

## **Cardiac Shunts and Venting of IV Tubing to Reduce Air Embolism Risk:**

If a patient has a communication of the blood flow between the right and left side of the heart, any entry of intravenous air will pose a risk. Defects can be congenital or acquired. A Patent Foramen Ovale (PFO) or Atrial Septal Defect (ASD) is the most common communication between the right and left atria. A Ventricular Septal Defect is a communication between the right and left ventricle. A patent ductus arteriosus (PDA) is a persistent connection between the aorta and pulmonary artery. Complex congenital cardiac anomalies can include one or more communications, which are usually identified early in life. Patients can have undiagnosed defects identified during critical illness through a bubble study (may be done when patients have unexplained or refractory hypoxemia). Less frequently, defects such as VSD may develop secondary to a myocardial infarction.

Blood that travels through a communication within the heart (or shunt) will flow from the area of high pressure to low pressure. If heart pressures are normal this will usually be from left (oxygenated) to right (deoxygenated). Oxygenated blood will mix with deoxygenated blood on the right, and travel to the lung. This is a non-cyanotic defect.

If the right heart pressure become higher than the left (or the defect is very large or in combination with other defects), blood can flow from right to left. This causes hypoxemia (or a cyanotic defect) as deoxygenated blood is forced directly into the left side, bypassing oxygenation.

Right heart failure increases the risk for right to left heart shunting. Pulmonary hypertension for any cause increases right heart pressures and the risk for shunt reversal (to right to left). ARDS can cause significant pulmonary hypertension, with onset increased in severe disease and disease of prolonged duration.

Transient elevations in right heart or pulmonary artery pressures can cause intermittent shunting with desaturation or cyanosis. Examples of causes for intermittent right to left shunt include coughing, suctioning, breath holding or childbirth. In children with cyanotic cardiac defects, hypoxemia worsens with suckling or crying, whereas, crying will often improve oxygenation if the cyanosis is due to respiratory issues (e.g. pneumonia).

While shunting of deoxygenated blood with hypoxemia is one important problem for patients with an intracardiac shunt, the entry of air into the blood stream poses another.

If air enters the circulation and crosses directly to the left side of the heart, the air can travel to the brain (causing a stroke) or other organs/tissues (infarction). Coughing, suctioning or childbirth places the patient at increased risk. Venting of air bubbles from all IV tubing is extremely important for patients with cardiac communications, particularly when right heart pressures or pulmonary pressures are elevated either continuously or intermittently. Patients with right heart failure, COPD, respiratory infections, mechanical

ventilation or during labour are at highest risk as they may increase their PA pressures with coughing or suctioning.

## **HOW TO FILTER FOR AIR**

An air elimination vent is added to the most distal end of all IV tubing. It should be positioned below the last Y injection port whenever possible. If a Y port is present below the filter, it should be taped and identified as “do not use”.

***Saline flushes should be carried out with a filter.***

Be aware that although infusion pumps are designed to detect air at the onset of the infusion, they do not detect air that enters below the pump.

### **Notify Pharmacy**

We currently do not have an orderable in our EHR to alert pharmacy of the use of filters. Some medication cannot be filtered. When new drugs are ordered and IV filters are in place, review with pharmacy to ensure venting is appropriate.

## **How to Vent Air During Crystalloid Administration (Dextrose, Saline or Lactated Ringers)**

We keep 0.2 micron inline filters in stock. These are the most common filter size available. They can be used for either air or drug particulate filtering (e.g. amiodarone and phenytoin). There are some drugs that do not need as small a filter, but stocking the smallest size eliminates the need to choose).

In the absence of an inline .2 filter, TPN (amino acid) tubing can be used with its built-in filter can be used as an air vent. When running amino acids, TPN tubing will provide both particulate and air venting needs.

If you are warming crystalloid products, they can be administered with a Level 1 fluid warmer with the addition of an L10 gas vent. Propofol cannot be heated.

Change the air vents every 24 hours.

## **How to Vent Lipids and Propofol**

While a 0.2 micron filter can be used to vent air from an infusion of propofol, lipid emulsions will plug the filter frequently and require changing more often.

The standard for Lipid Emulsion therapy (e.g. TPN lipids) is a 1.2 micron filter. We did at one time have 1.2 micron inline filters but are currently having trouble sourcing a product. Our

alternative has been to use lipid emulsion IV sets, but because lipids are now provided in a bag, we only have non-vented sets (vented tubing is needed for a bottle).

The product literature for the L10 gas vent says that it is to be used with the Level 1 warming system only. We are awaiting feedback from the manufacturer to identify the actual size of the L10 gas filter (not provided on packaging), and whether it can be used as a stand-alone filter, or if it can be used on the Level 1 warmer with the temperature turned off (you cannot heat propofol).

***The only options we currently have for propofol are to use a 0.22 micron filter and change more frequently.*** Alternatively, review sedative options to determine options other than propofol (e.g. dexmedetomidine or narcotic only).

Hopefully, we will be able to update this as soon as we can source other products. The L10 gas vent should not be used at present time; unless new information becomes available.

## **Blood Productions Administration**

Blood products require particulate filtering with a 170-280 micron filter. This is provided using blood transfusion tubing (standard set or filter that is built into the Level 1 **Rapid** Infuser).

***BLOOD FILTER TUBING DOES NOT ELIMINATE AIR.***

All RBCs, plasma, platelets and cryoprecipitate require the use of blood filter tubing. Products that have been filtered during manufacturing (e.g., albumin) can be administered with regular IV tubing.

Products that are reconstituted by the Blood Transfusion Lab are generally prefiltered and do not require blood tubing (can be run with regular IV tubing). However, the addition of an air vent may damage the blood products or plug the tubing. We are currently investigating this from a product safety perspective.

## **TWO WAYS TO VENT BLOOD PRODUCTS**

### **Level 1 Fluid Warmer**

For non-urgent blood product administration. Add in the L -10 gas vent to the Level 1 Hotline fluid warmer circuit (HMMS Item #55367). These are kept on the left cart in Bay 1 supply room. The OR and OBCU also carry this product. If you are using this product, let HMMS know to increase the supply.



**Figure 1:** L 10 Gas Vent for use with Level 1 Hotline

**Note:** the L-10 inline vent is identified as containing Latex, however, the latex is only on the outside of the device and does not come in contact with the fluid pathway.

We do not currently have any literature that identifies the size of the filter (presumably it is large enough for blood products, so would not be suitable for drug particulate), or whether it can be used with other IV sets (the manufacturer says it must be used with a Level 1 warmer set). This will be updated when new information becomes available. Currently the L 10 gas vent should only be used for warming of crystalloid solutions and for blood product administration that requires venting of air.

### **Level 1 Fluid Warmer**

The Level 1 rapid infuser has a built in blood filter and air venting.

### **Priming and Care of the Air Vent Filter**

Prime the tubing ***without inverting the filter***. Keep the distal end of the filter pointing down (the air vent is proximal – air needs to rise to escape).

Once the filter is wet, air will no longer be able to enter the patient's site.

Keep the filter at or below the level of the heart.

Change the filters every 24 hours to prevent plugging.

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