Is Chest Radiography Necessary After Uncomplicated Insertion of a Triple-Lumen Catheter in the Right Internal Jugular Vein, Using the Anterior Approach?*

Klaus-Dieter Lessnau, MD, FCCP

**Study objectives:** Chest radiographs are required in many institutions by protocol after the insertion of a right internal jugular vein triple-lumen catheter (TLC), even if the anterior approach is used. This study investigates whether correct placement can be predicted during insertion and whether a “routine” postprocedural chest radiograph can be safely omitted.

**Design:** The operators included 18 first-, second-, or third-year medical residents, 3 pulmonary fellows, and a board-certified pulmonary medicine and critical care attending, with at least 1 certified physician present during the procedure. All operators were trained in the “seven number rule.”

**Patients:** One hundred consecutive patients who required central venous access. Patients with left internal jugular vein or subclavian catheters were excluded.

**Setting:** Single institution, medical ICU, step-down unit, and floors.

**Interventions:** Right internal jugular vein TLC insertion, anterior approach, with subsequent chest radiograph.

**Measurements and results:** Eighty-eight patients had uncomplicated insertions, as defined by fewer than four sticks with a 22-gauge pathfinder needle and fewer than four slides with the 18-gauge introducer needle. Ninety-eight catheters were in accurate position, 1 catheter was in the distal superior cava vein, and 1 catheter was in an S-shaped position.

**Conclusions:** It is safe to omit the routine chest radiograph after uncomplicated insertion of a TLC. IV treatment can be initiated early. However, if there is any doubt about the correct position, a chest radiograph should be obtained.

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**Key words:** catheterization; central venous; chest; intraoperative complications; jugular veins; medicine; postoperative complications; radiography

**Abbreviations:** TLC = triple-lumen catheter

In the United States, physicians insert > 5 million central venous catheters every year,1 many of which are triple-lumen catheters (TLCs). The position within the superior cava vein is conventionally confirmed with a chest radiograph. Many institutions have protocols that require a chest radiograph to confirm the position of the catheter prior to its use. This can delay the administration of life-saving anti-

microbial therapy and IV volume, such as crystalloids, and the withdrawal of a previous, possibly infected TLC as a source of bacteremia (“kissing sign” with two indwelling adjacent catheters). The so-called “clearance” of a TLC is not only time

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consuming and expensive, but may paradoxically increase adverse effects to the patient by prohibiting the early use of the catheter in the absence of adequate peripheral veins or additional IV lines.

We conducted a prospective study of consecutive adult patients who required the insertion of a right internal jugular vein TLC via the anterior approach. It was investigated whether correct placement could be predicted prior to the review of the chest radiograph. The purpose of this study was to evaluate the necessity of obtaining a “routine” postprocedural chest radiograph.

**Materials and Methods**

The patients were selected based on the need for central venous catheters, such as lack of peripheral IV access and requirement of vasoactive medication, fluid, or antimicrobials. Informed consent was obtained for each patient, either from the patient or the surrogate. The ethics review board approval was waived because of the observational cohort study approach without change of standard care.

This prospective study consists of 100 consecutive patients who underwent placement of a TLC (22 cm long; Arrow Kit; Baxter; Boston, MA). The study was limited to the anterior approach of the right internal jugular vein to increase uniformity and decrease the possibility of pneumothorax. All eligible patients were included, and all 100 insertions were performed between November 2000 and February 2001. The operators included 18 first-, second-, or third-year medical residents, 3 pulmonary fellows, and a board-certified pulmonary medicine and critical care attending, with at least 1 certified physician present during the procedure. In order to become certified, all participants had to undergo five supervised right internal jugular vein TLC insertions, and they had to be able to explain the “seven number rule” (Table 1). Eligible patients were hospitalized and in the medical ICU, pulmonary step-down unit, or on a medical floor. The central venous catheters were placed under sterile conditions using face mask, cap, gown, gloves, and complete bed cover sheet. All patients were in supine or Trendelenburg positions. The anterior approach was used without the use of imaging devices. The entry site was the upper angle of both sternocleidomastoid muscles that was marked with an intradermal circular wheal with 2 to 4 mL of 1% lidocaine, with skin color lightening and “orange skin.” The 22-gauge pathfinder needle was 3.5 cm in length. It was inserted along the median margin of the lateral sternocleidomastoid muscle and was inserted without touching the patient, avoiding to distort anatomy. In most patients it was inserted up to two thirds of its length. The pathfinder needle and the syringe were left in place once the needle was located within the jugular vein and adequate blood return was proved. The 18-gauge introducer needle was slid along the pathfinder needle until free blood return was confirmed again. The J-shaped guidewire was inserted to approximately 20 cm without resistance. The appearance of atrial arrhythmias in ECG-monitored patients was also used to confirm correct placement of the guidewire. The introducer needle was repositioned if resistance to the guidewire was encountered. The skin was incised with a provided blade and a dilator was inserted to about half its length. The TLC was then advanced to a depth of 15 cm. After confirming appropriate blood return in all three lumens, the line was secured with three sutures: one at the entry site and two at the hub.

A “complicated insertion” was defined as an insertion that required more than three sticks or more than three slides that encountered resistance during guidewire insertion, induced hematoma or excessive bleed, had no blood return in one or more lumens, or included the possibility of a pneumothorax. The procedure was always defined as complicated if the primary operator was in doubt about complicated or “uncomplicated” insertions.

The study questionnaire included demographics and diagnoses. An assessment was obtained prior to the result of the chest radiograph with a complication risk profile. The postprocedure assessment consisted of an anteroposterior chest radiograph (portable chest radiograph) to determine the accurate positioning of the catheter and to confirm the absence of an ipsilateral pneumothorax. The investigating physician read the chest radiograph, and official reports that were read by a radiologist blinded to the study were followed. Patients with placement into the external jugular veins, left internal jugular vein, and subclavian and femoral veins were excluded.

**Results**

This cohort included 51 male and 49 female patients. The median age was 66 years (range, 19 to 100 years), the median height was 165 cm (range, 148 to 215 cm), and the median weight was 76 kg (range, 39 to 203 kg). The ethnicity profile consisted of 59 African Americans, 24 whites, 12 Hispanics, and 5 Asian Americans. The underlying diseases contained 76 cases of acute respiratory failure on positive pressure ventilation, 71 cases of sepsis, 44 cases of pneumonia, 41 cases of coagulopathy, 19 cases of acute renal failure, 25 cases of COPD, 6 cases of liver failure, and 4 cases of cerebrovascular accidents. The catheters were introduced in a controlled situation and not during cardiopulmonary resuscitation. The main investigator was present at 17 line insertions. All catheters were inserted by or supervised by a certified physician.

Ninety-eight anterior right internal jugular vein TLCs were in the correct superior cava vein position above the right atrium. Two insertions were not in accurate position, with one distal tip being 7 cm above the right atrium, and one in an S-shaped position. The first patient had an unusual body height of 215 cm. The second catheter required approximately 20 sticks and five slides, and the

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**Table 1—The Seven Number Rule**

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<th>Table 1—The Seven Number Rule</th>
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<td>One stick with the pathfinder needle; one slide with the introducer needle</td>
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<td>Two needles; two syringes</td>
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<td>Three lumens with good blood return after insertion</td>
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<td>Needle bevel at 6, 9, and 12 o’clock, but not at 3 o’clock, to avoid right subclavian vein entry</td>
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<td>15 cm central line secured at entry site</td>
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<td>22-gauge pathfinder needle</td>
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<td>45° angle for needle insertion</td>
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catheter was found to be in an unusual position with the middle part extending to the lateral side and the distal part positioned in a 90° angle, next to the mediastinal wall of the superior cava vein. Additionally, the blood return in two lumens was inadequate. Twelve patients had complicated insertions as determined by the operator. Additional complications included one local hematoma that was controlled with local pressure. Two insertions of the guidewire encountered resistance during advancement. Ninety-nine insertions had good blood return in all three lumens. Eighty-eight insertions were classified as uncomplicated insertions prior to obtaining a chest radiograph. All of them were in the correct position. Pneumothoraces did not occur because the needle entry was high above the lung apex with the upper triangular angle as sole entry site.

**Discussion**

This study shows that it is safe to omit the routine chest radiograph with uncomplicated insertion of a TLC via the right internal jugular vein, using the anterior approach. It should be appreciated that the anterior approach is quite different from the subclavian approach and the anterior approach is quite different from the posterior approach. There are four pivotal concerns with the placement of central lines.

The first concern is the possibility of a pneumothorax. The maximal needle insertion depth with the described technique is always above the lung apex due to the cranial insertion site, the location with the 3.5-cm, 22-gauge pathfinder needle, and the sliding of the insertion needle. The 6-cm guidewire needle should never be used to locate the vein, and the chest radiograph may not be omitted if such a technique is used.

The second possibility is placement within the carotid artery. This can be easily detected by estimating pressure by palpating with the tip of the index finger, letting blood return into the distal lumen, and estimating the central venous pressure by holding the TLC upward until the level equilibrates with the central venous column. The need for aggressive volume infusion immediately after securing the new line can also be estimated by measuring central venous pressure without waiting for a pressure reading on the monitor. The use of ultrasound-guided insertion may also decrease arterial insertion, although the needle direction during the anterior approach always points away from the carotid artery. It is rarely necessary to obtain an arterial blood gas via the TLC. Newer catheters with oxygen saturation measurement may also detect intraarterial placement.

Third, extravascular placement is excluded by documenting adequate blood return in all three lumens that start at 0 cm at the distal end of the catheter, and 2 cm and 6 cm with many catheters. Last, the rare complication of retrograde right subclavian vein placement is avoidable by pointing the bevel away from 3 o’clock. Intraatrial placement is avoided by not exceeding the length of 15 cm. A nomogram by Peres is based on the patient’s height in centimeters divided by 10 (eg, a catheter would be advanced to 15 cm for a 152-cm person). Although this may fine-tune the insertion length, it was not found to be necessary for average-sized patients in this study. The tip of the catheter in all uncomplicated cases was in the correct position just above the right atrium in the superior cava vein.

In a study of 107 consecutive patients by Gladwin et al, there were six axillary vein malpositions. However, the study included left internal jugular approaches, and bevel positioning was not mentioned. In a similar study of 358 patients by Bailey et al, the cutoff for complications was less than three needle passes, and the “surgical gestalt” of having had a straightforward procedure. The study included subclavian and left-sided catheters, and eight malpositions were observed with uncomplicated insertions either in the right atrium or the subclavian vein. Interestingly, the complications included three pneumothoraces that were not seen on the initial chest radiograph, and only at least 18 h later. It is agreed that surgical gestalt is part of the art of medicine. However, the insertion technique will be safer if it can be expressed in numbers that are teachable, reproducible, and useful in daily practice.

A procedural protocol was not helpful in a small study of 24 multilumen catheters, but specific technical help was not provided in the protocol. Interventional radiologists do not generally advise post-procedural chest radiography, but fluoroscopy is routinely used during these insertions. A study of 572 internal jugular insertions found that two patients with symptoms prompted additional radiographs and delayed pneumothoraces were found. The authors concluded that immediate postprocedural radiographs are not routinely needed after image-guided internal jugular catheter insertion. A study with 98 patients reported 81 placements without incidence and one minor pneumothorax. However, no specific instructions were reported and only subclavian lines were included. Interestingly, even in this study, chest tubes were not necessary with uncomplicated insertions.

One may argue that the study size is too small with 100 consecutive patients. Nonetheless, it is unlikely that additional unpredicted and asymptomatic adverse effects would occur in a future study of, maybe,
10,000 consecutive patients. Although tips of central venous catheters have been found in an azygos vein, internal thoracic vein, or anomalous left superior cava vein, these events are so rare that multiple chest radiographs have to be performed to discover one aberrant position with unknown side effects. Many critically ill patients have daily chest radiographs in the morning that would discover unusual positioning early enough to avoid adverse effects. Although the results of a randomized study would increase the evidence level, it would be ethically difficult to design such a study if it leads to delays in the group of patients who require early treatment.

The continuing education and experience of the operator allow for a variable cutoff for the ordering of a chest radiograph, which is determined by the number of sticks and slides used as cutoff to determine complicated and uncomplicated insertion. The increasing experience of the physician will correlate with an increase of the cutoff. For the physician who wants to become more comfortable with this omission there is a learning curve that will continuously increase this cutoff. This reflects the value of more experienced physicians vs the beginner. In fact, many physicians already use this thumb rule to determine if they should immediately review the chest radiograph.

The economic impact of these findings is considerable with millions of central venous catheters per year and an estimated cost of about $200 for hardware and professional reading of an anteroposterior chest radiograph, not to mention the well-known inconvenience to locate these images. Hospital protocols that require mandatory chest radiographs should therefore be revisited or, at least, it should be possible for the educated clinician to override such local hospital policies. Because of a delay in the administration of essential medication, while awaiting the confirmation of the correct position of the TLC by chest radiographs, the so-called “clearance” of the TLC may increase adverse effects to the patient. In septic patients, it has been shown that early appropriate antimicrobials and early “aggressive” administration of crystalloids improve outcome and increase survival. The decision to omit chest radiographs after uncomplicated right internal jugular TCLs is cost-effective, does not compromise patient safety, prevents the delay of administering medications and may, in fact, improve survival. Delaying early goal-directed therapy by awaiting radiographic findings will increase mortality. A low estimate of decreasing mortality by 1% implies that 1 patient out of 100 could be saved by not ordering unnecessary radiographic images, provided that the result will be available in approximately 1 to 4 h. This would translate into a number to treat of 100. Future research will have to prove that obtaining routine chest radiography after uncomplicated insertion of a right internal jugular approach does not delay the initiation of life-saving antimicrobials and aggressive fluid therapy. Additional clinical research could be useful in this area.

In conclusion, it is potentially lifesaving to omit routine chest radiographs after the insertion of an uncomplicated TLC in the right internal jugular vein, using the anterior approach, by a certified physician who knows the seven number rule. However, if there is any doubt about the correct position of the catheter, a chest radiograph should be obtained.

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REFERENCES