How to Improve Safety & Outcomes in the Cath Lab

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Disclosures

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• None
Acknowledgements

• Sharon L. Cheatham, PhD, ACNP
• Grace Deyo, PhD, ACNP

For their leadership roles in implementing the TEAM HUDDLE for cath lab patients
Keep in Mind….

....... carelessness and overconfidence are usually far more dangerous than deliberately accepted risks.

Wilbur Wright, 1900
Safety in the lab……
What could go wrong? Anything!

• Staff competency (Physician, NP, RN, Rad Tech, RCIS)
• Equipment failure (defibrillator, ablation, radiation etc)
• Intubation / difficult airway
• Medication errors
• Vascular injury
• Cardiac perforation / bleeding / tamponade
• Conduit rupture / vessel dissection / uncontained tear
• Device embolization / lead perforation
• Stroke
• Cardiac arrest
• Death
How can we minimize risk and keep patients safe during procedures?

- **Equipment checklists**
- **Continuing staff education (i.e. PALS)**
- **Experience / practice models**
- **Networking, conferences etc.**
- **Learn from our (and other’s) mistakes**
Safety Checklist: Background of CRM

• Originally called “Cockpit Resource Management”
• Training system for improving air safety
• Focused on interpersonal communication, leadership, and decision making in the cockpit
• Originated, from NASA workshop in 1979
• Found primary cause of most aviation accidents due to human error
• United Airlines first to adopt CRM training in 1981
• 1980s – 1990s FAA & Dept. of Defense (U.S.) and JAA (EU) mandated CRM training for commercial pilots
How is Surgical Safety Related to the Aviation Industry?

- Institute of Medicine's report, To Err is Human: Building a Safer Health System, recommended that medicine adopt aviation's approach to safety and error management.
- Safety practices in aviation industry applied to surgical safety to avoid errors and improve outcomes.
- CRM encompasses team building, briefing strategies, situation awareness, and stress management.
National Practitioner Data Bank
Surgical “Never Events” Reported

- Estimated 80,000 events from 1990 to 2010
- 4,044 events in the United States annually
- 9,744 malpractice judgments totaling $1.3 billion
- Mortality 6.6%
- Permanent injury 39.2%
- Temporary injury 59.2%
- Foreign object left in body 39 times per week
- Perform wrong procedure 20 times per week
- Operate on wrong body part 20 times per week

Mehtsun, et al. Surgery,

http://dx.doi.org/10.1016/j.surg.2012.10.005.2013
**SURGICAL SAFETY CHECKLIST (FIRST EDITION)**

**Before induction of anaesthesia**  
- **SIGN IN**
  - Patient has confirmed
    - Identity
    - Site
    - Procedure
    - Consent
  - Site marked/not applicable
  - Anaesthesia safety check completed
  - Pulse oximeter on patient and functioning
  - Does patient have a:
    - Known allergy?
      - No
      - Yes
    - Difficult airway/aspiration risk?
      - No
      - Yes, and equipment/assistance available
  - Risk of >500ml blood loss (7ml/kg in children)?
    - No
    - Yes, and adequate intravenous access and fluids planned

**Before skin incision**  
- **TIME OUT**
  - Confirm all team members have introduced themselves by name and role
  - Surgeon, anaesthesia professional and nurse verbally confirm
    - Patient
    - Site
    - Procedure
  - Anticipated critical events
    - Surgeon reviews: what are the critical or unexpected steps, operative duration, anticipated blood loss?
    - Anaesthesia team reviews: are there any patient-specific concerns?
    - Nursing team reviews: has sterility (including indicator results) been confirmed? Are there equipment issues or any concerns?
  - Has antibiotic prophylaxis been given within the last 60 minutes?
    - Yes
    - Not applicable
  - Is essential imaging displayed?
    - Yes
    - Not applicable

**Before patient leaves operating room**  
- **SIGN OUT**
  - Nurse verbally confirms with the team:
    - The name of the procedure recorded
    - That instrument, sponge and needle counts are correct (or not applicable)
    - How the specimen is labelled (including patient name)
    - Whether there are any equipment problems to be addressed
  - Surgeon, anaesthesia professional and nurse review the key concerns for recovery and management of this patient

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*This checklist is not intended to be comprehensive. Additions and modifications to fit local practice are encouraged.*
WHO Guidelines for Safe Surgery

• October 2007 - September 2008
• 8 hospitals (Toronto, Canada; New Delhi, India; Amman, Jordan; Auckland, New Zealand; Manila, Philippines; Ifakara, Tanzania; London, England; Seattle, WA) representing diverse populations
• Pre-checklist: 3733 patients ≥16 years of age undergoing noncardiac surgery enrolled
• Post introduction of Surgical Safety Checklist: 3955 patients
  • primary end point was rate of complications, death within first 30 days post-op

WHO Guidelines for Safe Surgery

RESULTS:

• Mortality 1.5% before checklist
• Decreased mortality to 0.8% afterward (P=0.003).
• Inpatient complications 11% of patients at baseline
down to 7% after introduction of the checklist
(P<0.001)
How do we apply this to the cath lab to help avoid adverse events?

1. **What is the nature and level of severity of the adverse event?**

2. **How often does the adverse event occur?**

3. **Was the adverse event preventable?**
C3PO - Participating Centers

1. Children's Hospital Boston (Sponsor)
2. Cincinnati Children's Hospital Medical Center
3. Morgan Stanley Children's Hospital of New York
4. Nationwide Children's Hospital
5. St. Louis Children's Hospital
6. Rady Children's Hospital – San Diego
7. Pittsburgh Children's Hospital
8. Doernbecher Children’s Hospital
# Adverse Event Severity

<table>
<thead>
<tr>
<th>Severity Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Severity Level 1 – None</strong></td>
<td>No harm, no change in condition, may have required monitoring to assess for potential change in condition with no intervention indicated.</td>
</tr>
<tr>
<td><strong>Severity Level 2 – Minor</strong></td>
<td>Transient change in condition, not life threatening, condition returns to baseline, required monitoring, required minor intervention such as holding a medication, obtaining lab test(s).</td>
</tr>
<tr>
<td><strong>Severity Level 3 – Moderate</strong></td>
<td>Transient change in condition may be life threatening if not treated, condition returns to baseline, required monitoring, required intervention such as reversal agent, additional medication, transfer to ICU for monitoring, or moderate transcatheter intervention to correct condition.</td>
</tr>
<tr>
<td><strong>Severity Level 4 – Major</strong></td>
<td>Change in condition, life threatening if not treated, change in condition may be permanent, may have required ICU admit or emergent readmit to hospital, may have required invasive monitoring, required interventions such as electrical cardioversion or unanticipated intubation or required major invasive procedures or trans-catheter interventions to correct condition.</td>
</tr>
<tr>
<td><strong>Severity Level 5 – Catastrophic</strong></td>
<td>Any death and emergent surgery or heart lung bypass support (ECMO) to prevent death with failure to wean from bypass support.</td>
</tr>
</tbody>
</table>
# Adverse Event Preventability

<table>
<thead>
<tr>
<th>Category I: Preventable</th>
<th>Events where definite breech of standard technique was identified; necessary precautions were not taken; event was preventable by modification of technique or care.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category II: Possibly Preventable</td>
<td>Events where definite breech of standard technique was not identified but may have occurred; necessary precautions may not have been taken; event may have been preventable by modification of technique or care.</td>
</tr>
<tr>
<td>Category III: Not Preventable</td>
<td>Events where no obvious breech of standard technique occurred; necessary precautions were taken; no clearly known alteration in method or care exists to prevent the event.</td>
</tr>
</tbody>
</table>
# Procedure Type Risk Categories

<table>
<thead>
<tr>
<th>Procedure Type</th>
<th>Risk Category 1</th>
<th>Risk Category 2</th>
<th>Risk Category 3</th>
<th>Risk Category 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic Case</td>
<td>Age ≥ 1 year</td>
<td>Age ≥ 1 month &lt; 1 year</td>
<td>Age &lt; 1 month</td>
<td>Mitral Valve&lt;br&gt;Aortic Valve &lt; 1 month</td>
</tr>
<tr>
<td>Valvuloplasty</td>
<td></td>
<td>Pulmonary Valve ≥ 1 month</td>
<td>Aortic valve ≥ 1 month&lt;br&gt;Pulmonary valve &lt; 1 month Tricuspid valve</td>
<td>VSD&lt;br&gt;Perivalvar leak</td>
</tr>
<tr>
<td>Device or Coil Closure</td>
<td>Venous collateral&lt;br&gt;LSVC</td>
<td>PDA&lt;br&gt;ASD or PFO&lt;br&gt;Fontan Fenestration&lt;br&gt;Systemic to Pulmonary Artery Collaterals</td>
<td>Systemic Surgical Shunt&lt;br&gt;Baffle Leak&lt;br&gt;Coronary Fistula</td>
<td>VSD&lt;br&gt;Perivalvar leak</td>
</tr>
<tr>
<td>Balloon Angioplasty</td>
<td>RVOT&lt;br&gt;Aorta dilation &lt; 8 ATM</td>
<td>Pulmonary artery &lt; 4 vessels&lt;br&gt;Pulmonary artery ≥ 4 vessels all &lt; 8 ATM&lt;br&gt;Aorta &gt; 8 ATM or CB&lt;br&gt;Systemic Artery (not aorta)&lt;br&gt;Systemic Surgical Shunt&lt;br&gt;Systemic to Pulmonary Collaterals&lt;br&gt;Systemic vein</td>
<td>Pulmonary Artery ≥ 4 vessels&lt;br&gt;Pulmonary vein</td>
<td>Pulmonary Vein&lt;br&gt;Ventricular septum&lt;br&gt;Pulmonary artery&lt;br&gt;Pulmonary vein&lt;br&gt;Systemic Surgical Shunt&lt;br&gt;Systemic pulmonary Collateral</td>
</tr>
<tr>
<td>Stent Placement</td>
<td>Systemic vein</td>
<td>RVOT&lt;br&gt;Aorta&lt;br&gt;Systemic artery (not aorta)</td>
<td>Ventricular septum&lt;br&gt;Pulmonary artery&lt;br&gt;Pulmonary vein&lt;br&gt;Systemic Surgical Shunt&lt;br&gt;Systemic pulmonary Collateral</td>
<td></td>
</tr>
<tr>
<td>Stent Redilation</td>
<td>RVOT&lt;br&gt;Atrial Septum&lt;br&gt;Aorta&lt;br&gt;Systemic Artery (not Aorta)&lt;br&gt;Systemic vein</td>
<td>Pulmonary Artery&lt;br&gt;Pulmonary vein</td>
<td>Ventricular septum</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Myocardial Biopsy&lt;br&gt;Trans-septal puncture</td>
<td>Atrial septostomy&lt;br&gt;Recanalization of Jailed Vessel in Stent&lt;br&gt;Recanalization of Occluded Vessel</td>
<td>Atrial Septum Dilation and Stent&lt;br&gt;Any Catheterization &lt; 4 days after Surgery&lt;br&gt;Atretic valve perforation</td>
<td></td>
</tr>
</tbody>
</table>

Bergersen et al. Procedure Type Risk Categories for Pediatric and Congenital Cardiac Catheterization. 
*Circ Interv* 2011
Model Odds Ratio 95% CI

Bergersen et al. Procedure Type Risk Categories for Pediatric and Congenital Cardiac Catheterization.

Circ Interv 2011
Hemodynamic Vulnerability

- LV end diastolic press $\geq 18$ mmHg
- Systemic arterial saturation
  - Single ventricle $\leq 72\%$
  - Two ventricles $\leq 95\%$
- MPA pressure
  - Single ventricle mean $\geq 17$ mmHg
  - Two ventricles systolic $\geq 45$ mmHg
- Cardiac Index
  $\leq 2.8$ L/Min/M$^2$
## CHARM Model

<table>
<thead>
<tr>
<th>Procedure Type Risk Group</th>
<th>95% Odds Ratio</th>
<th>Confidence Interval</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>2</td>
<td>2.3</td>
<td>(1.6, 3.2)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>3</td>
<td>4.6</td>
<td>(3.2, 6.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>4</td>
<td>6.3</td>
<td>(4.8, 8.3)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

### Hemodynamic Vulnerability

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>95% Odds Ratio</th>
<th>Confidence Interval</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥1</td>
<td>1.0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>&lt;1</td>
<td>1.3</td>
<td>(1.0, 1.6)</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Bergersen et al. Catheterization for Congenital Heart Disease Adjustment for Risk Method (CHARM). JACC Card Interv 2011
Preventable & Possibly Preventable AE

• Access problems
• Balloon overinflated -> balloon rupture
• Brachial plexus injury due to positioning
• Unrecognized R main bronchus ETT placement
• Urethral trauma during foley placement
• Vessel trauma, conduit tear
• Retroperitoneal bleed
• Delayed resuscitation efforts (i.e. blood not available, equipment not available or failure)
“SIGN IN” Before Entering Cath Lab

Cath Lab NP / Cardiology Fellow / Cardiologist:
• Confirm correct patient, diagnosis, procedure
• Assessment / pertinent exam findings
• Lab Results (i.e. INR, hgb, electrolytes, etc.)
• Known allergies
• Medications
• Consents Signed

Anesthesia:
• h/o difficult airway, equipment concerns?
• Pre-med?
TEAM HUDDLE

Interventional Team:
1) The planned procedure & interventional approach
2) Concerns from the interventional team
3) Interventional objectives/Goals
4) Blood Conservation plan
5) Previous Radiation exposure

Anesthesiology Team:
1) Anesthesia approach/objectives
2) Airway management
3) Access plan / medications (inotropes, PGE1, plan for antibiotic prophylaxis)
4) Blood Conservation plan; availability of blood
5) Post procedure plan
TEAM HUDDLE

Cath Lab Team:

1) Equipment checked (AVOX, I-STAT, Fluoro/acquisition, echo, IVUS, etc)
2) Sterile table set up, any inventory concerns for procedure
3) Staffing issues
4) Family issues
Weight _____ Kg
Height _____ cm
Allergies __________

Date of Cardiac Cath: _____ / _____
Confirm patient, Dx, procedure
Start time of Huddle: <Patient Label>
End time of Huddle:

<table>
<thead>
<tr>
<th>Cardiac Catheterization Team:</th>
<th>Goal</th>
<th>Post Huddle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cath Lab NP / Cardiology Fellow:</td>
<td>Findings:</td>
<td></td>
</tr>
<tr>
<td>Cheatham / Deyo / Fellow Name:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Assessment / exam findings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) Lab Results</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) Medications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) Consents Signed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Interventional Team: Cardiologist / PhD-ACNP
JPCheatham RHolzer SLCheatham Hoffman Daniels
(1) The planned procedure
(2) The Interventional approach
(3) Concerns from the Interventional team
(4) Interventional objectives/Goals
(5) Previous Radiation Exposure & date

Concerns: __________

Anesthesiology Team: Post-op Anesthesia issues:
Corridore / Kahn / McKee / Moharir / Naguib / Winch
CRNA / SRNA / Fellow / Resident Name:
(1) Anesthesia approach/objectives
(2) Induction and plan
(3) Blood Management
   a. conservation □ Yes □ No Central Line location____
   b. Availability of blood □ Yes □ No A-line Location____
(4) Antibiotics Redose frequency____
(5) Post procedure plan Blood use □ PRBCs____ml

Nursing or Technologist Issues: Ending ABG: time____
Jason Kelly Mark Matt Paul Todd Ending ACT

Equipment Checked and Ready
3DRA Covered Stents Imaging (ICE, IVUS)
Hemostasis / Dressing
Distal Pulses

Specimens: Pathology/Research
□ Path _______ □ Research

Patient Disposition
PACU CTICU Cardiology____

Staffing
Other

Family / Visitors

Staffing
### Cardiac Catheterization Team:
- **Cath Lab NP / Cardiology Fellow:** Wilhelm
- **Interventional Team:**
  - JPCheatham, R Holzer SLCheatham, Hoffman, Daniels
  - (1) The planned procedure
  - (2) The Interventional approach (access, sheath size, etc)
  - (3) Concerns from the Interventional team
  - (4) Interventional objectives/Goals
  - (5) Blood Conservation plan
  - (6) Previous Radiation Exposure

### Anesthesiology Team:
- **Corridor / Khan / McKee / Moharir / Naguib / Rehman / Winch / CRNA / SRNA / Fellow / Resident Name:**
  - (1) Anesthesia approach/objectives/premed
  - (2) Induction and access plan
  - (3) Blood Management
    - blood conservation
    - availability of blood
  - (4) Antibiotics prior to intervention
  - (5) Post procedure plan

### Nursing or Technologist concerns:
- **Equipment or inventory issues:** 3DRA, Covered Stents, Imaging (ICE, IVUS)
- **Specimens/labs:** specimen to pathology
- **Patient Disposition:**
- **Staffing issues:**
- **Family / Visitors:**

### Plan / Goal
- **TOP S/p Repair (transannular patch)**
- **32yrs S P KS Klippel-Feil syndrome 80% CSA newly diagnosed untreated Echo 9/10/13 dilated LV, mild residual PS, moderate PR
- **MRI:** RV EF-41%, SV INDEX 14.8 mL/m2
- **Follow up tests:** Echo, CXR, EKG

### Post Huddle
- **Findings:** APLLateral c-spine plexus
- **Concerns:** NTA tracheal perme-valvar leak following placement

### Other:
- **Post-op Anesthesia issues:**
- **Central Line location:**
- **A-line Location:**
- **Blood use:** PRBCs
- **End of ABG time:**
- **Ending ACT:**
- **Hemostasis / Dressing:**
- **Distal Pulse:**
- **Specimens/labs:**
- **Bed space:**
- **PACU / CTICU / Other:**

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*Surgical Operating Plan (SOP) Form CTS-001 (Rev 2/2011)*
“TIME OUT” in the Cath Lab

All team members introduce themselves and their role
Prior to undergoing induction of anesthesia, the anesthesiologist and cath lab staff confirm:

- Correct patient
- Diagnosis
- Planned procedure
Prevent injury and pressure ulcers

- Appropriate positioning, prevent brachial plexus injury
- Use of Z-flow, etc under knees, heels, head, elbows
- Small position changes when possible
- Remind anesthesia to turn head when possible
“SIGN OUT” Post Procedure

• Debriefing by Cath team
• Physician to Physician
• APN/Fellow to APN/Fellow
• Cath Lab Staff to RN
• Brief Cath/Interventional Procedure Note in EMR (EPIC) & Cath Diagram/Photos sent with chart
• Operators, diagnosis, important findings during procedure, intervention performed, results of intervention, complications, plan, sign out
Handoff: Team to CTICU Team

In attendance:
- Cath MD/NP
- Anesthesia
- Nursing
- APN
- ICU Physician
- Respiratory Therapy
Summary

• **Positioning to prevent injury (i.e. brachial plexus injury)**
• **Small position changes are important, especially with turning head**
• **Padding to prevent pressure ulcers (Z-Flow)**
• **Potential for corneal abrasion**
  • Eyes taped closed under general anesthesia
  • Prevent patient from rubbing eyes waking up from anesthesia (PIV, tape, etc. can cause injury)
Summary

• Safety training programs aimed to improve communication, coordination of care, and reduce error
• Pre-procedure “Time Out” requirement by the Joint Commission on Accreditation of Hospital
• Implementation of surgical safety checklists have decreased mortality and complications from surgical procedures
• Implementing cardiac cath safety checklists (HUDDLE) may also decrease preventable and possibly preventable adverse events
Thank You

Mya

Cooper

Willa

Olivia