MINISTRY OF HEALTH OF UKRAINE

ODESSA NATIONAL MEDICAL UNIVERSITY

Department of General and Clinical Pharmacology and Pharmacognosy

APPROVE

Vice-Rector for Scientific and Pedagogical Affairs
works

_____ Eduard BURYACHKIVSKY

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METHODOLOGICAL RECOMMENDATIONS
TO INDEPENDENT WORK OF HIGHER EDUCATION STUDENTS
FROM THE ACADEMIC DISCIPLINE

Academic discipline

Information technology in pharmacy

2025

Approved:

Meeting of the Department of General and Clinical Pharmacology and Pharmacognosy
Odessa National Medical University

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TOPIC

" Database management systems in medicine "

Objective: To have in-depth knowledge of the role and architecture of database management systems (DBMS) in the healthcare and pharmacy sectors. To know the basic terminology of relational databases (normalization, keys, integrity) and the role of SQL in working with medical and pharmacy information systems. To be able to formulate query logic to extract analytical information.

Basic concepts (list of questions):

1. DBMS (Database Management System): Definition, functions and main components.
2. Relational data model: Concepts of table, field, record, primary and foreign keys.
3. Data Integrity Integrity): Principles for ensuring the accuracy and consistency of medical information.
4. Security and confidentiality of medical data: The role of DBMS in protecting Electronic Medical Records (EMR).
5. SQL (Structured Query Language): Main groups of commands (DDL, DML) and their application in pharmaceutical data analysis.

Plan

1. **Theoretical questions:**

   1. MIS architecture and the role of the DBMS: The relationship between the client interface, application server, and database in the functioning of pharmacy and hospital systems.
   2. Database normalization: Explanation of the need for normalization (using the example of eliminating redundancy in data about drugs, manufacturers, and suppliers).
   3. Electronic Health Record (EHR): Structure and management of EHR data using a DBMS.
   4. SQL language for pharmacist-analyst: Using SELECT, WHERE, JOIN commands to generate reports on sales, balances, and expiration dates.

2. **Questions for self-control (list of questions):**

   1. What is a primary key and why should it be unique?
   2. What is the main purpose of the SELECT command in SQL?
   3. Give examples of non-relational DBMSs and their applications in medicine.
   4. How does the DBMS ensure referential integrity between the "Medicines" and "Sales"

tables?

5. State what "Second Normal Form" is in the context of a pharmacy database.

3. Tasks for independent study of the material :

Practical work / individual tasks:

Task: The student needs to formulate the logic of an SQL query (SELECT, FROM, WHERE, ORDER BY commands and a conditional JOIN) to extract specific data from a conditional pharmacy database consisting of three tables (Medicines, Sales, Patients).

No.	Product Name/Manufacturer/Condition	Search and Filtering Conditions	Query Type (Logic)
1	The medicine "Aspirin"	Sales for the last week, quantity > 50 packages.	SELECT ... WHERE ... AND ...
2	Manufacturer "Darnitsa"	Medicines that have **Contraindications** "For pregnant women" (conditional field).	SELECT ... WHERE ...
3	Active ingredient " Ibuprofen "	Sales made to customers **under 18 years of age** .	SELECT ... JOIN ... WHERE ...
4	The medicine "No -shpa "	Display **the Name** and **Expiration Date** of medications that expire **in 30-90 days** .	SELECT ... WHERE ... BETWEEN ...
5	Sales > 500 UAH	Display the Patient **Name** and **Average Check** for the last 3 months.	SELECT ... GROUP BY ... AVG()
6	Diagnosis 'J01' (Code MKH-10)	Display **the name of** the medication most often purchased by patients with this diagnosis.	SELECT ... JOIN ... GROUP BY ... ORDER BY
7	Medicines from " Farmak "	List of drugs that have not been sold **for more than 6 months** (dependent tables).	SELECT ... LEFT JOIN ... WHERE ... IS NULL
8	Active ingredient " Paracetamol "	**Number of** units sold in **the past calendar month** .	SELECT SUM() ... WHERE ...
9	Medicines that are out of stock	Display **the name** of the medicine whose **Current Balance** is **0** .	SELECT ... WHERE ...
10	Manufacturer " Bayer "	Find **the names** of patients who purchased medicines from this manufacturer **twice or more** .	SELECT ... GROUP BY ... HAVING COUNT(*) > 1
11	Medicine " Fucis "	Sales in **the amount** of **100 to 300** packages per quarter.	SELECT ... WHERE ... AND ... BETWEEN
12	Diagnosis 'R50' (ICD-10 Code)	Display the Drug **Name** and **Expiration Date** for this diagnosis.	SELECT ... JOIN ... WHERE ...
13	Medicines that have been sold less than 10 times	Remove the drug with the lowest sales frequency per year.	SELECT ... GROUP BY ... COUNT()
14	Sales less than 50 UAH	Find **the Name** of the Medicine and **the Average Price** for the last 6 months.	SELECT ... GROUP BY ... AVG()
15	Medicine " Renalgan "	Display **the date** and **quantity** of the last five sales.	SELECT ... ORDER BY ... LIMIT 5

Test tasks for self-control:

1. What is the purpose of the JOIN command in an SQL query?

a) Creating a new table.

b) Joining data from two or more tables on a common field.

c) Deleting records from the database.

d) Entering new data into the table.

2. What is the main task of a primary key in a table?

a) Storage of the sales amount.

b) Ensuring unique identification of each record.

c) Sorting data alphabetically.

d) Storing the date of the last update.

3. What protocol or standard most often governs the security of EMC and the confidentiality of patient data?

a) TCP/IP.

b) HTTP.

c) GDPR / HIPAA (depending on the region, responsible for privacy).

d) SMTP.

4. What type of DBMS is most often used to store Electronic Health Record data?

a) Hierarchical.

b) Network.

c) Relational.

d) Object-oriented.

5. What is included in the DDL (Data Definition Language) in SQL?

a) SELECT, INSERT.

b) CREATE, DROP, ALTER.

c) WHERE, ORDER BY.

d) COMMIT, ROLLBACK.

List of recommended literature:

Main:

1 Medical Informatics : textbook / I.Ye. Bulakh , Yu.Ye. Liakh , VP Martseniuk , I.Yo. Khaimzon . — 4 th edition . — Kyiv : AUS Medicine Publishing , 2018. - 368 p.

2. G.G. Shvachych , V.V. Tolstoy , L.M. Petrechuk , Y.S. Ivashchenko , O.A. Gulyaeva , O.V. Sobolenko Modern information and communication technologies: Textbook. - Dnipro: NMetAU , 2017. -230 p.

3. Computer modeling in pharmacy: a manual for pharmacy students of universities of the Ministry of Health of Ukraine / I. E. Bulakh, L. P. Voitenko, I. P. Kryvenko. – Kyiv: Medicine, 2017. – 208 p.

4. Forkun Yu. V. Informatics: a textbook . / Yu. V. Forkun , N. A. Dlugunovich . - – Lviv: Publishing house "Novyi svit – 2000", 2018. – 464 p.

Additional

1. Information technologies in pharmacy: a manual for pharmacists of universities and pharmacists of medical universities of the IV level of accreditation / I. E. Bulakh, L. P. Voitenko, L. O. Kukhar; ed. I. E. Bulakh. – Kyiv: Medicine, 2008. – 224 p.

2. Computers and computer technologies: teaching aids / Yu. B. Brodsky, K. V. Molodetska, O. B. Borysyuk, I. Yu. Grinchuk . – Zhytomyr: Publishing house "Zhytomyr National Agroecological University", 2016. – 186 p .

3. Pharmaceutical Encyclopedia. – Kh.: National University of Pharmacy : LLC "MORION", 2016.

4. Workshop on information technologies in pharmacy [Electronic resource]: a teaching aid for university students / S. V. Velma , N. M. Yatsenko, Yu. M. Penkin ; National University of Physics and Technology . – Kh.: National University of Physics and Technology , 2016. F A 1.1-26-295

Electronic information resources

1. https://info.odmu.edu.ua/chair/pharmacognosy/files – website of methodological recommendations of the Department of Pharmacognosy of Odessa National Medical University.

2. www.uacm.kharkov.ua – Ukrainian Association "Computer Medicine"

3. http://www.drlz.com.ua/ – State Register of Medicinal Products of Ukraine

4. http://www.compendium.com.ua – Compendium, medicines

5. http://www.openoffice.org/ – official OpenOffice.org website

6. https://www.libreoffice.org/ – official LibreOffice.org website

7. www.medinfo.com.ua – medical search engine of Ukraine

8. https://tabletki.ua/uk/ – pharmaceutical search engine of Ukraine

TOPIC

« Principles of building neural networks. Neural networks in pharmacy and medicine »

Objective: To have in-depth knowledge of the basic architectural principles and mechanisms of functioning of artificial neural networks (ANNs). To understand the role and scope of deep learning algorithms (Deep Learning) in the processes of drug development, disease diagnostics and personalized medicine. Be able to analyze examples of using ANNs for forecasting and optimization of pharmaceutical processes.

Basic concepts (list of questions):

1. **Artificial neuron:** Structure (input, weights, adder, activation function) and principle of operation.
2. **Neural Network:** Definition, layers (input, hidden, output) and topology (fully connected, feedforward).
3. **Activation function:** Role in decision making (e.g., sigmoid, ReLU) and its impact on network training.
4. **Learning process:** Concept of forward and backward error propagation (Backpropagation) and optimizers (e.g. gradient descent).
5. **Types of neural networks used in medicine:** Convolutional (CNN), Recurrent (RNN), and Generative Adversarial Networks (GAN).
6. **Deep learning (Deep Learning):** Difference from classical ANNs and its advantages in working with large, unstructured medical data.

Plan

1. Theoretical questions:

1. Biological neuron as a prototype: Comparative analysis of biological and artificial neurons, key parallels and differences.
2. Perceptron (MLP) Architecture : Construction principles, learning process for classification and regression.
3. Using CNNs in Radiology and Pathomorphology : A look at how convolutional networks identify pathologies in CT, MRI, and histological specimens.
4. Neural Networks in Drug Discovery and development of new molecules: Predicting efficacy, toxicity and optimizing the structure of potential drugs (in silico models).
5. Personalized medicine and ANM: Analysis of genetic and clinical data to predict an individual patient's response to treatment and dosage.

6. Artificial intelligence in pharmacovigilance and pharmacy inventory management: Application of ANNs to detect drug side effects and predict demand in the pharmaceutical market.

Questions for self-control (list of questions):

1. What role do weights play in an artificial neuron during training?
2. Give an example of the use of Recurrent Neural Networks (RNN) in clinical practice (e.g., ECG time series analysis).
3. Explain what "convolution" is in the context of CNN and why it is needed.
4. What ethical and legal issues arise when using ANNs to make medical diagnoses?
5. is backpropagation used in the ANN training process?
6. How can neural networks help a pharmacist manage medication expiration risks?

Tasks for independent study of the material:

Practical work / individual tasks (15 options):

Task: The student must research and describe a specific use case of Artificial Intelligence (AI) in a given field, providing clear answers to 4 key questions.

Version	Scope of AI application	4 Key Research Questions
1-3	Forecasting epidemics and disease outbreaks (Public Health	What type of ANN is used? What data is used as input? What is the accuracy of the prediction? How does the result affect the pharmacy?
4-6	Automated analysis of medical images (X-ray, MRI)	What type of ANN is used? What data is used as input? What is the diagnostic accuracy? How does this affect medication prescription?
7-9	Optimization of clinical trials (Clinical Trials)	What type of ANN is used? How does AI speed up patient selection? What are the ethical risks? What are the benefits for the drug developer?
10-12	Virtual drug screening (Drug Discovery)	What type of ANN is used? How does AI predict the interaction of molecules? What is the time/resource savings? How is the result verified in in vitro ?
13-15	Detection of side effects (Pharmacovigilance)	What type of ANN is used? What data is used as input (social media, EMR)? How are unexpected reactions detected? How does this affect the product information?

Test tasks for self-control:

1. What is the main function of the activation function in an artificial neuron?

a) Storage of input data.

b) Determining the weight of the connection.

c) Introducing nonlinearity into the neuron's output signal.

d) Determining the learning rate.

2. What type of neural networks is most effective for working with time series (for example, analyzing changes in a patient's condition over time)?

a) Convolutional neural networks (CNN).

b) Multilayer perceptron (MLP).

c) Recurrent neural networks (RNN).

d) Direct distribution networks.

3. What function allows a neural network to "learn" by adjusting weights based on prediction error?

a) Activation function.

b) Backpropagation of the error .

c) Direct distribution.

d) Normalization.

4. In the context of Drug Discovery , why do neural networks use virtual screening?

a) For diagnosing diseases in patients.

b) For the physical synthesis of molecules in the laboratory.

c) To predict the activity and interaction of molecules without physical experiments.

d) For financial accounting.

5. What is "deep learning" (Deep Learning)?

a) Network with a single hidden layer.

b) A network trained on a very large amount of data.

c) A neural network with two or more hidden layers.

d) Simple logistic regression.

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Main:

1 Medical Informatics : textbook / I.Ye. Bulakh , Yu.Ye. Liakh , VP Martseniuk , I.Yo. Khaimzon . — 4 th edition . — Kyiv : AUS Medicine Publishing , 2018. - 368 p.

2. G.G. Shvachych , V.V. Tolstoy , L.M. Petrechuk , Y.S. Ivashchenko , O.A. Gulyaeva , O.V. Sobolenko Modern information and communication technologies: Textbook. - Dnipro: NMetAU , 2017. -230 p.

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7. www.medinfo.com.ua – medical search engine of Ukraine

8. https://tabletki.ua/uk/ – pharmaceutical search engine of Ukraine

9. https://allchemistry.info/services/onlayn-redaktor-himicheskih-formul – online editor of chemical formulas

10 http://www.apteka.ua – online newspaper "Apteka"

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TOPIC

" Application of logical operations and truth tables in the diagnosis and treatment of diseases **"**

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Objective: To have a deep knowledge of the principles of Boolean algebra, logical operations (AND , OR , NOT) and their representation in truth tables. To acquire the skills to model clinical and pharmaceutical algorithms (diagnostic protocols, drug selection) using logical functions and to create decision support systems (DSS).

Basic concepts (list of questions):

1. **Boolean algebra:** Definition, basic laws, and their role in decision modeling.
2. Logical **operations:** Functions AND (conjunction), OR (disjunction), NOT (inversion).
3. **Truth table:** Purpose and construction rules for complex logical expressions (e.g., (A ∧ B) ∨ ¬C).
4. **Logical condition in diagnostics:** Formalization of clinical symptoms and laboratory parameters as binary variables (True / False).
5. **Decision Support Systems (DSS):** The architecture and use of logical rules to provide recommendations to a doctor or pharmacist.

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Plan

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1. Theoretical questions:

1. Formalization of medical knowledge: Converting medical protocols and guidelines into formal logical expressions that a computer can process.
2. Application of conjunction (I): Modeling situations where the simultaneous presence of several symptoms is required for diagnosis or drug prescription (e.g., Cough ∧ Temperature ∧ Test result > 0).
3. Application of disjunction (OR): Modeling exclusion or inclusion criteria where one of several conditions is sufficient (e.g., Prescribe antibiotic if (Bact . infection ∨ Complication).
4. NOT logic in contraindications: Using the NOT operator to block the prescription of medication if there are contraindications (Prescribe drug ∧ ¬Pregnancy ∧ ¬Allergy).

Questions for self-control (list of questions):

1. What is the difference between strict logical AND and loose OR when selecting diagnostic criteria?

2. Formulate an expression for prescribing drug X if the patient does not have allergy A or has concomitant pathology P.

3. Why are truth tables critical for testing DSS algorithms in medicine?

4. Give an example of how, using logical operations, you can check whether the current dose of medication corresponds to the patient's age (V) I weight (W) I kidney function (N)?

5. Which logical function corresponds to the rule of mutual exclusion (for example, when choosing one of two diagnoses is impossible)?

Tasks for independent study of the material:

Practical work / individual tasks (15 options):

Task: Create **a truth table** for a logical expression modeling a diagnostic or pharmaceutical protocol and determine **the Final Solution (P)** .

Conditions:

- **Symptom A:** (Temperature $\geq 38 \circ$ C) / **Contraindication A**

- **Symptom B:** (Presence of **bacterial infection**) / **Contraindication B**

- **Symptom C: (Leukocyte** count elevated) / **Special condition C**

No.	Scope of Application	Logical Expression	Variables used
1-5	Diagnostics	(A ∧ B) ∨ C	A, B, C - Symptoms
6-10	Purpose Antibiotics	(A ∨ B) ∧ ¬C	A, B - Symptoms; C - Allergy
11-15	Pharmacist . Consulting	(A ∧ ¬B) ∨ (C ∧ B)	A - Effectiveness; B - Prescription required; C - Alternative remedy

Execution procedure:

1. Determine the number of rows in the table (depends on the number of variables: 23 = 8 rows).

2. Fill in the variable columns (A, B, C).

3. Step by step calculate intermediate logical operations (¬C , A ∧ B , etc.).

4. Determine **the Final Solution (P)** for all 8 combinations.

Test tasks for self-control:

1. Which logical operation returns "True" only **when both of its operands are "True"?**

a) OR

b) ** I (AND) **

c) NOT (NOT)

d) Exclusive OR (XOR)

2. How many rows will the truth table have for an expression with 4 independent variables (A, B, C, D)**?**

a) 4

b) 8

c) 16 (24)

d) 32

3. The logical expression $A \lor \neg A$ **is always equal to:**

a) False

b) ** True **

c) Depends on A

d) Undetermined

4. What type of surgery is used in DSS when it is necessary to rule out an allergic reaction to make a diagnosis?

a) Conjunction (I)

b) **Inversion (NOT)**

c) Disjunction (OR)

d) Equivalence

5. What is the purpose of the "Final Decision" column in the medical protocol truth table?

a) Displays the amount of the cost of treatment.

b) Determines the final diagnosis or treatment recommendation.

c) Shows the time spent processing data.

d) Determines the sequence of command execution.

List of recommended literature:

Main:

1 Medical Informatics : textbook / I.Ye. Bulakh , Yu.Ye. Liakh , VP Martseniuk , I.Yo. Khaimzon . — 4 [th] edition . — Kyiv : AUS Medicine Publishing , 2018. - 368 p.

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8. https://tabletki.ua/uk/ – pharmaceutical search engine of Ukraine

9.   https://allchemistry.info/services/onlayn-redaktor-himicheskih-formul   –   online   editor   of chemical formulas

10 http://www.apteka.ua – online newspaper "Apteka"

" Clinical Decision Support Systems "

Objective: To have a deep knowledge of the concepts, architecture and components of clinical decision support systems (CDS). To understand the role of CDS in improving patient safety, preventing medical errors and optimizing pharmaceutical counseling. To be able to analyze and formalize pharmaceutical knowledge in the form of rules for integration into automated systems.

Basic concepts (list of questions):

1. **Clinical Decision Support System (CDSS):** Definition, goals and main functions (reminders, alerts, recommendations).

2. **Components of the KDSS:** Knowledge Base (Knowledge Base), Inference mechanism (Inference Engine), User interface.

3. **Types of CPAPs: Physician-directed (diagnostic) and** pharmacist -directed (pharmacotherapeutic).

4. **Types of rules in KDSS:** If-Then rules Rules) and algorithms based on logic trees.

5. **Application of CPAP in pharmacy:** Dosage control, detection of drug interactions and checking contraindications.

6. **Integration of the CPMS with the Electronic Medical Record (EMC):** Principles of data exchange and automatic analysis of patient history.

Plan

1. Theoretical questions:

1. Historical overview and evolution of DSS: From expert systems (MYCIN, DXplain) to modern intelligent systems.

2. KSPPR Knowledge Base: Sources of information (clinical guidelines, pharmacopoeias, research results) and methods of their formalization.

3. Role of the inference engine: Explains how the system applies logic (forward or backward chain of inference) to generate a recommendation.

4. Advantages of KDSPR: Reduction of medical errors, saving time for the doctor/pharmacist, standardization of treatment processes.

5. Pharmaceutical safety and CPMP: Notification mechanisms for critical drug-drug and drug-condition interactions.

Questions for self-control (list of questions):

1. What is the critical difference between the Alert system and the Suggestion system in the KDSS?
2. Name the three main sources from which the Pharmaceutical KDSPR Knowledge Base is formed.
3. Explain what the " If-Then Rule " is using the example of dosage control for a patient with renal failure.
4. Why should the CPMS be deeply integrated with the Electronic Medical Record (EMC) for effective operation?
5. What are the two main categories of errors that pharmaceutical QMS helps prevent?
6. Articulate how the CPSS can assist the pharmacist when dispensing over-the-counter (OTC) medications.

Tasks for independent study of the material:

Practical work / individual tasks (15 options):

Task: The student needs **to develop and formalize an "If -Then " rule** for a hypothetical pharmaceutical QMS that controls the safety of drug dispensing, and then determine its criticality.

Development rules:

1. Formulate a condition (**IF**): medical or pharmaceutical situation.
2. Formulate an action (**TO**): a recommendation or alert from the system.
3. Determine **the Alert Severity** (Critical/Warning/Informational).

No.	Area of control	Pharmaceutical Condition (A, B, C)	Example of a Precautionary Action
1	Interaction	A (Patient is taking Aspirin) ∧ B (Prescribed Warfarin)	TO: "Risk of bleeding. Dose adjustment required."
2	Dosage	A (Age < 12 years) ∧ B (Paracetamol dose > 500 mg)	TO: "Exceeding the pediatric dose. Reduce to 250 mg."
3	Contraindication	A (Prescribed Ibuprofen) ∧ B (Diagnosis: Stomach ulcer)	TO: "Contraindications. Offer an alternative NSAID."
4	Duplication	A (The EMR has Amlodipine) ∧ B (Prescribed Nifedipine)	TO: "Group duplication. Notify the doctor."
5	Regime	A (Antibiotic prescribed) ∧ ¬B (Duration of course not specified)	TO: "Warning: The course must last at least 7 days."
6	Interaction	A (1st generation antihistamine) ∧ B (Sedative)	TO: "Risk of excessive drowsiness. Recommend 2 generations."
7	Dosage	A (Creatinine clearance < 30) ∧ B (Prescribed Metformin)	TO: "Risk of lactic acidosis . Reduce dose by 50%."
8	OTC control	A (Request Codeine- containing drug) ∧ B (Patient bought it a week ago)	TO: "Potential risk of abuse. Pharmacist consultation."
9	Contraindication	A (Patient: pregnancy) ∧ B (Prescribed Tetracycline)	TO: "Categorical contraindication (teratogenicity). Replacement."
10	Lab . indicators	A (Serum potassium > 5.5) ∧ B (Potassium-sparing agent prescribed diuretic)	TO: "Risk of hyperkalemia . Discontinue the drug."
11	Duplication	A (Active ingredient X in 3 different drugs)	TO: "Risk of exceeding daily dose X. Reduce quantity."

12	Regime	A (Drug taken before meals) ∧ B (Time of administration after meals)	TO: "Warning: Ineffective. Take 30 minutes before meals."
13	Interaction	A (Grapefruit juice) ∧ B (Statins)	TO: "Food interaction warning. Risk of rhabdomyolysis ."
14	Dosage	A (Age > 65 years) ∧ B (New sleeping pill)	TO: " Gerocontingent . Start with the minimum dose."
15	Contraindication	A (Prescribed Metronidazole) ∧ B (Patient drinks alcohol)	TO: "Critical: Disulfiram-like reaction. Avoid alcohol."

Test tasks for self-control:

1. Which component of the CPMS is responsible for storing clinical protocols and guidelines?

a) Inference mechanism.

b) User interface.

c) Knowledge Base (Knowledge Base).

d) Reporting module.

2. What is the main purpose of using the CPAP in pharmaceutical practice?

a) Automation of warehouse accounting.

b) Creating staff work schedules.

c) Preventing errors related to drug interactions and dosing.

d) Calculation of pharmacy profit.

3. If the CPMS issues a "Critical Interaction" alert when a pharmacist attempts to dispense a medication, what type of alert is this?

a) Informational.

b) Critical (requires immediate attention and action).

c) Warning.

d) Diagnostic.

4. What is the "Inference Mechanism" (Inference Engine)?

a) User manual.

b) A software module that applies logical rules to patient data to derive a recommendation.

c) Sensor for scanning barcodes.

d) Daily sales report.

5. The principle "If the patient is pregnant, THEN do not prescribe drug X " is an example of...

a) Predicate.

b) Activation functions.

If-Then Rules Rule).

d) The Law of Disjunction.

List of recommended literature:

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4. Workshop on information technologies in pharmacy [Electronic resource]: a teaching aid for university students / S. V. Velma , N. M. Yatsenko, Yu. M. Penkin ; National University of Physics and Technology . – Kh.: National University of Physics and Technology , 2016. F A 1.1-26-295

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1. https://info.odmu.edu.ua/chair/pharmacognosy/files – website of methodological recommendations of the Department of Pharmacognosy of Odessa National Medical University.

2. www.uacm.kharkov.ua – Ukrainian Association "Computer Medicine"

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TOPIC

" Principles and aspects of evidence-based medicine "

Objective: To know and understand the key principles and stages of evidence-based medicine (EBM) and the hierarchy of scientific evidence. To be able to find, critically evaluate and apply the best available scientific evidence for decision-making in pharmaceutical and clinical practice (selection, prescription and counseling on medicines).

Basic concepts (list of questions):

1. **Evidence-based medicine (EBM):** Definition and three main components (external evidence, clinical experience, patient values).

2. **Hierarchy of evidence (Hierarchy of Evidence):** The pyramid of evidence, its levels (from expert opinion to systematic reviews).

3. **Systematic Reviews and Meta-Analysis:** Their Role as the Highest Level of Evidence and Difference from Conventional Literature Reviews.

4. **Randomized controlled trial (RCT):** The "gold standard" of clinical evidence, concepts of randomization , blinding, and control group.

5. **PICO format:** A method of formulating a clinical question (Patient, Intervention, Comparison, Outcome) to search for evidence.

6. **Bias :** Types of bias in research and methods for minimizing it (e.g., selection bias, informational bias) **.**

Plan

1. Theoretical questions:

1. Stages of DM practice: Question formulation, evidence search, critical evaluation, application, evaluation of results.

2. Levels of recommendation: Relationship between level of evidence (IV) and strength of clinical recommendations (A-D).

3. Critical appraisal of RCTs: Analysis of the validity, reliability and applicability of the results (e.g., assessment of sample size and statistical significance).

4. The role of a pharmacist in DM: Participation in the formation of evidence-based formulas, providing substantiated information to doctors and patients.

5. Evidence-Based Databases: A Review of Key Resources (Cochrane Library , PubMed , NICE, UpToDate) and search strategies.

Questions for self-control (list of questions):

1. What place does a systematic review occupy in the hierarchy of evidence and why?
2. What are the ethical and methodological advantages of randomization in a clinical trial?
3. Explain how a placebo-controlled trial differs from an active-controlled trial?
4. Formulate a PICO question regarding the effectiveness of new drug X for treating headache.
5. Why is double-blinding used in research, and what bias does it minimize?
6. What are the implications for pharmaceutical practice of using recommendations based only on expert opinion (lower level of evidence)?

Tasks for independent study of the material:

Practical work / individual tasks (15 options):

Task: The student must analyze a hypothetical **clinical trial abstract on a given topic** and complete a critical evaluation table.

No.	Clinical Problem / Drug	Key finding for evaluation	Key Bias for Search
1-3	Antibiotic X against respiratory tract infections	X is more effective than placebo	Publication bias
4-6	Probiotic Y for the prevention of antibiotic-associated diarrhea	Y reduces the incidence of diarrhea by 15%	Selection bias
7-9	Drug Z for lowering cholesterol	Z reduces cholesterol by 20% Error! No file name specified.	Sponsor bias
10-12	V complex to boost immunity	V reduces the duration of acute respiratory viral infections	Outcome measurement bias
13-15	New painkiller N Error ! No file name specified.	N is more effective than Ibuprofen Error ! No file name specified.	Attrition bias bias)

Table to fill in:

Evaluation criterion	Answer (Yes/No)	Justification	Level of evidence (I, II, III...)
Was the study randomized ?			
Was there blinding (Single/Double)?			
Were the comparison groups (intervention/control) similar at baseline?			
Was bias minimized?			
Can the result be applied to the Ukrainian population?			
Strength of recommendation (A, B, C, D)	_____	_____	

Test tasks for self-control:

1. What level of evidence is considered the highest in the evidence-based medicine pyramid?

a) Expert opinion.

b) Cohort studies.

c) Systematic reviews and meta-analyses.

d) Case-Control study .

2. What is the "gold standard" for assessing the effectiveness of a drug?

a) Case series report.

b) Randomized controlled trial (RCT).

c) Cross-sectional study.

d) Research in in vitro .

3. Which of the following terms means that neither the patient nor the researcher knows whether the patient is receiving the study drug or a placebo?

a) Randomization .

b) Control.

c) Double blinding.

d) Selection bias.

publication bias"? Bias)?

a) Error due to incorrect measurement.

b) The tendency to publish only studies with positive results.

c) Error in selecting study participants.

d) Bias in data interpretation.

5. What is the purpose of the PICO format when searching for evidence?

a) Determine the cost of treatment.

b) Formulate a clear, focused clinical question.

c) Conduct statistical analysis.

d) Check the availability of a patent for the drug.

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TOPIC

" Hospital Information Systems **"**

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Objective: To know and understand the architecture, functional modules and key benefits of implementing hospital information systems (GIS). To understand the role of GIS in optimizing in-hospital pharmacy, inventory management and ensuring patient safety. To be able to analyze and model information flows in a clinical and administrative environment.

Basic concepts (list of questions):

1. **Hospital Information System (GIS):** Definition, objectives and main functions.
2. **GIS Architecture:** Main Modules (Administrative, Clinical, Pharmaceutical) and their Interaction.
3. **Electronic Health Record (EHR):** Its role as a central component of GIS.
4. **Pharmaceutical GIS module (Hospital Pharmacy Management System):** Key functions (accounting, requirements generation, release control).
5. **Decision Support Systems (DSS) in GIS:** Integration for monitoring interactions, dosages and allergies.
6. **The CPOE system (Computerized Provider Order Entry):** Electronic entry of medical prescriptions by a doctor and its benefits.
7. **Logistics of medicines in GIS:** Automation of accounting from warehouse to department.
8. **Data exchange standards:** The concepts of HL7, DICOM and their importance for system interoperability .

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Plan

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1. Theoretical questions:

1. GIS administrative modules: Registration, bed management, financial accounting, human resources.
2. Clinical GIS modules: EMR management, laboratory information system (LIS), radiology information system (RIS).
3. The full cycle of circulation of a medicinal product (MED) in GIS: Example: formation of the department's need → order by the pharmacy → distribution → recording of administration to the patient.
4. Advantages of CPOE: Reduced errors due to illegible handwriting, integrated dosage control.
5. Inventory control in a hospital pharmacy: Using GIS to minimize overdue and excess inventory.

Questions for self-control (list of questions):

1. What are the three main information flows that GIS brings together?
2. Why does the pharmaceutical GIS module need integration with the Electronic Medical Record module?
3. Describe how a CPOE system reduces the risk of medical errors at the medication prescribing stage.
4. What is a pharmaceutical requirement and how is it formed in GIS?
5. What patient data, besides appointments, is critical for the operation of the GIS-based CPD?
6. Why are data exchange standards (e.g. HL7) important for GIS effectiveness?

Tasks for independent study of the material:

Practical work / individual tasks (15 options):

Task: The student needs **to analyze and document** the information flows **of the Drug Cycle in GIS** for a specific department/drug.

Analysis scheme:

1. **Name of the Drug/Group:** (Specified individually).
2. **Initial event (Requirement):** Department → Create requirement.
3. **Logical Step 1 (Order):** Check availability at the pharmacy → System actions.
4. **Logical Step 2 (Leave):** Forming a leave invoice → System actions.
5. **Final Step (Introduction):** Fixing the drug administration in the patient's EMR → System actions.

No.	Department / Drug	Key Control GIS (tasks for modeling)	Requirements for Security (Problem Aspect)
1-3	Intensive Care Unit (ICU) / Narcotic Analgesics	Balance control and double-entry bookkeeping (CONSUMPTION)	Strict accounting and electronic journal keeping.
4-6	Cardiology Department / Anticoagulants	Integration with LIS (INR/INR results) and KDSS (DOSAGE)	Automatic notification of the doctor about critical indicators.
7-9	Surgical Department / Broad-spectrum antibiotics	Control of preventive prescription (PROTOCOL)	Adherence to surgical antibiotic prophylaxis protocols .
10-12	Therapeutic department / Insulins	Control of expiration dates and storage conditions (LOGISTICS)	Warning the pharmacist about the need to rotate stocks.
13-15	Reception / Vaccines	Fixing the series and batch number in the EMC (CONTINUITY)	Ensuring traceability of the drug to the end consumer.

Task to be completed: For your variant, describe each step of the cycle, indicating **which GIS module** is responsible for it and **which KDSPR check** should be activated.

Test tasks for self-control:

1. Which GIS module is responsible for the automated creation of medical prescriptions by a doctor?

a) LIS (Laboratory System).

b) CPOE (Computerized Provider Order Entry).

c) Financial accounting module.

d) RIS (Radiological System).

2. What is the main function of the Pharmaceutical GIS module?

a) Maintaining the patient's medical history.

b) Accounting, ordering, distribution and control of the release of medicines to the department.

c) Calculation of salaries for medical personnel.

d) Bed management.

3. What benefit of CPOE is most significant for improving patient safety?

a) Reduction of paper document flow.

b) Integrated monitoring of dosage and interactions at the time of administration.

c) Acceleration of patient discharge.

d) Automatic registration of patients in the reception area.

4. What is an Electronic Health Record (EHR) in the context of GIS?

a) Program for planning operations.

b) Centralized electronic repository of patient medical data.

c) Hospital visitor registration system.

d) Database of drug suppliers.

5. Prescribing an antibiotic to a surgical patient in the GIS should be accompanied by a check by the CPSS for...

a) Matching the color of the surgeon's gown.

b) Adherence to a standardized antibiotic prophylaxis protocol .

c) The average temperature in the chamber.

d) Department occupancy rate.

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TOPIC

« Linear programming. Optimization of drug mixture characteristics using linear programming method »

Objective: To know the mathematical model of linear programming (LP), key elements of the model (objective function and constraints) and basic methods for its solution. To be able to formulate and solve typical pharmaceutical optimization problems (cost minimization, dosage form composition optimization) using spreadsheet tools.

Basic concepts (list of questions):

1. **Linear Programming (LP):** Definition, objectives and scope of application in pharmacy.
2. **Objective function Function):** Essence, construction rules, examples (cost minimization, profit maximization).
3. **Constraints : Types of** constraints (resource, volume, concentration, quality) and their mathematical representation.
4. **Feasible solution domain (Feasible Region):** Graphical representation and economic content.
5. **Optimal solution:** The point at which the objective function reaches its extremum.
6. **Pharmaceutical applied problem of LP:** Optimization of the production of multicomponent medicinal mixtures (ointments, solutions, suppositories).
7. **LP Solving Tools: Overview of** the Solver Functionality in MS Excel or Google Sheets .

Plan

1. Theoretical questions:

1. General model of the LP problem: Mathematical notation of the objective function and the system of linear inequalities .
2. The main stages of building a mathematical model for a pharmaceutical problem: identification of variables, objectives, and constraints.
3. Graphical method for solving the LP problem (for two variables): constructing the region of feasible solutions and finding the extremum.
4. Economic content of restrictions: Interpretation of restrictions as requirements for drug quality, budget limits, or supply limits.
5. Analysis of optimization results: What does it mean if a problem has no solution or has multiple solutions.

Questions for self-control (list of questions):

1. What role do variables play in a pharmaceutical problem, and how should they be defined in a pharmaceutical problem?

2. Formulate an objective function for the cost minimization problem of producing 100 ml of disinfectant solution.

3. Give an example of a limitation on the concentration of an active substance in a solution and write it mathematically.

4. What is the domain of feasible solutions and what solutions are actually of interest to the pharmacist?

5. Explain why it is advisable to use spreadsheets to solve pharmaceutical problems of pharmaceutical companies.

6. What consequences will there be for the manufacture of medicinal products if the condition of impossibility of negative production is not included as a restriction?

Tasks for independent study of the material:

Practical work / individual tasks (15 options):

Task: Using the Solver functionality in MS Excel/ Google Sheets , **optimize the composition of a multicomponent dosage form** to **minimize total cost** while meeting all clinical and physicochemical constraints.

Scenario: A pharmacy needs to produce 500 grams **of a universal ointment base** using three available components (K1, K2, K3) that have different costs but affect the final characteristics (for example, indicator A is absorption capacity, indicator B is viscosity).

No.	Cost of components, UAH/g (K1/K2/K3)	Volume restrictions, g	Limits by indicator A (min/ max)	Limits by indicator B (min/ max)
1-3	4/6/3	Total weight: 500 g.	$0.20 \le A \le 0.35$	$0.50 \le B \le 0.80$
4-6	5/4/7	Total weight: 500 g.	$0.15 \le A \le 0.25$	$0.60 \le B \le 0.90$
7-9	3/5/4	Total weight: 500 g.	$0.25 \le A \le 0.40$	$0.40 \le B \le 0.75$
10-12	6/3/5	Total weight: 500 g.	$0.10 \le A \le 0.30$	$0.70 \le B \le 1.00$
13-15	7/4/6	Total weight: 500 g.	$0.30 \le A \le 0.45$	$0.35 \le B \le 0.65$

Additional conditions (Constants):

- The effect of components on the A index (absorption): $A = 0.05 \cdot K1 + 0.1 \cdot K2 + 0.02 \cdot K3$.

- The influence of components on the B index (viscosity): $B = 0.08 \cdot K1 + 0.04 \cdot K2 + 0.12 \cdot K3$.

- All variables (K1, K2, K3) cannot be negative.

Tasks to complete:

1. Formulate a mathematical model of the problem (objective function, constraints).

2. Create a spreadsheet and enter data.

3. Using **Solver** , find the optimal mass of each component (K1, K2, K3).

4. Calculate the minimum total cost of the ointment.

Test tasks for self-control:

1. The objective function in linear programming must always be:

a) Quadratic.

b) Exponential.

c) Linear.

d) Geometric.

2. The constraints of the LP problem are:

a) Multiplication of variables.

b) A system of linear inequalities or equations.

c) Random values.

d) The derivative of the objective function.

3. Which of the following statements is a typical objective function for a pharmacist?

a) Maximizing shelf life.

b) Minimizing the total cost of the manufactured dosage form.

c) Maximizing packaging size.

d) Minimizing the number of employees.

4. What is the "Region of Feasible Solutions"?

a) List of all possible drugs.

b) The set of all points that simultaneously satisfy all the constraints of the problem.

c) Price range established by the Ministry of Health.

d) Sales schedule.

5. What limitation is mandatory for all practical tasks in pharmacy?

a) $x < 100$ (mass less than 100).

b) $x \geq 1$ (mass greater than 1).

c) $x2 \leq 5$ (square of the mass).

d) $x \geq 0$ (impossibility of a negative number of components).

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" Modeling of biomedical processes "

Objective: To know the main classes of models (deterministic, stochastic) and their application in pharmacy and medicine. To understand the principles of pharmacokinetic modeling (single-compartment model). To be able to apply mathematical models to predict changes in drug concentration in the body and visualize the results.

Basic concepts (list of questions):

1. **Modeling of biomedical processes:** Definition, goals and stages of modeling.
2. **Classification of models:** Deterministic (fixed outcome) vs. Stochastic (probabilistic).
3. **Principles of Pharmacokinetic (PK) modeling:** The concept of the chamber, absorption and elimination rate constants.
4. **Single-chamber model:** Mathematical description and its clinical significance.
5. **Pharmacodynamic (PD) modeling:** Models of the relationship between concentration and effect.
6. **Dose and Dosing Regimen Modeling:** Using Models to Achieve Therapeutic Concentrations.
7. **Epidemiological models (e.g. SIR):** Applications to predict the spread of infectious diseases.

Plan

1. Theoretical questions:

1. The need for modeling: Models as a tool for predicting and optimizing clinical decisions without the need for numerous invasive studies.
2. Deterministic PK model: Single-compartment model as the simplest tool for describing drug distribution and elimination after rapid intravenous administration.
3. PK parameters obtained from the model: Elimination constant (K_e) , volume of distribution (V_d) , half-life ($T_{1/2}$) .
4. "Population-level" pharmacokinetics: Using models to individualize dosage based on age, weight, and comorbidities (e.g., renal failure).
5. Clinical Trial Simulation: Using models to simulate outcomes before conducting expensive phases of research.

Questions for self-control (list of questions):

1. Why are pharmacokinetic models often called "chamber" models?

2. Formulate a mathematical expression for the half-life (T1/2) based on the elimination constant.

3. What is the fundamental difference between a deterministic and a stochastic model? Give an example of a stochastic model in biology.

4. How can a pharmacist use knowledge of the volume of distribution (Vd) when evaluating a dosing regimen?

5. Explain why orally administered drugs require a more complex model than a single-chamber intravenous model.

6. What practical result does modeling of the "Concentration-Time" curve give in clinical pharmacy?

Tasks for independent study of the material:

Practical work / individual tasks (15 options):

Task: Based on **a single-compartment pharmacokinetic model** after intravenous administration (formula: $Ct = C0 \cdot e^{-Ke \cdot t}$), it is necessary to calculate and visualize the plasma concentration curve of the drug.

Output data (Constants):

- Ct — Concentration at time t (needs to be calculated).

- C0 — Initial concentration (at the time of injection, t = 0).

- Ke — Elimination rate constant.

- t — Time, hours.

Version	C0 (mg/l)	Ke (h−1)	T1/2 (Half -life)
1-3	10.0	0.231	**(Calculate)**
4-6	12.5	0.138	**(Calculate)**
7-9	8.0	0.346	**(Calculate)**
10-12	15.0	0.173	**(Calculate)**
13-15	9.5	0.115	**(Calculate)**

Tasks to complete (perform in MS Excel/ Google Sheets):

1. **Calculating** T1/2 : Using the formula $T1/2 = \ln(2) / Ke$, calculate the half -life for your variant.

2. **Creating a Table:** Create a table with columns for: t (from 0 to 12 hours in 0.5 hour increments) and Ct (calculated concentration).

3. **Calculating** Ct : Apply the formula $Ct = C0 \cdot EXPONENT(-Ke \cdot t)$ to fill in the Ct column .

4. **Visualization:** Construct a graph (diagram) of **Concentration (Ct) versus Time (t)** .

5. **Analysis:** On the graph, mark (highlight or indicate) the point in time when the drug concentration will decrease to **the Minimum Effective Concentration (MEC)** , if it is known that the MEC is 3.0 mg/L (a common condition for all).

Test tasks for self-control:

1. What does the constant Ke **(elimination constant) mean in the single-chamber model?**

a) The rate of absorption of the drug.

b) The rate of elimination of the drug from the body.

c) Volume of distribution.

d) Rate of distribution in tissues.

2. What mathematical function is commonly used to describe the decrease in plasma drug concentration after intravenous administration?

a) Linear.

b) Exponential.

c) Logarithmic.

d) Trigonometric.

3. If the T1/2 **(half -life) of a drug is 4 hours, then after 8 hours the concentration will decrease to approximately...**

a) 50% of the original.

b) 25% of the original.

c) 75% of the original.

d) 0% of the original.

4. What is the main goal of Pharmacokinetic Modeling?

a) Minimizing the cost of drugs.

b) Predicting drug interactions.

c) Prediction of drug concentration in plasma at any point in time.

d) Evaluation of the doctor's effectiveness.

5. What is the main limitation of the single-chamber model?

a) It does not take into account the elimination of the drug.

b) It assumes instant and uniform distribution of drugs throughout the body.

c) It cannot be solved using Excel.

d) It is for oral use only.

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List of recommended literature:

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Main:

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TOPIC

" Medical hardware and computer systems "

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Objective: To know the classification and functionality of the main medical hardware-computer systems (HCS) used for diagnosis, monitoring and treatment. To understand the principles of HCS integration with hospital information systems (HIS) and the role of the pharmacist in ensuring data accuracy and cybersecurity of medical information.

Basic concepts (list of questions):

1. **Definition and classification of ISS:** Diagnostic, therapeutic, monitoring, laboratory systems.

2. **ISS Integration:** Medical data exchange standards (e.g., **HL7**) and their role in GIS operations.

3. **Critical monitoring systems:** Features of patient monitors (recorded parameters) and infusion pumps.

4. **Laboratory information systems (LIS) and their connection with equipment:** Automation of collection and transmission of analysis results.

5. **Telemedicine and remote monitoring systems:** Application of ISS outside clinical settings.

6. **Cybersecurity and privacy requirements (GDPR, HIPAA):** Protecting data generated by ISS.

7. **Pharmacist's role in data verification:** Verifying the accuracy of results obtained from the ISS before using them in clinical decisions.

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Plan

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1. Theoretical questions:

1. ISS architecture: Components (sensor, microprocessor unit, software, user interface).

2. Diagnostic ISS: The principle of operation of imaging systems (CT, MRI) and their role in pharmacodiagnostics .

3. Laboratory Systems (LIS): Automated transmission of test results to the pharmacist for assessment of kidney/liver function (vital parameters for dosage adjustment).

4. Monitoring systems in the ICU: The importance of continuous monitoring of blood pressure, SpO2 , and heart rate for making pharmacotherapeutic decisions.

5. Integration challenges: Data incompatibility issues and the need for unification to form a single electronic health record (EHR).

Questions for self-control (list of questions):

1. What are the main functional differences between diagnostic and therapeutic ISS?
2. Why does a pharmacist need access to data coming from laboratory ISS (e.g. creatinine level)?
3. Explain what HL7 is and what role this standard plays in integrating hardware with GIS.
4. What is the risk if the infusion pump is not integrated with a computerized physician order ordering (CPOE) system?
5. What security measures (software or hardware) are used to protect the confidentiality of data collected by ISS wearables ?
6. How can a pharmacist verify the accuracy of results obtained from an automated hematology analyzer?

Tasks for independent study of the material:

Practical work / individual tasks (15 options):

Task: Analyze the data flow from the ISS **Vital Signs Monitoring** to the GIS, identify risks for **cybersecurity** and **pharmaceutical safety** .

Scenario: An intensive care unit (ICU) is using a new batch of **smart infusion pumps** and **bedside monitors** .

No.	Risk Scenario (Critical Incident)	Controlled parameter	Tasks of a pharmacist-analyst
1-3	**Phishing Cyberattack :** Nurse enters credentials on fake monitor screen, giving attackers access to the ICU network.	Reliability of EMC data	**1. Assess the impact:** What pharmaceutical data could be compromised (prescription, test results)? **2. Prevention:** What **software** safeguards should be implemented in the GIS?
4-6	**LIS integration error: The results of the patient's liver sample** analysis (ALT, AST) are automatically transmitted with an error (decimal point offset).	Dose adjustment	**1. Identify the risk:** What dosing error will misinterpretation of liver function lead to? **2. Control:** Which **CPMP module** should detect abnormally high/low values?
7-9	**Infusion pump error :** An unauthorized user enters a command to change the rate of administration of a critical cardiac drug.	Safety of therapy	**1. Technical protection:** What **hardware** control elements (e.g., biometric identifier) should be on the pump? **2. Audit:** Where in the GIS are **logs of changes in** infusion parameters recorded ?
10-12	**"Wandering" monitor data:** SpO2 (oxygen saturation) data from one patient accidentally becomes attached to another patient's EKG.	Rationale for therapy	**1. Pharmaceutical risk:** What medication (bronchodilator , oxygen therapy) could be misprescribed due to these errors? **2. Protocol:** What data **validation rules** should be implemented for healthcare professionals?
13-15	**Outdated ISS software:** The ventilator is running on outdated software that has a known vulnerability.	ISS cybersecurity	**1. Risk Management:** Who in the hospital (pharmacist, IT department) is responsible for **monitoring vulnerabilities** ? **2. Plan:** How should the GIS report the need to update critical ICS?

Design tasks: For your version:

1. Describe in detail how this incident will impact **the pharmaceutical supply process** and **patient safety** .

2. Determine which **GIS/MSDS module** should be used to prevent or detect this error.

3. Suggest **two specific organizational or technical recommendations** to minimize risk.

Test tasks for self-control:

1. What standard ensures the compatibility of medical devices (MSDs) and hospital information systems (GIS)?

a) SQL.

b) TCP/IP.

c) HL7.

d) DICOM.

2. Which type of ICS is most critical for dose adjustment by the pharmacist?

a) Television in the ward.

b) Laboratory Information Systems (LIS).

c) Lighting control systems.

d) Cardio machines .

3. What is the main task of an infusion pump in the context of GIS?

a) Temperature measurement.

b) Ensuring accurate and controlled administration of drugs.

c) Pressure recording.

d) Display of patient sleep schedules.

4. What does the term "Pharmaceutical Safety" mean in the context of the ISS?

a) Low cost of equipment.

b) Quick repair.

c) Prevention of dosing and administration errors based on data obtained from the ISS.

d) Long battery life.

5. Which of the protection methods is the primary one for data transmitted from the ISS?

a) Printing on paper.

b) Voice confirmation.

c) Data encryption .

d) Data storage only on the device .

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« Principles of using video communication in medicine and pharmacy »

Objective: To know the technical, legal and ethical aspects of using video communication (VTC) in telemedicine and telepharmacy . To be able to apply protocols for safe and effective remote consultation of patients and healthcare professionals, as well as to assess the requirements for the confidentiality of the transmitted data.

Basic concepts (list of questions):

1. **Definition and scope of VTC:** Telemedicine, telepharmacy , distance learning.
2. **Types of video communication :** Synchronous (real-time) vs. Asynchronous (store -and-forward).
3. **Technical requirements for VTC:** Video and audio quality, connection stability, platform security.
4. **Legal and ethical aspects:** Patient consent, licensing (interregional), liability.
5. **Privacy and Cybersecurity :** Encryption, protection of patient personal data (e.g., **GDPR**) .
6. **Telepharmaceutical counseling:** Protocols for remote assessment of treatment adherence and monitoring of side effects.
7. **The role of the VTC in a multidisciplinary consultation:** Sharing clinical information between specialists.

Plan

1. Theoretical questions:

1. VTC technical infrastructure: Comparison of software solutions (secure platforms) with universal ones (Zoom , Skype) and requirements for their compliance with medical standards.
2. Clinical benefits of VTC: Reducing geographical barriers, increasing access to specialized care, saving patient time.
3. Legal framework for telemedicine in Ukraine: Main regulatory documents regulating the use of VTC.
4. Ethical challenges: Ensuring patient identification, obtaining informed consent electronically, risk of "alienation" in communication.
5. VTC in Pharmacy: Use for remote pharmacy operations, clinical trial monitoring, and telepharmaceutical supervision (Medication Therapy Management , MTM).

Questions for self-control (list of questions):

1. Name three key technical requirements that a VTC platform must meet for use in clinical practice.
2. What legal risks arise when providing telemedicine services to a patient who is in another country?
3. Explain what "synchronous" video communication means and give an example of its use by a pharmacist.
4. Why is encryption critical for VTC consultations, but less important for "general education" webinars ?
5. What steps does the remote pharmaceutical consultation protocol via video link include ?
6. Articulate how VTC can help increase patient adherence to a complex treatment regimen (compliance).

Tasks for independent study of the material:

Practical work / individual tasks (15 options):

Task: To develop a protocol **for Telepharmaceutical Consultation** for a patient with a chronic disease using the VTC platform and assess privacy risks.

Scenario: A pharmacist needs to conduct a remote consultation with a patient who is being prescribed a multi-component treatment regimen for the first time.

No.	Patient's condition and Purpose of counseling	Pharmacist action required	Privacy risk	Student assignment
1-3	Chronic hypertension. Objective: Assessment **of compliance** (regularity of intake).	Ask the patient to show the medication on camera.	Visual identification **of drugs in the frame** by outsiders.	**Protocol:** How to ensure frame confidentiality.
4-6	Type 2 diabetes. Purpose: Control of **insulin injection technique** .	Demonstration of injection technique by the patient.	Risk of **video signal interception** during transmission.	**Requirements:** What minimum **encryption (e.g., AES-256)** should the platform have?
7-9	Polypharmacy (8 drugs). Objective: **Analysis of interactions** and side effects.	Recording (audio/video) of the consultation for further analysis.	Legal requirements for **record retention** (who has access, how much to keep).	**Consent:** What points should the patient's **informed consent** for recording contain?
10-12	Prescribing an antibiotic. Purpose: To inform about the importance of completing the full course and **potential side effects** (allergies).	Using an unverified free VTC service.	Risk **of selling consultation metadata** to third parties.	**Analysis:** What **security criteria** should a pharmacist check before choosing a platform.
13-15	Child with acute respiratory viral infections. Purpose: Counseling on dosage and use **of a nebulizer** .	The patient (parents) shares **their electronic medical record** via the platform's chat.	Risk of **unauthorized access** to the ECM through the VTC chat functionality.	**Instructions:** How to securely **exchange documents** during a VTC session.

Design tasks: For your version:

1. Develop a step-by-step consultation **protocol (5-7 steps), including identification and completion stages.**

2. Describe in detail how the specified privacy risk should be **technically or procedurally minimized .**

3. Justify whether this type of counseling is **synchronous** or **asynchronous** .

Test tasks for self-control:

1. What is the main advantage of synchronous video communication in pharmaceutical consultation?

a) Recording capability.

b) Real-time interaction and visual assessment of the patient's condition.

c) Low Internet requirements.

d) No need to identify the patient.

2. What is the primary requirement for a VTC platform used for telepharmacy ?

a) The presence of emojis .

End-to-end encryption encryption).

c) Possibility of public streams.

d) Low video resolution.

3. What is " Telepharmacy "?

a) Selling medicines over the Internet.

b) Provision of pharmaceutical care and services (consultations, monitoring) using telecommunication technologies.

c) Remote management of the pharmacy.

d) Production of medicines using robots.

4. What is the main ethical barrier to VTC?

a) High cost of equipment.

b) Poor video quality.

c) Ensuring the confidentiality and privacy of medical information.

d) Difficulty installing the program.

5. What can a pharmacist use asynchronous video communication for ?

a) To provide emergency care.

b) For preliminary analysis of recordings made by the patient (e.g. demonstration of skin changes).

c) To conduct a multi-day surgical consultation.

d) To issue a check.

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TOPIC

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« Medical information protection. Fundamentals of cybersecurity in pharmaceutical activities »

Objective: To know the principles and legal framework for the protection of medical information (MMI) and personal data of patients (Law "On the Protection of Personal Data", GDPR). To understand the main cyber threats (phishing , encryption viruses) and to be able to develop and apply basic cybersecurity protocols at the level of the pharmacist's workstation and pharmacy network.

Basic concepts (list of questions):

1. **Medical information and its value:** Definition, classification and why it is a target for cyberattacks.
2. **Three security whales (CIA Triad): Confidentiality** , **Integrity** , **Availability** of data .
3. **Cyber threats in pharmacy:** Phishing , Ransomware (encrypting viruses), insider threats.
4. **Legal framework for media:** National legislation and international standards (**GDPR** , **HIPAA**).
5. **Security methods:** Encryption, authentication, access control (**ACL**).
6. **Network security:** The role of firewalls , antivirus software, and VPNs.
7. **Pharmacist's workstation security:** Rules for working with passwords, software updates, and physical computer protection.

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Plan

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1. Theoretical questions:

1. Data confidentiality: The need to process patients' personal data exclusively within the framework of professional duties. Requirements for depersonalization (anonymization) of data.
2. Data integrity: How to prevent unauthorized changes to the ECM or the pharmacy accounting system (for example, changing the price of a product).
3. Authentication and Authorization: Multi-factor authentication (MFA) as a mandatory requirement for access to critical pharmaceutical systems.
4. Backup : It is critical to regularly create copies of your data to recover from a cyberattack (e.g., Ransomware) .
5. "Clean Desk" Policy: Physical security of the pharmacist's workplace to prevent unauthorized access.

Questions for self-control (list of questions):

1. Name the three main components of the "CIA Triad" and explain their significance for pharmaceutical data.
2. What type of cyberattack poses the greatest threat to the availability of data in a pharmacy? (Hint: ransomware).
3. What is the difference between authentication and authorization in an accounting system?
4. Why does a pharmacist need to know about GDPR legislation (even if the pharmacy is in Ukraine)?
5. What requirements should be placed on a secure password for accessing the EMC?
6. What is Phishing and how should a pharmacist respond to suspicious emails?

Tasks for independent study of the material:

Practical work / individual tasks (15 options):

Objective: Develop and justify a cybersecurity policy for a medium-sized pharmacy that has access to **patient EMRs** and **financial information** .

Scenario: A pharmacy is part of a network and uses a single database for accounting, customers, and electronic prescriptions.

No.	Risk scenario	Area of control	Key CIA Triad Violation	Student assignment
1-3	**Weak password policy:** Passwords "123456" and " apteka ".	Access to the accounting system	**Privacy**	Develop **a Password Policy** (length, complexity, change period) for pharmacists.
4-6	**Phishing attack:** A pharmacist clicks on a link in a fake email from the "Tax Service".	Email security	**Integrity**	Create **Instructions** for identifying a suspicious email (3-4 signs).
7-9	**Ransomware :** An encryption virus attacks the server, blocking access to the drug residue database.	Data availability	**Accessibility**	Describe the **Backup Procedure** (what, how often, where to store copies) for work recovery.
10-12	**Insider threat:** A departing employee (pharmacist) copies the customer database to a USB flash drive.	Access control	**Privacy**	Develop **a Protocol** for blocking access for the employee on the day of dismissal.
13-15	**Open Wi-Fi :** The pharmacy provides customers with open Wi-Fi , which is used to connect **the pharmacist's workstation** .	Network security	**Integrity / Confidentiality**	Justify the need for **network segmentation** and the use of **VPN** for office computers.

Design tasks: For your version:

1. Describe how the implementation of the specified risk will affect **pharmaceutical activities** (for example, the inability to issue an electronic prescription).

2. Develop 3-4 key **recommendations (rules)** that need to be included in the briefing for staff.

3. Determine which **protection measure** (software or organizational) is most effective in this case.

Test tasks for self-control:

cybersecurity perspective ?

a) Money in the cash register.

b) Electronic medical records (EMR) and personal patient data.

c) Paper instructions.

d) Prices of goods.

2. Which of these threats violates the principle of "Availability" of medical data?

a) Password theft.

b) Ransomware attack .

c) Changing the patient's name.

d) Espionage.

3. Which function is responsible for verifying a user's identity before granting access?

a) Authorization.

b) Authentication.

c) Depersonalization.

d) Encryption.

4. What is the "physical security" of a pharmacist's workplace?

a) Installing antivirus.

b) Hard disk encryption.

c) Enforcing a "Clean Desk" policy and locking the computer when leaving.

d) Regularly update Windows.

5. What is the most effective method of protecting the confidentiality of data transmitted over a network?

a) Antivirus.

End-to-end encryption encryption).

c) Long password.

d) Mail filtering.

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