HEALTHCARE ASSOCIATED INFECTIONS

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Common Healthcare-Associated Infections (HAIs) & Infection Control

- Significance of Healthcare-Associated Infections
- Specific HAIs:
  - Significance, Pathogenesis, Etiology, Prevention
    - Urinary Tract Infection (CAUTI)
    - Surgical Site Infection (SSI)
    - Pneumonia (VAE/VAP)
    - IV Catheter-Associated Infection (CLABSI)
- Horizontal Interventions to prevent HAIs

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Infection Control Year 1500

Nosocomial Infection Rate ~ 90%

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Significance of Nosocomial Infections

- 4% of all hospitalized patients in the US develop a nosocomial infection (722,000 HAIs)
- Approximately 75,000 deaths/yr
- 7th leading cause of death in the US
- AIDS: 15,815 deaths (2019), Motor vehicle accidents: 35,766 deaths (2020), Breast cancer: 42,280 deaths (2019), Gun violence: 45,222 (2020)
- > 10 billion dollars/yr
- Many (most) of these infections are preventable!

https://www.cdc.gov/winnablebattles/report/HAIs.html

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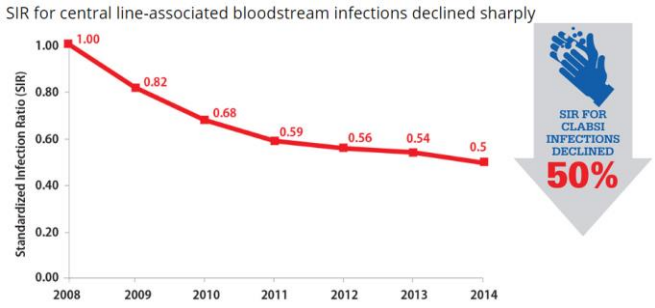
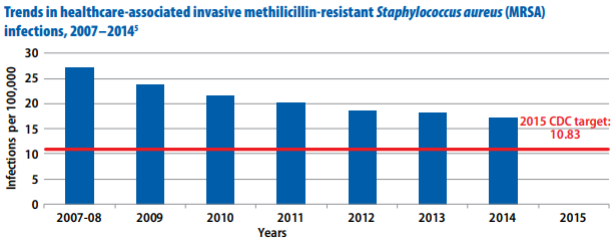
HAI Prevention – a partial success story!





https://www.cdc.gov/winnable battles/report/docs/wb-hai.pdf

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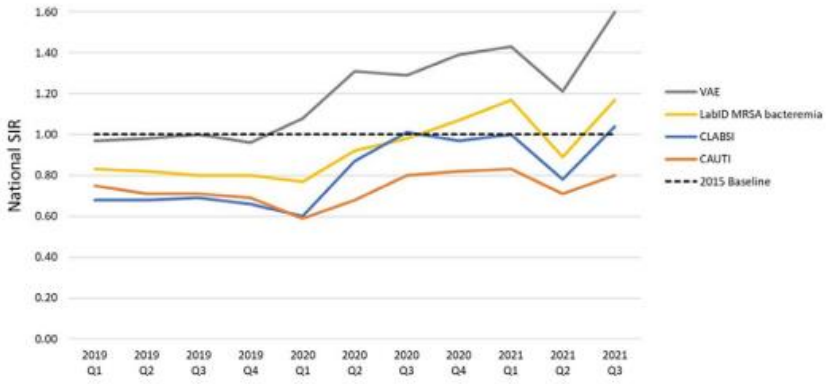
COVID-19: Reversal of Trends



Lastinger, et al. ICHE 2023

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Nosocomial UTI

- ~15% of adult hospital patients have an indwelling urinary catheter; each day of catheterization is associated with a 3%-7% risk of bacteriuria
- UTI is 5th most common HAI, 62,700 cases/yr in US
- Mortality: 13,000 deaths/yr due to UTI
- LOS: 1-4 days
- Cost $750/case; 350-450 million

https://www.ahrq.gov/hai/cauti-tools/guides/implguide-pt1.html
https://www.hospitalsafetygrade.org/media/file/CAUTI.pdf
https://www.cdc.gov/nhsn/pdfs/pscmanual/7psccauticurrent.pdf

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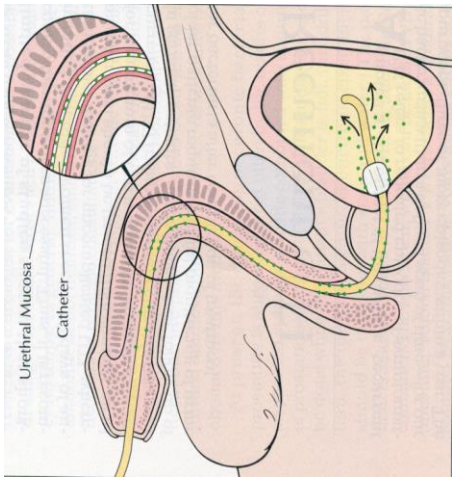
CAUTI - Pathogenesis



- Major risk factor for Nosocomial UTI is presence of urinary catheter
- Pathogenesis involves interactions between device, microbe, and host
- Catheter balloon prevents complete bladder emptying resulting in residual urine/culture media

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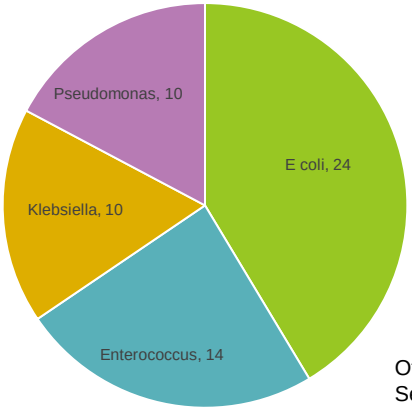
Microbial Etiology of CAUTI



Others: Proteus, Enterobacter, Serratia, Citrobacter, etc.

Antimicrobial-Resistant Pathogens Associated With Healthcare-Associated Infections: Summary of Data Reported to the National Healthcare Safety Network at the Centers for Disease Control and Prevention, 2011-2014.AU Weiner et al. Infect Control Hosp Epidemiol. 2016;37(11):1288.

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Prevention of CAUTI

- Prevention of UTI
  - Only use a catheter when truly needed. Appropriate Indications: Obstructive uropathy, Intensive monitoring of I & O, Periop, Sacral wound, Comfort care
  - Insert with aseptic technique, maintain closed system, maintain unobstructed urinary flow
  - Antiseptic coated catheters
    - Cost effective means to prevent UTI?
- Prevention of inappropriate urine cultures
  - Don't culture the urine of patients with asymptomatic bacteriuria
  - No pyuria = no culture for routine patients

https://www.cdc.gov/infectioncontrol/guidelines/cauti/index.html

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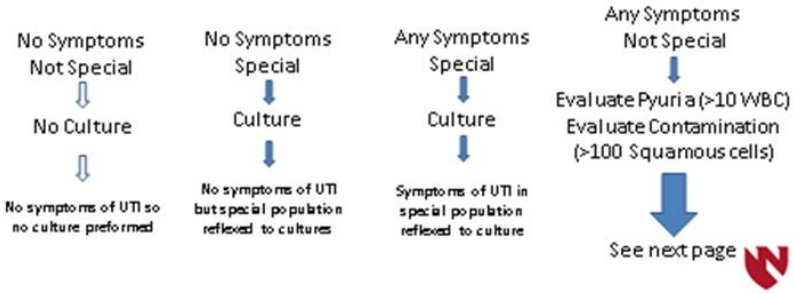
UTI Evaluation Order Panel

Assess symptoms

- No symptoms
- Typical (dysuria, new onset frequency or urgency, suprapubic or CVA tenderness) or Atypical symptoms (fever and unable to assess UTI symptoms, new alteration in mental status without clear cause, acute hematuria, etc.)

Assess if special population

- Pregnant, impending urologic surgery, kidney/pancreas transplant, children under 3 yrs., neutropenia, other



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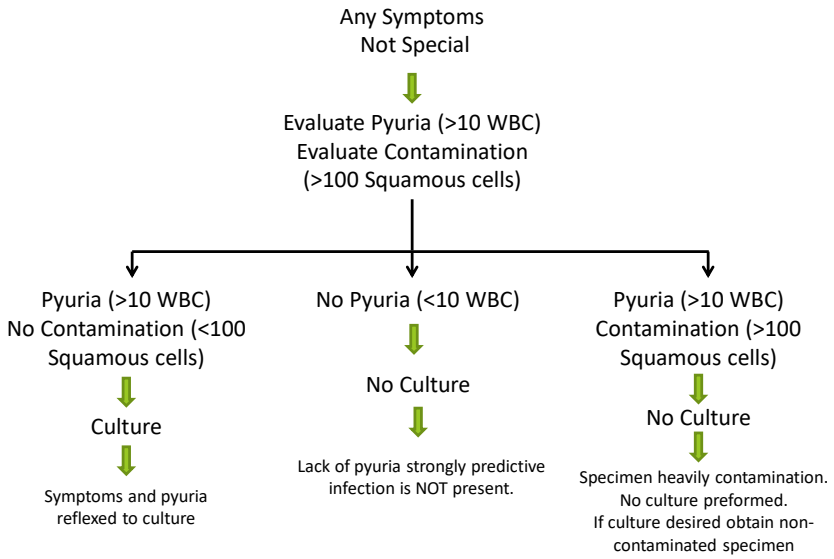

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Surgical Site Infections

- Scope of problem:
  - SSI occur in <1% - 5% of procedures
  - SSI account for approx 15% of nosocomial infections
  - LOS: approx 7 d
  - Cost: approx $15,000/case

Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017. Sandra I. Berríos-Torres, et al. JAMA Surg. 2017;152(8):784-791. doi:10.1001/jamasurg.2017.0904

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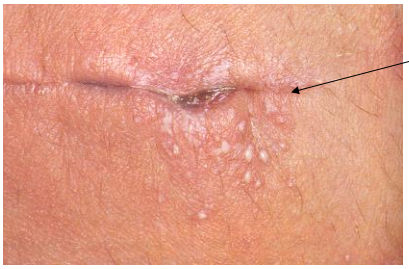
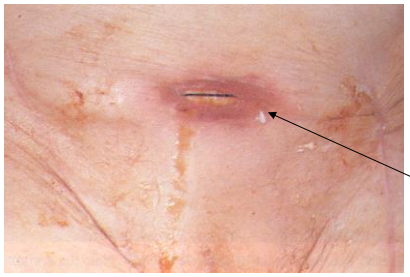
Surgical Site Infections



Superficial SSI

Gas Gangrene of Surgical Site



Vascular Graft SSI

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SSI Preventive Measures (CDC HICPAC 2017)

- Prophylactic Antibiotics
  - Right drug/right procedure
  - Timed to have bactericidal level in tissues at time of incision, (no more than 1 hour prior to surgery)
  - **Stop when skin is closed**
  - No rec for redosing, no rec for weight-based dosing
- Do not apply antimicrobials topically
- Consider triclosan sutures
- Consider intra-op irrigation of deep or SQ tissues with aqueous iodophor

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SSI Preventive Measures (CDC HICPAC 2017)

- Skin Preparation
  - Advise pts to shower at least night before operative day, no recs on timing, number, or CHG
  - Perform intraop skin prep with alcohol based antiseptic
  - Use clippers not razors
- No rec re: antimicrobial dressings
- No need for microbial wound sealants
- No need for plastic adhesive drapes
- Glucose Control
  - Keep glucose no greater than 200

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SSI Preventive Measures (CDC HICPAC 2017)

- Hypothermia
  - Maintain normothermia – no recs on lower limit of normothermia or how to achieve normothermia
- Oxygenation
  - For pts with normal pulm fxn and undergoing ETT, administer increased FiO2 during surgery and immediate postop. Maintain normothermia and volume. No rec on optimal target, duration, delivery method.
  - Recent skepticism re: FiO2

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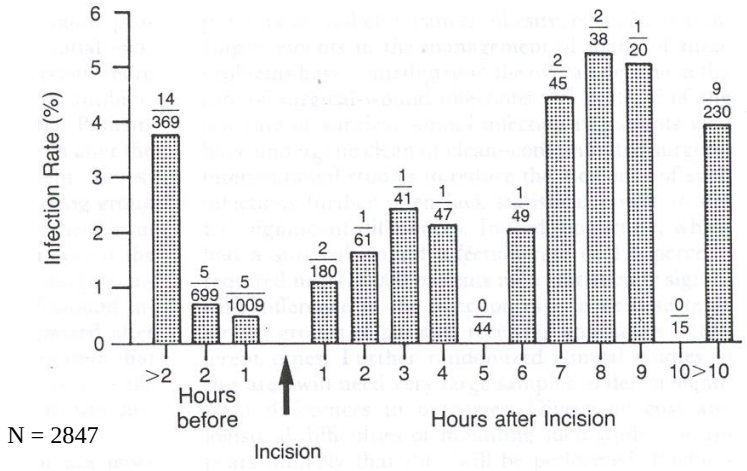
Importance of Timing of Prophylactic Antibiotics



N = 2847

(Classen, NEJM 1992)

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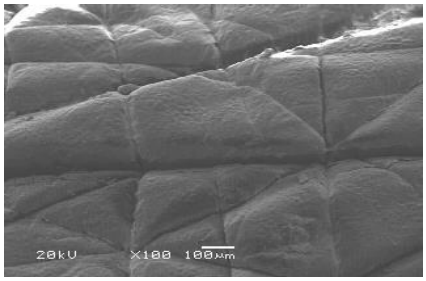
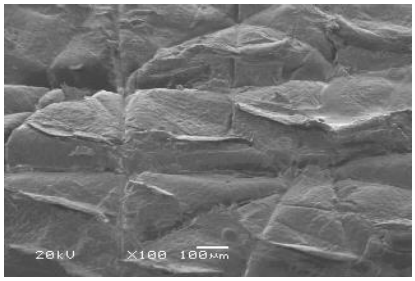
Hair Removal vs Surgical Site Infection





"Do not remove hair preoperatively unless hair at or around the incision site will interfere with the operation."
"If hair is removed, remove immediately before the operation, preferably with electric clippers."

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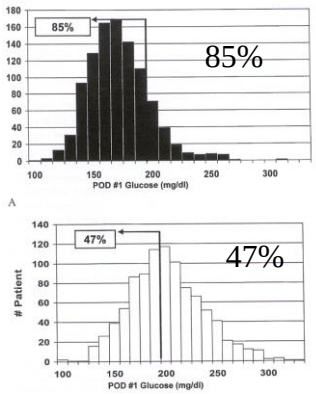
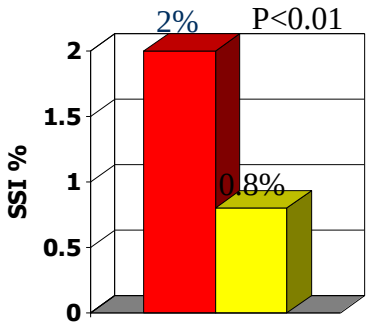
Control of Blood Glucose in Surgical Patients

Furnay, et al Ann Thoracic Surg, 1999
2467 consecutive diabetic pts undergoing open heart surgery
968 controls (Sliding Scale Insulin)
1499 IV insulin (goal; glu < 200)





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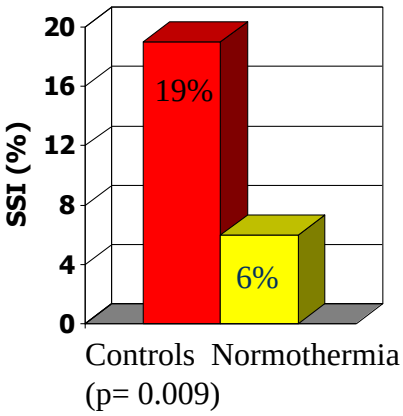
Hypothermia in Surgical Patients

- Kurz, et al NEJM 1996
- Colorectal Surgery
  - 104 normothermia (IV fluids, forced air warmer), mean temp 36.6^{0}C
  - 96 contols, mean temp 34.7^{0}C



(p= 0.009)

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Oxygenation and SSI

Effects of oxygen on post-surgical infections during an individualised perioperative open-lung ventilatory strategy: a randomised controlled trial

Carlos Ferrando[1,2,*], César Aldecoa[3], Carmen Unzueta[4], F. Javier Belda[5], Julián Librero[6],

Br J Anaesth. 124: (2020)

- Abdominal surgery, N=717. 0.8 vs 0.3 FiO2 during procedure and 3 hrs postop. RR of SSI 0.94 (0.59-1.5) P=0.9

Supplemental Oxygen and Surgical Site Infection in Colorectal Surgery: A Systematic Review and Meta-analysis

Scott K Shaffer [1], Tito D Tubog [2], Terri D Kane [3], Nathan E Stortroen [4]

AANA. 89: (2021)

- No significant effect of supplemental O2 (RR 0.91; 0.74-1.13)

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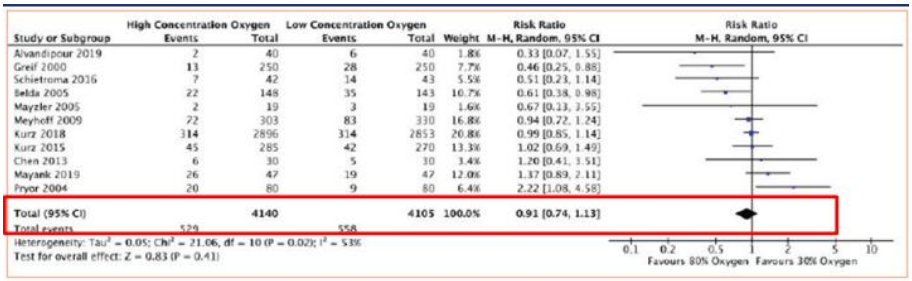

Figure 2. Forest Plot of the Incidence of Surgical Site Infection Comparing High Concentration (80% inspired) Versus Low Concentration (30-35% inspired) Oxygen for Colorectal Surgery

Abbreviations: CI, confidence interval; M-H, Mantel-Haenszel; Random, random-effects model

Shaffer et al. AANA. 89: (2021)

- Compendium change from “Basic/Essential Practice” to “Unresolved Issue”

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Nosocomial Pneumonia/VAP

- Most common HAI? 1:100 hospitalized pts; 1:10 on mechanical ventilation
- 275,000 cases per year?
- Mortality 10%
- Cost: LOS 7 days, 1.1 billion dollars/yr

SHEA/IDSA/APIC Practice Recommendation. Strategies to prevent ventilator-associated pneumonia, ventilator-associated events, and nonventilator hospital-acquired pneumonia in acute-care hospitals: 2022 Update. Infection Control & Hospital Epidemiology (2022), 43, 687–713. doi:10.1017/ice.2022.88

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Nosocomial Pneumonia: Risk Factors

- Mechanical ventilation
- Head trauma
- Abdominal/thoracic surg
- NG tube
- Sedation/analgesics
- Self-extubation
- Chronic lung disease
- Severity of illness
- Age
- Supine head position
- Bronchoscopy
- GI bleeding
- Shock
- Vent circuit changes < 48h
- Prior antibiotics

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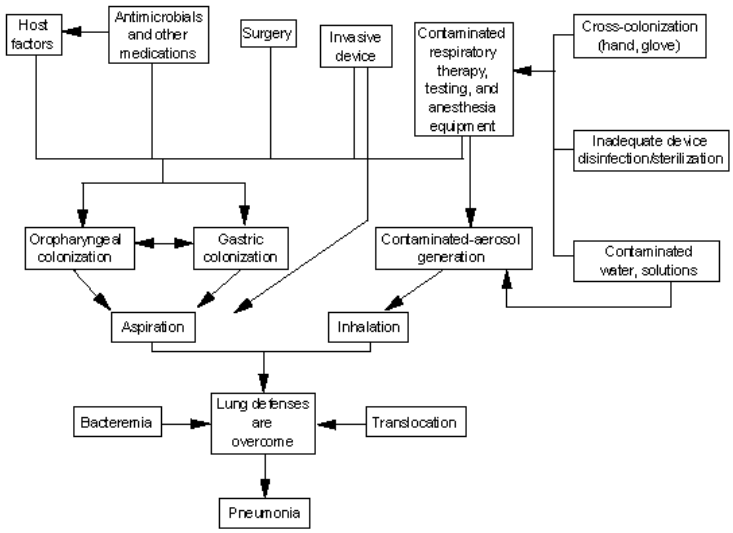
Pathogenesis of HAP



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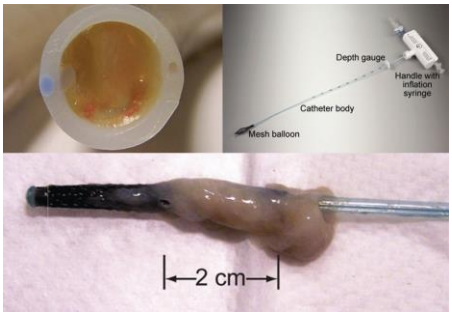
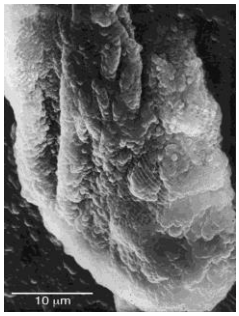
VAP: Pathogenesis





- Endotracheal intubation increases risk of nosocomial pneumonia 10-20 fold
- Eliminates gag/cough protective mechanisms
- Leakage of secretions around ET cuff is thought to be major route of inoculation of pathogens

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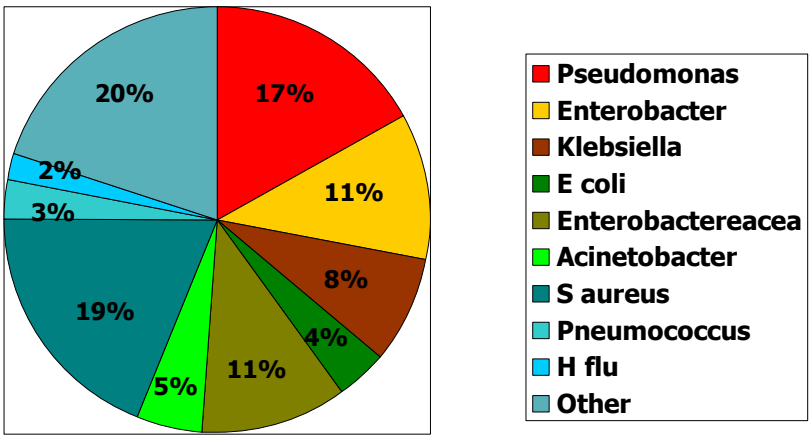
Nosocomial Pneumonia: Microbial Etiology



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Prevention "The VAP Bundle"

- Avoid intubation and prevent reintubation
  - Use high-flow nasal oxygen or noninvasive positive pressure ventilation (NIPPV) whenever safe and feasible (HIGH)
  - Minimize sedation (MODERATE)
    - Avoid benzodiazepines in favor of other agents
    - Use a protocol to minimize sedation
    - Implement a ventilator liberation protocol
  - Maintain and improve physical conditioning (MODERATE)
  - Elevate the head of the bed to 30–45° (LOW)
  - Provide oral care with toothbrushing but without chlorhexidine (MODERATE)
  - Provide early enteral vs. parenteral nutrition (HIGH)
  - Change the ventilator circuit only if visibly soiled or malfunctioning (HIGH)
- Additional approaches
  - Use selective oral or digestive decontamination in countries and ICUs with low prevalence of antibiotic resistant organisms
  - Utilize endotracheal tubes with subglottic secretion drainage ports for patients expected to require >48–72 hours of mechanical ventilation
  - Consider early tracheostomy
  - Consider postpyloric rather than gastric feeding for patients with gastric intolerance or at high risk for aspiration

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Not Recommended

no impact or negative impact on duration of mechanical ventilation, length of stay, or mortality.

- Oral care with chlorhexidine
- Probiotics
- Ultrathin polyurethane endotracheal tube cuffs
- Tapered endotracheal tube cuffs
- Automated control of endotracheal tube cuff pressure
- Frequent cuff-pressure monitoring
- Silver-coated endotracheal tubes
- Kinetic beds
- Prone positioning
- Chlorhexidine bathing
- Stress-ulcer prophylaxis
- Monitoring residual gastric volumes
- Early parenteral nutrition

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CLABSI: Scope of the Problem

- Approximately 78,000 patients experience catheter-related BSI in the United States hospitals and dialysis units yearly
- LOS: ~7 days, Cost $32,000 per case

SHEA/IDSA/APIC Practice Recommendation Strategies to prevent central line-associated bloodstream infections in acute-care hospitals: 2022 Update. Infection Control & Hospital Epidemiology (2022), 43, 553–569. doi:10.1017/ice.2022.8

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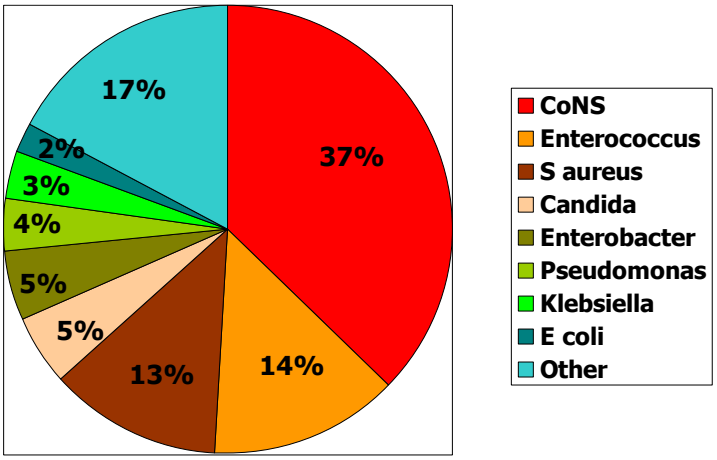
Nosocomial Bacteremia – USA CDC NHSN



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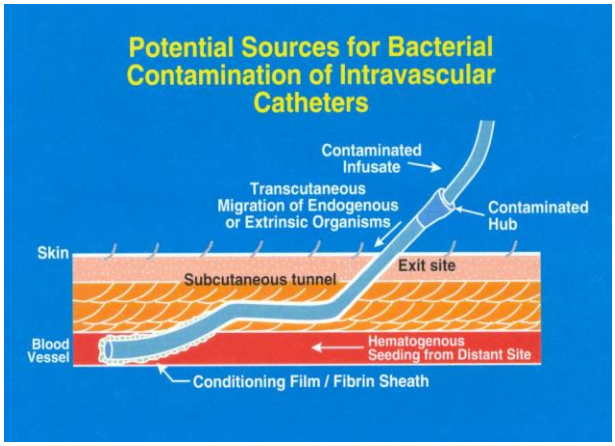
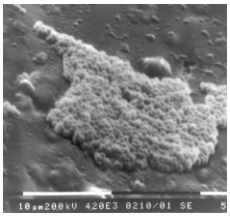
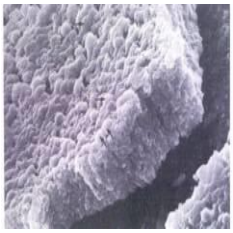
Pathogenesis of CLABSI







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Prevention of CLABSI: "The Bundle Approach"

Before insertion

- Provide easy access to an evidence-based list of indications for CVC use to minimize unnecessary CVCs
- Require education and competency assessment of HCP involved in insertion and maintenance of CVCs
- Bathe ICU patients aged >2 months with a chlorhexidine preparation daily

At insertion

- Have a process in place, such as a checklist, to ensure adherence to infection prevention practices
- Perform hand hygiene prior to catheter insertion or manipulation
- The subclavian site is preferred to reduce infectious complications
- Use an all-inclusive catheter cart or kit
- Use ultrasound guidance for catheter insertion
- Use maximum sterile barrier precautions during CVC insertion
- Use an alcoholic chlorhexidine antiseptic for skin preparation

After insertion

- Ensure appropriate nurse-to-patient ratio and limit use of float nurses in ICUs
- Use chlorhexidine-containing dressings for CVCs in patients over 2 months of age
- Change transparent dressings and perform site care with a chlorhexidine-based antiseptic at least every 7 days or immediately if the dressing is soiled, loose, or damp. Change gauze dressings every 2 days
- Disinfect catheter hubs, needleless connectors, and injection ports before accessing the catheter
- Remove nonessential catheters
- Routine replacement of administration sets not used for blood, blood products, or lipid formulations can be performed at intervals up to 7 days
- Perform surveillance for CLABSI in ICU and non-ICU settings

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Prevention of CLABSI

Additional Approaches

- Use antiseptic- or antimicrobial-impregnated CVCs
- Use antimicrobial lock therapy for long-term CVCs
- Use recombinant tissue plasminogen activating factor (rt-PA) once weekly after hemodialysis in patients undergoing hemodialysis through a CVC
- Utilize infusion or vascular access teams for reducing CLABSI rates
- Use antimicrobial ointments for hemodialysis catheter insertion sites
- Use an antiseptic-containing hub/connector cap/port protector to cover connectors

Avoid

- Do not use antimicrobial prophylaxis for short-term or tunneled catheter insertion or while catheters are in situ
- Do not routinely replace CVCs or arterial catheters

Unresolved Issues

- Routine use of needleless connectors as a CLABSI prevention strategy before an assessment of risks, benefits, and education regarding proper use
- Surveillance of other types of catheters (eg, peripheral arterial or peripheral venous catheters)
- Standard, nonantimicrobial transparent dressings and CLABSI risk.
- The impact of using chlorhexidine-based products on bacterial resistance to chlorhexidine
- Sutureless securement
- Impact of silver zeolite-impregnated umbilical catheters in preterm infants
- Necessity of mechanical disinfection of a catheter hub, needleless connector, and injection port before accessing the catheter when antiseptic-containing caps are being used

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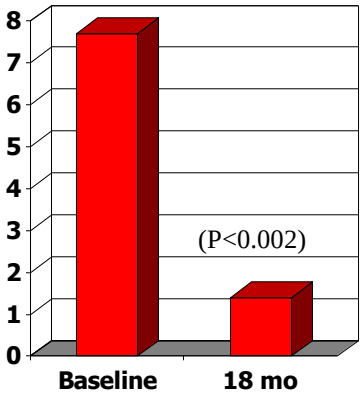
An Intervention to Decrease Catheter-Related Bloodstream Infections in the ICU

Peter Pronovost, M.D., Ph.D., Dale Needham, M.D., Ph.D., Sean Berenholtz, M.D., David Sinopoli, M.P.H., M.B.A., Haitao Chu, M.D., Ph.D., Sara Cosgrove, M.D., Bryan Sexton, Ph.D., Robert Hyzy, M.D., Robert Welsh, M.D., Gary Roth, M.D., Joseph Bander, M.D., John Kepros, M.D., and Christine Goeschel, R.N., M.P.A.

Intervention in 108 ICUs:

- Daily goals sheet
- Hand Hygiene
- Full Sterile Barrier Precautions
- Chlorhexidine Antiseptic
- Avoidance of the Femoral Site
- Removal of CVCs asap

Mean BSI/1000 CVC d



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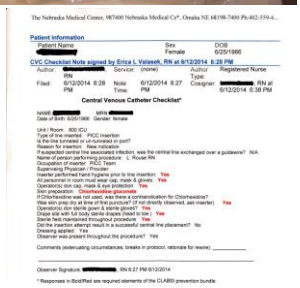
Nebraska Medicine CVC Insertion Kit



Patient Information

Patient Name: [redacted] Sex: Female DOB: 6/25/1966

CVC Checklist Note signed by Erica L Valasek, RN at 6/12/2014 6:28 PM

Author: [redacted] RN Service: (none) Author Type: Registered Nurse

Filed: 6/12/2014 6:28 PM Note Time: 6/12/2014 6:27 PM Cosigner: [redacted] RN at 6/12/2014 6:38 PM

Central Venous Catheter Checklist*

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Hospital Onset Bloodstream Infection: HOB

- Definition: A bacterial or fungal pathogen from a blood culture specimen collected on the 4th calendar day of admission or later
  - Easy to identify based on lab result – electronic surveillance
  - HOB correlates with CLABSI
  - HOB captures other vascular catheter associated BSI (PIV, midlines, arterial caths, etc), as well as non-vascular catheter causes (pneumonia, UTI, SSI, etc).
  - HOB metric would discourage “cost shifting” away from CLABSI
  - HOB may promote blood culture stewardship

  - Proportion of HOB that are preventable is unknown (~2/3 in Dantes et al. ICHE 2019)
  - HOB may result in “don’t culture, just treat” approach

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How to control MRSA/VRE/other MDROs?

Horizontal vs Vertical Infection Prevention Interventions

- Intervention that affects narrow group of patients (eg. Active surveillance cultures for MRSA) vs intervention that cuts across lines and affects numerous patient groups (eg. Chlorhexidine bathing)

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Doing the most good for the most people in the most cost efficient manner possible

- Hand Hygiene & Standard Precautions
- Environmental Cleaning
- Chlorhexidine Bathing
- Eliminate Fomites
- Insert and care for devices correctly
- Respiratory etiquette and vaccination
- Presenteeism
- Antimicrobial stewardship

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Hand Hygiene

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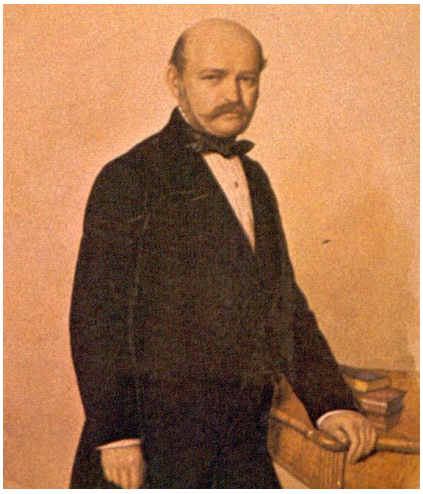
Hand Hygiene



- Ignaz Philipp Semmelweis (1818-1865)
- “Etiology, Concept, and prophylaxis of Childbed Fever” 1861

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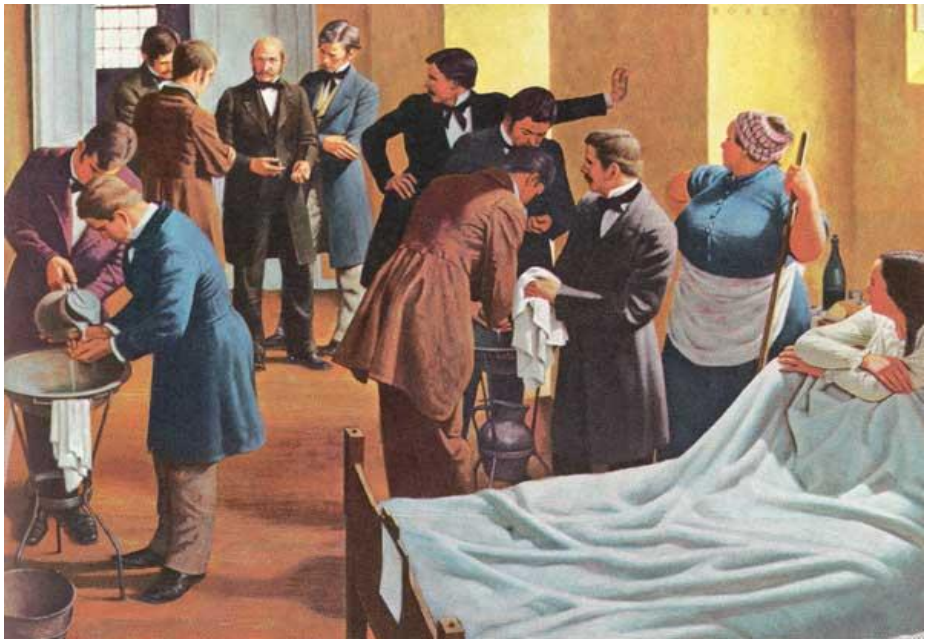

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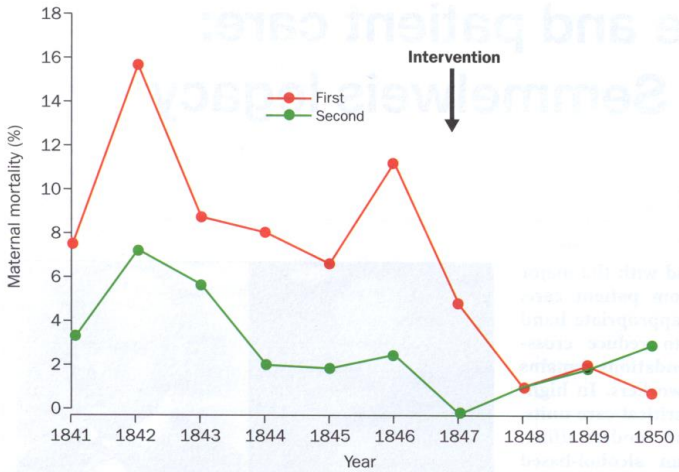
Impact of Hand Hygiene on Puerperal Fever – Semmelweis 1861



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Because of my convictions, I must here confess that God only knows the number of patients that have gone prematurely to their graves by my fault. I have handled cadavers extensively, more than most doctors. As painful and depressing, indeed, as such an acknowledgement is, still the remedy does not lie in concealment and this misfortune should not persist forever, for the truth must be made known to all concerned."

Ignaz Semmelweis

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Barriers to Hand Hygiene

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Barriers to Hand Hygiene

Where is the sink?

Here it is!

Do you want to wash your hands here?

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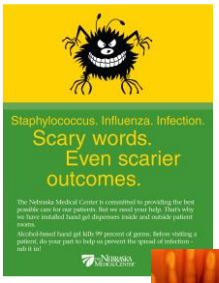
Hand Hygiene at Nebraska Medicine



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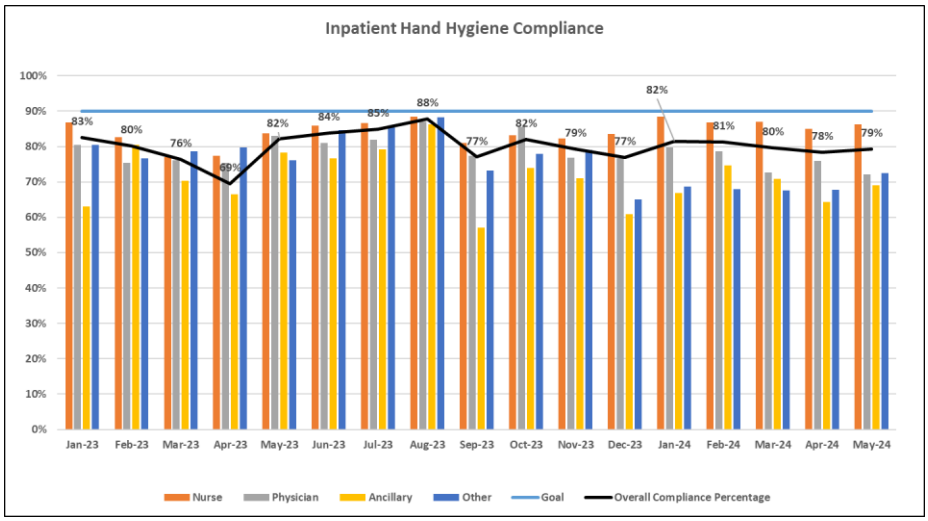
HAND HYGIENE AT NMC



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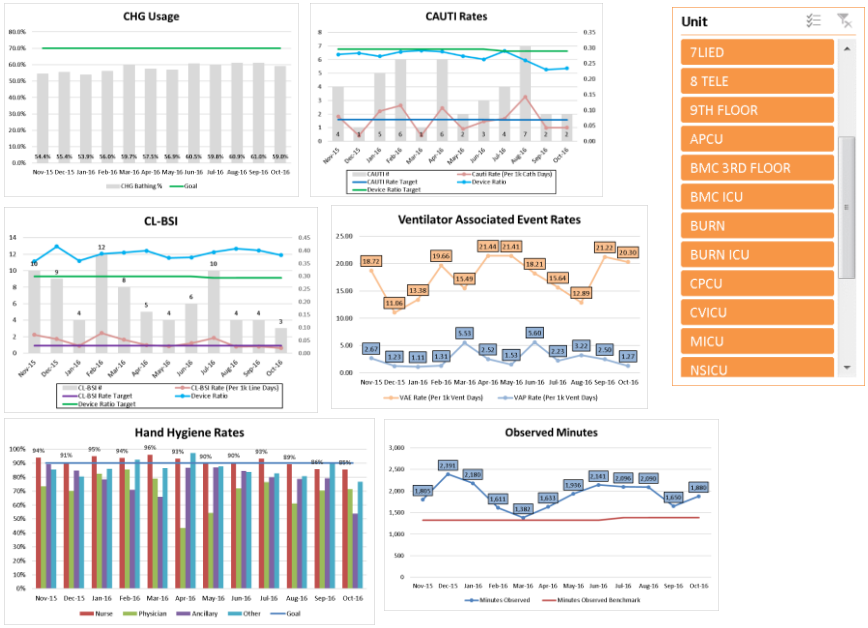
Inpatient Unit Specific Dashboard



50

Provide a Clean Environment

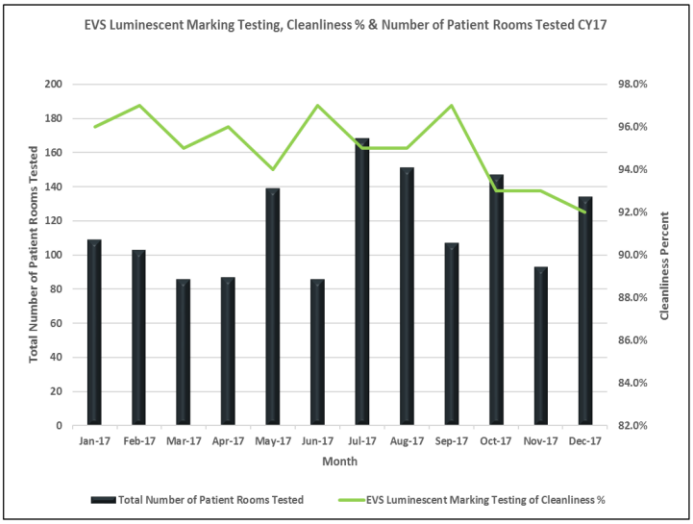
- Use of a UV marking solution to assess environmental cleaning

51

High Touch Surfaces

52

EVS data



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UV Disinfection

54

Fomite Elimination

93% Contamination rate
20% *S. aureus*
13% Gram-negative bacilli

55

Patient Dedicated Stethoscope

56

Chlorhexidine Patient Bathing

Effectiveness of Chlorhexidine Bathing to Reduce Catheter-Associated Bloodstream Infections in Medical Intensive Care Unit Patients

Susan C. Bleasdale, MD; William E. Trick, MD; Ines M. Gonzalez, MD; Rosie D. Lyles, MD; Mary K. Hayden, MD; Robert A. Weinstein, MD

Arch Intern Med 2007

ORIGINAL ARTICLE

Selective Use of Intranasal Mupirocin and Chlorhexidine Bathing and the Incidence of Methicillin-Resistant *Staphylococcus aureus* Colonization and Infection Among Intensive Care Unit Patients

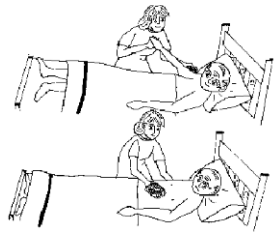
Glenn Ridenour, MD; Russell Lampen, DO; Jeff Federspiel; Steve Kritchevsky, PhD; Edward Wong, MD; Michael Climo, MD

ICHE 2007

Effect of Hospital-Wide Chlorhexidine Patient Bathing on Healthcare-Associated Infections

ICHE 2012

Mark E. Rupp, MD;[1,2] R. Jennifer Cavalieri, RN;[1] Elizabeth Lyden, MS;[3] Jennifer Kucera, MS;[1] MaryAnn Martin, RN;[2] Teresa Fitzgerald, RN;[2] Kate Tyner, RN;[2] James R. Anderson, PhD;[3] Trevor C. VanSchooneveld, MD[1,2]



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Two Sides of the Same Coin

Infection Prevention

Antibiotic Resistance & Nosocomial Infections

Antimicrobial Stewardship

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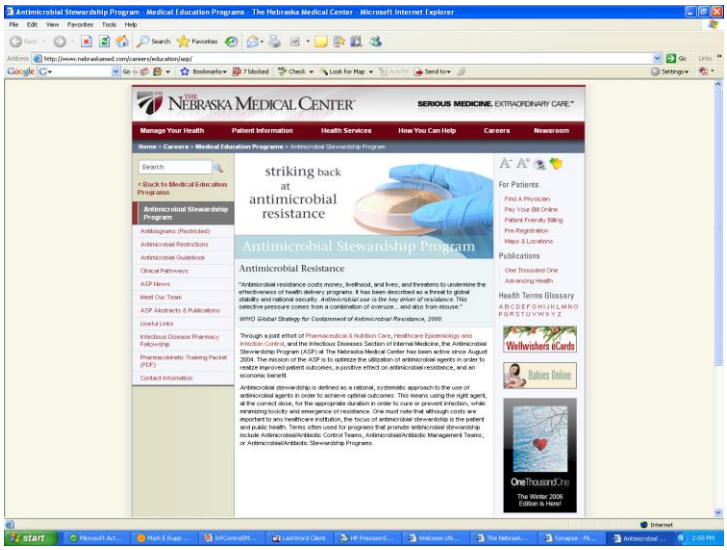
Antimicrobial Stewardship Program

http://www.nebraskamed.com/careers/education/asp/index.aspx



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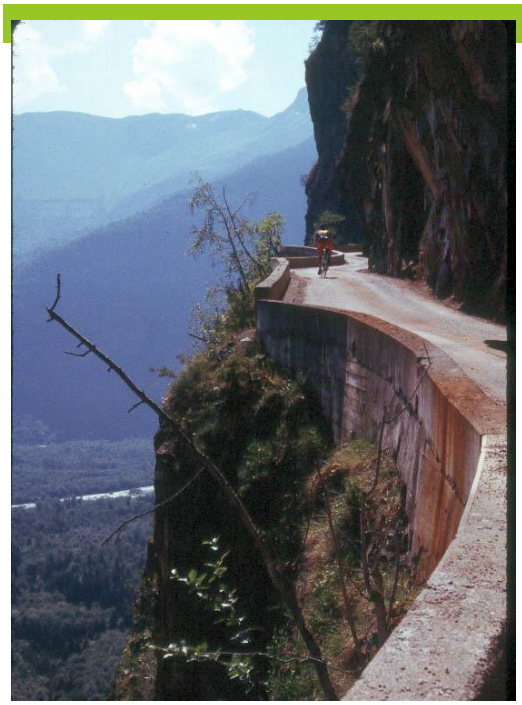

Taking the high road

Prevention of HAIs because it is the right thing to do.

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