

2025 Hyper/ hypo perfusion - tubing kink

Permission to print: Yes

Category hypo / hyper perfusion

Severity Good Catch No Harm Incident

Duration of incident: minutes

Procedure acuity: Emergent

Description: Patient presentation: 60 Year Male; 172 cm; 73 Kg; 4.46 L/min @ 2.4 L/min m². Presented urgent Type A dissection with the false lumen extending into the right innominate and right carotid artery, moderate AR and normal LV function. Baseline conscious INVOS rO₂ 60% (L) & 54% (R) with oxygen mask in situ. Cardiopulmonary componentry: Stockert S5 Heart-Lung Machine, LivaNova BMV 1900 softshell venous reservoir bag, SRT ½"ID, roller pump, with Fusion Balance coated oxygenator BB811 and D733 40 U arterial filter. Circuit coated with phosphorylcholine. 2000 mL Crystalloid/ Albumex prime and full heparinisation. Routine full pre bypass checklists completed. Operation sequence: After a median sternotomy, the right axillary artery was directly cannulated with an 18 F cannula; venous drainage via central cavoatrial cannulation. 30,000 IU heparin; ACT >600 secs. Commencing cardiopulmonary bypass. 1) When going on CPB, due to the involvement of the brachiocephalic anatomy, care was taken to go on partially and progressively whereby haemodynamic parameters, arterial line pressures, cerebral oximetry, blood flow on TOE were confirmed before committing to full bypass. This proceeded as expected. 2) However, on full CPB it was noted that the SvO₂ fell to 40%, the patient became hypotensive with vasopressors increased. rO₂ declined to 47/52% (L/R). 3) A large venous return volume was noted despite full flow & knowledge that the pump occlusion had been calibrated 4) Oxygenator outlet/ arterial line appeared visually oxygenated. Venous blood not obviously deoxygenated. 5) Urgent ABGs sent off; gas flow to oxygenator confirmed with bobbin test; further confirmation of blender function with capnography. 6) When requested to fill the heart for coronary sinus then left ventricular vent insertion, patient became hypertensive. 7) Anatomical shunts discussed but not noted on TOE and considered unlikely. 8) Consideration of coming off CPB to reassess situation as perhaps oxygenator failure or malperfusion due to extensive dissection; however, surgeon wished to proceed in light of pathology. 9) ABGs satisfactory: pO₂ 600 mmHg; pCO₂ 28 mmHg 10) Mixed venous gases confirmed to exclude mal calibration of the Medtronic Biotrend. 11) Left radial gases confirmed satisfactory. 12) The clinical picture presented as an open shunt scenario as if the recirculation line was not occluded. All potential circuitry shunts were carefully examined and excluded. 13) Applied the flow probe from unused CP5 on heart-lung machine to oxygenator outlet. Flows measured at 50% dialed roller pump flow but a shunt was not the explanation. 14) Close inspection of pump boot showed that in its inflow segment from the outlet of the venous reservoir to the roller pump there was a partial kink directly below (distal to) the bubble sensor. The bubble sensor was positioned proximal to the kink and thus would be unlikely to pick up cavitation [no cavitation bubbles were observed] 15) Full flows were confirmed by the flow probe upon unkinking the tubing. Normal haemodynamic parameters resumed, cerebral oximetry rose, SvO₂ normalised, vasopressors could be reduced. 16) The duration of impaired flows was approximately 13 minutes at 35 °C nasopharyngeal. 17) The operation continued uneventfully: Proximal aorta anastomosis with aortic valve resuspension. Open distal hemiarch anastomosis at 22 °C during 20 minutes of circulatory arrest; antegrade cerebral perfusion not performed due to desire not to clamp dissected innominate artery. Total

bypass time 186 minutes. Postoperative: Intubated for 18 hours. In ICU for 7 Days.
Discharged Day 12 - alert and settled, independent with his ADLs

GOOD CATCH - what went well Every potential source of the failure was progressively investigated until the cause was identified. Note that many of these investigations were occurring rapidly, at the same time over a relatively brief period. Furthermore, the extent of the dissection and urgency of the procedure were further confounders to the scenario.

What could we do better The fault identified the partial hidden kink was at its most inconspicuous. If it had been more occluded, the pump boot may have become more distorted and thence observed, if less it may have passed unnoticed. It is important to reinforce that the selected roller pump flow is a calculated parameter only and may not reflect the actual flow being delivered to the patient.

Preventive actions Our unit was in the process of transitioning away from a circuit that had been used for over a decade but was no longer available. We had been using the replacement circuit over dozens of patients for several months. A new circuit, with its subtle differences in length, layout, softness/hardness, components etc reinforces that the acquired knowledge, even subconscious, of being intimately familiar with a historical circuit should not be underestimated. How the new circuit may behave when subjected to a myriad of variables may not be predictable. Hence the transition strategy had been to use the new circuit for simpler routine case before its introduction for complex scenarios. However, at some stage its use in all cases was inevitable whereby all its foibles would become exposed and needed to be. Consequently, there is a learning curve for all users with the knowledge gained to be shared amongst the team. Accordingly, adjustment of pump boot tubing length and its proximity to the reservoir bag are factors for us to consider in the next phase of further tubing modifications. However, [we don't have CDI 550 or Spectrum or B-Capta – only a BioTrend monitoring venous saturations] aside from the circuitry issues, the modern heart-lung machine should provide the perfusionist with both an arterial line flow probe and blood saturation sensor to confirm delivery of oxygenated blood at expected flow immediately upon commencing cardiopulmonary bypass. Such a requirement should be considered as a standard of care.

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| Type of incident: | Management |
| Timing of incident: | CPBhypothermic |
| Discussed with team: | Yes |
| Hospital incident filed | No |
| Ext Authority Advised | No |
| Knowledge issue | No |
| Protocol issue | No |
| Rule issue | Yes |
| Skill issue | No |
| Team Issue | No |
| Violation | No |
| Patient outcome variance | Nil |



Commentary This detailed report of a circuit issue (kinked tubing to pump inflow) during complex emergent aortic dissection that manifested as hypoperfusion is an exemplar of logical and thorough problem solving to find a very subtle root cause. The report has important lessons for all perfusionists - importantly "It is important to reinforce that the selected roller pump flow is a calculated parameter only and may not reflect the actual flow

being delivered to the patient.” The temptation to accept digital measures on the HLM as gospel truths is a trap of modern technology. PIRS has only had one similar report from 2019 where an arterial line flow probe was in use that facilitated discovery - however a minor kink pre pump is not easily identifiable. PIRS2 Eds