MINISTRY OF HEALTH OF UKRAINE
NATIONAL O.O. BOHOMOLETS MEDICAL UNIVERSITY
DEPARTMENT OF PEDIATRICS №2

GUIDELINES
to practical (seminar) classes
FOR STUDENTS

Educational discipline Propaedeutic Pediatrics
Discipline "Health care"
Specialty 222 "Medicine"
Department of Pediatrics No. 2

Approved on methodic meeting of department of pediatrics №2 from «28» august 2023., protocol №1

Considered and approved: CMC on pediatric disciplines from «28» august 2023., protocol №1

Lesson topic: Anatomical and physiological features of the respiratory organs, methods of clinical examination of the respiratory organs in children.

Competencies: (formulation of competencies):
To kow the anatomical and physiological features of the organs of the respiratory system at different age periods of a child's life and their clinical significance
To be able to conduct a clinical examination of children of different ages and evaluate the obtained data
Ability to abstract thinking, analysis and synthesis
Ability to learn and master modern knowledge
Knowledge and understanding of the subject area and understanding of professional activity when working with children of different ages and with diseases of the respiratory system in children.
The ability to make informed decisions when studying propaedeutics of pediatrics.
Ability to evaluate the data of clinical examination of the respiratory system in children of different ages.
The ability to analyze the leading symptoms and syndromes of diseases of the respiratory system in children of different ages.
Ability to evaluate the results of laboratory and instrumental methods of examination in diseases of the respiratory system in children of various ages.
The ability to diagnose emergency conditions based on clinical signs of damage to the respiratory system in children.

Purpose: 1. To lay the foundations of knowledge on the peculiarities of the development and formation of the respiratory system in children, its anatomical and physiological features in children of different ages.
2. To determine directions of formation of skills of clinical interpretation of objective examination, analysis of symptoms and syndromes in respiratory system lesions and assessment of results of laboratory and instrumental examination methods in diseases of this system in children of different ages.
Equipment - textbook, computer, mannequin, phonendoscope, spatula.

Lesson plan and organizational structure

Name of the stage	Description of the stage	Learning levels	Time
Preparatory stage	Organizational measures	*	10
The main stage	Test control on the subject of the lesson, checking and announcing the results. - theoretical survey; - clarification of the most important points regarding the application of various methods of assessing children's respiratory system; - students' work on acquiring skills for assessing the physical development of children of different ages; - acquisition by students of the skills of providing recommendations to parents of children with physical development disorders. Solving problems according to the subject of the lesson	** *, **, *** **, ***	20 55 20

The final stage	Analysis and assessment of student work results. Announcement of the topic of the next lesson, an indicative map for independent work with literature.	*	10
	Разом 2,5 академічних години		**115**

* Introductory, **reproducible, *** reconstructive, **** creative learning levels.

Literature:

1. Jan E Drutz. The pediatric physical examination: HEENT. 2021. UpToDate- online recourse. 2022. https://www.uptodate.com/contents/the-pediatric-physical-examination-heent

2. Nelson Textbook of Pediatrics, 21th Edition, 2019 by ROBERT M.KLIEGMAN, NATHAN J. BLUM, SAMIR S. SHAH, JOSEPH W. ST GEME III, ROBERT C. TASKER, KAREN M. WILSON, RICHARD E. BEHRMAN, P. pp. 2150-2166

3. Jan E Drutz. The pediatric physical examination: Chest and abdomen UpToDate- online recourse. 2022 https://www.uptodate.com/contents/the-pediatric-physical-examination-chest-and-abdomen

4. KatilovAV, Dmitriev DV, Dmitrieva KY, Makarov S.Yu. Clinical examination of the child - 2 nd ed. - Vinnitsa: New Book, 2019. - 520 p. стор. 116-170.

The respiratory system serves to supply sufficient oxygen to meet metabolic demands and remove carbon dioxide. Abnormalities in any of the multiple processes (including ventilation, perfusion, and diffusion) that are involved in tissue oxygenation and carbon dioxide removal can lead to respiratory failure. The pathophysiologic manifestations of respiratory disease processes are profoundly influenced by age- and growth-dependent changes in the physiology and anatomy of the respiratory control mechanisms, airway dynamics, and lung parenchymal characteristics. Smaller airways, a more compliant chest wall, and poor hypoxic drive render a younger infant more vulnerable compared to an older child with similar severity of disease
Anatomical and physiological features of the nasal cavity in children:
1. Up to 6-8 months of age, breathing is carried out only through nose

2. Relatively narrow and dry.

3. Insufficient development of the cavernous part of the submucosa.

4. Lack of the lower nasal passage up to about 4 years old.

The newborn has cells of the ethmoid sinuses and maxillary sinuses. It is believed that ethmoid sinuses may be involved from 6 months of age, and the maxillary are pneumatized by 2 years. The sphenoid sinus is formed usually by the age of 5, the frontal sinuses begin to form at the age of 7-8.

Anatomical and physiological features of the pharynx in children:
1. Relatively small and narrow.

2. The lymphoid hyperplasia

3. The auditory tubes are wide, straight, short and horizontal

Hyperplasia of lymphoid tissue on the posterior wall of the pharynx in children determines the possibility of the development of a pharyngeal abscess, and hyperplasia of the adenoid, tubal and palatine tonsils often contributes to violation of nasal breathing and resonance of the voice, as well as frequent otitis media. Approximately at 7-10 years old auditory tube location becomes similar as in adults, which causes a lower prevalence of otitis media in older children.
The larynx in children is different from such in adults:
1. Has a funnel shape (in adults it is cylindrical).

2. Located higher, at the level of the 4th cervical vertebra (in adults — 6th).

3. The glottis is relatively narrow.

4. The vocal cords are loose.

5. There is lymphoid tissue in the ligamentous space.

Lymphoid tissue and loose submucous layer in the subglottic space explains the possibility of stenosing laryngotracheitis (false croup) and persists in children up to 5-7 years old.

In addition, the lymphoid tissue of the subglottic space causes a high incidence of post-intubation stenosis of the larynx compared to adults.

The lower airways begin at the 5-6th tracheal ring. Quantity of cartilaginous semirings of the trachea is constant (16-20) and does not change with age. Insufficient development of cartilage tissue promotes significant prolapse of the tracheal walls inward during breathing. The walls of the trachea in children are soft and easily can be squeezed. In adults, bifurcation of trachea is located at the level of IV-V thoracic vertebrae, in children – III- IV thoracic vertebrae.
On the front surface of the chest cells have the following topographic landmarks:

1. The first intercostal space is located directly below the clavicle and I ribs.

2. The angle between the handle and the body of the sternum (Louis' angle) corresponds to the place of attachment of the II rib.

3. The lower borders of the lungs are crossed along the mid-clavicular line - VI rib and along the middle axillary — VIII rib.
Topographic landmarks on back of the chest are the spinous processes cervical and thoracic vertebrae, as well blade angles:

1. The upper borders of the lungs are located approximately at the level of the spine of the VII cervical vertebra.

2. The lower borders pass almost horizontally at the level of the spinous from the X thoracic vertebra.

3. Borders between top and bottom lobes of the lung from behind pass along the line connecting the III edge (along paravertebral line), which is located just above spinous process of the third thoracic vertebra, and the VII rib corresponding to the angles of the scapula.

4. The angle of the scapula is in the seventh intercostal space.

Pathophysiological features of respiratory organs in children:

1. The relative narrowness of the lumen of the respiratory tract.

2. Imperfect mechanisms of mucociliary clearance.

3. Insufficient development of the cartilaginous framework of the trachea and bronchi.

4. High frequency of aspiration.

5. High frequency of obstruction of the auditory tube.

6. Propensity to develop bronchoobstructive syndrome.

HISTORY

The history begins with a narrative provided by the parent/caretaker with input from the patient. The history should include questions about respiratory symptoms (dyspnea, cough, pain, wheezing, snoring, apnea, cyanosis), chronicity, timing during day or night, and associations with activities including exercise or food intake. The respiratory system interacts with a number of other systems, and questions related to cardiac, gastrointestinal, central nervous, hematologic, and immune systems may be relevant. Questions related to gastrointestinal reflux, congenital abnormalities (airway anomalies, ciliary dyskinesia), or immune status may be important in a patient with repeated pneumonia. The family history is essential and should include inquiries about siblings and other close relatives with similar symptoms or any chronic disease with respiratory components.

Complaints, specific for respiratory diseases:

- Nasal congestion, runny nose, sneezing, cough, voice change, shortness of breath, chest pain, hemoptysis.

- General symptoms include fever, weakness, decreased appetite.

- Rhinitis assessment parameters:

1. Acute (lasting up to a month) or chronic (more than 1 month).

2. Amount of discharge (slight, moderate and abundant).

3. The nature and color of the discharge (mucus or purulent).

4. The presence of pathological impurities (for example, blood).

5. Allocations are observed from one or both nasal passages.

Considering that children in the first 6-8 months of life breathe exclusively through their nose, the presence of any rhinitis leads to anxiety and refusal to eat. This is due to the fact that the child's epiglottis is in direct contact with the soft palate, which makes mouth breathing possible only at the moment of a cry.

Rhinorrhea from both nasal passages is a prerequisite for rhinitis of any etiology (infectious, allergic rhinitis), and unilateral rhinitis characteristic of a foreign body.

The most common causes of nasal obstruction are: swelling of the nasal mucosa, polyps in the nose, curvature of the septum and foreign bodies.

Symptoms that increase the likelihood of bacterial infection in respiratory diseases:

1. Febrile fever for 3 consecutive days with the presence of symptoms of damage to the respiratory tract.

2. Febrile temperature during the day in combination with tachypnea, not appropriate for the fever.

3. Repeated febrile increase in body temperature and higher on the background of respiratory infection.

Cough is assessed by the following parameters:
1. Type of cough (dry, wet).

2. Frequency (rare, frequent, debilitating).

3. Duration (acute, subacute, chronic).

4. Character (superficial or deep).

5. Intensity during the day (day, night).

6. Relationship of cough with vomiting.

7. The presence of pain in the chest with coughing.

8. Communication with a certain position of the body.

9. Connection with physical activity.

Physiological cough is often observed in children 2-5 months of life due to the onset of active work of the salivary glands.

Clinical features of cough in bronchoobstructive syndrome:
1. Cough dry or slightly productive (profuse sputum not typical).

2. Characterized by the presence of nocturnal or morning cough.

3. Chronic cough along the course.

4. Worsening of cough during physical activity.

Clinical features of cough with postnasal drip syndrome:
1. The cough is wet, unproductive or productive.

2. Presence of nasal congestion.

3. Increased cough in the horizontal position.

4. Periodically vomiting occurs in the morning on the background of cough.

Clinical features of cough with whooping cough:
1. Duration of cough 3 weeks -2 months.

2. Paroxysmal cough with reprisals-whoops.

3. The presence of repeated vomiting on background of cough.

4. Facial hyperemia and lacrimation with bouts of coughing.

5. Tilting the head forward with a cough.

6. Discharge of "vitreous" wetness at the end of a coughing attack (in classic cases).

The inspection includes an assessment of the following parameters:
1. The degree of impairment of consciousness.

2. Physical development of the patient and appropriateness to age.

3. Psychomotor development.

4. Constitutional body type.

5. Motor activity of the child.

6. Skin color and visible mucous membranes.

7. Respiration characteristics (frequency, amplitude and rhythm).

8. The presence or absence of clinical symptoms of dyspnea.

9. Signs of chronic damage of respiratory tract ("drumsticks ", chest deformity, emphysematous chest).

10. Signs of pain.

PHYSICAL EXAMINATION
Examination of the nose is conducted with the patient's head tilted back in a sniffing position and the clinician sitting directly opposite. The shape, size, and position of the nose should be noted. Inspection of internal structures is done using a bright light source and nasal speculum or, for the smaller child, an ear speculum. To reduce patient discomfort and steady the head, the examiner should position the outer ulnar aspect of the hand not holding an instrument against the patient's forehead; the thumb of that hand is used to elevate the tip of the nose. This procedure allows for optimal visualization of each vestibule, the nasal turbinates, septum, and mucosal surfaces.
Normally, the mucosal surfaces are pink, and the vestibules are patent and easily visible to the level of the middle turbinates. The septum should be in the midline, although a slight deviation is acceptable. Transient septal deformity secondary to in utero positioning may be noted in the newborn. The differential diagnosis of septal perforation includes infectious diseases, inhaled drugs (particularly cocaine), and traumatic injury. Swelling, bleeding, abnormal lesions, and types of secretions should be noted.
Nasal discharge
●Thin serous or watery nasal discharge may be seen in patients with allergic rhinitis or a viral upper respiratory tract infection (URI).
●An almost crystal-clear nasal discharge can occur with leaking cerebral spinal fluid
●A more viscous nasal discharge may occur during the latter stages of a viral URI.
●Thick purulent nasal discharge is typical of a viral or bacterial infection involving the nasopharynx or sinuses.
●An impacted foreign body should be suspected in the patient with unilateral, malodorous, purulent nasal discharge.
Epistaxis

Nasal obstruction — If a newborn has an apparent nasal obstruction, the examiner should rule out the possibility of choanal atresia by attempting to pass a small-gauge feeding tube or French catheter through each nasal passageway.
Occluded nasal passageways caused by boggy nasal mucosa may develop as a result of allergies, vasomotor rhinitis, or overuse of nasal decongestants.
Nasal polyps caused by allergies or associated with cystic fibrosis may cause unilateral or bilateral nasal obstruction.
Adenoidal enlargement can obstruct the nasopharynx, making nasal breathing difficult and creating the typical open-mouth adenoid facies.
Tonsils
Visualization of the palatine tonsils generally is not possible until the child is six to nine months old. Once fully developed, the tonsils remain enlarged throughout childhood. Removal is not necessary unless they become a nidus of significant recurrent infection or are enlarged enough to obstruct normal breathing.
Enlarged tonsils with exudate may be caused by bacterial infection of the throat and tonsils with group A beta-hemolytic Streptococcus and other infectious agents (eg, diphtheria, Epstein-Barr virus).
Tonsillar crypts can harbor bacteria. Calcified concretions of bacteria, mucus, and other debris may form within the crypts and are called tonsilloliths. Tonsilloliths may have a foul smell and can contribute to bad breath.
Tonsillar asymmetry or unilateral tonsillar enlargement may be caused by infection, chronic inflammatory process, or neoplasm (particularly lymphoma).
Pharynx
Examination of the pharynx usually requires visualization only. Pharyngitis is suggested by erythema and/or pharyngeal adenopathy (cobblestoning). It can be caused by viral, bacterial, or fungal disease; by a chemical irritant; or by a complication of some other condition. Soft tissue lesions and foreign body injuries should be noted.

Respiratory dysfunction usually produces detectable alterations in the pattern of breathing. Values for normal respiratory rates depend on many factors, most importantly, age. Repeated respiratory rate measurements are necessary because respiratory rates, especially in the young, are exquisitely sensitive to extraneous stimuli. Sleeping respiratory rates are more reproducible in infants than those obtained during feeding or activity. These rates vary among infants but average 40-50 breaths/min in the 1st few wk of life and usually <60 breaths/min in the 1st few days of life.
Respiratory control abnormalities can cause the child to breathe at a low rate or periodically. Mechanical abnormalities produce compensatory changes that are generally directed at altering minute ventilation to maintain alveolar ventilation. Decreases in lung compliance require increases in muscular force and breathing rate, leading to variable increases in chest wall retractions and nasal flaring. The respiratory excursions of children with restrictive disease are shallow. An expiratory grunt is common as the child attempts to raise the functional residual capacity (FRC) by closing the glottis at the end of expiration.
Children with obstructive disease might take slower, deeper breaths. When the obstruction is extrathoracic (from the nose to the mid-trachea), inspiration is more prolonged than expiration, and an inspiratory stridor can usually be heard. When the obstruction is intrathoracic, expiration is more prolonged than inspiration, and the patient often has to make use of accessory expiratory muscles. Intrathoracic obstruction results in air trapping and, therefore, a larger residual volume and, perhaps, greater FRC.
Chest wall — The chest examination begins with careful observation and inspection of the chest wall. Normally, the chest is symmetrical and, in the infant or young child, almost round. The transverse diameter increases with age. When a persistently round, barrel-shaped chest is seen in

an older child, the examiner should consider the possibility of an underlying chronic pulmonary disease, such as cystic fibrosis or chronic asthma.
Lung percussion has limited value in small infants because it cannot discriminate between noises originating from tissues that are close to each other. In adolescents and adults, percussion is usually dull in restrictive lung disease, with a pleural effusion, pneumonia, and atelectasis, but it is tympanic in obstructive disease (asthma, pneumothorax).
Auscultation confirms the presence of inspiratory or expiratory prolongation and provides information about the symmetry and quality of air movement. In addition, it often detects abnormal or adventitious sounds such as stridor (a predominant inspiratory monophonic noise), crackles (or rales) (high-pitched, interrupted sounds found during inspiration and more rarely during early expiration, which denote opening of previously closed air spaces), or wheezes (musical, continuous sounds usually caused by the development of turbulent flow in narrow airways).
A periodic sigh is normal in everyone. Shallow, rapid breathing can be seen with anatomical defects, pulmonary infection, pleuritic disease, and metabolic disorders. Slow breathing may occur as a result of central nervous system pathology, metabolic disease, and drug effect. Vigorous exercise, a state of anxiety, and metabolic acidosis may cause deep, rapid breathing. A prolonged expiratory phase occurs in patients with an acute exacerbation of reactive airway disease or true asthma. A sleeping infant may have brief periods of rapid breathing alternating with respiratory pauses.
Thorough auscultation of lung fields in children sometimes is difficult; successful examination frequently depends upon the age of the child. Fear of the examiner and discomfort from illness generally account for the patient's uncooperative behavior. Some of the anxiety may be alleviated if a caregiver holds the child. An experienced clinician, aware of the difficulty of auscultation of a noncompliant, often screaming child, concentrates on the inspiratory phase, as often little will be gained by trying to listen during the expiratory phase.
An organized symmetrical approach to auscultation of the lung fields should be used. Sequential auscultatory examination proceeds from one side of the chest to the other, comparing breath sounds in anatomically similar areas. Either the bell or the diaphragm of the stethoscope may be used, depending upon the size of the child; the diaphragm is more appropriate for listening to the lungs of larger patients.
The sounds produced by breathing may help localize a particular area of involvement or specific pathologic condition. Ordinarily, deep mouth breathing produces clear, soft breath sounds over the lungs. Atypical breath sounds in the form of crackles, rhonchi, or wheezes are heard most often in patients with underlying pulmonary disease. Upper airway congestion in small children often produces coarse sounds that, when transmitted through the larger airways, may give the impression of an underlying lung abnormality. Frequently, coughing and/or vigorous crying will clear a congested upper airway, helping the clinician distinguish between upper and lower airway sounds.
In small children, an inspiratory high-pitched stridorous sound with or without significant respiratory distress may be the result of narrowing at or near the larynx or anywhere along the trachea. This condition can be caused by a croup-like illness, anatomical defect, mass lesion, foreign body, or external obstruction. Patients in severe respiratory distress with stridor may have epiglottitis or croup.
When absent or decreased breath sounds are heard over a particular lung area, spoken words may sound muffled or the letter E may sound more like an A (egophony), especially in a child with a segmental or lobar consolidation. Fairly well-localized squeaky crackles during respiration may be caused by a pleural friction rub.
Digital clubbing is a sign of chronic hypoxia and chronic lung disease but may be a result of nonpulmonary etiologies.

3. Questions for the lesson

1. Name the anatomical and physiological features of the nose and paranasal sinuses in children.
2. Name the anatomical and physiological features of the pharynx and larynx in children.
3. Name the anatomical and physiological features of the trachea in children.
4. Name the anatomical and physiological features of the bronchi in children.
5. Name the anatomical and physiological features of the lungs in children.
6. Name the anatomical and physiological features of the chest in children.
7. Types of percussion of lungs in children.
8. The sequence of percussion of lungs in children.
9. Standard types of sounds obtained by percussion.
10. Assessment of percussion note
11. The main rules of auscultation of lungs in children.
12. The technique of auscultation of lungs in children.
13. Standard types of sounds obtained by auscultation.
14. Assessment of auscultation
15. Normal breath sounds.
16. Bronchial breathing
17. Causes of bronchial breath sounds
18. Causes of diminished vesicular sound
19. Additional sounds: crackles, wheeze, pleural friction rub.
20. Causes of crackles
21.The differential diagnosis of crepitation and pleural friction rub.

Recommended literature.

Basic:

Nelson textbook 21th Edition by Robert M. Kliegman, MD, Joseph St. Geme, Nathan J. Blum, Samair S. Shan, Robert C. Tasker, Karen M. Wilson, Richard E. Behrman Видавництво: Elsevier, 2019. P. 3693-3704.

Additional:

1. Fundamentals of pediatrics according to Nelson. Karen J. Marcdante, Robert M. Kligman; translation of the 8th Eng. edition in 2 volumes. Scientific editors of the translation V.S. Berezenko, T.V. Rest Kyiv: VSV "Medicine", 2020.

2. Katilov O.V., Dmitriev D.V., Dmitrieva K.Yu., Makarov S.Yu. Clinical examination of a child. 2nd edition. Vinnytsia: Nova Kniga, 2019. 520 p.

3. Pediatrics: textbook. T.O. Kryuchko, O.Y. Abaturov, T.V. Kushnereva et al.ed. by T.O. Kryuchko, O.Y. Abaturov. Kyiv: AUS Medicine Publishing, 2016. 208 p. (p.39-49) ISBN 978-617-505-485-7.

The methodical guideline for practical class was made by assoc.pr. Mozyrska O.V.