Complications of Central Venous Catheterization

Ogori N. Kalu, MD
Kings County Hospital Center
December 29, 2006
Case History

8/23/06 545pm: 17F restrained backseat passenger of a van involved in a 30 mph head on collision with another vehicle arrived at KCHC ER.
Afebrile  BP 116-149/52-90  HR 160s, restless
CXR, Pelvic XR neg

Medical History: Cornelia de Lange Syndrome
Mental retardation, seizures
Observed in ER over 6hrs; by 1100pm patient decompensated:
T101.9  BP 63/52  HR 130s  Oxy Sat 85-89% on FM
Intubated by anesthesia, unresponsive to fluid challenges
Case History, cont’d.

ABG: 7.29/28/542/99/15 /-12.2 lactate 5.8 WBC 7.2

Started on Levophed;

100am Trauma consult called

Physical Exam: short stature, microcephaly, cleft palate, hirsutism, intubated, sedated
Tachycardic

Lungs: CTAB
Abdomen: tense, distended, bowel sounds; +seatbelt sign with RLQ bruising
Rectal: no gross blood
200am: Emergent laparotomy

Findings: gross intraabdominal contamination
- cecal perforation, ileocolic mesenteric injury, ileal perforation: ileocecectomy with primary stapled anastamosis
- sigmoid blowout: resection and Hartman’s Procedure

EBL: 200 ml

Replacements: 1 U PRBCs, 3 L crystalloid

Post Op: intubated, pressors, SICU
Post op Course

Cardiac arrest within hours post op
ACLS protocol, successfully resuscitated
Right subclavian TLC
Continued labile bp despite pressors

**POD #1:**
Head CT negative; C-spine CT negative
**Chest CT: b/l PTX**
Abd/Pelv CT post op changes, L5 vertebral body fracture
Post op course, cont’d

**POD #11**: remains in SICU on mechanical ventilation. Off pressors, hemodynamically stable.

Attempted right subclavian central venous catheter change over wire
Hospital course

Catheter tip retrieved by IVR

**POD#13**: extubated, placed on BIPAP at night

**POD #19**: transferred out of SICU to Pediatric service

Discharged to facility 3 months post op

Currently admitted to Peds service for dehydration due to high colostomy output
Complications of Central Venous Access

More than 5 million CVC inserted per year

Hemodynamic monitoring
Vascular Access: Fluid resuscitation, Hemodialysis, TPN
Administration of medications

Routes: internal jugular, subclavian, femoral veins

(Bowyer MW, Bonar JP Noninfectious complications of invasive hemodynamic monitoring in the ICU. Complications in ICU: Recognition, Prevention & management. 1997)
Central Venous Catheters

More than 15% have complications:
- mechanical 5-19%
- infectious 5-26%
- thrombotic 5-26%


Table 2. Frequency of Mechanical Complications, According to the Route of Catheterization.*

<table>
<thead>
<tr>
<th>Complication</th>
<th>Internal Jugular</th>
<th>Subclavian</th>
<th>Femoral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial puncture</td>
<td>6.3–9.4</td>
<td>3.1–4.9</td>
<td>9.0–15.0</td>
</tr>
<tr>
<td>Hematoma</td>
<td>&lt;0.1–2.2</td>
<td>1.2–2.1</td>
<td>3.8–4.4</td>
</tr>
<tr>
<td>Hemothorax</td>
<td>NA</td>
<td>0.4–0.6</td>
<td>NA</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>&lt;0.1–0.2</td>
<td>1.5–3.1</td>
<td>NA</td>
</tr>
<tr>
<td>Total</td>
<td>6.3–11.8</td>
<td>6.2–10.7</td>
<td>12.8–19.4</td>
</tr>
</tbody>
</table>

* Data are from Merrer et al.,5 Szajdor et al.,6 Mansfield et al.,8 Martin et al.,22 Durbec et al.,23 and Timsit et al.24 NA denotes not applicable.
Internal Jugular Access

EJV  →  IJV
Internal Jugular Cannulation

- Clavicle
- Sternal notch
- Subclavian vein and artery
- Common carotid artery (under muscle)
- Internal jugular vein
- Sternocleidomastoid muscle
- Syringe
Subclavian Approach
Femoral Anatomy

Key
N nerve
A artery
V vein
E empty space
L lymphatics

common iliac artery
internal iliac artery
external iliac artery
femoral artery

deep artery of the thigh
lateral circumflex femoral artery
medial circumflex femoral artery

William Scavone ©2003
## Complications

<table>
<thead>
<tr>
<th>PTX</th>
<th>Airway injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial puncture</td>
<td>Thrombosis</td>
</tr>
<tr>
<td>Hematoma</td>
<td>Air Embolism</td>
</tr>
<tr>
<td>Infection</td>
<td>Catheter malposition</td>
</tr>
<tr>
<td>Dysrhythmias</td>
<td>Nerve injury</td>
</tr>
<tr>
<td>Vascular/cardiac perf</td>
<td>Thoracic duct injury</td>
</tr>
</tbody>
</table>
Pneumothorax

Subclavian catheters
Up to 6% of complications
Pleuritic chest pain, dyspnea, diminished breathe sounds, tracheal deviation, hypotension
Up to 50% of patients are asymptomatic
Risk of developing into tension PTX

RULE OUT PTX WITH CXR AFTER FAILED ATTEMPTS

Prevention: patient position, proper supervision, alternate approach based on pt’s history and habitus
Arterial Puncture

Up to 19% of complications
May be obscured by hypotension and hypoxemia
Hematoma
Risk of bleeding

Prevention: Identify landmarks, ultrasound
ABG, no dilator
Avoid subclavian in patients with coagulopathy
Infection

Infection of exit site with migration of pathogen along external surface
Hub contamination, intraluminal contamination
Hematogenous seeding

**Prevention**: use of antimicrobial impregnated catheters
subclavian approach
avoid routine catheter changes
A central venous catheter in place for at least 3 days and at least one of the following: suspected infection without another confirmed source, signs of sepsis, sepsis, septic shock, or exit-site infection.

- **Catheter needed?**
  - No: Order two blood cultures. Continue evaluation for infection.
  - Yes: Order two blood cultures.

- **Exit-Site Infection**
  - Remove catheter
  - Insert new catheter at new site
  - Start empirical antibiotics if septic or septic shock is present

- **Catheter site infected?**
  - Yes: Start empirical antibiotics
  - No: Start empirical antibiotics

- **Septic or septic shock?**
  - Yes: Source of infection other than catheter probable?
  - No: Change catheter over guide wire. Culture catheter tip

- **Catheter Infection Unlikely**
  - Continue evaluation for other sources of infection.

- **Tip culture positive?**
  - No: Tip culture positive?
  - Yes: Blood cultures positive?

- **Catheter Colonization**
  - Remove catheter and insert new catheter at new site (if not already done).
  - Antibiotics are not indicated.

- **Catheter-Related Bloodstream Infection**
  - Remove catheter and insert new catheter at new site (if not already done).
  - Antibiotics are indicated.
  - Tailor antibiotics to the sensitivity of organisms.
  - Treat for 10-14 days.
**Thrombosis**

Virchow’s triad: local trauma, stasis, hypercoagulability
Thrombotic material at catheter tip
Risk of limb ischemia, rare
Increased in females and patients with PVD
Predisposing factors: low flow state, dehydration, sepsis, hypercoagulable

Edvisinghe NK, et al. iatrogenic Vascular Lesions: *Surgical Perspective* 2003
Thrombosis, cont’d.

Catheter related thrombosis:
- 21.5% Femoral vein catheter
- 1.9% Subclavian vein catheter

Risk is 4X greater in IJ compared to SVC

Prevention: subclavian catheter, avoid trauma to vein

Catheter Malposition
Other Complications

Catheter/guidewire fragmentation and embolization

Loss of guidewires

Catheter/guidewire kinking or knotting
<table>
<thead>
<tr>
<th>Type of Complication and Intervention</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infectious</td>
<td></td>
</tr>
<tr>
<td>Use antimicrobial-impregnated catheters</td>
<td>The use of antimicrobial-impregnated catheters reduces the risk of catheter-related bloodstream infections and reduces costs when the rate of catheter-related bloodstream infection &gt; 2%9−11</td>
</tr>
<tr>
<td>Insert catheters at the subclavian venous site</td>
<td>The risk of catheter-related infection is lower with subclavian catheterization than with internal jugular or femoral catheterization6,9,12,13</td>
</tr>
<tr>
<td>Use maximal sterile-barrier precautions during catheter insertion</td>
<td>Use of a mask, cap, sterile gown, sterile gloves, and large sterile drape reduces the rate of infections and reduces costs14</td>
</tr>
<tr>
<td>Avoid the use of antibiotic ointments</td>
<td>The application of antibiotic ointments increases the rate of colonization by fungi,15 promotes the development of antibiotic-resistant bacteria,16 and has not been shown to affect the risk of catheter-related bloodstream infections17</td>
</tr>
<tr>
<td>Disinfect catheter hubs</td>
<td>Catheter hubs are common sites of catheter contamination18</td>
</tr>
<tr>
<td>Do not schedule routine catheter changes</td>
<td>Scheduled, routine replacement of central venous catheters at a new site does not reduce the risk of catheter-related bloodstream infection19,20; scheduled, routine exchange of catheters over a guide wire is associated with a trend toward increased catheter-related infections19</td>
</tr>
<tr>
<td>Remove catheters when they are no longer needed</td>
<td>The probability of colonization and catheter-related bloodstream infection increases over time9,10,21</td>
</tr>
<tr>
<td>Mechanical</td>
<td></td>
</tr>
<tr>
<td>Recognize risk factors for difficult catheterization</td>
<td>A history of failed catheterization attempts or the need for catheterization at sites of prior surgery, skeletal deformity, or scarring suggests that catheterization may be difficult8</td>
</tr>
<tr>
<td>Seek assistance from an experienced clinician</td>
<td>Insertion by a physician who has performed ≥50 catheterizations is half as likely to result in a mechanical complication as insertion of a catheter by a physician who has performed &lt;50 catheterizations8</td>
</tr>
<tr>
<td>Avoid femoral venous catheterization</td>
<td>The frequency of mechanical complications with femoral catheterization is higher than with subclavian or internal jugular catheterization2,8,22−24; the rates of serious complications are similar with the femoral and subclavian approaches5</td>
</tr>
<tr>
<td>Use ultrasound guidance during internal jugular catheterization</td>
<td>The use of ultrasound guidance during internal jugular catheterization reduces the time required for insertion and reduces the rates of unsuccessful catheterization, carotid-artery puncture, and hematoma formation23,25</td>
</tr>
<tr>
<td>Do not schedule routine catheter changes</td>
<td>Scheduled, routine replacement of catheters at new sites increases the risk of mechanical complications19,37</td>
</tr>
<tr>
<td>Thrombotic</td>
<td></td>
</tr>
<tr>
<td>Insert the catheter at the subclavian site</td>
<td>Subclavian catheterization carries a lower risk of catheter-related thrombosis than femoral or internal jugular catheterization5,24</td>
</tr>
</tbody>
</table>
Conclusion

Most complications associated with central venous catheterization are iatrogenic and therefore preventable.

Strict adherence to safe and sterile insertion techniques

Appropriate credentials required prior to performing any invasive procedure; proper supervision is mandatory

Removal of all catheters as soon as possible