Infection-Related Root Cause Analysis: A Primer for the ICP

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Objectives

- **Be able to define and identify Sentinel Events (SE)**
- **Have an understanding of the steps involved in a Root Cause Analysis (RCA) process**
- **Compare steps in SE and outbreak investigations, and performance improvement methodology**
- **Discuss one example of infection-related RCA**

I'd like to acknowledge…

The infection control, patient safety, performance improvement & risk management experts that I have learned from, especially those who were kind enough to allow me to blend their ideas or slides with mine:

- *Jan Mc Donald & Teresa Garrison from the Center for Healthcare Quality and Effectiveness and the ICHE Consortium, BJC Health Care.*
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- *Janet Frain, Gigi Dash and Marie Kasai, APIC Board*
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And of course, the Academy

What is Root Cause Analysis?

- **A process for identifying the basic or causal factors that underlie variation in performance.**
- **This process should be used to identify risk that led to a sentinel event (SE)**

What is a Sentinel Event?

- **"An unexpected occurrence involving death or serious physical or psychological injury or risk thereof."**

Examples of Sentinel Events

- **Death resulting from a medication error or other treatment related error**
- **Suicide of a patient in a setting where they receive around-the-clock care**
- **Surgery on the wrong patient or body part regardless of the magnitude of the operation**
- **Hemolytic transfusion reaction involving the administration of incompatible blood or blood products**
- **Infection-related death or permanent disability**

Infection-Related Root Cause Analysis

Denise Murphy, RN, MPH, CIC

A Webber Training Teleclass

JCAHO - Categories of reported SE

▪ *Patient suicide*	*382*	*15%*
▪ Op/post-op	330	12.9
▪ *Wrong-site surgery*	*310*	*12.1%*
▪ Medication error	291	11.4%
▪ Delay in treatment	172	6.7%
▪ *Restraint death/injury*	*113*	*4.4%*
▪ Patient fall	114	4.5%
▪ Assault/rape/homicide	89	3.5%
▪ Transfusion error	73	2.9%
▪ Perinatal death	71	2.8%

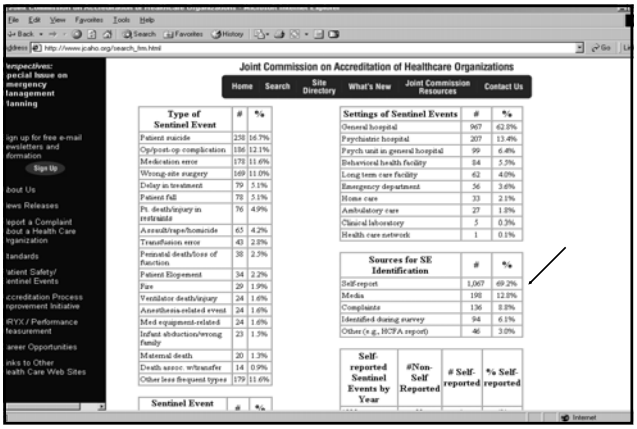
▪ Patient elopement	49	1.9%
▪ Fire	45	1.8%
▪ Anesthesia event	38	1.5%
▪ Med equipment	33	1.3%
▪ Vent death/injury	39	1.5%
▪ Maternal death	31	1.2%
▪ Infant abduction	19	0.7%
▪ Transfer death	18	0.7%
▪ Other	297	11.6%

JCAHO Sentinel Event Statistics June 2004

Outcomes of reported SE

Sentinel Event Outcomes	#	%
Patient death	2,000	75%
Loss of Function	268	10%
Other	399	15%
Total patients impacted	2,667	100%

JCAHO Sentinel Event Statistics June 2004



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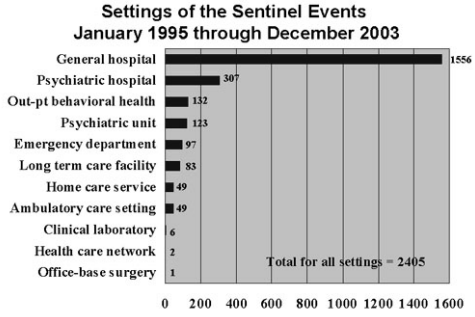
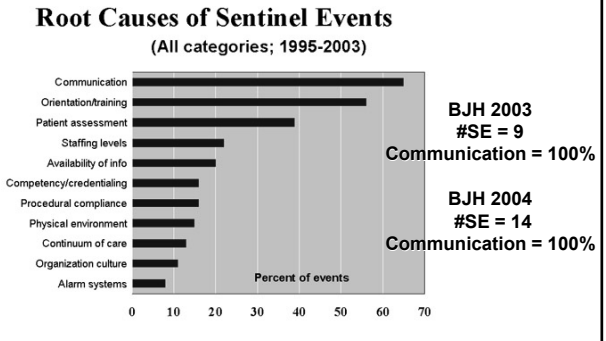


Source: JCAHO Sentinel Event Statistics April 2004

Root Causes



Source: JCAHO Sentinel Event Statistics April 2004

Most Common Root Causes of Medical Errors:

Agency for Healthcare Research and Quality

1. **Communication problems**
2. **Inadequate information flow**
3. **Human problems**
4. **Patient-related issues**
5. **Organizational transfer of knowledge**
6. **Staffing patterns/work flow**
7. **Technical failures**
8. **Inadequate policies and procedures**

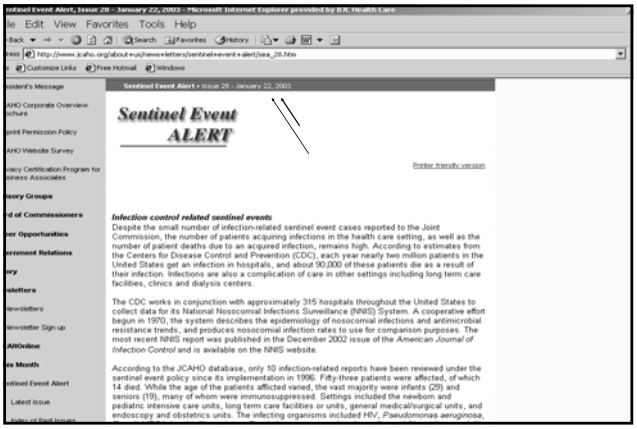
JCAHO 2004 Patient Safety Goal #7

- **Comply with current CDC hand hygiene guidelines**
- **Manage as sentinel events all identified cases of unanticipated death or major permanent loss of function associated with a healthcare-acquired infection**

What are the issues ICPs need to address?

- ***Issue 1:***
  - **"Unanticipated death" or "permanent loss of function" related to HAI is grossly underreported**
  - **ANY unanticipated death or permanent loss of function should always be considered a sentinel event**
- ***Issue 2***
  - **All SE should be investigated**
  - **SE are investigated using root cause analysis (RCA)**
  - **Hence, National Patient Safety Goal #7:**

    "All unanticipated deaths or permanent disability related to nosocomial infections should be handled as a sentinel event"
- ***Issue 3***
  - **All reporting of SE to JCAHO is "voluntary"…but JCAHO does encourage reporting**
  - **WHY? RCA results in identifying risk factors**
- ***Issue 4***
  - **NPSG #7 requires 100% compliance**
  - **Interpretation: You don't have to *report* them all, you do have to *investigate* them all, so you better know how to find them!**



Sentinel Event Alert, Issue 28 - January 22, 2003 - Microsoft Internet Explorer provided by B.C. Health Care

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Sentinel Event ALERT

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Infection control related sentinel events

Despite the small number of infection-related sentinel event cases reported to the Joint Commission, the number of patients acquiring infections in the health care setting, as well as the number of patient deaths due to an acquired infection, remains high. According to estimates from the Centers for Disease Control and Prevention (CDC), each year nearly two million patients in the United States get an infection in hospitals, and about 90,000 of these patients die as a result of their infection. Infections are also a complication of care in other settings including long term care facilities, clinics and dialysis centers.

The CDC works in conjunction with approximately 315 hospitals throughout the United States to collect data for its National Nosocomial Infections Surveillance (NNIS) System. A cooperative effort begun in 1970, the system describes the epidemiology of nosocomial infections and antimicrobial resistance trends, and produces nosocomial infection rates to use for comparison purposes. The most recent NNIS report was published in the December 2002 issue of the *American Journal of Infection Control* and is available on the NNIS website.

According to the JCAHO database, only 10 infection-related reports have been reviewed under the sentinel event policy since its implementation in 1996. Fifty-three patients were affected, of which 14 died. While the age of the patients afflicted varied, the vast majority were infants (29) and seniors (19), many of whom were immunosuppressed. Settings included the newborn and pediatric intensive care units, long term care facilities or units, general medical/surgical units, and endoscopy and obstetrics units. The infecting organisms included HIV, *Pseudomonas aeruginosa*,

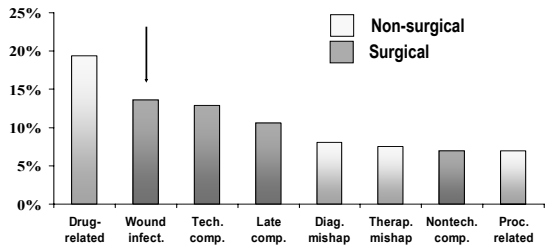
Why the Focus Now?

- **Institute of Medicine report on the Quality of Healthcare in America (1999)**
  - **In 1997 more Americans died because of medical error than because of auto accidents (43,458), breast cancer (42,297), or AIDS (16,516).**
- **The Harvard Medical Practice Study (1984)***
  - **98,609 adverse events, 27,179 of which were due to negligence**
  - **2,550 suffered permanent total disability**
  - **13,451 died, at least in part as a result of the adverse event**
- **The Colorado and Utah Study (1992)**
  - **In 1992, an estimated 5,614 adverse events occurred in Utah and 11,578 in Colorado.**

*In-patients only**

Proportion of Adverse Events

Harvard Medical Practice Study



Source: Brennan et al. N Engl J Med. 1991; 324:370-376

Why include IC in NPSG?

- **CDC estimates 2 million patients/year are infected**
- **Approximately 90,000 die (1 death every 6 minutes)**
- **Cost over $4.5 billion**
- **250,000 central venous catheter-related bloodstream (CRBSI)/year**
  - **Attributable mortality 12%-25%**
  - **$25,000 per episode**

Thanks Teresa

What do ICPs bring to the RCA process?

- **Ability to investigate outbreaks and identify risk factors associated with infectious events**
- **Data collection, organization, analysis**
- **Familiarity with use of standards and prevention guidelines**
- **Experience in literature search**
- **Working with multidisciplinary teams**

What happens once the ICP identifies a SE?

• A *credible* root cause analysis has to be completed within 45 days of the event occurring.

• The Joint Commission has created a framework to use to make sure all elements are addressed

• A multidisciplinary team should tackle each of these content areas to help identify contributing factors, identify root cause, and put effective control measures in place to reduce the risk of recurrence.

• Include Risk Mgt. & Performance Improvement experts!

Source:* Framework for Investigating Infection-related Sentinel Events
www.apic.org

Identifying HAI-related Sentinel Events

- **Work with medical records dept. to identify all deaths**
- **Compare hospital deaths with your HAI database to identify potential HAI-related deaths**
- **Work with hospital epidemiologist or ICC chair to review chart; determine if death or disability is "unanticipated"**
- **Know expected mortality rate associated with type of infection**
  - **e.g., patients with VAP have a highly anticipated mortality rate (up to 60%); may be hard to consider VAP death as unanticipated**
  - **patients having elective surgery with few risk factors for SSI are not expected to die of SSI-related infection**
- **Unanticipated deaths should be considered SE and must be investigated**

SEE ALGORITHM

Steps in Root Cause Analysis

Step One: Organize a Team

- **Leader(s) lay the groundwork**
  - **Identification and reduction of risks**
  - **Processes not individuals – blame**
- **Multidisciplinary – (10 or less)**
  - **May include ad hoc members**

1

- **May be a new or already existing team**
  - **Individuals closest to the event**
  - **Individuals critical to implementation of recommendations**
  - **A respected & credible leader**
  - **Individuals with diverse knowledge base**
    - **(& PI experience)**
  - **Be sensitive to clinician's needs/fears**

1

- **First Team Meeting**
  - **Establish ground rules**
    - **Decision making**
    - **Attendance**
    - **Meeting schedule**
    - **Opportunity to speak**
    - **Disagreements**
    - **Assignments**

Step Two: Define the Problem

- ***Describe* what happened**
  - **Focus on** what **happened not why it happened**
  - **Verbalize accurately and succinctly**
  - **"Mrs. Jones was a 55 y/o pt. who underwent elective CABG procedure. She had a cardiac arrest and died on her third post-op day. No signs of SSI. Sepsis was found confirmed by blood cultures and autopsy. Central line sepsis suspected."**

Step 3: Study the Problem

- **Collect information related to the event or possible event**
  - **Witness statements of those directly & indirectly involved**
  - **Observations**
  - **Physical evidence (purulent secretions at CVC insertion site)**
  - **Documentary evidence ("pus noted at insertion site" in progress note)**

3

- **Information format**
  - **Written documentation**
  - **Audiotape**
  - **Photographs**
  - **Videotape (may be intimidating)**

Step 4: Determine What Happened

- **Flowchart the sequence of the event**
  - **First, chart the actual sequence of events**
  - **Then flowchart the ideal sequence of events (highlight the differences)**
  - **Flowchart the steps in the policy/procedure**
  - **Compare the gaps**

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- **Create a timeline of the events**

TIME	EVENTS	ACTIONS
4/1/04	Patient underwent CABG surgery CVC placed in PACU	Patient transferred to CTICU
4/2/04	CVC functioning, site looks clean, no S&S infection	
4/3/04	Patient transferred to step down unit at 1800	ICU RN pulled line out prior to transfer to step down unit. Pus noted at insertion site. Afebrile.
4/4/04	Pt. developed fever and shaking chills at 0500	Attending notified, blood cultures ordered and drawn at 0540. Antibiotics started 0620.
	Nurse found patient unresponsive, no pulse or respirations at 0655	Code called 0656
	CPR started by nurse at 0658; Patient expired 0800	

Step 5: Identify Contributing Process Factors

- **Why did the event occur?**
  - **Which processes were involved in the event or could have lead to the event? (brainstorming, affinity diagrams)**
  - **What are the steps in the process as designed? (flowchart of policy/procedure)**
  - **Which steps may have contributed to the event?**

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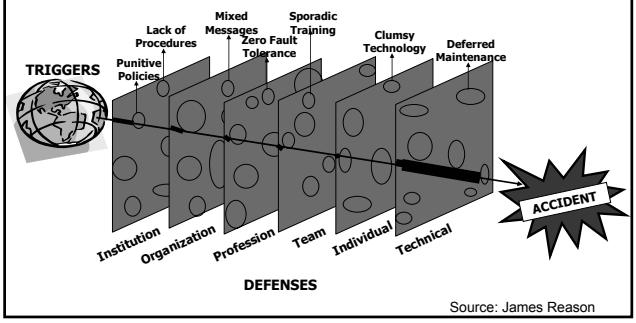
- **Continue asking why the event occurred?**
  - **What is currently done to prevent failure at this step? (fault tree analysis)**
  - **Was it done? (barrier analysis)**
  - **If not, why?**
  - **What additional services/departments are effected?**

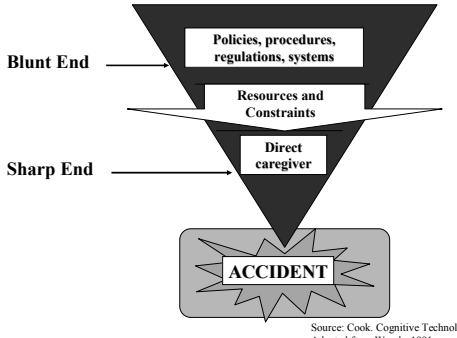
Swiss Cheese Model of Accident Causation



Source: James Reason

What causes medical errors?

Blunt and Sharp End Model



Source: Cook. Cognitive Technologies Laboratory, 2000
Adapted from Woods, 1991

Step 6: Identify Other Contributing Factors

- **Minimal Scope of Root Cause Analysis for Specific Types of Sentinel Events (see next slide)**

Minimum Scope of Root Cause Analysis for Specific Types of Sentinel Events

Detailed inquiry into these areas is expected when conducting a root cause analysis for the specified type of sentinel event. Inquiry into areas not checked (or listed) should be conducted as appropriate to the specific event under review.

CVC-BSI

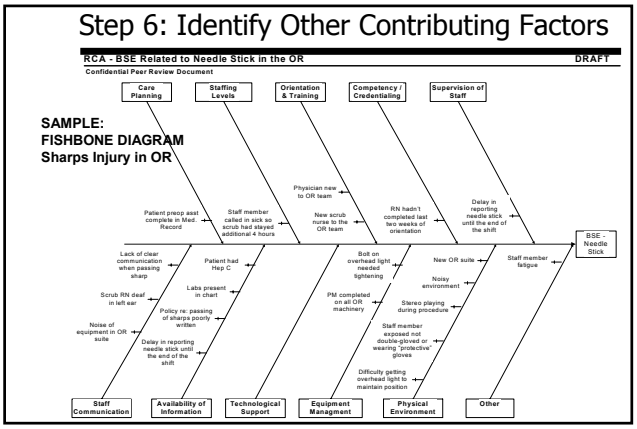
Areas of Investigation	Suicide (24-hr. care)	Medication error	Procedure complication	Wrong-site surgery	Treatment delay	Restraint death	Elopement death	Assault/ rape/homicide	Transfusion death	Infant abduction/ wrong discharge
Behavioral assessment process	×					×	×	×		
Physical assessment process†	×			×		×	×			
Patient identification process		×		×					×	
Patient observation procedures	×					×	×	×	×	
Care planning process	×		×			×	×			
→ Staffing levels	×	×	×	×	×	×	×	×	×	×
→ Orientation and training of staff	×	×	×	×	×	×	×	×	×	×
→ Competency assessment/ credentialing	×	×	×		×	×	×	×	×	×
→ Supervision of staff‡		×	×		×	×			×	
Communication with patient/family	×			×	×	×	×			×
→ Communication among staff members	×	×	×	×	×	×			×	×
→ Availability of information		×	×	×	×				×	
→ Adequacy of technological support		×	×							
→ Equipment maintenance / management		×	×			×				
→ Physical environment §	×	×	×				×	×	×	×
Security systems and processes	×						×	×		×
Control of medications storage/access		×								
Labeling of medications		×							×	

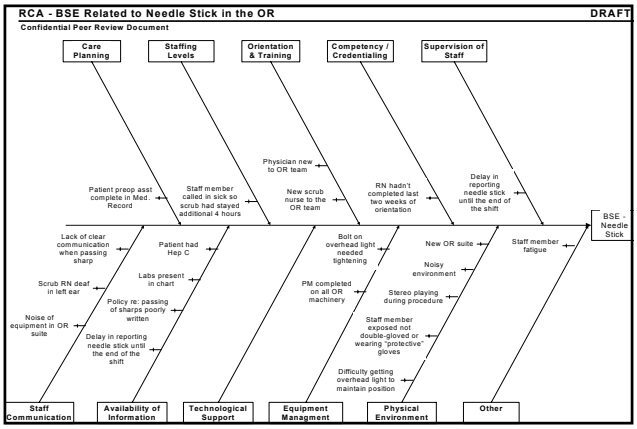
* Includes the process for assessing patient's risk to self (and to others, in cases of assault, rape, or homicide
† Includes patient handoffs.
‡ Includes supervision of physicians-in-training.
§ Includes furnishings, hardware (for example, bars, hooks, rods), lighting, distractions.

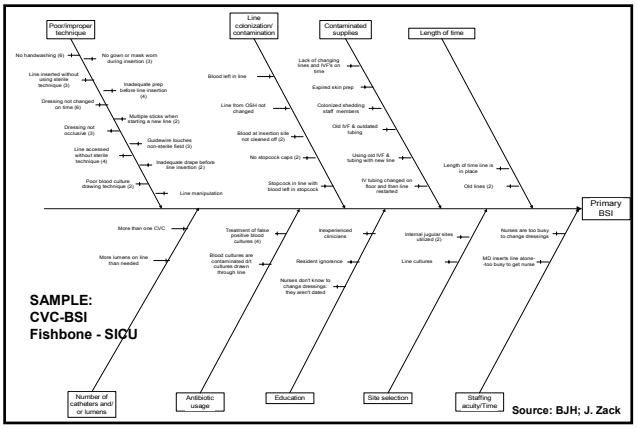
Figure 1-1. This matrix indicates those areas requiring inquiry when conducting a root cause analysis for a specific sentinel event.

SOURCE: www.jcaho.org **(Root Cause Analysis Matrix)**

Step 6: Identify Other Contributing Factors







Step 7: Measure - Collect & Assess Data

(Proximate and Underlying Causes)

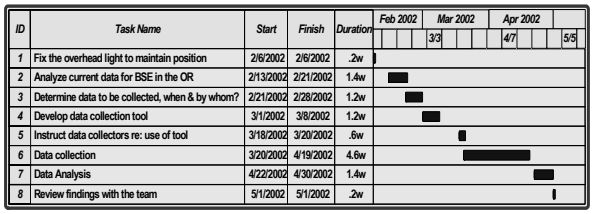
- **Baseline data – *is this a one time event or a trend?***
- **Measure a process or step in a process**
- **Assess effectiveness of improvement interventions**
- **Measurements should be rate-based**
  - ↗ **% central lines placed in femoral sites**
  - ↗ **CVC-BSI/1,000 line days in CTICU**

Step 8:
Design and Implement Interim Changes

- **Fix low hanging fruit**
- **Create a timeline, Gantt chart or implementation tree to help the team & administration view key steps and time frames needed to complete each step**

Step 8:
Design and Implement Interim Changes

- **Example Gantt Chart**



ID	Task Name	Start	Finish	Duration
1	Fix the overhead light to maintain position	2/6/2002	2/6/2002	.2w
2	Analyze current data for BSE in the OR	2/13/2002	2/21/2002	1.4w
3	Determine data to be collected, when & by whom?	2/21/2002	2/28/2002	1.2w
4	Develop data collection tool	3/1/2002	3/8/2002	1.2w
5	Instruct data collectors re: use of tool	3/18/2002	3/20/2002	.6w
6	Data collection	3/20/2002	4/19/2002	4.6w
7	Data Analysis	4/22/2002	4/30/2002	1.4w
8	Review findings with the team	5/1/2002	5/1/2002	.2w

Step 9: Identify Which Systems Are Involved

The Root Causes

- **Identify the underlying causes for the <u>proximate</u> causes (using BSE example)**
  - **Why did the nurse wait to report the sharps injury until the end of the shift?**
  - **Why did the nurse not know a sharp was being handed to her?**
  - **Why hadn't the nurse completed orientation?**

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The Root Causes

- **May involve multiple causes**
- **Drill down using the flowcharts, fishbone, barrier analysis, FMEA or fault tree analysis**
- **May include factors beyond the organizations control (e.g., nursing shortage)**

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The Root Causes

Proximate Cause	Underlying Cause
Delay in reporting needle stick until the end of the shift	RN hadn't completed last two weeks of orientation & was unfamiliar with the policy re: reporting BSE immediately
Lack of clear communication when passing sharp	Physicians not trained on policy to 1st announce intent to pass sharp

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Five Rules of Causation*

(*Adapted from David Marx)

1 - Causal statements must clearly show the "cause and effect" relationship.
2 - Negative descriptors (e.g., poorly, inadequate) are not used in causal statements.
3 - Each human error must have a preceding cause.
4 - Each procedural deviation must have a preceding cause.
5 - Failure to act is only causal when there was a pre-existing duty to act.

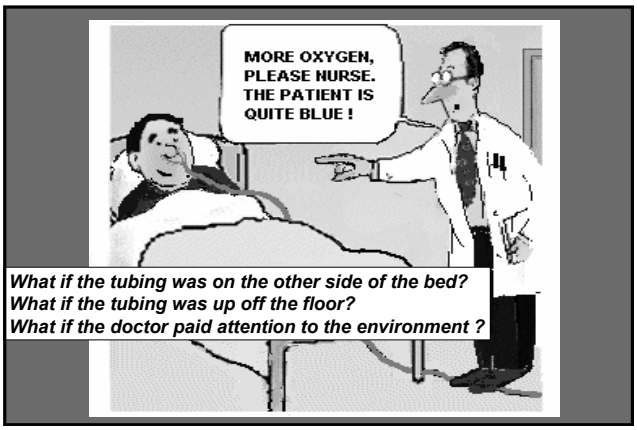
http://www.patientsafety.gov/causation.html

Step 10: Prune the List of Root Causes

Ask three questions to each cause

- **Would the problem have occurred if Cause #1 had not been present?**
- **Will the problem recur due to the same causal factor if Cause #1 is corrected or eliminated?**
- **Will correction or elimination of Cause #1 lead to similar events?**

If answer is NO, you have the root cause;
if answer is YES, you have contributing cause



Step 11: Confirm Root Causes

- **Literature review**
  - **Risk – reduction strategies**
    - **System approach - do not blame individual (s)**
    - **Each stage of system development**
  - **Error prevention strategies**
    - **Systems should be designed to absorb errors**
    - **Look to "mistake-proof" when possible**

Step 12: Explore & Identify Risk-Reduction Strategies

- **Failure Mode & Effect Analysis (FMEA)**
  - **Look at the steps in the process**
  - **Flow chart the process, predict where risk or "failure modes" exist and redesign process to eliminate risk**
- **Determine the severity of potential cause**
  - *Catastrophic* **– death, suicide, rape,**
  - *Major* **- permanent lessening of bodily functioning (sensory, motor, physiologic, or intellectual), disfigurement**
  - *Moderate* **– increased length of stay**
  - *Minor* **– near miss**

What is Failure Mode & Effect Analysis (FMEA) ?

- **"A prospective assessment that identifies and improves steps in a process thereby reasonably ensuring a safe and clinically desirable outcome.**
- **"A systematic approach to identify and prevent product and process problems before they occur."**

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FMEA

- **Determine the probability of the *potential* cause or risk**
  - *Frequent* **- Likely to occur immediately or within a short period**
  - *Occasional* **- Probably will occur (may happen several times in 1 to 2 years)**
  - *Uncommon* **- Possible to occur (may happen sometime in 2 to 5 years)**
  - *Remote* **- Unlikely to occur (may happen sometime in 5 to 30 years)**

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Failure Mode & Effect Analysis
Hazard Scoring Matrix

Probability	Severity			
	Catastrophic	Major	Moderate	Minor
Frequent	16	12	8	4
Occasional	12	9	6	3
Uncommon	8	6	4	2
Remote	4	3	2	2

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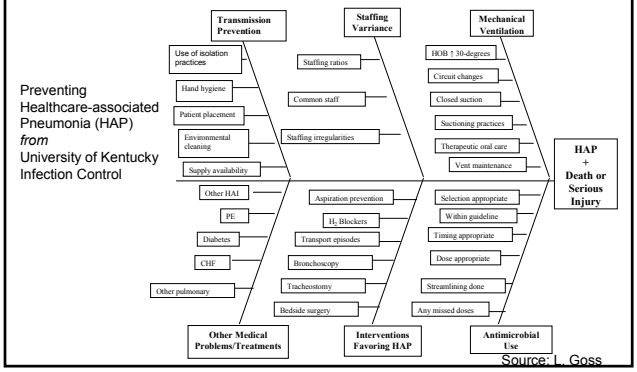
- Design a system to absorb errors
- Standardize procedures
  - Reduce variation
- Training & re-training
  - Competency assessments
- Create a safe reporting environment

Step 13: Formulate Improvement Actions

- Directed at processes
- Tools
  - Brainstorming
  - Flowchart
  - Cause & effect diagram (Fishbone)

FMEA: BEFORE a sentinel event occurs, anticipate risk and institute prevention measures

Preventing Healthcare-associated Pneumonia (HAP) *from* University of Kentucky Infection Control



Source: L. Goss

Step 14: Evaluate Proposed Improvements

- Rank the ideas based on the criteria
  - Individuals rank each idea best to worst (1-5)
  - Then consolidate into team ranking
- Are improvement actions objective and measurable?
- Ensure team reaches consensus
- May rank according to multiple criteria
  - Cost, risk, implementation time, etc.

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- Each selected improvement action should:
  - Address a root cause
  - Offer a long-term solution to the problem
  - Offer more positive then negative impact on other processes (no negative ripple effect)
  - Objective and measurable
  - Defined implementation time
  - Have assigned accountability

Step 15: Design Improvements

- What?
  - Determine scope of actions
- How?
  - Sequence of events
  - Measurement – quantitative
- When?
  - Timeline for implementation
- Who?
  - Who owns the process – initially & eventually
- Where?
  - Clarify where each action will be implemented

Step 16: Ensure Acceptability of Action Plan

- Acceptable to the Joint Commission if:
  - Focuses primarily on systems and processes, not individual performance
  - Identifies who is responsible for implementation
  - Identifies when actions will be implemented (including pilots)
  - Identifies how the actions will be evaluated (measurement)

Step 17: Implement the Improvement Plan

- Scientific Method
  - Plan, test, study, implement
- PDSA
  - Plan, Do, Study, Act

Step 18: Develop Measures of Effectiveness & Ensure Their Success

- Collect Data
  - Team is responsible for measurement
    - Bring in organization experts (RM, PI, QI, Analyst) to design
    - Is software available?
    - Information management resources

Step 19: Evaluate Implementation Efforts

- Data analysis & presentation
  - Internal comparisons – before & after
    - Run chart, control chart, histogram
  - External comparisons – benchmarking
  - Practice guidelines/parameters
  - Performance targets, specifications or thresholds
    - NNIS, other professional organizations

Step 20: Take Additional Steps

- If meeting goals –
  - Communicate the results
  - Revise processes or procedures
  - Complete training related to new policies, processes, procedures, documentation tools, etc.
  - Plan for continued monitoring
  - Roll out improvements to other areas
    - Radiology
    - Laboratory

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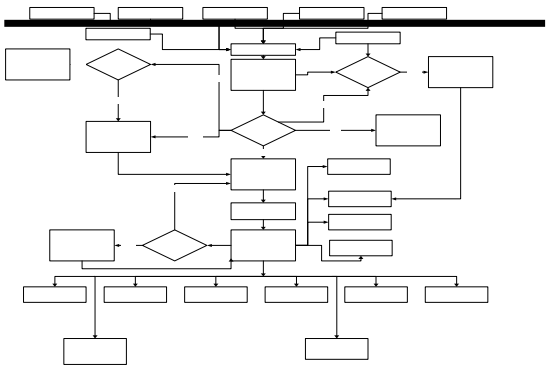
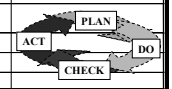
- **If NOT meeting goals –**
  - **Ask if improvement was fully implemented**
    - **Leadership involvement - sponsorship**
    - **Communication gaps**
  - **Confirm the root causes**
  - **Identify risk reduction strategy**
  - **Plan for continued monitoring**
  - **Roll our improvements to other areas**
    - **Radiology**
    - **Laboratory**

Step 21: Communicate the Results

- **Communication is key THROUGHOUT the RCA process**
  - **Sponsorship**
  - **Departments/services impacted by changes (proposed changes)**
  - **New or revised policies**
  - **Celebrations/recognition for team**



FOCUS-PDCA	Steps in Preparing for a Root Cause Analysis		*Outbreak Investigation*
F ind an opportunity			
O rganize a Team	Step 1	Organize a Team	1. Confirm existence of outbreak
	Step 2	Define the Problem	2. Confirm diagnosis of cases
C larify the current process	Step 3	Study the Problem	3. Prepare or investigation
	Step 4	Determine What Happened	4. Create case definition
U nderstand variation	Step 5	Identify Contributing Process Factors	5. Search for additional cases
	Step 6	Identify Other Contributing Factors	6. Characterize epidemic by person, place, time (line list)
	Step 7	Measure – Collect and Assess Data on Proximate and Underlying Causes	
	Step 8	Design and Implement Interim Changes	7. Generate tentative hypothesis
	Step 9	Identify Which Systems Are Involved – Root Causes	8. Test hypothesis
	Step 10	Prune the List of Root Causes	9. Institute additional studies
S elect the improvement solution	Step 11	Confirm Root Causes	10. Iimplement interventions
	Step 12	Explore and Identify Risk Reduction Strategies	11. Communicate findings
P lan the improvement	Step 13	Formulate Improvement Actions	12. Move to process improvement!
	Step 14	Evaluate Proposed Improvement Actions	
	Step 15	Design Improvements	
	Step 16	Ensure Acceptability of the Action Plan	
D o the improvement; and collect data	Step 17	Implement the Improvement Plan	
C heck and study the results	Step 18	Develop Measures of Effectiveness and Ensure Their Success	
	Step 19	Evaluate Implementation of Improvement Efforts	
A ct and hold the gain	Step 20	Take Additional Action	
	Step 21	Communicate the Results	



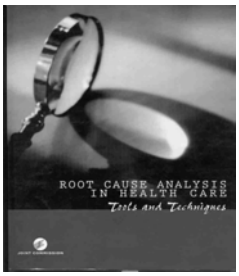
Joint Commission Resources

- **http://www.jcaho.org/sentinel/sentevnt_frm.html**
  - **SE Policies & Procedures**
  - **Root Cause Analysis Matrix**
  - **Sentinel Event Statistics**
  - **Glossary**
  - **Links to other sites**

Joint Commission Resources

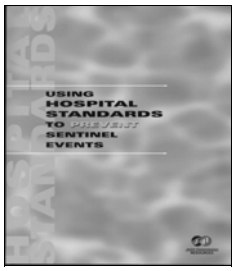
This publication is to provide health care organizations with the "how to" of conducting a root cause analysis.

Describes "how to" conduct each of the twenty-one steps.



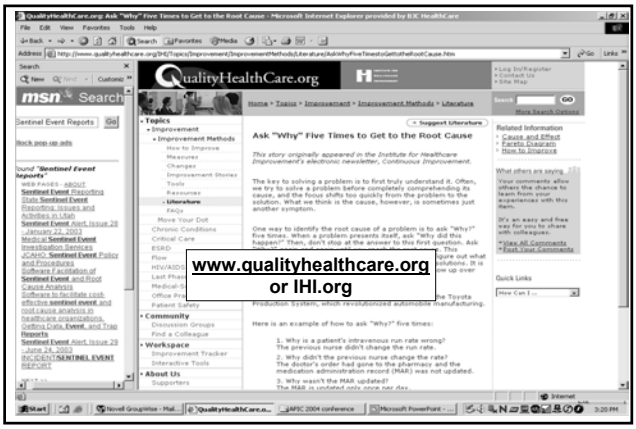
Joint Commission Resources

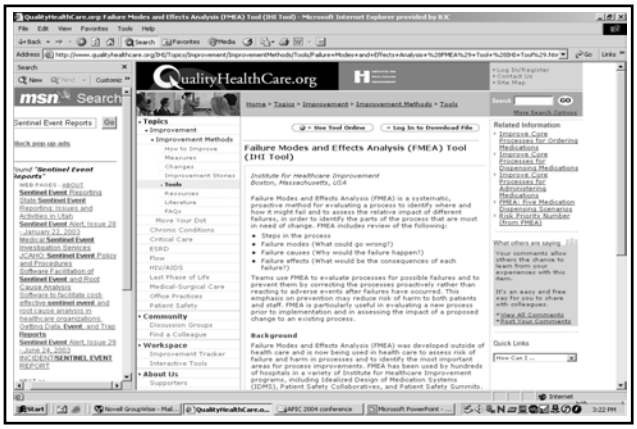
This publication is intended to help health care organizations improve processes and procedures in order to avoid critical errors. The first 12 chapters are organized according to the sentinel events most frequently reported to the Joint Commission.

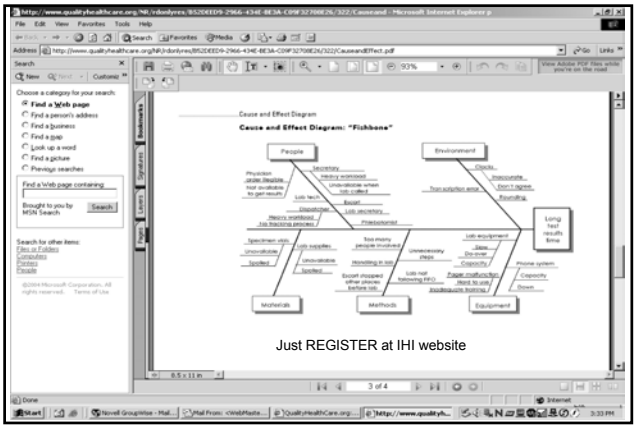


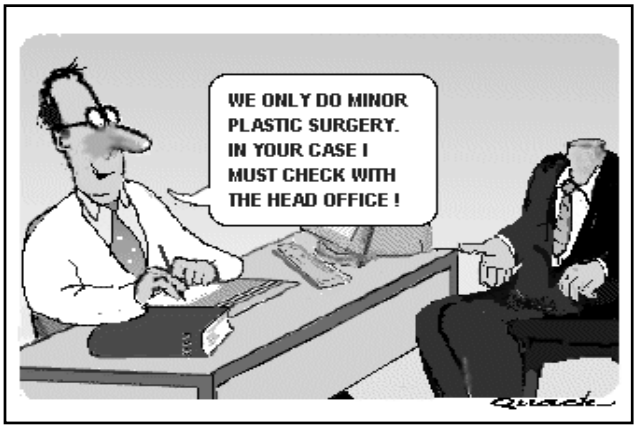
Patient Safety Resources

- **http://www.patientsafety.gov/index.html**
  - **The National Center for Patient Safety (NCPS) homepage**
  - **David Marx's Rules of Causation**
- **http://www.patientsafety.gov/HFMEA.html**
  - **Failure Mode and Effects Analysis course online & PowerPoint presentation**
- **http://www.ahrq.gov/HFMEA.html**
  - **National Patient Safety Goals**
  - **Sample FMEAs**









Other 2005 Teleclasses

For more information, refer to www.webbertraining.com/schedule.cfm

- ***April 14*** – Disinfectants and Environmental Impact, **with Dr. Franz Daschner**
- ***April 19*** – Methods for Testing Hand Disinfectants, **with Dr. Manfred Rotter**
  Sponsored by Deb Medical Hand Hygiene www.deb.co.uk
- ***April 21*** – Creutzfeldt-Jakob Disease: Recommendations for Disinfection and Sterilization, **with Dr. William Rutala**
- ***April 28*** - Overcoming the Resistance of Biofilms, **with Dr. Peter Gilbert**
  Sponsored by Virox Technologies Inc. www.virox.com

Questions? Contact Paul Webber paul@webbertraining.com