Epidemiology of Healthcare-Associated Infections

By. Dr Ahmed Mekawy

Lec.1

Learning Objectives

1. Describe the epidemiology of healthcare associated infections (HAI).
2. Summarise how agent, host and environmental factors affect the occurrence of HAIs.
3. Outline the types of epidemiologic studies that can be used in HAI epidemiology.

Healthcare - Associated Infections - 1

Refer to infections associated with health care delivery in any setting

- hospitals
- long-term care facilities
- community and ambulatory settings
- home and community care

Healthcare - Associated Infections - 2

- Definition
  - A localised or systemic infection that results from an adverse reaction to the presence of an infectious agent(s) or its toxin(s), for which there is no evidence of infection on admission to a health care facility
- An infection is frequently considered an HAI if it appears ≥48 hours after admission

Epidemiology

- Study of the dynamic occurrence, distribution, and determinants of health-related events in specified populations
- Defines the relationship of a disease to the population at risk
  - Involves the determination, analysis, and interpretation of rates

Epidemiology of HAIs

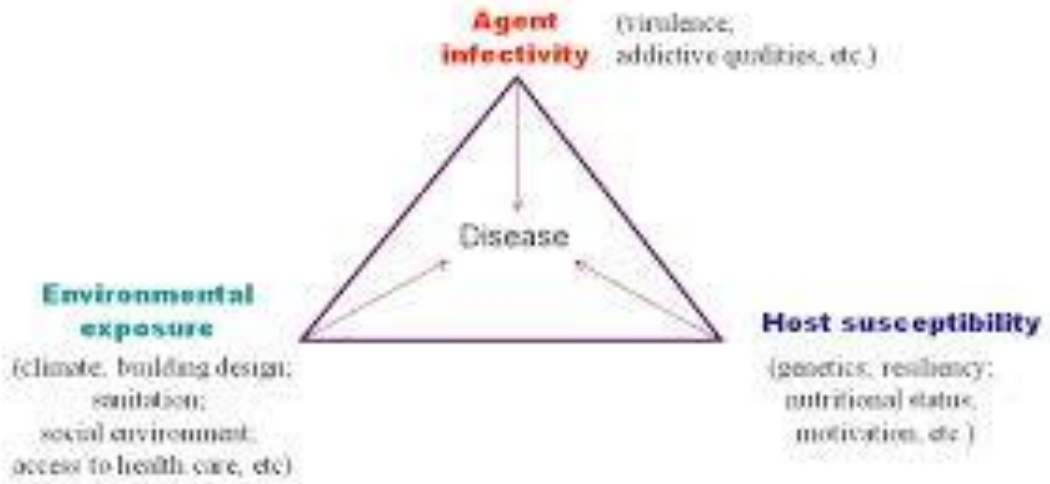
- Explains occurrence of HAIs among patients and the magnitude of the problem
- Includes the distribution of HAIs by
  - patient type
  - causative pathogen
  - unit of treatment
  - period of time

Major Types of HAIs

- Catheter-associated urinary tract infection (CAUTI)
- Ventilator-associated pneumonia (VAP)
- Surgical site infection (SSI)
- Catheter related bloodstream infection (CR-BSI)

Epidemiologic Factors

- There are 3 main factors related to development of HAIs
  - Host factors
  - Agent factors
  - Environmental factors



Host Factors

- Coma
- HIV infection
- Malignancies
- Diabetes mellitus
- Severe malnutrition
- Circulatory impairment
- Open wound or trauma
- Bronchopulmonary disease
- Advanced age or premature birth
- severe burns and certain skin diseases
- Chronic obstructive pulmonary disease
- Immunodeficiency (due to drug, or irradiation)

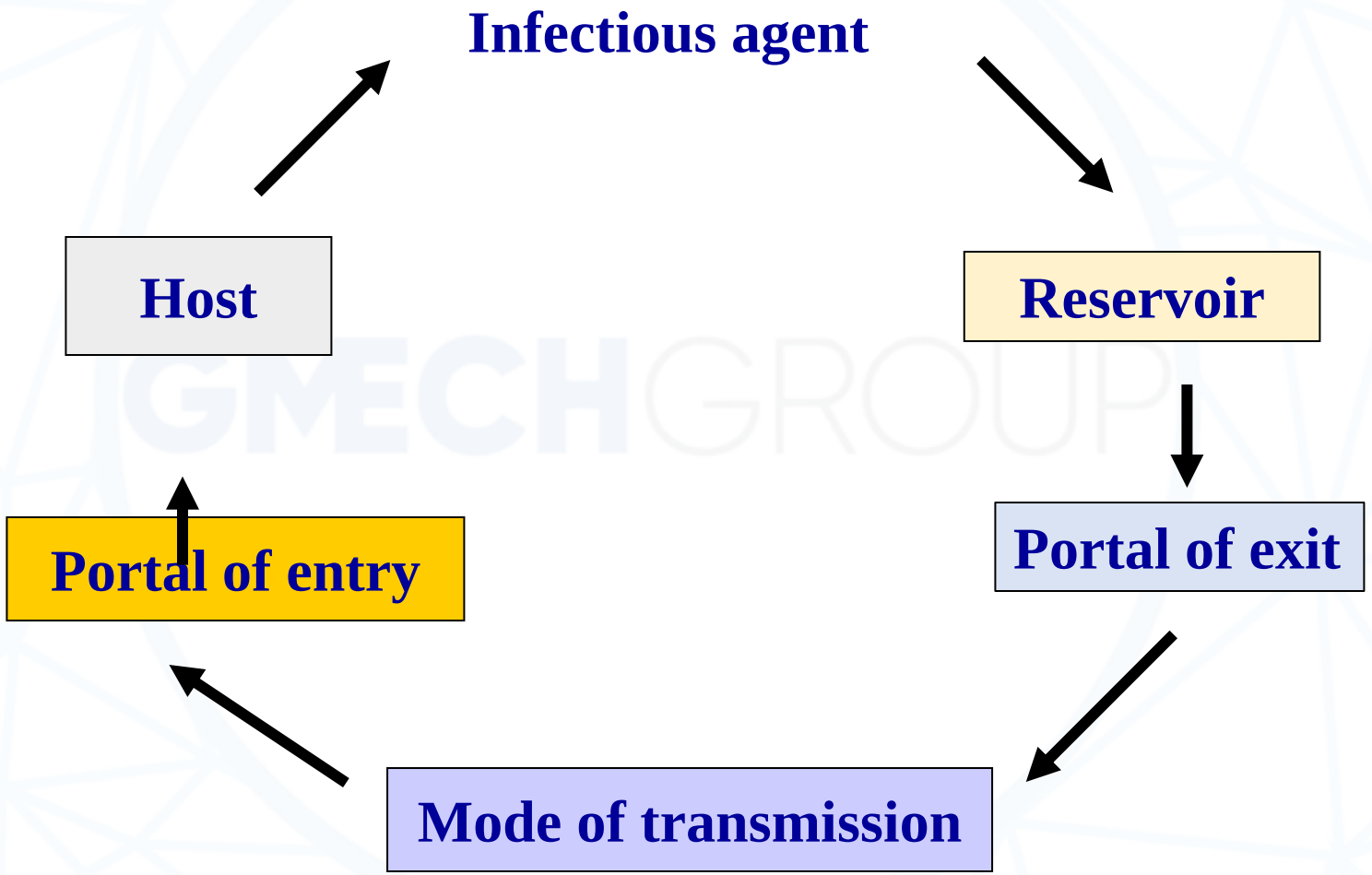
Agent Factors

- An infectious agent can be bacteria, virus, fungus, or parasite
- The majority of HAIs are caused by bacteria or viruses
- Two major types of bacteria that cause HAIs
  - Gram-positive cocci (e.g., *Staphylococci* and *Streptococci*)
  - Gram-negative bacilli (e.g., *Acinetobacter, Pseudomonas, Klebsiella*)

Environment Factors

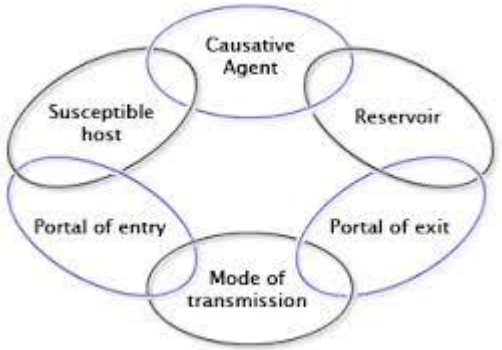
- Extrinsic factors that affect either the infectious agent or a person's risk of exposure to that agent
- Include both the animate and inanimate environment of patients

Chain of Infection - 1



Chain of Infection - 2

- Infection results from an interaction between an infectious agent and susceptible host
- The interaction occurs by means of contact between the agent and the host and is affected by the environment
- Breaking the chain of infection by interrupting transmission generally the best way to prevent HAIs



Infectious Agents

- A pathogen that causes an HAI
- Most important pathogens causing HAI are Gram-negative bacteria

Reservoir

Definition:

- Place in which an infectious agent can survive but may or may not multiply

Common reservoirs:

- humans
- animals
- equipment/fomites

Human Reservoirs

Human reservoir:
Persons with acute or subclinical illness

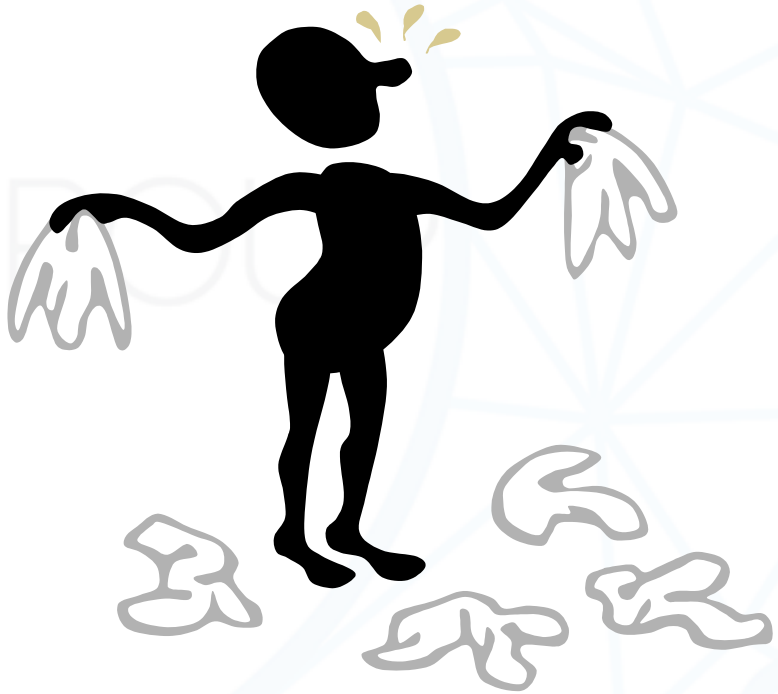
Carriers

- convalescent carriers
- chronic carriers
- intermittent carriers

Portal of Exit

The path by which an infectious agent leaves the reservoir

- Respiratory tract
- Genitourinary tract
- Gastrointestinal tract
- Skin/mucous membrane
- Blood
- Transplacental



Modes of Transmission

- A pathogen may be transmitted by a single route or it can be transmitted in several ways
- Modes of transmission are as follows:
  - Contact transmission: direct, indirect-contact, and droplet
  - Airborne transmission
  - Vehicle transmission
  - Vector-borne transmission

Contact Transmission

Direct contact

- person-to-person spread, actual physical contact

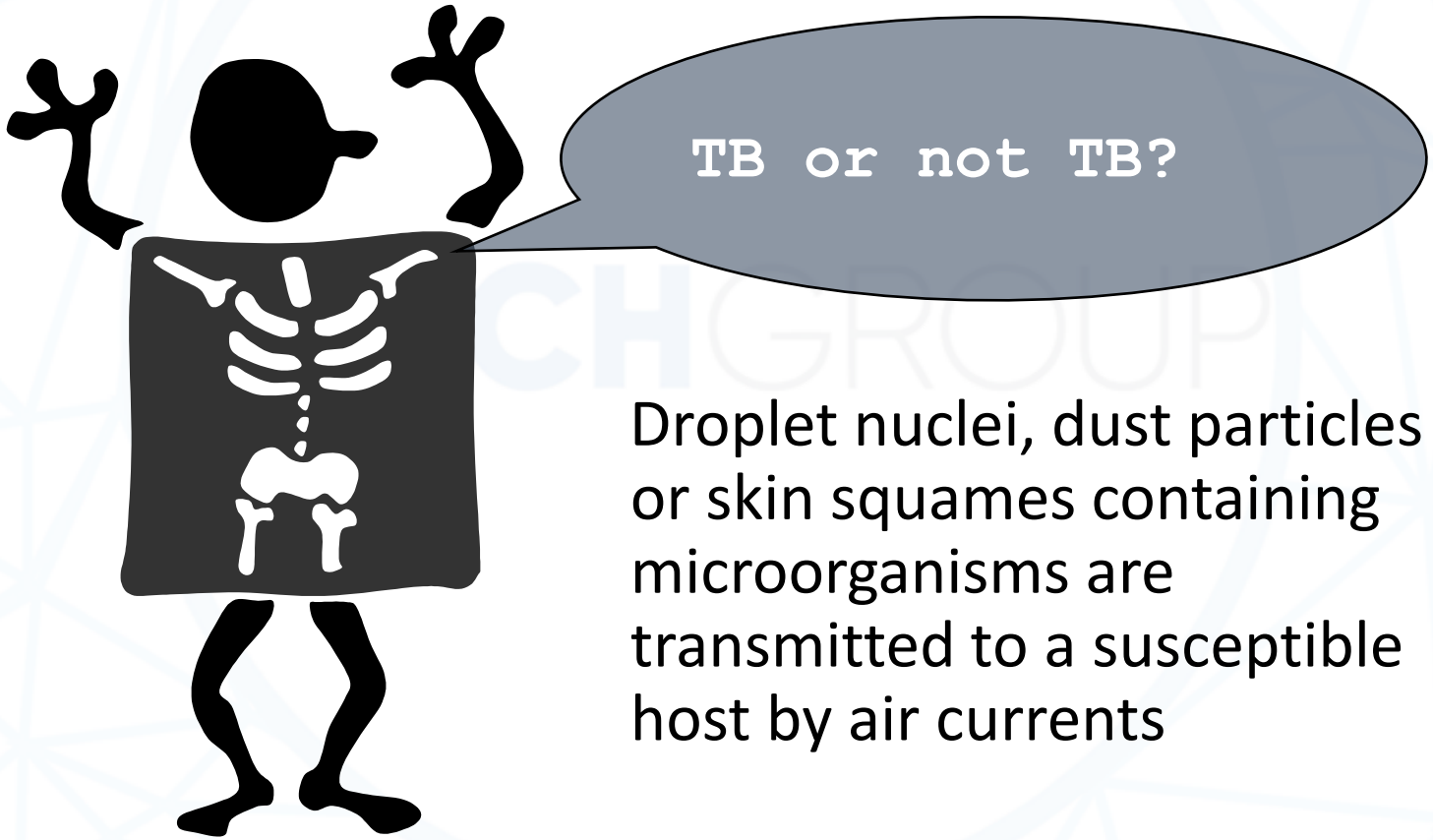
Indirect contact

- contact with contaminated intermediate object

Droplet Transmission

- Large droplets generated by an infected or colonised person during coughing, sneezing, talking, suctioning, etc.
- Droplets propelled a short distance <3m
- Droplets deposited on a susceptible host's eyes, nasal mucosa or mouth

Airborne Transmission



Droplet nuclei, dust particles or skin squames containing microorganisms are transmitted to a susceptible host by air currents

Common Vehicle Transmission

Microorganisms are transmitted to susceptible hosts from common items:

- Food
- Water
- Medications
- Devices/equipment

Vector-borne Transmission

- Transfer of microorganisms by insects, flies, rats, or other vermin
- Uncommon mode of transmission in hospitals

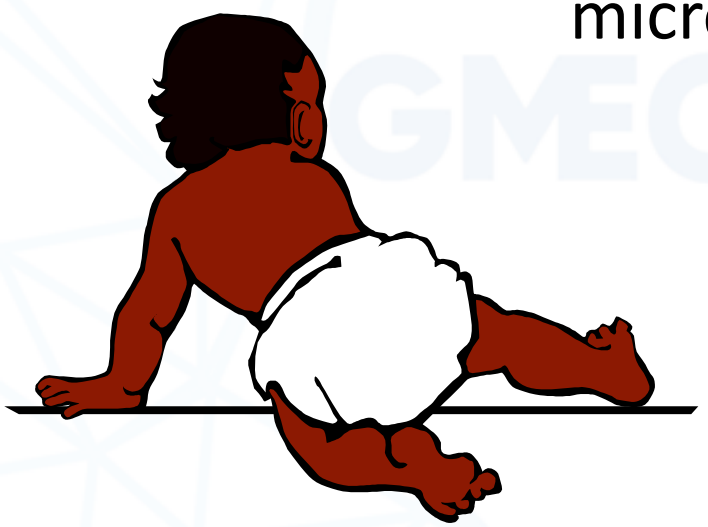
Portal of Entry

The path by which an infectious agent enters the susceptible host

- Respiratory tract
- GU tract
- GI tract
- Skin/mucous membrane
- Parenteral
- Transplacental

Susceptible Host

A person lacking effective resistance to a particular microorganism



HAI Surveillance

- Systematic, active, on-going observation of the occurrence and distribution of HAIs and of the events or conditions that increase the risk of HAI occurrence
- Information that allows facility to direct efforts toward the most serious HAI problems and risks, to obtain support of personnel, and to provide feedback on the results of preventive changes

Use of Surveillance Information

- Provide baseline information on HAI occurrence
- Identify epidemics
- Evaluate efficacy of HAI preventive measures
- Reinforce appropriate infection prevention and patient-care practices
- Defend against malpractice suits
- Provide data for comparisons, problem solving and/or research
- Plan and measure the impact of implementing recommendations

Types of Studies

- Epidemiological studies can be classified as either observational or experimental
- The most commonly used types of epidemiological studies are:
    - Descriptive study
    - Analytic study
    - Experimental study

Descriptive Study

Describes the occurrence of a disease in a population and is often the first step in an epidemiological investigation

Analytic Study

- Analyses and tests relationships between a disease and its causes
- Case-control studies are used to investigate causes of diseases, especially rare diseases
  - The possible cause is compared between cases (people with a disease) and controls (people without a disease)

Cohort Study

- A group of people (a cohort) is evaluated, none of whom has experienced the outcome of interest
- People in the cohort are classified according to characteristics or exposures that might be related to the outcome
- Groups with and without certain exposures or characteristics are then observed over time to compare the outcome

Experimental Study

- Involves an active attempt to change a disease determinant, such as an exposure or behavior, or the progress of a disease, through treatment, usually involving a randomized controlled trial with patients as subjects
- Field trials and community trials are other experimental designs in which the participants are healthy people and communities, respectively

Type of epidemiological studies

Type of study	Alternative name	Unit of study
Observational studies		
Descriptive studies		
Analytical studies		
Ecological	Correlational	Population
Cross-sectional	Prevalence	Individuals
Case-control	Case-reference	Individuals
Cohort	Follow-up	Individuals
Experimental studies	Intervention studies	Patients
Randomised controlled trials	Clinical trials	Patients
Field trials		Healthy people
Community trials	Community intervention studies	Communities

Summary - 1

- HAIs can cause serious complications and greatly impact patients, their families, and health care personnel
- Health care personnel need to understand the epidemiology of HAIs to prevent them in their own settings
- Understanding the chain of infection and epidemiology of HAIs can lead to effective prevention and control intervention

Summary - 2

- The epidemiology of HAIs can explain what happens to whom, and where and when it happens
  - i.e., the occurrence and distribution of HAIs
- Using evidence-based recommendations can reduce infection rates
  - This information supports effective planning and implementation of programs to prevent HAIs

References

- Ostrowsky B. Epidemiology of Health care-Associated Infections. In: *Bennett & Brachman's Hospital Infections*. 5th edition. Wolters Kluwer Lippincott Williams & Wilkins, Philadelphia. 2007; 3-23.
- Doshi RK, Patel G, MacKay R, Wallach F. Health care-Associated Infections: Epidemiology, Prevention, and Therapy. *Mount Sinai J Med* 2009; 76: 84–94.
- Overview of Epidemiologic Study Designs. In: *Essentials of Epidemiology in Public Health*. Aschengrau, A, Seage, GR, eds. Jones and Bartlett, Sudbury MA. 2006; 135-162.

Web Resource

- Centers for Disease Control and Prevention Self-Study Course: Principles of Epidemiology in Public Health Practice, Third Edition
- The introductory self-study course is available online. The course provides an introduction to applied epidemiology and biostatistics; it consists of six lessons: Introduction to Epidemiology, Summarizing Data, Measures of Risk, Displaying Public Health Data, Public Health Surveillance, and Investigating an Outbreak. Continuing education credits are offered to physicians, nurses, veterinarians, pharmacists, certified public health educators, and other professionals.
- The textbook is available at no charge at http://www.cdc.gov/training/products/ss1000/ss1000-ol.pdf and the self-study course (SS1000) is available at no charge at http://www2a.cdc.gov/tceonline/registration/detailpage.asp?res_id=1394.

Quiz

1. Epidemiologic information can help the healthcare facility plan interventions to prevent HAIs. True/False?
2. What is the most frequent and important mode of transmission of HAIs?
   a. Airborne
   b. Droplet
   c. Vectorborne
   d. Contact
3. What type of retrospective design study is often used to investigate causes of HAIs, comparing people who have an HAI with people without an HAI.
   a. Correlational
   b. Case-control
   c. Prevalence
   d. Randomised clinical trial


Thank you