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Safe Central Venous Access in an Overburdened Health System

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Case Summary

A previously healthy man, intubated in the intensive care unit (ICU) for respiratory failure due to coronavirus disease 2019 (COVID-19), required central venous access for vasopressor infusion. The intensivists were occupied managing other critically ill patients, so an available intern attempted to place a triple-lumen catheter in the right internal jugular vein using only anatomic landmarks for guidance. When the access needle was inserted, pulsatile return of blood was noted.

Multimedia

What Should Be Done Next?

- Remove the needle and hold pressure.
- Place a small single-lumen catheter to prevent bleeding.
- Use a percutaneous closure device to close the puncture site.
- Surgically expose the artery to remove the needle and repair the artery.

Consider the Options

With immediate recognition of the arterial puncture and only the access needle in place, the needle can safely be removed and prolonged pressure held over the site for 10 to 30 minutes.[1] The risk of hematoma or pseudoaneurysm formation is low and can be further reduced by using a small 22-gauge or 25-gauge micropuncture needle for the access.[1] The tract should not be dilated by placement of a single-lumen catheter. Percutaneous arterial closure devices have been effectively used off label for repair of iatrogenic carotid artery injuries associated with central venous access when a large-bore catheter has been placed.[2] However, given that the artery was not dilated and the catheter was not yet placed, neither percutaneous closure nor surgical repair is indicated. In the unlikely event that despite prolonged pressure a hematoma or pseudoaneurysm results, surgical repair may be required.

Root Cause Analysis

This iatrogenic arterial injury associated with a central venous access procedure may have resulted from several factors, including failure to use ultrasound guidance, which is the contemporary standard practice, and central line placement attempt by an inexperienced and likely inadequately trained operator.[3]

Correct the Errors

Placement of central venous access, a routine occurrence in critical care units and emergency departments, poses a unique challenge during health care crises when experienced clinicians are overburdened with acutely ill patients. To better utilize the specialized skills of the available workforce and maximize patient safety during the COVID-19 pandemic, central venous access line teams have been developed to address the venous access needs of hospitalized patients.[4,5] The teams typically include vascular surgeons, general surgeons, interventional radiologists, and anesthesiologists, all specialists with training and experience in central venous access. During the height of the COVID-19 pandemic and other health care emergencies, elective operations and procedures were deferred, freeing up personnel and resources that could serve on line insertion teams. These specialists also have experience identifying and managing the complications associated with these procedures. Some line insertion teams also placed arterial lines, orogastric and nasogastric tubes, and Foley catheters to further assist other overburdened clinicians.[5]

To evaluate the implementation and outcomes of these central venous access line teams, a cross-sectional, self-reported multiinstitutional study was performed.[5] Sixty hospitals in 13 countries and 37 US states contributed data regarding their experiences of creating and implementing line insertion teams. They also reported on technical aspects of the central venous access procedures in the pandemic setting and the management of associated iatrogenic complications. Of the 60 hospitals, 58 had designated teams of clinicians available for central line placement. Most of these hospitals did not have line insertion teams prior to the pandemic. Line insertion team protocols were rapidly developed to address urgent and unique venous access requirements during the pandemic. Most of the participating hospitals were urban, academic, university-affiliated hospitals with more than 400 beds. Data were collected between April 22 and May 4, 2020. Most line insertion teams provided services for ICU patients with positive or pending COVID-19 test results. Some teams also placed lines in COVID-19–negative patients to assist the overburdened ICU teams, and some also placed lines for patients in the medical/surgical units or in the emergency department. All centers continued to adhere to standard practice and use ultrasound guidance for central venous access procedures whenever possible, including confirming wire position in the long-axis ultrasound view.

There were 2657 lines placed in patients with positive, pending, and negative COVID-19 test results in the 20 participating sites that were able to report the total number of lines placed. Of these, 11 (0.41%) line placements were associated with iatrogenic complications, less than the expected complication rate of 4% to 9%.[6-9] There were 2 inadvertent arterial catheter placements, 7 puncture-site bleeding episodes (hematoma or active bleeding), 1 pneumothorax, and 1 air embolism. The air embolism was in a patient with COVID-19 who was not intubated, and the patient died shortly thereafter. This was the only death reported from these sites that was directly related to an iatrogenic venous access complication. The lower-than-expected complication rate might have been attributable to the greater level of experience and expertise of the vascular access teams.

Line insertion teams managed a total of 48 iatrogenic complications in COVID-19–positive patients at 23 of the 60 participating sites. Most (39/48) complications were associated with line placement procedures performed by clinicians who were not part of the line insertion team. In 20 of the 48 complications, the participating site reported that the complications were attributable to insufficient operator experience and inadequate use of ultrasound or wire

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control during the procedures. Every line insertion team reported using ultrasound guidance for all procedures, but this was not the case for lines placed by clinicians who were not associated with the line insertion teams.

When initiating a central venous access line team, an appropriate schedule for the team's activation should be established based on available resources and institutional needs. Ideally, the team should be available at all times and be able to provide service throughout the hospital; any limitations of hours or sites served should be communicated clearly to all relevant hospital personnel. The activation and conclusion of line insertion team services should be tailored to the needs of the institution and the requirement of the line insertion team members' expertise in other clinical areas. Understanding variations in individual institutional resource allocation and having open communication between relevant stakeholders is key to providing appropriate, high-quality service to all hospitalized patients at the optimal time and place. In preparation for future surges of the COVID-19 pandemic and other health care emergencies, protocols should be developed that include central venous access line teams composed of physicians with percutaneous vascular access expertise, development of standardized protocols, and a method to track procedural outcomes.

An adequately stocked line cart increases the efficiency of line placements. This cart should have all the supplies and personal protective equipment (PPE) necessary to safely perform the procedures. An appropriately stocked cart minimizes potential clinician exposure to infectious agents and allows for a more streamlined performance. Further increases in the efficiency of clinician utilization can be realized by limiting the number of clinicians in the room performing the procedure to 2, with a runner outside the room to retrieve additional supplies as needed. This likewise can preserve PPE and minimize personnel exposed to infectious agents.

The internal jugular vein was the preferred anatomic location for central venous access used in this study of 60 hospitals during the COVID-19 pandemic due to ease of accessibility by ultrasound. Subclavian lines were discouraged, given the known increased incidence of pneumothorax compared with internal jugular lines. Due to the frequent use of prone positioning in patients with COVID-19, study participants reported successfully placing a triple-lumen catheter in the popliteal vein under ultrasound guidance with techniques commonly used in the lysis of iliofemoral deep vein thrombosis (see related video at jama.com).[10] This demonstrates the ability of clinicians with appropriate specialized technical expertise to adapt to unusual challenges that may be imposed by a health care crisis. A caveat of placing central lines in the popliteal vein is a potential increase in the risk of deep vein thrombosis. Thus, each case should be carefully considered and executed with caution.

Outcome

The needle was removed and pressure was held for 20 minutes. The patient did not develop any clinical signs of a hematoma or pseudoaneurysm during the hospitalization, which was confirmed by ultrasound.

Bottom Line

- Even during a health care emergency, standard practices including use of ultrasound guidance for central venous access and prioritization of standard anatomic locations should be maintained to minimize procedural complications.
- Dedicated central venous access line teams composed of physicians trained in percutaneous central venous access can ease a stressed health care system during a health care crisis.
- Appropriately staffed dedicated central venous access line teams can perform high volumes of procedures with low procedural complication rates.
- Planning for future health care emergencies should include protocols for central venous access line teams that describe staffing, a dedicated line cart, recommendations on the optimal anatomic site and technique, and a method to evaluate outcomes.

ARTICLE INFORMATION

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