

# Hospital-Acquired Infection

## Health care–associated infection (HAI or HCAI)

Lecture 4

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### Nosocomial Infections



# Definition

**nosocomial infection** is an infection that is acquired in a hospital or other health care facility. To include both hospital and nonhospital settings, it is sometimes instead called a health care–associated infection (HAI or HCAI). Such an infection can be acquired in hospital, nursing home, rehabilitation facility, outpatient clinic, diagnostic laboratory or other clinical settings.

# Epidemiology of Nosocomial Infections

Studies conducted in different parts of the world show that in North America and Europe 5%–10% of all hospitalizations result in nosocomial infections, while Latin America, Sub-Saharan Africa and Asia show more than 40% hospitalizations with nosocomial infections.

In the United States, the Centers for Disease Control and Prevention(CDC) estimated roughly 1.7 million hospital-associated infections from all types of microorganisms.They cause or contribute to 99,000 deaths each year

A study conducted by Dept. of Medicine, College of Medicine, Baghdad University, data were collected by reviewing the case records of patients admitted to RCU for two periods from Nov. 2003 to Oct. 2004, and Nov. 2004 to Oct. 2005, A total of 43 **(44.8%)** patients got nosocomial infection out of the total admissions to RCU (96).

# Criteria of diagnosis

**Nosocomial infections are infections acquired in hospitals and other healthcare facilities. The infection to be classified as nosocomial infection should be:**

**1- The patient must have been admitted for reasons other than this new infection or new pathogen.**

**2- The patient must also have shown no signs of active or incubating infection.**

# **Criteria of diagnosis**

**The nosocomial infections occur:**

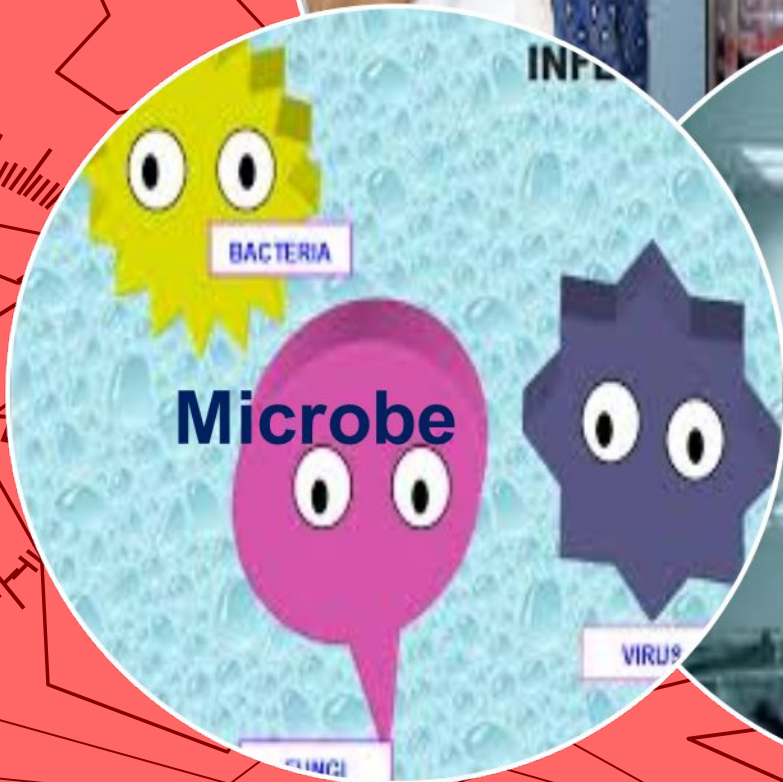
**up to 48 hours after hospital admission**

**up to 3 days after discharge from the hospital**

**up to 30 days after an operation in a healthcare facility when a patient was admitted for reasons other than the infection**



# What are the factors influence the development of infection in hospital?



The background features a compass rose on the left side, with cardinal and intercardinal directions labeled: NW, N, NE, E, and S. The rest of the background is a reddish-brown color with a faint, abstract pattern of lines. In the center, there are several purple, oval-shaped microorganisms, possibly spores or bacteria, arranged in a vertical line. A large, white, rounded rectangular box is positioned on the right side of the image, containing the title and a list of factors.

# **Microbial factors**

**intrinsic virulence**

**resistance to antimicrobial agents**

**amount of infective material (inoculum)**

**opportunistic pathogens**

**Characteristic of microorganism**

# Host

## Related to treatment

- ▶ Blood transfusion
- ▶ Recent antimicrobial therapy
- ▶ Immunosuppressive treatments
- ▶ Stress-ulcer prophylaxis
- ▶ Recumbent position
- ▶ Parenteral nutrition
- ▶ Length of stay



- ▶ Related to invasive procedures
  - ▶ Endotracheal or nasal intubation\*
  - ▶ Central venous catheterisation\*
  - ▶ Extracorporeal renal support
  - ▶ Surgical drains
  - ▶ Nasogastric tube
  - ▶ Tracheostomy
  - ▶ Urinary catheter

## Related to underlying health status

- ▶ Advanced age
- ▶ Malnutrition
- ▶ Alcoholism
- ▶ Heavy smoking
- ▶ Chronic lung disease
- ▶ Diabetes

## Related to acute disease process

- ▶ Surgery
- ▶ Trauma\*
- ▶ Burns



## **Environmental factors**

**Health care facilities are the sites of contact between infectious person & susceptible person**

**Frequent transfer of patient from unit to another.**

**Contaminated hands of medical staff, equipments ,air, water, surfaces.**

**Crowded sites**

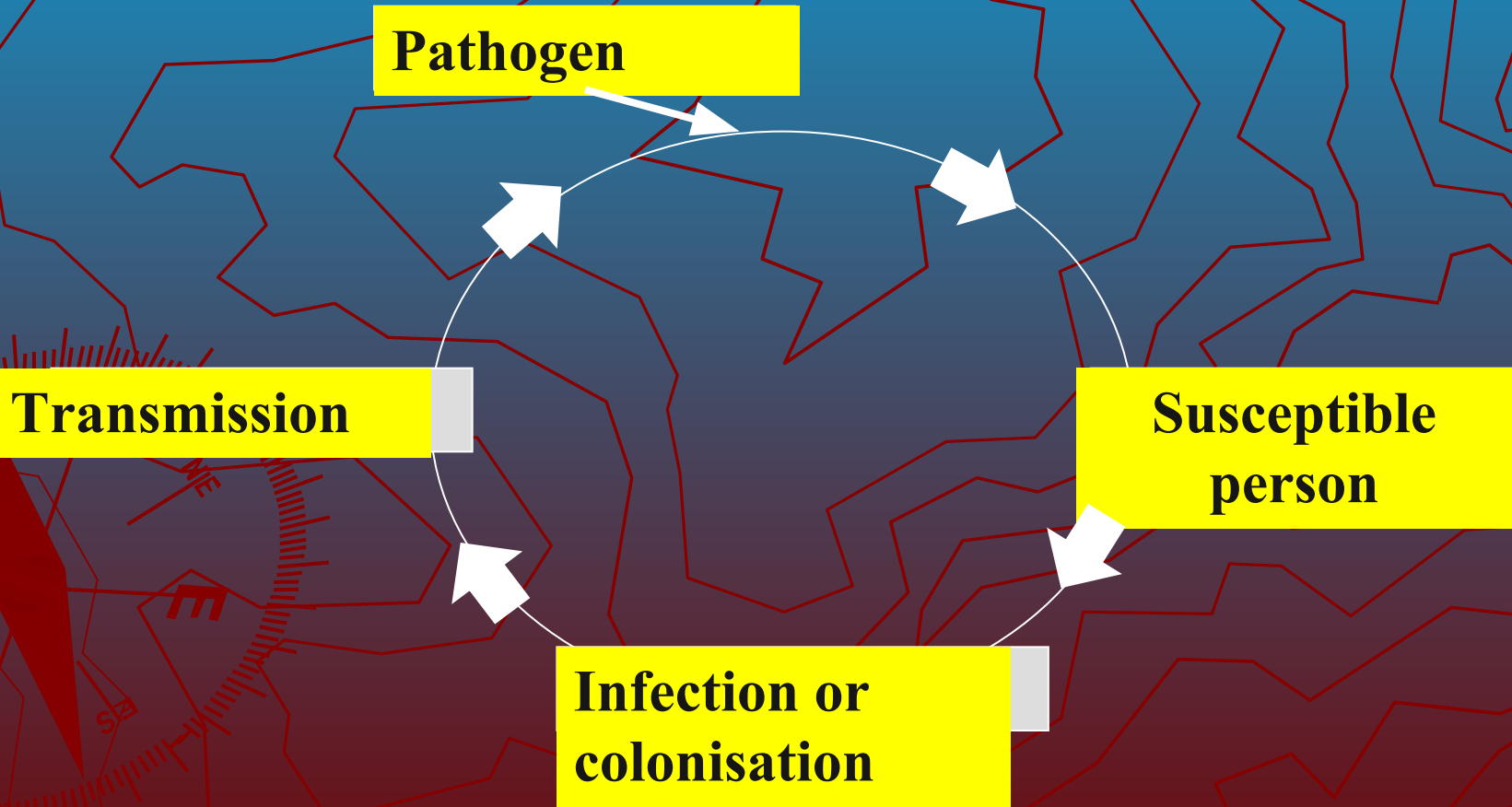


**WHO notes that the rate of nosocomial infections will continue to rise as a result of four factors :**

- Crowded hospital conditions
- Increasing number of people with compromised immune systems
- New microorganisms
- Increasing bacterial resistance



# The Cycle of Contagion



## AGENTS OF NOSOCOMIAL INFECTIONS



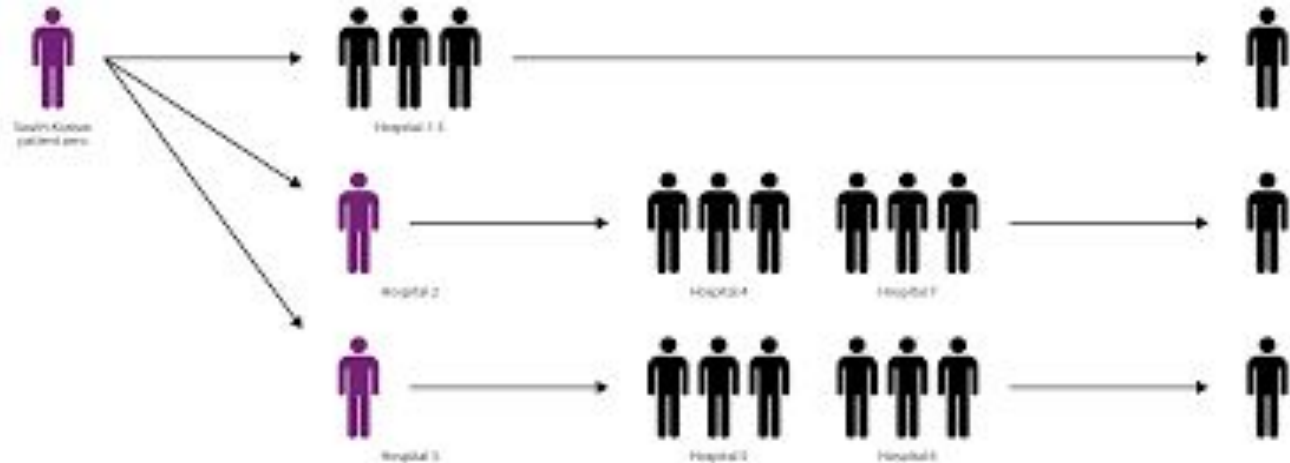
Bacteria are responsible for about **90%** infections, enterococci, *P. aeruginosa*, *S. aureus* and *E. coli* have a major role, other less common include Legionella and Enterobacteriaceae family members including *Proteus mirabilis*, *Klebsiella pneumonia*

Methicillin-resistant *S. aureus* (MRSA) causes up to 60% of nosocomial infection in ICU. Gram-positive





- ❑ Enterococcus is part of the normal intestinal flora of humans.
- ❑ A large genus of lactic acid bacteria Enterococci are gram-positive cocci that often occur in pairs (diplococci) or short chains, and are difficult to distinguish from streptococci on physical characteristics alone.[4] Two species are common commensal organisms in the intestines of humans: *E. faecalis* (90–95%) and *E. faecium* (5–10%). Enterococci are facultative anaerobic organisms, i.e., they are capable of cellular respiration in both oxygen-rich and oxygen-poor environments. They are not spores forming.
- ❑ Important clinical infections caused by Enterococcus include urinary tract infections , bacteremia, bacterial endocarditis, diverticulitis, meningitis, and spontaneous bacterial peritonitis. Sensitive strains can be treated with ampicillin, penicillin and vancomycin.



## Fungal:

### Candida albicans, Aspergillus

Candida albicans is an opportunistic pathogenic yeast that is a common member of the human gut flora. It can also survive outside the human body. It is detected in the gastrointestinal tract and mouth in 40–60% of healthy adults. It is usually a commensal organism, but it can become pathogenic in immunocompromised individuals under a variety of conditions.

**Viruses** account for about 5% of all nosocomial infections. Viral cross-infection is most common in infants and children but also occurs in other groups, respiratory syncytial virus, varicella zoster virus, influenza virus

Hepatitis C&B in dialysis units.

Parasites :e.g. Giardia lamblia) are transmitted easily among adults or children.

## Sources of Infection

### **Endogenous:**

- Patients own flora may invade patient's tissue during some surgical operations or instrumental manipulations
- Normal commensals of the skin, respiratory, GI, UG tract

### **Exogenous:**

- From another patient / staff member / environment in the hospital
- Environmental sources: Inanimate objects, air, water, food
- Cross infection from: other patients, hospital staff (suffering from infections or asymptomatic carriers)

# Modes of transmission of nosocomial pathogens

Router	Description
Contact transmission	The most important and frequent mode of transmission is by direct contact.
Droplet transmission	Transmission occurs when droplets containing microbes from the infected person are propelled a short distance through the air and deposited on the host's body; droplets are generated mainly by coughing, sneezing, and talking, and during the performance of certain procedures, such as bronchoscopy.
Airborne transmission	Dissemination can be either airborne droplet nuclei (5 $\mu\text{m}$ or smaller in size) of evaporated droplets in the air for long periods of time or dust particles containing the infectious agent. Microorganisms carried in this manner can be dispersed widely by air currents and may become inhaled by a susceptible host within the same room or over a longer distance from the source patient, depending on environmental factors; therefore, special air-handling and ventilation are required to prevent airborne transmission.
Common vehicle transmission	This applies to microorganisms transmitted to the host by contaminated items, such as food, water, medications, devices, and equipment.
Vector borne transmission	This occurs when vectors such as mosquitoes, flies, rats, and other vermin transmit microorganisms.

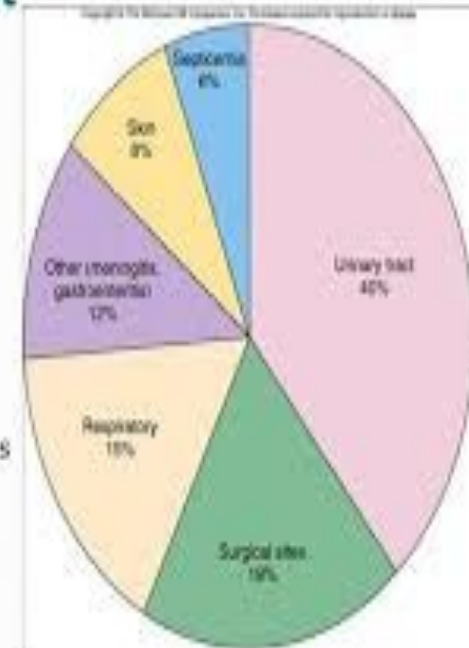


# Types of Nosocomial Infections

- ◆ Urinary tract infections (UTI)
- ◆ Surgical site infections (SSI) major types
- ◆ Pneumonia
- ◆ Blood stream infections
  - catheter associated
  - Septicemia
- ◆ Others
  - Skin & soft tissue infections e.g. bed sores
  - Gastroenteritis

## Sites of the most common nosocomial infections

- 1- Urinary tract Infections
- 2- Surgical sites infections
- 3- Respiratory tract Infections
- 4- Blood stream infections



## Pathogens Most Commonly Associated with Nosocomial Infections

The following seven group of bacteria are the most common causes of nosocomial infections:

### Gram Positive Bacteria

- *Staphylococcus aureus*.
- Coagulase-negative Staphylococci (CNS).
- *Enterococcus* spp.

### Gram Negative Bacteria

- *Escherichia coli* (*E. coli*).
- *Pseudomonas aeruginosa*
- *Enterobacter* spp.
- *Klebsiella* spp.

# Symptoms & Signs of Hospital Acquired Infections



Fever

Headache

Rashes

Severe coughing

Diarrhea

## Symptoms of MRSA

- MRSA infections are mainly characterized by painful, irritating red bumps and rashes. However, if the bacteria enter the bloodstream, the infection can spread to and damage vital organs. In extreme cases, MRSA infections can be fatal.



*Staphylococcus aureus* is a commensal bacterium, but is also a human pathogen that causes various diseases.



*Staphylococcus aureus*

Commensal  
in nasal cavity, skin surface



abscess



food poisoning



sepsis



pneumonia

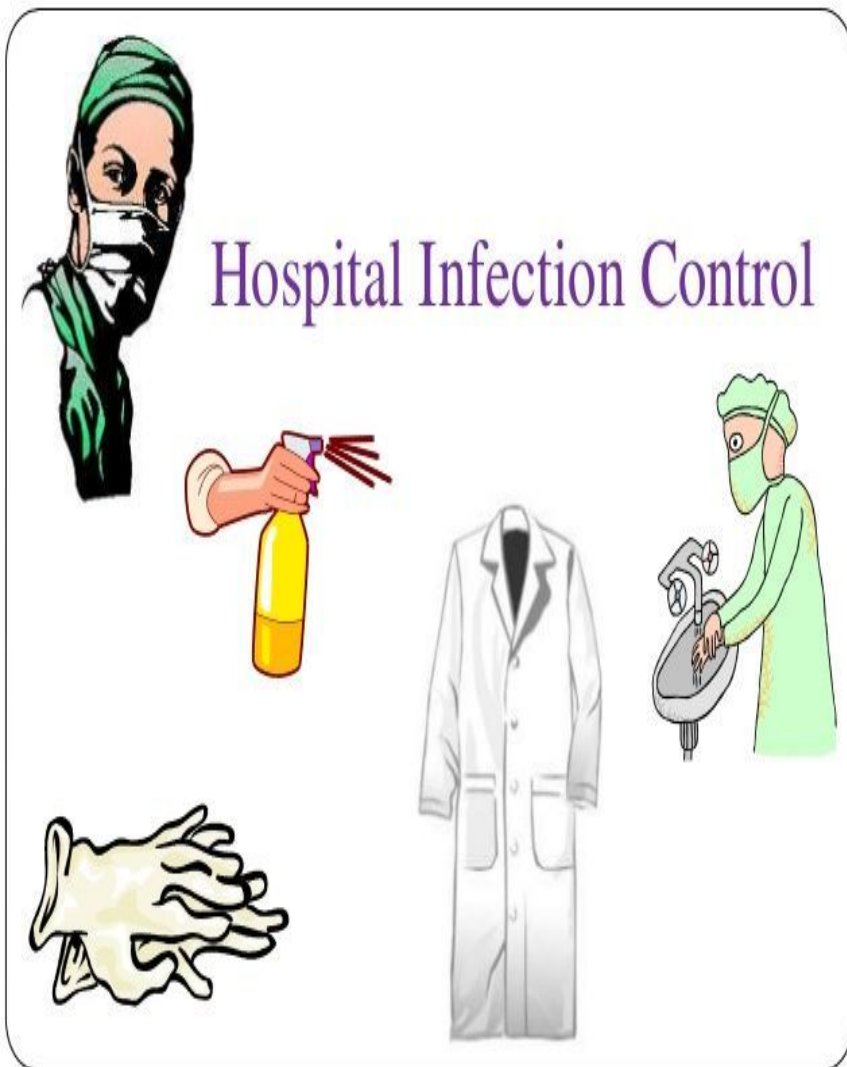
meningitis  
toxic shock syndrome  
etc.



A pair of hands holds a white rectangular sign against a bright blue sky filled with white, fluffy clouds. The sign features the text 'PREVENTION IS BETTER THAN CURE' in a bold, dark red, sans-serif font, arranged in four lines. The hands are positioned at the left and right edges of the sign, with fingers gripping it. The overall scene is bright and clear, emphasizing the message on the sign.

**PREVENTION  
IS BETTER  
THAN  
CURE**

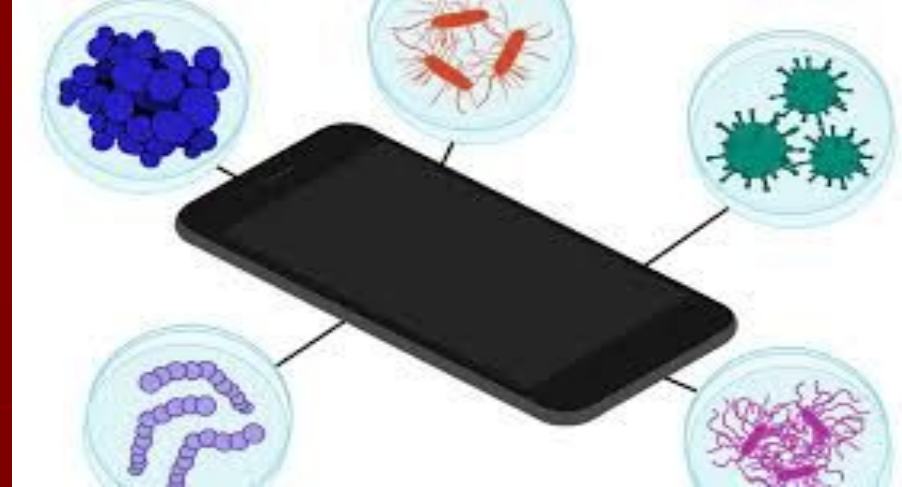
**Hand washing with soap: Handwashing is the single most important measure to reduce the risks of transmitting skin microorganisms from one person to another or from one site to another on the same patient.**



**The Second Line of Defense: Gloves**  
Gloves play an important role in reducing the risks of transmission of microorganisms.

- **Sanitizing surfaces is an often overlooked, yet crucial, component of the strategy for the cycle of infection in health care environments.**





### Contamination of cleaning materials and cleaning solutions



If material and solution are not replaced frequently, previously uncontaminated areas become contaminated when being cleaned.  
In accordance with RRI-recommendation cleaning and disinfection procedures must be organized, in a way that cross-contamination is avoided.



# The 5 pillars of infection control

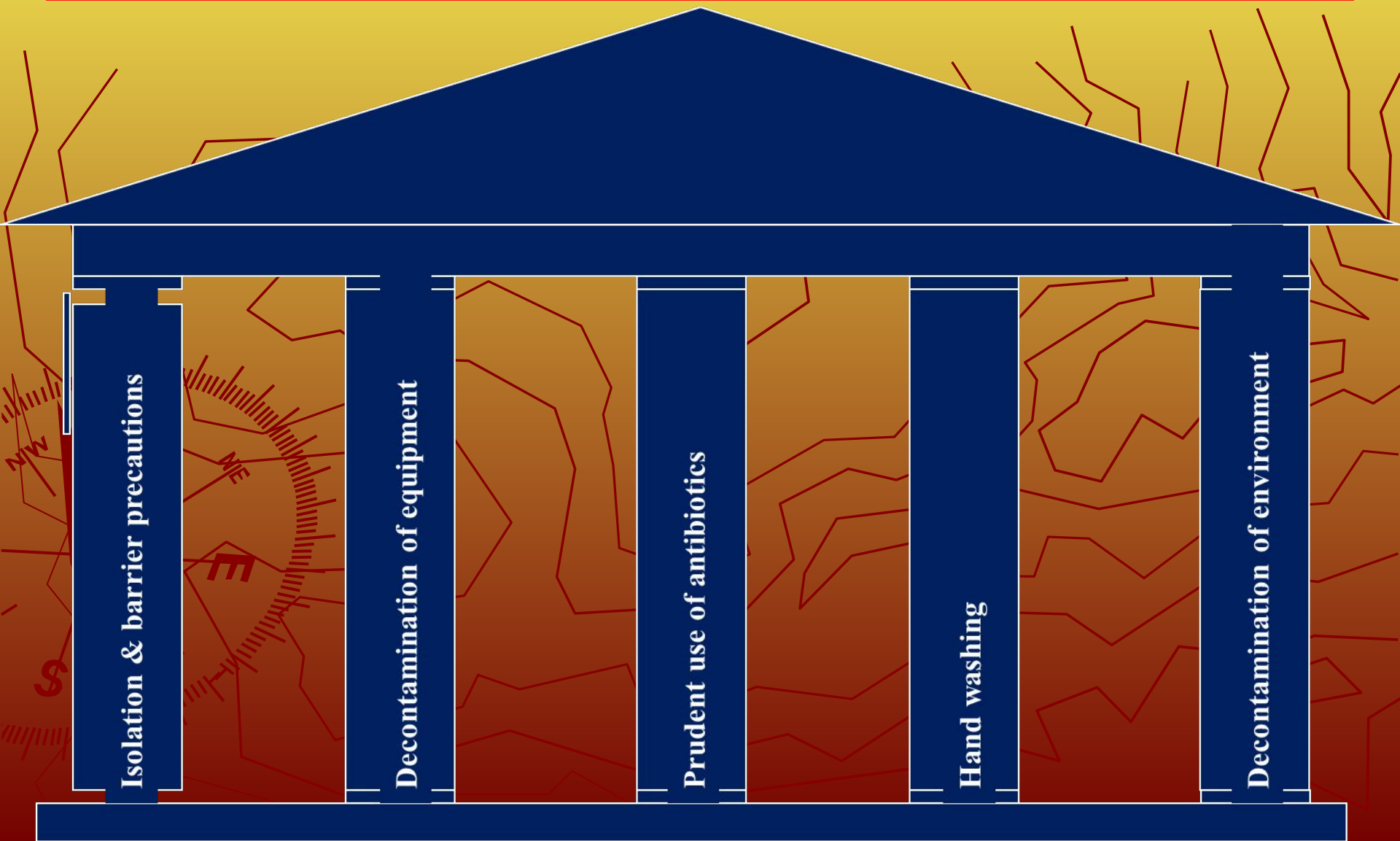
Isolation & barrier precautions

Decontamination of equipment

Prudent use of antibiotics

Hand washing

Decontamination of environment





Healthcare  
Provider  
Hand wash  
Nonbeliever

Unwashed  
Hands

He never  
maintain  
Hand hygiene !!  
He is my favorite

Antibiotics

Old Age

Popping  
Antibiotics  
Two weeks

I am C. Diff,  
Omnipotent  
in Hospitals

Heat resistant  
C.diff Spores

Hot Soup

C.diff on  
Bed Sheets

Prolonged  
Hospital Stay

Creative-Med-Doses



**Thank you**