Haemodynamic Response to Change in Fluid Status in and Experimental Rats - Case Study

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Case Study

Haemodynamic Response To Change In Fluid Status In An Experimental Rat

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Introduction:

An improved understanding of physiology and pathophysiology in animals and humans can be acquired by studying animal models. Cardiac Output (CO) is a core physiologic observation and essential to most animal studies, if only to confirm that an intervention or therapy is not cardiopressive. Currently, as in humans, most animal CO studies involve an invasive thermodilution method or an inaccurate alternative. USCOM is an accurate noninvasive CW Doppler which both increases sensitivity to haemodynamic change and is ethically more desirable. USCOM has been used in humans, dogs, sheep, pigs (large and small), but not previously in rats as heart rates are often above 300bpm.

Presentation:

1 rat was examined as part of an IRB approved study to evaluate therapy in burns. USCOM was used to evaluate haemodynamics and determine the feasibility of USCOM measurment of high HR circulation.

Observations:

Baseline rat weight: 455gms

Protocol

1. Baseline post anaesthesia (n=10)
2. Post insertion of tracheal tube and invasive lines (n=5)
3. Pre-burn (n=10)
4. 1 minute post burn (n=10)
5. 5 minutes post burn. Hypovolemia from fluid shift, and low BP (n=11)
6. 0.6ml of fluid infused (n=10)
7. I minute post fluid infusion (n=43)
8. SV Variability study (n=5)
9. Post fluid CO measures (n=10)

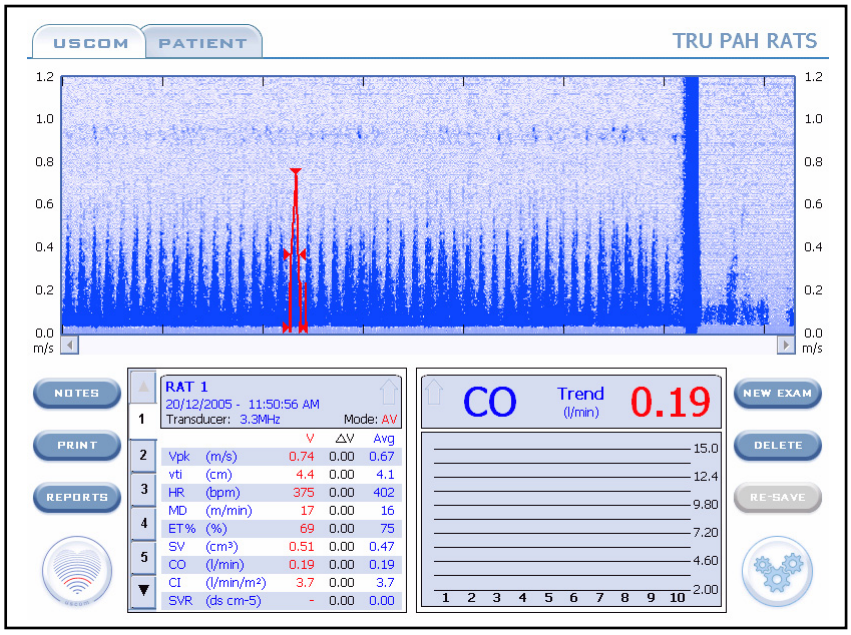

Figure 1 USCOM screen during rat study demonstrating an average HR of 402bpm

USCOM values:

1. Baseline post anaesthesia (n=10)
   SV=0.62±0.05mls HR=329±26 CO=0.21±0.02l/min
2. Post insertion of tracheal tube and invasive lines (n=5)
   SV=0.62±0.05mls HR=358±23 CO=0.22±0.02l/min
3. Pre-burn (n=10)
   SV=0.62±0.12mls HR=339±31 CO=0.21±0.03l/min
4. 1 minute post burn (n=10)
   SV=0.47±0.03mls HR=402±30 CO=0.19±0.02l/min
5. 5 minutes post burn. Hypovolemia from fluid shift, low BP, (n=11)
   SV=0.45±0.07mls HR=357±27 CO=0.16±0.03l/min
6. 0.6ml of fluid infused (n=10)
   SV=0.59±0.11mls HR=343±38 CO=0.20±0.02l/min
7. 1 minute post fluid infusion (n=43)
   SV=0.63±0.13mls HR=375±36 CO=0.23±0.05l/min
8. SV Variability study (n=5)
   SV=0.72±0.07mls HR=358±18 CO=0.26±0.02l/min
9. Post fluid CO measures (n=10)
   SV=0.69±0.13mls HR=356±47 CO=0.24±0.04l/min
10. Total Observations (n=114)
    SV=0.60±0.13mls

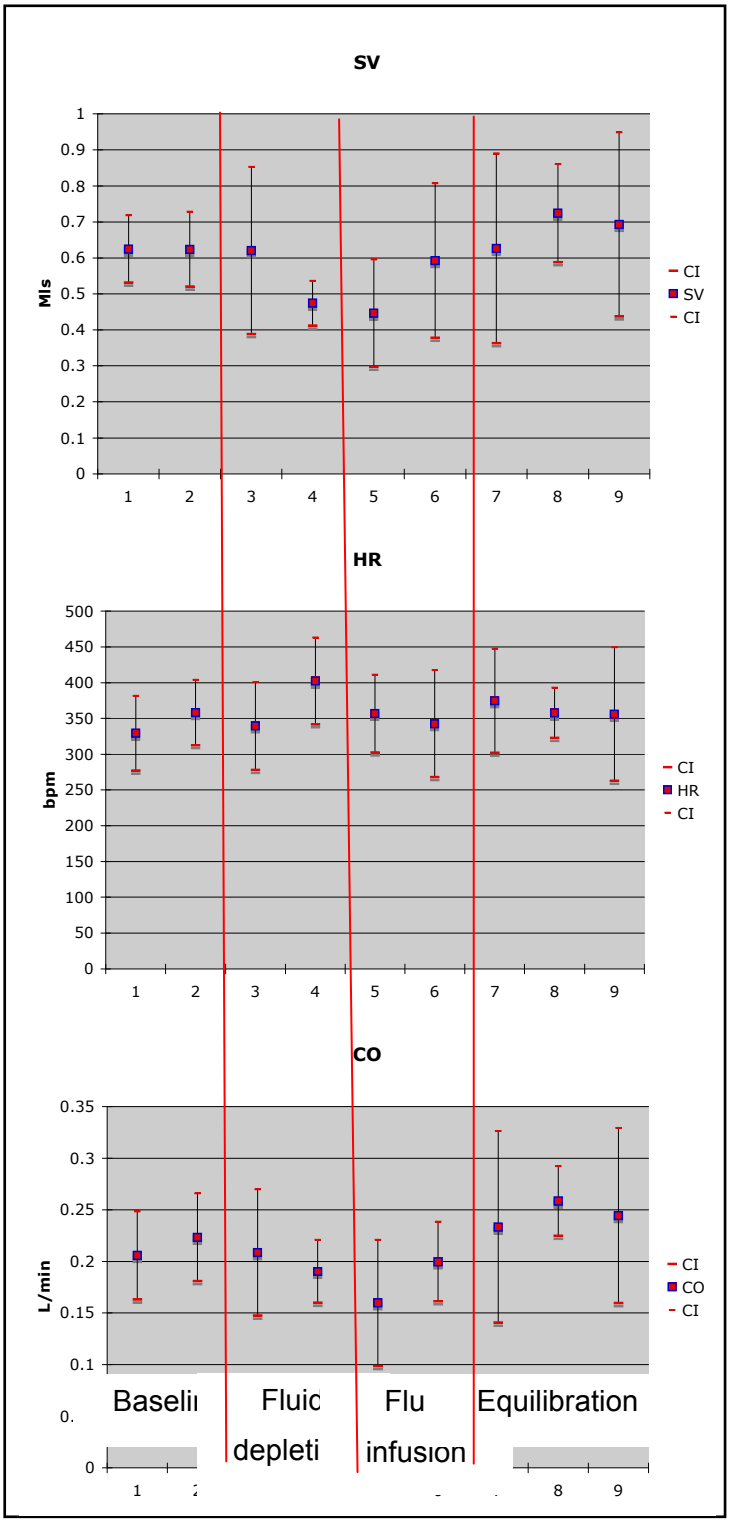

Figure 2 SV, HR and CO with CIs at each intervention over full time course

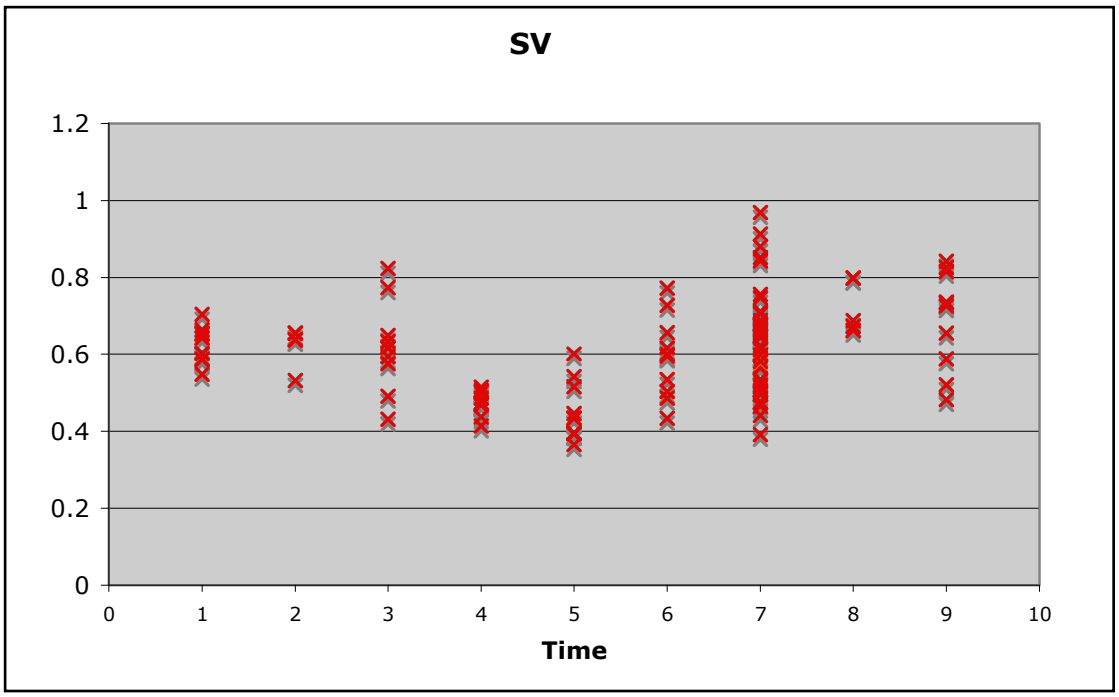

Figure 3 Scatterplot of all SV measures over full time course

	r	p	n
HR vs SV	-0.346	0.000	114
HR vs CO	0.165	0.080	114
SV vs CO	0.863	0.000	114

Table 1 Correlation of HR with SV and CO, demonstrating HR is a poor correlate of CO and SV

Observations:

HR is not a good surrogate of SV or CO.

SV rose with fluid infusion from 0.63cm^3 to 0.72cm^3 (14%) and then fell during equilibration to 0.69cm^3 (10%).

SV changes associated with fluid depletion and infusion were detected using USCOM. Haemodynamic measurements were feasible at HRs up to 461bpm.

Conclusion:

Measurement of cardiac performance in a rat was feasible using USCOM at heart rates up to 461bpm.

USCOM measured anticipated SV, HR and CO changes associated with induced hypovolemia and fluid therapy.

Beat to beat haemodynamics provides unique physiologic insights.

References:

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2. Lester A Critchley, Zhi Y Peng, Benny S Fok, Jules Flach, Simon C Wong, Anna Lee, Robert A Phillips. Testing the reliability of a new Ultrasonic Cardiac Output Monitor, the USCOM, using aortic flow probes in anaesthetized dogs. Anesth Analg 2005;100:748-53