

## Late Cardiac Tamponade in Adults Secondary to Tip Position in the Right Atrium: An Urban Legend? A Systematic Review of the Literature

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**C**ENTRAL VENOUS CATHETER (CVC) placement is a very common procedure, considering that the Food and Drug Administration (FDA) has estimated that 5 to 6 million CVCs are placed annually in the United States. The FDA also receives reports that are useful in the identification of emerging problems associated with device use. More than a decade ago, one of these emerging problems was cardiac tamponade, a very rare but potentially fatal complication associated with CVC placement. Diagnosis of cardiac tamponade (CT) often is delayed, even when signs and symptoms are typical.<sup>1-3</sup> Onset time of clinical features can vary from a few minutes to some days after insertion of the CVC, with a median time to occurrence of 3 days after insertion.<sup>4</sup> Risk factors for the development of cardiac tamponade include incorrect tip position (right atrium and ventricle most common), infusion of hyperosmolar fluids such as for parenteral nutrition, and vein wall damage caused by guidewires and introducers. The aim of this systematic review of the literature was to analyze relevant papers and data related to early and late cardiac tamponade cases related to central venous catheterization complication in adults and to suggest possible solutions to prevent it.

Although cardiac perforation has been reported equally in neonates and adults, pericardial effusion with resulting cardiac tamponade has been reported more frequently in neonates. Cardiac tamponade (CT) can occur during or after CVC insertion and it may happen because of perforation of the right atrium, perforation of the right ventricle, or perforation of the superior vena cava (SVC) in the tract wrapped by the pericardial reflection (lower third of SVC). Cardiac tamponade can be defined according to the time it occurs as early cardiac tamponade (ECT) if it is due to an acute damage during the maneuver of insertion (caused by needle, guidewire, dilator, introducer, etc) or late cardiac tamponade (LCT) if it is caused by chronic erosion of the wall by mechanical (tip of the catheter) and/or chemical injury (chemotherapy or irritant drugs). ECT and LCT might be difficult to differentiate because the perforation during CVC placement may be minimal, so that ECT can occur late (48 hours or more) and may become manifest only when infusion through the central line is started (even days after insertion).

Depending on the site of rupture, perforation may be associated with hemomediastinum/mediastinitis, if it occurs in the brachiocephalic veins or in the upper/middle third of the SVC, or with cardiac tamponade, if it occurs in the lower third of the SVC, or inside the heart (pericardial sac).

### METHODS

After proper preparation of a review protocol according to the PRISMA statement checklist,<sup>5</sup> all articles with no language restrictions were considered, including randomized controlled trials, cohort studies, observational studies, case-control studies, reviews, case series, and case reports.

All adult cases (> 18 years of age) of cardiac tamponade (early or late) with no restrictions to specific population characteristics (race or the presence of a particular condition for risk factors), settings, or the practitioner's experience.

The primary outcome measured was the occurrence of cardiac tamponade after central venous catheterization. Secondary outcomes were the time when this complication occurred (ECT or LCT), mortality, and causes of cardiac tamponade (rupture of the vessel, erosion of the atrium wall, guidewire).

The authors independently assessed the titles and abstracts (when available) of all reports identified by literature searching. All selected studies were masked by obscuring authors' name and affiliation, journal of publication, and any other potential identifiers.

The authors searched in the following databases: MEDLINE (1966 to March 1, 2014), EMBASE (1966 to March 1, 2014), the Cochrane Central Register of Controlled Trials (CENTRAL), references list of articles, "Grey literature" (GreyNET), and dissertations. A specific search strategy was developed for each database. The authors attempted to identify all relevant articles in all possible fields using the basic search function (using the following key word terms: "Cardiac tamponade", "acute", "late", "central venous catheterization", and "adults only"). An additional hand-search focused on cardiology and anesthesia journals, critical care journals and nephrology journals, and abstracts and proceedings of scientific meetings. The authors also attempted to identify unpublished or ongoing case series or even case reports by contacting companies and experts in the field and searched in 2 trials registers (Current Controlled Trials, ClinicalTrials.gov).

The authors independently screened the articles and abstracts of reports identified by electronic searching. All potentially relevant studies were retrieved and evaluated at least by one author, in full-text version. Disagreements on relevant papers were resolved by discussion. Once disagreements were resolved, the extracted data were recorded on the final data extraction form.

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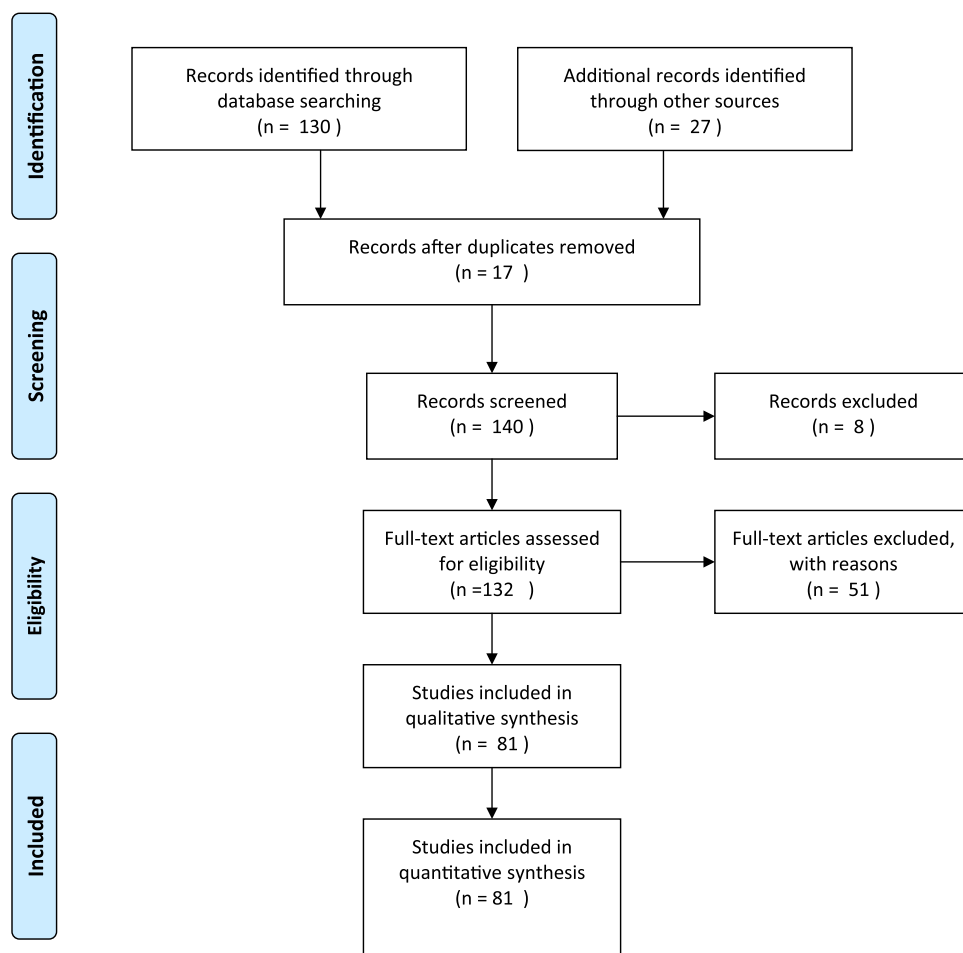


Fig 1. Flow diagram of included studies. From Moher 2009.<sup>6</sup>

The March 2014 search strategy in MEDLINE identified a total of 130 citations. The search in all other sources retrieved a total of 27 additional citations. After title and abstract screening of the 76 citations, they were excluded because they were considered not related to the search (Fig 1).

#### LITERATURE APPRAISAL

A vast bibliography on ECT and LCT in neonates and children is available.<sup>7–12</sup> In pediatric patients, both ECT and LTC appear to be rare (<0.7/1000 central venous catheters placements) but well-recognized complications and have been reported with any kind of central line (short-term central line catheters, peripherally inserted central catheters, umbilical catheters, etc). In neonates and children, ECT usually is insertion-related and may be difficult to differentiate from LCT that often is position-related. Most cases of cardiac tamponade/pericardial effusion have been reported in infants <1 year of age.

In adults, ECT is a very rare complication—typically related to a “blind” insertion (ie, without ultrasound guidance) of the central venous catheter or to gross errors in handling the guidewire or the introducer/dilator—that sometimes still is reported in the literature. Typical gross errors in handling the guidewire or the introducer/dilator are (1) the guidewire is

inserted far too deep (in adults, more than 20 cm on the right side and more than 25 cm on the left side), so that it may enter the atrium and even reach the tricuspid valve; (2) the straight stiff end of the guidewire is inserted, and not the J-tip, which may cause a perforation of the vein wall or of the myocardium; and (3) the introducer/dilator is advanced too deep and/or beyond the tip of the guidewire. On the contrary, LCT in adults virtually has disappeared in the last decades. This complication has been described in adults in the 1970s and in the 1980s, especially with catheters made of materials that currently are not adopted for CVC anymore (polyethylene, polyvinyl Chloride, and first-generation polyurethane).

Though often confused with ECT (which is related to errors at insertion), clinical cases of LCT gradually have disappeared from the medical literature, though many reviewers still mention them.

Chabanier et al did a systematic revision of the papers regarding ECT/LCT in adults from 1968 to 1988.<sup>13</sup> This review collected 67 cases reported over a 20-year period: 29 of them were perforation of the right atrium, 18 of the right ventricle, 3 of the SVC, and the rest remained undefined. The perforation often was associated with stiff catheters made of polyethylene,<sup>14,15</sup> first-generation polyurethane,<sup>16–20</sup> and polyvinyl Chloride.<sup>21</sup>

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