

Citation

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Full Text

Among the 3,533 claims in the ASA Closed Claims Project database, there are 48 claims involving problems with central venous catheters or pulmonary artery catheters. Eighteen of the claims involved fatalities. Despite the widespread perception that pulmonary artery catheters are more dangerous than central venous catheters, only two of the 48 claims were explicitly related to pulmonary artery catheters.

A variety of technical misadventures resulted in injuries or deaths [Table 1]. Some of the complications may have been unavoidable, but most appear to be the result of operator errors. Presumably, we can learn from these mistakes and reduce the occurrence of morbidity in the future.

Table 1

Central Line Complications in Closed Claims Project		
Complication	Total	Fatalities
Cardiac tamponade	11	10
Wire or catheter embolism	12	0
Vascular injuries (nonpulmonary artery):	13	5
Hemothorax	6	4
Hydrothorax	3	1
Carotid artery injury	3	0
Subclavian artery aneurysm	1	0
Pulmonary artery rupture	2	2
Pneumothorax	7	1

Air embolism	2	2
Fluid extravasation in neck	1	0
Total	48	20

The majority of the 48 claims were accounted for by three classes of problems: perforation of the heart with pericardial tamponade (11 claims), catheter or wire embolism (12 claims) and injury to veins or arteries other than the pulmonary artery (13 claims). These problems are preventable in most cases by paying meticulous attention to technique.

The Food and Drug Administration (FDA) and various manufacturers have expressed their concern for the incidence of complications from central lines and have promoted educational messages to practitioners;¹ for example, the FDA, in cooperation with various private organizations, recently released a series of three educational videotapes titled "Central Venous Catheter Complications" (available from the National Audiovisual Center, 8700 Edgeworth Drive, Capitol Heights, MD 20743-3701; telephone: (800) 788-6282).

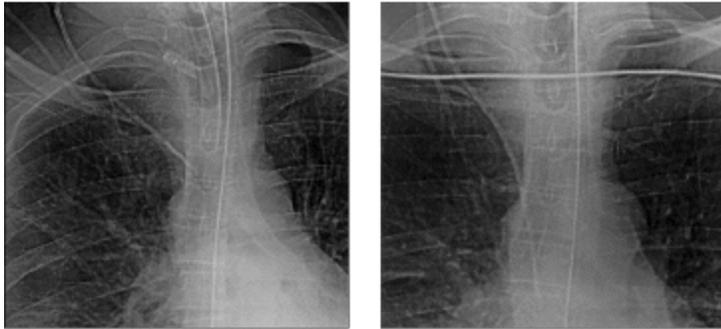
In addition, manufacturers provide a variety of "package inserts" in central line kits, containing warnings and recommendations for avoiding complications. Judging from the explicit and detailed warnings in package inserts, manufacturers consider perforation of the heart and pericardial tamponade to be a major problem.

Interestingly, this complication was the most common cause of death in the central line-related claims from the ASA Closed Claims Project. Of the 11 patients with cardiac tamponade, 10 died. Numerous reports in the literature confirm the seriousness of the problem.¹⁻⁸ The scenario usually involves a central venous catheter with the tip inside the right atrium or abutting the wall of the superior vena cava at an acute angle. With repeated motion of the catheter tip against the heart or vena cava, perforation may eventually occur. Blood or intravenous fluid can then enter the mediastinum or pericardium, depending upon the location of the perforation. Blood or intravenous fluid in the pericardium may result in pericardial tamponade. This complication usually presents postoperatively, after the catheter has been in place for hours or days, although it may occur immediately following catheter placement.⁸

The key to prevention of pericardial tamponade is to keep the central venous catheter outside of the heart. Chest X-rays should be obtained and carefully reviewed as soon as possible following placement of the catheter.^{5,7} For catheters placed in the operating room, X-rays are usually obtained postoperatively in the recovery room or intensive care unit.

When reviewing the chest X-ray, three key features should be assessed. First, the catheter should lie in the vena cava, outside of the cardiac silhouette. Second, the catheter should be relatively parallel to the walls of the vena cava. Third, the catheter tip should not abut the wall of the vena cava.⁷ An example of the use of chest X-rays to detect potential problems is shown in Figure 1, taken from the author's practice.

Figure 1



A catheter inserted from the right internal jugular vein was found not to be parallel to the walls of the superior vena cava on a portable chest X-ray (left). This catheter position may be more likely to cause injury to the vena cava. The catheter was advanced a few centimeters, resulting in a safer orientation (right).

A central venous catheter placed via the right internal jugular vein was found initially not to lie parallel to the walls of the superior vena cava. Advancement of the catheter by a few centimeters resulted in a safer placement. Continuous monitoring of the pressure waveform may also be useful; while the waveforms obtained in the superior vena cava and right atrium are indistinguishable, the waveform from the right ventricle can be identified easily.

An exception to the rule of keeping the catheter out of the heart may reasonably be made for aspiration of air emboli during sitting neurosurgical procedures or other procedures prone to venous air embolism.⁹ However, such catheters should be placed very carefully and should be withdrawn from the right atrium at the earliest possible time.

The 12 claims involving catheter or wire embolism were not as serious as cardiac perforation, since no deaths were recorded. Although it was impossible to know the precise cause of each of these events from the information in the ASA Closed Claims Project database, the usual causes of these problems are well-known and avoidable. Wires or catheters should virtually never be withdrawn through a needle because of the risk of shearing. The proximal end of a wire should always be under the control of the operator in order to prevent the entire wire from entering the blood vessel while the catheter is being advanced.

Of the 13 claims involving injuries to veins or arteries (other than the pulmonary artery), the most serious problems resulted in hemothorax or hydrothorax; of the nine patients affected, five died. Although the exact cause of these complications was not evident in every case, in some of the cases, the apparent cause was the inadvertent insertion of an introducer sheath or large bore catheter into an artery instead of a vein, resulting in injury to the artery. This problem should be avoidable. After placement of a needle in the blood vessel, the vessel should be positively identified as a vein prior to cannulation. Numerous methods have been used for this purpose, including the subjective evaluation of the force with which blood appears to spurt from the needle, the color of the blood, assessment of blood gases and transduction of a pressure waveform.

Of these methods, the author strongly prefers the transduction of a pressure waveform as the most convenient and reliable technique.¹⁰ Many central line kits are now supplied with tubing and connections designed specifically for transducing a waveform prior to cannulation of the vein, and package inserts describe this procedure.

There are two take-home messages from this review of central line complications in the ASA Closed Claims Project database. The first lesson pertains to the positioning of central venous lines. Unless clinical needs dictate the placement of a catheter tip in the right atrium or ventricle, the tip of the central venous catheter should be located in the superior vena cava with the catheter oriented parallel to the vessel walls. The chest X-ray is the key to making this assessment; monitoring the pressure waveform will identify a catheter that has entered the right ventricle. The second lesson pertains to inadvertent cannulation of an artery. The vein should be positively identified prior to cannulation; the author recommends examination of the pressure waveform as the most convenient and reliable method for distinguishing between the venous and arterial systems.

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