Review scope of errors related to CPB and Cardiac Surgery and discuss human interaction and communication and their role in error propagation

The Scope of the Problem- 
The Institute of Medicine Report, To err is Human: Building a Safer Health System estimated that 44,000–98,000 people die each year die from medical errors. Even the lower estimate is higher than the annual mortality from motor vehicle accidents (43,458), breast cancer (42,297), or AIDS (16,516), thus making medical errors the eighth leading cause of death in the United States. Evidence suggests that medical errors may result more frequently from the organization of healthcare delivery. James Reason suggested that some systems are more vulnerable and therefore more likely to experience adverse events. What does a vulnerable system look like and is cardiopulmonary bypass one of these more highly vulnerable systems? According to Reason, “vulnerable system syndrome” is characterized by; the blaming front line individuals, denying the existence of systemic weaknesses, and the blind pursuit of the wrong type of performance measures. One need not look to long or hard to find examples of blaming, denial, and blind pursuit. Stammers and Mejak documented that cost pressures may have great influence over decisions to use various devices even when they are known to have superior safety and effectiveness. Communication failures are the leading cause of inadvertent patient harm. Analysis of 2,455 recent sentinel events reported to the Joint Commission for Hospital Accreditation revealed that the primary root cause in over 70% was communication failure. Reflecting the seriousness of these occurrences, approximately 75% of these patients died. An estimated 234 million patients undergo surgical procedures and more than one million die from complications related to the surgery many of which are related to how the surgical team interacts and communicates. Use of a simple checklist could have prevented one half of these deaths each year. The World Health Organization has designed a checklist that serves as a forcing function for team communication. The checklist has been piloted in eight cities around the world and the result of this work will likely be published within the next 60 days. Communication and safety training transformed aviation into a highly reliable industry. Hunt’s observations, summarized in the table below, describes some of the similarities between these two industries and some of the opportunities for the latter.

<table>
<thead>
<tr>
<th>Aviation</th>
<th>Perfusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controlled layout of the flight deck</td>
<td>Variable configuration of the CPB circuit.</td>
</tr>
<tr>
<td>Standard Operating Procedures</td>
<td>Variable practice related to monitoring.</td>
</tr>
<tr>
<td>covers Normal and Abnormal situations</td>
<td>Variable operating procedures often Surgeon Specific</td>
</tr>
<tr>
<td>Flight Manual / Quick References</td>
<td>Most Centers have written “Policy and Procedure Manuals”</td>
</tr>
<tr>
<td>Checklist</td>
<td>Local reporting System, State requires report of adverse events, not specific, and not Global</td>
</tr>
<tr>
<td>Detailed and 100% Mandatory</td>
<td></td>
</tr>
</tbody>
</table>

Most of what we know about perfusion accidents is from retrospect surveys conducted over the past thirty years. The subjective sensitivity of survey responders, the retrospective nature of the surveys, respondent recall issues, and possible misinterpretation of questions are inherent weaknesses to safety survey methodology. However, these surveys provide us with some approximation of the rates of these errors and an estimate of the opportunity for improvement. The two following tables summarize six safety surveys related to cardiopulmonary bypass.

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Centers</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stoney 1980</td>
<td>1972-1977</td>
<td>349</td>
<td>374,819</td>
</tr>
<tr>
<td>Wheeldon 1981</td>
<td>1974-1979</td>
<td>608</td>
<td>43,262</td>
</tr>
<tr>
<td>Wheeldon 1981</td>
<td>1980</td>
<td>146</td>
<td>9,013</td>
</tr>
<tr>
<td>Kurusz 1986</td>
<td>1982-1985</td>
<td>524</td>
<td>573,785</td>
</tr>
<tr>
<td>Mejak 2000</td>
<td>1996-1998</td>
<td>552</td>
<td>653,621</td>
</tr>
<tr>
<td>Charriere 2006</td>
<td>2005</td>
<td>57</td>
<td>34,496</td>
</tr>
</tbody>
</table>

What might work for reducing Human Factor and Communication related errors?

Checklists and Algorithms

Glouberman and Zimmerman recommend distinguishing simple, complicated and complex problems.

Simple: A simple task would be analogous to baking a cake if one follows a recipe the cake will be consistently good. Errors in cardiac surgery that may be prevented by
simple recipe can be corrected with checklist, for example checking the blood, a checklist for the hand off by anesthesia to the CTICU is a simple process but a checklist can help to make more reliable. Making sure the circuit is properly assembled is another process that may be made more reliable by a checklist. Checklist should be used where there is agreement about how a process should be performed and also certainty that following the steps addressed in the checklist will produce a desirable result.

**Complicated:** A complicated problem would be analogous to sending a rocket to the moon. This can be done but it requires a large number of complex steps to execute. In cardiac surgery anti coagulation management or glucose control may be made more reliable by using an algorithm. Often there is less certainty or less agreement in these areas however if we focus our efforts on adoption of a treatment algorithm we can reduce the variation in these areas and make care more consistent.

**Complex:** A Complex problems are those problem where there is little certainty or agreement. With complex issues there is no prescriptive solution or guarantee. Complex problems are analogous to raising a child. No matter what you do, the outcome is not guaranteed.

Cardiac teams should use algorithms and checklist as much as possible to make the simple and complicated processes more reliable, these tools are an effective means of forcing efficiency and will provide more time for the team to work thoughtfully on the complicated issues. The Stacey diagram below provides an example of how this may look for a cardiac team.

![Stacey diagram](image)

**Readiness for Surgery Checklists**

Currently urgent patients with or without a recent MI make up 60% of the isolated CABG surgery deaths. With urgent cases the patient hand-off may be less than optimal. The NNECDSG believes there are opportunities during the preoperative period to reduce a patient’s risk of dying. The NNE has a regional initiative underway to assure that a patient is ready for surgery. In a recent study from Brown in the Annals of Thoracic Surgery from June of last year complications and costs were analysed. Approximately 14% of CABG patients in a cohort of more than 14,000
patients had complications following surgery. The leading complications were bleeding (38% of all complications), respiratory complications (24% of all complications), re-
operations (15% of all complications), renal complication (8% of all complications),
Infection/ Septicemia (11% of all complication). Readiness checklists may alert the
team about preoperative issues that increase the risk of these types of complications.
These checklist should include proven treatments such as adequate beta blockade,
glycemic control, stroke risk screening, and antibiotic prophylaxis. Forcing functions
should be designed into the readiness checklist that will cancel the procedure in certain
cases when the patient is not ready for surgery.

**Peer Huddles**
Morning Team Huddles prior to the patients arrival provide an opportunity for teams to
disseminate changes, to reflect on the previous day to discuss what worked and what
could have been better, it provides an opportunity to discuss the cases scheduled for a
given day and then to make sure that there are adequate resources and that they are
used in the most effective manner.

**Time outs**
Time-outs are a JCAHO mandate and are now used universally. The WHO initiative
previously mentioned provides is designed to make time-outs more effective. The link
listed in the bibliography provides access to the WHO Checklist and instruction
manual which includes both in depth and abbreviate instructions.

**Post CPB Debriefings**
Conducting post CPB debriefings has extraordinary value. Informal dialogue between
surgeons, anesthesiologist, and perfusionists provide an opportunity for iterative
learning. Team members should be provided an opportunity to reflect on the CPB
procedure regarding what went well, what was unexpected, and what could have been
better. Computerized data acquisition systems are capable of quantifying variation in
variation that occurs in physiological parameters during the procedure. When the team
reflects on this variation immediately following CPB, it provides a means of furthering
their understanding about details during the procedure that were associated with the
variation that occurred. Variation in blood pressure, fluid balance, and measurements
of tissue oxygen delivery may be readily quantified by the acquisition system. This
dialogue helps the team to develop a common mental model and to have a deeper
understanding about the delivery of care to the patient and provides an opportunity for
continuous improvement in performance.

**Bibliography of Safety Surveys**
-Stoney WS, Alford WC Jr, Burrus GR, Glassford DM Jr, Thomas CS Jr. Air embolism

-Wheeldon DR. Can cardiopulmonary bypass be a safe procedure? In: Longmore DB


