Reducing the risk of air embolism associated with central venous catheter use on the intensive care unit

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SQA21

Introduction

Air embolism is a rare but potentially catastrophic complication associated with central venous access. Air may be entrained into the vascular space when a central venous catheter (CVC) is left open to the atmosphere, which can occur with inappropriate configuration of catheter seals.

This patient safety initiative was prompted by a serious incident at the project site and supported by a recent safety bulletin released by the Faculty of Intensive Care Medicine (FICM).

FICM safety alert March 2021

"In order to prevent future deaths from air embolism associated with central lines, it is recommended that ICUs, HDUs and other clinical areas caring for patients with CVCs ensure that any unused taps attached to CVCs are closed to air and capped off with an appropriate device. … All CVCs should also have clamps associated with each lumen of the line, and these should be used to clamp closed any lumens that are not in use as an additional safety measure…"[1]

Objectives

1. Evaluate the configuration of CVC seals and compare this with standards outlined in the FICM safety alert and NICE guidelines
2. Introduce safety and quality improvement interventions in order to reduce future risk of air embolism

Study Design

Prospective single-centre study
22-bed adult ICU

Data Collection

Snapshot daily assessment of all CVCs over 2-week period, including:
- Type of central access
- Number of lumens available and in use
- Clamp status of lumens
- Dividers and their configuration
- Presence of cap devices on lumens

Analysis

Safety breaches for unused lumens defined as:
- Unused lumen unclamped
- 3-way tap divider open to patient and unused port
- Unused port left uncapped

Identify areas for improvement

Intervention

1. Introduction of octopus dividers with built-in 'bionector' non-return valves in place of 3-way taps
2. Staff education programme
   - Daily safety briefing
   - Educational posters
   - Simulation model and sessions

Figure 1. Closure devices and dividers in use (from left): bung, non-return 'bionector' valve, 3-way tap, 2-lumen octopus.

Results

Baseline:
- 101 CVCs audited, resulting in 380 intrinsic lumens. 41.8% (n=159) were not in use.
- Total safety breaches on unused lumens = 55 (35%)

Post-intervention:
- 135 CVCs audited, resulting in a total 515 lumens. 23.1% (n=119) were not in use.
- Total safety breaches on unused lumens = 29 (24%)

Figure 2. Type of divider in use over all lumens surveyed.

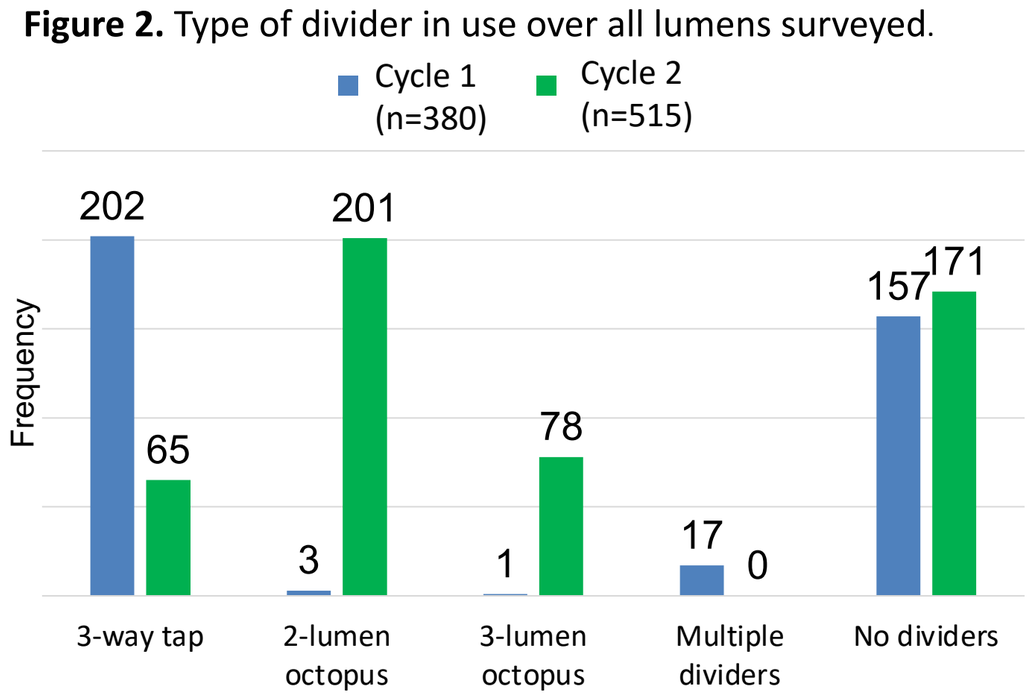
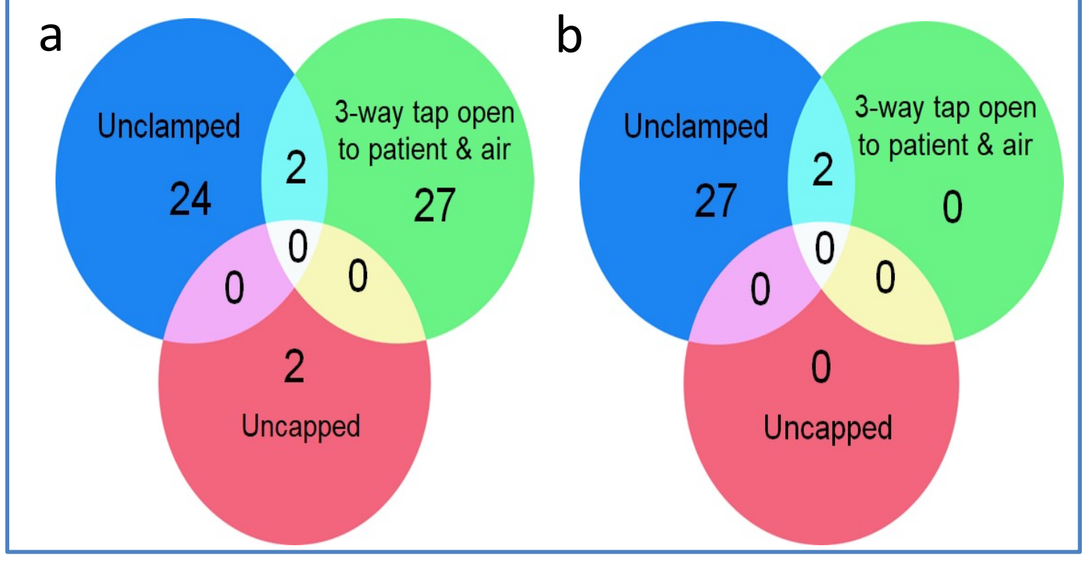


Figure 3. Frequency of safety breaches on unused lumens in (a) Cycle 1 (n=159) and (b) Cycle 2 (n=119).



Discussion

- There are multiple safety mechanisms in place, meaning that a safety breach with failure at each stage resulting in air embolus is a rare event.
- The most common divider system in use during the first audit cycle were 3-way taps, which allow many different configurations and are prone to user error.
- Incidence of multiple dividers (e.g. 3-way taps connected in tandem) was reduced to zero.
- The introduction of octopus dividers significantly reduced the use of 3-way taps. A key safety feature of this device is the built in non-return valves, removing the potential for error when connecting and disconnecting infusions. The subsequent incidence of unused ports being uncapped and open to air was zero.

Conclusions

The introduction of octopus dividers with built-in non-return valves and a staff education programme resulted in a reduction in safety breaches related to CVC use, and thus we hypothesise a reduced risk of air embolism.

References

[1] Faculty of Intensive Care Medicine. Air Embolism Safety Alert. [Internet] FICM.ac.uk. 2021 [cited August 2021]. Available from: https://www.ficm.ac.uk/sites/default/files/air_embolism_safety_alert_sbar.pdf

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