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Learning From Others: A Case Report from the Anesthesia Incident Reporting System

CASE 2021-09: If In Doubt

A 78-year-old female presented to the hospital where she was diagnosed with an acute lateral wall myocardial infarction, occluded circumflex coronary artery, free wall rupture of left ventricle, and cardiac tamponade.

A left femoral intra-arterial balloon pump was inserted emergently along with a left radial arterial line, peripheral intravenous catheter, and a right femoral 6 Fr introducer. The patient was resuscitated with 5 L crystalloid and transferred to a secondary institution for definitive emergent intervention. Transfer of care report was given by the emergency medicine physician to the receiving hospital's emergency physician.

At the secondary institution, the patient arrived in the OR at 19:30 for a planned coronary artery bypass graft and patch repair of the left ventricle. Intravenous induction was performed using the in situ *peripheral line after transfer of care report was received by the anesthesia team from the emergency physician.*

When fluids were connected to the in situ *right femoral introducer, no free flow of fluids to gravity was evident despite easy flushing and smooth blood return. An attempt was then made to insert a right internal jugular introducer using ultrasound guidance. Once in place, this new right IJ catheter, however, did not produce blood return and required high pressures to flush the line.*

Due to urging of the surgeon to proceed with the case, the decision was made to utilize the in situ *right femoral introducer catheter as the primary volume and central line. Cardiopulmonary bypass was initiated at 21:00.*

Throughout the case, the right femoral line was used to deliver vasopressor infusions (norepinephrine, vasopressin, dobutamine), fluids, blood products, and heparin. At the end of the case, the right IJ central line was found to be kinked and was therefore removed. A left IJ introducer was therefore inserted under ultrasound guidance and the patient was transferred to the cardiothoracic intensive care unit intubated in stable condition.

Due to the poor flow of fluids using the right femoral introducer, a transducer was connected in the ICU and revealed a characteristic pulsatile arterial waveform. Additionally, the right leg was noted to exhibit cyanotic mottling. The right femoral line was subsequently removed, and a vascular surgery consult was called.

A heparin infusion was initiated, and no further intervention was required. The patient was extubated on POD#6 and suffered no adverse effects from the right femoral arterial catheter.

This case presents two valuable learning opportunities. First, what are the consequences and treatment of inadvertent administration of fluids, blood products, and medications through an arterial line? Second, how can the inadvertent use of intra-arterial lines for such administrations be prevented?

Parenteral drugs or fluids/blood product administration via central venous access can result in several unintended consequences. Specifically, these infusions meant for intravenous route can end up in the following locations inadvertently (*Br J Anaesth* 2013;110:333-46):

- Intra-arterial (as in this case)
- Subcutaneous (a.k.a., extravasation)
- Intrapleural, mediastinal, peritoneal
- Wrong vein (e.g., tip traverses brachiocephalic vein to contralateral internal jugular, pointing upward, or secondary to anatomic variation of a patient).

Concerning intra-arterial infusions, have they always been considered harmful? As early as 1883, surgeons used the intra-arterial route to administer blood or saline for traumatic amputations and sepsis. In fact, this was considered a preferred route for resuscitation for patients in hemorrhagic and septic shock (Refusion in the treatment of carbonic oxide poisoning. 1884). During WWII, many reports demonstrated successful intra-arterial blood transfusions. Various sites necessitating different infusion pressures were described, including the common carotid, radial, dorsalis pedis, and femoral arteries (*Khirurgiyi* 1944;8:33-7). Complications of intra-arterial infusion were not unknown to the practitioners at that time. They cautioned against thromboembolism and arterial spasm and recommended cessation of transfusion after 30 minutes. Interestingly, such practitioners in 1950s strongly recommend the following precautions: "… one person be completely and solely responsible for the transfusion in order to prevent air embolism and regulate pressure gradient" (*Can Med Assoc J* 1951;65:95-8). This practice was eventually abandoned in the 1960s.

As was observed by these earlier clinicians, almost any fluid other than saline or blood can cause arterial spasm, direct tissue damage, chemical arteritis, and release of thromboxane leading to thrombosis exacerbated by lumen occlusion of the catheter, ultimately resulting in tissue ischemia and gangrene. Numerous case reports exist describing inadvertent intra-arterial injection of various drugs, such as propofol, thiopental, and benzodiazepines, as well as phenytoin and antibiotics, to name a few (*Eur J Vasc Endovasc Surg* 2002;23:378-9). The degree of damage depends on the nature of a drug, the concentration, and the amount and speed of administration.

Unfortunately, there is no uniform consensus on definitive treatment to prevent limb ischemia and gangrene following accidental intra-arterial injection. Several protocols exist, advocating keeping the cannula in place for infusion of local anesthetics, anticoagulants, or vasodilators (*Ann Plast Surg* 1990;25:279-82). Sympatholytic therapy (stellate ganglion block), high-dose steroids, hyperbaric therapy, and nitro-paste application all have been used with various success (*J Oral Maxillofac Surg* 2006;64:965-8).

To avoid these complications, how can one prevent inadvertent intra-arterial infusions? Several factors contributed to the lack of recognition of the intra-arterial right femoral line in the scenario reported into AIRS. These include:

- Emergent insertion of the right femoral central line in a patient with low blood pressure secondary to cardiogenic shock
- Verification (e.g., pressure transduction, blood gas analysis, manometer, ultrasound) of correct placement was not done at either institution secondary to emergent nature of the procedure and hemodynamic instability of the patient requiring prompt treatment
- Different clinicians were involved in this error: a) the clinician who initially inserted the right femoral line and b) the clinician who ran infusions through the line
- Lack of communication about line verification during transfer of care.

An updated report by the ASA Task Force on Central Venous Access issued in 2020 includes several recommendations regarding verification of needle, wire, and catheter placement summarized in the following algorithm (*Anesthesiology* 2020;132:8-43). Unfortunately, the current literature is insufficient to address the optimal modality for verification – ultrasound, pressure-waveform analysis, blood gas analysis, visual inspection of blood color, or absence of pulsatile flow. The guidance merely states, "the consultants and ASA members strongly agree that after final catheterization and before use, confirm the residence

Table 1: Cognitive Error Catalogues

Cognitive Error	Definition	Illustration
Anchoring	Focusing on one issue at the expense of understanding the whole situation	While troubleshooting an alarm on an infusion pump, you are unaware of sudden surgical bleeding and hypotension
Availability bias	Choosing a diagnosis because it is in the forefront of your mind due to an emotionally charged memory of a bad experience	Diagnosing simple bronchospasm as anaphylaxis because you once had a case of anaphylaxis that had a very poor outcome
Premature closure	Accepting a diagnosis prematurely, failure to consider reasonable differential of possibilities	Assuming that hypotension in a trauma patient is due to bleeding, and missing the pneumothorax
Feedback bias	Misinterpretation of no feedback as 'positive' feedback	Belief that you have never had a case of unintentional awareness, because you have never received a complaint about it
Confirmation bias	Seeking or acknowledging only information that confirms the desired or suspected diagnosis	Repeatedly cycling an arterial pressure cuff, changing cuff sizes, and locations, because you 'do not believe' the low reading
Framing effect	Subsequent thinking is swayed by leading aspects of initial presentation	After being told by a colleague, 'this patient was extremely anxious preoperatively', you attribute postoperative agitation to her personality rather than low blood sugar
Commission bias	Tendency toward action rather than inaction. Performing un-indicated manoeuvres, deviating from protocol. May be due to overconfidence, desperation, or pressure from others	'Better safe than sorry' insertion of additional unnecessary invasive monitors or access; potentially resulting in a complication
Overconfidence bias	Inappropriate boldness, not recognizing the need for help, tendency to believe we are infallible	Delay in calling for help when you have trouble intubating, because you are sure you will eventually succeed
Omission bias	Hesitation to start emergency manoeuvres for fear of being wrong or causing harm, tendency towards inaction	Delay in calling for chest tube placements
Sunk costs	Unwillingness to let go of a failing diagnosis or decision, especially if much time/resources have already been allocated. Ego may play a role	Having decided that a patient needs an awake fiberoptic intubation, refusing to consider alternative plans despite multiple successful attempts
Visceral bias	Counter-transference; our negative or positive feelings about a patient influencing our decisions	Not trouble-shooting an epidural for a laboring patient because she is 'high-maintenance' or a 'complainer'
Zebra retreat	Rare diagnosis figures prominently among possibilities, but physician is hesitant to pursue it	Try to 'explain away' hypercarbia when MH should be considered
Unpacking principle	Failure to elicit all relevant information, especially during transfer of care	Omission of key test results, medical history, or surgical event
Psych-out error	Medical causes for behavioural problems are missed in favour of psychological diagnosis	Elderly patient in PACU is combative – prescribing restraints instead of considering hypoxia

Table adapted from *Br J Anaesth* 2012;108:229-35

of the catheter in the venous system as soon **as clinically appropriate** [emphasis ours]."

Additionally, these practice guidelines do not address the topic of emergent placement of central venous catheters (*Anesthesiology* 2020;132:8-43). As seen in the case presented, an emergent situation creates various potential pitfalls: lack of immediate availability of ultrasound equipment, lack of availability of transducer during placement, low blood flow states lacking pulsatile flow, and oxygenated color of arterial blood.

Other important contributory factors in this case presentation are numerous cognitive biases. The anesthesia clinician was informed that there was an *in situ* femoral catheter. The "unpacking principle bias" prevented the anesthesia clinician from eliciting more information during the transfer of care. While the anesthesia clinician observed that there was no "free flow" of fluid using the femoral introducer catheter, the clinician was "anchored" by the fact that the transferring physician informed the team that a functioning right femoral line was intact.

After several unsuccessful attempts to troubleshoot and obtain free flow of fluids through the catheter, the clinician arrived at "premature closure" by accepting the diagnosis of a partially kinked but functional catheter. The fact that blood could be withdrawn and appeared dark in color, plus the observation that the blood pressure in fact stabilized when blood was given through the line, served as "confirmation bias" that the femoral line was a venous line. Additionally, as an experienced cardiac anesthesiologist who had placed many central lines during their career, "overconfidence bias" led this clinician to ignore their doubts and proceed with drugs and blood product administration. Finally, the clinician hesitated to take action and call for a second opinion or remove the existing line for fear of delaying the case and appearing inept in front of the surgeon, all in accordance with "omission bias" (*Br J Anaesth* 2012;108:229-35).

In summary, this case demonstrates the inherent danger of using a central venous catheter without proper verification of placement. One should exercise caution and vigilance when using a catheter that was placed by another clinician, especially in an emergent situation when there is an increased opportunity for mistakes. Warning signs, such as lack of flow to gravity in a presumably patent venous catheter, should not be ignored but rather investigated further. Additionally, due to easy access, the femoral vein site is commonly used for central line placement in a code situation. This can present particular challenges since chest radiographs are not useful for placement verification as in upper-body central line placements, and low-flow states are common during codes where pulsatile blood flow may not be obvious.

Review of unusual patient care experiences is a cornerstone of medical education. Each month, the AQI-AIRS Steering Committee abstracts a patient history submitted to the Anesthesia Incident Reporting System (AIRS) and authors a discussion of the safety and human factors challenges involved. Real-life case histories often include multiple clinical decisions, only some of which can be discussed in the space available. Absence of commentary should not be construed as agreement with the clinical decisions described. Feedback regarding this article can be sent by email to **airs@asahq.org**. Report incidents or download the AIRS mobile app at **www.aqiairs.org.**