2024 Air in circuit

Permission to print:	Yes
Category	Air in circuit
Category 2	Communication
Severity	Good Catch No Harm Incident
Description:	78 year old. female 162 cm 50 kg BSA 1.63M2 predicted flows 3.9 LPM for re-do sternotomy , prior MVR 2023 now re-do MVR and Tricuspid Annuloplasty ring with HLM, Inspire 6 oxygenator with external paediatric line filter (D734 max rated flow 5 LPM). Patient was low on volume CVP 5 pre CPB, Hb 97 g/dL. Operative date May,2024. On CPB uneventfully, aortic (22 EOPA cannula) bicaval venous cannulation # 24x 28 FR metal tip cannula. RAP of arterial line done approx. 250mL fluid off. Normal CPB for 8 minutes. ABG Hb at 2 minutes on CPB (67 g/dL), then level alarm stopped pump, volume added 100mL automatic restart of pump. (Level set at just below 200 mL mark on reservoir). Over the next 60 seconds the level alarm sounded 4 additional times, volumes of 100 mL added each time automatically resetting the pump each time. At the one minute mark of start of event (event level alarm 10:27:57 to 10:29:00) Bubble alarm (set at medium) sounded at 10:29:15 no air seen in arterial line inlet into filter nor at the bubble alarm prior to filter inlet. Blood colour change appeared a bit lighter but attributed to addition of crystalloid solution of 500 mL over prior minute. The level alarm sounded one more time at 10:29:00 (final time during case) and reset itself. The bubble alarm sounded an additional 5 times during the period 10:29:26 and 10:31:07, again no visible air noted in the circuit. The perfusionist looked into the top of the arterial line filter and noted microair bubbles around the internal housing. The arterial line post filter was immediately clamped as the arterial pump was turned off and venous line clamped and the surgeon was simultaneously informed of air in the arterial line and filter by the perfusionist and that we were off CPB until filter could be deaired. The time was 10:31:07 Patient nasopharyngeal temp was 33.9 C art and venous blood temps 33.2C and 33.6C. The surgeon had initially responded that he had not seen any air in the patient arterial/aortic line. The perfusionist opened the recirculation line and arterial filter shunt line and deaired the filter, tapping on it and inverting it over the next 3 minutes until he was satisfied the filter and filter bypass lines were deaired. At the same time the surgeon noted that the venous line had deprimed. The surgeon cut the line and re-primed with fluid. Simultaneously the anaesthesiologist administered one litre of fluid as the patient was empty, heart beating but no output, internal cardiac massage was performed by the registrar and the NIRS dropped from mid 40's to 15. The surgeon informed the perfusionist that he had be replacing a snare on the SVC cannula when air became entrained in the venous line depriming it. The arterial filter remained clamped post filter and CPB was recommenced via the arterial filter bypass line and the perfusionist continued to deair filter via shunt line. The perfusionist announced that he would come off CPB one more time to deair microbubbles post filter which had been clamped off once off CPB initially. Arterial and venous lines clamped the CPB machine was stopped for 25 seconds to deair post filter via the recirculation line. CPB was restarted , the NIRS recovered to the 70's within the next minutes. The aorta was clamped, cardioplegia delivered and the operation was undertaken in the normal fashion with an MVR and Tricuspid Annuloplasty. The patient was weaned off CPB uneventfully, was extubated at midnight that night and awoke the following morning with no adverse neurological event suffered. The patient was discharged home. Conclusion of event: Due to the level alarm stopping the arterial pump 5 (five) times in one minute probably resulted in gas being drawn across the membrane fibres (gas flow was 2.5LPM) due to abnormal negative pressures caused by the frequent stopping and starting of the arterial pump over a very short time frame. Micro emboli mixed with blood and set off the bubble alarm , then became trapped in arterial line

	filter. The venous reservoir never became empty since the level alarm shut down the pump. The level alarm was never over-ridden during the case. The oxygenator purge line was opened for a couple of seconds later during the case and in a 5mm space fluid was seen mixed with approximately 20 tiny bubbles. The evidence confirms that microair was present in the membrane, not a massive air embolism as seen with a complete reservoir emptying
What could we do bette	Improved, more rapid and earlier communication during the event between the perfusionist and surgeon as discussed by both at the debrief.
Preventive actions	The surgeon and perfusionist discussed the incident in depth and suggested increased communication early on such as declaring to the surgeon that there was a problem. Setting the level alarm at a higher level , now being set at just below 300mL. Post debrief with surgeon and perfusionist was held . Post debrief with perfusionist and cardiac anaesthesiologist was held. Post debrief on weekly Cardiac Surgery MDM was held with consultant cardiac surgeons, cardiac anaesthesiologists as well as several registrars and interns and the perfusionist involved in the incident The line of vision of the venous line and reservoir on the left hand side against the OR table is suboptimal for viewing by the perfusionist as the alarm and computer system of the S5 is on the far right side, thus field of vision is not a constant straight line. Discussion around future redesign of system was also discussed.
Type of incident:	Management
Duration of incident:	minutes
Hospital incident filed	Yes
Ext Authority Advised	No
Discussed with team:	Yes
Team Issue	Yes
Patient outcome variance	Nil
Commentary	This report details micro air in the arterial line, the suspected origin being air drawn across the fibre bundle due to a hammer effect with the repeated pump stop. Van Kaam and colleagues demonstrated this in an invitro model (van Kaam P, Stehouwer M. Sudden pump stop may cause air release in oxygenators, 'The Hammer Effect ': An in vitro evaluation. Perfusion. 2024), however they point out this is unlikely top occur during CPB as “the negative pressure wave will be cancelled out by the compliance of the patients vascular system”. Air entrained across the membrane has been repeatedly reported to PIRS during MUF due to negative circuit pressures. While this incident was judiciously managed avoiding patient harm, the importance of timely clear communication has been identified as an area for improvement. Communication is an underlying factor in many adverse events and precise clear closed loop communication during CPB cannot be overstated. PIRS Ed