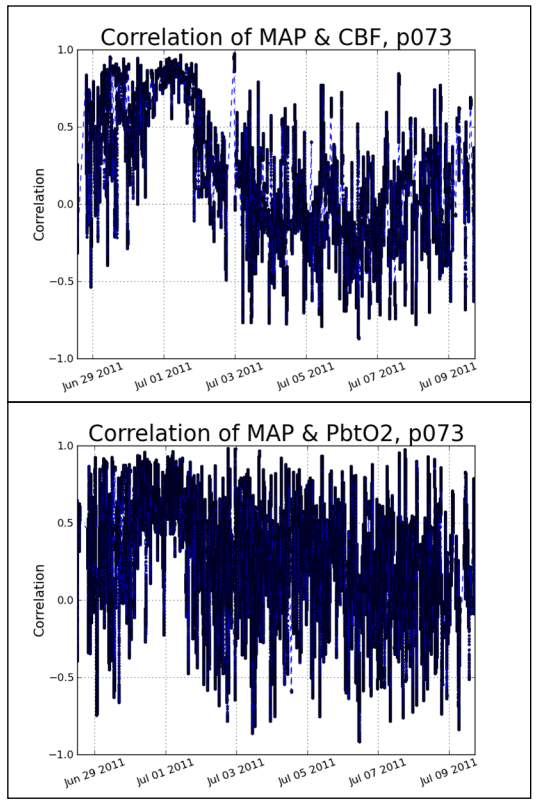


Fig 6. Same Patient/timeline as fig 4&5: although the feature is not as sharp, the MAP vs PbtO2 correlation curve indicats a similar autoregulation loss-then-regain pattern to what can be discerned from the MAP vs CBF correlations curve.