

Environmental Pathology

- Environmental diseases: diseases that are not entirely genetic caused by exposure to chemical or physical agents in the ambient, workplace, and personal environments, including diseases of nutritional origin
- Can be a consequences of major disasters
- Physical Injuries:
 - Mechanical injury: blunt, or sharp force injury, and gunshot injury.
 - Thermal injury
 - Radiation injury

Mechanical Trauma

- Mechanical forces may inflict a variety of forms of damage.
- The type of injury depends on the shape of the colliding object (Blunt vs. Sharp), the amount of energy discharged at impact, and the tissues or organs that bear the impact
- patterns of injury seen in mechanical force:
 - **abrasion:**
 - is a wound produced by scraping or rubbing, resulting in removal of the superficial layer.
 - Skin abrasions may remove only the epidermal layer.
 - **A contusion, or bruise:**
 - is a wound usually produced by a blunt object
 - characterized by damage to blood vessels and extravasation of blood into tissues.
 - **A laceration**
 - a tear or disruptive stretching of tissue caused by the application of force by a blunt object.
 - In contrast to an incision, most lacerations have intact bridging blood vessels and jagged, irregular edges.
 - **An incised wound:**
 - inflicted by a sharp instrument.
 - The bridging blood vessels are severed
 - **A puncture wound :**
 - caused by a long, narrow instrument
 - termed penetrating when the instrument pierces the tissue and perforating when it traverses a tissue to also create an exit wound.

- One of the most common causes of mechanical injury is **vehicular accident** a common pattern of injury sustained by a driver who is not wearing a seat belt includes:
 - trauma to the head (windshield impact), were brain contusion.
 - chest (steering column impact), common chest injuries include sternal and rib fractures, heart contusions, aortic lacerations, and (less commonly) lacerations of the spleen and liver.
 - knees (dashboard impact) may lead to hip, femur and lower limb fracture
 - in caring for an automobile injury victim, it is essential to remember that internal wounds often accompany superficial abrasions, contusions, and lacerations. in many cases, external evidence of serious internal damage is completely absent.

Gunshot wounds

- a. Contact wounds
 - i. grey-black discoloration from the soot
 - ii. abrasion ring
 - iii. Some times the gases released go into the subcutaneous tissue and cause the star-shaped laceration.
 - iv. muzzle imprint
 - b. Intermediate-range wounds
 - Powder tattooing (stippling) of the skin around the entrance site
 - Irregular
- Long-range wounds
- No powder tattooing
 - The entrance wound roughly equal projectile fired
- Exit wounds
- Typically larger and more irregular than entrance wounds

Thermal injury:

- **Hyperthermia:**

Prolonged exposure to elevated ambient temperatures can result in heat cramps, heat exhaustion, and heat stroke.

- **Heat cramps:**

- Result from loss of electrolytes via sweating.
- Cramping of voluntary muscles, usually in association with vigorous exercise,
- Heat-dissipating mechanisms are able to maintain normal core body temperature.

- **Heat exhaustion**

- The most common hyperthermic syndrome.
- Its onset is sudden, with prostration and collapse,
- It results from a failure of the cardiovascular system to compensate for hypovolemia, secondary to water depletion.

- After a period of collapse, which is usually brief, equilibrium is spontaneously re-established.
- **Heat stroke**
 - Associated with high ambient temperatures and high humidity.
 - Thermoregulatory mechanisms fail, sweating ceases, and core body temperature rises.
 - The underlying mechanism is marked generalized peripheral vasodilatation with peripheral pooling of blood and a decreased effective circulating blood volume.
 - Necrosis of the muscles and myocardium may occur. Arrhythmias, disseminated intravascular coagulation, and other systemic effects are common.
 - Elderly persons, individuals undergoing intense physical stress (including young athletes and military recruits), and persons with cardiovascular disease are prime candidates for heat stroke

Type of Injury	Body Temperature	Skin	Mental Status
Heat cramps	37.0°C (98.6°F)	Moist and cool	Normal
Heat exhaustion	>37.8°C (>100°F)	Sweating	Minimally altered
Heat stroke	>40°C (>104°F)	Dry (anhidrosis)	Impaired consciousness

Burns

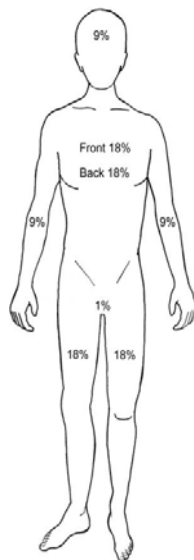
- a. **First-degree**
 - i. Painful partial-thickness burns (e.g., sunburn)
 - ii. Heal without scarring
- b. **Second-degree**
 - i. Painful partial-thickness burns
 - ii. Damage to entire epidermis
 - iii. Blister formation
 - iv. Usually heal without scarring

c. Third-degree

- i. Painless full-thickness burns
- ii. Extensive necrosis of epidermis and adnexa
- iii. Scarring is inevitable.
 - Keloids (exaggerated scars) commonly occur.
 - Potential for developing squamous cell carcinoma
- iv. Healing of epithelial surface
 - Proliferation of residual epithelium located at burn margins and lining adnexal structures

Outcome of burns depends upon:

- Depth
- Percentage of body involved (rule of nine).
- Internal injury because of fume inhalation



Despite continuous improvement in therapy, any both at the burn site and systemically, which can result in hypovolemic shock

Complications

- Inhalation of smoke and toxic fume: produce inflammation and swelling, which may lead to partial or complete airway obstruction. Lipid-soluble gases, such as nitrous oxide and products of burning plastics, are more likely to reach deeper airways, producing pneumonitis which show after 48h

- Hypovolemic shock: develops within hours, burn exceeding 50% of the total body surface, whether superficial or deep, is grave and potentially fatal. With burns of more than 20% of the body surface, there is a rapid shift of body fluids into the interstitial compartments
- Infection
 - Sepsis due to *Pseudomonas aeruginosa* is the most common cause of death.
 - antibiotic-resistant strains of other common hospital-acquired bacteria, such as *S. aureus*, and fungi, particularly *Candida* specie,
 - septic shock with renal failure and/or the acute respiratory distress syndrome (ARDS) are the most common serious sequelae
- Curling's ulcers in stomach (acute hemorrhagic gastritis)

Cold-Induced Injuries:

- **Frostbite**
 - Pathogenesis
 - Localized tissue injury caused by direct damage (e.g., ice crystallization intra & extracellular)
 - Indirect damage : Depending on the rate at which the temperature drops and the duration of the drop, induce vasoconstriction and thrombosis.
 - Clinical findings
 - Loss of pain sensation
 - Waxy appearance
 - Gangrene
- **Hypothermia**
 - Prolonged exposure to low ambient temperature leads to hypothermia, a condition seen frequently in homeless & alcohol persons.
 - At about 90°F (32.2°C) loss of consciousness occurs, followed by bradycardia and atrial fibrillation .

Radiation Injury:

- Radiation is energy distributed across the electromagnetic spectrum as waves (long wavelengths, low frequency) or particles (short wavelengths, high frequency).
- it can be divided into nonionizing and ionizing radiation.
- **Nonionizing radiation** :

- characterized by long wavelengths and low frequencies
 - they produce vibration and rotation of atoms in biologic molecules.
 - E.g. electric power, radio waves and microwaves, infrared, and **ultraviolet light**
- **Ionizing radiation:**
 - short wavelengths and high frequency
 - ionize biologic target molecules and eject electrons.
 - it can be in the form of :
 - Electromagnetic (x-rays, γ rays)
 - particulate (α particles, β particles, protons, neutrons)
 - Alpha particles :consist of 2neutrons and 2 protons.they have strong ionizing power but low penetration because of their large size.
 - Beta particles: are electrons emitted from the nucleus of an atom these have weaker ionizing power but higher penetration than alpha particles.

The dose of ionizing radiation is measured in several units:

- **A roentgen:** the amount of ionization produced in air.
- **RAD :Absorption Of Radiant Energy**
 - Biologically the more important parameter.
 - A rad defines the energy, expressed as ergs, absorbed by a tissue.
 - One rad equals 100 ergs(0.01joule) per gram of tissue.
- **Gray (Gy):**
 - corresponds to 100 rads (1 joule/kg of tissue)
 - centigray (cGy) is equivalent to 1 rad.
- **Sievert (Sv) :**
 - depends on the biologic rather than the physical effects of radiation.
 - a unit of equivalent dose :*corresponds to the absorbed dose (expressed in Grays) \times the relative biological effectiveness (RBE) of the radiation*
 - The RBE depends on the type of radiation, the type and volume of tissue exposed to radiation, the duration of the exposure...

- **Pathophysiology**
 - Injury correlates with type of radiation, cumulative dose, and amount of surface area exposed.
 - Direct DNA injury, or indirect through formation of hydroxyl free radicals.
- **Morphology:**
 - **Nuclear swelling** and condensation and clumping of chromatin; sometimes the nuclear membrane breaks.
 - **Apoptosis** .
 - Giant cells with pleomorphic nuclei or more than one nucleus may appear and persist for years after exposure.
 - **cytoplasmic changes**, including cytoplasmic swelling, mitochondrial distortion, and degeneration of the ER.
 - During the immediate post-irradiation period, vessels may show only dilation. Later, endothelial cell proliferation and collagenous hyalinization with thickening of the media, resulting in marked narrowing or even obliteration of the vascular lumina
- **Tissue susceptibility**
 - Most radiosensitive tissues (highest mitotic activity)
 - Lymphoid tissue (most sensitive)
 - Bone marrow
 - Mucosa of gastrointestinal tract, germinal tissue
 - Least radiosensitive tissues
 - Bone (least sensitive)
 - Brain, muscle, skin
- **Radiation effects in different tissues**
 - **Hematopoietic**
 - Lymphopenia (first change)
 - Thrombocytopenia
 - Bone marrow hypoplasia
 - **Vascular**
 - Thrombosis (early), fibrosis (late)
 - Ischemic damage
 - **Epidermal**
 - Acute effects are erythema, edema, blistering
 - Chronic effect is radiodermatitis
 - Potential for squamous cell carcinoma
 - **Gastrointestinal**
 - Acute effect is diarrhea.
 - Chronic effects are adhesions with potential for bowel obstruction.
- **Cancers caused by radiation**
 - Acute leukemia (most common)
 - Papillary carcinoma of the thyroid
 - Osteogenic sarcoma

Organ	Ac. Injury	Delayed complications
Bone marrow	Atrophy	Hypoplasia, leukaemia
Skin	Erythema	Atrophy of epidermis & fibrosis of dermis, cancer
Heart	----	pericardial fibrosis
Lung	Edema,endo.&ep.cell death	Interstit. & intra-alveol. fibrosis, Ca
<u>GIT</u>	Edema, mucosal ulcers	Ulcers, fibrosis, strictures, adhesions,
Liver	Veno-occlusive disease	Cirrhosis, liver tumors
Kidney	Vasodilation	Cortical atrophy, interstitial fibrosis
Urin. Blad.	Mucosal erosion	Submucosal fibrosis, Ca
Brain	Edema ,necrosis	Necrosis of white matter, gliosis,
<u>Testis</u>	Necrosis	Tubular atrophy
<u>Ovary</u>	Atresia of follicle	Stromal fibrosis
<u>Thyroid</u>	-----	Hypothyroidism, Ca
Breast	-----	Fibrosis, Ca

- **Total-Body Irradiation:**

- atomic bomb, nuclear power plant accident
- even in very low doses - devastating effect
- effect on hematopoietic system, GIT and brain

- 1-5 Gy - hematopoietic form - nausea, vomiting, lymphopenia, thrombocytopenia, neutropenia, later anemia
- 5-50 Gy - gastrointestinal form - diarrhea, hemorrhage, toxemia (from large bowel) - death in 8-9 days
- >50 Gy - cerebral form - drowsiness, listlessness, convulsions, coma (death within hours, max. 3 days)

- **Acute radiation syndrome:**

	0-1 Sv	1-2 Sv/≤1Gy	2-10 Sv/1-5 Gy acute radiation syndromes	10-20 Sv/5-50 Gy -	>50 Sv/>50 Gy
Main site of injury	None	Lymphocytes	Bone marrow	Small bowel	Brain
Main signs and symptoms	-	Moderate leukopenia	Leukopenia, hemorrhage, epilation, vomiting	Diarrhea, fever, electrolyte imbalance, vomiting	Ataxia, coma, convulsions, vomiting
Timing	-	1 day to 1 week	4-6 weeks	5-14 days	1-4 hours
Lethality	-	None	Variable (0% to 80%)	100%	

1 Sv ≈ Gy = 100 rad. / 1 rad = 1 rem

Chemical injury:

- Injury By Therapeutic Agents
- Tobacco Abuse
- Alcohol Abuse
- Drug Abuse: Cocaine And Heroin Abuse
- Exposure To Toxic Chemical Substance:
 - Carbone monoxide
 - carbon tetrachloride
 - Cyanide ,lead poisoning, Mercuric chloride
- **Adverse effects of Therapeutic Drugs:**
 - Adverse drug reactions - extremely common in practice of medicine
 - believed to affect 7% to 8% of patients admitted to a hospital, about 10% of these prove fatal
 - Most frequently in : antibiotics, antineoplastic agents, immunosuppressive drugs
 - adverse reaction:

- Predictable (dose-dependent) - purposeful over dosage: digitalis, streptomycin , sedatives
- Unpredictable
 - ✓ idiosyncrasy - massive necrosis of the liver after paracetamol
 - ✓ Hypersensitivity :Anaphylactic shock

Adverse effects	Drugs
agranulocytosis, pancytopenia aplastic anemia	chloramphenicol Antineoplastic agents, immunosuppressives
urticaria, exfoliative dermatitis	Antineoplastic agents, sulfonamides, hydantoins, some antibiotics, and many other agents
acute tubular necrosis, Tubulointerstitial disease necrosis of papillae,	sulphonamides, analgetics :Phenacetin, salicylates
lung fibrosis, Asthma	bleomycine, busulphan Salicylates
liver steatosis, cholestasis, necrosis of hepatocytes	tetracycline, estrogens, halothane, chlorpromazine.
Respiratory depression	Sedatives

- **Broad spectrum antibiotic side effect:**
 - Diarrhea: pseudomembranous colitis
 - Candidacies :mouth, vagina
 - Skin eruption
 - develop of bacterial resistance
 - Other drug specific
- **cancer chemotherapeutic:**
 - Nausea and vomiting
 - Susceptibility to infection even minor infection can be fatal
 - Tumor lysis syndrome
 - Malignancy: lymphoma
- **Acetaminophen:**
 - very safe :The window between the usual therapeutic dose (0.5 gm) and the toxic dose (15-25 gm) is large
 - accidental over dosage occurs in children, and suicide attempts
 - Conversion to free radicals in the liver

- Toxicity begins with nausea, vomiting, diarrhea, and sometimes shock, followed in a few days by jaundice
- very large doses May result in damage to the liver at centrilobular areas of the hepatic lobules
- May result in damage to the kidneys (e.g., renal papillary necrosis)
- **acetylsalicylic acid(Aspirin):**
 - accidental overdosage occurs in children, and suicide attempts
 - Stomach :ulcer, acute hemorrhagic gastritis
 - Platelet dysfunction &bleeding
 - Asthma
 - Reyes Syndrome
 - In Acute over dose:
 - Tinnitus, vertigo, change in mental status (confusion, seizures), tachypnea
 - Acid-base disorders
 - Hyperthermia
 - fulminant hepatitis.
- **Proprietary analgesic mixtures of aspirin and phenacetin or its active metabolite, acetaminophen , when taken over several years, can cause tubulointerstitial nephritis with renal papillary necrosis, referred to as *analgesic nephropathy***

Tobacco Smoking:

- Smoking is the most preventable cause of human death.
- It reduces overall survival, and the impact is dose dependent
- Cessation of smoking greatly reduces the risk of death from lung cancer
- Nicotine is an important constituent responsible for tobacco addiction
- Nicotine is an alkaloid that readily crosses (7sec)the blood-brain barrier and stimulates nicotine receptors in the brain.It immediately stimulates the release of many chemical messengers including acetylcholine, catecholamine: increase : heart rate and blood pressure, coronary artery blood flow, contractility and cardiac output), dopamine, and beta-endorphins. This results in enhanced pleasure, decreased anxiety, and a state of alert relaxation.
- Most of the deaths related to smoking :lung cancer, cardiovascular disease, and chronic respiratory disease
- Directly linked to the action of carcinogens in smoke are:
 - a. Bronchial carcinoma.
 - b. Oral cancer.
 - c. Carcinoma of the larynx.
- The incidence increased significantly in smokers:

- a. Carcinoma of the esophagus.
- b. Carcinoma of the urinary bladder.
- c. Carcinoma of the uterine cervix.
- d. Carcinoma of the kidney.
- Carcinoma of the pancreas. Polycyclic hydrocarbons are the primary carcinogens.
- Systemic effect:
 - a. RS:

Laryngeal cancer: squamous cell carcinoma
 Chronic obstructive pulmonary disease: chronic bronchitis, emphysema
 Lung cancer: squamous cell carcinoma, small cell carcinoma, some types of adenocarcinoma

- b. CVS:

Acute myocardial infarction (AMI)
 Sudden cardiac death
 Peripheral vascular disease(Burger disease)
 Hypertension; cardiac arrest in women who take oral contraceptives

- c. CNS:

Strokes: intracerebral bleed, subarachnoid hemorrhage

- d. GI:

Oropharyngeal cancer: squamous cell carcinoma
 Upper, midesophageal cancer: squamous cell carcinoma
 Gastroesophageal reflux disease: decreases tone of lower esophageal sphincter
 Delayed healing of peptic ulcers
 Pancreatic cancer: adenocarcinoma

- e. GUS:

Cervical cancer: squamous cell carcinoma
 Decreased testosterone in males
 Decreased estrogen in females
 Kidney cancer: renal cell carcinoma
 Urinary bladder cancer: transitional cell carcinoma

- f. Maternal smoking:

increases the incidence of sudden infant death syndrome, even 10 cigarettes per day can cause fetal hypoxia; low birth weight, prematurity, and increased incidence of spontaneous abortion

- Passive (secondhand) smoke inhalation
 - a. Greatest impact on children
 - Increased risk of respiratory and middle ear infections
 - Exacerbates asthma
 - b. Increased risk for lung cancer and coronary artery disease
- Beneficial effects of smoking cessation
 - a. Risk for cardiovascular disease
 - Approaches nonsmoker after 15 years
 - b. Risk for lung cancer
 - Approaches nonsmoker after 15 years
 - c. Risk for stroke
 - Approaches nonsmoker after 5 to 15 years
 - d. Other benefits
 - Reduced risk for cancers of the mouth, larynx, esophagus, pancreas, and urinary bladder
 - Improved pulmonary function regardless of severity of the disease
 - Reduced risk for pneumonia, influenza, and bronchitis

Tar	Carcinogenesis
Polycyclic aromatic hydrocarbons	Carcinogenesis
Nicotine	Ganglionic stimulation and depression, tumor promotion
Phenol, acetaldehyde	Tumor promotion; mucosal irritation
Benzopyrene	Carcinogenesis
Carbon monoxide	Impaired oxygen transport and utilization
Formaldehyde, hydrogen cyanide;	Toxicity to cilia; mucosal irritation

Oxides of nitrogen	Toxicity to cilia; mucosal irritation
Nitrosamine	Carcinogenesis

