

Arterial Lines - Notes on ICU Nursing

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Arterial Lines

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I thought it might be interesting to get away from big scary things like balloon pumps, PA-lines and defibrillation, and to try focusing on something that we use routinely, and try to look at it in detail. I read once that pilots will sit and argue about the right way to do anything – taxiing, turning, whatever – that they never stop trying to refine their skills at both the big things and the little ones. Close attention to little things really helps in the MICU, and looking closely at a tool like an a-line might be useful in showing how details matter...as usual, please remember that this is preceptor material, and not meant to be official in any way. When you find mistakes, let us know and we'll fix them. Thanks!

1- What is an A-line?

A-line stands for Arterial line. Our teams use the same 20-gauge straight IV catheters that they use for peripheral lines, and insert them into – usually – the radial artery in one wrist or the other.

2- What are the parts of an a-line?

We start with a bag of heparinized saline: 2units of heparin per cc. The bag is connected to a standard transducer setup: soft tubing from the bag to the transducer, and stiff tubing from the transducer to the patient (some of us old guys call this “Cobe tubing”, named after the manufacturer of the tubing we used back in the last Ice Age. Anybody else remember Norton domes?) The stiff tubing goes from the transducer to a stopcock – the stopcock is connected to a short length of softer tubing that we call a “T-piece” (I have no idea why we call it a t-piece – doesn’t look like a ‘t’.) The t-piece screws onto the stopcock at one end, and the other end plugs into the open end of the arterial catheter.

The bag of flush is pumped up to 300mm of pressure with a white pump bag – the transducer controls the forward flow of flush into the artery, keeping it open, at a rate of (I think) 3cc per hour. If the line weren’t pressurized this way, the arterial pressure would make the patient’s blood climb right back up the line.

3- Does it matter if the flush setup is made with plain saline or heparinized saline?

Actually I think that it doesn’t matter in terms of keeping the vessel open – but it does matter if your patient is heparin-sensitive. We’ve been seeing more patients turning up positive for the heparin-induced-thrombocytopenia thing – lately when I’m making my own flushes for a new patient that I know nothing about, I use saline. If your patient’s platelet count drops for no apparent reason, you can go ahead and change them to saline line flushes – apparently even a tiny bit of heparin can cause this problem, which seems to go away after the heparin does.

4- What are a-lines used for?

Two things mainly: blood pressure monitoring, and for patients who need frequent blood draws. Any patient on more than a small amount of any vasoactive drip really needs to have an a-line for proper BP management – if they’re sick enough to be put in the unit and need pressors, then they’re sick enough for an a-line. Non-invasive automatic blood pressure cuffs are useful, but if a person is labile – push for an a-line.

Certain situations absolutely require an a-line for BP monitoring: any use of any dose of nipride, for example. This is a truly powerful drug – it works very quickly, and your patient can rapidly get into all sorts of trouble unless you’re monitoring BP continuously.

I’ve heard lately that there’s a trend towards using fewer a-lines – it seems silly (and painful) to have your patient get stuck what seems like twelve times in a shift for labs and ABGs. Remember that it’s always been our unit’s policy for nurses to send ABGs after every vent change, or for any clinical change that the patient makes.

Update – this has changed a little: ABGs probably don’t seem to be necessary for vent changes that are only going to affect oxygenation: changes in FiO2 or PEEP, since the O2 sat will keep

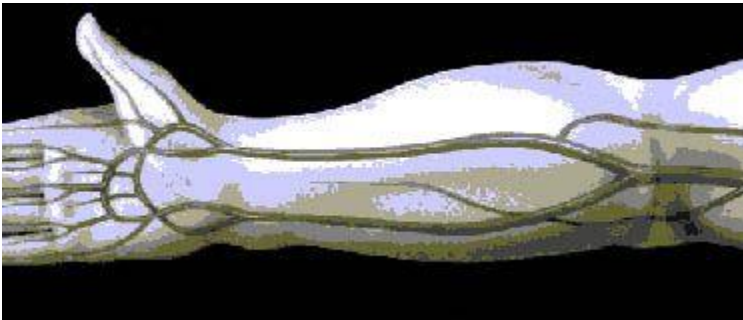
you pretty well informed about where your patient's oxygenation is at. Changing something that is going to affect ventilation or pH is a different matter though – these probably still merit a blood gas.

5- What do I have to think about before the a-line goes in?

First – unless the patient is unresponsive, or has no proxy at hand – the team should get informed consent for this procedure. You need to remember that you're putting something in one of the two vessels that supply the hand with blood. Is the patient hypotensive – are you going to need a doppler to find the pulse in the first place? Is the patient anticoagulated? Which hand does the patient use to write with? – get the team to use the other one. Is the patient very agitated, and likely to pull the line out – does she need some sedation?

Oh yes – have a transducer setup ready to hook up to the new line. House officers do not always think of this, especially if they're just learning the procedure – they're trying to do it right and not hurt the patient. Hook the setup to the monitor with a cable, and zero the transducer so that you'll be able to see the waveform when the line goes in.

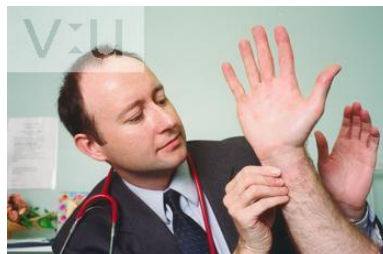
6- What is an Allen test?



Two main arteries. Which is the radial, and which is the ulnar?

http://www.medicalexpress.com/cardiologia/car_02_01_37/car_02_01_37.htm

The idea here is to figure out if the ulnar artery will supply the hand with enough blood, if the radial artery is blocked with an a-line. Here's the way I was taught: ask the patient to make a fist and hold it. Use your two thumbs to compress both the radial and ulnar arteries of the wrist, and have the patient open the hand. Now release the ulnar artery - the hand should quickly become nice and pink. Allen testing should be done before any a-line insertion, and maybe even before any blood gas sampling.



Uh, doc?...I think that was: release the ulnar artery, to see if the hand will perfuse...but see how well that hand pinked up? (He's probably checking both...)

<http://www.visualsunlimited.com/browse/vu126/vu1263.html>

7- Where can a-lines go besides the radial artery?

I've seen ulnar a-lines, brachials, axillaries, and the occasional one placed in the dorsalis pedis – the foot.



There are actually two pulses in the foot that you need to know about – this is one of them.

<http://www.latrobe.edu.au/podiatry/vascular/pulses.html>



Which one is this?

What would you do if you couldn't find them?

<http://www.latrobe.edu.au/podiatry/vascular/pulses.html>

Lots of patients come back from the cath lab with femoral artery sheaths in place. You always want to transduce any line that goes into an artery – what if it came disconnected? What could happen? Why would you want to know?

8- Who inserts a-lines?

House officers put these in, sometimes medical students under direct supervision. A-lines are tricky – sometimes you may have to ask the junior to help out an intern who's tried a few times...

Now and again the team is just not able to place the line – the patient is very hypotensive, maybe he's vasculopathic and just doesn't perfuse too well anywhere; or maybe he's very "clamped down" – which means that the arterial bed is very tight, as in cardiogenic shock.

In tough situations, the thing to do is to have the team get in touch with the anesthesia resident on call – these people can usually put an a-line in a marble statue while they're asleep. They are also the folks who will use other sites than the radial artery – foot, axilla, etc.

9- How is it done?



For the radial artery, the most common insertion, the arm is restrained, palm up, with an armboard to hold the wrist dorsiflexed. A straight number 20 IV catheter is inserted puncture-wise over the

radial pulse, on something like a 30 degree angle from the skin. If nice bright red blood comes up into the catheter, the stylet is removed, and the catheter is pulled back a little until the blood really starts flowing – this means that the tip of the catheter is at the puncture site in the artery. Now a short guide wire is fed through the catheter, and because it's stiff, it will slide into and along the lumen of the artery. The catheter is slid down the wire, following it's path into the vessel, and the wire is removed. At this point the physician will put her sterile, gloved thumb over the end of the catheter to stop the blood flow. You want to pass the end of the transducer line with the t-piece to the physician, who will insert it into the catheter hub. Encourage her to place it firmly – it's very unpleasant if these two parts separate. Now take look up at the monitor. Good waveform? The catheter gets sutured in, and we apply a standard dressing.

<http://www.ispub.com/xml/journals/ijh/vol3n1/aline-fig4.jpg>

10- What kinds of problems can happen during a-line placement?

Think about what might happen to any part of the body if its perfusion were disturbed: the patient could develop a hematoma of one size or another – this could even produce a compartment syndrome in the arm if not watched carefully. Make sure that you always keep an eye on the stick site – check the pulse routinely, check the distal capillary refill and feel the warmth of the hand overall a couple of times during the shift. Any time your patient is stuck for an arterial specimen – hold and compress the site for a while afterwards. This reliably prevents hematoma formation, and will save your patient a lot of grief. (Was he anticoagulated?)

A-lines can sometimes be hard to place. Inexperienced team members will often go through a number of catheters, sometimes hitting the artery a couple of times. Arteries don't like this very much, and, (just like the doctors), sometimes they'll go into spasm, tightening up – the pulse becomes harder to find. Encourage the team to try the other arm if this happens, or to wait a while to see if the spasm goes away.

Another problem that “goes with the territory” when a-lines are going into hypotensive patients is the fact that they are, uh...hypotensive. It's going to be hard to find the pulse. Try turning up the patients' pressor drip – often very helpful.

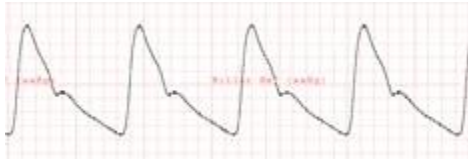
11- How do I use an a-line to monitor blood pressure?

A transducer is a device that reads the fluctuations in pressure – it doesn't matter if it's arterial, or central venous, or PA – the transducer reads the changing pressure, and changes it into an electrical signal that goes up and down as the pressure does. The transducer connects to the bedside monitor with a cable, and the wave shows up on the screen, going from left to right, the way EKG traces do.

A couple of things to remember:

- The transducer has to sit in a “transducer holder” – this is the white plastic thing that screws onto the rolling pole that holds the whole setup.
- The transducer has to be levelled correctly. Use the spirit level in the room to make sure that it's at the fourth intercostal space, at the mid-axillary line.
- Make sure there's no air in the line before you hook it up to the patient – use the flusher to clear bubbles out of the tubing.
- Zero the line properly, and choose a screen scale that lets you see the waveform clearly. This can be really important in situations like balloon pumping.

Let's take a second to look at a (hopefully) typical arterial waveform:



http://www.datascope.com/ca/images/millar_waveform3.jpg

The highest point is the systolic pressure, the lowest is the diastolic. Everybody see the little notch on the diastolic downslope? – there's one in each beat. A little after the beginning of diastole – the start of the downward wave – the aortic valve flips closed, generating a little back-pressure bump: called the "dicrotic notch". You'll need to remember that when the time comes for balloon pumping.

12- How should I set the alarm limits?

Set them meaningfully. Make sure that the limits will tell you if your patient gets into trouble. I always recheck all the alarm limits at the beginning of my shift. For example: the heart rate limits that are built into the monitor default at 50 and 150 – do you really want your patient's heart rate to go to 150 before the monitor will tell you?

13- How do I draw blood samples from a-lines?

Senior staff nurse Jane says: "It takes a year just to learn which way to turn the stopcocks!" This is really true: some stopcocks point to where they're open, and some point to where they're closed – it just takes some time to learn which is which. Drawing samples isn't hard – we use a vacutainer, draw a red discard tube of 5cc, and then plug the specimen tubes into the vacutainer the same way you would if you were doing a peripheral vein stick. The trick is remembering which way to turn the stopcock, and avoiding a mess. Don't forget to clear the stopcock, recap, and then flush the line. Keep things nice and sterile.

14- What order do I draw the tubes?

The trick here is remembering not to contaminate one tube with what might be left from the one before. The main one to watch for is the blue PT/PTT tube – if it gets contaminated by heparin from the line or the previous tube, you'll get results that have nothing to do with the patient. Draw the blue-top specimen right after the red discard tube.

15- How often does the transducer setup have to be changed?

The routine now is 96 hours – make sure that you label the line setup when you hang it. Obviously, change the line setup if it is contaminated in any way.

16- What kind of dressing goes on an a-line site?

Our routine is: scrub the site with a sterile 4x4 soaked in betadine, then paint about an inch away from the site – all around it – with benzoin. Cut a sterile piece of 4x4 to go on the site, and cover with a small clear tegaderm dressing. Try to resist the temptation to reinforce the site dressing with tape – this can make it really hard to get the dressing off without almost losing the line.

17- What is the armboard for?



The armboard and roll holds the wrist in a (gently) dorsiflexed position, which keeps the catheter from kinking if the patient bends his wrist.

<http://www.dalemed.com/images/armboard.jpg>

18- Does the patient's arm have to be restrained?

It ought to be, if there is any chance that she might lose the line by moving around. If the patient is very sedate or chemically paralyzed, you'd probably be safe without a restraint. Be careful judging this: patients can lose blood rapidly from a disconnected a-line hub.

19- What if the a-line has a good tracing on the screen, but I can't draw blood from it?

This probably means that the artery being monitored has "clamped down", or gone into spasm. You need to think about things that might make this happen: is the patient very cold? Are his extremities poorly perfused? Is he on a "shipload" of pressors, making his arterial bed tighten up – is he "dry" as well? Sometimes arteries become unhappy with catheters in them, and you just have to convince the team that the patient needs a new one placed in another site.

20- What does "dampened" mean?

To me, dampening is what happens when the catheter can't see the patient's blood flow clearly – he's bent his wrist, kinked the catheter – sometimes the top of the catheter pushes up against the vessel wall. The waveform flattens out on the screen – doesn't look much like an a-line trace any more. The trick is to learn the difference between a dampened waveform and a hypotensive one! If straightening out the patient's wrist doesn't help, sometimes you can take the dressing down and back the catheter out just a bit – this often works well. (I think there's a more technical definition of dampening – does anybody know? What's "ringing"?)

21- What if I lose the trace completely?

This could be a couple of things, and you need to do a little troubleshooting. The first thing to think about is: is the arterial catheter still in place? Yes? Try drawing with a 3cc syringe from the stopcock – if it draws normally, then you've got a hardware problem. Cables come loose? Once in a great while a transducer setup will fail – try a new setup. Did the screen scale get accidentally set to, say, 40, instead of 150 or 200mm of pressure? - you'll only see a flat line.

If the line doesn't draw – is there a clot in the hub? Try taking the site dressing down – is the catheter kinked going into the patient? Sometimes art-lines just fail – the artery spasms and won't open up – time for a new site.

22- How often should I check the pulse at the a-line site?

Strictly speaking, every hour. In practice, if your patient has tolerated having the line in place for some time, this can be loosened up a little, but try to remember that a-lines are a lot more invasive than IV's. A vasculopathic patient whose extremities may be poorly perfused is always at risk, even if his arteries don't have catheters in them.

23- How do I know if the patient's hand is at risk?

Usually this will be pretty obvious: the pulse will diminish, or go away altogether. The hand may look dusky, or be cold, or lose some sensation – remember to assess for coloring, sensation, motion, and capillary refill. If you think that the a-line is threatening the patient's hand, let the team know right away, and be ready to set up for another insertion somewhere else if the line is still necessary.

24- What do I do if the line disconnects at the hub/stopcock/transducer?

This is what alarms are for – the monitor should flash “line disconnect”. You really want to get down to the room right away – the patient is definitely at risk for losing some blood in this situation.

If the catheter hub has come apart from the t-piece, the thing to do is to screw a syringe onto it, keeping it sealed and clean while you attach a clean t-piece (they're in sterile packages) to the stopcock. Get someone to hold the artery proximal to the catheter (north along the wrist, above the insertion site) while you remove the syringe and replace it with the new t-piece end. (Flush the line clear first!)

If the t-piece comes loose from the stopcock, try to see if the parts are still sterile – usually in this situation they haven't been tightened enough. Just screw the parts together to make a tight seal and flush the line.

If the stiff transducer tubing comes loose at the transducer itself, blood will back up quickly along the line. If the loose end is hanging, turn the site stopcock off to the patient to stop the blood flow, and put together a new transducer setup right away. Always make sure that your setups are screwed together tightly!

25- What do I do if the patient pulls out her a-line?

Compress the site with a sterile 4x4 for several minutes, longer if the patient is anticoagulated. Assess the perfusion of the hand. Try to see if the patient has ripped out her sutures or not...make sure you put the patient on the non-invasive cuff at meaningful intervals while you talk to the team about replacing the line.

26- How do I know when it's safe to take out my patient's a-line?

This is usually pretty obvious – the patient is hemodynamically stable, needs only one or two blood draws in a day, no more need for ABGs – you know all that stuff.

26- How do I remove the line?

You'll want to disconnect the cable from the monitor before you do this, which will automatically turn off the alarms. What I do is clamp the t-piece, which has a little line clamp on it like the ones on the lumens of a triple-port cvp line – that leaves a minimum of hardware connected to the patient while you work on removing the catheter. Take out the sutures in the usual way with a fresh sterile kit. Have a 4x4 ready, pull the catheter, and manually compress the site for at least 3 to 5 minutes. Make sure the patient's hand is still perfused. Check for hematoma or bleeding, put a compression dressing on the site (not too tight!), which you can then take off after about an hour. Recheck the site hourly for a few hours afterwards – a hematoma could still form, and since there isn't a whole lot of room in a wrist, you'd definitely want to know!

Quiz Questions

True or False:

- 1- Any patient, on any dose of any pressor, should have an arterial line.
- 2- Any patient on any dose of nipride should have an arterial line.
- 3- Allen tests are for sissies.
- 4- It's perfectly safe for a patient to have an arterial line.
- 5- Arterial line site dressings don't have to be sterile.
- 6- A-line blood pressures are more accurate than cuff blood pressures.
- 7- Radial a-line pressures are more accurate than ulnar ones. Pedal ones. Femoral ones.
- 8- Restraining an a-lined arm is for sissies.
- 9- The author of these questions is pretty darned flip!