Techniques, Advantages, and Pitfalls of Ultrasound-Guided Internal Jugular Cannulation: A Qualitative Study

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Abstract

Background: *National guidelines advocating ultrasound guidance for internal jugular venous cannulation were introduced in the United Kingdom in 2002, followed by international guidelines a decade later. However, the benefits of ultrasound guidance do not appear to have universally translated into clinical practice. This study aimed to investigate the effect of ultrasound on the practice of internal jugular vein cannulation.*

Methods: *We conducted an ethnographic study incorporating observations, interviews, and focus groups in 2 hospitals in the north of England over a 4-month period.*

Results: *Twenty-seven clinical observations, 10 interviews, and 3 focus groups were conducted. In 25 clinical episodes, ultrasound guidance was used. Four distinct needling techniques were observed, which we classified in terms of needle angulation: the traditional landmark technique, the ultrasound-guided traditional approach, ultrasound-guided medial angulation, and the ultrasound-guided steep approach. The latter 2 techniques represent a departure from conventional practice and appear to have developed alongside ultrasound guidance. Although no serious complications were observed, there appears to be enhanced potential for complications to occur with medial angulation and the steep approach. Participants described a loss of anatomic knowledge and a false sense of security associated with the adoption of ultrasound guidance, which may account for the emergence of new, potentially riskier needling techniques.*

Conclusions: *The introduction of safe technologies may lead to unintended consequences, and clinicians should attempt to recognize and mitigate them when they occur. Education to increase awareness of the pitfalls of ultrasound guidance is recommended.*

Keywords: *central venous catheterization, interventional ultrasonography, patient safety, social sciences*

Background

Percutaneous cannulation of the internal jugular vein (IJV) using an approach based on anatomic landmarks was first described in the 1960s.[1,2] During the decades that followed, a number of variations on the technique were developed that shared the common principles of a shallow angle of needle insertion in a trajectory that does not transect the carotid artery.[3,4] Despite these anatomic principles, landmark-based cannulation of the IJV is associated with a number of potentially serious procedural complications.[5,6] In addition, procedure failure results in delayed administration of therapy. In an attempt to address these issues, ultrasound guidance was pioneered by Yonei in 1986, who reported a case series of 160 IJV cannulations without complication.[7]

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This innovation was followed by numerous randomized, controlled trials comparing ultrasound guidance with landmark-based techniques.[8-14] These trials universally favored the safety and efficacy of the new technique, and prompted the UK National Institute for Clinical Excellence to issue guidelines in 2002 advising the use of ultrasound to guide all elective IJV central line placements.[15,16] A decade later, international evidence-based recommendations were published that advocate the routine use of ultrasound for central venous access, regardless of anatomic site or urgency.[17]

Despite the unequivocal recommendations of guideline authors, the transition to ultrasound guidance has been incomplete: The most recent national survey of central venous cannulation practice in the United Kingdom, conducted in 2006, suggested that ultrasound guidance is the "first choice technique" for only about one-third of senior anesthetists, with the largest proportion preferring to use anatomic landmarks.[18,19] Furthermore, the degree to which the reduction in complications obtained using ultrasound guidance in the research setting translates to clinical practice is unclear, with some authors reporting an increase in complications following its introduction.[20] Implicit within such counterintuitive findings is that there are various ways to use ultrasound in the insertion of IJV cannulae, and that some methods may be less safe than others, or less safe than not using ultrasound at all. Variation in ultrasound-guided IJV cannulation practice can be found in the existing literature; for example, Yonei et al[7] initially described an in-plane approach, whereas the trials on which the UK National Institute for Clinical Excellence guideline was based[8-14] all adopted an out-of-plane technique. Beyond this, the techniques employed in each trial were not fully described, with information such as the anatomic site and direction of needle insertion omitted. Although an exhaustive description of any practical technique is unattainable due to the presence of a tacit element,[21] the dearth of description in the existing literature leaves clinicians with little direction as to how to best use ultrasound guidance, and creates the conditions for variation in practice to occur.

To explore the real-world techniques used for ultrasound guidance of IJV cannulation in clinical practice, we conducted an ethnographic study in 2 teaching hospitals in the north of England between July and October 2013.

Methods

Approvals from the research and development departments of the participating hospitals and the Lancaster University Faculty of Health and Medicine Ethics Committee were obtained. Members of the hospitals' anesthetics and intensive care departments were briefed in writing and verbally. Written informed consent was obtained from all of the clinicians who participated, and research was conducted according to Good Clinical Practice guidelines.

Adopting an ethnographic approach allows the practice within a particular setting to be explored. It makes use of systematic direct observation, informal discussion, and secondary techniques, such as interviews, to allow researchers to illuminate a particular phenomenon, in this case the techniques used for ultrasound-guided cannulation of the IJV.[22,23]

The settings within hospitals were stratified: hospital 1 was divided into operating theatres and intensive care unit, and hospital 2 was divided into operating theatres, intensive care unit, and cardiothoracic department. Data collection in each of these settings commenced with semistructured interviews with the consultants responsible for management of the department (eg, clinical director) and for the training of junior staff (eg, college tutor). The purpose of these interviews was to provide context for the study. This was followed by observation of clinical episodes in which IJV catheterizations were attempted. The clinical episodes were purposively sampled using a maximum variation strategy; that is, aiming to observe the widest possible variety of clinical settings, grades of anesthetist, times of day, and degrees of clinical urgency. The study was concluded with semistructured focus group discussions to which all study participants were invited. All observations and interviews were undertaken by the same researcher (CS), who is an anesthetic registrar familiar with the procedure and settings being studied.

Data were recorded by way of audio recording (interviews and focus groups) and field notes (interviews, focus groups, and observations). These notes and recordings were transcribed at the earliest convenience. Names of individuals and institutions were replaced with anonymized identifiers (eg, "consultant 1 [C1]" and "trainee 2 [T2]") and original recordings and notes were confidentially destroyed. The anonymized transcripts were then imported into Atlas.ti version 7 (Atlas.ti Scientific Software Development GmbH, Berlin, Germany) for coding and analysis.

Analysis of the data began with detailed reading of the transcripts followed by the identification of passages with recurring content, resulting in the development of provisional emergent themes. These were developed through an iterative process involving re-reading and comparison. Regular meetings with co-investigators allowed samples of the data analysis to be scrutinized, and triangulation between interviews, observations, and focus group material was noted. Finally, the emergent themes were presented to the participants to seek feedback and confirm the validity of the study findings.

Results

The study was undertaken in 2 teaching hospitals in the north of England. Hospital 1 has approximately 400 beds. Critical care is provided in a combined intensive care and high-dependency unit. Hospital 2 has approximately 800 beds and has a large cardiothoracic surgery unit. Critical care services include an intensive care unit, a high dependency ward, and a separate cardiothoracic critical care unit. As a result of its larger size and specialist services, substantially more central venous catheterizations are undertaken at hospital 2.

Twenty-seven clinical episodes were observed, in which 39 IJV cannulations were attempted and 36 central venous catheters were successfully inserted. Nine observations were in the cardiothoracic setting (in which 2 central venous catheters were typically inserted in the same IJV), 10 were in operating