# Severe air embolism resulting from a perforated cap on a high-flow three-way stopcock connected to a central venous catheter

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EDITOR:

*Case Report*: A 41-yr-old white male, body mass index (BMI) 18, presented with a cholangiocarcinoma invading locally into the portal vein and was scheduled for an extended right hemi-hepatectomy. As part of the anaesthetic technique, a Certofix® Quinto central venous line (B Braun, Melsungen, Germany) was inserted into the right internal jugular vein under ultrasound guidance. A Smiths SC-3 high flow three-way stopcock (Smith's Medical, Rockland, MA, USA) was attached to the 12 g lumen of the central venous catheter (CVC) and to a Level 1 rapid infuser. The surgery proceeded for a period of 2 h at which point the tumour was found to be technically unresectable and the procedure was therefore abandoned. The patient was woken up and extubated in theatre and found to be comfortable with a good working thoracic epidural. Once awake, the patient was transferred to the post anaesthetic care unit (PACU) where his care was handed over to the recovery staff.

One hour later, a distress call was received from the PACU. The nursing staff had turned the patient to make him more comfortable, immediately after which he had complained of severe chest pain and had become acutely hypoxic. On review, he was clearly very distressed, gasping and had a grayish appearance. Examination showed a rapid respiratory rate, central cyanosis and a pulse oximeter reading of 80% saturation, despite receiving high-flow oxygen through a non-rebreathing system. Air entry was bilaterally equal and the breath sounds were normal. The lungs were resonant to percussion throughout. The heart rate (HR) was 130 beats $min^{-1}$ and blood pressure (BP) 65/30 mmHg. Heart sounds S1 and S2 were heard along with a loud 'machinery' murmur. Further inspection showed that the intravenous (i.v.) fluids had been disconnected from the central venous line during the turning of the patient. The three-way stopcock was open to the patient and closed to the distal position. The intermediate position was 'sealed' with the manufacturer's cap. The manufacturer's cap, in fact, has a patent lumen (Fig. 1). Air was clearly visible within the central venous line. The patient was immediately placed head down in the left lateral position and the line aspirated with a 50 mL syringe. Approximately 100 mL of a frothy mix of air and blood were aspirated to a dramatic effect. The pulse oximeter reading rapidly rose to 97% and a rapid improvement in BP was observed. The patient described feeling better almost immediately. The manufacturer's cap was replaced with a sealed bung and a critical incident form completed. The patient made an uneventful recovery.

Gas embolism (also known as air embolism) is a well-described, potentially fatal, iatrogenic clinical problem [1]. It refers to the ingress of gas, most commonly air, into the vascular system. This can result in a venous air embolus (VAE), as in our case report, an arterial air embolus or a paradoxical air embolus. Since the earliest reports of VAE, dating back to 1947 [2], one of the most common factors implicated in the cause of VAE is the CVC. Reports range from cases of fatal gas embolism due to accidental disconnection of the CVC [3] to cases of acute gas embolism on removal of the CVC [4]. We could, however, find no reports of gas embolism resulting from bungs or caps manufactured with perforated lumens and connected to the intravascular equipment.

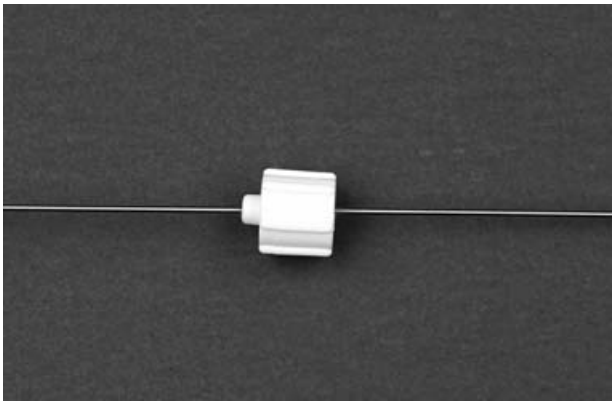

**Figure 1.**
*Cap supplied attached to the high-flow stopcock.*

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The case reported here highlights the potential risks of packaging any intravascular equipment, or three-way taps, with caps containing perforated lumens. The purpose of the perforated lumen is said to allow internal sterilization of the equipment by passing through an ethylene oxide gas mix. Manufacturer's guidelines state that the 'bio-barrier caps' should be removed before use but do not always state that they should be replaced with sealed caps [5]. Without prior knowledge, identification of the perforated lumen is possible only on close visual inspection. The caps otherwise look very similar to ordinary sealed caps as provided with standard, low flow, three-way taps. As highlighted by the case history, the potential for misidentification of the caps exists with the associated risk of an air embolus or extravasation.

The question arises as to why any intravascular equipment currently supplied with perforated caps connected, cannot be sterilized without the caps connected and separate sealed caps supplied. This would negate the need for caps with perforated lumens and their associated risks. Many forms of i.v. catheters are indeed already supplied with sealed caps attached, as in the case of the Certofix® Quinto CVC supplied with Safsite® valves.

Finally, while intravascular equipment is produced with perforated caps (bungs), it must ultimately be the responsibility of the physician inserting or using the equipment to check and replace all perforated caps with sealed caps.

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5. Instruction leaflet provided with Smith's SC-3; Level 1 Inc., 160 Weymouth St, Rockland, MA 02370, USA.

 

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