Rethinking Arterial Catheters in the ICU

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No Conflicts of Interest
Introduction

- The only appropriate rationale for any medical intervention is that it provides benefit to patients, society or both (relevant endpoints)
  - anecdotes, or the fact that an intervention has been used for many years and, therefore, “must” be of some benefit, are not scientific arguments
  - neither is the belief that it “might” be of benefit

- Lots of reasons are given for routine use of ACs, but virtually none have data supporting them

- As we’ll see, ACs have real complications -- which are underappreciated
AC Usage in ICUs

- They’re used a lot, around the world  

- Especially in Canada
  - 97% say they “always or almost always” use an AC in septic shock (McIntyre Crit Care 11:R74,2007)
  - In Calgary, Vancouver, Winnipeg: 63-73% of all ICU patients, 75-92% of those on MV or pressors

- Large variation between ICUs in AC use
Big Variation in AC Usage

Arterial catheters

CVCs

Project IMPACT, 168 US ICUs -- Gershengorn Anesthesiol. 120:650,2014
Bloodstream Infection Due to ACs

- Risk is intermediate between that of peripheral and CVCs
  - two systematic reviews:
    - Maki *Mayo Clin Proc* 81:1159, 2006 -- BSI/1000 catheter-days
      \[\text{peripheral}=0.5 \quad \text{CVC}=2.7 \quad \text{A-line}=1.7\]
    - O’Horo *CCM* 42:1334, 2014
      \[\text{0.96/1000 catheter-days} \quad \text{1.26 in studies that cultured all devices, not just those clinically suspected as the source} \ldots\]

- Poor recognition:
  - poor concordance between tip vs. blood cultures drawn through the AC; infected AC rarely appear infected to the naked eye (Thomas *CCM* 12:860, 1984)
  - median estimate by SCCM members of RR of BSI due to AC vs. CVC = 0.05 (truth is 0.40-0.90) (Cohen *CCM* 43:2346, 2015)
AC-related Arterial Thrombosis

- Thrombosis -- not rare (~20%), but usually reversible
  (Scheer Crit Care 6:199,2002)

The AC was here

Digital ischemia

(other hand did not look like this)
Reasons Given for Ubiquitous Use of ACs

- Facilitate blood sampling
- BP measurement
- BUT, both of these can be done without an AC
- Reputed advantages:
  - avoids discomfort of repeated cuff pressures
  - avoids discomfort of intermittent arterial puncture
  - much higher BP sampling frequency (near-continuous values)
  - more accurate BP values
**Rationale#1: Facilitate ABGs, Other Bloods**

- Their presence increases blood testing *(Low Chest 108:216,1995)*
  - this is independent of actual test results \(\Rightarrow\) ACs increase unneeded testing *(Muakkassa J Trauma 30:1087,1990)*

- Blood testing is a major contributor to anemia & need for transfusions *(Corwin Chest 108:767,1995; Salisbury Arch Int Med 171:1646,2011)*

- Cultures drawn through lines have substantially higher rates of false-positive bacteremia *(Everts J Clin Micro 39:3394,2001; Mahieu J Hosp Infec 48:20,2001)*

- Can do appropriate blood testing, and obtain needed information, without them
Common but mistaken belief: AC BP values are “correct” and NIBP values (esp. automated cuffs) are a poor substitute

Oscillometry is prone to various inaccuracies and artifacts (Fessler, in *Principles and Practice of Intensive Care Monitoring*. 1998)

The values occasionally differ by a lot (Horowitz *Chest* 143:270,2013)

But virtually everything known about the epidemiology of BP, and what’s normal for a given patient, comes from NIBP value

High sampling frequency ⇒ more spurious values

AC pressures are likewise prone to various artifacts, and can be either too high and too low (Fessler as above; Dorman *CCM* 26:1646,1998; Kleinman *J Clin Mon* 5:137,1989; Grossman in *Cardiac Catheterization*. 2006)
**Rationale#2: Continuous BP Measurement**

- Since both BP measurement methods can be inaccurate, it’s more relevant to ask about concordance regarding clinically relevant events → single center, prospective study (Lakhal *CCM* 40:1207,2012)
  - paired NIBP/Aline pressures in mixed ICU cohort
  - NIBP accuracy for MAP_{AC}<65 mmHg: Sens=95%, Spec=95%
  - NIBP accuracy for >10% change in MAP_{AC} after IVF bolus or increase in pressor dose: Sens=91%, Spec=95%

★ But what is of MOST importance is whether patient management with one vs. the other modality results in differences in relevant outcomes
The First Study Addressing This

(Gershengorn, JAMA-IM, 143:1746,2014)

- Project IMPACT database 2001-08
  - AC use is a required field -- considered to have had an AC if it was in place for any portion of the ICU stay

- Primary outcome = hospital mortality

- Primary cohort = medical patients needing invasive MV
  - + 9 secondary cohorts

- Primary analysis = propensity-matched pairs pts ± AC
Main Results

- Primary cohort: 13,603 PS-matched pairs
  - raw Hospital mortality: AC=35.5% no AC=36.0%
  - adjusted OR = 0.98 (95% CI=0.93-1.03; p=0.40)

- Hospital mortality for all 10 PS-matched cohorts:
Other Results (primary cohort)

- AC patients had:
  - More median ventilator-days: 4.0 vs. 3.1 (p<.001)
  - Longer median ICU LOS: 6 vs. 5 (p<.001)
  - Similar median pressor-days: 2 vs. 2 (NS)
The Second Study Addressing This
(Hsu, Chest 2015 (epub ahead of print))

- BI/Deaconness MIMIC-II database 2001-08
- On MV>24 hrs, excluded if sepsis, pressors, cardiac surgery, AC before intubation
- Exposure: AC placed any time after intubation
- Primary analysis = propensity-matched pairs pts ± AC (348 pairs)
- RESULTS:

<table>
<thead>
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<th></th>
<th>AC</th>
<th>no AC</th>
<th>adj. Odds Ratio or Mean Difference</th>
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<tr>
<td><strong>28-day mortality</strong></td>
<td>14.7</td>
<td>15.2</td>
<td>0.96</td>
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<tr>
<td>ICU LOS</td>
<td>3.7</td>
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<td>9.4</td>
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<td>3.5 *</td>
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<tr>
<td>MV-days</td>
<td>2.1</td>
<td>1.0</td>
<td>1.1 *</td>
</tr>
<tr>
<td>ABG+VBG/day</td>
<td>2.4</td>
<td>1.0</td>
<td>1.4 *</td>
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Existing (sparse) evidence does not show that ACs meet the test of benefitting patients or society
  - since like every intervention, it has real costs and real risks, continued use of this *potentially* harmful tool should be justified by the results of multiple, rigorously performed studies

There is equipoise for conducting such studies -- including, but not necessarily limited to RCTs (*Cochrane Database Syst Rev* 2014;4:MR000034)

Situation is comparable to that of PACs in 1987 (*Chest* 92:727,1987)
  - 14 RCTs have failed to identify any subgroup of critically ill patients who benefit from routine use of PACs

Who DOES need an AC???
  - those for whom you *cannot* do the things you need to do without one
Reasons Given for A-line Use ⇒ 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 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 ⇒ Comments

- Need them to draw blood ⇒ No you don’t, and it may be safer not to do so

- They 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

- They make the doctors more comfortable ⇒ The health care system exists to service the patients (slippery slope)

- My teachers did it that way &/or I’ve always done it that way ⇒ That would only be OK if they were free, and had zero potential for harm
Thank You
the plural of "anecdote"
is not "data"
Don’t Need AC to Routinely Assess Oxygenation

Rice Chest 132:410, 2007
Don’t Need AC to Routinely Assess Blood CO2

• AC and CVC usage has not decreased over time

(168 Project IMPACT ICUs in US)