How Much Hypotension Matters? Cognitive Dysfunction after Cardiac Surgery in Four Patients without Stroke.

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Introduction

Cognitive dysfunction after major surgery is a common entity, with far-reaching social and familial ramifications. It is regarded by patients and surgeons as an unavoidable and unpredictable hazard of surgery. Cardiopulmonary bypass is a state of 'controlled shock' and entails a high risk of cognitive dysfunction. Although formal neuropsychometric testing is not performed before or after surgery, cognitive dysfunction after cardiac surgery is occasionally overt, and leads to the suspicion of an acute cerebrovascular event. The correlation between haemodynamic change and overt cognitive dysfunction was examined in 4 patients over a 2 year period.

Methods

Over a 2 year period, 85 patients had continuous haemodynamic monitoring from the preinduction period until discharge from ICU. Data was collected for all patients at 1 minute intervals throughout surgery, and at 10 minute intervals for the duration of their ICU stay. All data was plotted using a series of 2D graphs (CO vs SVR, SV vs HR, SV vs riVR) All patients undergoing open heart surgery were studied, and the relationship between haemodynamic status and neurological function examined.

What is a low blood pressure?

Until there is a physiologically grounded consensus on pathological low blood pressure, establishing the relationship between pressure and microcirculatory perfusion and organ function(including cognitive dysfunction) is doomed to futility. Unpublished data on 280 elderly patients presenting for elective major surgery reveals a 'systemic pressure gradient'(i.e.MAP-CVP) >80 mm Hg in 96%. By contrast, anaesthesia and intensive care in the elderly typically accepts a systemic pressure gradient of 53-55mm Hg. The Rivers' study on sepsis defined successful resuscitation as a MAP of 65mm Hg, and CVP 10-12mm Hg. Physiology texts define the 'closing pressure' of the micro-circulation as 30 mm Hg. If the closing pressure is a gradient of 30mm Hg, and if the gradient in health is 80-120mm Hg, then a gradient of 55mm Hg (30+25) represents a loss of 50-73% of the pressure gradient above the closing pressure. Vasculopathic subjects are likely to have a closing pressure above 30mm Hg.

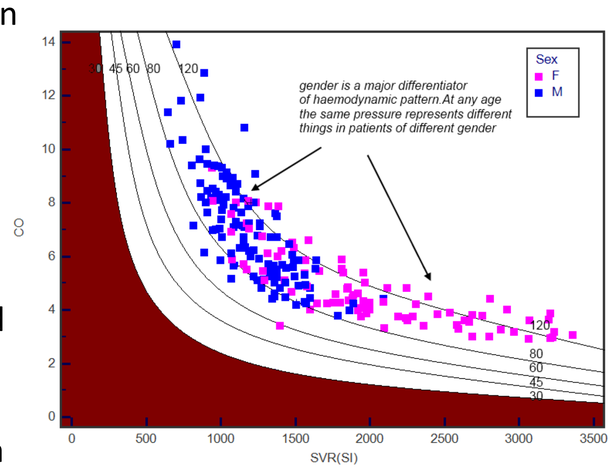

Fig.1. Resting CO,SVR and SPP (MAP-CVP) in >250 elderly patients presenting for elective major surgery.

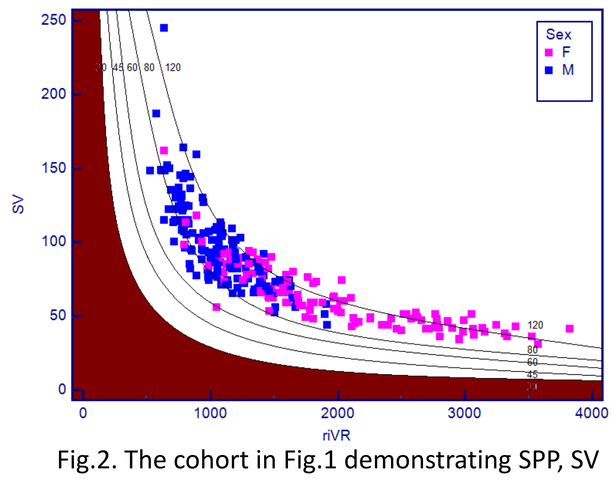

Fig.2. The cohort in Fig.1 demonstrating SPP, SV and riVR/elastance. Note the effect of gender!

*riVR: textbooks that follow Guyton analyze the performance of the heart and circulation using the formula: MAP-CVP=CO x SVR; this gives SVR the units Pt/V, implying that resistance is a time dependent variable. The better equation is MAP-CVP = SV x riVR, where riVR is 'rate-independent' vascular resistance, since riVR has the units P/V and represents arterial elastance.

Results

Over a 2 year period, 4 patients were identified with overt cognitive dysfunction in the postoperative period following open heart surgery. 4/85 patients manifested overt cognitive dysfunction without evidence of a stroke: 2 had nominal aphasia, one had a global confusional state and short term memory loss, and one had delirium lasting weeks. All 4 patients had normal-for-age CT brain scans, and all had resolution of symptoms before discharge. 3 of 4 patients demonstrating overt cognitive dysfunction had prolonged periods of hypotension during surgery, defined as a systemic perfusion gradient (MAP-CVP) less than 60mm Hg. The fourth patient had sustained relative hypotension in the postoperation period. None of the 81 patients without overt cognitive dysfunction had prolonged periods of low systemic perfusion pressure, apart from the period of extracorporeal perfusion. The causes of sustained hypotension differed in each of the four cases (sepsis, rapid AF, surgeon request to control aortic root blood pressure, postoperative vasodilation)

Conclusions

5% of patient in this cohort demonstrated overt cognitive dysfunction which appeared to correlate with a sustained fall in systemic perfusion pressure. CT scans post-operation excluded a CVA, and in each case the symptoms resolved before discharge. It is likely that relatively short periods of hypotension during anaesthesia cause overt cognitive dysfunction, some of which is likely to be irreversible.

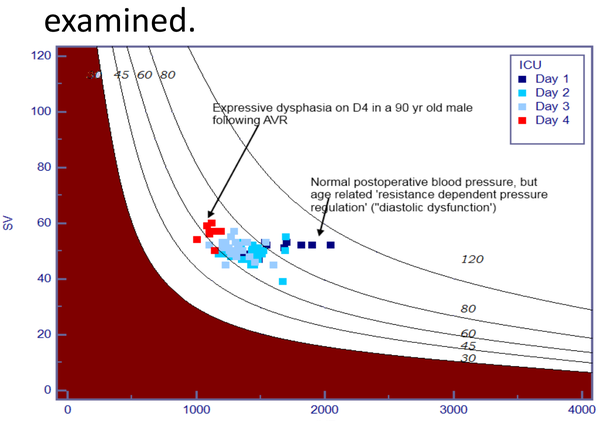

Figure 3. CASE 1: 90 yr male, EF20%,severe AS,post AVR. Postop. Pressure loss at fixed CO, with expressive dysphasia developing on D4.

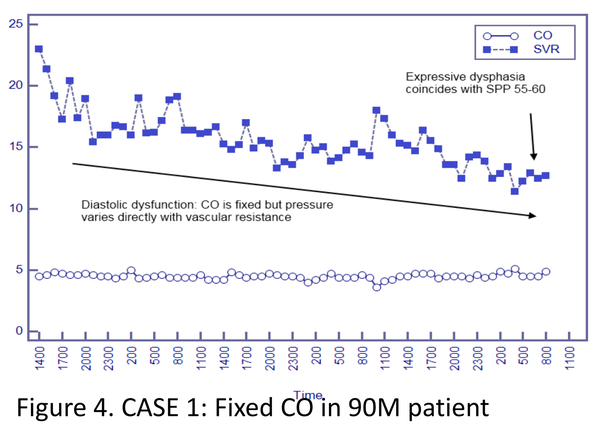

Figure 4. CASE 1: Fixed CO in 90M patient postAVR. Resistance (+pressure) falls steadily for 4 days,then recovers

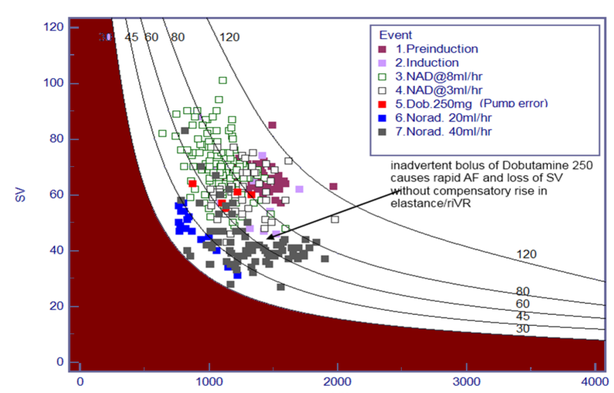

Figure 5.CASE 2: 86M OPCAG, showing SPP of 30-60 mm Hg following inadvertent bolus of dobutamine and onset of AF.

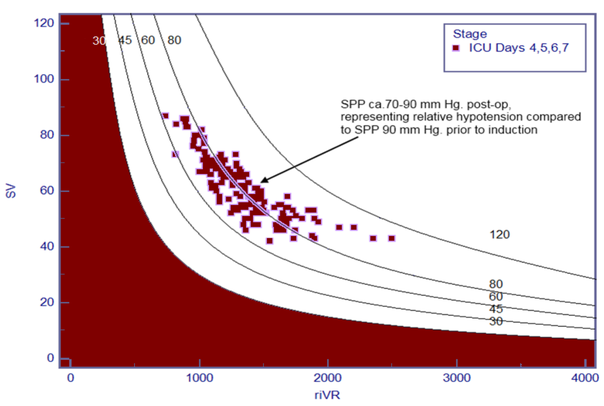

Figure 6. CASE 2: 86M,SPP maintained at 70-90mm Hg postoperation.

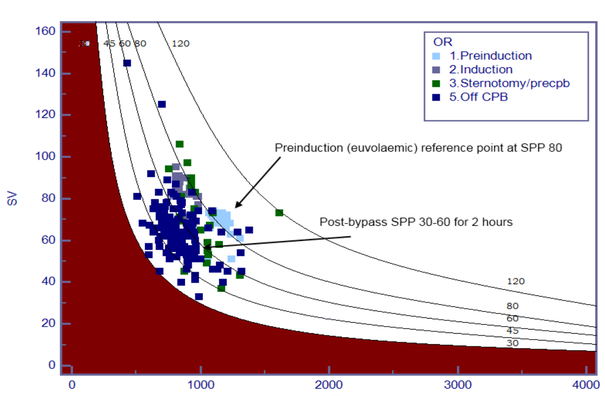

Figure 7. CASE 3: 75M,severe AS,AVR. Postbypass, bleeding of aortic root led to surgeon request to keep pressure low. SPP 30-60 >2 hours.

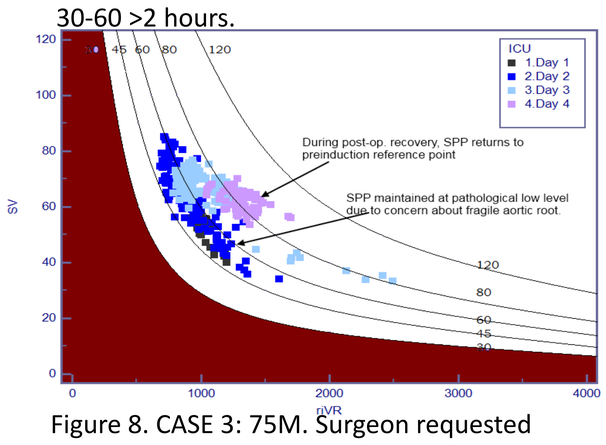

Figure 8. CASE 3: 75M. Surgeon requested sedation and systolic BP no higher than 100 mm Hgpost-op. On Day 4,SPP returns to preinduction level.

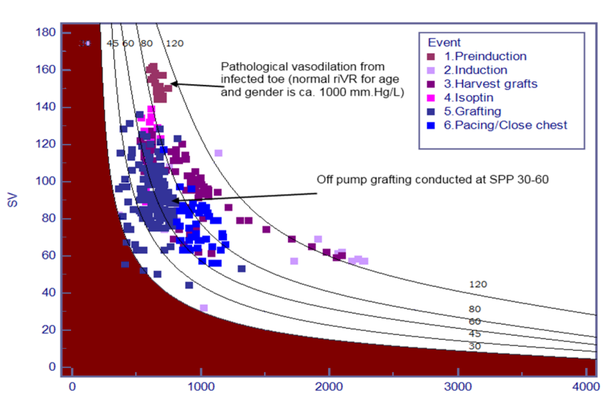

Figure 9. CASE 4:SV fall during surgery leading to sustained low SPP for 2 hours.

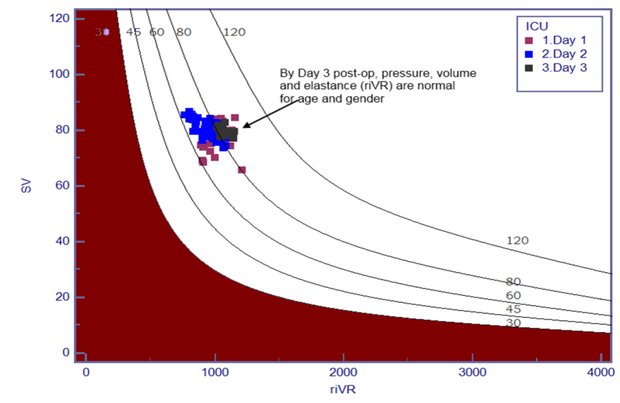

Figure 10. CASE 4: 84M OPCAG. Normal SPP for age and gender post-operation.