Respiratory Dysfunction & Thoracic Trauma

WEEK 1

REMEMBER:
Pressure moves from
HIGH to LOW

Anatomy of thoracic cavity
Mechanics of breathing – action of breathing occurs when pressure changes within the thorax compared to outside
Inhalation:

- Intercostal muscles move ribcage outwards
- Diaphragm contracts & flattens – chest wall expands
- Size of thoracic cavity increases
- Air pressure inside lungs ↓(negative) compared to air outside to equalise pressure between thoracic cavity & outside air – outside air rushes into lungs

Breathing in - high pressure atmospheric pressure & low pressure in lungs (pressure moves from high to low)
Diaphragm flattens to enable lungs expanding and filling up with air

Exhalation:

- Diaphragm & intercostal muscles relax – return to resting position (reducing size of thoracic cavity)
- Air pressure inside lungs ↑(positive) compared to outside – forces air out

Breathing out - low pressure atmospheric pressure & high in lungs
Diaphragm goes up

Rise in CO_2 levels detected by chemoreceptors – hypothalamus in the brain causes body to breathe – to expel CO_2 & inhale O_2
Can't breathe - low CO2 (breathing into a brown paper bag - re breathing in the CO2 to regulate levels)

Visceral pleura: covers lung
Parietal pleura: covers chest wall
These 2 pleurae face each other & create a space (negative pressure so layers stick close together) for serous pleural fluid – allows lungs to slide against the chest wall without catching, the negative pressure keeps the lung expanded so it doesn't collapse (bleed/fluid into the space changes the pressure of pleural space to positive pressure)

Negative pressure - suction (pleural space)
Once blood/air enters that space the pressure becomes positive/high therefore then tries to enter lung as the lung has a lower pressure resulting in a collapsed lung

Pathophysiology of lung pleura:
Each lung is surrounded by its own pleural cavity – compromised of 2 separate membranes
Inner most layer VISCERAL PLEURA is continuous w lung parenchyma & has no sensory nerves
Outer most layer PARITAL PLEURA is attached to thoracic wall & is innervated by intercostal & phrenic nerves
The space between these 2 membranes is 5-10ml of serous fluid (acts as lubricant to decrease friction & enables pleural membranes to slide easily over each other during respiration)

Intra-pleural pressure within the space is slightly NEGATIVE in comparison to atmospheric pressure

- Provides suction between 2 membranes which resists the natural tendency of lungs to recoil inwards (therefore lungs are held against chest wall & diaphragm – preventing pulmonary collapse)

HOWEVER – presence of air/fluid in pleural cavity interferes with the negative pressure resulting in partial/complete collapse of affected lung

Principles of gaseous exchange
Diffusion occurs when molecules from an area of ↑ concentration to a level of ↓concentration
Gaseous exchange occurs as blood in the capillaries (↓O_2) surrounding the alveoli (↑O_2)
Capillaries & alveoli have walls that are only one cell thick which allows for gaseous exchange across the membranes

Normal arterial blood gas levels *normal levels*
pH: determines if blood is too acidic (↓pH: acidaemia) or too alkaline (↑pH: alkalaemia) 7.35-7.45
potential of hydrogen
PaO_2: pressure of arterial O_2 – low level indicates hypoxaemia 80-100mmHg
Partial pressure of oxygen
HCO_3: indicates how much bicarbonate is in the blood – used to alkaline blood when it's too acidic 22-28mEq/L
Bicarbonate
$PaCO_2$: reflects alveolar ventilation (↑levels: hypoventilation & ↓ levels: hyperventilation) 35-45mmHg
Partial pressure of carbon dioxide
SaO_2: oxygen saturation 94-100%
CO_2 is completely proportional to your minute ventilation → ***Hudson masks can't be less than 4L otherwise too much CO_2 will be retained***

Thoracic - ribs

Reason - increased intravascular volume - to increase BP
Fluid resus, dehydration, hypovolemic
Rapid, bolus - increases rate of the drip and the rate of osmosis so much faster than a isotonic solution

Isotonic
Same concentration
0.9% saline
Reason - increasing intravascular volume - increases BP (fast rate) will increase at the rate of the drip
Dehydration (moderate/slow rate)

Colloid:
Blood volume expanders/plasma expander - increases circulating volume fast
Extreme/emergency situations
Large molecules so they don't leak back out of vascular space
Increased perfusion and BP increases

Increasing vascular volume
Natural: albumin, RBC, FFP (plasma)
Synthetic: gelofusine (gelo)

4. Markers of systemic inflammation

T >38 or <36
High HR >90
High RR >20
PaCO2 <32
WBC >12,000 or <4,000 (low - no immune system to fight the infection)

5. Nursing management of a patient with sepsis

Vital signs - Temp, RR, HR, SaO2, BP, GCS
Bloods - FBE, blood cultures, U&Es, CRP <3
IV fluids
IV Abs
Vasopressors (increased CO)
Fluid balance chart

6. Assessment tools of systemic inflammation

SIRS - Systemic Inflammatory Response Syndrome

QSOFA - Quick Sepsis Related Organ Failure Assessment
1 point for each criteria: (Systolic BP <100, RR >22, GCS <15)

Systemic Inflammation
Injury /infection
↓
Cell damage
↓
Histamine, prostaglandins, cytokines
↓
Vasodilation (BP decreases)
↓
Increased capillary permeability (leaky)
↓
Oedema (peripherals, orbital, APO, abdomen ascites)
↓
Activation clotting cascade (microvascular clotting - renal, liver, eyes, lungs, stroke = MODS)
↓
Ischemia (drop in O2 to cells/organs/tissues)

Vascular space depleted - hypovolemic

Acute on Chronic Disease

WEEK 3

Physiology of the kidney
Excretion of waste, reabsorption of nutrients, acid-base homeostasis, hormone secretion & homeostasis of BP

WEEK 5

Pathophysiology of cellular structure & immune system

DNA:

- Deoxyribonucleic acid is a molecule made up of 2 chains that coil around each other forming a double helix – that carries genetic instructions used for the growth, development, functioning & reproduction of all known organisms.

RNA:

- Ribonucleic acid is a nucleic acid present in all living cells, a single helix
- Main role is to act as a messenger carrying instructions from DNA for controlling the synthesis of proteins *(in some viruses' RNA carries genetic information instead of DNA)*
- RNA copies of our DNA genes → messages (mRNAs) reflect the sequence of bases in our DNA & travel out of the nucleus into the cytoplasm where they are translated into proteins → proteins go on to do jobs in the cell & the unstable mRNAs simple decay/degraded

Normal cell:

- Cytoplasm
  - Made up of a jelly like fluid (cytosol) and other structures that surround the nucleus
- Cytoskeleton
  - Network of long fibres that make up the cell's structural framework. Critical functions: determining cell shape, cell division & allowing cells to move. Provides a track-like system that directs movement of organelles & other substances within cells
- Endoplasmic reticulum
  - Helps process molecules created by cell. Transports molecules to their specific destinations either inside or outside cell.
- Golgi apparatus
  - Packages molecules processed by endoplasmic reticulum to be transported out of the cell
- Lysosomes & peroxisomes
  - Recycling centre of cell. Digest foreign bacteria that invade the cell, remove waste substances & recycle worn out cell components
- Mitochondria
  - Organelles that convert energy from food into a form that the cell can use. They have own genetic material, separate from the DNA in the nucleus & create copies of themselves
- Nucleus
  - Serves as cell's command centre, sending directions to the cell to grow, mature, divide or die. Also stores DNA, the cell's hereditary material. Nucleus is surrounded by a membrane called the nuclear envelope which protects the DNA & separates the nucleus from the rest of the cell
- Plasma membrane
  - Outer lining of the cell. Separates the cell from its environment & allows materials to enter & leave the cell
- Ribosomes
  - Organelles that process the cell's genetic instructions to create proteins. These organelles can float freely in the cytoplasm or be connected to the endoplasmic reticulum.

Describe the processes involved in the biology of cancer

2 main dysfunctions in the process of cancer cells are defective proliferation (growth) & defective cell differentiation.

Defect in cell proliferation

- Proliferation = growth
- Cell proliferation originates in the stem cell & begins when the stem cell enters the cell cycle
- Cell cycle – M phase mitosis which is usually followed by cytokinesis → G1 gap 1 phase the gap between mitosis & initiation of DNA replication. The cell is metabolically active & continuously growing but doesn't replicate its DNA → S phase synthesis where DNA replication takes place → G2 gap 2 phase cell growth continues & proteins are synthesised in preparation for mitosis
- Normally cell growth is only activated when other cells die or if there is a need for more cells (presence of infection)
- Cancer cells usually proliferate at the same rate as normal cells, however they respond differently from normal cells to the intracellular signals that regulate the state of dynamic equilibrium. Difference is that proliferation of cancer cells is indiscriminate & continuous & may produce more than 2 cells at the time of mitosis (pyramid effect)

Defect in cell differentiation

- Normally an orderly process that progresses from a state of immaturity to a state of maturity
- All cells can perform all functions – however as cells differentiate this potential is repressed, & the mature cell is only able to perform specific functions

Genetics

- Cancer involves that malfunction of genes that control proliferation & differentiation. 2 types of genes that can be affected by mutation are proto-oncogenes & tumour supressing genes
  - Proto-oncogenes: regulators of normal cell processes. Promotes growth! Genetic lock that keeps cell in functioning state. When unlocked (through exposure to carcinogens or oncogenic virus), genetic alterations/mutations occur. Mutations can cause these to function as oncogenes (tumour inducing genes). Oncogenes can change a normal cell to a malignant one.
  - Tumour supressing genes: function to regulate cell growth. Suppress growth & prevent cells from going through the cell cycle. Mutations cause them to become inactive, resulting in a loss of their tumour supressing action. *E.g. BRCA 1 & 2*

Differentiate between the phases of cancer development (initiation, promotion, progression, metastasis)

10. Describe the signs and symptoms in a patient with seizure activity
Jerking, loss of consciousness, confusion, paralysis

11. Describe the appropriate nursing assessment and collaborative management of the patient with seizure activity
MRI, CT, EEG, medications – anticonvulsants, nerve stimulation – influencing neurotransmitter release

Week 5

1. Describe the processes involved in the biology of cancer
Dysfunctions in process of cancer cells are defective proliferation & defective cell differentiation
Cell proliferation – growth – can produce more than 2 cells at the same time of mitosis (normally cell growth occurs only when cells die or there's a need for more cells e.g. Infection)
Cell differentiation – not all cells mature – therefore can't perform all functions

2. Differentiate between the phases of cancer development (initiation, promotion, progression, metastasis)
Initiation: mutation of cell DNA sequence
Promotion: reversible proliferation of altered cells – can be fixed/changed (change diet/stop smoking)
Progression: increased growth rate of tumour & increased invasiveness
Metastasis: rapid growth of primary tumour – spreads to different site of body – tumour creates its own blood vessels, cells can detach from tumour and travel other vascular/lymph vessels

3. State the classification systems used for grading cancer
Histological grading: assesses abnormal cells based on degree to which they resemble the tissue of origin
   → Grade I: cells differ slightly from normal cells – mild dysplasia – well differentiated – low grade
   → Grade II: cell more abnormal – moderate dysplasia – moderately differentiated – intermediate grade
   → Grade III: cells are very abnormal – severe dysplasia – poorly differentiated – high grade
   → Grade IV: immature/primitive – anaplasia – undifferentiated – origin hard to determine – high grade
   → Grade X: grade can't be assessed

TNM classification: only used for solid tumours
   → T: tissue – size & extent of main/primary tumour
   → N: node – number of nearby lymph nodes that have cancer
   → M: metastasis – where cancer has metastasised

4. Explain the pathophysiology of different types of cancer, including solid tumours such as breast and prostate; and **haematological cancer including leukaemia's**
Solid tumours: abnormal mass of tissue with no cysts/liquid areas - 2 distinct parts parenchyma & stroma
   - Breast & Prostate

Haematological: starts in bone marrow (where blood produced) normal development f RBC/WBC/platelets is interrupted by uncontrolled growth of abnormal blood cells.
   - Leukaemia: cancer found in blood/bone marrow – caused by rapid production of abnormal WBC – can't fight infection & impair bone marrow to produce RBC & platelets

5. Describe the effects that cancer has on the body in each system
CNS: increased ICP, neuropathy, memory loss, fatigue, confusion
CVS: pericarditis, myocarditis, hypotension
RESP: pneumonia, SOB, cough
GIT: N&V, diarrhoea, constipation, anorexia
REN: cystitis, nephrotoxicity
INTEG: alopecia, rashes, dry skin, sores

6. Describe the nutritional and metabolic alterations in patients with cancer and the nutritional therapy of patients with cancer
Cells of mucosal lining of GI tract are highly proliferative so are sensitive to chemo/radiation causing vomiting/nausea/diarrhoea – damage to GI tract may cause body to not absorb nutrients – weight loss
Also, loss of appetite side effect of chemo/radiation → small/frequent high protein foods better tolerated
Enteral/parental nutrition may be required if food can't be kept down/malnourished

7. Explain the role of the nurse in the prevention and screening for early detection of cancer
Educating on early detection, reducing exposure to carcinogens,
Balanced diet, limiting alcohol, exercise, healthy weight, eliminating stressors
Practicing self-examination, knowing warning signs, reducing risks such as smoking etc.

8. Explain the use of surgery, chemotherapy, radiation therapy, and biological and targeted therapy in the treatment of cancer and the effects of each on different body systems and normal tissues
Surgery: remove cancer & as much of surrounding tissue as possible