ALL HANDS ON DECK! A Multi-Disciplinary Approach to Preventing Hospital Acquired Infections

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Assistant Professor of Surgery
Thomas Jefferson University

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Disclosures

Conflicts of Interest

- none

My Credentials

- Boarded in SCC
- Surgical Intensivist
- Chair, subcommittee for CVC care
- VAP working group
- NSQIP

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"Healthcare Associated" Infections

- CDC Definition
  - Infections caused by a wide variety of common and unusual bacteria, fungi, and viruses during the course of receiving medical care
  - As our ability to prevent HAIs grows, these infections are increasingly unacceptable
  - This includes traditional hospital settings as well as outpatient surgery centers, long-term care facilities, rehabilitation centers, and community clinics

http://www.cdc.gov/hai/index.html

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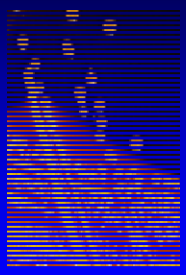
Overview

- Hospital Acquired Infections
  - Common offenders
  - Types & Etiologies
  - National data
- The "Jefferson Experience"
  - SSI
  - VAP
  - CLABSI
    - Timeline of interventions
- What can you do?
- Future directions



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Most Common "HAI"

- Central Venous Catheter (CVC)
- Ventilator-associated Pneumonia (VAP)
- Catheter-associated UTI (CAUTI)
- *Clostridium difficile* Infection (C.diff)
- Surgical Site Infection (SSI)

Two-thirds of all HAIs

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Annual U.S. Direct Hospital Cost of Treating HAIs

March 2009 – R. Douglas Scott – Economist – CDC&P

- Adjusted for consumer price index / inflation
- Inpatient hospital services
  - **$35.7 to $45 Billion**

- Extrapolated "range of effectiveness" of possible infection control interventions
- Inpatient hospital services
  - **$25 to $31.5 Billion**

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Study Methods

2009 Scott Report on Direct Medical Costs
http://www.cdc.gov/HAI/pdfs/hai/Scott_CostPaper.pdf

- Systematic Review
  - Based on:
    - Systematic reviews
    - Larger, hospital-wide studies
- Stratified by type
- CPI'ed to 2007 dollars

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Social Costs of HAIs

Categories of Cost*		
Direct Hospital Costs	Fixed Costs	Buildings Utilities Equipment/Technology Labor (laundry, environmental control, administration)
	Variable Cost:	Medications Food Consultations Treatments Procedures Devices Testing (laboratory and radiographic) Supplies
Indirect Costs		Lost/Wages Diminished worker productivity on the job Short term and long term morbidity Mortality Income lost by family members Forgone leisure time Time spent by family/friends for hospital visits, travel costs, home care
Intangible Cost		Psychological Costs (i.e., anxiety, grief, disability, job loss) Pain and suffering Change in social functioning/daily activities

*Adapted from Haddix AC and Shaffer PA. Cost-effectiveness analysis. In Prevention Effectiveness: A Guide to Decision Analysis and Economic Evaluation. Oxford University Press, 1996.

http://www.cdc.gov/HAI/pdfs/hai/Scott_CostPaper.pdf

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Estimated Number of HAIs by Site of Infection

Major site of Infection	Estimated Number of Infections
Healthcare-Associated Infection (all HAI)	1,737,125
Surgical Site Infection (SSI)	290,485
Central Line Associated Bloodstream Infections (CLABSI)*	92,011
Ventilator-associated Pneumonia (VAP)**	52,543
Catheter associated Urinary tract Infection (CAUTI)***	449,334
Clostridium difficile-associated disease (CDI)[17]	178,000

* Total BSI adjusted to estimate CLABSI (248,678 x 0.37^{16}) = 92,011
** Total Pneumonia infections adjusted to estimate VAP (250,205 x 0.21^{16}) = 52,543
*** Total UTIs adjusted to estimate CAUTI (561,667 x 0.80^{16}) = 449,334

http://www.cdc.gov/HAI/pdfs/hai/Scott_CostPaper.pdf

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2007 Average Attributable Per Patient Cost by Site of HAI

Infection site	Low Estimate of average attributable Costs ($ base year)	High Estimate of average attributable Costs ($ base year)	Low estimate adjusted to 2007 $ using CPI-U	High estimate adjusted to 2007 $ using CPI-U	Adjusted to 2007 $ using CPI for Inpatient Hospital Services	Adjusted to 2007 $ using CPI for Inpatient Hospital Services
SSI	$10,443[18] (2005)	$25,546[5] (2002)	$11,087	$29,443	$11,874	$34,670
CLABSI	$ 5,734[19] (2003)	$22,930[19] (2003)	$ 6,461	$25,849	$ 7,288	$29,156
VAP	$11,897[20] (1999)	$25,072[18] (2005)	$14,806	$27,520	$19,633	$28,508
CAUTI	$ 589[21] (1998)	$ 758[18] (2002)	$ 749	$ 832	$ 862	$ 1,007
CDI	$ 5,042[22] (2003)	$ 7,179[22] (2003)	$ 5,682	$ 8,090	$ 6,408	$ 9,124

http://www.cdc.gov/HAI/pdfs/hai/Scott_CostPaper.pdf

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2007 Aggregate Cost by Site of HAI

	# of infections	Range of $ estimates based on 2007 CPI for all urban consumers	Range of $ estimates based on 2007 CPI for Inpatient hospital services	Range of estimate using CPI for all urban consumers (billions)	Range of estimate using CPI for Inpatient hospital services (billions)
SSI	290,485	$11,087 - $29,443	$11,874 - $34,670	$3.22 - $8.55	$3.45 - $10.07
CLABSI	92,011	$ 6,461 - $25,849	$ 7,288- $29,156	$0.59 - $2.38	$0.67 - $2.68
VAP	52,543	$14,806 - $27,520	$19,633 - $28,508	$0.78 - $1.45	$1.03 - $1.50
CAUTI	449,334	$ 749 - $ 832	$ 862 - $ 1,007	$0.34 - $0.37	$0.39 - $0.45
CDI	178,000	$ 5,682 - $ 8,090	$ 6,408 - $ 9,124	$1.01 - $1.44	$1.14 - $1.62

*Example calculation for SSI:
2007 CPI for all urban consumers:
Low 290,485 x $11,087 = $3.22 billion
High 290,485 x $29,443 = $8.55 billion
2007 CPI for hospital inpatient services
Low 290,485 x $11,874 = $ 3.45 billion
High 290,485 x $34,670 = $10.07 billion

Grand Total: **$35.7 - $45.0** (Billion)

http://www.cdc.gov/HAI/pdfs/hai/Scott_CostPaper.pdf

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Range of Estimated Direct Medical Cost of All HAIs Adjusted by the Preventable Proportion

	Range of Estimates (billions $)	20% of infections preventable (billions $)	50% of infections preventable (billions)	70% of infections preventable (billions)
2007 CPI-U	$28.4 - $33.8	$5.7 - $6.8	$14.2 - $16.9	$19.9 - $23.7
2007 CPI hospital inpatient services	$35.7 - $45.0	$7.1 - $9.0	$17.9 - $22.5	$25.0 - $31.5

http://www.cdc.gov/HAI/pdfs/hai/Scott_CostPaper.pdf

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Implications

- Medicare
- Medicaid
- 3rd Party payers
- Complications
  - Preventable
- ↑ Reluctance to pay

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Penna. Act 52

- Must report all health care associated infections as serious events
- Will not reimburse at higher DRG rate for certain hospital acquired complications
  - Retained FB, air embolism, cath. assoc.UTI, blood incompatability, pressure ulcers, venous cath. Infections, mediastinitis post CABG, and **hosp. acquired injuries.**
- Quality improvement payment (2009) for 10% reduction in health care associated infections compared to prior year

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Common Hospital Acquired Organisms

- Acinetobacter
- Clostridium difficile
- Enterobacteraceae
- Influenza
- Klebsiella
- MSSA / MRSA
- Mycobacterium
- VRE

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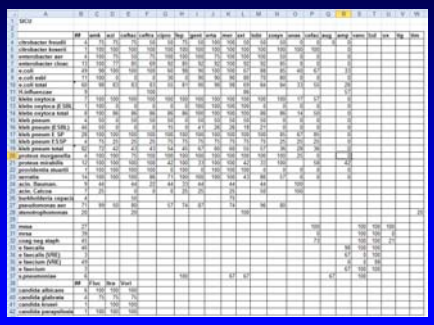
TJUH Data



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Thomas Jefferson University Hospital

- 957 Beds
- 46k admissions
- 7 adult ICU's
- Infection Control program

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Infection Control at TJUH

- CDC's National Healthcare Safety Network
- Real-time data collection
- Microbiology data correlated to vascular access, duration of ventilator, other documentation
- Final verification via IC director

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Surgical Site Infections

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National Surgical Quality Improvement Program (NSQIP)

- An outcomes based
- Risk adjusted
- Peer directed
- Measure and improve outcomes

American College of Surgeons
Inspiring Quality Highest Standards, Better Outcomes
ACS NSQIP®

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General Surgery Surgical Site Infection

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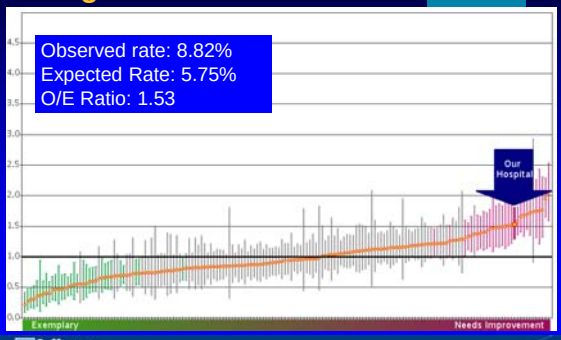

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PAGE 2

Report No. 3462
Site No. 60

O/E Over Time

Presented below are the O/E ratios for each semiannual report period since your site began participating in ACS NSQIP. The data below allow longitudinal assessment of outcomes to determine where your site has had "Exemplary" outcomes (low outlier, L), "As Expected" outcomes (not an outlier), or where your site "Needs

Overall (Non-Multispecialty) *

	1/05 - 12/05	7/05 - 6/06	1/06 - 12/06	7/06 - 6/07	1/07 - 12/07
30-Day Mortality		1.66	2.14 H	1.99 H	0.98
30-Day Morbidity		1.02	1.14	1.16	1.24 H
Cardiac Complications		0.90	1.07	1.08	1.12
Pneumonia		0.65	0.79	0.87	0.84
Inplanned Reintubation		1.47	1.54 H	1.15	0.97
Ventilator > 48 Hours		1.40	1.34	0.80	0.78
DVT/PE		1.46	1.44	0.97	0.79
Renal Failure		0.49	0.84	0.84	0.55
Urinary Tract Infection		2.03 H	1.69 H	1.73 H	1.01
Surgical Site Infection		1.18	1.42 H	1.69 H	1.53 H

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Using NSQIP Data for Performance Improvement

- Analyze data at regular intervals
- Slice data various ways to identify potential trends/issues
- Drill down into case details
- Make recommendations for Performance Improvement
- Develop Surgical Care Committee

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Surgical Care Committee "A-Team"

- NSQIP team
- Surgeons
  - All disciplines
- Anesthesiologists
- Nursing Research
- Pharmacy
- Product Procurement
- Infection Control
- Operating Room Administration
- Hospital Admin

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SPECIAL ARTICLE

◂ Previous Volume 360:491-499 January 29, 2009 Number 5 Next ▸

A Surgical Safety Checklist to Reduce Morbidity and Mortality in a Global Population

Alex B. Haynes, M.D., M.P.H., Thomas G. Weiser, M.D., M.P.H., William R. Berry, M.D., M.P.H., Stuart R. Lipsitz, Sc.D., Abdel-Hadi S. Breizat, M.D., Ph.D., E. Patchen Dellinger, M.D., Teodoro Herbosa, M.D., Sudhir Joseph, M.S., Pascience L. Kibatala, M.D., Marie Carmela M. Lapitan, M.D., Alan F. Merry, M.B., Ch.B., F.A.N.Z.C.A., F.R.C.A., Krishna Moorthy, M.D., F.R.C.S., Richard K. Reznick, M.D., M.Ed., Bryce Taylor, M.D., Atul A. Gawande, M.D., M.P.H., for the Safe Surgery Saves Lives Study Group

In close to 4000 patients in two groups in eight different hospitals
Mortality went from 1.5% to 0.8% (P=0.003)
Morbidity went from 11.0% to 7.0%(P<0.001)

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Clinical Pathway to reduce SSI

- Preoperative Factors
- 1. Smoking Cessation - Category IB
- 2. Remote Infection – Category IA
- 3. Antiseptic Shower – Category IB
- 4. Approp preop Abx, redose intraop – Category IA
- Intraoperative/Postop Factors
- 1. No razor skin shave – Category IA
- 2. Chlorhexadine skin prep – Category IB
- 3. Normothermia – Kurz et al. NEJM 1996; 334(19): 1209-15
- 4. Glycemic control – Blondett et al. Curr Opin Crit Care 2007; 13(4): 421-7.
- 5. Maintain high FiO2: Grief et al. NEJM 2000; 342(3): 161-7. Belda et al. JAMA 2005; 294(16): 2035-2973

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Jefferson Surgical bundle

- Pre-op smoking cessation
- Absence of remote infection
- Pre-admission antiseptic skin preparation
- Peri-op antibiotic administration
- Pre and post-op briefing
- Clipper and chlorhexadine skin prep
- Intra-op wound edge protection
- Glycemic and temp control
- DVT and β blocker

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Annual Report Summary 2008

Specific Procedure Tracking
Hernia (Ventral)

Hernia Cases 2007		Hernia Cases 2008	
Total	443	Total	400
Total number of infections	21	Total number of infections	7
Total Hernia Rate 2007	4.70%	Total Hernia Rate 2008	1.75%
Number of Ventral Hernia	137	Number of Ventral Hernia	190
Number of Ventral Hernia Infections	19	Number of Ventral Hernia Infections	6
Ventral Hernia Rate 2007	13.90%	Ventral Hernia Rate 2008	3.16%
Number of Ventral Hernia with implants	16	Number of Ventral Hernia with implants	5

Analysis:
Ventral Hernia implants- there was no association with infections noted.
Comparing ventral hernia implants (2007 to 2008) there was a statistically significant decrease identified by Chi square analysis (P = 0.001).
Comparing **ALL** Hernia cases (2007 – 2008) there was a statistically significant decrease identified by Chi square analysis (P=0.016)

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Biliary (Whipple)

Biliary (Liver/Pancreas) Cases 2007		Biliary (Liver/Pancreas) Cases 2008	
Total	256	Total	311
Total Number of infections	22	Total Number of infections	17
Total Biliary Liver/Pancreas) Rate	8.60%	Total Biliary Liver/Pancreas) Rate	5.50%
Number of Whipple procedures	112	Number of Whipple procedures	103
Number of Whipple infections	18	Number of Whipple infections	7
Whipple Infection Rate 2007	16.10%	Whipple Infection Rate 2008	6.80%

Analysis:
Comparing Whipple cases (2007 to 2008) there was a statistically significant decrease in infection rate identified by Chi Square analysis (P = 0.034).

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Mastectomies

Breast Cases 2007 (Mastectomy)		Breast Cases 2008 (Mastectomy)	
Total Number of Mastectomies	190	Total Number of mastectomies	195
Total Number of infections	9	Total Number of infections	21
Total Mastectomy Infection Rate	4.50%	Total Mastectomy Infection Rate	10.80%

Data for reconstructive surgery following Mastectomies:
Of the total number of mastectomies, 60 patients for 2007 and 91 patients for 2008 had immediate reconstruction following the mastectomy procedure. Of the reconstructive surgery, there were (8) infections in 2007 and (20) infections in 2008
Reconstructive data:

Number of Implant procedures	60	Number of Implant procedures	91
Number of Implant infections	8	Number of Implant infections	20
Implant Infection Rate 2007	13.33%	Implant Infection Rate 2008	22.10%

Analysis:
Comparing **Mastectomy** procedures (2007 to 2008) there was a statistically significant increase identified by Chi square analysis (P = 0.040).

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General Surgery Surgical Site Infections
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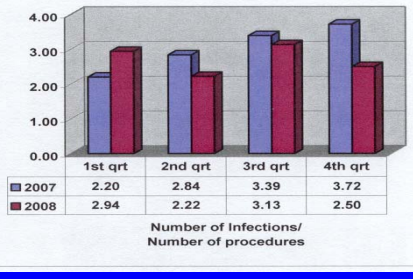

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Ventilator Associated Pneumonia

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Mechanical Ventilation

The basic principles of ventilator design and management were based on non-parenchymal respiratory failure, i.e. Polio

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The Issues at Hand

- Acute Lung Injury
- Acute Respiratory Distress Syndrome (ARDS)
  - Inflammatory lung edema
    - Loss of compliance
      - hypoxemia
- Ventilator Induced Lung Injury (VILI)

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Ventilator Induced Lung Injury

- Barotrauma
  - High intrathoracic pressures causes parenchymal stress or rupture
- Atelectrauma
  - Local injury from intra-tidal opening and closing (repetitive shearing forces)
- Biotrauma
  - Inflammatory reaction of the lung to non-physiologic stress
- Volutrauma
  - Excessive stretch of the aveoli
- Oxygen toxicity

Gattinoni et al. JAMA 2008; 299:691-693

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Goals of "Advanced" Ventilation

- Avoid extension of lung injury
- Minimize oxygen toxicity
  - Use mean airway pressure
- Recruit alveoli
  - Use mean airway pressure (PEEP or I-time)
- Minimize mean airway pressures
- Prevent atelectasis
- Use sedation and paralysis judiciously

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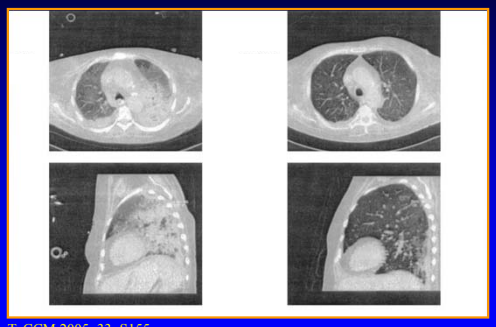
Lung Protective Strategies



Luecke T. CCM 2005; 33: S155

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VAP Working Group "Dream Team"

- December 2006
- Literature review
- Best practices
  - Care bundle
- Multi-disciplinary
- All stakeholders
- Institution-wide
- Full support from administration

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VAP Interventions

Order Set

- HOB > 30°
- Sedation Vacations
- Daily readiness to wean
- PUD prophylaxis
- Oral care
  - (chlorhexidine)
  - Shared responsibility

- Electronic documentation & Tracking
- Monthly compliance reporting
- Global education

- Hi/Lo tubes
- Preferential mini-BAL

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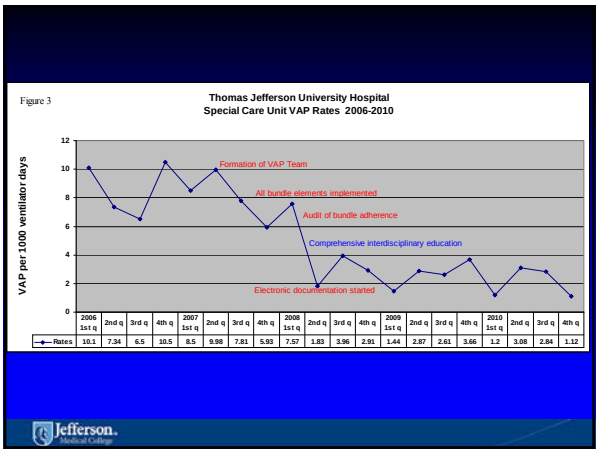

Cost Analysis

- 2010 TJUH data
- $4,220 per day
  (average, on the day following VAP Dx)
- VAP = 6.2 days*
  (Safdar et al. Crit Care Med, 2005; 33: 2184-2193)
- Thus, each VAP at TJUH costs: **$26,164**

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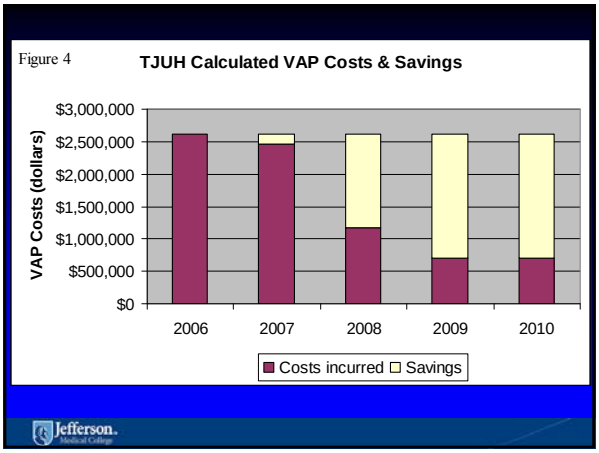

Central Line Associated Blood Stream Infection

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CVC Working Group

- December 2006
- Literature review
- Best practices
  - Care bundle
- Multi-disciplinary
- All stakeholders
  - Surgery
  - Anesthesia
- Institution-wide
- Full support from administration

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Benchmarks

- PA Cost Containment Council
- University Healthsystem Consortium (UHC)
- National Database of Nursing Quality Indicators

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Routes of Contamination

- Skin
  - Insertion site, suture sites
  - Bandage integrity
- Intra-luminal
  - IV solutions, TPN, etc
  - IV disconnects
- Blood stream contamination
  - Secondary

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CLABSI Interventions

- Kit change
  - Large drape
  - Chlorhexidine skin prep
  - Suture-less stabilization
- Chlorhexidine patch
- Education
  - ↓ femoral lines
  - Nursing presence & empowerment
- Nursing Care
  - "Scrub the hub"
  - ↓ blood sampling
  - TPN dedication
  - Snap gowns

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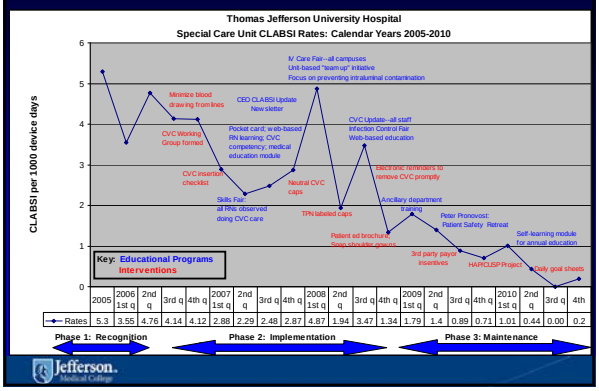

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Cost Analysis

- 2010 TJUH data
- $3,444 per day (mean)
  (on the day following CLABSI Dx)
- CLABSI = 7 days*
  (Pittet et al. JAMA 1994; 272:1819-1820)
- Thus, each CLABSI at TJUH costs: **$24,108**

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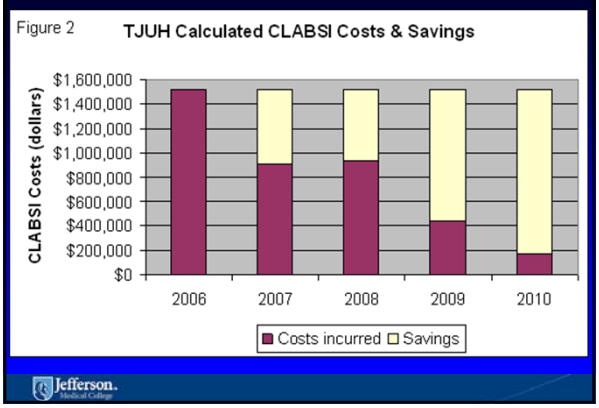

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General Interventions

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Indirect Interventions

- Nutritional support
- Environmental Services
- Physical Therapy
- Occupational Therapy

- Many Others (Global Institution)

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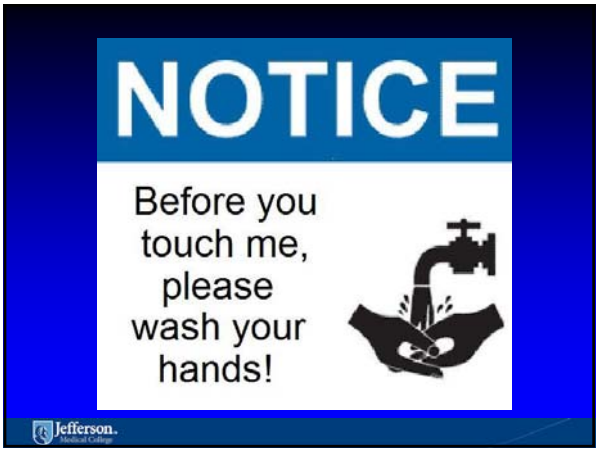

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Nutrition – Gut Biology and Immuno-modulation

- Loss of IgA
- Ineffective MALT
- Pro-inflammatory cytokines

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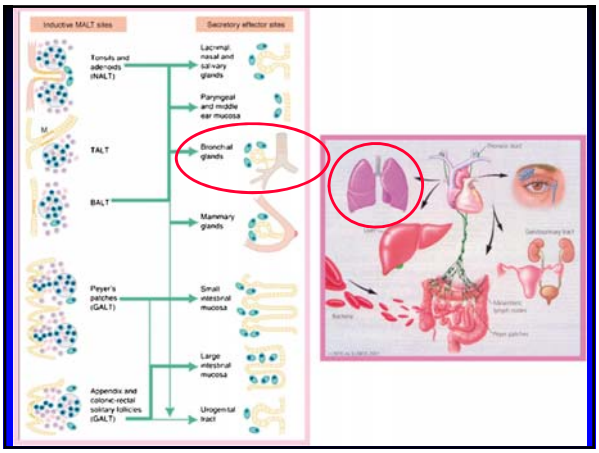
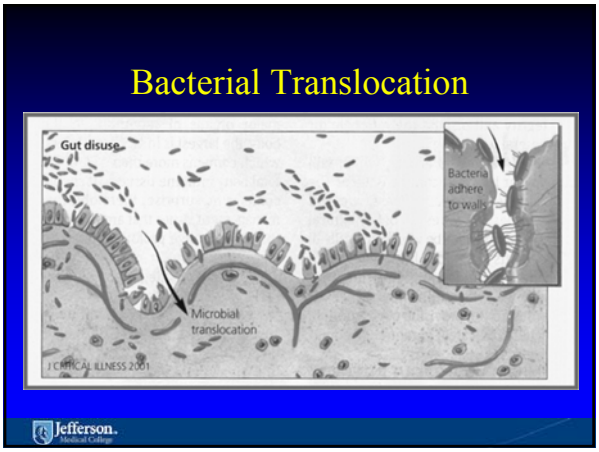

Inductive MALT sites
Secretory effector sites
Tonsils and adenoids (NALT)
TALT
BALT
Peyer's patches (GALT)
Appendix and colonic-rectal solitary follicles (GALT)
Lacrimal, nasal and salivary glands
Pharyngeal and middle ear mucosa
Bronchial glands
Mammary glands
Small intestinal mucosa
Large intestinal mucosa
Urogenital tract


Bacterial Translocation
Gut disuse
Bacteria adhere to walls
Microbial translocation
J CRITICAL ILLNESS 2001
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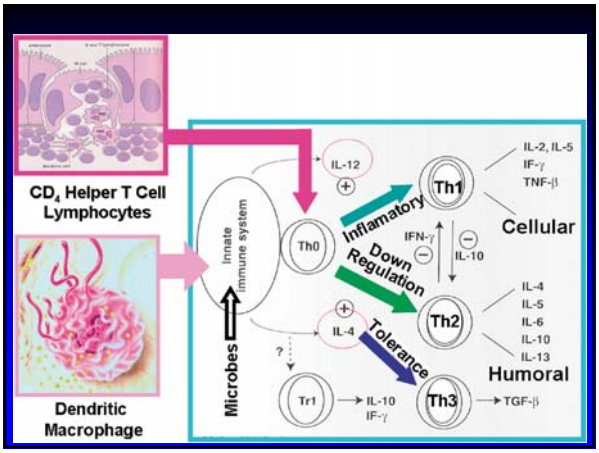
CD4 Helper T Cell Lymphocytes
Dendritic Macrophage
Microbes
Innate immune system
Th0
IL-12
Inflamatory
Th1
IL-2, IL-5
IF-γ
TNF-β
Cellular
IFN-γ
IL-10
Down Regulation
IL-4
Th2
IL-4
IL-5
IL-6
IL-10
IL-13
Humoral
Tolerance
Tr1
IL-10
IF-γ
Th3
TGF-β

Early vs. Late Enteral Nutrition

- Marik et al. (meta-analysis)

  Feeds within 36 hours or beyond 36 hours
  - 55% reduction in overall infection rates (p=0.0006)
  - Decreased LOS by 2.2 days (p=o.0004)
  - Decreased mortality by 48% (p=0.08)

Marik et al. 2001 Crit Care Med 29:2264-2270

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Summary

- HAI are preventable!
- HAI add morbidity and mortality
- HAI cost a lot of money
  - Patient
  - Payer
  - Us
- EVERYONE is responsible

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Summary

- Remember your best practices
- Attention to detail
- Speak up
- Wash your hands!

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Discussion

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