

MINISTRY OF HEALTH PROTECTION OF UKRAINE
ODESSA NATIONAL MEDICAL UNIVERSITY

Department of occupational pathology and functional diagnostics

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«APPROVED»



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Vice rector for scientific and pedagogical work
Eduard BURIACHKIVSKYI
" 14 " September 2023

**WORKING PROGRAM OF ELECTIVE DISCIPLINE
" FUNDAMENTALS OF ULTRASONIC DOPPLERGRAPHY "**

Level of higher education: second (master's)

Field of knowledge: 22 "Health care"


Specialty: 222 "Medicine"

Educational and professional program: Medicine


The working program is compiled on the basis of the educational and professional program "Medicine" for the training of specialists of the second (masters) level of higher education in the specialty 222 "Medicine" of the field of knowledge 22 "Health care", approved by the Scientific Council of the Odessa National Medical University (protocol No. 9 of " June 29, 2023).

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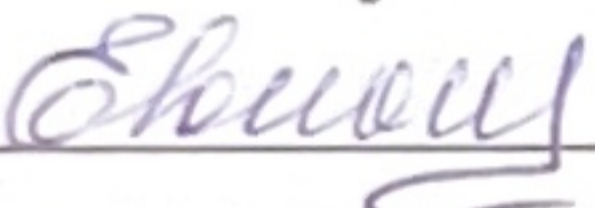
The working program is approved at the meeting of the department of occupational pathology and functional diagnostics, Minutes No.1 dated August 30, 2023.

Head of the department  Oleksandr IGNATIEV

Approved by the guarantor of the

Educational and professional program  Valerya MARICHEREDA

Approved by the subject-cycle commission for therapeutic disciplines of ONMedU, Minutes No.1 dated August 31, 2023.

Head of the subject-cycle commission for therapeutic disciplines of ONMedU
 Olena VOLOSHYNA

occupational diseases and functional diagnostics and plithisiopulmonology
Revised and approved at the meeting of the department, Minutes No.1 from "04_09 2023_.

Head of Department  Oleksandr IGNATIEV

Revised and approved at the meeting of the department, Minutes N_ from " _ " 202_.

Head of Department _____

1. Description of the academic discipline

Name indicators	Field of knowledge, specialty, specialization, higher level education	Characteristics of the educational disciplines
The total number of: Credits: 3.0 Hours: 90 Content modules: 5	Branch of knowledge 22 "Health care" Specialty 222 "Medicine" Level of higher education second (master's)	<i>Full-time education</i> <i>Elective discipline</i>
		<i>Year of training: 5</i>
		<i>Semesters IX-X</i>
		<i>Lectures (0 hours)</i>
		<i>Seminars (0 hours)</i>
		<i>Practical (30 hours)</i>
		<i>Laboratory (0 hours)</i>
		<i>Independent work (60 hours) including individual tasks (0 hours)</i>
		<i>Final control-test</i>

2. The purpose and tasks of the educational discipline, competences, program learning outcomes.

Purpose: Acquisition of theoretical and practical knowledge by a seekers of higher education, formation of elements of professional competences from the basics of ultrasound dopplerography, improvement of skills and competences acquired during the study of previous disciplines.

Task:

- acquiring the required amount of modern knowledge on:

- 1) history of the emergence and development of dopplerography;
- 2) organization of the ultrasound diagnostic service for conducting dopplerographic studies;
- 3) topographic anatomy of a person - in relation to the specifics of ultrasound research being conducted;

- 4) normal and pathological physiology of the studied organs and systems;
- 5) the physical principles of the Doppler research method and the mechanisms of the biological effect of ultrasound;
- 6) features of the equipment used for ultrasound examinations;
- 7) analyze the regularities of the functioning of the vascular system, use the knowledge of anatomical and physiological bases, the main methods of clinical examination and assessment of the functional state of the patient's body for timely diagnosis;
- 8) to detect the main pathological signs of diseases of the vascular system in patients with the help of ultrasound examination, to use the diagnosis algorithm (main, secondary, complications);
- 9) before making an instrumental diagnosis based on an ultrasound diagnostic study.
- 10) modern methods of ultrasound diagnostics; mastering the basic, additional and special methods of ultrasound examination of vessels, improving the skills of analyzing sonograms, drawing up ultrasound examination protocols.
- 11) methods of quality control of ultrasound studies;

- The process of studying the discipline is aimed at forming elements of the following **competencies**:
- **General (GC):**
- GC1. Ability to abstract thinking, analysis and synthesis
- GC3. Ability to apply knowledge in practical situations
- GC4. Knowledge and understanding of the subject area and understanding of professional activity
- GC 6. Ability to make informed decisions
- GC 7. Ability to work in a team
- GC 8. Ability to interpersonal interaction
- GC 10. Ability to use information and communication technologies
- GC 11. Ability to search, process and analyze information from various sources
- GC 12. Determination and persistence in relation to assigned tasks and assumed responsibilities
- GC 16. The ability to evaluate and ensure the quality of the work performed.

Special competences (SC):

- SC1. Ability to collect medical information about the patient and analyze clinical data

- SC2. Ability to determine the necessary list of laboratory and instrumental studies and evaluate their results
- SC3. Ability to establish a preliminary and clinical diagnosis of the disease
- SC4. The ability to determine the necessary regime of work and rest in the treatment and prevention of diseases
- SC6. Ability to determine the principles and nature of treatment and prevention of diseases
- SC7. Ability to diagnose emergency conditions
- SC8. Ability to determine tactics and provide emergency medical care
- SC10. Ability to perform medical manipulations
- SC13. Ability to carry out sanitary and hygienic and preventive measures
- SC16. Ability to maintain medical documentation, including electronic forms
- SC 25. Adherence to professional and academic integrity, to be responsible for the reliability of the obtained scientific results
- SC26. The ability to determine the management tactics of persons subject to dispensary supervision

Program learning outcomes (PLO):

- PLO 1.** Have thorough knowledge of the structure of professional activity. To be able to carry out professional activities that require updating and integration of knowledge. To be responsible for professional development, the ability for further professional training with a high level of autonomy.
- PLO 2.** Understanding and knowledge of basic and clinical biomedical sciences, at a level sufficient for solving professional tasks in the field of health care.
- PLO 3.** Specialized conceptual knowledge that includes scientific achievements in the field of health care and is the basis for conducting research, critical understanding of problems in the field of medicine and related interdisciplinary problems.
- PLO 4.** Identify and identify leading clinical symptoms and syndromes (according to list 1); according to standard methods, using preliminary data of the patient's history, data of the patient's examination, knowledge about the person, his organs and systems, establish a preliminary clinical diagnosis of the disease (according to list 2).
- PLO 5.** Collect complaints, anamnesis of life and diseases, evaluate the psychomotor and physical development of the patient, the state of organs and systems of the body, based on the results of laboratory and instrumental studies, evaluate information about the diagnosis (according to list 4), taking into account the age of the patient.
- PLO 6.** Establish the final clinical diagnosis by making a reasoned decision and

analyzing the received subjective and objective data of clinical, additional examination, differential diagnosis, observing the relevant ethical and legal norms, under the control of the managing physician in the conditions of the health care institution (according to the list 2).

PLO 7. Assign and analyze additional (mandatory and optional) examination methods (laboratory, functional and/or instrumental) (according to list 4), patients with diseases of organs and body systems for differential diagnosis of diseases (according to list 2).

PLO 14. Determine tactics and provide emergency medical care in emergency situations (according to list 3) in limited time in accordance with existing clinical protocols and treatment standards.

PLO 17. Perform medical manipulations (according to list 5) in the conditions of a medical institution, at home or at work based on a previous clinical diagnosis and/or indicators of the patient's condition by making a reasoned decision, observing the relevant ethical and legal norms.

PLO 21. Search for the necessary information in the professional literature and databases of other sources, analyze, evaluate and apply this information.

PLO 25. It is clear and unambiguous to convey one's own knowledge, conclusions and arguments on health care problems and related issues to specialists and non-specialists.

PLO 27. Communicate freely in the state language and in English, both orally and in writing to discuss professional activities, research and projects.

As a result of studying the academic discipline, a seekers of higher education should **know:**

- physical basis of obtaining the Doppler spectrum;
- main characteristics of the Doppler spectrum;
- the dependence of the determined velocity of the blood flow on the angle between the ultrasonic beams and the direction of the blood flow in the vessel;
- spectrum of Doppler techniques;
- formation of color Doppler mapping;
- advantages and disadvantages of different modes of dopplerography;
- main characteristics of the Doppler spectrum;
- artifacts during the Doppler study;
- indications for ultrasound of arteries and veins;
- criteria for the main vascular diseases of the brain, neck, upper and lower extremities;

- ultrasound anatomy of brachiocephalic arteries, arteries and veins of upper and lower extremities, abdominal aorta;
- characteristics of unchanged spectrum of blood flow in brachiocephalic arteries, arteries and veins of upper and lower extremities, abdominal aorta;;
- classification of atherosclerotic plaques;
- criteria for subclavian theft syndrome
- criteria for the failure of valves of the veins of the lower extremities;
- levels of collateral circulation;

be able:

- evaluate the echogenicity and structure of atherosclerotic plaques;
- choose an ultrasonic sensor frequency adequate to the research task;
- detect ultrasound image artifacts;
- choose a dopplerography mode adequate to the research task;
- detect distortion of the Doppler spectrum;
- to correct the angle during the spectral examination of the vessel;
- determine the degree of flow turbulence;
- assess the degree of blood flow resistance in the vessel;
- to determine the presence of arterial stenosis and its degree on the ultrasound picture;
- assess the condition of the vascular wall;
- evaluate the data of compression tests;
- determine ultrasound criteria of stenoses of various degrees;
- to differentiate the main extracranial vessels, main vessels of the upper and lower extremities, abdominal aorta and their branches;
- determine the pathological tortuosity of vessels and its shape;
- determine the indications for transcranial examination of the vessels of the brain, arteries and veins of the lower extremities;
- choose an ultrasound approach for the study of cerebral vessels;
- evaluate the effectiveness of collateral blood circulation;

3. Content of the optional discipline "Fundamentals of Doppler ultrasound"

Content module 1. Physical foundations of dopplerography

Topic 1. General issues of dopplerography

Doppler effect. The basic formula of dopplerography. Dependence on the angle between the direction of blood flow and the ultrasound beam. Angle correction. Basic characteristics of the Doppler spectrum. Pulse and continuous-wave modes of recording the Doppler spectrum. Aliasing is a syndrome. Nyquist limit. Distortion of the spectrum.

Topic 2 Basic laws of hemodynamics.

The driving force of blood flow. Resistance of the circulatory system. Volume of regional blood flow in different organs. Functional classification of vessels. Cross-section of blood vessels and linear velocity of blood flow.

Topic 3. Factors affecting speed indicators and the shape of the spectrum. Resistance to blood flow. Degree of resistance. Resistance indices. Turbulent and laminar blood flow. Formation of turbulent flow.

Content module 2. Duplex (triplex) scanning.

Topic 4. Principles of distinguishing modes in ultrasound dopplerography.

Ultrasound dopplerography (USDG). The concept of duplex scanning. The concept of triplex scanning. Advantages of duplex (triplex) scanning versus ultrasound.

Topic 5. Vessels with high and low resistance, their speed characteristics.

Vessels related to vessels with low peripheral resistance. Vessels related to vessels with high peripheral resistance. Indices of total peripheral resistance. Resistance index. Pulsation index. Doppler identification of vessels with low and high peripheral resistance.

Content module 3. Ultrasound anatomy of vessels of the head and neck, methods of research of vessels of the neck.

Topic 6. Anatomy and ultrasound anatomy of the main arteries and veins of the head and neck

The structure and location of the common, external and internal carotid arteries, vertebral arteries, anterior, middle and posterior cerebral arteries, basilar arteries, jugular and brachiocephalic veins. Relations with adjacent bodies. Features of

hemodynamics. Indications for ultrasound examination of neck vessels, location of extracranial vessels. The main approaches to ultrasound examination of extracranial vessels of the neck. Identification of common, external, internal carotid arteries, vertebral arteries, jugular and brachiocephalic veins, V1 and V2 segments of vertebral arteries. Echo structures of the walls. Main blood flow parameters.

Topic 7. Ultrasound anatomy and diagnosis of arteries of the base of the brain. Ultrasound diagnostics of main arteries and veins of the brain.

Ultrasound anatomy of the relationship of the arteries of the base of the brain with adjacent structures. Indications for ultrasound examination of brain vessels.

Technology of ultrasound examination of brain vessels. Scanning planes during ultrasound examination. Identification of the intracranial part of the internal carotid artery; anterior, middle and posterior cerebral arteries, basilar arteries, intracranial segment of vertebral arteries.

Spectral Doppler study of blood flow in the arteries of the circle of Willis.

Parameters of unchanged blood flow in the arteries and veins of the brain during a spectral Doppler study. Color Doppler study of blood flow in brain vessels.

Parameters of unchanged blood flow in cerebral arteries during color Doppler examination

Topic 8. Study of the venous system of the brain

Structural units of the venous system of the brain (postcapillary venules, cerebral superficial veins and deep, venous sinuses, trunk veins). Sinuses: upper and lower sagittal, direct, lumbar, cavernous, sigmoid. Veins: internal cerebral veins, basal vein (Rosenthal), large cerebral vein (Galena). Internal jugular vein. Characteristics of blood flow in the jugular veins. External jugular vein. Spinal vein. Ophthalmic vein. Examination of jugular veins. Reflux in the jugular vein. Basic Doppler characteristics of the venous system of the brain. Signs of intracranial hypertension. The main causes of venous stasis. Jugular vein thrombus.

Content module 4. Functional tests. Cerebrovascular reactivity. Ultrasound data of the main vascular lesions

Topic 9. Functional tests based on mechanical factor, chemical influence and metabolic mechanism.

The concept of cerebrovascular reactivity. Conducting method.

Parameters of assessment of cerebrovascular reactivity in normal and pathological conditions. The main criteria for vascular damage. Ultrasound diagnosis of anomalies of the development of main arteries and veins of the head and neck in B-mode, PWD-mode, CD-mode, duplex mode and triplex mode. Atherosclerosis and its stages. Ultrasound criteria of non-stenotic and stenotic atherosclerosis. Classification of atherosclerotic plaques. Determining the degree of stenosis during B-mode examination. Anomalies of development. Aneurysm Deformations.

Arteriovenous shunts. Carotid sinus tumors. Vasculitis Traumatic injury. Dissection of arteries. Components of dopplerographic assessment of blood flow changes. A change in the spectrum of blood flow in stenosis, aneurysm of a vessel. Dependence of linear and volumetric velocity of blood flow on the degree of stenosis. Factors influencing the hemodynamic significance of stenosis. Scheme of changes in the blood flow velocity profile in different sections of the artery with hemodynamically insignificant and hemodynamically significant stenosis. Spectrum of blood flow at different percentages of stenosis. Subtotal stenosis. Occlusion. Spectrum of blood flow at bends of vessels. Blood flow during arteriovenous shunting. Blood flow in aneurysms. Spectrum during compression of blood vessels. Assessment of blood flow compensation disorders.

Topic 10. Violations of hemodynamics in extracranial vessels

Indications for the study of brachiocephalic arteries. Ischemic symptoms in the ICA pool. Ischemic symptoms in the XA pool. The most frequent localization of atherosclerotic lesions. Stenosis of the CA, CA (various percentages, subtotal stenosis). Occlusion. Collateral blood flow in severe stenoses and occlusions. Spinal-subclavian table-syndrome (initial, transient, full). Test with reactive hyperemia. Stenosis and occlusion of the brachiocephalic trunk. Arterial changes in arterial hypertension. Deformation of the vessels of the aortic arch. Disruption of blood flow during extravasal compression. Osteochondrosis of the cervical spine.

Topic 11. Violations of hemodynamics in transcerebral vessels.

Spectral Doppler study of blood flow in intracranial vessels. Circle of Willis. Vascular diseases of the brain. Pathogenesis and nature of cerebral circulation disorders. Pathogenetic variants of ischemic stroke. Stages of compensation of cerebral blood flow disorders. Autoregulation of cerebral blood circulation. Basic parameters of assessment of blood flow through intracranial arteries. Normative indicators of cerebral arteries.

Evaluation of the effectiveness of collateral circulation. Criteria of hemodynamically significant stenoses. Arteriovenous malformations. Vasospasm in subarachnoid hemorrhages and criteria of its severity. Diagnosis of microemboli. Monitoring of cerebral blood circulation during thrombolysis.

Content module 5. Duplex examination of the abdominal aorta and its visceral branches, vessels of the limbs

Topic 12. Ultrasound anatomy of the abdominal aorta and its visceral branches.

Duplex scanning technology. Ultrasound diagnosis of diseases of the abdominal part of the aorta using B-mode, TDC and spectral doppler. Pathology of the aorta. Aortic aneurysm. Traumatic injury of the aorta, atherosclerosis of the aorta. Normal

ultrasound anatomy of kidney vessels. Research technology of renal vessels.

Topic 13. Peculiarities of the structure of the vessels of the limbs depending on the function performed

Ultrasound anatomy of trunk arteries and veins of limbs. Research technology. Ultrasound diagnosis of diseases of the arteries of the limbs. Anomalies of development. Atherosclerosis. Aneurysms. Arteriovenous shunts. Vasculitis Injuries

Topic 14. Vascular diseases of the limbs and their ultrasound verification.
Ultrasound diagnosis of diseases of the lower hollow system veins, veins of limbs. thrombosis. Thrombophlebitis, etc.

4. The structure of the academic discipline

Topic name	Number of hours					
	Total	Including				
		Lectures	practical	seminars	laboratories	IWS
Content module 1. Physical foundations of dopplerography						
Topic 1. General issues of dopplerography	6	0	2	0	0	4
Topic 2. Basic laws of hemodynamics.	4	0	2	0	0	2
Topic 3. Factors affecting speed indicators and the shape of the spectrum.	6	0	2	0	0	4
Total by module 1	16	0	6	0	0	10
Content module 2. Duplex (triplex) scanning						
Topic 4. Principles of distinguishing modes in ultrasound dopplerography.	5	0	2	0	0	3
Topic 5. Vessels with high and low resistance, their speed characteristics.	5	0	2	0	0	3
Total by module 2	10	0	4	0	0	6
Content module 3. Ultrasound anatomy of the vessels of the head and neck, methods of researching the vessels of the neck.						
Topic 6. Anatomy and ultrasound anatomy of the main arteries and veins of the head and neck. Indications for	10	0	4	0	0	6

ultrasound examination of neck vessels, location of extracranial vessels.						
Topic 7. Ultrasound anatomy and diagnosis of arteries of the base of the brain. Ultrasound diagnostics of main arteries and veins of the brain.	4	0	2	0	0	2
Topic 8. Study of the venous system of the brain.	6	0	2	0	0	4
Total by module 3	20	0	8	0	0	12
Content module 4. Functional tests. Cerebrovascular reactivity. Ultrasound data of the main vascular lesions.						
Topic 9. Functional tests based on mechanical factor, chemical influence and metabolic mechanism. The main criteria for vascular damage. A change in the spectrum of blood flow in stenosis, aneurysm of a vessel.	16	0	4	0	0	12
Topic 10. Violations of hemodynamics in extracranial vessels	4	0	0	0	0	4
Topic 11. Violations of hemodynamics in transcerebral vessels.	4	0	2	0	0	2
Total by module 4	24	0	6	0	0	18
Content module 5. Duplex examination of the abdominal aorta and its visceral branches, vessels of the limbs						
Topic 12. Ultrasound anatomy of the abdominal aorta and its visceral branches.	8	0	2	0	0	6

Pathology of the aorta.						
Topic 13. Peculiarities of the structure of the vessels of the limbs depending on the function performed. Ultrasound diagnosis of diseases of the arteries of the limbs	8	0	2	0	0	6
Topic 14. Vascular diseases of the limbs and their ultrasound verification	4	0	2	0	0	2
Total by module 5	20	0	6	0	0	14
Total hours	90	0	30	0	0	60

5. Topics of lectures/seminars/practical/laboratory classes

5.1. Lecture classes are not provided.

5.2. Seminar classes are not provided.

5.3. Topics of practical classes

No	Topic	Number of hours
1.	Topic 1. Practical lesson 1. Physical foundations of dopplerography.	2
2.	Topic 2. Practical lesson 2. Physiological aspects of hemodynamics.	2
3.	Topic 3 Practical lesson 3. Modes of dopplerography. Disadvantages and advantages of different modes of dopplerography. Color Doppler mapping. Directed energy doppler.	2
4.	Topic 4. Practical lesson 4. Duplex (triplex) scanning.	2
5.	Topic 5. Practical session 5. Peculiarities of dopplerography of vessels with high and low peripheral resistance. Indices of vascular resistance.	2
6.	Topic 6. Practical lesson 6. Ultrasound anatomy of vessels of the head and neck	2
7.	Topic 7. Practical lesson 7. Techniques for researching vessels of the neck	2
8.	Topic 8. Practical session 8. Ultrasound anatomy of main intracranial arteries and veins of the head.	2
9.	Topic 9. Practical lesson 9. Technology of transcranial duplex scanning of intracranial vessels of the head	2
10.	Topic 10. Practical lesson 10. Functional tests. Cerebrovascular reactivity	2
11.	Topic 11. Practical lesson 11. Ultrasound data of the main vascular lesions.	2
12.	Topic 12. Practical lesson 12. Ultrasound diagnosis of extra- and intracerebral vascular pathologies.	2
13	Topic 13. Practical session 13. Duplex examination of the abdominal aorta of its visceral branches.	2
14	Topic 14. Practical session 14. Ultrasound diagnosis by duplex scanning of vessels of limbs and abdominal trunk.	2
15	Topic 15. Practical lesson 15. Diseases of the vessels of the limbs and their ultrasound verification	2
16	Total hours	30

5.4. Topics of laboratory classes

Laboratory classes are not provided.

6. Independent work of a seekers of higher education

No	Topics for students independent work	Number of hours
1.	Topic 1. Preparation for practical lesson 1	6
2.	Topic 2. Preparation for practical class 2	4
3.	Topic 3. Preparation for practical lesson 3	3
4.	Topic 4. Preparation for practical lesson 4-5	3
5.	Topic 5. Preparation for practical lesson 6-7	3

6.	Topic 7. Preparation for practical class 8	3
7.	Topic 8. Preparation for practical class 9	6
8.	Topic 9. Preparation for practical class 10	3
9.	Topic 10. Preparation for practical lesson 11	9
10.	Topic 11. Preparation for practical lesson 12	6
11.	Topic 12. Preparation for practical class 13-14	6
12.	Topic 13. Preparation for practical class 15	8
	Total hours	60

7. Teaching methods.

Practical class – detailed consideration by a seekers of higher education of individual theoretical provisions and the formation of skills in their practical application through individual implementation.

Independent work: outside classroom work of a seekers of higher education with recommended literature, electronic information resources, independent work with a bank of test tasks.

8. Forms of control and evaluation methods

(including criteria for evaluating learning outcomes)

Current control: oral survey, testing, solution of situational clinical tasks, assessment of activity in class.

Final control: credit

Evaluation of the current educational activity in a practical session:

interviews, solving situational clinical problems, determining the ability to correctly prescribe and interpret the results of an ultrasound doppler examination, justifying a diagnosis based on the analysis of clinical and dopplerographic data.

The structure of the current assessment in the practical session:

1. Evaluation of theoretical knowledge on the subject of the lesson:

- methods: survey, solving a situational clinical problem
- maximum score – 5, minimum score – 3, unsatisfactory score – 2.

2. Control of practical skills:

- the ability to properly treat the patient, prescribe and interpret the results of dopplerographic data, substantiate the diagnosis based on the analysis of clinical and dopplerographic results and auxiliary examination methods.
- maximum score – 5, minimum score – 3, unsatisfactory score – 2;

3. Evaluation of work with the patient on the subject of the lesson:

- methods: assessment of: a) communication skills of communication with the patient,
- b) the correctness of appointment and evaluation of dopplerographic and instrumental studies, c) compliance with the differential diagnosis algorithm, d) substantiation of the clinical diagnosis, e) drawing up a plan for further examination and treatment;
- maximum score – 5, minimum score – 3, unsatisfactory score – 2.

Criteria for current assessment in class:

«5»	A seekers of higher education is fluent in the material, takes an active part in discussing and solving a situational clinical problem, confidently demonstrates practical skills and interpretations of clinical, laboratory and instrumental research data, expresses his opinion on the subject of the class, demonstrates clinical thinking.
«4»	A seekers of higher education has a good command of the material, participates in the discussion and solution of a situational clinical problem, demonstrates practical skills in the interpretation of clinical, laboratory and instrumental research data with some errors, expresses his opinion on the subject of the class, demonstrates clinical thinking.
«3»	A seekers of higher education does not have sufficient knowledge of the material, takes part in the discussion and solution of the situational clinical problem without confidence, demonstrates practical skills during the interpretation of clinical, laboratory and instrumental research data with significant errors.
«2»	A seekers of higher education of higher education does not master the material, does not take part in the discussion and solution of the situational clinical problem, does not demonstrate practical skills in the interpretation of the data of dopplerographic and laboratory research.

Test is given to a seekers of higher education who completed all tasks of the work program of the academic discipline, took an active part in practical classes, completed and defended an individual assignment and has an average current grade of at least 3.0 and has no academic debt.

9. Distribution of points received by the a seekers of higher education.

The obtained average score for the academic discipline for students who have successfully mastered the work program of the academic discipline is converted from a traditional four-point scale to points on a 200-point scale, which is shown in the table: **Conversion table of a traditional assessment into a multi-point scale**

National assessment	Points
«5» (excellent)	185-200
«4» (good)	151-184
«3» (satisfactory)	120-150
«2» (unsatisfactory)	Below 120

A multi-point scale (200-point scale) characterizes the actual success of each seekers of higher education in learning the educational component. The conversion of a traditional assessment into a 200-point assessment is performed by the information and technical department of the University. According to the obtained points on a 200-point scale, the achievements of the applicants are evaluated according to the ECTS rating scale. Further ranking according to the ECTS rating scale evaluates the achievements of a seekers of higher education in the educational component, who are studying in the same course of the same specialty, according to the points they received. The ECTS scale is a relative-comparative rating that establishes a seekers of higher education belonging to the group of the best and worst among the reference group of fellow students (faculty, specialty). An "A" grade on the ECTS scale cannot be equal to an "excellent" grade, and a "B" grade to a "good" grade, etc. When converting from a multi-point scale, the limits of grades "A", "B", "C", "D", "E" on the ECTS scale do not coincide with the limits of grades "5", "4", "3" on the traditional scale. A seekers of higher education who received grades "FX" and "F" ("2") are not included in the list of ranked acquirers. The grade "FX" is awarded to a seekers of higher education who have obtained the minimum number of points for the current learning activity, but who have not passed the final score. A grade of "F" is assigned to a seekers of higher education who have attended all classes in the discipline, but have not received an average score (3.00) for the current academic activity and are not admitted to the final score.

A seekers of higher education who study in one course (one specialty), based on the number of points scored in the discipline, are ranked on the ECTS scale as follows:

Criteria for determining the ECTS assessment

Evaluation of ECTS	Statistical indicator
«A»	is the best 10% of a seekers of higher education
«B»	next 25% of a seekers of higher education
«C»	next 25% of a seekers of higher education
«D»	next 25% of a seekers of higher education
«E»	last 10% of a seekers of higher education

10. Methods of provision.

- Working program of the academic discipline
- Syllabus
- Methodical developments for practical classes
- Methodical recommendations for independent work of a seekers of higher education
- Multimedia presentations

- Situational clinical tasks
- Electronic bank of test tasks by subdivisions of the discipline
- Educational and methodical literature

11. Questions for the final control

1. The main characteristics of the Doppler spectrum;
2. Doppler image artifacts.
3. The main modes of dopplerography.
4. Regulation of the Doppler spectrum.
5. Principles of color Doppler mapping.
6. Characteristics of the spectrum in hemodynamically significant stenosis.
7. Criteria of plaque embologenicity.
8. Basic characteristics of the Doppler spectrum
9. Assessment of vascular bed resistance.
10. Ultrasound diagnosis of bends and aneurysm of vessels.
11. Indications for conducting an ultrasound examination of the vessels of the head and neck, abdominal aorta.
12. Classification of atherosclerotic plaques.
13. Peculiarities of hemodynamics in veins.
14. What is the ultrasound picture "Wings of a seagull"?
15. Doubling of renal arteries, color duplex scanning mode.
16. The plane in which an ultrasound examination of the abdominal part of the trunk is performed.
17. Ultrasound criteria of style syndrome
18. Dopplerographic signs of arteriovenous fistula.
19. Ultrasound examination in vasculitis.
20. Signs of a floating thrombus.
21. Anatomy of the abdominal aorta
22. Assessment of the state of the vascular wall. Definition of the intima-media complex
23. Ultrasound subtypes of abdominal aortic aneurysm (on pathogenesis and localization of the process)

24. Identification of the intracranial part of the internal carotid artery; anterior, middle and posterior cerebral artery, basilar artery.
25. Identification of head and neck veins.
26. Spectral Doppler study of blood flow of main arteries and veins of head and neck.
27. Color Doppler examination of the blood flow of the main arteries and veins of head and neck.
28. Vertebral artery visualization technique. Definition of segments.
29. Examination of the brachiocephalic trunk and subclavian arteries.
30. Advantages and disadvantages of different modes of dopplerography;
31. Characteristics of the unchanged spectrum of blood flow in brachiocephalic arteries;
32. Levels of cerebral collateral circulation;
33. Adjusting the ultrasound device according to the research tasks;
34. Determination of the linear speed of blood flow in different phases of the cycle and the average speed of blood flow in a vessel;
35. Setting parameters of the Doppler spectrum;
36. Measurement of the degree of stenosis by diameter and cross-sectional area of the vessel;
37. Conducting compression tests to determine the source basin blood supply compensation;
38. Determination of reactivity of brain vessels;
39. Definition of valvular insufficiency of veins.
40. Evaluate the echogenicity and structure of atherosclerotic plaques;
41. Angle correction during spectral examination of a vessel;
42. Degree of flow turbulence;
43. Pathological tortuosity of vessels and its shape
44. Indications for examination of the veins of the lower extremities;
45. Assess the effectiveness of collateral blood circulation in the vessels of the lower extremities;
46. The technique of visualization of the valvular apparatus of veins and carrying out the Valsalva test.
47. Classification of veins of the lower extremities

48. What are perforating veins
49. What is the term "Eye of Safena"
50. Anatomical characteristics of the small and large saphenous vein.
51. Ultrasound picture of "Mickey Mouse", what are the anatomical components.
52. Ultrasound criteria for failure of venous valves on the lower extremities.
53. Acute thrombosis of the veins of the lower extremities.
54. Criteria of collateral blood flow in the arteries of the lower and upper extremities.

12. List of recommended literature

Main (basic):

1. Clark's Essential Guide to Clinical Ultrasound: Jan Dodgeon, Gill Harrison: CRC Press. – **2023**. 392 p.
2. Diagnostic Ultrasound, Third Edition Peter R Hoskins, Kevin Martin, Abigail Thrush CRC Press. – **2019**. 400 p
3. Diagnostic Ultrasound, Third Edition Peter R Hoskins, Kevin Martin, Abigail Thrush CRC Press. - **2019**. 400 p
4. Vascular **ULTRASOUND HOW, WHY AND WHEN** Abigail Thrush Timothy Hartshorne Colin Deane Elsevier; 4th edition. – **2022**. 350 p.
5. Vascular Ultrasound. B-Mode, Color Doppler and Duplex Ultrasound, Contrast-Enhanced Ultrasound Kubale, R. — Stiegler, H. — Weskott, H. Editorial Thieme LIBRO IMPRESO. 1ª Edición Julio – **2023**. 574 p.
6. Naritaka H., Ishikawa M., Terao S., Kojima A., Kagami H., Inaba M., Kato S. Ultrasonographic Superb Microvascular Imaging for Emergency Surgery of Intracerebral Hemorrhage. *J. Clin. Neurosci.* **2020**; 75:206–209. doi: 10.1016/j.jocn.2020.03.002.
7. Pellerito J., Polak J.F. Introduction to Vascular Ultrasonography, 7th Ed. Elsevier, **2020**, 882 p.
8. Sharma P, Hegde R, Kulkarni A, Sharma S, Soin P, Kochar PS, et al. Traumatic vertebral artery injury: a review of the screening criteria, imaging spectrum, mimics, and pitfalls. *Pol J Radiol.* - **2019**; 84:e307–18. <https://doi.org/10.5114/pjr.2019.88023>.

Additional:

1. Essentials of Abdomino-Pelvic Sonography: A Handbook for Practitioners
Goyal Routledge: 2018: 296 p
2. Yum S.K., Im S.A., Seo Y.M., Sung I.K. Enlarged subarachnoid space on cranial ultrasound in preterm infants: Neurodevelopmental implication. Sci Rep. 2019; 9(1): 19072.
3. Xiaohong Chen, Jialiang Xu, Yumeng Zhang, Muhui Lin, Hao Wang, Ying Song, Evaluation of hemodynamic characteristics in posterior circulation infarction patients with vertebral artery dominance by color doppler flow imaging and transcranial doppler sonography, International Journal of Neuroscience, 10.1080/00207454.2020.1773820, 131, 11, (1078-1086). 2020.
4. Caterina Kulyk, Chiara Voltan, Marialaura Simonetto, Anna Palmieri, Filippo Farina, Francesca Vodret, Federica Viaro, Claudio Baracchini, Vertebral artery hypoplasia: an innocent lamb or a disguise?, Journal of Neurology, 10.1007/s00415-018-9004-7, 265, 10, (2346-2352). 2018.
5. Nasra K, Osher M. Sonography Vascular Peripheral Arterial Assessment, Protocols, And Interpretation. [Updated 2022 Apr 30]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK570577/>

Electronic information resources:

- Informational and educational environment - info.onmedu
https://info.odmu.edu.ua/chair/occupational_diseases_and_functional_diagnostics/files
- ultrasound.net.ua - Ukrainian portal of ultrasound diagnostics
- <http://moz.gov.ua> – Ministry of Health of Ukraine
- www.ama-assn.org – Американська медична асоціація / American Medical Association
- www.bundesaerztekammer.de – German Medical Association