Neuroscience and Anaesthesia – Current and Future trends

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It is a fascinating time for neuroscience, with novel therapeutic techniques and good physiological and clinical research improving our understanding of the complexity of the human CNS.

Interventional stroke therapy (IST) has become a treatment standard in many centre's and yet controversy remains regarding clinical outcomes and the role of anaesthesia in managing stroke patients. Initial studies suggested inferior outcomes for stroke patients requiring general anaesthesia for clot retrieval in the neuroradiology suite compared to sedation only. Davis et al. (1), in a retrospective series, reported worse modified Rankin score at 3 months in GA patients (fig 1) but also reported significantly lower systolic blood pressures during treatment in the same group. This accorded with earlier work (Fig 2) from Leonardi-Bee (2) suggesting that optimal survival rates post-stroke correlated with a systolic BP of 140 -180mmHg. Further work is ongoing – RCT's on IST and anaesthesia vs. sedation for IST are in progress.

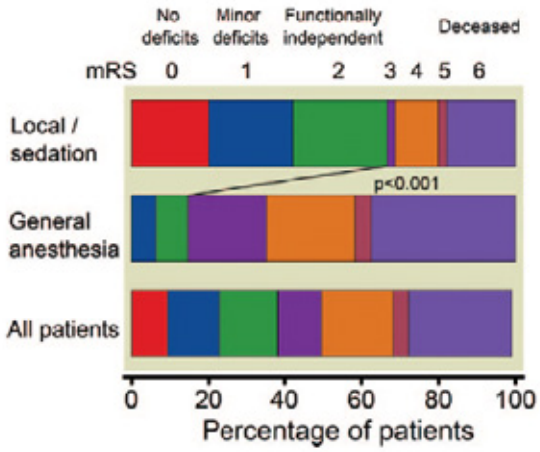

Fig. 1

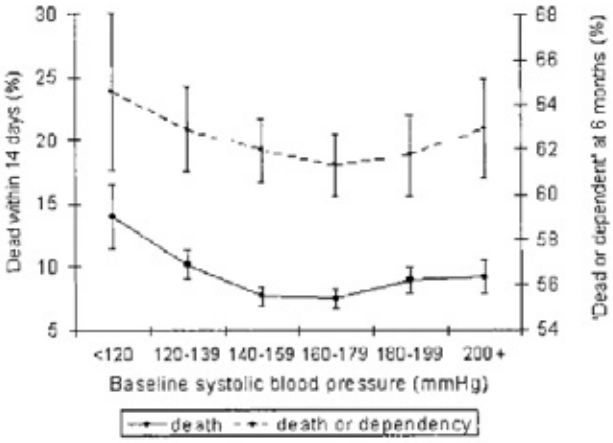

Fig. 2

Covert stroke after surgery and anaesthesia is now recognised as a potential cause of poor recovery, post-operative cognitive decline (POCD), depression, dementia and ongoing disability. The Framingham Heart Study (3) has estimated the covert stroke rate in the general population to be 12.3% (CI 10.9 – 13.8%), rising to nearly 40% after carotid stent procedures (4) and it is recognised that the covert stroke rate is many times higher than the published overt prerioperative stroke rate of 0.2 - 4.3%.

The NeuroVISION pilot study (n=70) found a 11.4% covert stroke rate post-surgery and the multi-centre prospective cohort study resulting from this finding is now underway. Patients >65 years having non-cardiac surgery will receive a diffusion weighted brain MRI between days 3 and 9 postoperatively. Primary outcomes are the impact of covert stroke on neurocognitive function at 1 year and a Montreal Cognitive Assessment Tool decrease of > 2 points.

Two related research topics have potential to alter our practice with regard to covert stroke. The first is a revision of the physiology of autoregulation of cerebral blood flow. Willie et al. (5) have produced a comprehensive review of the topic and the key messages from this review are that CBF autoregulation (CA) occurs over a much narrower range that was thought hitherto (Fig 3, new model on the right); there is important synergism and interdependence between CA and $PaCO_2$ / PAO_2 responsiveness; that the regulatory response is not solely at the micro-arterial level and that neurogenic control of CA is important. These are all important messages for anaesthetists.

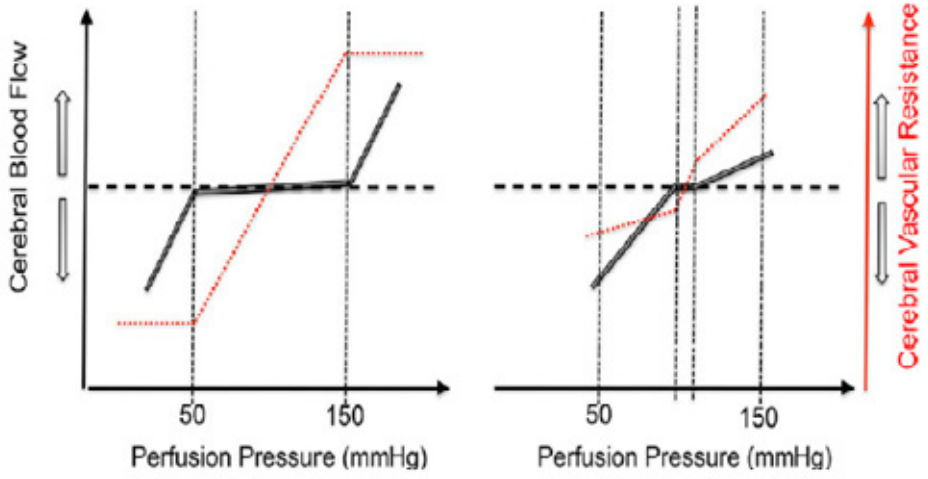

Fig. 3

Other work has backed up these assertions with clinical examples. Papers from Joshi et al. (6), Ono et al. (7) and Brady et al. (8) have demonstrated, using trans-cranial Doppler (TCD) and near infra-red spectroscopy (NIRS) techniques, that the lower limit for CA varies widely in patients undergoing cardiac surgery. Values for lower CA threshold ranged from MAP of 45mmHg to as high as 80-90 mmHg and indeed in some patients, there was no evidence of CA at any MAP value; that is their circulation was entirely pressure–passive. Figure 4 demonstrates a single patient trace with a lower CA threshold of 80mmHg MAP.

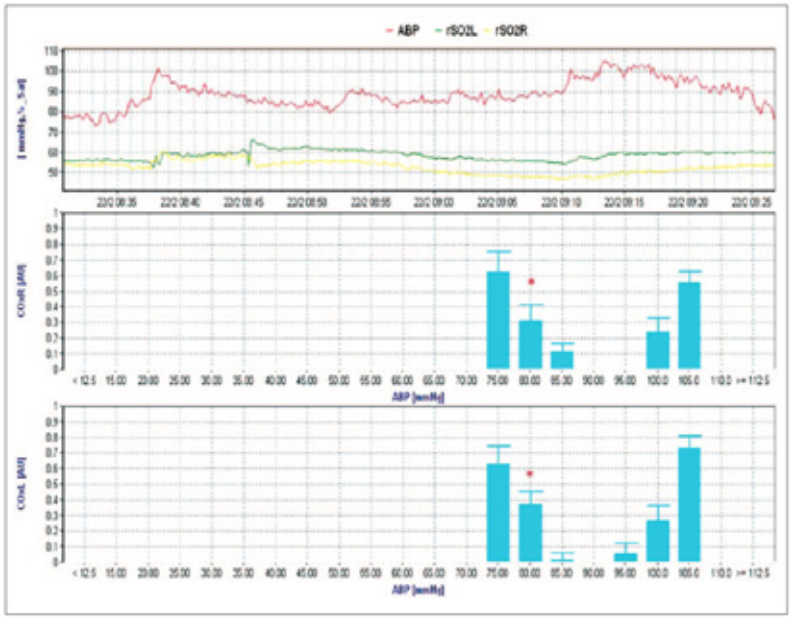

Fig. 4

A fascinating paper by Purkayastha et al. (9) looked at the association of impaired cerebrovascular haemodynamics and the development of white matter hyper-intensities that may represent covert stroke and found that changes in TCD pulsatility index may be a predictor of white matter damage, a potentially important tool for clinicians.

The second topic of interest is that of neuro-inflammation. It is now apparent that this process is a response to injury in the CNS, that it may be very long-lasting and that it may be a powerful cause of cognitive decline and dementia. The role and influence of glial cells, particularly M1 and M2 – type microglia (fig. 5) and astrocytes has been well elucidated in a review by Cherry et al. (10) and Johnson et al (11) have demonstrated that inflammation and white matter degeneration persist for many years after traumatic brain injury (TBI) in up to one third of patients, with striking histological evidence of corpus callosum volume loss (fig. 6 post TBI patients panels A,C,E, aged matched controls B,D,F).

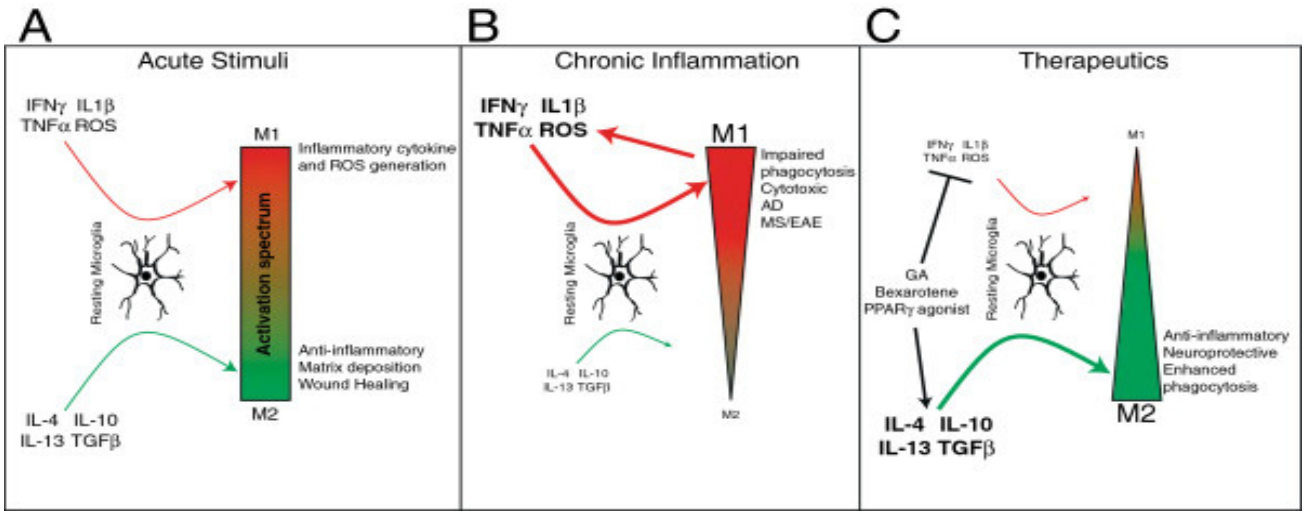

Fig. 5

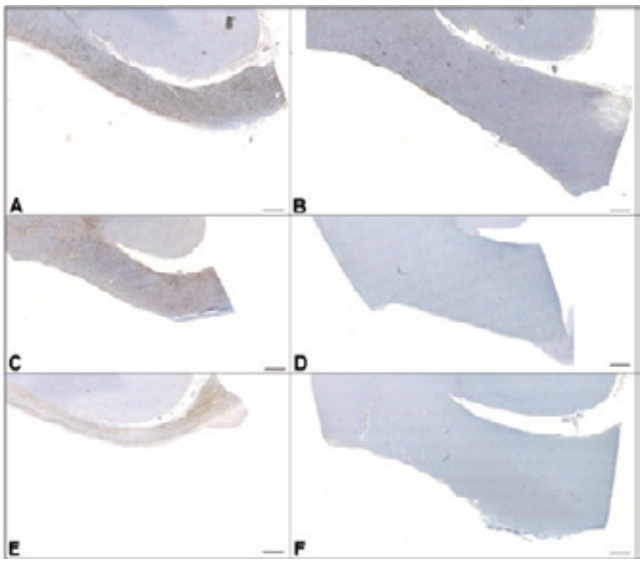

Fig. 6

Iliff et al. (12), in a fascinating paper, reviewed the evidence for a cerebral lymphatic system (the Glymphatic pathway, fig. 7) and its potential contribution to the blood brain barrier, recovery from (TBI) and development of chronic inflammation, cognitive dysfunction and dementia.

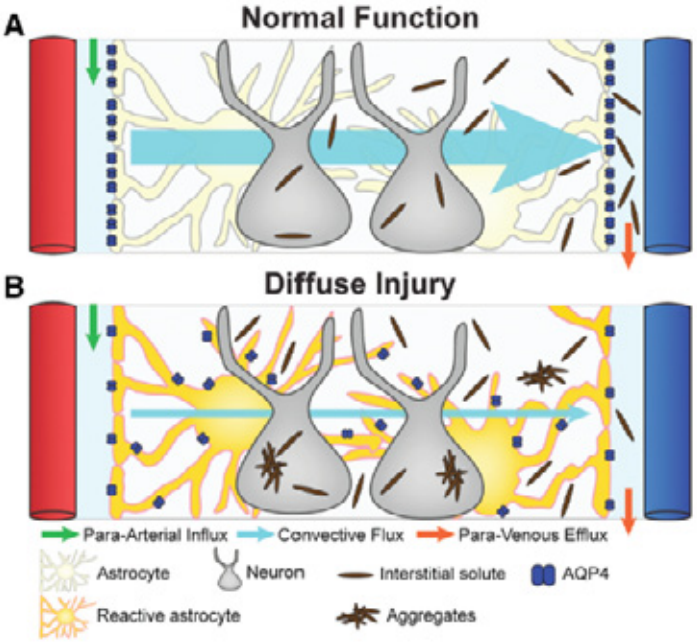

Fig. 7

Finally, anaesthetists are regularly exposed to significant levels of radiation in the neurointerventional suite (fig.8) and Anastasian at al. (13) have produced a nice review of these risks with compelling data.

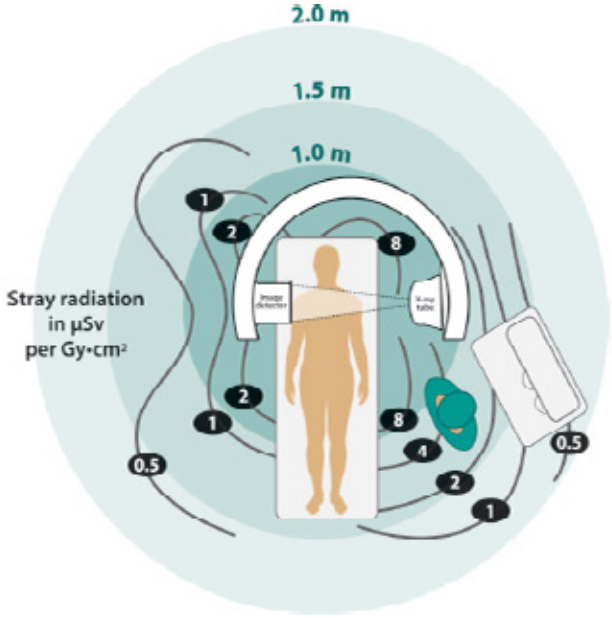

Fig. 8

References:

1. Davis et al., Anesthesiology 2012; 116: 396-405
2. Leonardi-Bee et al., Stroke 2002; 33: 1315 – 1320
3. Framingham Heart Study. Neurobiol. Aging 2005; 26(4): 491 -510
4. Schnaudigel et al., Stroke 2008; 39(6) : 1911 -1919
5. Willie et al. , J. Physiol. 2014; 592.5: 841-859
6. Joshi et al., Anesth. Analg. 2012; 114(3):
7. Ono et al., Crit. Care Med. 2013; 41 : 464-471
8. Brady et al., Stroke 2010; 41: 1951 -1956
9. Purkayastha et al., J. Cereb. Blood Flow Met. 2014; 34: 228 -234
10. Cherry et al., J. NeuroInflamm. 2014; 11: 98
11. Johnson et al. Brain 2013; 136: 28-42
12. Iliff et al., Stroke 2013;44 (suppl 1): S93 – S95
13. Anastasian et al., Anesthesiology 2011; 114: 512 -20