



Arterial Lines: Good or Bad?

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First, A Parallel Story -- About PACs

- By the 1980s they were very widely used (*CCM* 25:910,1997)
- In 1987, Eugene Robin wrote an editorial calling for a moratorium on their use until rigorous, controlled trials were performed (*Chest* 92:727,1987)
 - “Death by pulmonary artery flow-directed catheter” -- *The benefits of the use of the catheter are dubious. Even if there are subgroups of patients for which improved outcome could be demonstrated, such subgroups have not been established.*
- *A priori* rationale for PAC use is much stronger than for A-lines
 - the physiologic parameters measured with a PAC are not accurately assessed noninvasively (Connors *Chest* 98:1200,1990; Dawson *Med Decis Making* 13:258,1993; Saudinger *J Trauma* 44:902,1998)
 - **BUT**, the BP and HR data from an A-line can be obtained noninvasively, and the blood drawn from them can easily be done by phlebotomy (which may well be safer than drawing from a line)

The PAC Story - continued

- In 1996 Connors published a propensity score analysis of the SUPPORT ICU data suggesting that PACs might worsen outcomes (*JAMA* 276:889,1996)
- This led to lots of (angry) debate -- it took 6 more years for the first RCT to appear
- Now 6 RCTs have been done -- none found benefit in any of the populations studied: general ICU patients, high-risk surgical patients, severe CHF, shock, ARDS
 - Rhodes *Inten Care Med* 28:256,2002; Richard *JAMA* 290:2713,2003; Sandham *NEJM* 348:5,2003; Harvey *Lancet* 366:472,2005; Escape investigators *JAMA* 294:1625,2005; ARDSNet *NEJM* 354:2213,2006
- Despite this impressive weight of evidence, PACs are still in common use (*JAMA* 298:423,2007)

A-Lines are Ubiquitous in ICUs

- 6-8 million used yearly in the US
(*Crit Care* 6:199,2002 ; *Mayo Clin Proc* 81:1159,2006)
- Older study of 2,876 US ICUs (*CCM* 21:279,1993) -- 30% of patients had an A-line; 16% had a PAC
- Newer study of 393 US ICUs (*CCM* 34:1016,2006) -- 38% of patients had an A-line; 18% had a PAC
- Single French ICU (*CCM* 33:1276,2005) -- 36% had an A-line
- Survey of Canadian intensivists (*Crit Care* 11:R74,2007) -- **97%** say they “always or almost always” use an A-line in septic shock

Current data:	<u>n</u>	<u>All patients</u>	<u>MV or septic shock</u>	
– Calgary	11,473	73%	82%	(T. Stelfox)
– Vancouver	2,408	68%	75%	(P. Dodek)
– Winnipeg	24,076	63%	93%	

Reasons Given for A-line Use ⇒ With Comments

- Can't manage shock patients without one ⇒ Yes you can, using noninvasive BP and other evidence of the adequacy of perfusion
- Can't titrate pressors without one ⇒ There's no obvious reason to believe (and no evidence that) titration to A-line BPs produces better outcomes than titration to noninvasive BPs
- Noninvasive BPs are inaccurate when BP is low ⇒ Yes, but there's no evidence that outcomes are improved by distinguishing between MAP of 20 vs. 30 or 40 ("low is low")
- The BP fluctuation seen by A-line would be missed if only did noninvasive BP q15 min ⇒ Yes, but we know nothing about whether treating "high frequency" fluctuations is good or bad

More Reasons Given for A-line Use ⇒ With Replies

- Need them to draw blood ⇒ **No you don't, and it may be safer not to do so**
- Need them to facilitate ABGs ⇒ **But that may NOT be a good thing**
- Sticking patients for ABGs hurts, and inflating a cuff frequently is uncomfortable and fragments their sleep ⇒ **Yes, but those would be a small price to pay for reducing line sepsis and improving outcomes**
- My teachers did it that way &/or I've always done it that way ⇒ **????**

Evidence-Based Medicine

- Must avoid becoming prisoners to our training and past habits
- Justification for any medical choice should be **that it helps**, not that it *might* help, and (since everything costs real money) not that it doesn't do harm
 - there are many examples of things that *should* helped, but upon study proved to do nothing, or be harmful -- e.g., IMA ligation, anti-endotoxin Ab for septic shock, “renal dose” dopamine, hyperventilation for TBI, NOS inhibitors for septic shock
- A-lines have never been proven to improve outcomes -- indeed their effect on outcomes has never been studied
- It is possible (even easy) to care for ICU patients without them
- And there IS evidence indicating that they can and do cause harm -- and not rarely

Arterial Lines & ICU Utilization/Costs

- Muakkassa (*J Trauma* 30:1087,1990) -- single surgical ICU
 - presence of an A-line was the strongest predictor of # of ABGs done -- independent of whether patients were on MV, and independent of ABG results
 - strongly suggests that the presence of an A-line results in many unnecessary ABGs being done
- Low (*Chest* 108:216,1995) -- adult ICUs at Walter Reed
 - patients with A-lines had 41% more lab tests done, and 80% more blood removed by phlebotomy
- Garland (*AJRCCM* 174:1206,2006) -- single medical ICU
 - more testing (of all types) did not result in better outcomes
- Corwin (*Chest* 108:767,1995) -- single center study
 - 1/3 - 1/2 of RBC transfusions in ICUs attributable to phlebotomy

A-Line Safety: The Data

- There have been a couple dozen papers on this topic from the 1970's onwards
- Not clear why practitioners aren't aware of this data
- Data primarily covers 2 topics
 - infectious complications
 - vascular complications

Infectious Complications of A-lines

- Band & Maki (*Am J Med* 67:735,1979) -- single site study
 - blood & semiquantitative A-line cultures for 95 patients with A-lines felt to be at high risk for nosocomial infection
 - 18% of A-lines were colonized
 - 4% of A-lines caused bacteremia (same bug in both cultures) -- and these were 12% of all nosocomial bacteremias during the study
- Thomas (*CCM* 12:860,1984) -- single site study
 - clinical suspicion of catheter infection did not predict positive tip cultures or blood cultures
 - ∴ can't easily tell whether patient has an A-line-related infection
 - RELEVANCE: We shouldn't believe the commonly heard statement "*We don't have a problem with infections related to arterial lines*" -- especially in patients with an A-line and CVC

Infectious Complications of A-lines

★ Risk of A-lines is similar to that of untunnelled CVCs

- Traore (*Am J Med* 67:735,1979) -- single French ICU
 - 233 pts with both an A-line and CVC, each for avg of 8 days/patient
 - Colonization rate (per 10³ device-days): A-line= 9.3 CVC=12.0
- Mimosz (*CCM* 24:1818,1996) -- single French SICU
 - RCT of chlorhexidine vs. providone iodine for site sterilization among 315 A-lines & CVC in 162 pts
 - average time in place: A-line=4.5 days CVC=6.8 days
 - Rates (per 10³ device-days) of line-related colonization and sepsis

	Chlorhexidine		Iodine	
	Colonization	Sepsis	Colonization	Sepsis
A-line	15	8	32	10
CVC	8	5	31	19

Infection: Systematic Review

(Maki *Mayo Clin Proc* 81:1159,2006)

- Systematic review of 200 papers on device-related BSI rates, for all different types of intravascular devices
 - 14 papers included A-lines
 - pooled, weighted point estimates, with 95% C.I.

	# catheters	BSI rate/1000 device-days (CI)
Peripheral iv	10,900	0.5 (0.2-0.7)
CVC, untunnelled	20,226	2.7 (2.6-2.9)
A-line	4,366	1.7 (1.2-2.3)
PAC	2,057	3.7 (2.4-5.0)
PICC, inpatients	625	2.1 (1.0-3.2)

Vascular Complications of A-lines

- Bedford (*Anesthesiology* 38:228,1973) -- 20G catheters in ICU
 - arterial occlusion rates: 11% for 1-3 days, 29% at 10 days
- Bedford (*Anesthesiol Rev* 47:37,1977)
 - 108 patients, assessment via arteriography, U/S, Allen's test
 - incidence of radial-artery occlusion : 8% with 20G cannulas, 34% with 18G cannulas (p<.05)
- Martin (*Chest* 119:901,2001) -- radial A-lines in single French ICU
 - 22G catheters in 132 pts for mean of 13 days; did bedside angio right before removal; interpretation by blinded radiologists
 - 57% had partially occluding clots; 19% had totally occluding clots
 - all were clinically silent

Vascular Complications: Systematic Review

(*Sheer Crit Care Proc* 6:199,2002)

- Percentage of A-line patients with complication, by site:

	Radial site	Femoral site
Temporary ischemia	19.7	1.5
Permanent ischemia	0.1	0.2
Hematoma	14.4	6.1
Bleeding	0.5	1.6
Pseudoaneurysm	0.09	0.3

Summary & Conclusion

- Arterial catheters are used very frequently in ICUs
 - But, they are devices that carry a real risk, and real costs
 - The common perception that we cannot care for ICU patients (or certain subsets of them) without A-lines is easily refuted by those intensivists who do
 - almost always, the information we get from using A-lines can be obtained without them
 - There is no literature addressing the effect of A-lines on patient outcomes → there is equipoise
 - We are in the same position now w.r.t. arterial lines as we were in when Robin wrote his 1987 editorial about PACs
- ★ WE NEED RCTs ON ARTERIAL LINE USE IN ICUs