CHEMICAL KNOWLEDGE IN CLINICAL MEDICAL SPECIALTIES

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Abstract:
In a number of publications, a team of lecturers from the Faculty of Medicine of Trakia University – Stara Zagora studies how the basic knowledge of chemistry, gained in the course in "Medical Chemistry", is used in other medical disciplines, both preclinical and clinical. The process is bidirectional because students receive new knowledge in chemistry. To establish these interactions, explored and compared is the curricula, lecture courses, practical hours and basic teaching aids in "Medical chemistry" and the other disciplines of the FM curriculum. This article discusses the importance and application of chemical knowledge in internal diseases and in clinical medical specialties.
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Students gain their first knowledge on acids and bases in the seventh and eighth grade: they are acquainted with the properties of some mineral acids (hydrochloric, sulphuric) and bases (alkali bases). In the middle course the knowledge deepens with the study of inorganic and organic acids, the knowledge of bases is enriched. Substances are considered mainly under the TED (Arrenus), with students receiving initial knowledge of the Protolytic theory. During the course of "Medical chemistry", this knowledge is significantly expanded and deepened and attain a medical focus.

Studied are the main acid and base theories of Lewis and Bronsted-Lowry, the colligative properties of the solutions, hydrolytic processes, etc. Studied in the laboratory exercises is the Ph and the methods for its determination (colorimetric and electrometric), preparation and importance of the buffer systems (Henderson–Hasselbalch), etc. Disturbances of water-electrolyte and alkaline-acid equilibrium and the treatment affect the concepts and notions of Ph, protolytic theory of acids and alkalis, water, water balance of the organism, hypotonic, isotonic and hypertensive dehydration and over-hydration, buffers and buffer systems of the body, pulmonary, renal mechanisms for violation of acid-alkaline equilibrium-acidosis, alkalosis, balance of body fluids and electrolytes, water-electrolyte exchange, sodium, potassium, calcium, magnesium, phosphorus ions, hyper-and hypo-natremia, kalaemia, calcemia, magnesemia, phosphate osmosis and osmolality, gas composition of the blood – CO_2 and O_2. This is why the diagnostics of "Internal diseases" to be based largely on an analysis of the current Ph of the blood, current CO_2 of whole blood, current concentration of bicarbonate in blood plasma, standard bicarbonate of blood plasma, bases excess (BE), etc. Discussed is the occurrence of acidoses and alkaloses in the human body. Studied are the metabolic and respiratory mechanisms for their occurrence, the ability of the organism to compensate these conditions and the ways of therapeutic effects. Studied are the changes in the concentrations of a number of electrolytes at acidoses and alkaloses: sodium, potassium, chlorine, bicarbonates, etc. Students study a number of diseases, e.g. cardiovascular, renal, digestive system, etc. where there is a disturbed electrolyte balance. Studied is the metabolism of sodium, water, potassium, calcium, magnesium, acid-alkaline disturbances. Discussed also are the diseases leading to disturbances of the concentrations of oligoelements in the blood serum, for example, iron deficiency anaemia, thalassemia, professional poisoning with lead, zinc, etc., copper in Wilson-Konovalov disease, etc. Based on this knowledge of the student studying "internal diseases"

practical guidelines and solutions are offered such as: etiology, clinical case, laboratory diagnostics and treatment in case of disturbance of the processes of water-electrolyte and alkaline-acid equilibrium of the body. In their practical exercises in chemistry students of medicine study chemical composition and chemical analysis of concrements. This analysis is also an activity of the clinical laboratory. "Internal diseases" studies diseases caused by their formation: nephrolithiasis and cholelithiasis. The most direct, however, is the connection in the so-called. "chemical diseases"-silicosis, argyria and in various poisonings with inorganic acids and alkalis, some organic acids, nitrogen and its compounds, chlorine and its compounds, copper and its compounds, lead and its compound, carbon monoxide, ethyl alcohol, methyl alcohol, pesticides, and also various drug poisonings. In addition, while chemistry shows the source of the poisoning, the chemical composition and the constitution of the poison, the internal diseases offer the appropriate treatment. (1, 2, 3, 5)

"Clinical Toxicology" examines the exogenous poisonings caused by the widespread use of drugs, and as a part of internal diseases, it has found its own development in recent years. Proceeding from the poisoning agents, in the majority of chemical substances, the specialist in this field has to have good chemical knowledge. Poisoning with inorganic substances requires knowledge of some metals and their compounds - lithium, potassium, sodium, copper, silver, gold, platinum, osmium, beryllium, magnesium, barium, zinc, cadmium, mercury, aluminium, thallium, lead, bismuth, vanadium, cobalt, chromium, nickel, manganese, iron, uranium; knowledge of some non-metals and their compounds – fluorine, chlorine, bromine, iodine, oxygen, sulphur, selenium, tellurium, nitrogen, phosphorus, arsenic; knowledge of inorganic acids and bases.

Poisoning with organic substances requires knowledge of hydrocarbons – fatty saturated and unsaturated, low and high, aromatic hydrocarbons; halogenated derivatives of hydrocarbons; hydroxyl derivatives of hydrocarbons – alcohols, glycols, phenols; carbonyl derivatives of hydrocarbons – aldehydes and ketones; carboxylic acids and their derivatives; carbonic acid and its derivatives; nitrogen-containing organic compounds – amines, amino alcohols, nitro compounds, nitryls (cyanic acid and its salts); organic compounds containing sulphur – thiols, sulphuric acids; agricultural poisons-phosphorous-organic compounds, pesticides, carbamates, etc. In the special medical toxicology, chemical knowledge is required in poisoning with barbiturates, analgesics and other sedative drugs; poisonings with poisonous warfare agents - neuroparalytic, skin rash, suffocant, with psychotomimetic, tear gas, causing sneezing, etc. Food poisoning and poisonings with plants require chemical culture. (4)

The discoveries of W. Röntgen, A. Becquerel, Marie and Pierre Curie and other give the foundations of the medical discipline "Roentgenology and Radiology", which continues to develop only because of the discoveries in the field of chemistry and physics. Nowadays, one or another radiation therapy is used in the diagnosis and treatment of any disease of a sick person. Students learn the basics of radiophysical and radiochemical diagnostics – the structure of the atom, radioactivity, infrared rays, the nature and properties of X-rays, X-ray apparatuses, magnetic resonance imaging, ionizing radiations and also chemical contrast agents in the radiation diagnostics - barium sulphate, iodine compounds - water or fat-soluble and other, chemical substances such as pharmacological agents, pharmaco-radiological examinations and other, chemicals for the chemical treatment of films in roentgenography, etc. The textbook of K. Vlahov noted that "Nowadays we have a special area in science-radiation chemistry created, that studies radiation-chemical reactions resulting under the effect of X-rays. The effects of X-rays on water have a particularly important role in Radiochemistry. This question has even greater influence since 90% of the tissues of the human body contain water. "The author further examines the action of X-ray photons on water, the formation of ions and OH radicals and further chemical transformation of water. (6, 7)

"Anaesthesiology" started its beginning in the 19th century with the use of ether in the early XIX century in America as anaesthesia for pain management in surgical intervention. Then follows the "time" of the chloroform as an anaesthetic. Today, the means of anaesthesia, again, are chemical substances – local anaesthetics – cocaine, procaine, etc., narcotic analgesics – morphine (isoquinoline-phenanthrene alkaloid), analgin (pyrazolone derivative), barbituric hypnotics (derivatives of barbiturates and thiobarbituric acid), inhalational anaesthetics - dinitrogen oxide (laughing gas), cyclopropane, ether, trichloroethylene, etc. (9, 14)

In "Dermatology" the classification of medicinal products operates both with chemical terms – medicines, grouped as antioxidants (tocopherol, ascorbic acid, tartrates,citrates, EDTA, etc.), preservatives (alcohols, esters of the P-aminobenzoic acid, organic carboxylic acids and their salts, aldehydes – formalin, cresols, etc.), vitamins, salicylic preparations, and also with concepts used in dispersion systems – hydrophilic-hydrophobic, lyophilic – liophobe, homogeneous dispersion systems, Solutions of HMWC, molecular and Ionic Solutions, colloid (microheterogeneous) solutions-emulsions, suspensions, foams, aerosols, macroheterogeneous dispersion systems – powdered materials, granules, powders, etc. In the past, widely used for the treatment of skin diseases was arsenic, today the use has been significantly limited, but still some simple substances-calcium, magnesium, sulphur and others are well used. (10)

The first major breakthrough in the treatment of "Infectious diseases" is made by Alexander Fleming, who discovered the classic treatment of malaria – penicillin. Today, synthetic anti-malarial preparations are based on quinoline derivatives. Following is the discovery of modern synthetic antibacterial agents-sulphonamides, inhibiting the metabolism of para-aminobenzoic acid. Then follows the discovery and use of antibiotics having predominantly bacteriostatic effect, disrupting the exchange of parasitic microorganisms, for example, and penicillin, keeping the synthesis of the cell membrane susceptible to the bacteria, tetracycline, streptomycin and other antibiotics selectively suppressing the protein building of the microbial cell and other analgesic agents for calming pains such as salicylic preparations, pyrazolone preparations, prepartions of the belladonna and other sedative and sleeping pills agents – barbiturates, chloralhydrate, etc., antihistamine preparations etc. All these successes in the field of infectious diseases are due largely to the "programmed" synthesis of synthetic drugs. (11)

Chemical knowledge helps significantly in the epidemiology of infectious diseases. For the discipline "Medical epidemiology", chemical knowledge is the basis for the good application of a number of important epidemiological events – disinfection, disinsection, deratization and sterilization for the effective destroying of the living carriers of infectious diseases-pathogenic microorganisms, insects, rodents. Chemical methods include the use of acids (hydrochloric, acetic), alkalis (potassium, calcium), halogenated derivatives of hydrocarbons (DDT, hexachlorane, calcium oxychloride, iodoform), chloramines, iodine, phenol and its derivatives, alcohols (ethanol, glycerol, propanols), carbonyl derivatives (formalin, paraform, glutaraldehyde), and active agents (detergents, soaps), etc. (8)

Modern textbooks on "Surgical diseases" largely reflect the indisciplinary nature of surgery. The surgeon now should have more competence and knowledge in the field of physiology, immunology, gastroenterology, anaesthesia, intensive care, nutrition knowledge-determination of energy consumption, calormetry and metabolic exchange, protein losses, amino acids, carbohydrates, vitamins, fats, liquids; knowledge on the violations of water-electrolyte and alkaline-acid equilibrium; knowledge on the antiseptics - destruction of microorganisms on the surface of the body and inside the body with chemical preparations-carbol (phenol), used by D. Lister to the more modern lysol, chloramine, iodine, iodine-gasoline, alcohol, hydrogen peroxide, potassium permanganate, Rivanol, etc.; The use of various chemical preparations such as local and general anaesthetics – laughing gas (N_2O), cyclopropane (C_3N_6), Xenon, diethyl ether, divinyl ether, chloroform, barbiturates,

benzodiazepines, quinol compounds, etc. Considered as surgical problems requiring chemical knowledge are the occurrence of bile concrements, nephrolithiasis, chemical injuries and burns, etc. (14, 15, 16, 17, 18)

In the "Ophthalmology" and "ENT-diseases" curricula, chemical knowledge is needed to identify and properly classify chemical factors such as acids, alkalis, toxic aerosols, heavy metal salts, etc. having an impact on those organs, with direct contact with the environment. Chemical knowledge is also needed in the understanding of a number of secretions, which are excreted – composition of the mucous fluid, the earwax, cis-, trans forms of retinal, as well as the chemical composition of eye and ear drops, artificial tears, ointments and unguents and other medicinal preparations – antibiotics, sulphonamides (29, 30, 31)

In "Paediatrics" chemical knowledge gives the fundamental basis for the interpretation of the disturbances of water-electrolyte and alkaline-acid balance in the child's organism. Modern proper nutrition and control of the development and treatment of children requires knowledge about the mineral composition of the food – the necessary macro and micro elements, vitamins – the correct use of water and fat soluble vitamins to prevent states of vitamin deficiency and hypervitaminosis. (14, 15, 16, 17, 18)

In "Urology" and "Nephrology" the knowledge on the disturbances of water-electrolyte and alkaline-acid balance in the body-absorption of bicarbonate ions, titratable acidity, sodium balance, water balance, exchange of chlorine and potassium ions are determining the patient's condition. Nephrolithiasis and the formation of concrements in the renal pelvis and bladder also requires the establishment of their chemical composition and the reasons for their formation. The chemical study of urine requires the determination of protein, nitrites, leukocytes, urine sediment, determination of some non-protein low molecular nitrogen-containing substances-urea, uric acid, electrolytes-sodium, potassium, etc. (28, 33)

In the medical disciplines "Immunology", "Neurology" and "Tropical Medicine", chemical knowledge gives the idea of the clinician of the chemical formula, structure, properties, toxicity of a number of chemical preparations – solvents, petroleum products, pesticides, heavy metals, medicines, food, and knowledge on chemical, plant and animal poisons. (21, 22, 23, 32)

Modern anticancer preparations used in "Oncology" can be classified according to their chemical structure and the mechanism of their effect in several groups: alkylating reagents, platinum preparations, anticancer antibiotics, antimicrotubular products – alkaloids of Vinca rosea and taxanes, inhibitors of topoisomerase II – epipodophyllotoxin derivatives, antimetabolites, hormones, hormonal antagonists, inhibitors of the synthesis of steroid hormones, other (new) antitumour agents. (26, 27)

However, the large toxicity and side damaging effects in the use of anticancer drugs are also known. A team led by Prof. Z. Raykov at the VMI – Stara Zagora (today Faculty of Medicine at Trakia University – Stara Zagora) conducted research and development of a method of combined chemotherapy with the widely used in the modern drug therapy of malignant neoplasms BCNU (Carmostine) CCNU (Lomustine) and AIDS-labelled nitrosourea SLCNU-1, synthesized by Prof. Z. Raykov. These are nitrosourea preparations having both alkylating and carbylation effect, determined by their structure: R_1-NH-CO-N(NO)-R_1, where-NH-CO- is the alkylation part, and -N(NO)-R_1 is the carbylation. A therapeutic regimen of the simultaneous use of the three preparations was made, with an appropriate regression model of the dependency minimum toxicity expressed by the life extension criterion (LE%), in a function of the content of the three preparations. The results of the research showed, that with chemotherapy of tumours with the help of combinations of nitrosourea, can be achieved a significant reduction in the total toxicity of preparations and an increase in their anticancer effect. (34, 35)

Necessary to achieve the above results is not only knowledge, not only in chemistry but also in mathematical modelling of chemical objects, computational methods in drugs structure, mathematical methods reflecting the relation chemical formula-biological activity, etc., which significantly exceeds student knowledge. In addition, this is the real proof of the relation chemistry – medicine. Therefore, only the in-depth knowledge of chemistry students is the necessary and important prerequisite for understanding the diagnostic methods used, for interpreting the results, for making an accurate diagnosis and evaluating the results of the therapy.

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