PICCs and Venous Air Emboli

Question:

How frequently does an air emboli occur with a peripherally inserted central catheter (PICC)? Since the catheter exits on the arm, is there a risk of air emboli and if so, when does it occur with a PICC?

Answer:

The risk of air emboli from insertion and use of a PICC is lower in some aspects than the risk with other central venous catheter, however it is difficult to quantify that risk. A literature review on Medline does not reveal a report of air embolism associated with a PICC, but the catheter tip inside the thorax carries the inherent risk associated with negative intrathoracic pressure.

Pressure on the outside of the thorax is the same as atmospheric pressure and greater than the negative intrathoracic pressure. During inspiration, the negative pressure inside the chest pulls air into the lungs. This negative pressure is transmitted to the veins and assists with moving blood back to the heart. The superior vena cava and a portion of the innominate vein lying inside the thorax will not collapse while veins outside the thorax can collapse.

An open catheter or vein creates a conduit for the negative intrathoracic pressure to pull air into the veins because of this pressure gradient. Catheters and veins are "opened" during catheter insertion, catheter use and catheter removal and therefore air embolism can occur during these procedures.

The risk of air embolism during subclavian and jugular cannulation is greater because these sites are above the thoracic cavity. The patient is placed in Trendelenburg position, reducing the difference between intra- and extrathoracic pressure. This position increases intravascular pressure because the volume of blood in these veins increases. During steps in the procedure when the vein or catheter is open, the patient is instructed to perform a Valsalva maneuver, which in conjunction with the position reduces the risk of air entering the vein. Cannulation of veins of the extremity does not carry the same risk as venipuncture above the thorax.

Catheters are opened during use to change the tubing or injection cap, if they accidentally become disconnected from the tubing or cap, and when there is a fractured or ruptured catheter. In these situations, the tip of all types of central venous catheters, including PICCs, lies inside the thorax; therefore there is a similar risk of air emboli for all types of catheters regardless of the vein used for insertion.

A tract is formed between the skin and the vein when a catheter is present. This tract is longer when a deep vein is used because there is a greater distance between the skin and the vein entrance. Subclavian puncture would produce a longer subcutaneous tract that

other percutaneous insertion sites. A recent publication documented a near-fatal air embolism due to a fibrin sheath. In this case a 20-year-old man had a 7 Fr central venous catheter inserted via the left subclavian vein dwelling for 7 days. About 30 minutes after removal, he went outside to smoke. Upon taking a long, deep inhalation from the cigarette, he immediately reported sharp substernal chest pain and shortness of breath. A CT angiogram showed a fibrin sheath filled with a column of air extending from the subcutaneous tissue into the subclavian vein to the superior vena cava.1

PICC insertion through deep veins in the upper arm would produce a subcutaneous tract longer than the tracts produced by insertion into a superficial vein. A superficial subcutaneous tissue would close when pressure is applied, but deeper tracts could remain open. Catheters with longer dwell times have a greater risk of leaving the subcutaneous tract upon removal. Tract formation could also be enhanced by steroid use. 2, 3

Small air emboli have also been associated with the presence of short peripheral catheters. After catheter insertion, air has been documented in patients undergoing CT scans. These are usually small air bubbles found in the pulmonary trunk, right atrium and ventricle, brachiocephalic vein and intracranial venous sinuses. 4-6 While these small pockets of air have not produced negative patient outcomes, it is evidence that air does enter the circulation from a peripheral catheter.

The outcome from an air embolism is directly related to the amount of air and the rate at which it enters the vein. Calculated lethal rates of air are 70 to 150 mL per second in humans. The length of a PICC will slow down the rate of air passing into the bloodstream but a PICC does not eliminate the risk.

The risk of air emboli during PICC insertion and use is slightly different than with other central venous catheters. There is the possibility of air emboli when the hub is opened for tubing or cap changes and when the catheter is removed. Standard nursing procedures to reduce the risk of air emboli should be used when changing the tubing or caps and when removing a PICC. During tubing or cap change, the patient should be supine, the catheter clamped and/or patient instructed to perform a Valsalva maneuver. When removing the catheter, using an antiseptic ointment on a gauze pad taped securely over the site creates an occlusive dressing. The same procedures for care and maintenance of all central venous catheters reduces confusion and increases patient safety by firmly establishing that a PICC is a central venous catheter.

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