

Focus on
patient safety

MEASURING
& IMPROVING
QUALITY

Central venous catheter and air embolism

One bubble is all it takes

11 October 2023

It could happen to you too

Event 1

REMOVAL OF A CENTRAL VENOUS CATHETER RESULTING IN A FATAL AIR EMBOLISM

A 53-year-old male patient admitted to a pulmonology department high-dependency unit (HDU) following discharge from the intensive care unit had been fitted with an internal jugular triple-lumen catheter. Following an improvement in his condition, it was decided to remove the catheter. Immediately after removal of the catheter by the nurse, the patient presented extreme bradycardia with altered consciousness. The nurse called for help and quickly applied a dressing over the skin exit site. When the patient went into cardiac arrest, she then began cardiac massage. Despite resuscitation procedures, the patient died.

What happened? Immediate cause

Removal of the central venous catheter resulted in an air embolism.

Why did it happen? Root causes, barriers absent or deficient

- The clinical practice guidelines and protocols relative to catheter removal available within the hospital were not complied with:
 - removal of the catheter in the semi-sitting position + 40° instead of the Trendelenburg position (dorsal decubitus tilted to - 45° with the head lower than the hips);
 - removal without asking the patient to hold his breath or breathe out;
 - absence of prolonged massage of the subcutaneous path and of an airtight dressing.
- The triple-lumen catheter used was large, promoting the entry of air into the bloodstream.
- The pulmonology department HDU personnel were not experienced in the management of central venous catheters. The nurse, who had been in her post for many years, had not received any recent training in the procedure.
- The hospital information campaign on the prevention of air embolisms was not circulated to the pulmonology department, because it was considered not to be concerned.

DISCONNECTION BETWEEN AN INFUSION LINE AND A CENTRAL VENOUS CATHETER LINE RESULTING IN A CEREBRAL AIR EMBOLISM



A male patient in his sixties fitted with an internal jugular multi-lumen central venous catheter was admitted to the cardiac intensive care unit (ICU) following an interventional cardiology procedure. While the patient was eating his breakfast, he suddenly fell into a coma. His condition stabilised following intubation, mechanical ventilation and noradrenaline infusion. An echocardiogram demonstrated multiple air bubbles in all four heart chambers and a brain CT scan revealed air embolisms. Following treatment with hyperbaric oxygen therapy, the patient woke up, but presented seizures, with persistent hemiparesis.

What happened? Immediate cause

A faulty connection between the infusion line and a central venous catheter line resulted in a cerebral air embolism.

Why did it happen? Root causes, barriers absent or deficient

- An opaque dressing was used, making it impossible to check the connection between the infusion line and the catheter, despite the fact that the department's procedure recommends the use of a transparent dressing.
- Checking of the permeability and tightness of catheter lines was not recorded in the computerised patient file.
- The patient was sitting up to have breakfast; however, the department's procedure did not recommend checking the connections before moving the patient to the sitting position.
- Trans-septal catheterisation had been performed during the interventional cardiology procedure and allowed air to enter between the right and left heart chambers and the cerebral air embolism.

ACCIDENTAL CUTTING OF A CENTRAL VENOUS CATHETER RESULTING IN A FATAL AIR EMBOLISM

A male patient in his seventies hospitalised in the intensive care unit was fitted with an internal jugular central venous catheter. While the patient was being washed and shaved, he presented dyspnoea, followed by loss of consciousness and cardiac arrest. Despite resuscitation procedures, the patient died.

What happened? Immediate cause

While the patient was being shaved, the central venous line was nicked, resulting in an air embolism.

Why did it happen? Root causes, barriers absent or deficient

- Prolonged hospitalisation had compromised the peripheral venous capital and made a central venous catheter essential for intravenous antibiotic therapy, without it being possible to switch to oral treatment.
- Due to the patient's thick hair growth, the catheter dressing did not adhere properly to the skin, exposing the catheter to the razor.
- The patient was in a semi-seated position for washing and changing of the catheter dressing.
- A pair of nurses worked together to wash and shave the patient and replace the catheter dressing at the same time, exposing the catheter to the razor. The patient was shaved by a nurse who was less used to performing this procedure than a healthcare assistant.
- The workload was heavy at the time of the events.
- The personnel lacked knowledge of the risk and pathophysiology of air embolism.

CENTRAL VENOUS CATHETER PULL-OUT RESULTING IN A FATAL AIR EMBOLISM

A male patient in his fifties was admitted to a gastrohepato-biliary surgical department intensive care unit following a liver transplant due to alcoholic cirrhosis and had been fitted with an internal jugular central venous catheter. The course was favourable and the patient was awaiting a bed in a conventional medical ward. During an episode of confusion, the patient got out of bed, pulled out the central venous catheter, the arterial line and his abdominal drain, and disconnected the module from the monitor. The patient was found on the floor in cardiac arrest and died despite resuscitation procedures.

What happened? Immediate cause

The catheter was pulled out resulting in an air embolism.

Why did it happen? Root causes, barriers absent or deficient

- The jugular central venous catheter had not been replaced by a peripheral venous line due to thrombopenia preventing its removal.
- There was no procedure to assess and manage alcohol withdrawal.
- The overuse of morphine as postoperative analgesia, in the absence of locoregional analgesia of the abdominal wall, may have contributed to the patient's confusion.
- The layout of the premises and the absence of an alarm repeater in the staff rest room meant that the bed exit alarms sounded by the monitor in the patient's room could not be heard, resulting in a delay in care.
- Given the layout of the premises, the permanent presence of paramedical staff in the unit was poorly organised.

So it doesn't happen again

An **air or gas embolism** is a sudden blockage of a blood vessel by a bubble of gas, usually air. During the inspiratory phase of spontaneous breathing, particularly in the vertical position and when the patient is hypovolaemic, the intrathoracic pressure is negative and any communication between the outside and the intrathoracic central venous network - via a catheter or the tunnel it has left, for example - allows air to enter the bloodstream. The air then reaches the right heart chambers and can cause a venous air embolism, cardiac arrest or, after passing into the left heart chambers, an arterial gas embolism, particularly cerebral.

It is necessary to be aware of the risks of air embolism associated with the management (insertion, maintenance, monitoring, removal) of central venous catheters in the superior vena cava area. The risk of air embolism is particularly high on removal of the catheter, especially if the catheter has been in place for a long time or is large, or if the patient is thin and the subcutaneous pathway is short (which is usually the case when the catheter has been inserted under ultrasound guidance). But any vascular approach can be a port of entry allowing air into the blood circulation, under the effect of a syringe pump for example.

Numerous guidelines designed to ensure the safe management of central venous catheters have been issued in France and internationally. These guidelines stress the need for any department required to manage central venous catheters to have access to a **procedure describing all central venous catheter-related care**, along with the need for **initial training of all personnel** and **regular training to ensure they are aware of the risks**. Air embolism prevention is based on compliance with the guidelines during the various steps involved in central venous catheter-associated care, particularly in the superior vena cava area. In particular, it is necessary to place the patient in the Trendelenburg position (dorsal decubitus tilted to - 45° with the head lower than the hips) during catheter placement and removal, and to take care when shaving the patient's neck and handling infusion lines. Episodes of agitation in critical care patients expose them to a risk of catheter pull-out.

Personnel must know the signs of air embolism and the measures to be taken if an air embolism occurs or is suspected:

- clamp the catheter (or the Huber needle) if it is still in place;
- place the patient in the left lateral decubitus (or dorsal decubitus) position;
- alert the physician responsible for handling life-threatening emergencies;
- analyse and report the adverse event.

→ Always assess the need for a central venous catheter and the benefit-risk balance.

→ Always have trained personnel insert, maintain and remove central venous catheters.

→ Always bear in mind the risk of air embolism and take care when handling the central venous catheter.

Focus on patient safety collection

The "Focus on patient safety" collection aims to draw the attention of and raise awareness among healthcare professionals as to risk management. Each focus covers a specific and recurrent risk based on care-related adverse events, identified and selected from national care-related serious adverse event reporting databases or doctors' accreditation.

This focus concerns serious adverse events associated with the occurrence of air embolisms during the management of central venous catheters in the superior vena cava area. This guide relates events with which healthcare professionals have been confronted and which are always associated with a series of dysfunctions.

Find out more

CIRRNET, Patient safety Switzerland. Air embolism risk following removal of a central venous catheter (CVC). Quick-Alert 2013;(27 (V2.1)).
patientensicherheit.ch/wp/wp-content/uploads/2023/03/Quick-Alert_Nr-27V2.1_20130702_f.pdf

COMEDIMS. Preventing air embolisms in vascular approaches. Proper use of medical devices. Paris: AP-HP; 2019.
www.omedit-idf.fr/wp-content/uploads/2019/09/COMEDIMS-AP-HP-EMBOLIES-GAZEUSES-BU-janvier-2019-5.pdf

Haute Autorité de santé. Focus on patient safety. Tool to improve professional practices. Saint-Denis La Plaine: HAS; 2021.
www.has-sante.fr/jcms/p_3240311/fr/flash-securite-patient

Geneva University Hospitals, Alvarez R, Roulin M, Touveneau S, Massebiaux C, Dalloux N, *et al.* Care, monitoring, maintenance and removal of a central venous catheter – Adults [Online]. Geneva: HUG; 2014.
www.hug.ch/procedures-de-soins/soins-surveillance-entretien-ablation-catheter