PART 15

Infectious Diseases

Section 1

General Considerations

Chapter 214

Public Health Approach to Pandemics

Introduction to Public Health

- **Goals**:
  - Promote healthy lifestyles and communities.
  - Protect against health threats (infectious diseases, NCDs, environmental risks).
- **Roles in Infectious Disease**:
  - Prevention.
  - Preparedness.
  - Response (epidemics & pandemics).
- **Historical Foundation**:
  - John Snow & the Broad Street cholera outbreak.
- **Modern Tools**:
  - Traditional "shoe-leather" epidemiology.
  - Genomic sequencing.
  - Data analytics.
  - Medical innovation (therapeutics, vaccines).

Definitions

Term	Definition
Sporadic	Infrequent and irregular disease occurrence.
Endemic	Continuous low-level presence in a population.
Epidemic	Substantial increase above baseline; can be from a novel or endemic disease.
Pandemic	Epidemic spread across multiple countries/continents. Declared by WHO.
Transmission Dynamics	Depend on population susceptibility (naïve vs. partially immune).

Public Health Authorities & Partners

- **Collaborative Effort**:
    - Local, city, state, national public health authorities.
    - Governments, healthcare systems, clinicians, communities.
- **Key Component**: Community involvement in investigation, education, and communication.

International Role

- **World Health Organization (WHO)**:
    - Founded in 1948 under the UN.
    - Coordinates global health emergencies.

National Role

- **Departments** (e.g., US Dept. of Health and Human Services).
- **Agencies** (e.g., Centers for Disease Control and Prevention - CDC):
    - National surveillance.
    - Endemic and emergent disease tracking.

Regional & Local Role

- **City, County, State Public Health Departments**:
    - Surveillance, preparedness, response.
    - Liaise with:
        - Healthcare systems.
        - Schools, government agencies, community groups.

Aims of Public Health Response to Infectious Diseases

Primary Goals
Prevent emergence of novel diseases in humans.
Prevent spread or increasing prevalence of known diseases.
Mitigate health effects from disease spread.

Four Arms of Response:

1. **Mitigation/Prevention**
2. **Preparedness**
3. **Response**
4. **Recovery**

- **Cross-cutting Activities**:
    - **Education**.
    - **Public communication** across all four arms

Arms of intervention

1. Mitigation / Prevention

Goal:

Prevent emergence and spread of diseases—especially zoonoses—before they become epidemics or pandemics.

Key Concepts:

- **Spillover events** from animals to humans (e.g., Zika, SARS-CoV-2).
- Risk factors: **deforestation**, **land use changes**, **climate change**, and **animal-human interaction**.

One Health Approach:

- **Multisectoral, collaborative model** involving:
  - Agriculture regulators
  - Veterinarians
  - Environmental health professionals
- Recognizes **interconnectedness of humans, animals, and the environment**.

Antimicrobial Stewardship:

- Aimed at reducing **MDR/XDR organisms**.
- Managed at **individual patient level** by healthcare providers.
- Crucial to preserve antibiotic effectiveness for future pandemics.

2. Preparedness

Goal:

Prepare for **inevitable outbreaks**, whether **known or unknown threats**.

Key Elements:

- **All-Hazards Approach**: Plans not tied to specific pathogens.
- **Case-Based Surveillance**:
  - Monitors **disease incidence/prevalence** at all levels.
  - Requires **standardized case definitions** and reporting systems.

Surveillance Infrastructure:

- **NNDSS** in the U.S. oversees ~120 notifiable diseases.
- Needs strong partnerships with:
  - Labs
  - Healthcare providers
  - Local authorities

Early Warning Systems:

- Useful for **new/emerging diseases**.
- Techniques: **Syndromic surveillance**, **wastewater screening**, **genomic sequencing**.

Supplies and Capacity:

- **Stockpiling** of PPE and Medical Countermeasures (MCMs) (e.g., vaccines, antivirals).

- Limitations of "just-in-time" supply chains in crises.
- Need for:
    - Scalable **hospital capacity**
    - **Flexible patient care spaces**
    - Plans to **restrict elective care** temporarily

3. Response

Goal:

Activate plans rapidly upon **identification of a disease threat**.

Initial Steps (especially for novel pathogens):

- Identify pathogen (genus/species)
- Sequence genome
- Develop **diagnostic tests**, **vaccines**, and **therapeutics**

Public Health Measures:

- **Social distancing**: Reduce person-to-person contact
- **Transmission-based precautions**: PPE, especially facial masking
- **Isolation**: Enforced separation of confirmed cases
- **Contact tracing** and **quarantine**: For exposed individuals

Diagnostics & Vaccines:

- Genomic sequencing → diagnostic test development → vaccine production
- mRNA vaccine platforms accelerated during COVID-19
- Regulatory flexibility for emergency use approvals

4. Recovery

Goal:

Transition from active response to a steady state (endemicity or elimination).

Key Features:

- **Endemicity**: Low-level, continuous circulation of pathogen
- Indicators for transition:
    - Decline in case numbers
    - Lower pressure on healthcare systems
    - Other metrics: test positivity, hospitalizations, vaccine uptake

After-Action Analysis:

- **Evaluate**:
    - Response effectiveness
    - Public tolerance
    - Economic and social impact
- Generate **after-action reports** to guide future responses

Communication and Education (Spanning All Phases)

Goal:

Ensure **public understanding, trust, and compliance** across all phases.

Strategy:

- Clear, timely, consistent messaging
- Addressing misinformation
- Building public trust through **transparency**
- Adjusting communication based on **new data and evidence**

Section 2

Preventive Measures

Chapter 215
Immunization Practices

OVERVIEW

Importance of Immunization

- One of the **most beneficial and cost-effective** public health measures.
- Achievements:
  - **Smallpox eradicated**
  - **Polio nearly eradicated globally**
  - **Measles & Rubella no longer endemic** in the U.S.
- However, **vaccine-preventable diseases** like measles, mumps, pertussis still occur.
- **>99% reduction** in incidence of many childhood diseases vs. 20th-century data.

Definitions

- **Immunization**: Process of inducing immunity against specific diseases.
  - **Passive immunity**: Transfer of preformed antibodies.
  - **Active immunity**: Induction of host immune response by vaccine or toxoid.

Recommended Routine Immunizations (2023, USA)

Vaccines cover **19 pathogens**:

1. *Corynebacterium diphtheriae*
2. *Clostridium tetani*
3. *Bordetella pertussis*
4. Poliovirus
5. *Haemophilus influenzae* type b (Hib)
6. Hepatitis A
7. Hepatitis B
8. Measles virus
9. Mumps virus
10. Rubella virus
11. Rotavirus
12. Varicella-zoster virus
13. SARS-CoV-2
14. Pneumococcus
15. Meningococcus

16. Influenza virus
17. Human papillomavirus (HPV)
18. Respiratory syncytial virus (RSV)

PASSIVE IMMUNITY

Characteristics:

- Immediate but **short-term** protection (weeks to months)
- Sources:
  - **Human immunoglobulin** (IMIG, IVIG, SCIG)
  - **Hyperimmune globulin**
  - **Animal-derived antibodies / Monoclonal antibodies**
  - **Maternal antibodies** (transplacental IgG, breast milk IgA)

Indications:

- Immunodeficiency (esp. B-cell defects)
- Pre/post-exposure prophylaxis when:
  - Immediate protection is needed
  - Time is insufficient to mount an active response
  - Specific diseases require antibody therapy

Intramuscular Immunoglobulin (IMIG)

◆ *Description:*

- Contains 15–18% protein, mainly IgG.
- Derived from pooled adult plasma (cold ethanol fractionation).
- **Not safe for IV use**.

◆ *Common Uses:*

1. **Antibody deficiency** (replacement therapy)
   - Dose: **100 mg/kg monthly** (≈0.66 mL/kg)
2. **Measles exposure prophylaxis** (within 6 days)
   - Dose: **0.5 mL/kg** (max: 15 mL)
   - Do not give simultaneously with MMR vaccine.
3. **Hepatitis A postexposure prophylaxis**
   - <12 mo: IMIG preferred
   - 6–11 mo: Give hepatitis A vaccine before travel (not counted toward 2-dose series)
   - 12 mo: Hepatitis A vaccine preferred
   - 40 yrs, immunocompromised, or chronic liver disease:
     - Give vaccine + IMIG at separate sites if <2 weeks before travel

◆ *VSide Effects of Immunoglobulin*

- **Common**: Injection site pain, flushing, headache, nausea

- **Serious (Rare)**: Chest pain, dyspnea, anaphylaxis, systemic collapse
- **Contraindication**: Selective IgA deficiency (risk of anti-IgA reaction)

Table 215.1 – Decline in Annual Morbidity vs. 20th Century

Disease	20th Century Annual Morbidity	2019 Reported Cases	% Decrease
Smallpox	29,005	0	100%
Polio (paralytic)	16,316	0	100%
Measles	530,217	1275	>99%
Mumps	162,344	3780	98%
Pertussis	200,752	18,617	91%
Hib	20,000	18	>99%
Rubella	47,745	6	>99%
CRS	152	1	>99%
Diphtheria	21,053	2	>99%
Tetanus	580	26	95%

Table 215.2 – Morbidity from Newer Vaccine Targets

Disease	Pre-Vaccine Annual Estimate	2019 Estimate	% Decrease
Hepatitis A	117,333	18,846	86%
Hepatitis B (acute)	66,232	3544	95%
Pneumococcus (all ages)	63,067	19,689	69%
Pneumococcus (<5 yrs)	16,069	1091	93%
Rotavirus (<3 yrs hospitalizations)	62,500	30,625	51%
Varicella	4,085,120	8297	>99%

Intravenous Immunoglobulin (IVIG)

Preparation and Composition:

- A highly purified immunoglobulin preparation from adult plasma donors.
- Prepared using alcohol fractionation.
- Modified for intravenous (IV) use.
- Contains >95% IgG.
- Tested to ensure minimum titers against *C. diphtheriae*, hepatitis B, measles, and poliovirus.
- Antibody levels for other pathogens vary between products and batches.
- Available in **liquid** and **lyophilized (powder)** forms.
- Does **not** contain thimerosal.

FDA-Approved Indications:

1. **Primary immunodeficiency disorders –** replacement therapy.
2. **Kawasaki disease –** to prevent coronary artery aneurysms and shorten illness duration.
3. **Pediatric HIV infection –** prevention of serious bacterial infections.
4. **Hypogammaglobulinemia in chronic B-lymphocytic leukemia –** infection prevention.
5. **Immune thrombocytopenia –** to raise platelet counts.

Other Clinical Uses (Non-FDA approved but based on experience):

- Guillain-Barré syndrome.
- Chronic inflammatory demyelinating polyneuropathy.
- Multifocal motor neuropathy.
- Severe toxic shock syndrome.
- Parvovirus B19-induced anemia.
- **MIS-C (Multisystem Inflammatory Syndrome in Children)** related to COVID-19.
- **Post-exposure varicella prophylaxis** (if VariZIG unavailable).

Adverse Reactions (up to 25%):

- Common: Fever, headache, myalgia, chills, nausea, vomiting.
- Serious (rare): Anaphylactoid reactions, thromboembolic events, aseptic meningitis, hemolytic anemia, renal insufficiency.
    - **Renal failure** mainly in patients with pre-existing kidney dysfunction.
- Many side effects are **infusion-rate dependent** and can be reduced by slowing the infusion rate.

Table 215.3 – Immunoglobulin and Antisera Preparations

Product	Major Indications
IMIG (Intramuscular Ig)	Replacement in antibody deficiencies, post-exposure prophylaxis (Hep A, measles, rubella in pregnancy).
IVIG	See above.
SCIG (Subcutaneous Ig)	Primary immunodeficiency treatment.
Hepatitis B Ig (IM)	Post-exposure, perinatal prevention in infants of HBsAg-positive mothers.
Rabies Ig (IM)	Post-exposure prophylaxis.
Tetanus Ig (IM)	Wound prophylaxis, tetanus treatment.
Varicella-Zoster Ig (VariZIG, IM)	Post-exposure for high-risk patients.
Cytomegalovirus Ig (IV)	CMV prophylaxis in seronegative transplant recipients.
Vaccinia Ig (IV)	Complications of smallpox vaccination (not for smallpox treatment).
Human Botulism Ig (BabyBIG, IV)	Treatment of infant botulism.
Diphtheria Antitoxin (Equine)	Treatment of diphtheria.

Product	Major Indications
Heptavalent Botulinum Antitoxin (BAT)	Treatment of food/wound botulism (non-infant).
Palivizumab (IM)	RSV prophylaxis in high-risk infants.
Nirsevimab (IM)	Passive RSV prevention in infants and young children.
Crotalidae Antivenom (Equine)	Snake bites (rattlesnakes, copperheads, moccasins).

Subcutaneous Immunoglobulin (SCIG)

- **Used in**: Children and adults with **primary immunodeficiency**.
- **Administration**:
  - Weekly, **small subcutaneous doses**.
  - **More stable IgG levels** over time.
- **Advantages over IVIG**:
  - **Fewer systemic reactions**.
  - **Most common side effect**: Local **injection site reactions**.
- **Note**: No available data on using **IMIG subcutaneously**.

Hyperimmune Animal Antisera

General Information:

- Derived from **horses**.
- Treated with **ammonium sulfate** to concentrate immunoglobulin.
- Some products treated with **enzymes** to reduce allergic reactions.

Risks and Precautions:

- High risk of **severe allergic reactions**.
- **Requires:**
  - **Sensitivity testing** before use.
  - **Desensitization** if necessary.
  - Preparedness for treating:
    - **Fever**
    - **Serum sickness**
    - **Anaphylaxis**

Available Equine Antitoxins:

- **Diphtheria Antitoxin**:
  - Available from **CDC**.
  - Used to treat **diphtheria**.
  - CDC resource
- **Heptavalent Botulinum Antitoxin (A-G)**:
  - Used in **adults with botulism**.