

## Commentary

# What is the best site for central venous catheter insertion in critically ill patients?

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### Abstract

The choice of the best central venous access for a particular patient is based on the rate and the severity of failures and complications. Based on two recent papers, internal jugular access is associated with a low rate of severe mechanical complications in the intensive care unit as compared with subclavian access, and it is preferable for short-term access (<5–7 days) and for haemodialysis catheters. Subclavian access is associated with a lower risk for infection and is the route of choice, in experienced hands, if the risk for infection is high (central venous catheter placement >5–7 days) or if the risk for mechanical complications is low. The femoral route is associated with a higher risk for infection and thrombosis (as compared with the subclavian route). It should be restricted to patients in whom pneumothorax or haemorrhage would be unacceptable.

**Keywords** catheter, catheter-related infection, complications, femoral, iatrogenic, jugular, pneumothorax, subclavian

Central venous catheter (CVC) insertion is required in many critically ill patients. Selection of the insertion site should be based both on the ease of placement and on the risks associated with the procedure. The latter include infection, thrombosis and mechanical complications. Two recently published papers [1,2] have provided valuable new information on this issue.

### I: Subclavian versus internal jugular approach

There is a dearth of sound data comparing various CVC insertion sites. No well conducted randomized studies have compared complications related to the subclavian and internal jugular approaches. Among prospective cohort studies, most are biased by a preference given to one approach over the other as a result of habits in the intensive care unit (ICU) or experience of the operator. This selection bias may result in overestimation of the benefits of the more commonly used approach.

In a recent meta-analysis, Ruesch and coworkers [1] compared complication rates with the subclavian and jugular approaches. To minimize selection bias, they excluded trials with a greater than twofold difference between group sizes.

Of 85 studies published before 30 June 2000, only 17 were included in the meta-analysis. The meta-analysis population included ICU and non-ICU patients, and no distinction was made between catheters inserted for dialysis, pulmonary artery catheters and other catheters. Finally, CVC-related complications might have been under-reported in those studies in which they were a secondary end-point.

### Catheter malposition

Catheter malposition can have serious consequences. Positioning of the catheter tip in the cardiac silhouette is associated with an increased risk for cardiac tamponade, and positioning in the subclavian vein with a high risk for thrombus formation in cancer patients. Placement of a subclavian catheter tip in the opposite subclavian vein or neck veins may have more severe consequences than placement of a jugular catheter in the right atrium, which can be corrected simply by pulling the catheter back. However, malposition of internal jugular vein catheters in the axillary vein is frequently reported [3].

In the meta-analysis conducted by Ruesch and coworkers (six trials; 1299 catheters) [1], malposition was significantly

less common with the jugular approach (5.3% versus 9.3%; relative risk [RR] 0.66, 95% confidence interval [CI] 0.44–0.99). However, in two large case series that focused specifically on mechanical complications, subclavian catheter insertion by experienced operators was associated with malposition rates of only 4.2% [4] and 6% [5]. A far higher rate (14%) was observed with internal jugular catheter insertion [3]. Finally, in a recent prospective cohort study not included in the meta-analysis by Ruesch and coworkers, the rate of tip malposition was 12/661 (1.8%) with the internal jugular approach and 7/374 (1.8%) with the subclavian approach [6]. The malposition rate was higher with the low lateral jugular approach (3/487 [0.6%]) than with the high lateral jugular approach (9/174 [5.2%]).

In conclusion, although the meta-analysis from Ruesch and colleagues [1] supports the use of the internal jugular approach, the data vary widely across studies, according to the experience of the operators and to the venous approach used.

### Mechanical complications

In critically ill patients, barotrauma and puncture of an incompressible artery are probably the most common mechanical complications and can be life-threatening. The rate of mechanical complications has ranged from 0% to 12%, according to the experience of the operator and to the definition of complications [4–7]. Mechanical complications include arterial puncture, pneumothorax, mediastinal haematoma, haemothorax and injury to adjacent nerves. The recent introduction of more flexible catheters and of the J guide-wire insertion method has decreased the rate of severe mechanical complications. However, fatal complications still occur [8].

In the meta-analysis by Ruesch and coworkers [1], arterial punctures were significantly more common with the jugular than with the subclavian approach (six trials, 2010 CVCs; 3% versus 0.5%; RR 4.7, 95% CI 2.05–10.77). However, bleeding from a punctured internal carotid artery can usually be controlled by manual compression. A haematoma may occur, though, particularly when a dilator or pulmonary artery catheter is inserted in a patient with haemostasis disorders, and a large haematoma may produce rare but serious complications including airway obstruction, retrograde aortic dissection, arteriovenous fistula, or cerebrovascular events in patients with occlusive atheromatous disease of the carotid artery [9,10]. The potential adverse effects of subclavian artery injury are not as serious, because the risk for cerebral thromboembolism or airway compromise is practically nonexistent. However, bleeding from the subclavian artery is far more difficult to control by pressure alone and is more likely to escape detection because the blood can track into the pleural cavity. Consequently, the subclavian vein is generally thought to be the least suitable approach to the central circulation in patients who are on anticoagulant therapy.

In the meta-analysis by Ruesch and coworkers [1], the rate of haemothorax or pneumothorax was similar with the subclavian and internal jugular approaches (10 trials, 3420 CVCs; 1.3% versus 1.5%; RR 0.76, 95% CI 0.43–1.33). Patients at increased risk for pulmonary complications (severe emphysema, acute respiratory distress syndrome) were not included in the analysis – a fact that may explain this surprising finding. In a recent prospective study by Iovino and colleagues [6], the internal jugular approach was associated with a significantly lower risk of pneumothorax (0/661 versus 9/374 with the subclavian approach;  $P < 0.001$ ). It should be noted that failure of the first attempt at catheter insertion was associated with a dramatic increase in risk for pneumothorax associated with subclavian CVC insertion; the rate of pneumothorax was 4/450 (0.89%, 95% CI 0.24%–2.26%) when the first attempt was successful and 18/190 (9.47%, 95% CI 5.71%–14.6%) when it was unsuccessful [4]. The impact of mechanical complications on patient outcomes in the ICU is largely unknown, but pneumothorax usually requires chest tube drainage [4] and can be life-threatening in mechanically ventilated patients. All-cause barotrauma was associated with a 1.99 (95% CI 1.33–2.97) independent risk for death in a recent study conducted in 5183 mechanically ventilated patients [11].

In four of the studies (899 CVCs) included in the meta-analysis by Ruesch and coworkers [1], the risk for vessel occlusion was similar with the subclavian (1.4%) and jugular (0%) approaches.

With CVCs only, we found that thrombosis of the internal jugular vein was diagnosed far more often than thrombosis of the subclavian vein (RR 4.13) [12]. Haemodialysis catheter insertion is associated with an increased risk for venous thrombosis and subsequent stenosis [13]. When manoeuvred around the bend at the innominate–caval junction, the tip of the catheter or its introducer sheath may erode the endothelium, predisposing to mural thrombosis. The Seldinger technique with a J guide-wire and the new, more flexible polyurethane catheters may substantially reduce the risk for endothelial erosion. Consequently, when vascular access is needed for emergent haemodialysis, the subclavian approach should be avoided if the patient is likely to require a permanent vascular port.

### Infectious complications

Although no randomized studies are available, the internal jugular approach has been associated with significantly higher skin organism counts and subsequent infection rates. Thus, in adults, the subclavian approach is preferred for nontunnelled CVC insertion [14]. This accepted practice is not supported by the meta-analysis by Ruesch and coworkers [1], in which no significant difference was found in the rate of blood-stream infections between the internal jugular and subclavian approaches (three studies, 707 catheters; 8% versus 3.9%; RR 2.24, 95% CI 0.62–8.09). However, a multicentre survey

conducted in thousands of patients provides compelling evidence that blood-stream infections are less common with the subclavian approach [15].

## II: Subclavian versus femoral approach

A recent prospective randomized study conducted in 289 adult ICU patients compared the untunnelled subclavian approach to the untunnelled femoral approach [2]. Patients with severe hypoxia (PF ratio <150 mmHg) or coagulation disorders (platelets <50 000/mm<sup>3</sup>, partial thromboplastin time >1.6 times normal, activated partial thromboplastin time >2 times normal, anticoagulant therapy) were not included.

The femoral approach was associated with higher rates of significant catheter colonization (19.8% versus 4.5%;  $P<0.001$ ) and catheter-related blood-stream infection (4.4% versus 1.5%;  $P=0.07$ ). In the same study, an independent positive association was found between catheter-related thrombosis and the femoral approach (21.5% versus 1.9%;  $P<0.001$ ), and complete thrombosis was diagnosed in 6% of patients in the femoral group as opposed to none in the subclavian group ( $P=0.01$ ). Finally, the risk for major mechanical complications was not significantly different between the groups (subclavian 4/144 [four pneumothoraces] versus femoral 2/145 [two hematomas requiring blood transfusion and/or surgery];  $P=0.45$ ). In mechanically ventilated patients without severe haemostasis disorders or respiratory failure, subclavian access should be preferred over femoral access.

## III: What is the best central venous catheter insertion site in intensive care unit patients?

Although subclavian access is associated with fewer infectious complications, mechanical complications are common and can have serious consequences. When selecting the insertion site, the risk profile of the individual patient should be evaluated. Subclavian access is preferable when the risk for infection is high. Because the risk for infection increases with the duration of catheter use, the subclavian approach is probably the best choice if the patient is expected to require a catheter for 5 days or more. Because failure of the first attempt at subclavian catheter insertion dramatically increases the risk for mechanical complications [4], every effort should be made to increase the likelihood of a successful first attempt. The procedure should be performed with caution and by a trained operator. Real-time ultrasound guidance significantly decreased the risk for jugular and subclavian catheter placement failure (RR 0.32, 95% CI 0.18–0.55), for complications during catheter placement (RR 0.22, 95% CI 0.10–0.45) and for multiple catheter placement attempts (RR 0.6, 95% CI 0.45–0.79) as compared with the standard landmark placement technique [16].

When the risk for mechanical complications is unacceptable or when subclavian catheter insertion fails, insertion should be attempted through the internal jugular vein or femoral vein, and the catheter should be tunnelled to reduce the risk for infection.

When the expected duration of catheter use is less than 5–7 days, the risk for infection is limited and the jugular approach is therefore preferable, given its lower associated risk for life-threatening mechanical complications. In patients with severe hypoxia or haemostasis disorders, the femoral approach is associated with an acceptable rate of complications, especially when the catheter is inserted under strict aseptic conditions [2].

## Competing interests

None declared.

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