Infection prevention and design of healthcare facilities

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In Healthcare facilities:

- **Individuals with decreased immunity**
  - **Immune-deficiencies**
  - **Localised immune impairment**
- **Individuals with**
  - **Community acquired infections**
  - **Nosocomial infections**

ideal environment for transmission

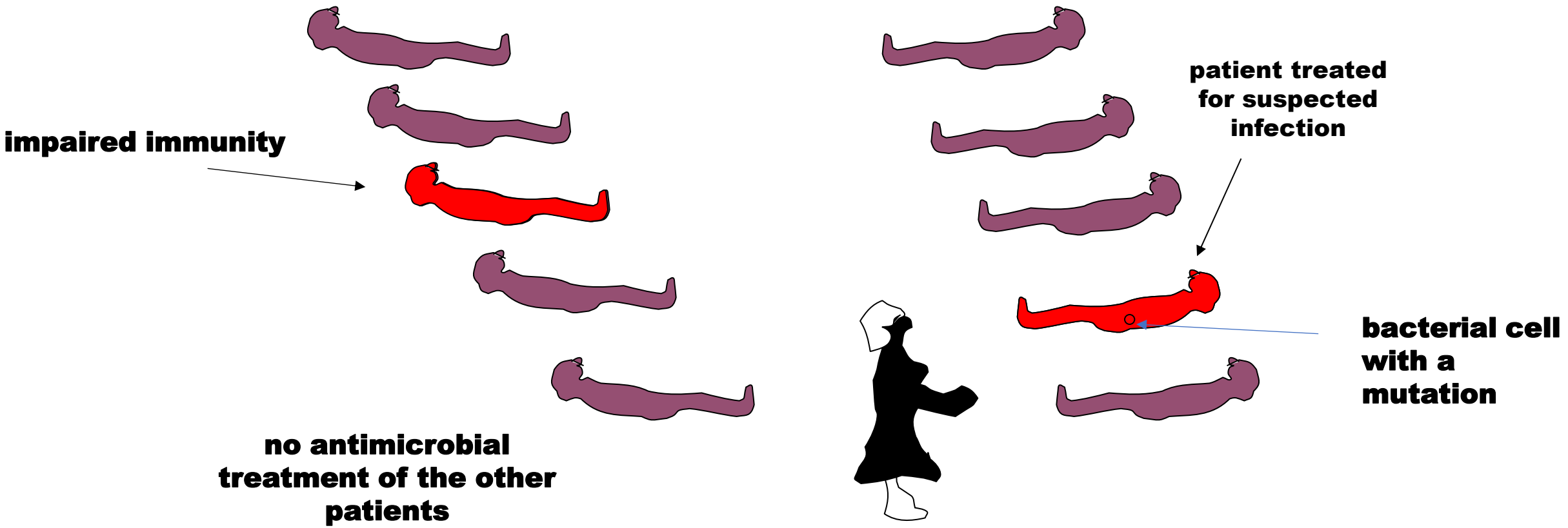
In Healthcare facilities:

- **Individuals on antimicrobial treatment**
- **Individuals with decreased immunity**
- **Large numbers of individuals in close proximity of each other**

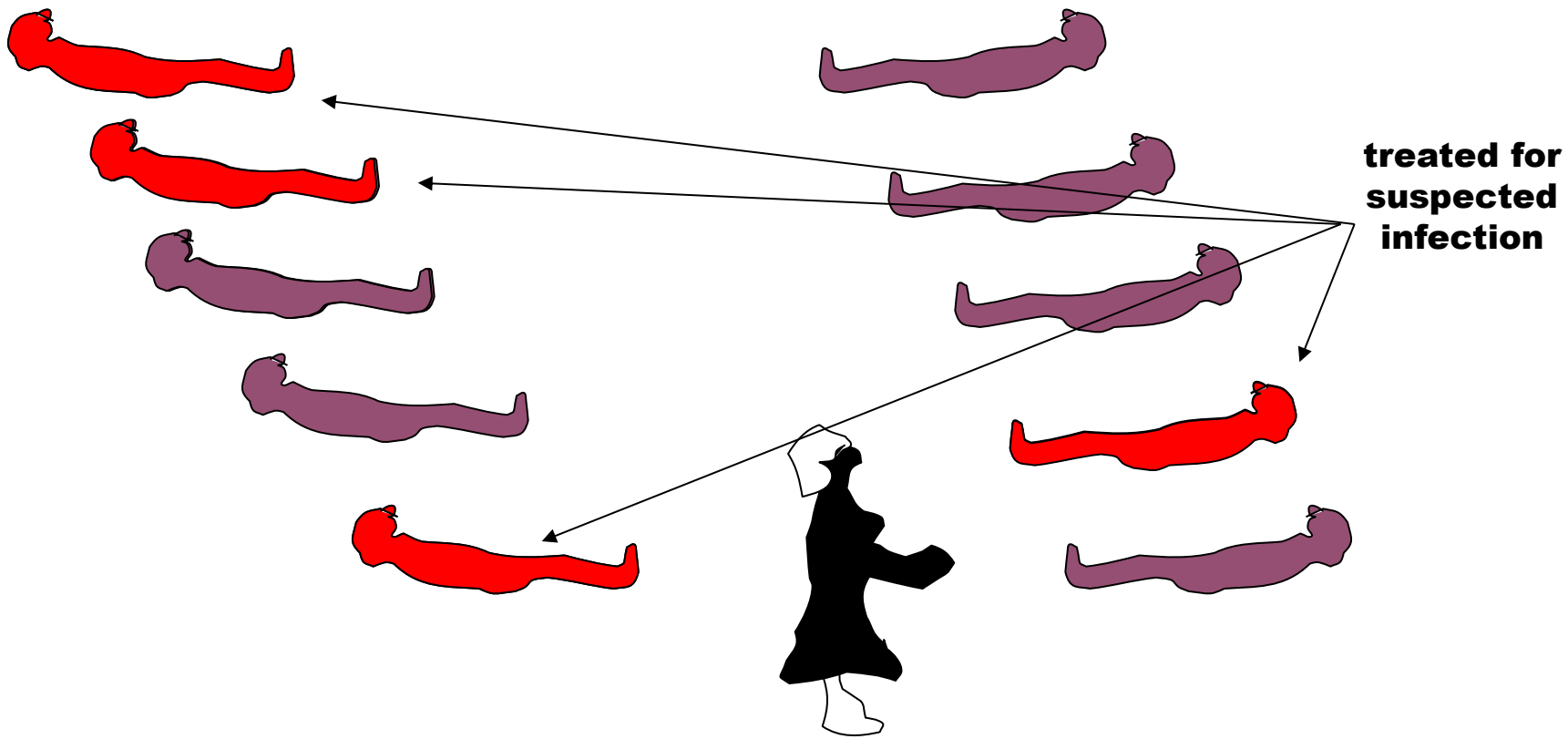
Facilitates:

1. **Transmission between individuals**
2. **Development of resistance**

A hospital ward with 10 patients



(mis)use of antimicrobial drugs acts in synergy with breach in infection prevention !!



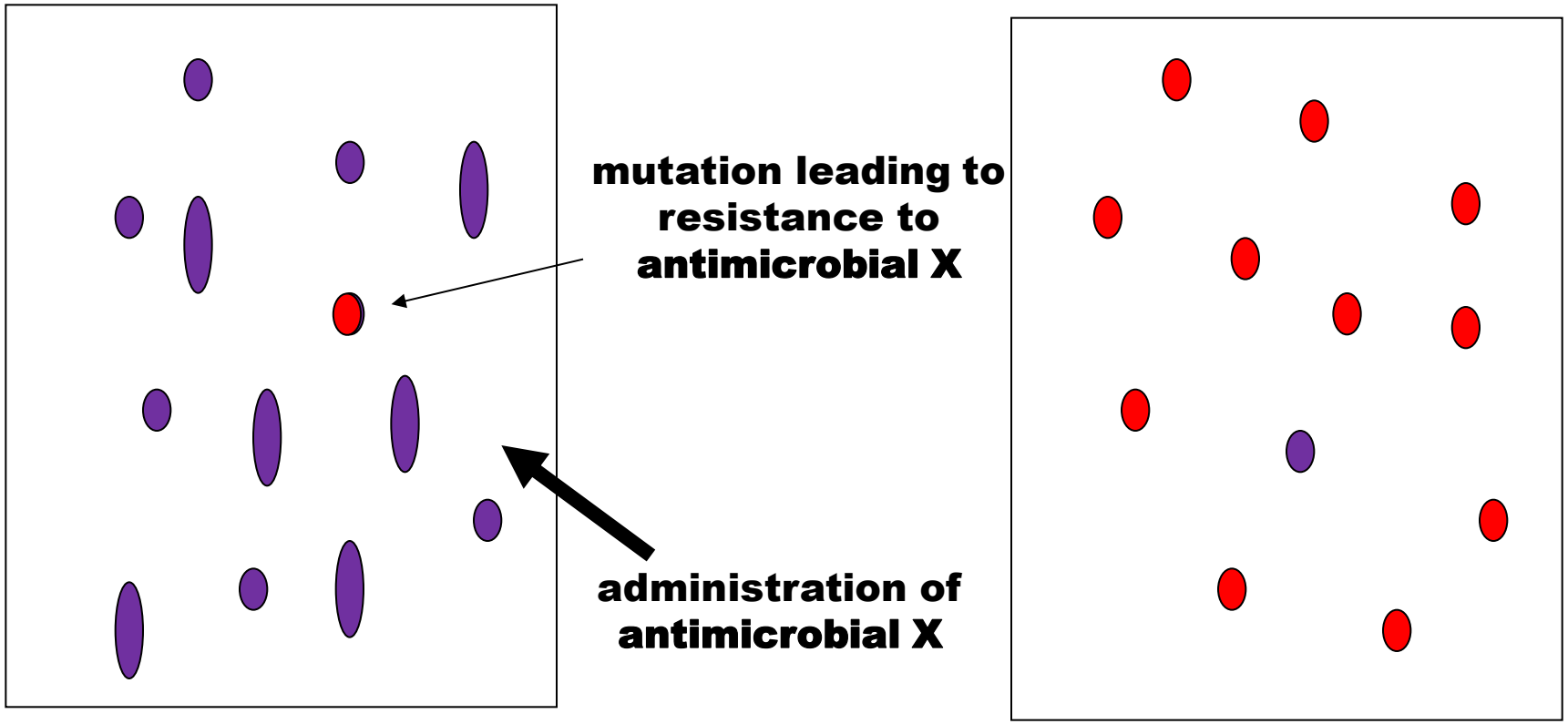
Use of antimicrobial drugs promotes development of drug resistance

How ?

Resistance

- **Natural resistance**
- **Acquired resistance**
  - **mutations**
  - **uptake of genetic elements from other bacteria**

How does antimicrobial treatment lead to resistance ?



In healthcare facilities:

- **“development” of resistance**
- **transmission of microbes**

transmission of drug resistant microbes

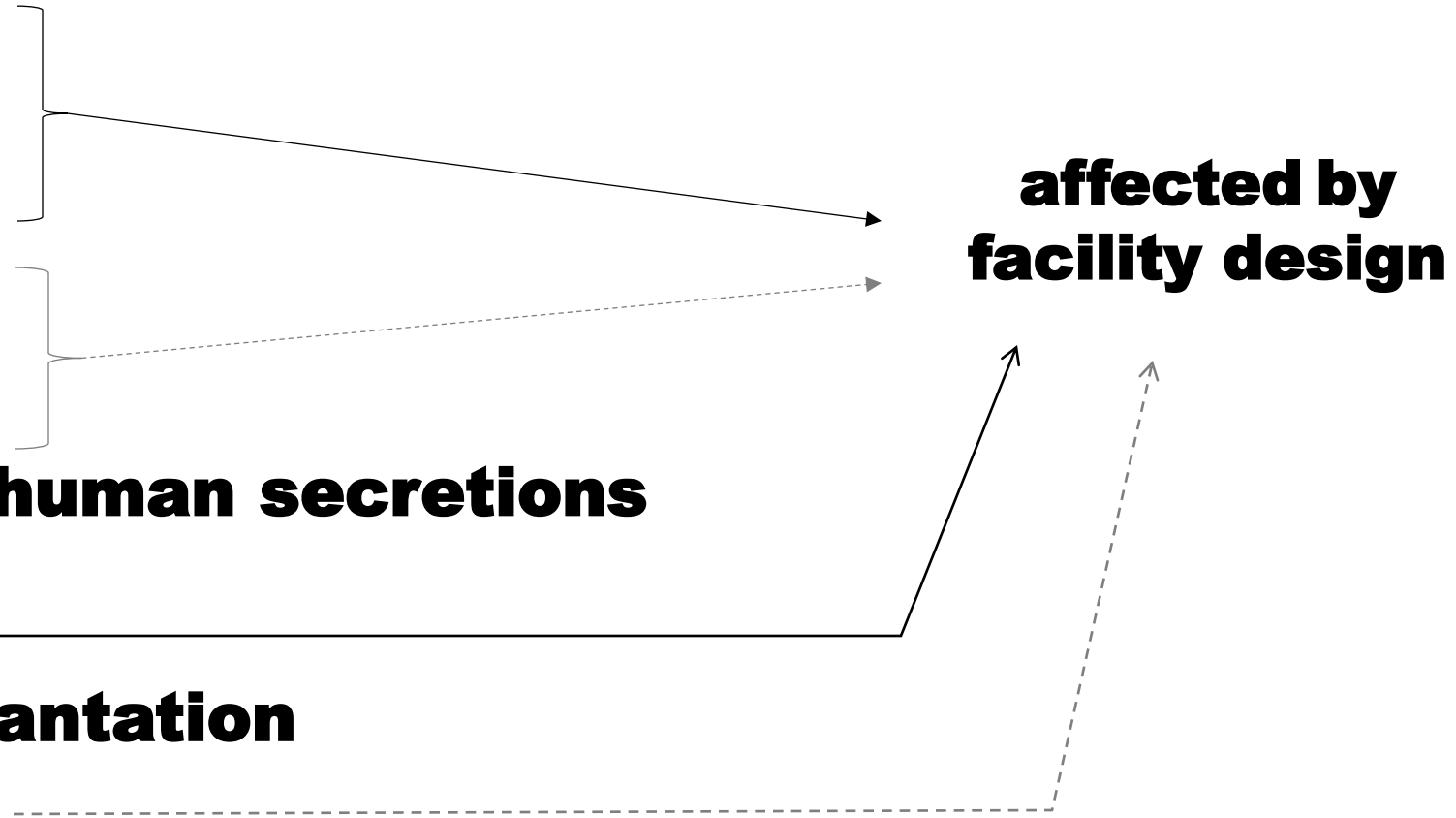
September 2016: UN Classifies Antibiotic Resistance as a Crisis, Putting It on Par With Ebola and HIV

Development of resistance and transmission of infection are influenced by human behaviour !

What has facility design to contribute ?

Routes of transmission of infection

- **Inhalation**
  - **Air**
  - **Droplets**
- **Ingestion**
  - **Water**
  - **Food**
- **Contact with human secretions**
  - **Direct**
  - **Indirect**
- **Injection/implantation**
- **Vector bites**



Routes of transmission of infection

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kitchen design: routing of clean and dirty material and utensils

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- Injection/implantation
- **Vector bites** →
  - **Dengue fever**
  - **Zika virus infection**
  - **others**

} **avoid entrance of insects**

Design issues related to infection prevention

- **Space**

- **Routing of dirty and clean material and people**
- **Facilitation of behaviour**

- **Prevention of accumulation of microbes**

- **Isolation facilities**
- **Air pressure regulation**

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Transmission through inhalation: infections of the respiratory tract

- **Air-born infections:**
  - **Microbes float in the air for extended period**
  - **No direct exposure needed**

- **Droplet infections:**
  - **Droplets of secretions containing microbes**
  - **Drop down**
  - **Direct exposure within range**

Diseases acquired through inhalation

- **Tuberculosis**
- **Anthrax**
- **Legionellosis**
- **Plague**
- **other bacterial causes of pneumonia**
- **Influenza**
- **Measles**
- **SARS**
- **MERS**
- **other respiratory tract viruses**

- ✓ **All through droplets**
- ✓ **Viral infections and some bacterial infections also through air**

What expels respiratory secretions ?

- **Sneezing**
- **Coughing**

- **Talking**
- **Singing**

Prevention of transmission by inhalation

- **Isolation rooms with negative pressure**
  - **Airborn infections with high morbidity/mortality**
  - **Droplet infections with high morbidity/mortality**
- **Distance between beds**
  - **Airborn and droplet infections with acceptable morbidity and no mortality**
    - **Droplets (except when produced by sneezing) “fly” not more than 1 meter**
- **Use of N95 masks**
  - **Combined with isolation rooms**
  - **Protect healthcare workers**

Mortality rates

	untreated	treated
Scarlet fever	15 – 20 %	1 – 2 %
The plague	50 – 100 %	3 – 5 %
Diphtheria	10 – 20 %	
Ebola	25 – 90 %	
MDR-TB		27 - 51 %
XDR-TB		± 80 %
Infections with drug resistant organisms		≥ 100000/year

Mortality of XDR-TB same as Ebola !

Droplets other than from the respiratory tract

- **Aerosols created in sluice rooms and ablution facilities disperse droplets**

- **Resistant bacteria are not only present in patients with infections**
- **The gastro-intestinal tract of all (admitted) patients is potentially colonised with resistant bacteria**

Droplets other than from the respiratory tract: impact on design

- **Sluice rooms**
  - **not opening directly into patient areas**
  - **away from stores that contain clean material**
  - **one door only**

- **Ablution facilities**
  - **automated door closure**
  - **multi-patient wards: ante-room**

Routes of transmission of infection

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- **Contact with human secretions**
  - **Direct** → **STDs**
  - **Indirect**
- Injection/implantation
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All secretions, including respiratory secretions, are transmitted through contact

Contact transmission

- **Through healthcare workers**
  - **Hands**
  - **Clothing**

- **Through inanimate objects**
  - **Matrasses**
  - **Bed curtains**
  - **Any other contaminated object or surface**

Prevention of contact-transmission through HCWs

- **Wash hands**
- **Wear impervious (plastic) apron**
  - **when physically attending to patients**
  - **when dealing with contaminated material**
- **Avoid contact with contaminated objects**

Prevention of contact-transmission through HCWs: impact on design

- **Wash hands** → **design facilitates behaviour** → **sufficient number of strategically placed handwash facilities**
- **Avoid contact with contaminated objects** → **routing of dirty and clean material**

1. **Theatre suite**
2. **Central sterilisation unit**
3. **Laundry**
4. **Infectious disease isolation unit**

Thank you