DEVICE-ASSOCIATED INFECTIONS (DAIs)

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HEALTHCARE-ASSOCIATED INFECTIONS (HAIs)

- **Healthcare-associated infections (HAIs) –** Is an infection occurring in a patient during the process of care in a hospital or other health care facility which was not present or incubating at the time of admission.
- HAIs may be caused by infectious agents from **endogenous or exogenous** sources.

  - **Endogenous sources** are body sites, such as the skin, nose, mouth, gastrointestinal (GI) tract or vagina that are normally inhabited by microorganisms.
  - **Exogenous sources** are those external to the patient, such as patient care personnel, visitors, patient care equipment, medical devices or the health care environment.

1ST PRINCIPLE OF INFECTION PREVENTION

-
- *at least 35-50% of all healthcare-associated infections are associated with only 5 patient care practices:*

  - Use and care of urinary catheters
  - Use and care of vascular access lines
  - Therapy and support of pulmonary functions
  - Surveillance of surgical procedures
  - Hand hygiene and standard precautions

Healthcare-Associated Urinary Tract Infection

- Urinary tract infection (UTI) causes ~ 40% of hospital-acquired infections
- Most infections due to urinary catheters
- 25% of inpatients are catheterized
- Leads to increased morbidity and costs

CAUTI Criterion

Patient had an indwelling catheter that had been in place for > 2 days on the date of event and was either: ▪ Present for any portion of the calendar day on the date of event or ▪ Removed the day before the date of event.	Patient has at least one of the following signs or symptoms: 1.Fever (>38.0°C) 2.Suprapubic tenderness 3.Costovertebral angle pain or tenderness 4.Urinary urgency 5.Urinary frequency 6. Dysuria	Urine culture with no more than two species of organisms identified, at least one of which is a bacterium of $\geq 10^5$ CFU/ml.

Prevention of Catheter-Associated Urinary Tract Infection (CAUTI)

Avoid unnecessary catheterization

Two main principles

Limit the duration of catheterization

Indications for the use of indwelling urethral catheters

- **Indications**
  - Perioperative use for selected surgical procedures
  - Urine output monitoring in critically ill patients
  - Management of acute urinary retention and urinary obstruction
  - Assistance in pressure ulcer healing for incontinent residents
  - **As an exception**, at patient request to improve comfort

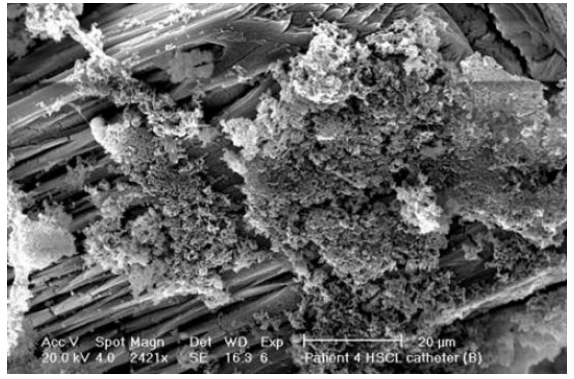
- Urinary incontinence is **not** an accepted indication for urinary catheterization
  - 21 to 50 percent of urinary catheters not indicated

Lo et al. (2008) *Infect Control Hosp Epidemiol* Suppl 1:S41-50

Is one catheter better than another?

- No significant difference between latex and silicone catheters
- What about coated / impregnated catheters?
- The concept: prevention of biofilm formation

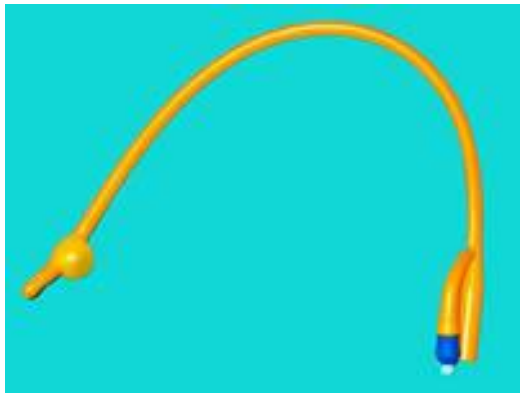
EM pictures of biofilms on silver coated catheters



Morgan et al. (2009) *Urol Res* 37:89–93.

Catheter insertion and maintenance

- Practice hand hygiene (A-III)
  - before insertion of the catheter
  - before and after any manipulation of the



http://www.who.int/gpsc/tools/en/

Catheter insertion and maintenance

Insert	Insert catheters by use of aseptic technique and sterile equipment (A-III)
Cleanse	Cleanse the meatal area with antiseptic solutions is unnecessary (A-I) •routine hygiene is appropriate
Secure	Properly secure indwelling catheters after insertion to prevent movement and urethral traction (A-III)
Maintain	Maintain a sterile, continuously closed drainage system (A-I)
Do not disconnect	Do not disconnect the catheter and drainage tube unless the catheter must be irrigated (A-I)

Lo et al. (2008) *Infect Control Hosp Epidemiol* Suppl 1:S41-50

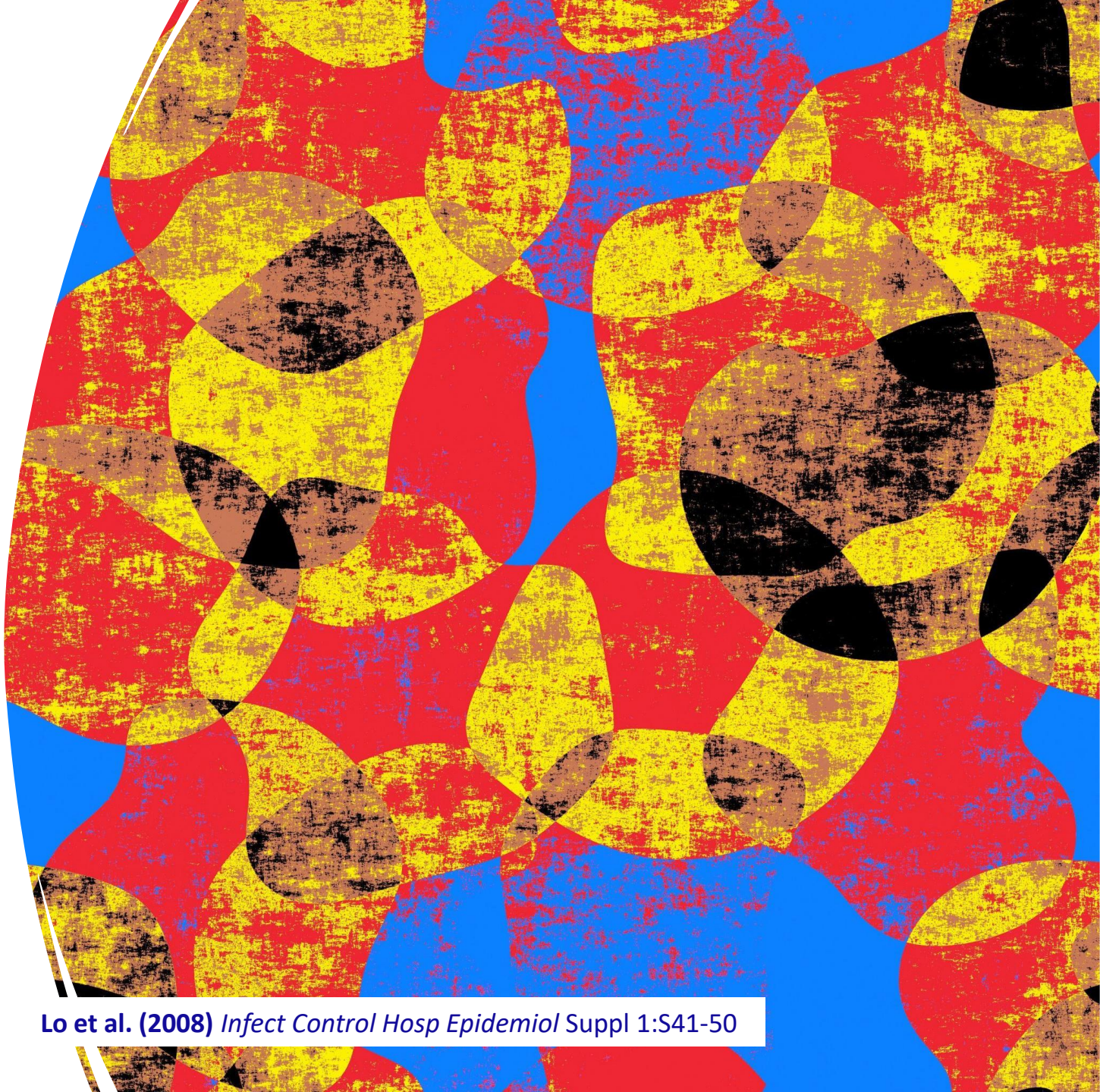
Catheter insertion and maintenance

Maintain	Maintain unobstructed urine flow (A-II)
Empty	Empty the collecting bag regularly, using a separate col- lecting container for each patient, and avoid allowing the draining spigot to touch the collecting container (A-II)
Keep	Keep the collecting bag below the level of the bladder at all times (A-III)
Do	Do not routinely use silver-coated or other antibacterial catheters (A-I)
Do not screen	Do not screen for asymptomatic bacteruria in catheterized patients (A-II)
Do not treat	Do not treat asymptomatic bacteruria in catheterized patients except before invasive urologic procedures (A-I)

Lo et al. (2008) *Infect Control Hosp Epidemiol* Suppl 1:S41-50

What you should not do to prevent CAUTI

- Do not use (avoid) catheter irrigation (A-I)
- Do not use systemic antimicrobials routinely as prophylaxis (A-II)
- Do not change catheters routinely (A-III)

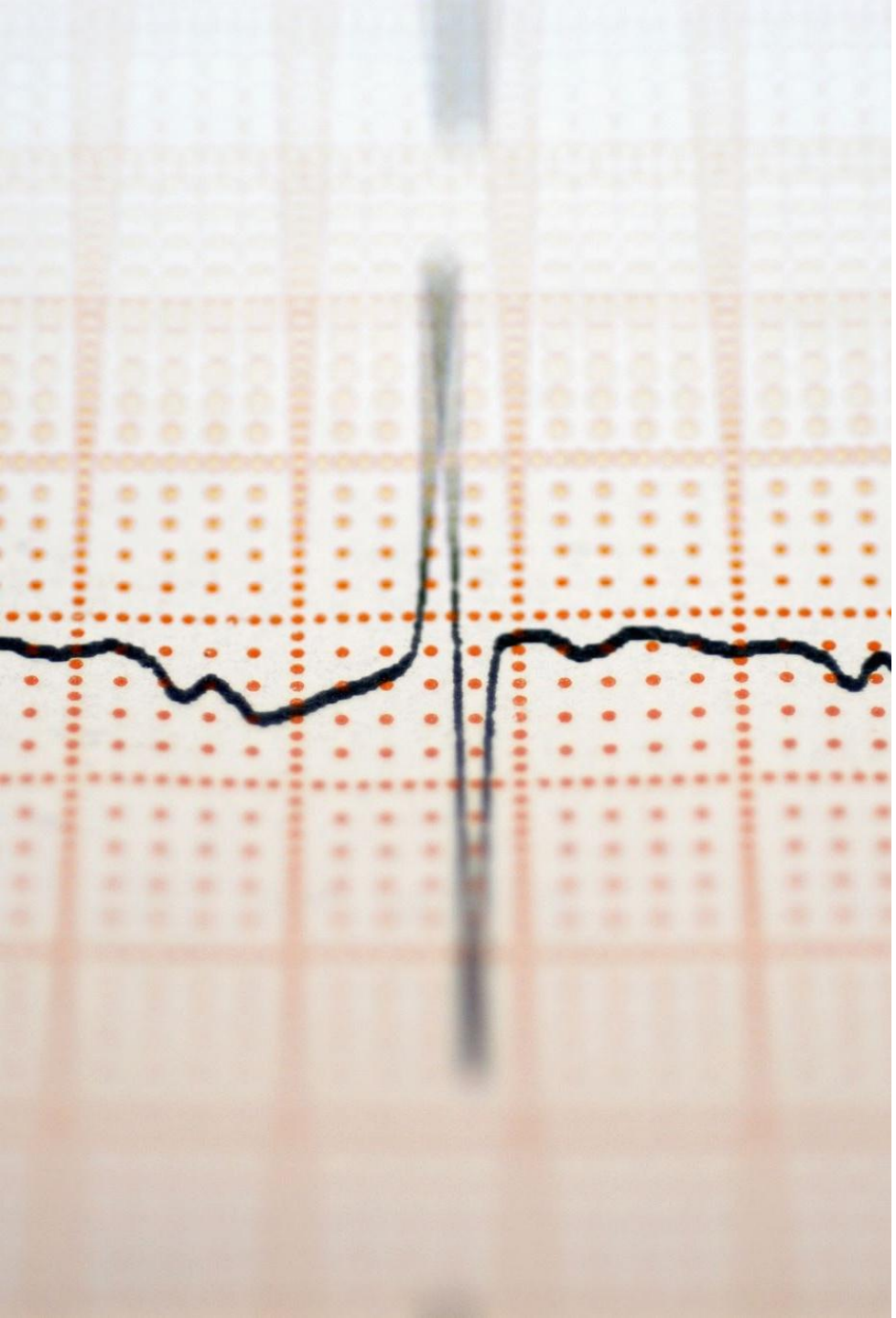


Lo et al. (2008) *Infect Control Hosp Epidemiol* Suppl 1:S41-50

1st principle of infection prevention

- *at least 35-50% of all healthcare-associated infections are associated with only 5 patient care practices:*

- Use and care of urinary catheters
- Use and care of vascular access lines
- Therapy and support of pulmonary functions
- Experience with surgical procedures
- Hand hygiene and standard precautions

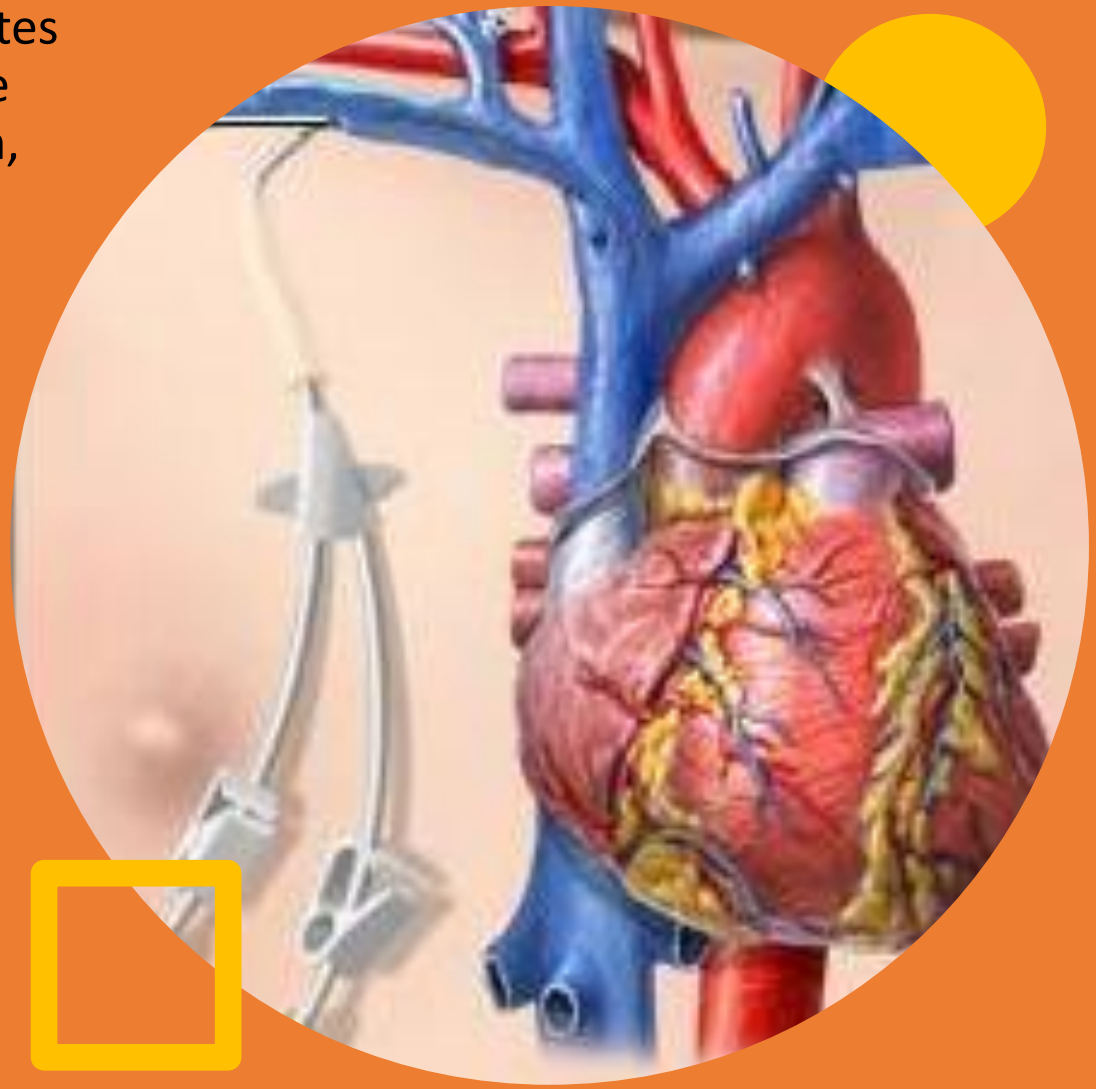


Central Line Associated Blood Stream Infection (CLABSI)

- A laboratory-confirmed primary bloodstream infection in a patient where the central line was in place for > 2 calendar days (48 hours) on the date of the event, with day of device placement being Day 1.

- **A central line is**
  - An intravascular catheter that terminates at or close to the heart or in one of the great vessels which is used for infusion, withdrawal of blood, or hemodynamic monitoring

- **Examples of Great Vessels include:**
  - Aorta
  - Pulmonary artery
  - Superior vena cava
  - Inferior vena cava
  - Brachiocephalic veins
  - Internal jugular veins
  - Subclavian veins
  - External iliac veins
  - Common iliac veins
  - Femoral veins
  - In neonates, the umbilical artery/vein



Sources of the catheter-associated bloodstream infection

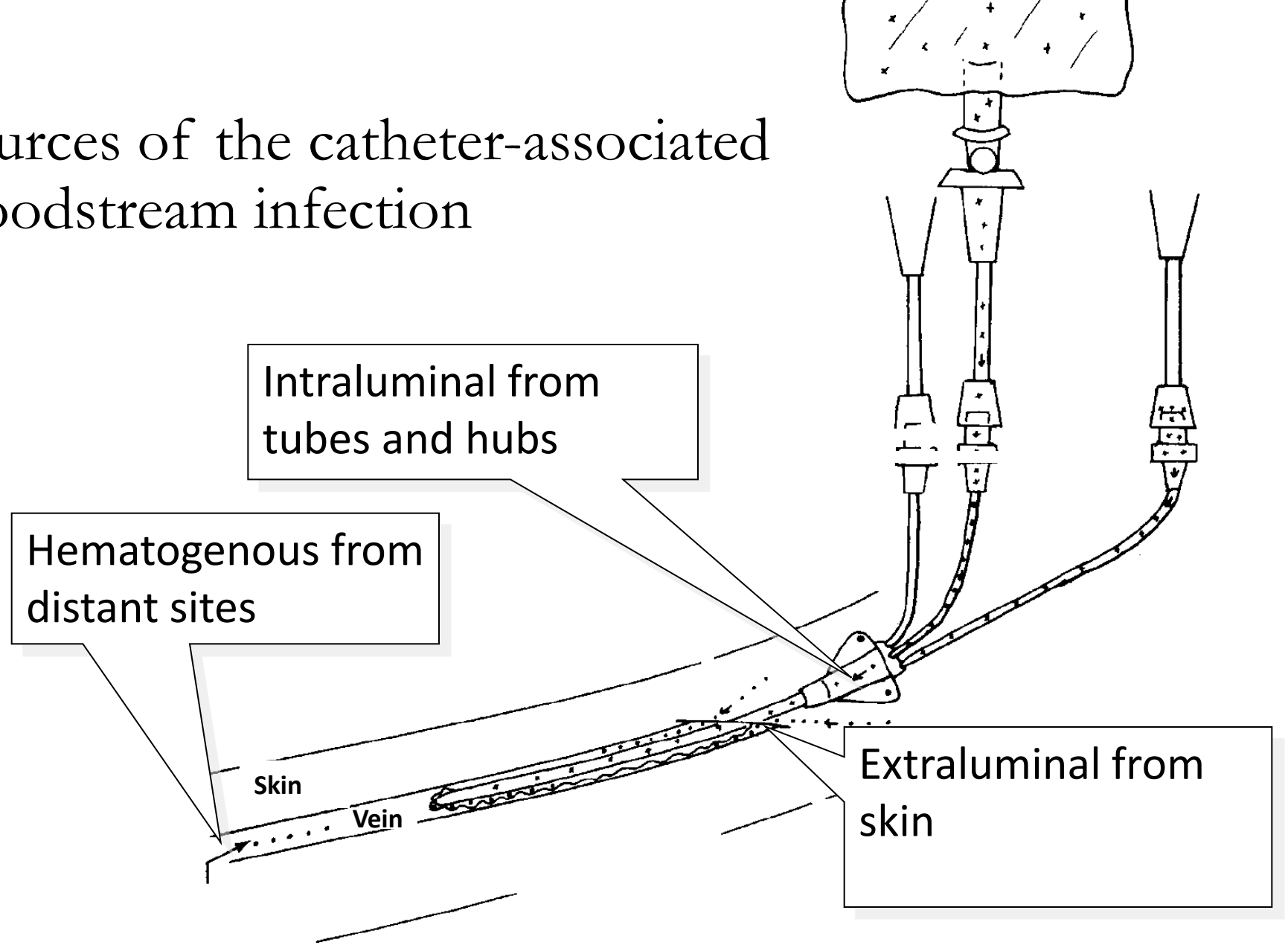
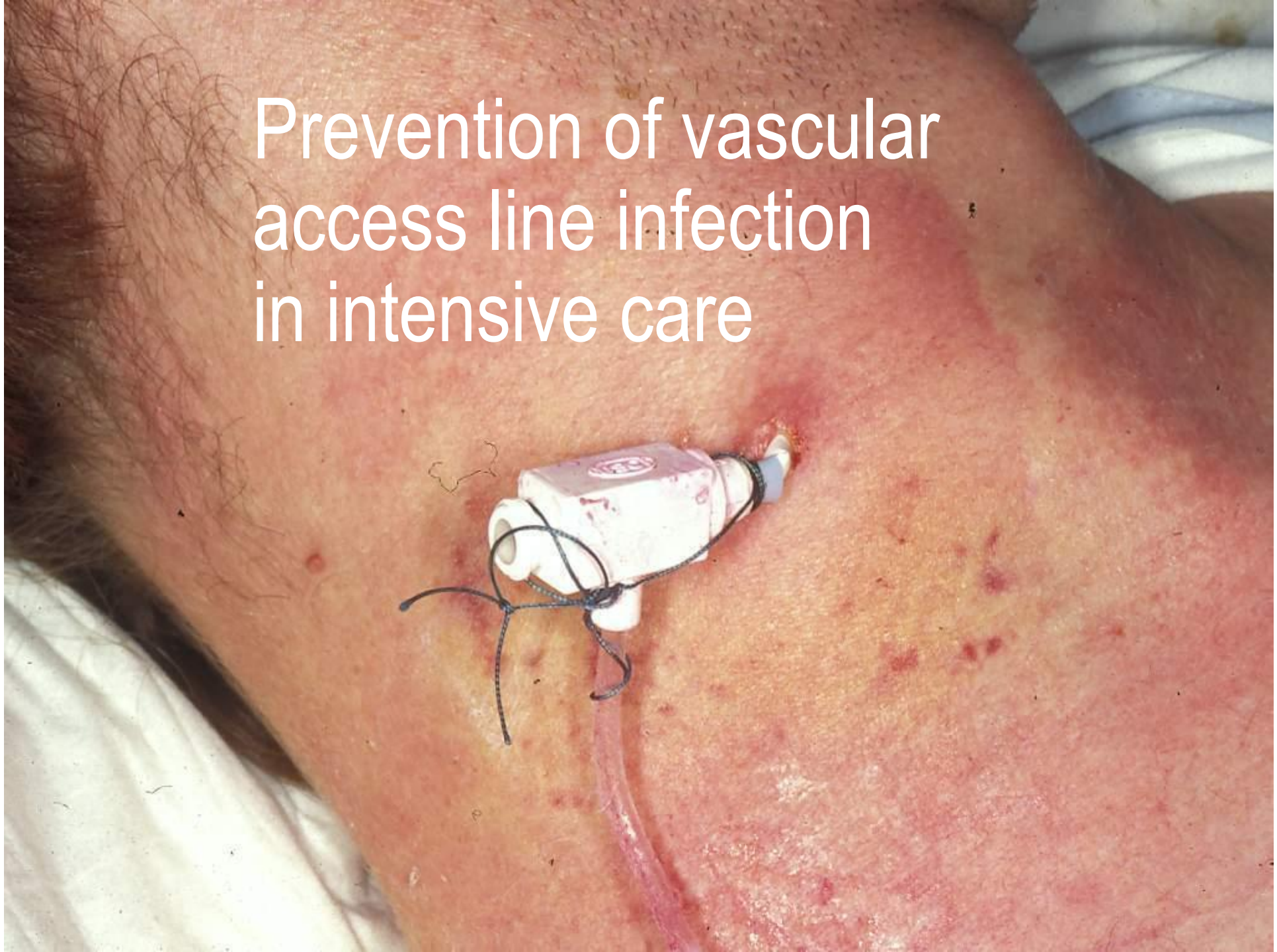
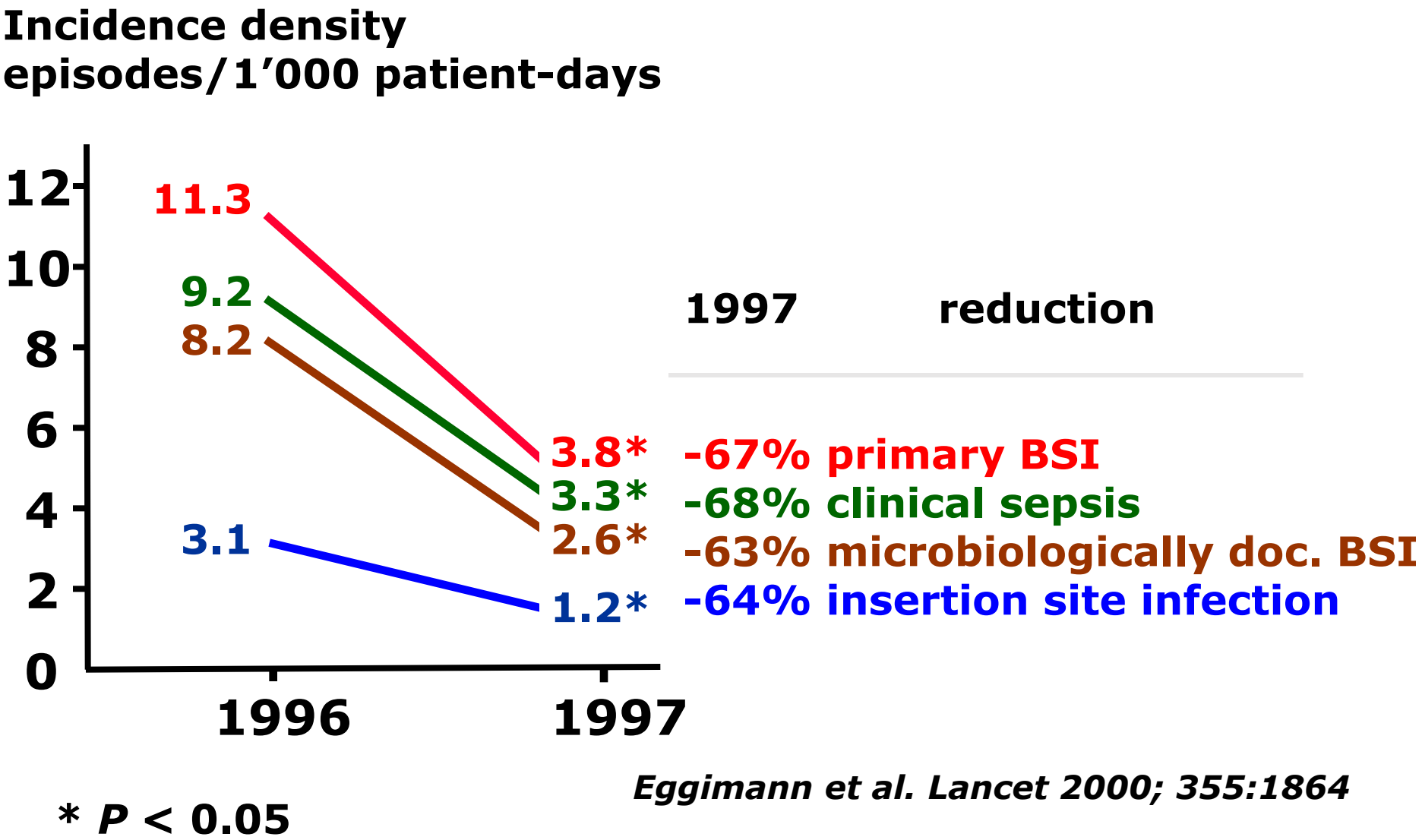


Figure. Source of intravascular catheter–related infections.

Prevention of vascular access line infection in intensive care



Prevention of vascular access line infection Medical intensive care unit



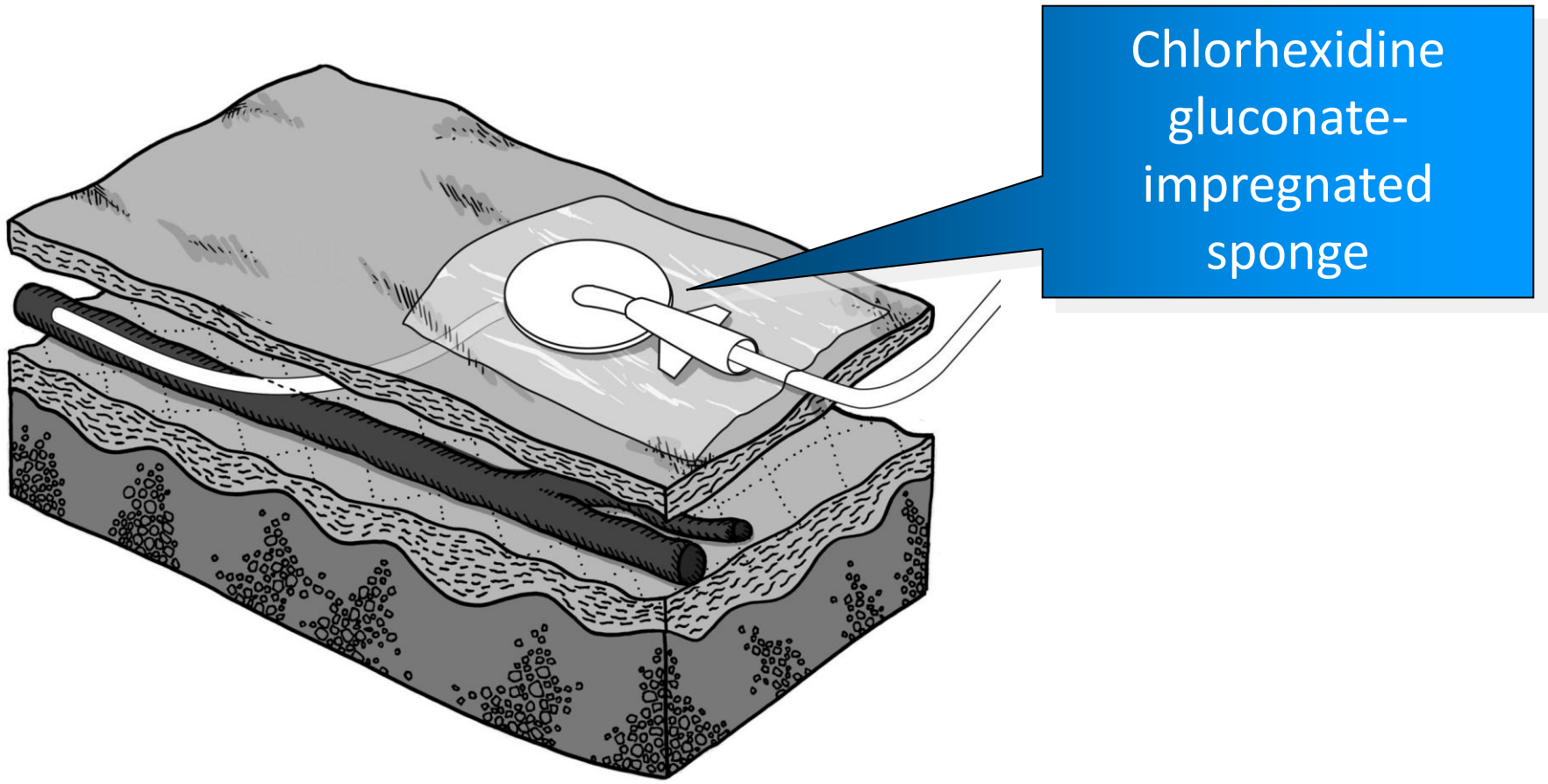
Eggimann et al. Lancet 2000; 355:1864

Multimodal intervention strategies to reduce catheter-associated bloodstream infections:

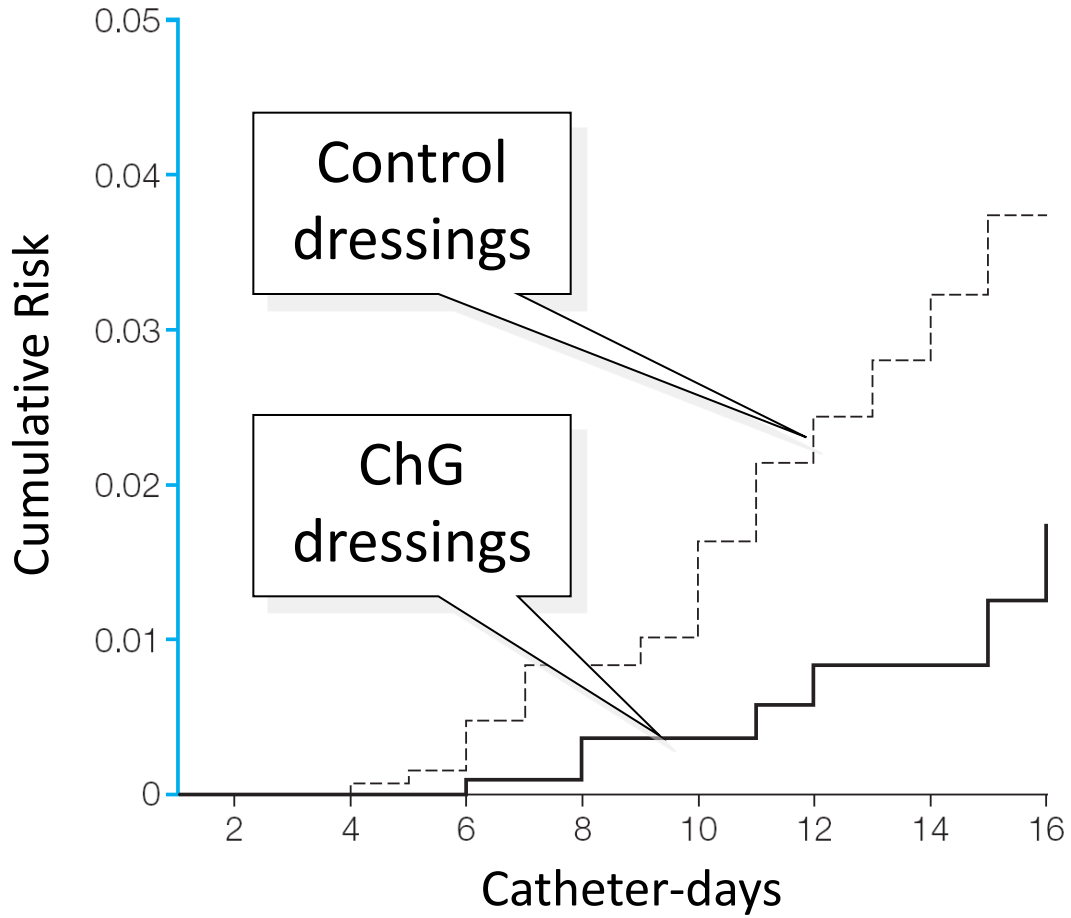
- Hand hygiene
- Maximal sterile barrier precaution at insertion
- Skin antisepsis with alcohol-based chlorhexidine-containing products
- Subclavian access as the preferred insertion site
- Daily review of line necessity
- Standardized catheter care using a non-touch technique
- Respecting the recommendations for dressing change

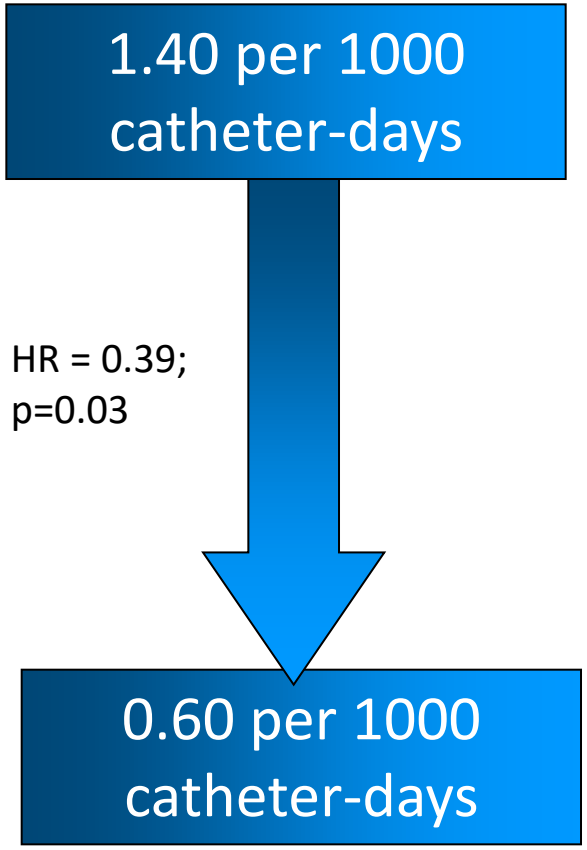
Eggimann P. *Lancet* 2000; 35: 290
Pronovost P. *N Engl J Med* 2006; 355: 26
Zingg W. *Crit Care Med* 2009; 37: 2167

Could we do better ?



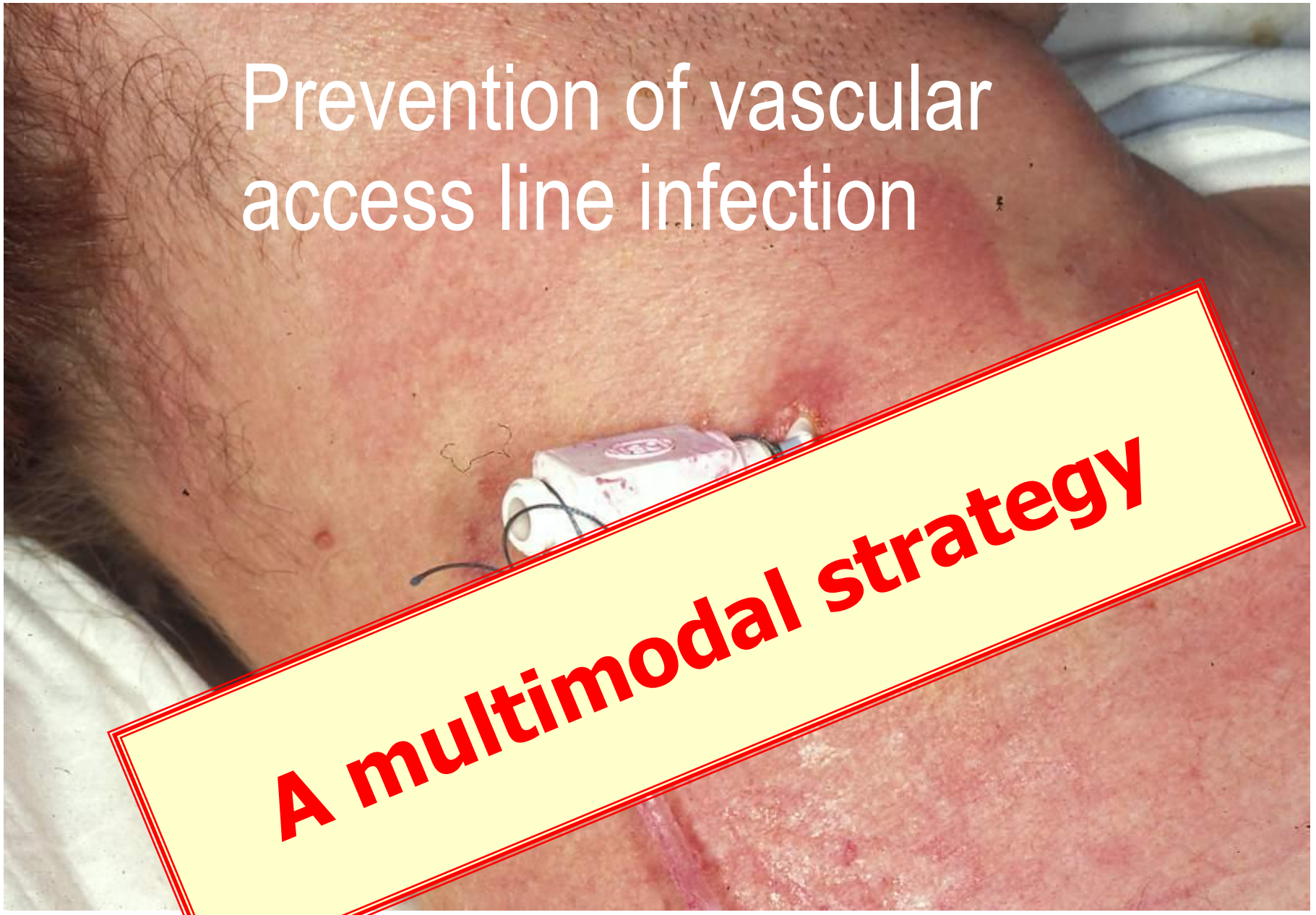
Chlorhexidine-gluconate impregnated dressings decreased major catheter-related infections:





Timsit JF. *JAMA* 2009; 301: 1231

Prevention of vascular access line infection



A multimodal strategy

1st principle of infection prevention

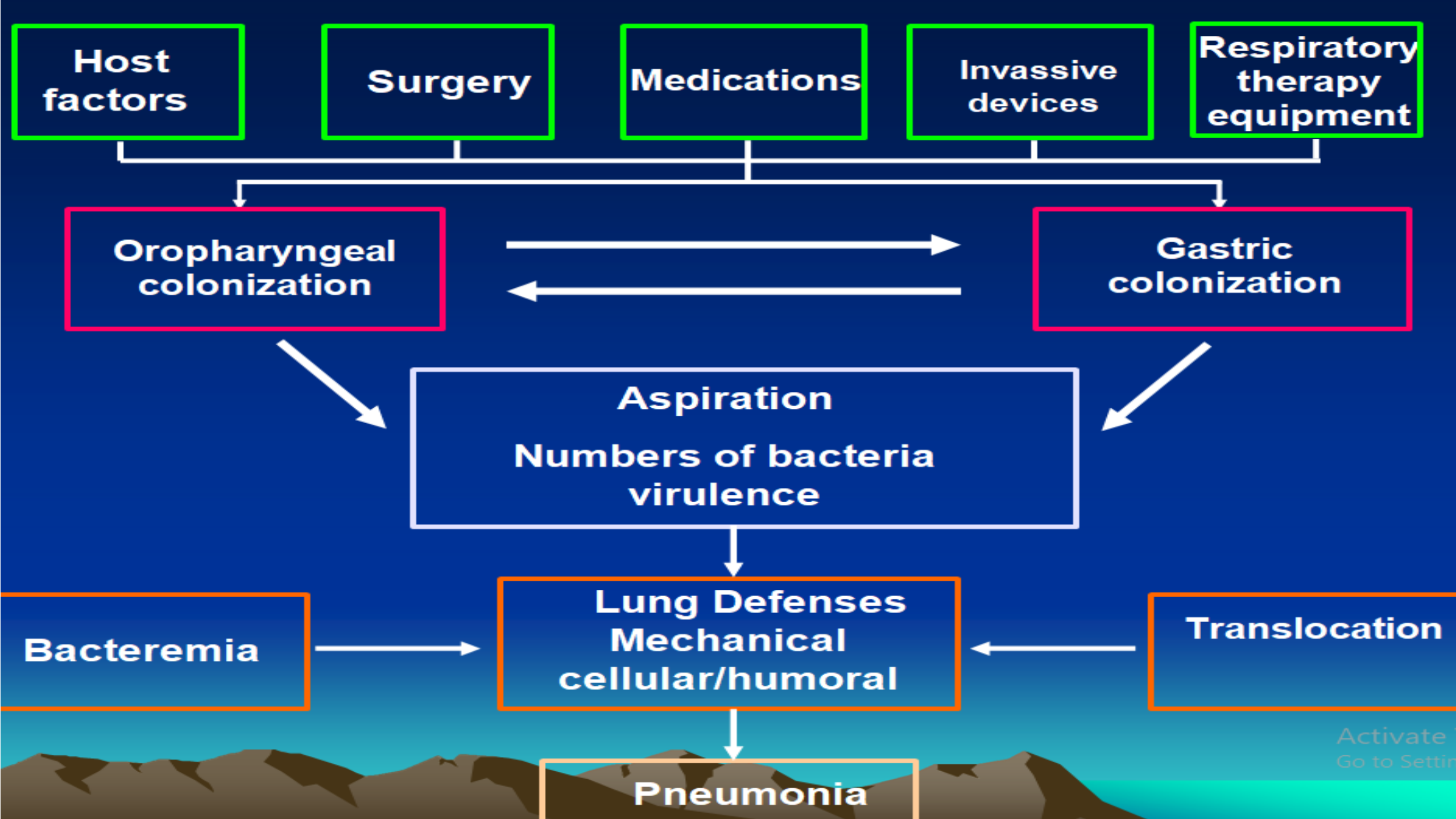
- *At least 35-50% of all healthcare-associated infections are associated with only 5 patient care practices:*

- Use and care of urinary catheters
- Use and care of vascular access lines
- Therapy and support of pulmonary functions
- Experience with surgical procedures
- Hand hygiene and standard precautions

Ventilator-Associated Pneumonia (VAP)

- This infection is with onset of 48-72 hours of hospitalization, development of a new or progressive infiltrate in CXR, fever, leukocytosis and purulent tracheobronchial secretions.

- This infection was neither present nor incubating at the time of hospitalization.


Host factors
Surgery
Medications
Invassive devices
Respiratory therapy equipment
Oropharyngeal colonization
Gastric colonization
Aspiration
Numbers of bacteria
virulence
Bacteremia
Lung Defenses
Mechanical
cellular/humoral
Translocation
Pneumonia

Risk factors for Ventilator-Associated Pneumonia (VAP)

Patient Related Factors

- Age
- Burns
- Coma
- Lung disease
- Immunosuppression
- Malnutrition
- Blunt trauma

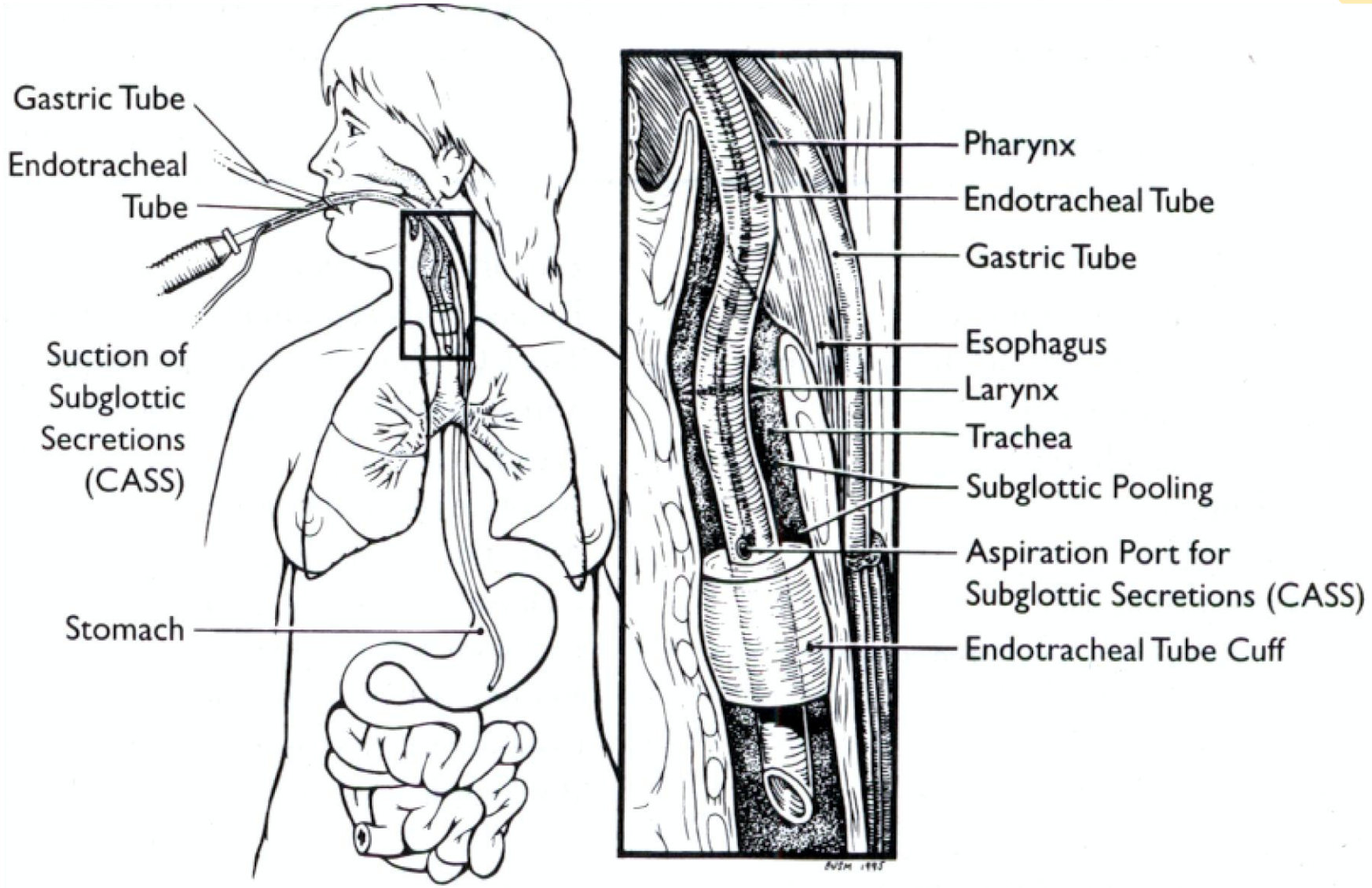
Devices Related Factors

- Invasive ventilation
- Duration of invasive ventilation
- Reintubation
- Medication
- Prior antibiotic treatment
- Sedation

General precautions

- Staff education, hand hygiene, isolation precautions (I)
- Surveillance of infection and resistance with timely feedback (II)
- Adequate staffing levels (II)

ATS Guidelines 2005


Gastric Tube
Endotracheal Tube
Suction of Subglottic Secretions (CASS)
Stomach
Pharynx
Endotracheal Tube
Gastric Tube
Esophagus
Larynx
Trachea
Subglottic Pooling
Aspiration Port for Subglottic Secretions (CASS)
Endotracheal Tube Cuff

Intubation and ventilation

- Avoid intubation and reintubation - I
- Prefer non-invasive ventilation - I
- Prefer orotracheal intubation & orogastric tubes - II
- Continous subglottic aspiration - I
- Cuff pressure > 20 cm H2O - II
- Avoid entering of contaminate consendate into tube/nebulizer - II
- Use sedation and weaning protocols to reduce duration – II
- Use daily interruption of sedation and avoid paralytic agents - II

ATS Guidelines 2005

Positive End Expiratory Pressure (PEEP)

A technique used in respiratory therapy in which airway pressure greater than atmospheric pressure is achieved at the end of exhalation by the introduction of a mechanical impedance to exhalation.

- Range: 0-15cm H_20.
- For surveillance 0-5cm H_20 is equivalent.

A sustained increase in the daily minimum PEEP of ≥ 3cm H_2O following a period of stability or improvement is a sign of deterioration.

For example, calculate daily minimum PEEP.

Time	6am	12pm	6pm	12am
Day 5	3	4	5	7
Day 6	6	6	7	6

Fraction of Inspired Oxygen(FiO2)

The fraction of oxygen in inspired gas. It can be adjusted depending on the patient's oxygen needs.
Range – 0.30-1 (30%-100%)
A sustained increase in the daily minimum FiO_2 of ≥ 0.20 (20%) following a period of stability or improvement on the ventilator is the second of the two criteria that can be used in meeting the VAC definition. For example, calculate daily minimum FiO_2

7pm	8pm	9pm	10pm	11pm	12pm
0.5	0.6	0.5	0.5	0.6	0.5

After a baseline period of stability or improvement on ventilator, defined by >2 calendar days of stable or decreasing daily minimum FiO_2 or PEEP values.

VAC	▪ An increase in the daily minimum baseline FiO_2>0.20, sustained for more than > 2 calendar days. ▪ An increase in the daily minimum baseline PEEP>3 cm H_2O, sustained for more than > 2 calendar days.
IVAC	▪ Temperature >38^0C, WBC≥12,000 cell/mm^3 or ≤4000cell/mm^3 and ▪ A new antimicrobial agent is started and continued for >4 days.
PVAP	▪ Positive culture/purulent secretions/histopathology evidence of infection.

Systemic and enteral antibiotics

- Selective decontamination of the digestive tract (SDD) reduces the incidence of VAP & helps to contain MDR outbreaks – I
- But SDD not recommended for routine use – II
- Prior systemic antibiotics helps to reduce VAP in selected patient groups but increases MDR – II
- 24-hour AB prophylaxis helps in one study but not for routine use - I

ATS Guidelines 2005

Stress bleeding, transfusion, hyperglycemia

- Trend towards less VAP with sucralfate (vs H2 blockers) but increased gastric bleeding > individual choice - I
- Prudent transfusion, leukocyte-depleted red blood cell transfusion - I
- Intensive insulin therapy to keep glucose 80 - 110 mg/dl - I

Aspiration, body position

- Semirecumbent position (30 - 45°) especially when receiving enteral feeding - I
- Enteral nutrition is preferred over parenteral because of translocation risk - I

ATS Guidelines 2005

A multifaceted program to prevent ventilator-associated pneumonia: Impact on compliance with preventive measures*

Lila Bouadma, MD; Bruno Mourvillier, MD; Véronique Deiler, RN; Bertrand Le Corre, RN; Isabelle Lolom, BS; Bernard Régnier, MD; Michel Wolff, MD; Jean-Christophe Lucet, MD, PhD

Crit Care Med 2010: volume 38 in Press

1. Adherence to hand hygiene
2. Adherence to glove and gown use
3. Backrest elevation maintenance
4. Correct tracheal-cuff maintenance
5. Orogastric tube use
6. Gastric overdistention avoidance
7. Good oral hygiene
8. Elimination of non-essential tracheal suction

VAP Prevention

- Hand hygiene before and after patient contact, preferably using alcohol-based hand rubbing
- Avoid endotracheal intubation if possible
- Use of oral, rather than nasal, endotracheal tubes
- Minimize the duration of mechanical ventilation
- Promote tracheostomy when ventilation is needed for a longer term
- Glove and gown use for endotracheal tube manipulation.

VAP Prevention (Don’t)

- Avoid non-essential tracheal suction
- Oral hygiene with chlorhexidine
- Backrest elevation 30-45^{o}
- Maintain tracheal tube cuff pressures (>20) to prevent regurgitation from the stomach
- Avoid gastric overdistension
- Promote enteral feeding
- Careful blood sugar control in patients with diabetes
- SDD in selected cases

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Surgical Site Infection (SSI)

Surgical Site Infection (SSI)		
Superficial incisional SSI ▪ 30 days. ▪ Skin and subcutaneous site of incision. **And one** of the following is positive: 1. Purulent discharge. 2. Culture positive. 3. Re opening following sings of inflammation. 4. Diagnosis by the primary surgeon.	**Deep incisional SSI** ▪ 30 or 90 days. ▪ Involves deep soft tissue. **And one** of the following is positive: 1. Purulent discharge. 2. Culture positive. 3. Spontaneous dehiscence or Re opening following signs of inflammation. 4. An abscess or deep infection.	**Organ /Space SSI** ▪ 30 to 90 days. ▪ Involves deep layers. **And one** of the following is positive: 1. Purulent discharge. 2. Culture positive. 3. An abscess or deep infection. And 4. Evidence of organ involvement.

Strategies to prevent SSI

Objectives

- Reduce the inoculum of bacteria at the surgical site
- Surgical Site Preparation
- Antibiotic Prophylaxis Strategies
- Optimize the microenvironment of the surgical site
- Enhance the physiology of the host (host defenses)

In relation to risk factors, classified as

- Patient-related (intrinsic)
- Pre-operative
- Operative

Patient-related factors

DIABETES (Recommendation -IDSA/SHEA)

- Preoperative
  - Control serum blood glucose; reduce HbA1C levels to <7% before surgery if possible (A-II)
- Post-operative (cardiac surgery patients only)
  - Maintain the postoperative blood glucose level at less than 200 mg/dL (A-I)

SMOKING

- Rationale
  - Nicotine delays wound healing
  - Cigarette smoking = independent RF for SSI after cardiac surgery
- Studies:- None
- Recommendation
  - Encourage smoking cessation within 30 days before procedure

Procedure-related risk factors

- Hair removal technique
- Preoperative infections
- Surgical scrub
- Skin preparation
- Antimicrobial prophylaxis
- Surgeon skill/technique
- Asepsis
- Operative time
- Operating room characteristics

Antimicrobial prophylaxis

- **Recommendations (A-I)**
  - Administer within 1 hour of incision to maximize tissue concentration
    - Once the incision is made, delivery to the wound is impaired

Antimicrobial prophylaxis

- Duration of prophylaxis (A-I)
  - Stop prophylaxis
    - within 24 hours after the procedure
    - within 48 hours after cardiac surgery
  - To:
    - Decrease selection of antibiotic resistance
    - Contain costs
    - Limit adverse events

Bratzler et al *Arch Surg* 2005, 140:174-82

Harbarth S et al. *Circulation* 2000;101:2916–2921

Surgeon Skill and Technique

- Excellent surgical technique reduces the risk of SSI (A-III)

- Includes
  - Gentle traction and handling of tissues
  - Effective hemostasis
  - Removal of devitalized tissues
  - Obliteration of dead spaces
  - Irrigation of tissues with saline during long procedures
  - Use of fine, non-absorbed monofilament suture material
  - Wound closure without tension
  - Adherence to principles of asepsis

7 “S” Bundle to Prevent SSI

- **SAFETY –** is your OPERATING ROOM safe?
- **SCREEN** – are you screening for risk factors and presence of MRSA & MSSA
- **SHOWERS** – do you have your patients cleanse their body the night before and morning of surgery with CHLORHEXIDINE (CHG)?
- **SKIN PREP –** are you prepping the skin with alcohol based antiseptics such as CHG?
- **SOLUTION** - are you irrigating the tissues prior to closure to remove exogenous contaminants? Are you using CHG?
- **SUTURES** – are you closing tissues with antimicrobial sutures?
- **SKIN CLOSURE** – are you sealing the incision or covering it with an antimicrobial dressing to prevent exogenous contamination?

Surgical practices	WHO 2018	CDC 2017	NICE 2017
Antiseptic showers	Advise patients to shower with either a plain or antimicrobial soap before surgery	Advise patients to shower with soap before surgery	Advise patients to shower with soap before surgery
Hair removal	Should not be removed or, if absolutely necessary, use clipper. Strongly discourages the use of razors	-	Use electric clippers on day of surgery
Skin preparation solutions	Use alcohol-based antiseptic solutions based on CHG	Skin preparation in the operating room should be performed using an alcohol-based agent unless contraindicated.	Use either povidone iodine or CHG solution with or without alcohol
Antibiotic prophylaxis	Antimicrobial sealants should not be used after surgical site skin preparation	Administer preoperative antimicrobial agents only when indicated based on published clinical practice guidelines	Give it to patients before clean, clean-contaminated and contaminated surgery
Hand decontamination or hygiene	Either by scrubbing with a antimicrobial soap and water or using a suitable ABHR before donning sterile gloves	-	The operating team should remove hand jewellery, artificial nails and nail polish before operations
Nasal decontamination		-	Do not use nasal decontamination with topical antimicrobial agents
Mechanical bowel preparation	Should be used in combination with preoperative oral antibiotics patients undergoing elective colorectal surgery	-	Do not use it routinely to reduce the risk of surgical site infection

Preoperative recommendations to prevent SSIs

- 1. WHO Global Guidelines for the Prevention of Surgical Site Infection, 20168 2. Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017.JAMA Surgery 3. Leaper et al., BMJ. 2008 Oct 28;337:a1924.

Surgical practices	WHO 2018	CDC 2017	NICE 2017
Glycemic control	Suggest use of protocol for intensive blood glucose control	Blood glucose target levels <200 mg/dL	Do not give insulin routinely to patients who do not have diabetes
Wound irrigation	Insufficient evidences to recommend for or against saline irrigation Use aqueous PVP-I solution before closure Antibiotic irrigation before closure should not be used	Consider intraoperative irrigation of deep or subcutaneous tissues with aqueous iodophor solution	Do not use wound irrigation
Surgical hand gloves	Insufficient evidences	-	Double gloves recommended
Nasal decontamination	Recommend mupirocin 2% ointment	-	-
Maintaining patient homeostasis	Use warming devices	Maintain normothermia	Maintain patient temperature in line with 'Inadvertent perioperative hypothermia
Gowns	Sterile, disposable, non-woven or sterile, reusable woven drapes and surgical gowns can be used during surgical operations	-	Operating team should wear sterile gowns during the operation
Hand decontamination		-	hands should be washed using either an alcoholic hand rub or an antiseptic surgical solution.
Wound dressing	Use wound protector devices	-	Cover surgical incisions with an appropriate interactive dressing at the end of the operation

Intraoperative recommendations to prevent SSIs

- 1. WHO Global Guidelines for the Prevention of Surgical Site Infection, 20168 2. Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017.JAMA Surgery 3. Leaper et al., BMJ. 2008 Oct 28;337:a1924.

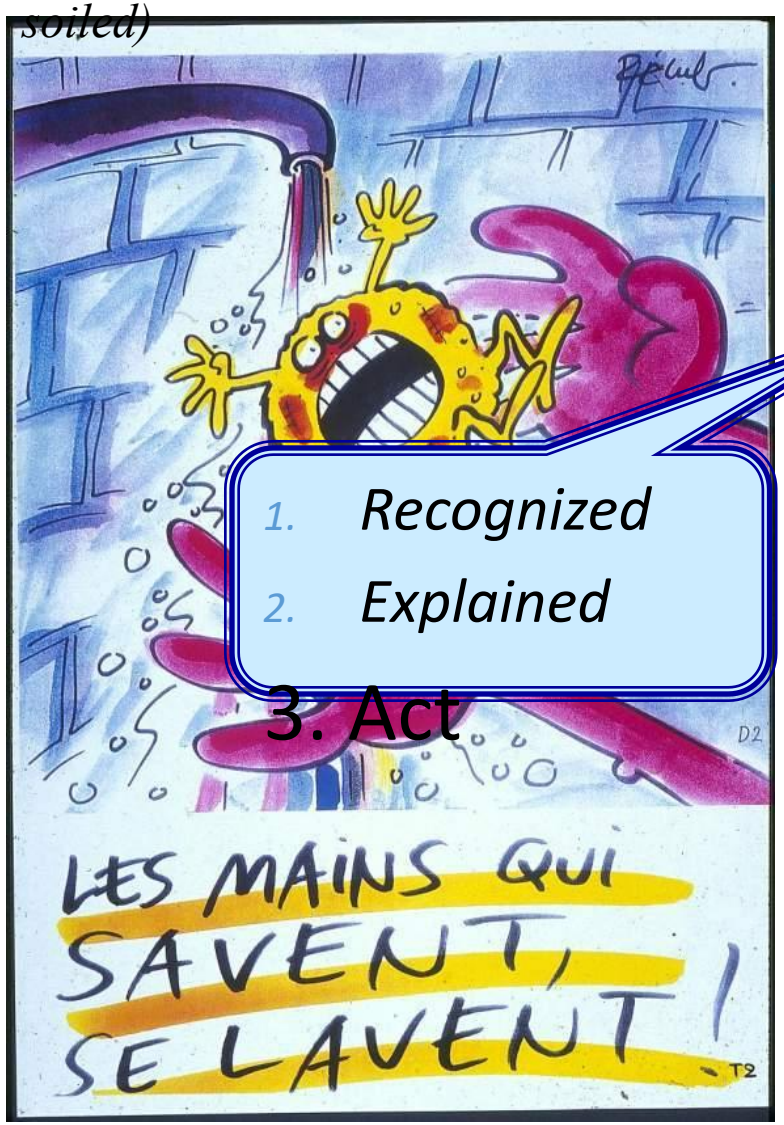
	WHO, 2016	CDC, 2017	NICE, 2017
Changing dressings			Use an aseptic non-touch technique for changing or removing surgical wound dressings
Topical antimicrobial agents for wound healing by primary intention	Perioperative antibiotic prophylaxis should not be continued in the presence of wound drain	Do not apply local antimicrobial agents to the surgical incision	Do not use topical antimicrobial agents for surgical wounds
Dressings for wound healing by secondary intention	Don't use any type of advanced dressing over a standard dressing on primarily closed surgical wounds	-	Do not use Eusol and gauze, or moist cotton gauze or mercuric antiseptic solutions Use an appropriate interactive dressing Refer to a tissue viability nurse for advice on appropriate dressings
Debridement	-	-	Do not use Eusol and gauze, or dextranomer or enzymatic treatments
Specialist wound care services	-	-	a structured approach to care is required

Postoperative recommendations to prevent SSIs

- 1. WHO Global Guidelines for the Prevention of Surgical Site Infection, 2018 2. Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017.JAMA Surgery 3. Leaper et al., BMJ. 2008 Oct 28;337:a1924.

Measure	Calculation
CAUTI Rate	$\frac{\text{The number of CAUTIs for a location}}{\text{The number of Urinary Catheter Days for a location}} \times 1000$
VAP Rate	$\frac{\text{The number of VAP for a location}}{\text{The number of ventilator Days for a location}} \times 1000$
CLABSI Rate	$\frac{\text{The number of CLABSI for a location}}{\text{The number of central line catheter Days for a location}} \times 1000$
SSI Rate	$\frac{\text{The number of SSI for a location}}{\text{The number of surgeries for a location}} \times 1000$

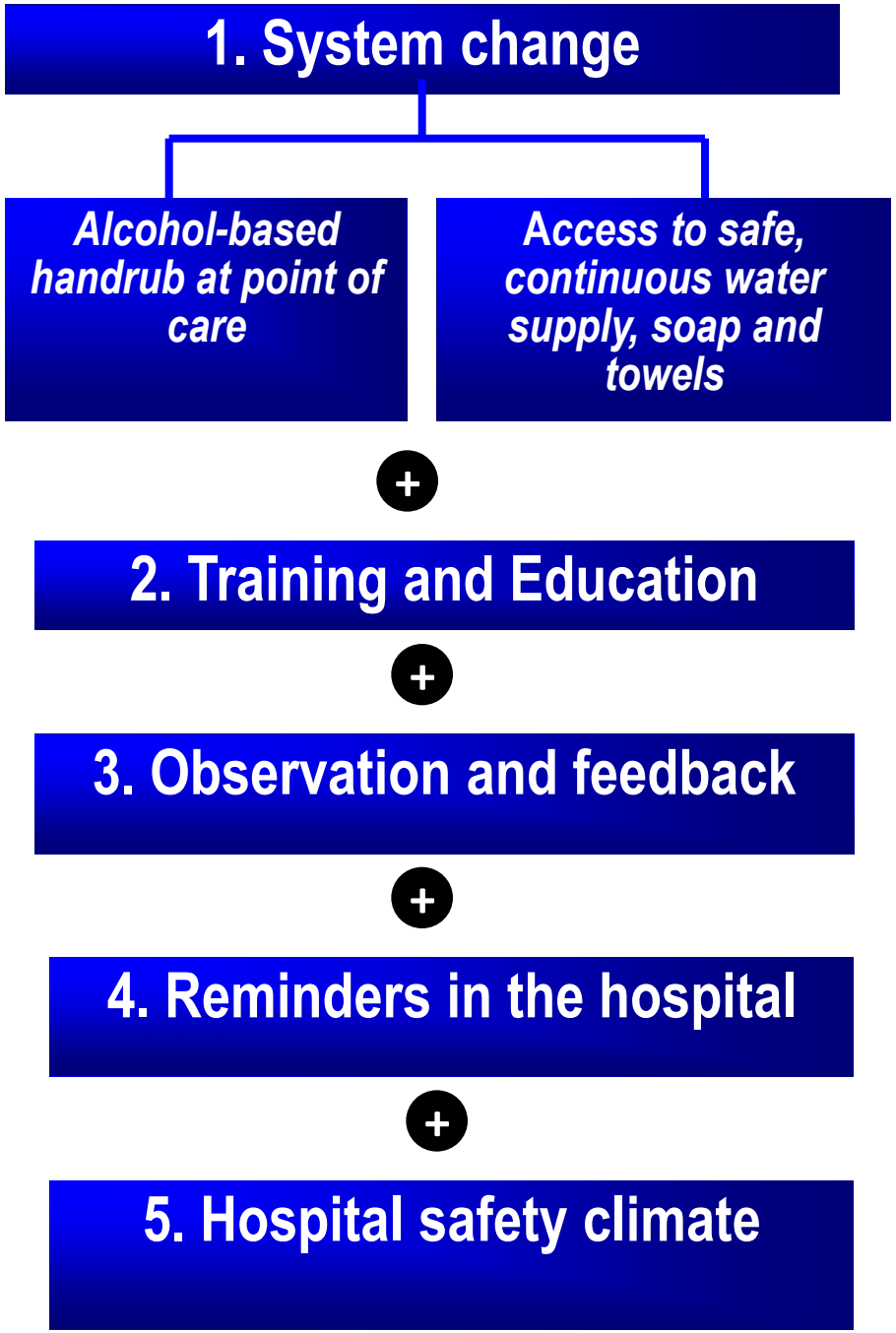
Handwashing …
an action of the past
(except when hands are visibly soiled)

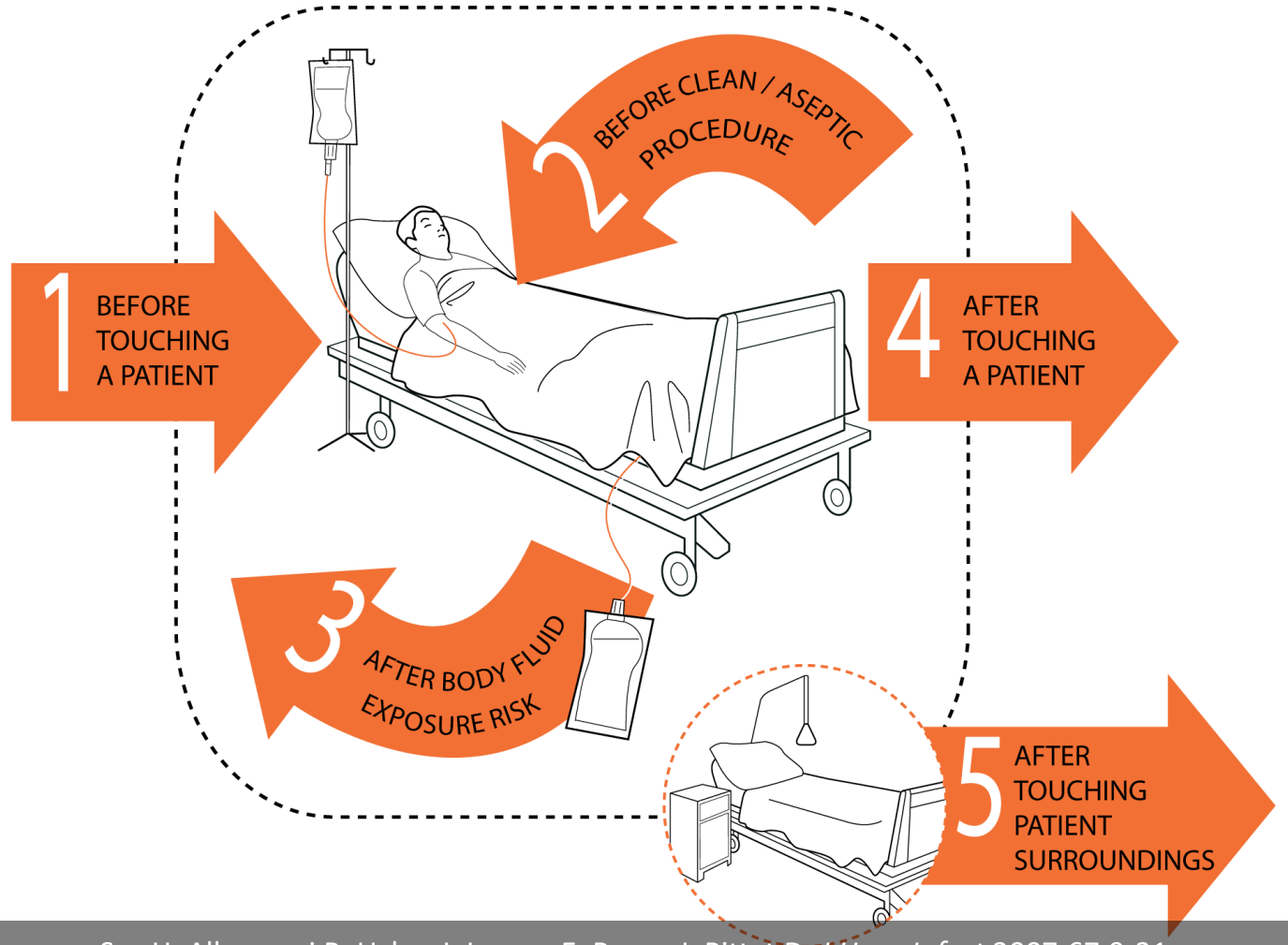


1. *Recognized*
2. *Explained*
3. Act

Alcohol-based hand rub is standard of care

The 5 core components of the WHO Multimodal Hand Hygiene Improvement Strategy



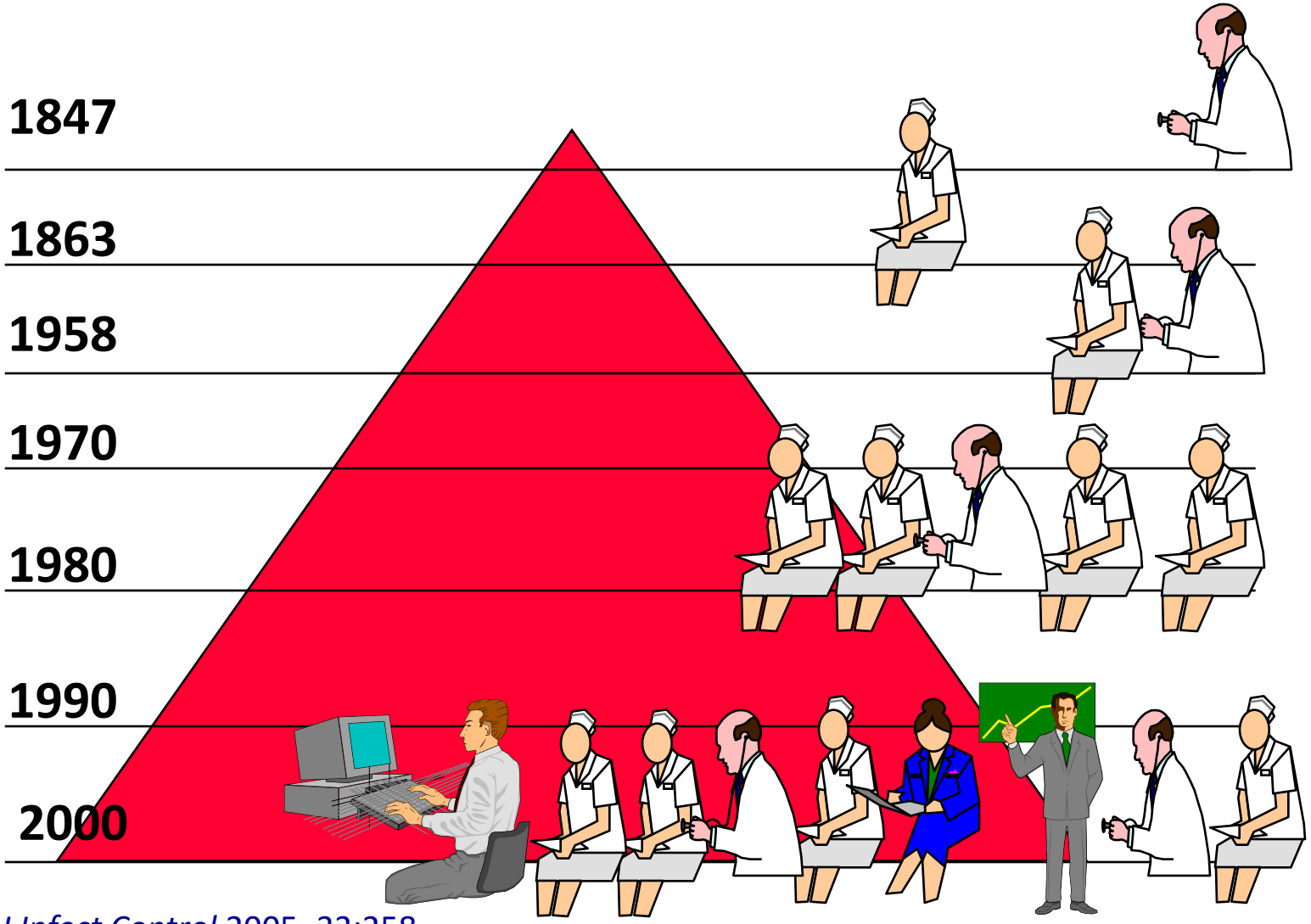


Sax H, Allegranzi B, Uçkay I, Larson E, Boyce J, Pittet D. *J Hosp Infect* 2007;67:9-21

"My 5 Moments for Hand Hygiene"

Infection Control and Quality Healthcare in the New Millenium

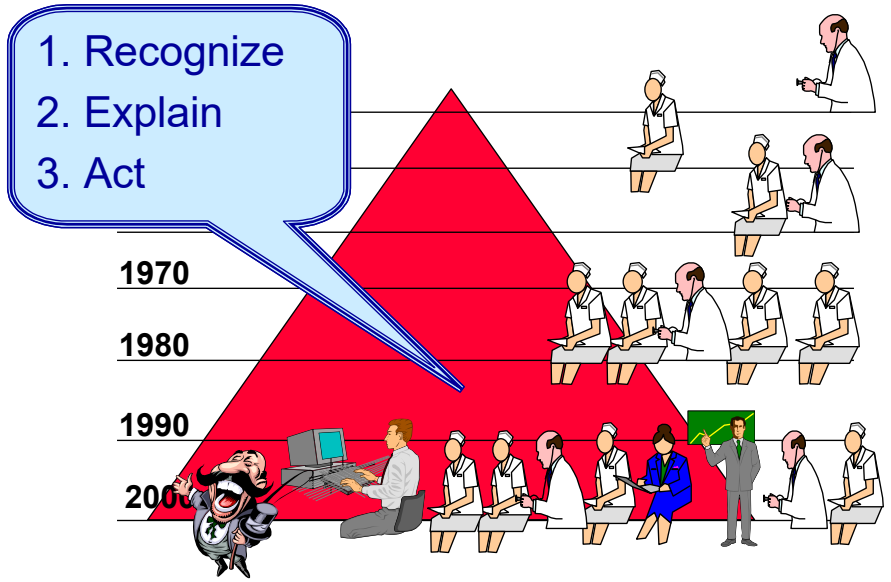
Multidisciplinary team approach



Pittet D, *Am J Infect Control* 2005, 33:258

Where are we going ?

Multidisciplinary team approach



Healthcare system:
-Hospitals
-Ambulatory services
-Nursing homes
-Long-term care facilities
-Home care delivery systems

State/country epidemiology program

International surveillance systems

Financing bodies

Patient safety promotion

Pittet & Sax, *Infectious Diseases.* Cohen textbook (2nd ed.), chap.85, 2004

A multimodal strategy

THANK YOU

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