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Editorial

Evidence-based decision making in ultrasound-guided central venous cannulation: choosing between the eye and the ear

Central venous cannulation (CVC) traditionally has been guided by surface landmarks. There is a spectrum of established techniques and associated risks [1]. The rates of failure and complications vary from 10.1% to 19.4% and from 5.4% to 11.0%, respectively, depending on factors such as level of operator experience and type of lung ventilation [1]. A major reason for these observations is that nearly 10% of patients have abnormal venous anatomy, including complete absence of the central vein of interest [2]. Clearly, surface landmarks have major limitations. The ability to accurately locate the central vein before and/or during cannulation would not only enhance the conduct of CVC but also presumably reduce patient risk.

The advent of vascular ultrasound-facilitated precise vein localization measurably improved the conduct of CVC ($P < 0.05$) [3]. Ultrasound-guided CVC minimized the impact of operator inexperience and was significantly cost-effective despite the initial setup costs [4,5]. There are, however, two types of ultrasound technologies available for CVC: audio-guided Doppler (relying on the ear) and B-mode ultrasound, which is also known as 2-dimensional ultrasound (relying on the eye because this technology generates a picture of the vein in real time). Both technologies have documented efficacy in CVC [3,4,6,7]. However, which technology is superior in the conduct of CVC? Is there evidence to guide a clinician's choice?

This question has been partially addressed in the meta-analysis of 18 clinical trials with a cumulative sample of 1646 subjects [7]. Compared with CVC by surface landmarks, CVC (adult internal jugular vein) with real-time, 2-dimensional ultrasound significantly lowered failure rate overall (relative risk 0.14) and on first attempt (relative risk 0.59). Three studies in infants all had similar findings (relative risk of 0.15). There was limited evidence favoring 2-dimensional ultrasound in adult CVC involving the subclavian or femoral veins.

Compared with CVC by surface landmarks, CVC (adult internal jugular vein) by audio-guided Doppler was more successful (relative risk 0.39), but less successful for the subclavian vein (relative risk 1.48). In infants, audio-guided Doppler was equivalent to surface landmarks for CVC of the internal jugular vein.

For this meta-analysis, there had been no direct comparison between 2-dimensional ultrasound and audio-guided Doppler in the conduct of CVC in adults or infants. Indirect comparison of relative risks in meta-analysis suggested that adult subclavian CVC would be more successful with 2-dimensional ultrasound than with audio-guided ultrasound (relative risk 0.09) [7].

Where to from here? What about the internal jugular vein in adults, a common perioperative site for CVC? In this issue of the *Journal of Clinical Anesthesia*, Schummer et al [8] compared these two techniques in adult CVC of the internal jugular vein. To my knowledge, this is the first comparative study of its kind to provide high-quality evidence to guide clinical decision making in CVC. These investigators studied adults undergoing internal jugular CVC after induction of general anesthesia: 189 patients in the audio-guided Doppler group (the ear) and 149 patients in the B-mode or 2-dimensional ultrasound group (the eye). Their main finding was that the two techniques are equivalent ($P = 0.567$) except in adults with a body mass index greater than 30, where B-mode ultrasound is superior (97.4% vs 77.1%; $P = 0.011$).

How do these findings impact clinical practice? Firstly, this study again underlines the use of ultrasound-assisted CVC of the internal jugular vein, regardless of technology. The success rates of either technology were around 95%, significantly better than any surface landmark technique. The routine conduct of CVC should include guidance by ultrasound, given the cumulative evidence [1-7]. Secondly, a major advantage with audio-guided Doppler is that during CVC, it does not require an additional operator (as explained

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in the article). Thus, in the time-oriented and resource-limited practice model that is the norm today, this consideration matters. In nonobese patients requiring CVC, the individual practitioner can optimize the procedure with audio-guided Doppler, with no extra assistance. Thirdly, in the obese patient, ultrasound-guided CVC should proceed with B-mode technology, that is, with a picture of the vein in real time.

What are the limitations of this study? First, CVC was studied after induction of general anesthesia, a maneuver already demonstrated to optimize CVC [9]. Although this is an advantage of the study in terms of bias, it also means that these findings may not apply in awake patients. Second, all the CVC procedures were performed by a single experienced operator. Although this minimizes operator bias in the study, it implies that these findings may not hold true in the typical practice model, where there are multiple operators with differing experience levels [10]. Third, as discussed in the paper, arterial puncture still occurs despite ultrasound-guided CVC: the frequency noted in the paper was 1.5%. This represents an ongoing challenge in CVC, not solved by current technologies including the needle guide [11]. Arteriotomy may result in significant arterial injury, such as pseudoaneurysm or fistula [12]. Prevention of arterial injury probably requires a mechanism for precise control of needle depth, particularly when the central vein overlies the artery. A possibility may be the introduction of 2-dimensional ultrasound that gives not only a short-axis but also a long-axis view of the vein to allow the operator to control needle depth more precisely. This possibility requires further study to document whether it can minimize arterial puncture.

Despite these limitations, Schummer et al are to be commended for advancing our understanding of the optimal conduct of CVC with ultrasound. Future work may compare these technologies in more CVC settings: different sites (eg, femoral, subclavian); different patient populations (eg, infants); and/or alternative patient care venues (eg, intensive care unit). Clearly, CVC with the ear or eye is here to stay: in the land of the deaf and blind, the man with an ear and/or eye is king.

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