Journal of Geriatric Cardiology | JGC
LETTER TO THE EDITOR
J Geriatr Cardiol 2024; 21(11): 1096–1098

Workflow for treating inadvertent arterial placement of the central venous catheter

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https://doi.org/10.26599/1671-5411.2024.11.006

We read the article "How to manage the malposition of deep vein catheterization into the artery" [1] with keen interest. However, we have several concerns with the proposed algorithm. First, the site of catheter misplacement is assumed to be the subclavian artery, the most frequent site of misplacement during internal jugular vein catheterization.[2] However, catheter misplacement can occur in the common carotid and vertebral arteries during internal jugular vein catheterization.[2,3] If a catheter is misplaced in one of these arteries, preventing cerebral ischemia is a priority.[2,4,5] For example, if a thrombus forms around the catheter, a method is chosen to resolve it while preventing dispersion and closing the perforation.[2,6] Therefore, open surgical closure must be selected. Second, the algorithm may not handle instances of realistic catheter misplacement in the arteries. We assume a case where an internal jugular venous catheter (5Fr double-lumen catheter) is inserted but accidentally penetrates the subclavian artery and is placed in the thoracic cavity. Suppose that the injured site is about 5 mm from the confluence of the right common carotid or vertebral arteries. The algorithm recommends endovascular treatment together with a vascular closure device. However, a stent graft should be chosen because of two injury sites (penetrating both anterior and posterior vein walls). If a stent graft is used, a landing zone of at least 2 cm is required (the exact minimum distance required for landing depends on the product). In these cases, open surgical closure may be performed to avoid cerebral ischemia. Third, catheter size and placement site are not the only factors in choosing the treatment for catheter misplacement in the arteries. The patient's general condition, arteriosclerosis, anticoagulation and antiplatelet medications, and the patient's and family's right to make treatment decisions are also crucial factors. Furthermore, the skills of the medical providers performing the procedure and the quality of the medical facilities are also relevant.

We do not deny the intentions of the authors. The development of endovascular therapy has been remarkable, and new guidelines are required to treat arterial catheter misplacement. However, as patients age, the risk of comorbid diseases increases, leading to rising risks in endovascular treatment and surgical procedures. Arterial catheter misplacement in the clinical setting is complex. Therefore, we propose a workflow rather than an algorithm. Workflow is also closely related to team medicine in terms of the involvement of different experts and improvement in medical care. Figure 1 shows the workflow of our hospital. We established this system after catheter artery misplacement in several critically ill patients. With this workflow, mechanical complications can be treated before they become fatal. This is primarily due to the immediate convening of expert physicians, facilitating a multifaceted evaluation of the risks associated with treatment.

We present our experience with a catheter mistakenly placed in the right subclavian artery during right internal jugular venous catheterization.[7] In this case, open surgery is considered the most reliable method for closing the right subclavian artery perforation. However, the patient was in a poor state of health. Therefore, an alternative approach that uses stent-grafts was selected. Patients should be evaluated for cerebral ischemia as occlusion of the vertebral artery is inevitable after stent graft insertion. Neurosurgeons of the expert team convened by the Patient Safety Department immediately performed contrast-enhanced magnetic resonance imaging to predict cereb-

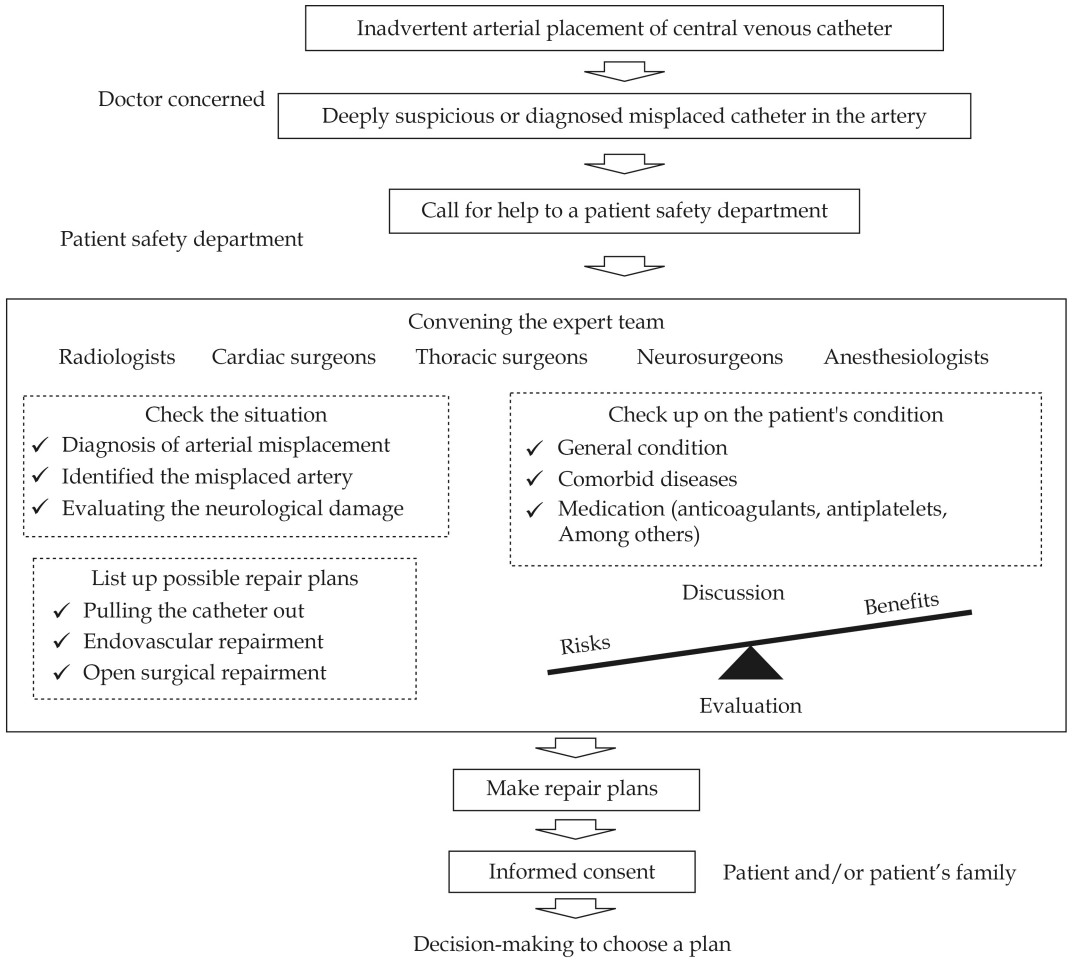

Figure 1 Workflow for treating mechanical complications for central venous catheterization. The attending physician, the person in charge of the patient safety department, and the surgeon explain the treatment to the patient and the patient's family.

ral blood flow in the event of right vertebral artery occlusion. In this case, a plan for stent-graft insertion was adopted, and the Patient Safety Department explained the risks and benefits of both stent-graft and open surgical closure to the patient and the patient's family, obtaining consent for the procedure. All procedures were performed expeditiously.

Before this workflow, the attending physician consulted the vascular surgeon, who identified the injury site and consulted a radiologist when in doubt. Generally, a radiologist does not offer an opinion unless the vascular surgeon consults about the possibility of endovascular treatment. In this algorithmic process, all consultations were sent to each department; however, this process was prolonged before concluding. During this time, mechanical complications became fatal, and the time for treatment was lost. A workflow was developed based on these considerations.

Any suspected arterial misplacement should be immediately reported to the Patient Safety Department to clarify all authorities and instructions. One aspect of this process is the workflow. In our experience, misplaced catheters in arteries are a common example of a medical incident related to central venous catheter insertion. Other organ injuries (e.g., pneumothorax and mediastinal deviation) may have occurred along with misplacement, making the typical case algorithm ineffective. Nevertheless, the organization must take all necessary measures to prevent mechanical complications from becoming lethal. This requires improved organizational and operational flows.

DECLEARATIONS

Conflicts of Interest

J.T. is a technical adviser at CardinalHealth Japan Co.

and has completed an ultrasound-guided technical training course.

Author Contributions

Conceptualization: Joho Tokumine, Keisuke Fujimaki, Kiyoshi Moriyama; Original draft writing: Joho Tokumine, Keisuke Fujimaki; Editing draft: Kiyoshi Moriyama, Tomoko Yorozu; Supervision: Tomoko Yoyozu.

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Please cite this article as: Tokumine J, Fujimaki K, Moriyama K, Yorozu T. Workflow for treating inadvertent arterial placement of the central venous catheter. *J Geriatr Cardiol* 2024; 21(11): 1096−1098. DOI: 10.26599/1671-5411.2024.11.006