

XXIX Days of medical physics – a part of international scientific presentation of the MFCU in Bratislava on the 2nd. Year of International Specialised Exhibitions €XPO Bratislava SR, Inpharmed, Interlab, Non-handicap

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The first of scientific publications „Fragment of MF CU history (Bratislava 1919–1999) was issued in the year 1999, the second one, “Profesionalism and Progress and Health Support” followed in 2000 as a part of scientific program of International Specialized Exhibitions (ISE) of Incheba SLOVMEDICA – SLOVPHARMA – SLOVREHA 1999 and 2000 under guarantee of the dean of MF CU in Bratislava.

In the last year, on the first year of the ISE €XPO Bratislava SR INPHARMED, INTERLAB, NON-HANDICAP this cooperation was renewed. The accompanying program under the patronage of the dean of MF CU, prof. Pavel Traubner MD, PhD, was pointed on university pedagogy in accordance with conclusions of the Bologna declaration Profession and professionalism of university teachers at medical faculties. It looks to be right, that the specialized content of accompanying scientific programs is dynamically changing. During the years of its existence it transforms to new forms and frames. In this year, the MF CU enabled presentation of position and significance of branches medical physics, biophysics and radiology supported by ICT as they belong to curriculum of all medical as well as non-medical study programs at medical faculties (table 1). They are also supporting branches in prevention, regeneration, diagnostics and therapy. This international undertaking, organized under the patronage of the dean of MF CU, prof. Pavel Traubner MD, PhD and the president of the conference prof. Elena Kukurová MD, PhD, is a part of scientific undertakings with guarantee of international scientific associations: AMEE, EFOMP and IMEKO. This year, the presentation of and publicity of MF CU is under patronage of the redaction of Bratislava Medical Journal. There were 83 papers published of the conference, 73 of which are published in alphabetical order. Authors come from 10 medical faculties in Czech Republic and Slovak Republic and they have international credit as top experts in medical physics, radiology and biophys-

ics in theoretical, clinical and practical medicine and nursery as well as in technical and pedagogical sciences. But there are also the youngest participants, students of external form of study, just waiting for their international tribute.

Topic is pointed on following problems:

Irrecoverable position and importance of Medical Physics and Biophysics in the integration with Radiology, Information and Communication Technologies – Medical Informatics, Telemedicine, Biomedical Engineering in the:

- a) basic and applied medical research,
- b) diagnostic and therapeutic processes in the frame of health care and in the social care centres,
- c) curricula of medical and non-medical study programmes at medical faculties and others public higher educational institutions.

Direct and distant teaching in the pregradual education in the medical and non-medical study programmes guaranteed by the grant project of Ministry of Education SR KEGA 3/2030/04 “Transformation of the teaching theory postulates into interactive integrated teaching model in the contextual algorithm of medical, health and sport sciences managed by original set of the didactic technologies”.

Lifelong education of medical and health professionals. Educational programme evaluated by credits in accordance with Public notice of Ministry of Health of Slovak Republic about the criteria and method of continuing education of health professionals evaluation No. 366/2005 guaranteed by Slovak Medical Chamber, Slovak Chamber of Nurses and Obstetricians and grant project of Ministry of Education SR VEGA 1/0237/03 “Profession and professionalism of university teachers at medical faculties”.

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Position of subjects pointed on physics and informatics in the curriculum of medical and non-medical study programs.
(Kukurová, E., Kozlíková K., Kráľová, E., 2006)

Table 1.

Study Programme	PHYSICS			INFORMATICS			Hours
	Y/T/F	Course Name	Hours	Y/T/F	Course Name	Hours	
General Medicine	1/W/I	Biophysics	36/36	1/S/I	Informatika	0/12	
General Medicine	1/W/I	Biophysics	36/36	1/S/I	Informatics	0/12	
Dentistry	1/W/I	Medical Biophysics	24/24	1/W/I	Informatika	0/12	
Dentistry	1/W/I	Biophysics	24/24	1/W/I	Informatics	0/12	
Nursing	1/W/I	Medical Physics and Radiology 1	12/24	1/W/I	Informatics in Medical Practice 1	0/12	
	1/S/I	Medical Physics and Radiology 2	12/12	1/S/I	Informatics in Medical Practice 2	0/12	
				1/W/I	Telemedicine 1	0/24	
				1/S/I	Telemedicine 2	0/36	
				1/S/E	Informatics in Medical Practice	0/10	
				1/S/E	Telemedicine	0/10	
Public Health	1/W/I	Medical Biophysics	36/36	1/W/I	Informatika 1	0/24	
				1/S/I	Informatika 2	0/24	
				2/S/I	Biostatistics	0/36	
Obstetrix	1/W/I	Medical Physics and Radiology 1	12/24	1/W/I	Informatics in Medical Practice 1	0/12	
	1/S/I	Medical Physics and Radiology 2	12/12	1/S/I	Informatics in Medical Practice 2	0/12	
	1/S/E	Medical Physics and Radiology	15/15	1/S/E	Informatics in Medical Practice	0/10	
Physiotherapy	1/W/I	Biophysics and Biomechanics 1	12/12	1/S/I	Basics on Informatics	0/10	
	1/S/I	Biophysics and Biomechanics 2	12/12	1/S/E	Basics on Informatics	0/10	
	1/W/E	Biophysics and Biomechanics 1	10/5				
	1/S/E	Biophysics and Biomechanics 2	10/5				
		Medical Biophysics	12/12	1/W/I	Informatics 1	14/28	
Laboratory Examination Methods in Medicine	1/W/I	Laboratory Technique	12/12	1/S/I	Informatics 2	14/28	
	1/W/E	Medical Biophysics	10/5	1/S/I	Seminar to Bachelor Work	0/18	
	1/W/E	Laboratory Technique	5/5	1/W/E	Informatics 1	5/10	
				1/S/E	Informatics 2	5/10	
Regeneration	1/W/I	Biophysics	12/12	2/W/E	Seminar to Bachelor Work	0/10	

Y/T/F Year of Study / Term (Winter, Summer) / Form (Internal, External)

Hours Lectures / Practicals (Seminars)

XXIXth DAYS OF MEDICAL BIOPHYSICS

Body surface mapping of electric field of heart atria

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Body surface mapping is a method, which started in the first half of the XX century. It is very advantageous as a high sophisticated method above standard diagnostics. Examination result is represented by electrocardiographic (ECG) body surface map – a displays of voltage over the whole chest.

Areas or points which have the same values of voltage, have the same colour or they are connected by a line. Isopotential ECG map shows distribution of voltage values on the chest surface in a given moment. A set of maps is used to display propagation of heart depolarisation. Location of maximum and minimum depends on direction of propagation of the activation front. Using these maps, 2 types of atrial activation in adolescents were recognised. The first one is vertical type and the second one is oblique type.

Isointegral maps provide more compact information of the electric field than the potential maps. They show disitribution of voltage time integrals. This enables reduction of data and of map number. These maps may be used to display changes on ECG maps caused by body position and respiration.

Overall changes of heart atria activation were studied using isointegral body surface maps. The 2 mostly used baseline set-

tings – 2-points and 3-points were evaluated. Significant changes were found only in P wave duration. If the 2-point baseline was used, P wave was shorter than P wave with the 3-point baseline.

Besides localisation and value of extrema, also dipolar or multipolar character of maps and appearance of pseudopodes is usually evaluated.

Application of P wave maps can be in rhythm disorders but first of all a suitable database of atrial activation maps under physiological conditions has to be formed.

References

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XXIXth DAYS OF MEDICAL BIOPHYSICS

Power spectral analysis of phrenic inspiratory nerve activity in the anesthetized cats

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In the present study, we performed the power spectral analysis of the inspiratory phrenic nerve activities in cats during quiet breathing under pentobarbital (QBP) and chloralose (QBCH) anesthesia, tracheobronchial (TBCP, TBCCH) and laryngeal (LCP, LCCH) cough under both types of anesthesia, respectively.

The experiments were carried out on anesthetized non-paralyzed adult cats under pentobarbital (P) and chloralose (CH) anesthesia. The power spectral analysis of the phrenic nerve activity was performed during eupnoeic inspiration and during inspiratory phase of mechanically induced tracheobronchial and laryngeal cough. Distribution of the spectral power was analysed in the four frequency bands (FB): p0-20, p20-40, p40-60, p60-80, which represent frequency range of the corresponding percentage intervals of total spectral power.

Comparison of FB widths in coughs and QB under P or CH anesthesia revealed that widths of p0-20 during LCP and TBCP were significant narrower than p0-20 in QBP. Conversely, p60-80 in both types of cough were wider comparing to p60-80 in QBP. In cats under CH anesthesia, p0-20 and p20-40 were narrower in LCCH than these FBs in QBCH. Also p0-20 of LCP was narrower compared to p0-20 during QBP. Conversely, p60-80 in LCCH and LCP were wider than p60-80 during QBCH and QBP. No significant differences were found among the widths of frequency bands for TBCCH and QBCH. Distribution of power in spectra of QB under different kinds of anesthesia exposed the following difference: the width of p0-20 for QBP was wider than that for QBCH. When we compared FBs in LC or TBC under both types of anesthesia, we found that p40-60 of LCP was wider than p40-60 of LCCH.

Similarly, p40-60 of TBCP was wider than p40-60 in TBCCH.

The spectral power for QBCH was more cumulated in the region of low frequencies than for QBP. On the other hand, the spectral power for TBCCH and LCCH was concentrated in the

regions of low frequencies under both types of anesthesia in cats. Thus, an influence of P and CH on spectra during cough augmented inspiratory activity seems to be different than the effect on the eupnoeic inspiration.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Transformation of medical study from the aspect of biomedical teaching subjects

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Realisation of generally accepted principles of Bologna declaration is a current task of many Slovak higher education institutions, namely in the context of the new Higher Education Act. Implementation of credit system based on European Credit Transfer System (ECTS) contemporary with recommendations of World Federation for Medical Education (WFME) by institutions prepared students in the medical study programmes has assured their compatibility with similar study programmes in European and world's universities. In despite of difficulties by their application the advantages for students and teachers mobility at faculties of medicine are undoubted.

Faculty of Medicine of Comenius University in Bratislava (FMCU) is preparing the compatible system of medical education according the recommendations of WFME and ECTS. It is the way of reaching the compatibility in European Higher Education Area (EHEA). Therefore all study programmes and curricula were reviewed. Credit transfer system is applied with the aim to open more possibilities for teachers and students mobility. In the same time the problems in compatibility of selected biomedical teaching subjects have arose by some theoretical (Medical Physics, Biophysics, Medical Chemistry, Biochemistry, Biology, Physiology etc.), preclinical and clinical subjects in European area, mainly in their syllabus, number of teaching hours and corresponding number of credits.

Institute of Medical Chemistry, Biochemistry and Clinical Biochemistry FMCU has continuously realised the reform of study programmes of the subjects Medical Chemistry and Medical Biochemistry. It has to be underlined the difference between the teaching subject Chemistry that is taught at secondary schools and Medical Chemistry and Biochemistry as extension and application at higher level during university medical study. Syllabi of both last mentioned teaching subjects together with other biomedical teach-

ing subjects are oriented on the study of natural and medical sciences fundamentals that are useful for understanding a lot of physiological and pathological mechanisms in the cells, organs and organism.

Beyond all expectation and tendencies, these subjects are not compatible with that at some Slovak, Czech a European medical faculties, till now. The main difference consists in the number of teaching hours in the semester, respectively school year. It can be concluded that both Medical Chemistry and Medical Biochemistry at our faculty have lower number of teaching hours than at Czech and European medical faculties (30 % and 25–30 %, respectively). From this state also different number of credits follows. Therefore the free transfer of students represents a problem and usually the exigency of additional teaching and exams.

For fulfilling the requirements of the EHEA in Slovakia we have to:

- create the committees of professionals that would synchronise the study planes, credits on the
- level of departments, faculties, universities with European educational system,
- evaluate and harmonize the academic degrees,
- solve transparently the economic guarantee of the higher education by Ministry of Education of Slovak Republic.

The scientific and pedagogical staffs in co-operation with faculties' management are obliged to prepare the possibilities for free mobility of students and transfer of credits, in the context of accepted documents (WFME, ECTS) in near future. Only accomplishing above mentioned tasks could be completely implemented the measures formulated in Bergen (2005) that create assumptions for satisfying requirements of EHEA till 2010.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

Asserting Bologna Declaration in restructuring of school system at Comenius University Medical School Bratislava

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Asserting Bologna Declaration into university education is a long-term and challenging process. New features have to be asserted sensitively in order to develop school system and to strengthen the baseline for Declaration. Slovakia has started the restructuring of university system and study programs undergoing the process of accreditation, however marked support (or

reform) for covering the costs of university education is missing (expressed as % of gross domestic product, Slovakia is still not comparable to other EU countries). At present, not satisfactory economic conditions prevent from reaching the content, personal and equipment preconditions at universities.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Frequency characteristics of Nitinol spiral stent as a comparative method to the non-destructive method testing the defects

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Our aim is to uncover the causes of the sources of defects and above all to uncover all possibly defective Nitinol spiral stents before they are used by a patient. For that reason we will use non-destructive testing methods.

This article is a part of a preliminary study of methods for finding frequency characteristics and resonance frequencies of Nitinol spiral stents. Destructive methods of testing materials using its frequency characteristics are very well known. It's very easy to define the relationship between the resonance frequency (frequencies) of the observed object and its material properties. We will use the most suitable method as a comparative „calibration“ test for our currently developed non-destructive method of testing the Nitinol spiral stents. The reason is relative simplicity and explicitness of these destructive methods. The first and simplest method we used was measuring the resonance frequency of forced oscillation of the Nitinol spiral stent. We used the electromagnetic field as a source of the forced oscillation. The measuring apparatus consisted of: the jig for generation of suitable electromagnetic field causing the forced oscillation of the Nitinol spiral stent; the permanent magnet used as a weight; the function generator ZOPAN POF-1; the ISES system with the module for

measuring the alternating current; the ISES system with the module for measuring the force. We observed the phase shift between the time flow of the measured alternating current passing through the excitation winding and the time flow of the force acting on the fixture of the Nitinol spiral stent with the permanent magnet as a weight in this method. If the shift between these two time flows is $\pi/2$, there and then the system is in resonance. Then we provoked a mechanical destruction of the Nitinol spiral stent and we observed the shift of the resonance frequency of the system. Also we assumed that the resonance frequency would fall down with the drop of the rigidity of the stent, caused by the mechanical destruction. But the result did not match our expectation! The explanation seems to be very simple according to the mathematical model. We had to consider the effect of elongation of the stent caused by the applied load which at the same time non-linearly changed the rigidity of the stent to higher values.

Because of this phenomenon this measuring method has been rejected as a comparative “calibration” test. Then, based on our measurements, we adjusted the procedures and developed more suitable measuring method. This method uses a constant range of deformations. Now we are testing this method.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Digitalization in radiology

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Diagnostic modality CT, MR a PET produce digital images which might be utilized by remote access (telemedicine, tele-radiology).

There is currently no digital network connectivity within Bratislava or Slovak Republic between scientific institutions of Medical Faculty, University Hospital and other specialized health care institutions for cardiology, neurosurgery, neurology, oncology, orthopedic etc.

Project designs the basis for remote communication of radiology studies (images of nuclear medicine) within Bratislava for workplaces offering undergraduate and postgraduate studies of

medical sciences. Basic system allows making image studies anonymous, which can be prepared and archive as a basis of exemplary diseases for the planned e/Learning system. Project will connect medical schoolrooms having IT infrastructure with radiology and nuclear medicine modalities and subsequently with other image sources like microscopes and endoscopes of histology, pathology and surgical disciplines. Students and postgraduate scholars will get possibility of remote access to most sophisticated diagnostic technology which can not be guaranteed in praxis by physical presence.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Effect of physical factors on cavitation threshold

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Cavitation constitutes potential hazard in ultrasound (US) diagnostics and therapy so that detection of cavitation is of great interest. However, cavitation represents even a higher risk especially when an microbubble-based echocontrast agent is used. The major goal of the present work was to develop a cavitation detection method based on increased level of cavitation noise in the range of low frequencies (about 1 Hz). This method was applied in vitro using a model of body fluid containing an echocontrast agent (ECA) simulated by 5 % sonicated solution of lyophilized egg albumin.

Thus, 250 ml of solution is applied to a chamber. The solution is then insonated by US with the frequency of 1 MHz and intensity of 0 to 1.3 W.cm⁻². US signal evokes cavitation in microbubble suspension accompanied by cavitation acoustic noise. The resulting signal is preamplified, sampled and processed by fast Fourier transform. In presence of cavitation, the level of noise voltage increases in the frequency range of 0.1 to 2 Hz. It is possible, using this method, to determine the value of cavitation threshold (i.e. the intensity of US able to cause cavitation).

The purpose of our study was also to find out how the cavitation threshold is affected by changing temperature, viscosity.

Tween 80 was used as a viscosity factor. It is absolutely inert to proteins and it can increase viscosity. Four types of experiments were carried out. The first one was a control measurement of the cavitation threshold in distilled water. Using this medium it was difficult to observe any cavitation under given conditions — intensity varies from 0 to 2.5 W.cm⁻² at 28 °C. The second experiment was the measurement of the cavitation threshold of ECA model in the normal laboratory conditions (28 °C). In this case, the threshold was 0.3 W.cm⁻². The last two experiments consist in changing the physical conditions. The cavitation threshold decreased with growing temperature from 0.3 W.cm⁻² at 24.5 °C to 0.1 W.cm⁻² at 38.5 °C. The cavitation threshold increased with growing kinematic viscosity from 0.3 W.cm⁻² at 9.07x10⁻⁷ m².s⁻² to 0.7 W.cm⁻² at 1.51x10⁻⁶ m².s⁻².

Presented method of cavitation threshold detection can be suitable for development of an algorithm, which would be able to recognize a sharp growth of the level of the acoustic emission. Then this method could be implemented to US diagnostic apparatuses.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

One equation for arterial pressure

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There are two models, systolic and diastolic, for arterial pressure resulting in two differential equations. We show that only

one equation will suffice. It could be used for smoothing the measurements of arterial pressure.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Influence of electromagnetic fields radiated by mobile phones on human organism and some investigation methods

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A question of safety of mobile phone use is one of most frequently discussed topics of these days. The aim of the work is to introduce some methods used for investigation of interaction between EM field radiated by mobile phone and human body. The single methods are briefly described and their results are introduced. A simple simulation model for determination of mutual effect of mobile phone and human head will be designed for comparison with the existing ones.

Because the inner part of a human body or human head are not accessible for measurements, both theoretical methods (using mostly principles of the finite element method) or experimental methods (using obviously some kinds of human body part models) are most frequently used. Some of models are made of artificial materials, permittivity of which is the same as of human tissue. Well known model of human head is a spherical glass shell filled with the liquid with the dielectric constant close to this one of human head tissue. The source of EM field can be real mobile phone or simple dipole antenna radiating at the same frequency as the mobile phone. Theory is based on Maxwell equations of electromagnetic field. The frequency is of 10⁹ Hz order which belongs to the category of non-ionizing radiation. For this

reason, thermal effects or field distribution or specific absorption rate (SAR) can be measured or calculated.

In this work, a simple model of spherical shape was designed, dimension of which was obtained from the average value of real human head dimension. There are three kinds of them. The first was a homogeneous model and the rest ones were inhomogeneous (or homogeneous in single parts). Model of mobile phone was of brick shape, with dimensions of usual handsets. Calculations (EM simulations) were performed in commercial code FEMM (with the planar symmetry). Electric (or magnetic) field distribution then has been displayed.

The results obtained by the use of a simple simulation model of human head show good agreement with the assumption. The geometry of a human head influences the field distribution in the system mobile phone – human head. Influence of hand holding the apparatus has not been taken into account.

The simple models has been developed, the accuracy of obtained results is in correspondence with accuracy of designed models. The aim of further work is to refine existing model and to compare it with the measurements performed on a phantom model.

XXIXth DAYS OF MEDICAL BIOPHYSICS

The influence of cholesterol and β -sitosterol on the EYPC multilamellar liposomes

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Sterols are important membrane components in all eukaryotic organisms. While animal membranes contain one major sterol — cholesterol, plant membranes are characterised by a higher complexity in their sterol composition. The most widespread sterols in plants are beta-sitosterol, campesterol and stigmasterol. Plant sterols differ structurally from cholesterol only with regard to their side chain. Interest is focused on plant sterols because of a wide range of their biological activities (anti-inflammatory, cholesterol-lowering, anti-microbial, anti-bacterial, anti-fungal, anti-tumour and chemopreventing activity).

We studied the effect of one of the plant sterols, beta-sitosterol (SIT), in a model system, multilamellar liposomes of egg yolk phosphatidylcholine (EYPC). Effect of SIT on the phospholipid bilayer was compared with that of cholesterol (CHOL).

First, we investigated the effect of both sterols on the Cu^{2+} -induced EYPC peroxidation. The process of lipid peroxidation was monitored spectrophotometrically by the estimation of lipohydroperoxides with the structure of conjugated dienes. SIT inhibited the EYPC peroxidation in the lag and propagation

phases. The effect of SIT on the EYPC peroxidation was similar to that of CHOL. We tested the scavenging radical activity of SIT and CHOL in the DPPH test and compared the results with known antioxidant stobadine. As expected, sterols were totally ineffective in scavenging DPPH radicals. Despite several oxidation products of cholesterol were detected during lipid peroxidation in the presence of CHOL, we believe that the crucial role of sterols in the peroxidation inhibition is the influence on the structural properties of EYPC bilayer. Therefore we studied the influence of both sterols on the behavior of two stearic acid spin labels in EYPC bilayer using EPR spectroscopy. We have shown that CHOL increased order parameter in the hydrophobic part of the bilayer near the lipid-water interface and decreased the mobility of acyl chains in the central part of bilayer. Both effects depend approximately linearly on the CHOL:EYPC molar ratio in the range 0–1. The effect of SIT is close to that of CHOL at molar ratios SIT:EYPC=0.1–0.4. With further increase of SIT concentration a plateau was observed for both order parameter and parameter characterizing the acyl chain mobility.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

Dynamics of mechanical behavior of bones – measurements, models and consequences

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Measurement of dynamic response of samples of bones. Identification of rheological models. Calculation of parameters. Influence of parameters on maximal stress in dynamic loading.

Dynamic mechanical behavior of bones is essential for assessment of the compatibility of bones and artificial materials. The dynamic is connected with risk of rupture and fragility of bones. Availability of measuring limits progress in this research. We designed convenient apparatus for measurement of dynamics of mechanical responses of biological material. Identification of models and estimation of their parameters was based on analysis of characteristics in bending and torsion loadings.

15 samples of human bone (caput femoris, substantia compacta) were measured. Age of donors was 50–80 years. Measuring system was described in our papers.

Behavior of samples corresponds to Voight's model connected with inertial body. Parameters of models were in intervals as follows: Young's module: 85–300 MPa, shear stress module: 32–130 MPa, viscosity: 58–250 kPas.

Dynamic response of bones with parameters as found in our samples will be of periodical character. Maximal stress and strain in impulse response will be inversely dependent on viscosity. The risk of rupture is growing with ratio between elastic and viscose coefficients.

XXIXth DAYS OF MEDICAL BIOPHYSICS

**Didactical aids of Sports Medicine for students of interdisciplinary studies Faculty of Sports and Physical Education and Medical Faculty Comenius University-regeneration
(The proposition of contents)**

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The aim of the didactical aids is to provide students of regeneration (interdisciplinary studies Faculty of Sports and Physical Education and Medical Faculty Comenius University) with sufficient literature, not only for examination preparation, but also for application of gained knowledge in future practice, independence study, distance and lifelong education.

Proposed contents of the project:

- 1) Definition and the aims of sports medicine.
- 2) Sources and release of energy at different stages of the effort.
- 3) Physiological responses and adaptations to exercise:
 - musculoskeletal,
 - cardiovascular,
 - respiratory,
 - immune,
 - excretory systems.
- 4) Complex medical examination of athletes.
- 5) Anthropometric examination.
- 6) Functional diagnostic tests in laboratory:
 - functional tests of cardiovascular and respiratory systems,
 - assessment of alactic and lactic anaerobic capacity,
 - assessment of endurance capacity,
 - ergometry,
 - spiroergometry.
- 7) States related to exercise.
- 8) Fatigue:
 - reasons,
 - types.
- 9) Regeneration:
 - forms,
 - indications.
- 10) Rehabilitation in regeneration of athletes.
- 11) Changes of the internal environment:
 - water and electrolyte balance during effort,
 - water and electrolyte balance during regeneration.
- 12) Sports medical field evaluation:
 - content,
 - methods.
- 13) Particularities of physical activity:
 - in children, adolescents,
 - females,
 - elderly.
- 14) Nutrition and water balance – its importance in regeneration.
- 15) Physical activities and sport under climatic extreme environment:
 - heat, humidity,
 - cold.
- 16) Physical activities and sport under extreme pressure environment:
 - underwater,
 - high altitude.
- 17) Biorhythms.
- 18) Doping and doping control.
- 19) Sports traumatology:
 - prevention and treatment of sports injuries,
 - acute sports injuries,
 - chronic overloading of the musculoskeletal system,
 - first aids.
- 20) Genetic factors limiting physical performance.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

Microwave measurement of biological materials dielectric properties

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Accurate measurements of biological substances dielectric properties are essential for both fundamental studies and biomedical application (e.g. microwave hyperthermia). The aim of our study was to measure the dielectric properties of muscle at microwave frequencies. Dielectric properties such as conductivity, loss tangent, absorption coefficient and penetration depth of electromagnetic field it is possible to determine from the measured complex permittivity values.

An essential element in the study of possible health hazards caused by microwaves is the calculation of the absorbed energy by human. Also for the study of microwave hyperthermia, it is necessary to simulate human biological materials at microwave frequencies. The amount of energy absorbed by living tissue is also a function of the complex permittivity of a biological material. Therefore, it is essential to know dielectric properties of biological materials.

Various measurement techniques can be adopted to measure the complex permittivity of biological material. We used non-destructive method for measuring the complex permittivity of muscle using rectangular waveguide measurement system in the

frequency range 9–10 GHz. Measurements were made on simulated muscle mixtures. The used mixtures had dielectric properties close to biological tissue. We have changed the concentration of NaCl and sucrose in water sample by modification of the Hartsgrove mixture, which using is not successful at the higher microwave frequency range.

We obtained the complex permittivity values for samples corresponding to various compositions of mixtures simulated muscle. We have showed that sucrose dominates the dielectric properties of measured materials. This is because sucrose molecules have significant effects on water molecular structure at high frequencies and our formulas are base on the dielectric properties of water.

The obtained results indicate the importance neither complex permittivity values nor dielectric volume of the constituents which enable tailoring of phantoms and substitutes of living tissues and find application in numerical simulation of cells, microwave imaging, Specific Absorption Rate determination in biomedical application.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Alternative methods of evaluation of pregradual medical education at medical faculties aimed to obtain objective information about the teaching process

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Education process in pregradual medical study has its own inputs and outputs. A teacher as well as a student is parts of this process, but their function is not passive. Students can be or not need to be passive consummates of service offered by the university. The quality of education on medical schools is understood in complex frame, so that the active role of students as well as interpersonal relations must be considered. University must ensure environment, which supports such active role of students.

Education model contains:

Input (students) – Education process (teaching) – Output (graduates)

Pregradual medical education requires the teaching goals defined in the profile of graduates of medical faculties to get familiar with use of modern technical aspects of teaching and with effective system of evaluation of the pedagogic process.

There are two ways of, control, management and evaluation of quality of education process: rational and objective. Both must respect the autonomy of evaluated subjects following from academic rights. Both ways evaluate teaching as a complex – inputs (analysis of all elements entering the education process), own process and its outputs (reached results). Most commonly applied was the use of measurable quality indicators and methods

of analysis of good and bad aspects – positives and negatives of the evaluation unit related to chosen quality aspects. It is necessary to use both ways parallel, since separately they do not provide complex information.

Approaches of education process analysis are:

1. a) Objective way (observation-based approach), when the teaching is analysed by exact methods.

b) Subjective way (perception-based approach), when the teaching is analysed on the ground of responds (students, teachers).

The teaching process can be analysed during the semester, during the examination period and after finish of the academic year. The measurable indicators are: participation on the teaching, obtained results, number of non-successful exam terms etc.

2. a) Autonomic evaluation is based on evaluation of the goal of the education process.

From autonomous point of view of student → teacher → student is changed, the key element is student. A student is introduced as a manager of its own education with necessary help of a teacher (assistant), who escorts (consults), evaluates obtained knowledge (seminars, practical training, ŠVOČ (scientific competition of students), dissertations).

b) Heteronomous evaluation evaluates the mean of teaching.

From heteronomous point of view the actor is changed in the way: teacher → student, the key element is the teacher. The teacher chooses optimal means of teaching and as the manager and motivating factor motivates the student.

Autonomous and heteronomous evaluation of the education process completes each other and they can be used also for evaluation of medical study.

3. Classical methods of education process evaluation:

a) Direct evaluation — represents direct evaluation of study programmes (balance of subjects, rate of content of lectures, prac-

tical training and independent study, flexibility, stages and practice in hospitals), organisation of the study (accessibility of basic information about the content of subjects, study literature, possibilities to interrupt the study, to change study branch or individual subjects, or to study at different faculties, forms and methods of teaching (lectures, seminars, practical training oriented to problems, teaching sing projects, ŠVOČ, consultations, distance teaching), evaluation of the teacher's participation, evaluation of the students progression) – evaluation during whole semester or only during the examination period, exams, credits, retake exams).

b) Indirect evaluation of education process – represents evaluation of outputs of the education process, – level of realisation of quality criteria for a graduate of a medical school. This enables to define the level of knowledge according to requirements of practice.

Evaluation of graduates of medical schools can contribute to significant increase of quality and affectivity of pedagogic work and to higher mobility of students as well as teachers leading to their assert on the work market of the EU.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

Is the professional damage of a skin by an ionising radiation still actual diagnosis in Slovakia?

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The damage of a skin by an ionising radiation differs in morphology and clinical picture depending on the character, the dose, level and space distribution of radiation energy, as well as the radio-sensitivity of each skin part. Long-term (chronic) radio-dermatitis often results from radio-dermatitis II and III level caused by doses bigger than 12–15 Gy or by summation of even repeated small doses in period of a few months to 2–10 years. It

usually affects the skin of fingers on the hands. Initial changes are discrete, without any signs of an inflammation, having a character of degenerative and proliferate changes. Poikilodermis – long-term (chronic) atrophy of usually sclerotic type, spotted hyperpigmentations and teleangiectasis – is created later, gradually.

Authors describe case of 61 years old man, who was working for 34 years as radiology technologist in hospital. Symptoms were

firstly recognized as poroceratosis Mibelli, later as focal neuro-dermatitis. These symptoms have began before 18 years with increased keratinizing together with formation of paining cracks of skin in the regions of elbows, metacarpal joint areas of both hands, and the ventral side of thorax, just below sternum.

Present local and typical histopathological findings represent long-term (chronic) radio-dermatitis.

Long-term (chronic) radio-dermatitis is always taken as a kind of professional disease, affecting predominantly the medical

employers. Atypical localization and slowly developed histopathologic findings may explain different diagnostic problems before the diagnosis is completed. Hence, we have put in a request for sanitary probe of his workplace considering the proposal for commission for examination of professional skin disease. This disease is represented as the long-term process with an uncertain behaviour in its future. However, it needs both to dispense and care for it as a serious precancerous problem.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Cartilage regeneration of miniature pigs using autologous chondrocytes

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Biodegradable artificial scaffolds seeded with autologous chondrocytes improve regeneration of cartilage defects, re-differentiation capacity of chondrocytes and provide them with an appropriate mechanical stability. Based on our previous successful six-week study on rabbits, we tested the properties of new collagen(hyaluronate)fibrin composite scaffold to repair the osteochondral defect of the knee of miniature pig. Nine male miniature pigs were included in the study. A mixture of chondrocytes (9×10^6 cells per ml of scaffold) in the composite scaffold containing hyaluronate sodium, type I collagen and fibrin was prepared. Simultaneously, we prepared the same scaffolds without cells. The scaffolds were implanted into the non-weight-bearing area of the femoral trochlea of miniature pigs. Defects of three

miniature pigs were left empty (control group). MR examination of the operated knee was performed 12 and 24 weeks after the operation. 24 weeks after the implantation, the femoral trochleas were analysed histologically and immunohistochemically.

The defects implanted with scaffolds containing autologous chondrocytes were filled predominantly with hyaline-like cartilage, partially fibrocartilage. The regeneration was accompanied with glycosaminoglycans and type II collagen production. The scaffolds without cells created fibrocartilage and control defects were filled with fibro-vascular tissue.

Composite collagen(hyaluronate)fibrin scaffold efficiently regenerated osteochondral defects in miniature pigs in a six-month study.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

Optical aids – The possibilities of compensation of low vision

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Low Vision (LV) is a deterioration of vision that significantly impairs the quality of life low vision patient (LVP) and can not

be adequately corrected with medical and surgical therapy, conventional eyeglasses or contact lenses. Low Vision Specialists

tend to use various compensatory devices and technics to help LVPs to utilize their remaining vision to its fullest potential. Low Vision can be caused by different eye and central visual system diseases with different type of functional consequences such as loss of acuity (overall blur), central or peripheral field defect or their combination. In Slovakia Low Vision is defined as worsening of the best corrected visual acuity (BCVA) less than 5/15 or constriction of visual field under 30°. The type and severity of eye disorder influences the ultimate effectiveness of any LV intervention. The magnification of the image on retina is a major tool of low vision rehabilitation. There is increasing number of LVPs, while only 1 Low Vision Specialist – Ophthalmologist is working in Slovakia. We would like to share our 6 years experience with prescribing of the optical aids for compensation of low vision.

After comprehensive low vision examination, including evaluation of distance and near acuity by using special distance and near chart, refraction, determining of visual field and contrast sensitivity, with prediction of magnification, we work with 4 types of magnifying optical aids depending on individual requirements. As near low vision devices we use spectacles (hypercorrection and hyperoculars), hand and stand magnifiers. The basic optical principle is the same, high plus lenses with different style of fitting which determine working distance. The dioptric power of lenses divided by four determine the magnification of devices, the focal point is reversed value of dioptric power in meters. The magnifiers can be without or with different type of illumination for enhancing the contrast. The telescopes are the only optical devices that magnify the image of distant, intermediate and near objects. There are two types of telescopic systems used for low

vision: Galilean and Keplerian. The Galilean telescope has a plus objective and a minus ocular lens that produces a virtual, erect image. The Keplerian telescope has a plus objective and a plus ocular lens that produces a real, inverted image. Internal prisms to produce an upright image are incorporated in a Keplerian telescope, which can have either straight-ahead or lateral optics. The ratio of dioptric power of ocular lens to objective lens determines the magnification of telescope. Telescopes are either handheld or spectacle-mounted. They can be for monocular or binocular use. If they are spectacle mounted, telescopes can be placed in various positions in a carrier lens or are available with the optical system as part of the frame. Most telescopes are focusable. The autofocus telescope changes focus automatically as the user changes the direction of gaze from near to intermediate to distant objects.

During the 6 years of our work (2000–2005) we had examined 730 patients (610 adults, 120 children) in Low Vision Clinic in Banská Bystrica. We had prescribed 30 hypercorrections, 235 hyperoculars, 397 magnifiers and 260 telescopes. We used hypercorrection max. +20 D, hyperoculars with magnification from 4x–12x, magnifiers from 1.7x–20x, telescopes with magnification from 2x to 10x for distance, 30x for near.

Our work proves that in Low Vision Service it is important to follow the individual requirements of LVP. We did not recommend to generalize any rule in prescription of low vision aids. All optical aids had their own advantages and disadvantages. We would like to stress that even patient with BCVA 1/50 can profit from using the optical devices and should undergo the low vision rehabilitation. I hope these facts will motivate the colleagues to work with and prescribe optical aids to LVPs.

XXIXth DAYS OF MEDICAL BIOPHYSICS

How to objectify educational performance of a medical school

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One of the most important shortages of the current undergraduate medical education at Slovak medical schools is absence of complex objective evaluation of education process. This results into shortage of relevant information on its structure, content, quality, on kinds of education activities and their distribution across the faculty members and departments. Another important shortage of the current education system is that it cannot provide reliable information on real contribution of individual teachers, group of teachers, departments, and medical school as a whole to medical school education mission. All these information are necessary for rational and effective control, planning and managing of education process.

The KEGA project 3/3186/05 “System of the objective evalu-

ation of education process at the medical schools in Slovak Republic” is devoted to elaborate the system, which would be able to measure education performance of each teacher, each department, and the medical school as a whole. It is derived from the experience of the members of the Medical Education Panel created at the Association of American Medical Colleges.

The proposed system is composed of:

- a) Elaboration the list of categories of education work that may be performed in each study programme,
- b) Elaboration the list of specific education activities that teachers in medical schools could perform in each category of education work,
- c) Elaboration of the system devoted for obtaining a relative

value scale and by this way to create relative value units for different education activities.

Up to now we elaborated first version of the list containing all categories of the education work and all known specific education activities that the teachers in medical schools could perform.

When medical schools will adopt the proposed system and involved it into their education strategy, it can provide critical

information that will assist the medical school leaders in evaluating, control and planning the education process more precisely. On the base of such information the rewarding the individual teachers and departments for their education work can be more righteous and it can has higher motivational power.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Medical information system for students

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Diagnostics and therapy in modern medicine cannot exist without a high level technical and instrumental support and information technologies. Medical faculties should be able to provide students with this complex knowledge to facilitate and accelerate their entering the medical practice. We have decided to include medical information system vertically and horizontally in practical curricula of all preclinical courses where it makes sense. We know that in practical classes students use modern diagnostic devices and they practice basic examination methods. These devices can be on-line connected to the medical information system so that we can successfully simulate the operation of modern primary care physicians' or specialists' office.

We plan to build a school medical information system in a network version (server containing the database and 60 working stations). We have selected MIS PC Doctor (Dialog MIS). Work stations will be of two types, the stations with on-line connected devices, which are typically placed in laboratories of departments, or stations without added hardware, which are placed in the computer rooms or offices of teachers. Each student may be registered in this database as a patient and also as a physician, other students acting as patients. The card list of all patients (students) will be

divided into offices which are represented by study groups. The set of physicians for given office is the same as the set of patients and this group has the access rights only to its office. The students will fill the database with the results of examinations in the labs during the whole period of their study of preclinical subjects.

In our opinion the basic advantage of this conception for students and for departments is that – the departments can closely cooperate and coordinate curricula (especially the practical part) – the departments can complete step by step the set of examinations and their technical background and they can more effectively coordinate the purchase of new devices to avoid duplications – students can see and study problems from different points of view of different subjects or from different levels of knowledge and this access can lead to the complex view of the patient or to his (her) disease – students can systematically observe their own health condition and its progress – students can practice the communication with a patient and they can also test the feelings of a patient during examination because they will be in both roles.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

Dynamic flow – a new technology of ultrasound imaging

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Dynamic Flow (DF) and its new version Advanced Dynamic Flow (ADF) represent a wide-band Doppler technique that fea-

tures high spatial resolutions combined with superior real-time images. In contradiction to conventional Colour Doppler tech-

niques ADF enables use of characteristics usually applied in B-mode imaging (reduced packet size and increased pulse repetition frequency). This results in a substantial increase in axial resolution and frame rate while the velocity range of tissue components decreases with regard to the Nyquist limit.

The main features of ADF technology are following:

- Transmission of consecutive broad band pulses on the same line
 - Optimization of bandwidth (spatial resolution) and sensitivity by means of a filter bank
 - Detection of flow signals by comparison of the receive signals on the same line
 - Elimination of static tissue signals.
- Technological means.
- Wide-Band Doppler
- Digital Image Optimizer – Adaptive Image Processing.

The wide-band Doppler causes an increased overlap of flow and tissue (clutter) components due to spectral broadening. To separate the overlapping components, a special algorithm called Digital Image Optimizer is introduced. The application of this technology results in uniform spatial resolution and sensitivity throughout the whole image. Adaptive Image Processing (AIP) is employed to combine ADF and B-mode information on one ultrasonic image. AIP analyses and compares the structure of flow and B-mode signals and generates a composite image from both components.

The Advanced Dynamic Flow technique is a new method for vascular imaging with B-scan quality. It can depict small tiny vessels with high resolution and high frame rate. ADF can be processed independently or in combination with echo-contrast agents. Its features present an extraordinary spatial and temporal resolution, a high sensitivity, minimized blooming and a low artifact level.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Application and methodics of medical thermography in rehabilitation of spinal cord injured individuals

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This paper reviews infrared thermography in medicine as an old-new diagnostic method with special attention to applications in rehabilitation medicine. Infrared (IR) thermal imaging has been used in medicine since the early 1960's. All objects, including human skin surface are continually emitting radiation at the rate with a wavelength distribution that depends upon the temperature of the object. Thus, medical thermography is a spectral emissivity diagnostic method that measures physiological functions by recording thermal heat emission from human skin surface. Rehabilitation is one of the factors, which are disturbing the balance between thermal production in the organism (thermal performance) and expenditure (thermal loss) into the external environment. Several thermographic measurements in spinal cord injured (SCI) individuals and able-bodied were realized. We evaluated skin surface temperature differences between both groups. We measured 20 individuals. Measurements in 10 SCI individuals were realized in clinical environment. According to a post-injury or post-surgery condition of the patients or their physical condition we selected appropriate rehabilitation method

and rehabilitation device (verticalization bed, CPM (Continuous Passive Motion) device, Orbitrack or unweighing lift system). Measurements were realized by means of FLIR IR-Thermocamera Thermacam PM 693, with thermal sensitivity 0.08 °C at 30 °C and accuracy $\pm 2\%$. Our aim was to compare changes of the surface skin temperatures in AB group (10 individuals) and SCI individuals. A reference values and the measurement methodics guide for AB group were also used thermographical pictures stored in the on-line thermal atlas of the human body. Initial measurements we realized in clinical practice in SCI group indicate some significant changes in the skin temperature, which varies of the measurement results of able-bodied control group. We also observed a difference between active (using residual muscle force of the patient) and passive rehabilitation method. The following subject and camera parameters should be controlled during the measurement: emissivity, ambient temperature, atmospheric temperature, distance, relative humidity of the air. More thermographical experiments should be realized to estimate correct and efficient methodics in SCI individuals.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

The helix-coil transition of DNA in presence of magnesium ions

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Studies on nucleic acid interaction with metal ions are of continuous interest in the past decades. For example, they stabilize the structure of nucleic acids, influence the synthesis rate and accuracy of the nucleotide sequence in DNA- and RNA-polymerase systems, take part in the processes of DNA transcription and replication, and cause mutagenesis and carcinogenesis. It is also important to note that the interaction of metal ions with DNA can serve as a simplest model for its binding to more complex ligands, including many drugs, mainly antibiotics, which are in ionic form and bind to DNA by cationic mechanism.

Our aim in this work is to characterize thermodynamic changes that DNA undergoes upon thermal melting in the presence of divalent alkaline earths metal ions. We investigate the effect of magnesium ion on the parameters of the helix-coil transition of DNA at low Na^+ concentration.

DNA-metal ion interactions and their effects on DNA structure have been investigated using a variety of techniques, including sedimentation equilibrium measurements, circular dichroism spectroscopy, UV-visible spectrophotometry, vibrational and NMR spectroscopy. From the UV-visible spectroscopy and circular dichroism experiments it was concluded that the alkaline earths interact primarily with DNA phosphates, stabilizing the double helix through reduced charge repulsion of its comple-

mentary strands. For example, they enhance base stacking, probably by reducing electrostatic repulsion along the DNA chain.

The helix-coil transition of deoxyribonucleic acid in presence of chloride salt of Mg^{2+} was studied by differential scanning calorimetry. This enabled us to observe the complex nature of the process and evaluate the temperature and enthalpy of the transition in a wide range of concentrations of metal ion. As a target of metal interaction calf-thymus DNA and DNA from chicken erythrocytes in aqueous solution was employed.

The dependence of the melting temperature of DNA, the width of its melting curve, and the enthalpy of the helix-coil transition on the molar ratio $[\text{Mg}^{2+}]/[\text{PO}_2^-]$ have been determined. The thermal stability of DNA is affected by the ion concentration and the nature of solvent. It increases at low $[\text{Mg}^{2+}]/[\text{PO}_2^-]$ ratios and the melting temperature T_m passes through the maximum. With a further increase of the ion concentration T_m changes very slightly, and decreases at high concentrations.

Our studies showed that Mg^{2+} ions interact with the ionic phosphates and show little interaction with bases. There is evidence that the interaction of Mg^{2+} ions with bases is realized indirectly. These results could be used in building more adequate mathematical model of the DNA transition and ligands (drugs) interaction with DNA.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Laser thin films for biomedicine

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Thin film of inorganic and organic materials were prepared by laser methods. Inorganic biocompatible layers were synthesized by method of Pulsed Laser Deposition (PLD) and organic layers by method of Matrix Assisted Pulsed Evaporation (MAPLE).

From inorganic layers the attention was paid on thin film of hydroxyapatite (HA), hydroxyapatite combined with zirconia (HA/ZrO_2) and on diamond-like thin films (DLC). Hydroxyapatite films were studied in vitro and in vivo. For in vivo experiments the real coated tooth prostheses and small minipigs were used. The osseointegration was studied for unloaded and loaded

regimes. Combination of HA/ZrO_2 films were tested in vitro with the goal to increase layer adhesion. Diamond like thin films were applied on new one construction of artificial heart valves and on a new kind of textile blood vessels.

From organic layers the attention was paid to fibrinogen and pullulan materials. The morphology was studied by Atomic force microscopy and bounds by Raman and Fourier transform infrared spectroscopy.

The technological details will be presented. The wide scale of laser layers in biomedicine will be documented.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Solubilization of unilamellar vesicles by N-dodecyl-N,N-dimethylamine-N-oxide

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N-dodecyl-N,N-dimethylamine-N-oxide (C12NO) is a potent bactericide. It is supposed that C12NO partitions into the bilayer of the membrane and destabilizes its structure. The final stage of this interaction is the membrane solubilization.

To study the membrane solubilization process using bilayers in unilamellar dioleoylphosphatidylcholine (DOPC) vesicles as a model system and to determine the lipid bilayer - aqueous phase molar partition coefficient of C12NO.

Unilamellar vesicles from synthetic DOPC (Avanti) were prepared by extrusion in redistilled water. The solubilization of vesicles was studied using turbidimetry at 37 degree Celsius.

The solubilization process passed through two different phases before reaching the state of full solubilization – the presence of

mixed DOPC+C12NO micelles. The solubilizing concentration c of C12NO was estimated from the break point in turbidity which occurs between the first and the second phase of the solubilization. At all DOPC concentrations studied, the solubilizing concentration was lower than the C12NO critical micelle concentration. From the linear c dependence on DOPC concentration, the lipid-bilayer-aqueous phase molar partition coefficient $K = 630$ was obtained.

For system of unilamellar DOPC vesicles in the aqueous phase at 37 degree Celsius the molar partition coefficient for C12NO is $K=630$.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

Physical principles of some scanning methods used in medicine

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Methods of human body scanning represent an inseparable part of modern medicine. They play a fundamental role in diagnostic tests, clinical treatment and operation procedures.

The paper contains a brief description of physical principles of some scanning methods used in medicine. It is no wonder that Nobel prizes were awarded for the discovery of these methods, which enabled us to take a look inside the human body. This prize was awarded in 1901 for the discovery of the X-ray radiation (discovered 8.11.1895). W. C. Roentgen, the discoverer, used this radiation to take an X-ray picture of his wife's hand one month later. Since then this radiation has been widely used in medicine. Another Nobel prize was awarded in 2003 for the utilization of nuclear magnetic resonance (discovered in 1946) in

medicine thanks to P.C. Lauterbur and P. Mansfield. The method of nuclear magnetic resonance, which has been used in physical, chemical and biological research, became generally known for its utilization in medicine in tomographic examinations of various diseases. In the recent years new scanning methods have been introduced. These include various tomographic methods, e.g. computed tomography (CT), positron – emission tomography (PET), as well as the new method of nuclear magnetic resonance scanning.

The aim we have taken in this paper is to show the importance, social value and utilization of physical discoveries in our everyday life.

XXIXth DAYS OF MEDICAL BIOPHYSICS

In vitro photodynamic treatment by phthalocyanine sensitizer on MCF7 cancer cell lines

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Photodynamic therapy (PDT) is a promising method for the treatment of tumours. The photochemical interactions of sensitizer, light, and molecular oxygen produce singlet oxygen and other forms of active oxygen, such as peroxide, hydroxyl radical and superoxide ion. The resulting damage of organelles within malignant cells leads to tumor ablation. The promising second generation of sensitizers — phthalocyanine CIAIPcS2, was tested as an inducer of the photodamage. We proved its very low cytotoxic and high phototoxic effect. We report the cellular uptake, the production of reactive oxygen species (ROS) and the phototoxicity of CIAIPcS2 on MCF7 human breast adenocarcinoma cells. As a source of radiation a semiconductor

laser (power 50 mW, wavelength 675 nm) was used. Viability of cells was determined by means of molecular probes for fluorescence microscopy (double staining with calcein AM and ethidium homodimer). The quantitative cell viability changes in relation to sensitizer concentration and irradiation doses were proved by fluoroscan. ROS generation and H₂O₂ release after PDT on MCF7 cells were detected using probe CM-H2DCFDA and recorded by luminescence spectrometer. Viability studies shown that the optimum phototoxic effect tested on MCF7 carcinoma cells was determined in the combination of laser dose 10 J/cm² and concentration of phthalocyanine CIAIPcS2 2 µg/ml.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

Register of pulse wave parameters

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The pulse wave is a complex physiological phenomenon observed and detected in blood circulation. Because of the transformation between the kinetic and potential energy of each segment of the ejected blood, a certain amount of blood is ejected and it is moved in the arteries. This all happens within a course of a heart systole. On each artery or venous section affected by a pulse wave, three coherent phenomena can be observed: blood streaming (streaming pulse), the increase of blood pressure (pressure pulse) and extension of transverse profile (profile or volume pulse). The plethysmography device allows us to measure the volume pulse wave of any surface artery. The aim of this long-time project “Register of pulse wave parameters” is to compare certain parameters between healthy subjects and uncomplicated subjects with relatively easily defined pathologies (IHD, diabetes, postoperative conditions after routine operations – Laparoscopic cholecystectomy), where changes in physiological functions are assumed especially related to subjective algæsthesia.

The pulse wave contour varies in different parts of the circulation. It depends on physiological or pathophysiological conditions of the organism.

The PW evaluated parameters were the following: crest time (CT), relative crest time (RCT), interwave distance (IWD), second direct wave time (T2), systolic amplitude (SA), dicrotic time (RDT), dicrotic amplitude (RDA), and augmentation index Aix. The complex parameter was PW velocity (PWV). The whole PW course can be submitted to second derivation.

By the measurement of control groups divided according to the gender, BMI and amount of subcutaneous fat, no significant differences were observed in the evaluated parameters on *radial artery*. So the similar hemodynamics parameters can be expected among the subject of the same age. The study evaluated the variability of parameters in two ways. First the variability in one pulse wave run, which means its sensitivity to higher circulation rhythms in blood pressure and heart frequency. Next the stability of parameters in repeated measurements, it means its ability to represent the conditions of individual’s vascular system. In the first part the averages of variations coefficient were about 6 %, the main parameter *PWV* had 6.76 %. The second derivation parameters had the value over 20 %. The best stability had the *RDT*, *T2*, *CT*, *Aix* and *PWV* parameters. In clinical part, two studies were done. The first one compared the pulse wave pa-

rameters of healthy subjects towards the same aged subject but suffered from IHD. There were no significance differences between these two groups. The other study compared the pulse

wave parameters of young healthy subjects with older subjects suffered from diabetes. Between these groups there were some significant differences in some the monitored parameters.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Dependence of vulnerability index value on the number of valid comparisons – linear and non-linear regression analysis

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Vulnerability index (VI) is an electrocardiographic quantitative parameter that is usable for arrhythmia risk evaluation. It is a spatial counterpart of the ventricular gradient. Both are based on ventricular repolarisation disparities.

VI is calculated as the root mean square signal of the vulnerability map obtained as optimised (minimal) difference between test's QRST isointegral map (IIM) and the sum of control's IIM QRS and IIM STT multiplied by optimisation coefficient alpha. Only the result with $-1 \leq \alpha \leq 1$ is accepted as a "valid" comparison. Therefore, for one test subject several control subjects are used as the resulting value of VI depends on the actual combination of maps.

We evaluated the dependence of VI value on the number of valid comparisons (N) using 3 control groups: F – 50 women, M – 67 men, C – sum of F and M. All 117 controls were 18–25 years old, without history of cardiovascular diseases, with normal ECG findings. Each subject was taken once as the test subject while all the others served as controls. The minimal obtained value of VI (VI_{\min}) and the average group value of VI (VI_{ave}) were correlated with N using linear and non-linear regressions.

The number of valid comparisons varied from 1 to 116. The VI value decreased with increasing N. Approximately for $N < 20$, the VI values reached obviously higher values than for larger N. Although in all 6 cases acceptable (correlation coefficient r is

different from 0, $p < 0.0001$), linear regression was never the best fit. A logarithmic regression was significantly better in 4 cases ($p < 0.05$ or less), a reciprocal regression was non-significantly better in 2 cases:

$$\begin{aligned} \text{C: } & VI_{\min} = 30.78 - 5.31 \times \ln N & (r = -0.83) \\ & VI_{\text{ave}} = 48.12 - 7.35 \times \ln N & (r = -0.85) \\ \text{F: } & VI_{\min} = 1 / (0.0581 + 0.0024 \times N) & (r = 0.73) \\ & VI_{\text{ave}} = 1 / (0.0451 + 0.0009 \times N) & (r = 0.66) \\ \text{M: } & VI_{\min} = 32.34 - 6.06 \times \ln N & (r = -0.82) \\ & VI_{\text{ave}} = 49.86 - 8.38 \times \ln N & (r = -0.84) \end{aligned}$$

Linear regression is not the best fit for evaluation of the decreasing VI value with increasing number of valid comparisons. Better fits are obtained with curves describing rapid decrease at low values and slower decrease at higher values. These results indicate that a minimal size of the control group or better of the number of valid comparisons should be stated in the next studies.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

Contextual university teaching of physically oriented subjects

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The mission of physically oriented subjects in the frame of university teaching is to give students knowledge and abilities that allow to understand and explain the physical and scientific

view on the living organism. The contextual learning and teaching has to be inevitable introduced to support this aim. Contextual learning and teaching approach represents a conception of

teaching and learning that helps teachers relate subject matter content to real world situations and motivates students to make connections between knowledge and its applications to their professional orientation.

Contextual teaching and learning strategies:

- emphasise problem-solving,
- recognise the need for teaching and learning to occur in a variety of contexts such as home, community and work sites,
- teach students to monitor and direct their own learning so they become self-regulated learners,
- anchor teaching in students' diverse life-contexts,
- use teams or interdependent group structures to encourage students to learn from each other and together,
- employ authentic assessment.

The advantages of teaching physics in context, both by applying previous knowledge to real life situations, and initially learning physics through analysing these situations are undoubted. Students are usually more motivated.

Context-based theoretical and practical teaching of physically oriented subjects in medical and health study programmes is specific and requires the modern teaching methods, procedures and didactic means supported by information and communication technologies.

Aim: The aim of investigation using anonymous questionnaire and analysis of obtained results was:

- to recognise students of medical study programmes (General Medicine, Dentistry) opinions and suggestions concerning content, extent, forms and methods of teaching of physically oriented teaching subjects,
- to reveal how the students use physical knowledge in the study and their suggestions about possibilities of physical knowledge applications in their prospective professional practice.

In academic years 2001/2002, 2002/2003, 2003/2004, 2004/2005 the anonymous pedagogical investigation using question-

naire by 150 respondents, 1st year students of General Medicine and Dentistry of Faculty of Medicine, Comenius University in Bratislava was realised.

It surveys the suggestions on position of medical physics and biophysics in the given study programme and their coordination with other subjects from the contextual point of view (medical chemistry, biochemistry, physiology, anatomy, biology, informatics, etc.). The most respondents (average 79 %) have presented their close, middle and very close horizontal link and their position in 1st study year as adequate.

Physical principles of modern diagnostic, therapeutic methods and medical technique as the most important contribution of physically oriented subjects were regarded. The hypothesis of positive reflection of topics with medical applications (optics, optic analyser, acoustics, acoustic analyser, biophysics of blood circulation, biophysics of respiration, etc.) was confirmed. Requests of instant contact with medical practice during above mentioned subjects teaching were also underlined.

Results of presented pedagogical research were considered by creating of new study texts published in last years. There were close interactions and relations between taught scientific disciplines emphasised. They contain the actual chapters dedicated to physical principles of modern diagnostic, therapeutic methods and medical equipment.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

Comparison the effect for continuous and pulse mode of cavitation ultrasound on *Artemia salina* larvae

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Effects of continuous and pulse ultrasound mode on larvae of the crustaceans *Artemia salina* were tested. Ultrasound may produce a combination of chemical, thermal and mechanical effects. The crustaceans *Artemia salina* belong to the Anostraca and live in inland salt lakes, salt-pans, etc. They are used to test the ef-

fects of chemical substances on the environment. The effects of ultrasound were tested on freshly hatched larvae 1 mm in size on average. The larvae hatched for 24 hrs at 25 °C in „sea water“ prepared. Later, groups of 50 larvae were placed to cylindrical vessels with the bottom made of a plastic-sheet membrane and

filled with 50 ml of "sea water". These samples were then insonated. A total of ten different insonation periods from 1 to 10 minutes were used. To keep the larvae at a constant temperature during exposure, the vessels with larvae were placed to a cooling water and ice bath during experiments. The temperature of the samples was between 20 and 21 °C. Subsequently, numbers of surviving *Artemia salina* larvae in individual samples were recorded at 24 hr intervals for five days. The source of ultrasound was the therapeutic instrument BTL-07p (Beautyline). Insonation was performed at 3 MHz frequency for continuous mode of ultrasound and 3 MHz frequency for pulse mode with duty cycles 5Hz 1:2, 1:4, using 4 cm² insonation head. The in-

strument output was set at 0.5 and 0.3 W.cm⁻². During insonation, samples were compared between intensively aerated (5 ml air per sec) to produce conditions enabling the creation of cavitation nuclei, and non-aerated. Based on the results of the study, graphs of the relationship between the number of surviving larvae after 3 and 5 days of the experiment and the length of insonation for all used frequencies and modes used were plotted. The diagrams showed that the longer the insonation period, the fewer *Artemia salina* larvae survived, and that the greatest effects were produced by ultrasound at continuous mode with aeration.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Courseware based on case reports related to antibiotic treatment

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The treatment with antibiotics, the only causal treatment of bacterial infections, follows two major objectives – effect and safety of treatment. The effect depends on a proper choice of antibiotics and level of resistance to them (often gained as a result of ill chosen antibiotic treatment), the safety is influenced by individual characteristics of the patients organism. Thus it is important to lead future physicians to individual approach to patients and careful consideration of treatment prescribed. One way towards this objective is to use case studies in medical education. The computer-assisted education based on suitably chosen case studies enables passing up-to-date expert knowledge on to students and examination of students, knowledge with minimum of teachers assistance. With regards to the increasing urgency of the problem of resistance to antibiotic therapy we made a learning/examining program package based on case reports related to antibiotic treatment.

The program has been developed using Macromedia Authorware 6.

The package involves four case studies on two levels of difficulty. The lower level case focuses on pharmacotherapy for tonsillitis in children and is suitable also for beginners in clinical pharmacology. The higher level case studies concern the antibi-

otic therapy in newborn infants, the antipyretic treatment in children, and the antibiotic treatment for pyelonephritis in the infant age. These studies are aimed at students after about a two-semester course of clinical pharmacology.

After choosing a case study the student is acquainted with the case history, the patients condition, and the results of examinations and laboratory tests already performed. Then, the student starts going through the test consisting of multiple choice questions and in turn makes decisions about the way of treatment.

Answers are accompanied by comments and educational documents as brief texts or pictures. The program has two versions. One is available via Internet and is aimed at training, the other one is accessible only in a computer lab at the department of pharmacology and is used for examination.

Both versions evaluate the students knowledge and offer automatic grading. The examination version permits to record the student,s performance, together with the final evaluation, in an output file.

The program has been employed in a course of clinical pharmacology and may also be used for self-study or postgraduate education of physicians.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

A web-based medical education portal: preliminary results

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Implementation of modern information technologies triggers changes in university medical education. There has been much progress in development of web tutorials, and biomedical image banks have become an invaluable source of information for medical students and educators.

The aim of our project was to design a medical education portal for better support to students at the Palacky University Faculty of Medicine in Olomouc. The cornerstone of our concept was to initiate a medical image bank as a virtual repository of original images and development of web-based tutorials for core subjects of the medical curriculum. Another unique collection will contain clinical case reports that are considered an important educational tool for best evidence medical education.

The complexity of the project required a wide range of methods: 1) SWOT analysis to control weaknesses and look for new opportunities of collaborative working, 2) team-building to develop a productive multidisciplinary team, 3) digitization of traditional collections of medical images, 4) decision-making to facilitate selection of web portal software, 5) specification of structure, style and contents of the education portal.

The initial pilot phase of the educational portal NOE (novel

education) was launched in January 2006 and it is now available at <http://noe.upol.cz>. Commercial software was selected for the portal development allowing modifications according to the project needs. The medical image bank currently contains approximately 400 items and more are being added. They are accompanied with detailed searchable descriptions and comprise different modalities, eg. ECGs, radiographs, clinical photographs, histology images, charts, endoscopy video clips etc. Example web-based tutorials including clinical case reports were developed for internal medicine and pediatrics to demonstrate major advantages of this educational tool and motivate other teachers to collaborate. The editorial board has been established to steer selection of teaching materials to be included according to a unified guideline to maintain structure and style uniformity of newly-developed tutorials.

The new educational portal NOE offers online educational and information resources for medical students to facilitate best evidence medical education. Its further development requires 1) flexible portal content management, 2) permanent enlargement of the image bank, 3) school-wide collaboration across disciplines and specialties, 4) process evaluation to assess effectiveness of user interface, 5) funding and institutional support.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Protein structure and dynamics determined by protein modeling combined with spectroscopic techniques

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Beside of the protein crystals, another attractive option in protein structure analysis has recently appeared: computer modeling of the protein structure based on homology and similarity with proteins of already known structures. We used the combination of computer modeling with spectroscopic techniques, such as steady-state or time-resolved fluorescence spectroscopy or Raman spectroscopy, and with molecular biology techniques. This method could achieve reliable results comparable with resolution obtained from crystal structures.

Molecular modeling of the ATP site within the H₄-H₅-loop revealed eight amino acids residues, namely besides the previously reported amino acids Asp⁴⁴³, Lys⁴⁸⁰, Lys⁵⁰¹, Gly⁵⁰² and Arg⁵⁴⁴, also Glu⁴⁴⁶, Phe⁴⁷⁵ and Gln⁴⁸², which form the complete ATP recognition site. Moreover, we proved that a hydrogen bond between Arg⁴²³ and Glu⁴⁷² supported the connection of two opposite halves of the ATP-binding pocket. Similarly, the conserved residue Pro⁴⁸⁹ is important for the proper interaction of the third and fourth-strands, which both contain residues that take part in the ATP-binding.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Biosensing with supported bilayer lipid membrane – application for the study of membrane/D-glucose interactions

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The aim of the study was to examine the supported bilayer lipid membrane (s-BLM) as electrochemistry and understanding of the formation process is still far from complete as well as to study the membrane/D-glucose interactions as a preliminary attempt for the biofunctionalization of s-BLM. The basic requirement, s-BLM shall meet to serve for the detection, is the ease of preparation without the loss of reproducibility, the long-term mechanical stability, and the electrically dense structure without defects. Though the successful attempts of integration of glucose transporters into BLM for glucose biosensing have been made, glucose by itself could alter properties of the lipid matrix. Thus a selective molecular recognition can be transformed into changes of macroscopic parameters of s-BLM.

A strategy of s-BLM self-assembling on the Pt support was used. S-BLM was examined by electrical impedance spectroscopy (EIS) over the range from 0.1 to 10 000 Hz. S-BLM parameters were extracted from EIS data by fitting to an equivalent electric circuit. The fractional coverage of s-BLM was estimated by cyclic voltammetry (CV). The average s-BLM resistance

reached the value of (87.2 ± 10.7) M Ω and is comparable well with data reported in the literature. The average s-BLM capacitance (1.4 ± 0.3) nF differs to some extent from that expected for the well-organized lipid bilayer. CV showed that the lipid film was sufficiently tight to prevent ferri/ferrocyanide couple from direct contact with the bare Pt surface indicating highly electrically isolating film. The lipid coverage of Pt surface reached the value as low as $\theta = 0.996$. The fitted coating parameters manifested the ability of glucose to modify s-BLM. The analysis revealed that the major changes were the lipid layer resistance and capacitance values when glucose was added to the system. Although parameters of s-BLM appear not to correspond with the well-defined lipid bilayer – the significant part of the support is covered with the monolayer or multilayer structures – D-glucose can effectively influence the properties of s-BLM by embedding between the lipid molecules and increasing the area per lipid molecule and permeability of the film. Entrapment of excess water changes the dielectric properties of the s-BLM as well.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

Voltage dependence of membrane capacitance at solid/liquid interface

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Our aim was to reveal, when the measured membrane capacitance depends on the transmembrane voltage and how it can be used to membrane investigation.

Measurement of membrane capacitance is effective way of membrane monitoring. Among various factors that influence the measured membrane capacitance, the effect of transmembrane voltage has been observed.

Metal or gel supported lipid membranes as model membranes were used. For now, we did not consider possible effects of certain proteins embedded into the lipid bilayer. Three methods of membrane capacitance measurement, associated with different equivalent circuit models were applied. After testing, methods were

applied to solid/liquid interface without membrane and with the supported lipid membrane in the same solution. All measurements were carried out with the Electrochemical analyzer IM6 (Zahner).

The measured membrane capacitance and its change with the voltage varies with measuring method and the ions concentration in solution. The higher quality of the membrane, the lower the capacitance change with the voltage is registered. The main contribution to the voltage dependence of a measured capacitance originates in the differential capacitance of electrical double layer at an interface.

The mechanisms by which a transmembrane voltage may cause capacitance changes can be classified into the two categories: 1.

The changes inside the membrane (thickness, area, permeability). They cause low capacitance changes and can be found in the interval given by measuring errors of our methods. 2. The changes outside the membrane or at the border between the membrane and the phase attached (electrode, solution), which were not separated, or which are difficult to distinguish rigorously from the membrane processes (adsorbed ions in the membrane

surface, electric double layer at the interfaces, defects in the membrane). These factors may cause high capacitance changes, which are associated mainly with ions adsorption, flow or diffusion. The strong voltage dependence of measured capacitance points at the poor quality of the supported lipid membrane, or at the poor equivalent circuit model of the interface, which did not separate the membrane and interfaces attached.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

Interaction of DNA with liposomes in presence of bivalent cations

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Cationic liposomes or neutral lipids in presence of bivalent cations are capable to condensate DNA in aggregates with ordered structures. These aggregates can be used as gene delivery systems.

To measure and compare the effectiveness of bivalent alkaline-earth metal and transition metal cations in condensation of DNA. To identify the structure of aggregates DNA+neutral lipid+bivalent cation.

The process of condensation was investigated by fluorescence spectroscopy. The structure of aggregates was studied by small and wide angle X-ray diffraction (SAXD, WAXD).

In condensation of DNA the transition metal cations had high efficiency. They were able to condensate the polynucleotide

molecule at five times lower concentrations in comparing with that of alkaline-earth metal cations. The SAXD measurements have revealed a condensed lamellar phase with ordered strands of DNA between the lamellae, the so-called sandwich-like structure in aggregates formed in presence of Ca^{2+} and Co^{2+} .

The aggregates formed in presence of magnesium and calcium cations are perspective gene-vectors, and could model the contact of DNA and lipid bilayers in organisms. The structure of DNA+neutral lipid+bivalent transition metal cations aggregates may help to shed light on the toxicity of these ions.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

In-depth analysis of data obtained from external students of nursing about effects of some chosen physical and psycho-social factors on their bio-psycho-social balance

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A lot of highly different factors of biological, physical, psychological and social nature are involved in process of origin and development of human diseases and also in maintaining and improving the health. Complex of factors of living environment, psychological and socio-psychological factors and others, e.g. material conditions belongs to them. In interaction with human organism they share or in some cases determine the extent of organism

health keeping or be taking ill. The rating of exposure to danger can be verified using many-factoring, bio-psycho-social model: health vs. disease. In our work we have directed mainly on mapping of frequency of possible technical, physical and psychosocial sources of unwanted effects in the working environment conditions in the health service institutions and social care centres.

The aim of investigation using anonymous questionnaires was

to obtain specific data from external students of 1st–3rd year of bachelor study programme of nursing for the needs of practical teaching; after results analysis to define the level of their functional physical literacy and orientation in the National Programme of Health Support; to affect their approaches to working conditions and health protection both health professional and patient against negative effects of factors in external environment also in the context with day mode and incorrect life style.

The investigation we realised in the group of 300 students of Faculty of Medicine Comenius University in Bratislava. We evaluate complete anonymous questionnaires composed of 20 questions from 242 respondents. First part of questions included the basic records and professional data of respondents at the beginning of acad. years 2003/2004, 2004/2005, based on them the respondents were divided into fourth groups according disciplines: internal, surgical and that working in the social care centres and centres for pensioners. Fourth, small group create respondents working in other health service institutions. Next class of questions was oriented on follow-up education, special practice, knowledge of foreign languages, etc. Third class was created by chosen questions from anonymous investigation, questionnaire in acad. years 2003/2004 and 2004/2005 in the 1st year of study ($n=170$). They were directed on the problems non-controlled interactions of physical, social and psychosocial factors with human organism as biological integrated system in the conditions of its working position.

Results: By analysis of investigation results we recognise: The higher special education graduate 40.1 % students and postgraduate special education 18.2 % students. Only 8.7 % respondents graduate attestation exams and training courses oriented on professional operations with technical instrumentation. The students have very bad health day mode, take meals irregularly, one-two times daily take meals 36.5 % students of nursing and 13.7 % of General Medicine. 68.8 % of respondents evaluate the stress charge related with working and study demands is big and very big.

Protection of health can be assured by creating of optimal conditions in quality preparation of health professionals. They consist mainly in their high professionalism acquired by education, active approach to lifelong education and consequently obtained qualification for working in given health service institution. Predictions for solving these problems are made by teachers in active cooperation with their teachers.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

Possible sources of unwanted effects of electromagnetic pollution in the health service institutions

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Technical sources of high-voltage and electromagnetic radiation (EMR) that are using both for authentic picture information with high medical information significance in diagnostic and therapeutic visual methods or as instrument of effective therapy represent possible source of unwanted effects of electromagnetic fields also by keeping safety rules.

Limit SAR (specific absorption rate) for EMR is 2 W/kg by power density 4.5–9 W/m².

Accumulation of absorbed doses super positioned to global loading by electromagnetic smog's background in extreme situations can negatively influence exposed biological structures. Monitoring of this exposition has not been required according valid hygienic rules, till now.

The aim of our research was to evaluate students' ability to estimate objectively the actual level of protection against unwanted effects of non-ionising radiation on organism in the health

service institutions. We have chosen the achievement of functional physical literacy by external students on the level required in Strategic documents of EU as a low margin of abilities. In relation with obtained results we have modified the forms and means of direct, distant and e-learning teaching.

The anonymous investigation using questionnaire was realised in the group of respondents ($n=300$), students of Faculty of Medicine, Comenius University in Bratislava. The standardised anonymous assisted and combined questionnaire composed of 20 scale and free questions was used. The three key conclusions were chosen and compared with investigation results among respondents, students of study programme General Medicine.

Analysed results of our investigation have showed that unsatisfied scientific technical orientation of students is the reason of not observing the hygienic rules by work and increases risk unwanted effects on their health.

Nevertheless, 92.7 % of respondents assess the state in hygienic rules keeping in their workplace as good, very good and excellent. This concept was explained by students as the sterility of working environment. The factors not specified in hygienic norms were considered harmless. Only 8.7 % of respondents graduate the attestation exams and training courses oriented on professional operations with technical instrumentation, although the using frequency of medical devices and equipments at 175 health service institutions from 7 regions of Slovakia is: in diagnostics (17 ± 2.9)/day, therapy (13 ± 3.1)/day, helping devices (27 ± 7)/day and totally (54 ± 5.1)/day. 68.8 % of respondents evaluate the stress charge related with working and study demands as big and very big. The stress induced by electromagnetic pollution overcharging they are not able to evaluate and reflected.

Investigation within external students of study programmes

nursing and midwifery and actual amendment of norms show that bigger teaching extent for solving of situations modelling the unwanted interaction of physical factors with biological integrated system has to be done.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

Comparison of non-invasive methods for arrhythmia risk – vulnerability index versus map non-dipolarity

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Non-invasive stratification of patients with high risk of arrhythmia development has not been sufficiently managed yet. However, there are several possible approaches in literature to solve this problem. In our previous works we tried to establish arrhythmia risk using the vulnerability index (VI), a quantitative parameter derived from isointegral maps. In this work we compared this method with another method described in literature – analysis of non-dipolarity of QRST isointegral maps (IIM).

Both methods were applied to 17 patients after myocardial infarction (MI – age 53.5 ± 9.4 year; 15 men, 2 women) as well as to 28 patients with hypertension and hypertrophy (age 52 ± 12 year; 16 men, 12 women). These states are connected with higher risk of arrhythmia development. We compared results of these patients to the group of 69 healthy people (age 19.5 ± 2.1 year, 5 men, 24 women) with neither electrocardiographic nor echocardiographic evidence of heart disease. We evaluated the value of VI and the number of extrema on IIM QRST maps.

Both groups of patients had VI values significantly higher than healthy persons. Values of patients after MI decreased after 6 months, after next six months the differences were negligible.

The VI values were compared to the number of extrema on IIM QRST. In the group of healthy controls, all maps had dipolar distribution with one minimum and one maximum.

5 of 28 (18 %) maps of patients with hypertension were non-dipolar. The average VI value of non-dipolar maps was 11.5 ± 6.1 mV.ms, average of the rest of the group was 10.2 ± 3.2 mV.ms (non-significant difference). The map with the highest VI value in this group (20.3 mV.ms, woman, 71 year) was also non-dipolar (3 minima + 1 maximum).

8 of 17 maps of patients measured 1 year after MI were non-dipolar. Average VI value of these maps was 12.5 ± 6.4 mV.ms, what is less than the average VI value of the rest of the group (13.3 ± 5.6 mV.ms, non-significant difference).

5 of 17 maps measured 6 months after MI were non-dipolar. Average VI value of these maps was 11.0 ± 9.1 mV.ms, while the average of the rest was (11.1 ± 5.1 mV.ms). It is surprising, that no map of those measured 1 month after MI was non-dipolar, despite VI value of these maps was the highest (18.9 ± 10.7 mV.ms). We cannot explain this fact yet.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

University education of nurses and midwives in Slovak Republic

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The formation of the specialization in Nursing is conceived on basic principals of health care system transformation and approximation in the education of nurses and midwives in the EU, as well as on the changes being prepared in qualification prerequisites of nurses. The EU directives on education of nurses classify the profession of nurse and midwife as a regulated profession being automatically recognised within EU supposing the coordination of education and qualification training.

The aims of the transformation of all degrees of nursing education, which has started at the beginning of 1990s, include:

- Help increasing the nurse care standard and improving the quality of health of people;

- Ensure compatibility of nurse education with EU criteria.

The nursing education has been influenced significantly by aspirations and requirements in the following aspects:

- Change of the existing medical, technical and performance model of nursing,

- Increase the education level of nurses,

- Eliminate the discrimination in the nursing education,

- Take into account the education and experience achieved so far in the process of increasing of the education degree,

- Ensure optimal and effective progression in nursing education.

The nursing education was activated as:

- University fulltime bachelor and master study in Nursing specialization intended for high school graduates with baccalaureate certificate.

- University external bachelor and master study in Nursing specialization intended for secondary medical school graduates with baccalaureate certificate. It is a study for employed nurses in practice.

- University fulltime bachelor study in Midwife specialization

intended for high school graduates with baccalaureate certificate.

- University external bachelor and master study in Midwifery specialization intended for secondary medical school graduates with baccalaureate certificate, with specialization of registered midwife in gynaecology nursing.

University bachelor and master study in Nursing specialization can be acquired at:

Comenius University, Faculty of Medicine, Bratislava

Jessenius Faculty of Medicine, Martin

Faculty of Health and Social Work, Tynnaviensis University, Trnava

Faculty of Medicine, Safarikiensis University, Kosice

Faculty of Health Services, The Catholic University, Ruzomberok

Alexander Dubček University, Trenčín

Faculty of Health Services of University, Presov

Pedagogical Faculty, Konstantin Philosopher University, Nitra

The graduates of master studies may undertake an examination in Nursing specialisation to be awarded the title PhD. The graduates of postgraduate studies obtain the academic title of Doctor (PhD).

The education of nurses and midwives is legislatively defined by:

Law of the National Council of Slovak Republic No. 742/2004 Coll. Laws on professional capability of performing health care occupation.

Law of the National Council of Slovak Republic No. 743/2004 Coll. Laws on further education process of health care providers, system of specialisations and certificated work activities.

Law of the National Council of Slovak Republic No. 578/2004 Coll. Laws on providers of health care services, on the health care staff, on the corporate organisations in health care system and on the change and completion of certain laws.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Point Spread Function in sonographed area

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It is absolutely essential to create a complex quality control system for sonographs which must include accurate and objective methods for enabling exact specification, evaluation of mal-

functions and assessment of the long-term stability of the quality parameters. We have developed a complex system based on the point reflector principle which has allowed us to analyze the Point

Spread Function (PSF) and in this way measure a number of significant image quality parameters at any point of the area being imaged. The system was designed for evaluation of Lateral Resolution (LR) using the 6 dB drop method which permits measurement of this parameter in a defined image area with any

step of reflector shift, adjustable from 0.01 mm. Our measuring system can detect malfunctions in dynamic focusing, size of aperture, time gain compensation function and/or transducer element failure.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Preparation of practical training in radiological subjects taught at Masarykiensis University

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The proposed BSc and MSc study programmes involve subjects with practical training in which students have to master methods of measurement of quantities characterising radiation and its interaction with matter. In these subjects, we suppose to start with physical principles of detectors, and to continue with quantities describing the source and field of radiation or its interaction with matter, respectively, emphasising quantities used in radiation protection and medicine. The students have to understand the detectors, to know how to evaluate the source, and how to assess quality of measurement (irradiation).

Measurements of this kind could be already done in the Department of Mathematics and Physics, University of Defence (UD), Brno, after an agreement between UD and Masaryk University. Moreover, new tasks will be completed: (1) Measurements of detector detection limits (2). Monitoring by means of thermoluminescence and semiconductor dosimeters (3). Measurement of photon dose and dose rate (4). Measurement of activity by a well detector (5). Measurement of surface contamination with beta emitters.

The educational process will be finished by practical application of measuring methods in therapeutic and diagnostic facilities under guidance of clinicians. It presents diagnostics of photon beams and fields, quality assurance, and diagnostics of the measuring systems themselves.

A study stay in Kings College, London, documentation obtained there, and contacts with some Czech specialists, improved substantially our insight in these problems. There is a need of advanced instrumental equipment. Today we have at disposal following top monitors and apparatuses:

- RADCAL 9010, ionising chamber 10X5-1800, measures X-ray and gamma beams in impulse and continuous mode,

- RADCAL 9095, ionising chamber 10X9-6, measures dose in the air and dose rate, cathode voltage and duration of voltage impulse,

- UNIDOS universal dosimeter, calibration source, ionising chamber TM 30012, water phantom type 41001; measures dose and dose rate mainly in radiotherapy.

There is a problem with convenient sources of diagnostic and therapeutic beams, considering namely the safety rules. It could be acceptable for students to get acquainted with measuring instruments in a lab at first, and after that they will be allowed to apply their skills in a clinical facility. It is our hope for future to collaborate with an existing project of „Diagnostic imaging and international radiology research institute“ at Medical Faculty, Brno, in which training laboratories are also incorporated.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Towards understanding the cellular and subcellular action of ultrasound

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Biological effects of ultrasound (US) are studied in the Department of Biophysics, Medical Faculty, Masaryk University, for more than 50 years. This topic is of increasing importance

with respect to the frequent use of US diagnostics (safety assurance), as well as, to the unrelenting effort to utilise US in minimally invasive therapy of cancer. In addition, the healing effect of

low intensity US was also not explained satisfactorily until now.

In general, we can distinguish thermal, cavitation and “the other” US effects. Our research is aimed to methods of chemical and acoustical monitoring of cavitation. This phenomenon occurs in high intensity ultrasound fields, but it can be also enhanced by the presence of bubble-based echocontrast agents. In chemical cavitation dosimetry, the best results were obtained (and compared with water radiolysis due to gamma radiation) with iodide oxidation and the Taplin dosimeter, which is a mixture of water and chloroform producing HCl when cavitation is present. Quite surprising results were reached in measurements of low frequency spectral component of acoustic noise accompanying cavitation. The measuring system was then improved and the determination of cavitation threshold became more reproducible.

Considering the relatively limited role of ultrasonic cavitation in interactions of US with living matter, the so-called non-thermal and non-cavitation effects seem to be an even more impor-

tant research field. Impairments of subcellular structures, e.g. the cytoskeleton (rarefaction and rearrangement) or biomembranes (structural changes and increase in permeability) were observed. When applying intensities below cavitation threshold, these changes are reversible as a rule. Higher US intensities cause onset of cavitation which destroys the cells, overlapping the moderate non-cavitation effects.

On the other hand, these results brought us to the hypothesis that US could enhance cytotoxic properties of some anti-cancer drugs. We obtained many encouraging results in studies dealing with proliferation of cultured cells or with their cytoskeletal changes. Therefore, more recently, we started to study combined effects of US and cytotoxic platinum and ruthenium complexes in co-operation with the Laboratory of molecular biophysics and pharmacology in the Institute of Biophysics of Academy of Sciences of the Czech Republic.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Comparing the influence of weak electromagnetic fields on *Escherichia coli* and *Staphylococcus aureus*

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In this work we investigated the influence of electromagnetic fields (EMFs) on *E. coli* and *S. aureus* bacteria.

We are surrounded by electric appliances and all of them are source electromagnetic fields. It is important to know their effects on human health and environment. In some works a negative effects of EMFs on human cells and organisms was observed. Strašák showed the decrease of Colony Forming Units (CFU) on *E. coli*.

Bacteria *Escherichia coli* (K 12 Row, genotype 58-161 metB1rpsL 1+ Fdef, P. Fredericq) was kindly provided by Luděk Strašák from Department of Biology on Medical Faculty of Masaryk University in Brno. *Staphylococcus aureus* is support from the Department of Medical Microbiology of Medical Faculty of Pavol Jozef Šafárik University in Košice. Experiments itself took place on Department of Medical Biophysics.

For generating the EMFs we used a cylinder coil with constant-current transformer powered by 50 Hz supply. Effective current was in range from 0.5 to 1.9 A. It is equivalent to mag-

netic induction in range from 2.7 to 10 mT. During the experiments the laboratory temperature varied from 22 to 26 °C, incubation was in thermostat with constant temperature 37 °C. Cultivation medium was TY stock, after 4–4.5 hours bacteria cells were inoculated on solid agar plate.

For statistics we compared data with t-test and significance was 0.95.

E. coli: we can see the significant negative correlation between the exposure time (4, 8, 12, 24 min) and CFU number (0.84; 0.63; 0.57; 0.42 to 1 as control).

S. aureus: again significant negative correlation between the exposure time (4, 8, 12, 24 min) and CFU number (0.84; 0.71; 0.65; 0.67 to 1 as control) although negative effect is not so great. Conclusion. Our results support an idea of negative effects of EMFs on bacteria. We can see significant negative correlation between the exposure time and CFU number. The effects differ between different bacterial species. It seems that sensitivity to EMFs is very individual.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Photodynamic therapy by porphyrin sensitizers free or bound to cyclodextrin in A549 cell line

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The photosensitizing effects of porphyrins have been the subjects of extensive studies because they are potential to use in photomedicine, e.g. in photodynamic therapy (PDT). Porphyrins and porphyrin-related macrocycles are most common sensitizers that are lipophilic and have a high propensity to accumulate in the membranes of intracellular organelles like lysosomes and mitochondria. Photodynamic therapy, a treatment for cancer and for certain benign conditions, involves the selective accumulation of sensitizers in tumor cells. PDT is primarily employed to kill tumor and other abnormal cells. The mechanism of cell destruction involves interaction between the triplet excited state of the sensitizer and molecular oxygen to produce singlet oxygen and other reactive oxygen species (ROS) to induce cell death.

The aim of this study was to investigate the generation of reactive oxygen species after PDT in vitro by examining second generation sensitizers and verification of their production by molecular probe CM-H2DCFDA. We compared ROS production in the presence of various porphyrin sensitizers free or bound to cyclodextrin carrier hpBetaCD in A549 cells (bronchogenic carcinoma). Particularly, as sensitizers we used porphyrin de-

rivative TPPS4 (Meso-tetrakis(4-sulfonatophenyl)porphyrin) and its zinc (ZnTPPS4) and palladium (PdTPPS4) complexes.

Cells in 96-well microplates were incubated in DMEM with 1, 10 and 100 μM sensitizer (TPPS4, ZnTPPS4, PdTPPS4) or with sensitizer bound to cyclodextrin (of hundredfold concentration with regard to sensitizer) for 24 hours. After incubation cells were treated with 10 μM CM-H2DCFDA for 30 min at 37 $^{\circ}\text{C}$ in darkness. The excess probe was washed out. The cells were subsequently irradiated by a halogen lamp at light doses of 25 and 50 $\text{J}\cdot\text{cm}^{-2}$. Fluorescence of CM-DCF was recorded by luminescence spectrometer.

Our measurements demonstrated that the porphyrin ZnTPPS4 seems to be the most suitable compared to TPPS4 and PdTPPS4 because of its the highest ROS production in A549. Moreover, the cells accumulated with free sensitizers exhibited higher fluorescent rates than that loaded with sensitizers bound to cyclodextrin carrier. This can be explained by a difference in an uptake of free and bound sensitizer into the cells after 24 hours of incubation. For both free sensitizer and that bound to hpBetaCD, the highest generation of ROS in A549 is shown by using 100 and 1 μM ZnTPPS4 at light doses of 25 and 50 $\text{J}\cdot\text{cm}^{-2}$, respectively.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

Decrease of speech non-fluency by bronchodilatation

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The main areas of the interest are speech disorders with unknown etiology like stuttering, in other words balbuties according to MKK-10 F98.5. EK FNO and LF UP discussed and agreed the final version of protocol of the study by which we intended to evoke bronchodilatation at balbuties.

The number of observed subjects was 40 (+2 in reserve). The set included the choice of children from the beginning of school attendance, young and adults till 26 year. An average age of subjects was 14.0 years (range 6–26 year, SD 4.3 let). 33 boys (78.6 %) and 9 girls (21.4 %) participated in this study. The primary aim of the study was the evaluation of bronchodilatation

effect on speech fluency. Study contained Screening visits in 6 centres, examinations of patients were then included biochemical examination, EEG and EMG examination, examination VSF (heart frequency variability), spirometric IOS (impulsive oscillometry) examination and running documentation of the speech records evaluated by patients. From the records of the fluency speech evaluation by mark 1–5 were counted four average marks: valuation of speech fluency during the period without application of Foradil, valuation of speech fluency after the period of two month application of Foradil, valuation of speech fluency after the period of four month application of Foradil, valuation

of speech fluency after the period of six month application of Foradil.

For the comparison of average marks in the whole patient file (n=42) was used non-parametric geminate Wilcoxon test. Tests were fixed on the level of significance that was 0.05. Test has shown statistically significant difference among average marks in the period without application of Foradil and in the period of 2 months usage of Foradil ($p < 0.001$). Results Statistically sig-

nificant difference was found among the average marks in the period without application of Foradil and after 2, 4 and 6 months usage of Foradil.

The speech fluency was always in every following period evaluated by better mark ($p < 0.01$). The evaluation of the remaining investigation is now in the stage of working and processing of the results.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Investigation of biological effects of RF fields by using human head phantom

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The Human head phantoms are used for biomedical research in a lot of areas. The one area is using the phantoms for investigation biological effects of RF (radiofrequency) fields. This research is very specific and it is always quite hard to simulate realistic human tissue. This paper deals about different phantoms and about the effectiveness of results by measurement with these phantoms.

The science wants to minimize a human body exposure by research biological effects of RF electromagnetic field in this time. There are many measurements in labours with animals and models or phantoms of human body. By RF fields are made mostly SAR measurements with human head phantoms.

Recent experiences with measurements of SAR indicate that the phantoms used by various laboratories are not based on com-

mon definition. Different types of phantoms and their properties have different results of measurements.

Only statistically significant features, from RF coupling point of view, shall be simulated, non-significant features should not be replicated in the phantom. The phantom shall realistically represent body features responsible between the RF current carrying elements and the tissue under examination.

The human head phantom can be used to measure SARs in cars, planes, helicopters, ships or trains arising from telecommunications equipment, radar and satellite up/down-links etc. In this time is often used SAM phantom that is corresponding to IEEE/CENELEC specified dimensions.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Pulse wave analysis in patients with vasovagal syncope

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Vasovagal syncope is a common clinical problem with difficult diagnosis. Routinely applied time-consuming tilt table test has a limited diagnostic value. Recent study demonstrated that subjects with vasovagal syncope might differ from healthy controls in a contour of peripheral arterial pressure pulse. It is not known whether this observation might predict the outcome of tilt table test.

The study enrolled 66 otherwise healthy subjects (51 women, 33 ± 14 years) with recurrent syncope of unknown origin. Recordings of continuous finger arterial blood pressure (Finometer) were obtained in all subjects during supine rest and during third minute

of orthostatic phase of tilt table testing. The following pulse wave descriptors were analysed: systolic (SBP), diastolic (DBP) and augmented (ABP) blood pressures, stiffness index (SI), time delay between systolic and diastolic peaks of pulse wave (DT) and amplitude of diastolic pressure wave (DA). Subjects with positive (T+) and negative (T-) outcome of tilt table test were compared with unpaired t-test.

Studied groups (35 T+ and 31 T-) were comparable in age, gender, body height and weight. DA during supine rest was slightly higher in T+ compared to T- subjects. During supine rest, there were no significant differences between studied groups in other de-

scriptors of pulse wave. Compared to T- subjects, T+ subjects had significantly higher drop of SBP (-7.3 ± 27.3 mmHg vs -22.8 ± 32.5 mmHg, $p < 0.05$), DBP (-8.0 ± 16.4 mmHg vs -18.3 ± 17.1 mmHg, $p < 0.05$) and ABP (5.1 ± 18.0 mmHg vs -9.4 ± 21.6 mmHg, $p < 0.01$) between periods of supine rest and early orthostatic phase of tilt test.

The study does not support the hypothesis that DT and SI descriptors might predict the outcome of tilt table testing. The study confirms the observations of other investigators that T+ subjects exhibit abnormal dynamics of blood pressure since the early asymptomatic phase of tilt testing.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Elearning course essentials of endocrinology

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The course „Essentials of Endocrinology“ was created in 2005 as a part of project Production of media courses for development of distant learning at Charles University. The course integrates a clinical subject – endocrinology – to a distant education. Until now, in medical faculties, the clinical subjects were taught only in attendance form of learning. The course is dedicated to medical students in the 4th and 5th year. The aim is to familiarize students with the basics in the endocrinology field.

The project core is a web based application in Moodle environment. It comprises seven chapters dealing with individual endocrine organs, hormones and their effect, i.e., Hormones and the mechanism of their action, Hypothalamus and pituitary gland, Thyroid gland, Parathyroid, Adrenal Cortex and medulla, Gonads, and Polyglandular syndromes.

Each lesson begins with an article explaining theoretical background of the theme in the understandable and practical form.

The article is accompanied by hypertext links, images and by other different components. Then students can verify their acquired knowledge by test or quiz. The communication with the tutor is led by email, electronic conferences, or possibly by chat. Each lesson concludes with a task requiring student's activity and searching for more information dealing with relevant diagnoses. An interesting case report is attached in some lessons.

The tuition is prepared as online course for the theoretical part of the subject and it is realized by distant education. It is ensued by a practical part, which is carried out at the clinical department (in this case Clinical Department of Endocrinology and Metabolism of 1st Medical Faculty and General Public Hospital in Prague). The final examination is also in an attendance form. The described course is available at the distant learning web page of Charles University (<http://dl.cuni.cz>).

XXIXth DAYS OF MEDICAL BIOPHYSICS

Biophysics in medical training at University of Veterinary Medicine in Kosice

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The University of Veterinary Medicine (UVM) provides possibilities of study in the following accredited educational programmes: 1) General Veterinary Medicine in Slovak, 2) General Veterinary Medicine in English, and 3) Food Hygiene. These programmes are lasting 6 years and the graduates are awarded the degree of Doctor of Veterinary Medicine. In addition, a new BSc-programme Kynology was accredited a few years ago. In next school year 2006/2007 MSc-programme Pharmacy starts to teach at the UVM. Subject biophysics is taught in all programmes with exception Kynology. In the effort

to prove scientific level of medical education the UVM has voluntarily undergone specialized evaluation by the EU evaluation board already in 1996. The commission confirmed the fulfilment of EU regulations (1026–27, 28/70) and the university was included into the list of evaluated and recommended veterinary schools in the European Union.

Study of theoretical and pre-clinical disciplines in the first years is aimed at cognition of biophysical and biochemical processes together with physiology of organs and micro-organism and macro-organism systems varying in particular animal species.

Biophysics as interdisciplinary scientific field gives physical explanation of biological phenomena and it researches influence of physical factors to living organisms. In agree with this definition, medical biophysics as a subject in curriculum of medical veterinary training grants inevitable basic knowledge necessary for understanding these laws, phenomena and processes proceeding in the living organisms, which have physical base. This subject gives also the information about experimental methods, which are used in veterinary diagnostics, therapy and research. In veterinary training, biophysics stands between mathematics, physics, physical chemistry and biological sciences on the other hand. It gives physical bases necessary for managing subsequent subjects such as physiology, veterinary surgery, radiology, ortho-

paedics, and pharmacology. Biophysics ranks among basic subjects and it is taught by means lectures and practical lessons in first grade.

In the past, medical physics dealt with teaching of selected parts of physics with some particular importance to students of human and veterinary medicine. In the effort to find connections among different physical knowledge the new syllabus was prepared, which considers logical connections among chapters. This syllabus is made up in intentions of EU requirements and reflects specific necessity of above mentioned study programmes. However, general approach to explanation of physical phenomena in living organism is conserved.

XXIXth DAYS OF MEDICAL BIOPHYSICS

The monitoring of the growth of yeast *Saccharomyces cerevisiae* on mercury electrode

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The implantation of a biomaterial into the human body is influenced by susceptibility of a infection. Interactions between biomaterial surfaces and microorganisms are based on forces including electrostatic, Van der Waals, hydrofobic as well as various specific receptor-ligand interactions. Bacteria or yeast can be also bound on the proteins adsorbed on the metal surface. Impedance spectroscopy and generally measurement of electrochemical properties of cell cultures are very good tools for their analysis. It can be used in medical diagnosis or in industrial bioprocess controls.

The ability of microorganism to be bound on surfaces can be utilized for determining of number of cells in culture. The forming of biofilms is very important process in orthopedic, or dental implantations.

Microbiological objects were electrochemically studied and analyzed on gold electrodes. We performed our experiments on mercury drop electrodes. The advantage of mercury is smooth surface and the same experimental conditions for each measurement.

The prototrophic tetraploid strain *a/A* of yeast *S. cerevisiae* CCY 21-4-59 (yeast collection, Institute of Chemistry, Slovak Academy of Science, Bratislava) was used. Yeast cultures were grown in Malt extract Broth (MEB) (2 % Malt extract broth – Fluka, 2 % Glukose – Lachema Brno) in the thermostat with the temperature 30 °C. CFU – Colony forming unit were counted on

the agar plates (2 % Malt extract broth – Oxoid. Basingstoke, Hampshire, England, 2 % D-Glukose – Lachema Neratovice, Czech Republic, Agar No2 – Imuna, Šarišské Michaľany, Slovakia). For all experiments fresh yeasts cultures were used.

All electrochemical measuring were performed using electrochemical station ZAHNER IM6e (Germany). We used hanging mercury drop electrode (HMDE) using Metrohm VA 663 Stand. The surface of the mercury drop calculated from the mercury flow rate by weighing of hundred droplets was $S=(0.33\pm 0.01)$ mm² corresponding to position 2 on the Metrohm 663 VA Stand, and the diameter of the drop was $r=0.16$ mm. Counter electrode was a Pt wire, reference electrode was Ag/KCl.

We measured differential capacity of yeast culture in MEB in potential range from -0.2V to -1.25V. The frequency of superimposed potential was 200 Hz. We measured differential capacity of yeast culture from the beginning of the growth 8 hours. The maximum of capacity, that have appeared in potential -0.4V, were higher for longer time of cultivation. Comparing with the CFU (Colony forming unit – the number of cells in culture) we stated that the differential capacity depends on the number of cells in electrolyte. We were able to make the calibration curves and we estimated the number of cells in solutions in the range 10³–10⁶ cells/ml. By measuring of capacity in different time we were able to characterize the formation of biofilm on the mercury electrode.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Effect of low-frequency magnetic fields on bacteria

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The increasing exposure of the population to electromagnetic fields in everyday life has enhanced public interest in epidemiological and experimental studies. Environmental exposure to extremely low frequency electromagnetic fields is strongly increased in developed countries as a consequence of the distribution and use of electricity. A lot of papers were published in last years. The studied objects were organisms in vivo or in vitro, cells, tissues, and a plenty of biological processes were examined. The importance of research of electromagnetic effects showed fact that the World Health organization classified electromagnetic fields to Class 1B, possible carcinogen.

We studied effect of magnetic fields on different bacteria in vivo. We compared the viability of cells exposed to magnetic fields ($B_m \text{ max} = 10 \text{ mT}$, duration of exposure till 60 min, $f=50\text{Hz}$, temperature at the place of exposure $20-25 \text{ }^\circ\text{C}$ – laboratory temperature). We generated our magnetic fields by cylindrical coil. Bacteria were exposed in broth or on agar plates in Petri dishes. The magnetic fields in the place of exposed samples were homogenous. We estimated the viability of bacteria by counting of CFU (Colony forming units) or by measuring of optical density (OD, spectrophotometer Libra S22 (Biochrom).

We exposed to magnetic fields rod-like (*Escherichia coli*, *Leclercia adecarboxylata*) and spherical bacteria (*Staphylococcus aureus*, *Paracoccus denitrificans*, *sphingomonas paucimobilis* and *Rhodococcus erythropolis*). We observed the decrease of viability for all measured strains. The magnetic field effect

was bigger for rod-like bacteria. It seems that this effect is affected by the shape of bacteria, it means that it can be caused by the electric current induced inside the bacteria. From the growth curves it seems that magnetic fields act immediately after exposure. Their growth after exposure continues with similar division time like the growth of control cultures. It seems that switching on magnetic field kills a part of bacteria in culture, the rest develops normally. Because the growth of bacteria is based on the geometric progression, the small change of the number of cells on the beginning of the growth can dramatically change the whole growth curve. This work shows importance of very carefully interpretation of magnetobiological effects, we observed different qualitative results for different bacteria. It is necessary to perform all experiments with well-defined cells. It can be seen, that similar experiments do not lead to the same results. Differences in strain and in used magnetic fields play an important role in the results.

It will be probably a long way to answer the question if such fields can have some effect on human. First, the field with induction of 10mT is very rare in our environment. We can detect it very seldom in the vicinity of welding machines or induction furnaces. ICNIRP limit for personal exposure is 100 nT, it is one hundred times lower.

On the other hand it is important to do similar experiments with strong, maybe stronger fields, to determine the mechanisms of possible acting of the external field on organisms.

XXIXth DAYS OF MEDICAL BIOPHYSICS

The whole-body cryotherapy

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The whole-body cryotherapy is one of the physical therapy methods the application of which is based on body reaction to the stimulation of the temperature lower than $-100 \text{ }^\circ\text{C}$.

At present, the whole-body cryotherapy ranks the modern methods used in the rehabilitation and in physical medicine.

The history of applying cold for cure effects is almost so old as the humanity and medicine itself. The Egyptians used cold to

treat injuries and inflammation as early as about 2500 BC. Already in Homer's Illiadis we can find reports about using cold for fracture treatment and Hypocrates stated that cold has an analgetic effect. Favourable effects of the application of cold were also known to Avicena. Analgetic effect of cold was known and often used during various operations in the 16th century. In the 17th century Severino and his student Bartoli used cold for

the treatment of inflammatory disorder. Larrey, Napoleon's legendary surgeon from Egypt to Waterloo, used it to facilitate amputations during the historic retreat from Moscow. In the 19th century, Arnott described the benefits of local cold application in the treatment of numerous conditions, including headaches and neuralgia.

In the medical care, the coldness has been systematically used, for more than hundred years.

The introduction in 1978 of the whole-body cryotherapy to medical prophylaxis is attributed to Professor Toshiro Yamauchi. Having been inspired by the positive treatment results of Japanese scientists, professor Reinhardt Frick and his group from Germany began the cooperation with the Japanese center in 1980 and transferred the method in all its applied forms to Europe.

The whole-body cryotherapy is effectuated in cryochambers (other names, e.g. cryocabins, polaria. are also used in practice). The cryochambers serve for cooling the whole body, i.e. for cur-

ing the patient totally, including his or her head. Significant role in this field is played by the Polish specialists. The Polish cryotherapy originated in 1983 (Professor Zdzisław Zagrobelny). In 1989, the first cryochamber was constructed (the second in Europe, the third in the world).

The cryochambers have already been installed in the Czech and the Slovak Republics as well and further studies leading to the fructification of the efficiency of this method with regard to diagnosing the patients have been started.

The main indications, absolute contraindications and relative contraindications for the whole-body cryotherapy can be found in publications.

Evidently, the development of the cryochambers was influenced by the development of scientific knowledge and of technology

The paper deals with the the development and presents the state-of-the-art of designing the cryochambers.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Finding a job on the internet in health care not only for graduates

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This system is designed mainly for young doctors who are looking for their first job. However, it can be also used by doctors with working experience. The reason for creating this was to fill in the gap in this field. Although there are many agencies that can help to find a job on the Internet, none of them are focused on the health service. Our system can offer more specific information about the specialization you are interested in and this makes it different. The application consists of two parts. One part is for employers (mainly hospitals) and the other is for doctors searching for a job. The part for employers consists of a registration form, a form for entering job offers and a searching form. First you have to register. Submit your contact information and choose a location from the list of regions (former districts). Then, your contact details are validated and the access to the system is granted. This means that you can log in and enter a job offer for any medical specialization listed. It is possible to choose from the all basic specializations such as internal medicine, surgery, paediatrics, etc. If you would like to make your offer more specific e.g. looking for a gastroenterology specialist, you can choose "internal medicine" and write "gastroenterology" into the notes. It is also possible to make your offer for doctors from particular regions only.

The entering procedure for job applicants is quite similar. As a doctor who is looking for a job you have to register first. This means you complete the form with contact information, to submit details about your specialization and to enter a region where you would like to work. It is possible to look for several specializations in several regions at the same time. If interested, you can also search for a hospital where your specialization is needed. You do not need to be registered for this.

The link to the application can be found on the web site of Faculty of Medicine in Hradec Králové (<http://www.lfhk.cuni.cz>). We are open to all suggestions for any improvement. Wide support from hospitals' managements and representatives of Czech and Slovak medicine would be appreciated.

XXIXth DAYS OF MEDICAL BIOPHYSICS

The importance of university education of the nurses from the social care facilities in Slovakia pursuant to the European Union's new legislation

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We live in a developing democratic society where we may interpret our opinions, attitudes, and life and labor experiences in public. One of the main tasks of the profession of a nurse is the mission – art – to give a helping professional and human hand to the seniors, handicapped citizens, to ill persons, persons suffering from chronic diseases and to those who are dying.

At the present time we have to consider the work of the nurses in the social care facilities not from the medical viewpoint but mostly from the viewpoint of a professional who will manage the knowledge and skills under the new conditions of the European Union. Only the way at the level of the university education of the nurses leads to an appropriate fulfillment of the documents the Slovak Republic has accepted at its accession to the European Union and thus has admitted itself to new qualitative changes at caring about the citizens in their health and illness not only in our country but also in the European Union's lands.

The World Health Organization (WHO) alleges the holistic conception of the nursing care in its Strategic Documents issued for the nurses and midwives and accepted at the 45th World Assembly in May, 2001. By the accession of the Slovak Republic into the European Union a new directive of the European Union comes actually in awareness of the nurses titled "The Directive of the European Parliament and Council No. 2005/36/EC about the acknowledgement of professional qualifications", dated 7.9.2005. The stated Directive provides to the persons having acquired a professional qualification in a regular profession in a member state of the European Union the right to the same profession and to a professional output in other member state of the European Union. The new legislation gives guarantee also to the nurses from the social care facilities in Slovakia a possibility to use their acquired

knowledge and skills within a free movement in the European Union.

This trend requires orientating the education of the nurses to an independent and separate provision of the team and individualized nursing care to a patient in the environment of various types of institutions and communities. From this result also several core tasks for a nurse. One of it is to be for these citizens living in social facilities the protector and defender of their civil rights and of the rights of patients if they find themselves in a condition when they cannot or will not, because of health reasons, to care about themselves.

The nurse has its irreplaceable position at the professional field in specialist outputs precisely defined in our legislation. These outputs cannot and may not be provided by any other person lacking the necessary qualification and registration for them.

One of the very serious problems in the Slovak legislation is the definition of the nursing care in social facilities – what does a nursing output mean at all and what is an output off the frame of nursing practice?

Unfortunately, maybe incidentally or maybe intentionally, a word has not been incorporated in the legislation that in the social facilities the nursing care is provided off the ambulant care. Pursuant to the valid legislation only the provision of nursing care is ensured in the social facilities. A great hope is expected from the concepts of a long-term care the initiator of which is the Ministry of Health. The new legislation under preparation in the field of a long-term nursing care that relates to the transformation of the social facilities onto the social-health ones will finally open the way for the nurses from the social facilities to completely fulfill their acquired education and skills. The naming of these professional nursing activities would be required if we have the citizens in our facilities that do not require these services. But the contrary is true.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Model simulation of ventricular repolarization heterogeneity and its representation by the heart vector

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The shape of the electrocardiographic T wave and the vectorcardiographic T loop is the result of voltage gradients within the

cardiac ventricles during repolarization. These gradients depend on the heterogeneity of action potentials as well as on their tim-

ing due to propagated depolarization. Although the electrophysiological processes from the cellular to the whole heart level are experimentally well documented, application of these results for direct interpretation of the T wave shape is impossible. This is due to impossibility to determine synchronously their relation to the surface ECG. This limitations designate the computer modeling as a convenient tool to study the relation of the cardiac activation and recovery to its electrocardiological parameters.

Our computer model of ventricular activation was used to study the effects of eventual differences in the repolarization patterns between the right and left ventricular walls as well as between the apical and the basal parts of ventricles, on the heart vector. The model allowed to simulate the transmural repolarization heterogeneity as well as the differences in repolarization between the parts of ventricles. The model action potentials (MAPs) of the model elements were chosen differently with respect to their localization in the respective layers of the wall and to their pertinence to both the left or the right ventricle and to the apical or the basal part of ventricles.

In two series of simulations the difference of MAP durations of the epicardially localized elements in the right and the left ventricle was gradually changed from -15 to 15.0 ms. In the third series the ventricles were divided in apico-basal direction into two parts. In these parts the difference of MAP durations of epicardially localized elements was gradually changed from -10 to 10 ms. The simulation experiments were quantitatively characterized by the resultant heart vector.

The above mentioned changes in repolarization patterns showed that the vectorcardiographical spatial T loop was very sensitive on the changes in the right to left ventricular gradient of MAPD, while the similar changes in apico-basal gradient of MAPD influenced the T loop minimally. Besides the fact, that the obtained results may be of some value for diagnostic interpretation of noninvasively measured electrocardiographic parameters, the presented model is a suitable additive tool for the medical students education in electrocardiology.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

Magnetic drug targeting

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The main problems currently associated with systematic drug administration are a) even biodistribution of pharmaceuticals throughout the body, b) the lack of drug specific affinity toward a pathological site, c) the necessity of a large total dose of a drug to achieve high local concentration, e) non-specific toxicity and other adverse side-effects due to high drug doses. Magnetic drug targeting (MDT) can bring solution to all these problems. In very general sense MDT means accumulation of drug immobilized on magnetic nanoparticles in the target organ or tissue selectively and quantitatively using by external magnetic field. The intended drug and a suitable magnetically active component (magnetic nanoparticles) are formulated into a pharmacologically stable formulation. This compound is injected intravenously in the presence of an external magnetic field with sufficient field strength and gradient to retain the carrier at the target site. This contribution provides information concerning to preparation of biocompatible magnetic nanoparticles with controllable size and the different modes of immobilization of biologically active substances to the magnetic particles. For example by direct coupling method it is possible to bind proteins and enzymes (such as BSA, Dispase, Chymotrypsine, Streptokinase etc.) onto mag-

netic particles in the presence of CDI (carbodiimide) without the aid of a primary coating of freshly prepared magnetic particles. The coupling reactions of these substances were carried out using various ratios of magnetic particles to protein, and different values of pH to find out the optimum conditions of immobilization. The second mode of immobilization was liposome formulation where the hydrophilic drug (in our case the dye as a model was used) together with magnetite nanoparticles has been encapsulated in DPPC (Dipalmitoylphosphatidylcholine) liposomes. The temperature dependence membrane transport of dye from DPPC liposomes to magnetoliposomes has been observed. By means of polymer method the hydrophobic drug indomethacin as nonsteroidal anti-inflammatory drug together with magnetite nanoparticles have been successfully incorporated into PLA biodegradable polymer nanoparticles. The results showed that at the optimal value of aqueous phase pH = 3.0 we obtained 30.5 % of drug entrapment. The release profile of immobilized drug was studied also. The response on external magnetic field shows that above mentioned pharmacologically stable substances can be used for magnetic drug targeting.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Atomic Force Microscopy in Photodynamic Therapy

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Atomic Force Microscopy (AFM) is modern experimental method for imaging of conducting or non-conducting samples. New trends in application of Scanning Probe Microscopy (SPM) give us ability to scan living cells directly in their ingenuous surroundings or in special surroundings like in air, vakuum, liquid or low temperature. One of biological application in AFM is presented in our works. The aim of presented study is picture of cell surface in liquid surroundings of nutrient media or in air. The minimal forces between tip and surface of the sample avoid damage of biological preparation. We used special Liquid Scanner to picture cells in Non-contact or Tapping mode use in biological application of AFM. Liquid scanner give us possibility to study of cells in vitro. In our work we used cell line G361 and T98 as biological materials. The cell line was imaged with Liquid Scanner size 100x100 μm , and normal dry scanner the same size. We use plastic microscope slide Thermanoxr like substrate for sample.

We imaged cell line before PDT (Photodynamic Therapy) and after PDT. One million cells were displaced to the plastic slide and put to the Petric dishes. Cells were incubated in cultivation medium DMEM at $37 \pm 0.5^\circ\text{C}$ and 5 % CO_2 with photosensitizer 20 μM ZnTPPS4. The first part of Petric dishes was used as a nega-

tive control (cells with cultivation medium alone). The second part of the dishes cells in the presence 20 μM ZnTPPS4, were irradiated with dose 15 $\text{J}\cdot\text{cm}^{-2}$. After irradiation, cells were cultivated 12 hours in the same conditions. Our results are images of cells line T98 and G361 before and after PDT. Optimal photoactivation radiation was determinate in previous study. In our case was 15 $\text{J}\cdot\text{cm}^{-2}$. We have three type of pictures – topography, phase image, z-piezo scanning. Individual cell before PDT has got smooth surface without protrusion on complete cover. Cell after PDT hasn't smooth surface but, its surface is rough with protrusion and its surface is cleavage. Own works solve problems and artefacts presented during scanning of biologic materials located in liquid or nutriet media. Scanning of this materials is limited by construction of AFM. The aparatus was replenished with inverse optical microscope, now we observe tip scanning individually cell. For provoke PDT we use efficient LED source and photosensitizer ZnTPPS4. Our results give us facts that, we can induce photodynamic effect use LED source and shape surface of cell depose other type death of cell differently than natural death.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

Viability decrease on melanoma cells induced with phthalocyanine CIAIPcS2 and LEDs as a radiation source

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Photodynamic therapy (PDT) consists of introducing a photoactive non-toxic dye (photosensitizer) into the body and subsequent illumination of tumour tissue by visible or near infrared light of appropriate wavelength. In the presence of oxygen, illumination activates the drug and in turn produces reactive oxygen species leading to tissue damage.

The aim of this analysis was to study viability decrease with phthalocyanine CIAIPcS2 on tumour cell line G361 in an in vitro experiment. An irradiator planted by light-emitting diodes (LED) emitting in wavelength 630 nm was used as a radiation source. The optimal density of radiation energy was determined on 15

$\text{J}\cdot\text{cm}^{-2}$ defined in previous experiments. We found out that it is possible to make with PDT 63 % decreasing in cells viability (in comparison with control cells) after 14 hours.

Half a million human melanoma cells (cell line G361) were displaced to the Petric dishes and were incubated in cultivation medium DMEM at 37° and 5 % CO_2 with 20 μM CIAIPcS2. The first part of Petric dishes was used as a negative control (cells with cultivation medium alone), the second part of the dishes, cells in the presence of 20 μM CIAIPcS2, were irradiated with dose 15 $\text{J}\cdot\text{cm}^{-2}$. After irradiation, cells were cultivated for 4 to 24 hours at 37°C and 5 % CO_2 . Cells were subsequently trypsinised

(4–5 minutes, at the RT) and processed with quantitative measurements of apoptotic and necrotic cells performed by flow cytometer (FACSCalibur) using fluorescence probe PI (Sigma-Aldrich) in compliance of the standard staining protocol.

PDT caused significant decrease in viability of tumour cells. With optimal photo-activation radiation dose 15 J.cm^{-2} with combination of $20 \mu\text{M}$ photosensitizer CIAIPcS2 we can induce 80 % reduction of cell viability after 14 hours from the irradiation. We found out that phthalocyanine CIAIPcS2 has good in vitro

PDT efficiency, because of good tissue penetration of red light and has good presumption in use in clinical applications.

The data summarized here indicate that it is possible to design efficient LED source to provoke PDT with photosensitizer CIAIPcS2 and we demonstrate that LED source was found to be practical device. Our results clearly demonstrates that, at least in vitro, it is possible to induce photodynamic effect.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

Health information system in prevention of diseases

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Health policy, creation and exploitation of health information systems, programme of health support, some parts of hygiene, epidemiology and disease prevention are integrated in the scientific branch public health, nowadays. For effective disease prevention in modern meaning the communication channels are indispensable. By them information is transferring intentionally on the level of individual, community, state and world. Operational system of information transfer should influence positively on information and communication technologies (ICT) user equipped by computer literacy in the individual health care.

The aim is to suggest, after investigation of functional computer literacy level of students of study programmes nursing, public health, midwifery and laboratory medicine, effective forms and set of didactic means of teaching to improve their knowledge and skills by using ICT.

Using the personal computer in education as a supporting tool of medical and health informatics. The intention is not to substitute the teacher but to use the computer as:

- a dynamic, interactive library (data and knowledge base),
- an easy-to-handle, non dangerous laboratory for (simulation) experiments,
- a powerful machine for numerical or symbolic calculations and logical reasoning.

Combined with other devices like videodisc, videotex, audio-equipment, graphic tables, touch screen, diverse sensors etc, the computer, if provided with appropriate software, can become a powerful, versatile, much used general tool — not only for teachers and students, but for everybody in professional and daily life.

ICT can be used as modern educational and teaching mean in disease prevention:

- direct – for primary prevention and enlightenment of wide public and elderly people

- distant – mostly in higher forms of education of health professionals, e.g. postgradual education

- elearning – ICT exploitation in the interactive educational methods.

In all educational forms performs the dominant role functional computer literacy and technical support of virtual educational systems.

The aim will be the analysis of results of investigation oriented on grading the computer literacy level. The investigation was realised using questionnaire during academic years 2003/2004, 2004/2005, 2005/2006. Daily and external students of non-medical study programmes created the group of respondents. In the group of 242 respondents- students of external form of nursing ($N_1=242$) and in the group 197 respondents-students of daily forms of study ($N_2=197$), we find user level of computer literacy in N_1 78.5 % and in N_2 80.7 %. They have no experience in information searching from health prevention.

Education using computers should show:

- how to discover that the environment in which we live and work is full of algorithmic processes concerned of bio-psychosocial basis of hygiene,

- that it is very useful to see our world also from a systems point of view, i.e. as a number of interrelated complex systems, which again have a complicated modular structure and which follow different strategies to organise the activities of the agents (persons, machines) in a profitable way,

- that a number of new formalisms and concepts are needed to describe such systems and processes in a clear way (behavioural medicine) and

- that, before computerising and activity, or before bringing computer aid into a specific organisation a systematic analysis from the point of view of systems and algorithmic processes is absolutely necessary.

Therefore education using computers also does not simply mean teaching programming, although some programming knowledge helps to understand better how algorithmic processes can be specified and how such specifications can be made operational. Education on computers should be much more an education in informatics, which to some extent can even be done without computers, since many of the basic concepts and formalisms and even some of the methods and techniques of informatics can be discussed, exemplified and explained by using examples from daily life and by interpreting knowledge from other disciplines.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

Use of Models for Interpretation of Measured Cardiac Potentials

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Possibility to interpret measured body surface potential maps using simplified model of the cardiac generator and geometrical model of the torso is discussed in the presentation. Equivalent current dipole was used as a model to represent cardiac electrical activity in two specific abnormal conditions: in WPW syndrome with single accessory pathway and in local ventricular ischemia. Results of a simulation study and experimental verification of the approach on a few patients are presented.

Initial ventricular activation in different locations along the atrio-ventricular ring that can be seen in WPW patients with single accessory pathway was simulated and corresponding surface potentials were calculated by a forward model. Locus of the arrhythmogenic tissue was then assessed from potential maps during the early depolarization phase. Similarly, local subendocardial and subepicardial ischemic lesions in three regions typical for stenosis of main coronary arteries were simulated as areas with changed repolarization characterized by shortening and/or decrease of the myocyte action potentials. Positions of the lesions were then inversely estimated from changes in surface QRST integral maps. In both cases, influence of selected error factors was analyzed: incomplete knowledge of the thorax heart geometry, noise in measured surface potentials and limited number of measured ECG leads. Simulated accessory pathways were located with a mean error of about 5 mm when none of the analyzed factors was present and increased to 11 mm when all factors were reasonably accounted. Experimental localization of the accessory pathway in a WPW patient was in good agreement with the invasively obtained site.

Simulated small ischemic lesions were located with a mean error of 9 mm, while considerably larger error of 17 mm was observed for larger transmural lesions. Prevalence of subepicardial or subendocardial type of the lesion was reflected in the dipole orientation. In experimental verification of the method, estimated dipole position and orientation matched the treated vessel in 7 of 8 examined patients that underwent PCI.

Despite the limitations of the simulation study, presented results suggest that diagnostic interpretation of body surface potential maps based on dipolar source model and known patient torso geometry can be a useful tool for noninvasive assessment of pathological heart states in selected situations. Moreover, this approach seems more promising than direct interpretation of body surface potential maps using comparison of measured maps with templates for normal and pathological situations.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Output parameters of the ^{131}I bi-phasic versus monoexponential biokinetics model in thyroid gland

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Absorbed radiation dose following administration of radiopharmaceutical in nuclear medicine is the quantity determining treatment efficiency and its radiation protection aspects. To describe patient specific biokinetics of radioactive iodine ^{131}I in thyroid gland the alternative bi-phasic model was developed. Its superiority over the elder, generally used monoexponential model was proven previously.

Reveal the difference in crucial output values yielded from the bi-phasic and monoexponential model. These outputs are the effective half-life and the time integral of activity cumulated in thyroid gland, used in practice to describe radiopharmaceutical biokinetics and to determine the absorbed dose in target and other tissues.

There were 3848 data sequences containing time-activity pairs, representing examinations following diagnostic or therapeutic administration of ^{131}I processed. Based on these data, the novel bi-phasic model was identified in the Bayesian way. The posterior probability density function of model parameters was sampled using MCMC techniques, where prior constraints representing expert knowledge and basic biophysical presumptions were applied. This function was numerically transformed to probability distribution of modeled function time integrals, those were ana-

lyzed and further on treated as approximately log-normal. Parameters of 95 % confidence intervals of cumulated activity time integrals and of the effective half-lives were evaluated for each data sequence using both compared models.

Effective half-lives 95 % confidence intervals lower and upper boundaries differed relatively in 1.289 and 0.056 respectively. For cumulated activity time integrals these values relatively differed in 0.385 and -0.089 respectively. Relative width comparison of above-mentioned intervals was 4.35 for effective half-lives and 4.48 for cumulated activity time integrals in favor of the bi-phasic model.

These result show significant discrepancy between the two compared models. According to previously proved higher accuracy of bi-phasic model, the output results based on this model can be advised to achieve higher accuracy in absorbed dose estimation and prediction in practice. In particular, significantly narrower average of 95 % confidence interval width for bi-phasic model should imply more precise decision making, which is expected to be further improved by custom made prior information used for modeling.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

Changes in nuclear envelope structure after exposure to ultrasound

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The aim of the study was to gain an insight into the effect of ultrasound on the nuclear envelope of cancer cells. Suspensions of HL-60 cells derived from human promyeloeloid leukemia were irradiated, at therapeutic doses, by an ultrasound BTL-07p generator (continuous mode; frequency 1 MHz; intensity 2 W/cm²) for 15 min in a water bath at 36 °C. The sonicated cells were fixed in 3 % glutaraldehyde in 0.1 M cacodylate buffer for 2 h, and subsequently placed in 25 % glycerol. The cells were studied by freeze-fracturing which allows us to view the inner surfaces of split cell membranes and cell organelles. The samples were frozen in liquid Freon 22 and stored in liquid nitrogen. Replicas were

prepared with a BAF 060 BAL-TEC apparatus where specimens were fractured with a cooled microtome knife and coated with a platinum and carbon film. After cleaning with sulfuric acid, the replicas were viewed and photographed with a Morgangi 268D Philips transmission electron microscope. Images were processed using ACC image analysis software (Adaptive Contrast Control).

The control and irradiated specimens were compared, the number of nuclear pores per 1 μm^2 counted and statistically evaluated. A significant increase was found in the number of pores per unit area due to irradiation. In some pores, this was also associated with changes in pore structure, as compared with the

state before and after treatment. Ultrasound exposure apparently affected the pores and interfered with their fine inner structure. Another morphological change related to ultrasound irradiation was greater variability in the depth of pores in the replicas.

Ultrasound treatment under conditions mentioned above affected the number, morphology and depth of nuclear pores in HL-60 cells.
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XXIXth DAYS OF MEDICAL BIOPHYSICS

New contexts of university teachers' professionalization

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At the beginning of 21st century the question of conception and quality of university education is raised again as a political, research, theoretical and practical problem. An ever-changing demands on education are determined by new paradigms and concepts: *human resources development, knowledge-based society/economy, sustainable growth etc.* It brings for education new challenges, tendencies and principles. There are concepts like: *lifelong learning, learning society, harmonization of European educational landscape, quality and excellence in education, equity* (Lisbon and Bologna declaration, UNESCO report *Learning the Treasure Within*). What do these contexts bring into our rethinking of university education? EU debate on the role of universities in knowledge society revealed that universities have the key position in production of new knowledge, its transmission through education and training future professionals and also researchers, and exploitation of research results in practice.

If the traditional functions of universities are influenced by new contexts we have to be interested in many aspects of higher education but above all in university teachers who educate students, make research and produce knowledge. Are the academics able to reflect new conditions and demands on their profes-

sion and include them into their performance? For many years we have debated at the European Network for Staff Development (CEPES) the problem of professionalization of university teachers as a necessity for raising the quality of higher education. The main difficulties experienced by teachers are mainly in pedagogical competency (new strategies of teaching/learning, curriculum design, new approaches toward assessment and evaluation, interpersonal strategies). In USA and many European countries (incl. CR) the programmes on higher education pedagogy are offered.

Pedagogical competency is understood as complex of specific expert knowledge and skills that provide a sustainable level of excellence of teaching/learning processes and educational outcomes, intellectual spirit and academic culture.

What are the dimensions of university teachers' professionalism? There is a need to see in all the wide his/her academic roles, activities and background. British experts Light and Cox (2001) created concept of *reflective professional* based on „*professing-in-action*“ in different professional situations like: 1. *instruction-research-administration-extension*, 2. *science field-department-faculty-university*, 3. *ethical-social-economical-political context*, 4. *local-regional-international context*

XXIXth DAYS OF MEDICAL BIOPHYSICS

Monitoring of psychogalvanic skin reflex using ida microelectrodes

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New modification of non-invasive biomedical monitoring of psychophysiological processes based on local skin conductivity measurements by interdigitated array (IDA) of microelectrodes has been developed. From electrical model of IDA microelectrode/skin interface and simulations the important out-

come has arisen: the electric field distribution and depth of penetration into the outer skin layers depend on the configuration and size of electrode system. We used it for the analysis of electrophysiological processes in skin when the person is under the stress. Our aim is nonstop monitoring. Standard psy-

chotests showed that the response signals of commercial macro-electrodes measured with GSR method and of our microelec-

trodes were similar – microelectrode signals were more stable with shorter response time.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Improhealth – e-learning for health care management

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Project Improhealth mission is to broaden the access to the vocational managerial education and training in order to improve quality, effectiveness and efficiency of the healthcare organization services.

Project products:

Virtual Quality Center on web

eLearning courses

eImplementation

eImprovement

Project objectives:

Establishment of the Virtual Quality Center (VQC) for managerial Vocational Education and Training (VET)

Development of the eGlossary

Authoring of materials for courses and training in the area of implementation and improvement of quality management system

Run of the pilot e-Courses

Management of the information days and special seminars

The mission of the eLearning course is to offer managers, doctors, researchers and other healthcare personnel the possibility to obtain certified knowledge in Quality Management, Change Management, Performance Management and Human Resource Management.

The objectives of the eLearning course is to develop the abilities, skills and expertise of the participant so that they gain: professionalism, as the faculty of dealing with various tasks and problems of a healthcare organization using modern managerial tools and methods, flexibility, meaning the ability to manage successfully restructuralizion and change of identity in a healthcare organization, ethical integrity, meaning the ability to tackle tasks and problems of a healthcare organization in a way which respects the dignity of the patients/clients and personnel, in a way which ensures that the organization is viewed positively by the public and in a way which guarantees excellent economic results.

Each course module has its own national certificate issued by the responsible university. Teaching is conducted via the Internet. Applicants have access to course syllabi, a time table, instructions for study, a textbook, teaching cards, lectures and an evaluation form. Any issues which are unclear can be consulted with the lector by electronic mail.

The pilot course was provided free of charge for selected participants who cooperated in development of the courses.

Improhealth – Improvement of the Quality, Effectiveness and Efficiency of Healthcare services through Vocational Education and Training.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

High density lipoprotein detection using supported bilayer lipid membranes

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Lipoproteins, that transport cholesterol in the circulation, play an essential role among plasma molecules. A relevant position among them from point of view of coronary heart disease takes

high density lipoprotein (HDL), that takes up free cholesterol from cell membranes and transport approximately 20–30 % of plasma cholesterol.

High density lipoprotein has inherent tendency to interact with lipid bilayer structures and therefore model lipid membranes could be applied for the detection of HDL in plasma.

Lipid membranes deposited on solid supports represent a relatively biocompatible structure for the development of new types of electrochemical sensors and biosensors with fast response times (in the order of a few seconds) and high sensitivity (i.e. nanomolar detection limits).

The technique of formation of s-BLMs is based on the interaction of an amphiphilic molecule with a nascent metallic surface. The experiments were performed using Universal Electrochemi-

cal Interface, IM6, Zahner elektrik, Germany that includes a potentiostat/galvanostat and personal computer.

HDL – s-BLM interaction is observed by change of membrane electrical parameters. The dependencies of membrane resistance and capacitance on HDL concentration in solution were obtained in the medically relevant concentration range. The HDL — membrane interaction results in the decrease of membrane conductance and capacitance.

This paper demonstrates potential of supported bilayer lipid membranes for HDL measurements in plasma.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Education of nurses and midwives at Medical Faculty in Bratislava

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During school year 2002/2003 the Medical Faculty in Bratislava activated – on the basis of transformation changes within the medical workers education – the study programme Nursing and one year later also the study programme Midwifery. The independent Institute of Nursing created by specialists in Nursing and Midwifery, who provide a tuition within both study programmes, has been established simultaneously.

Duration of study programme Nursing lasts in full-time study form in bachelor degree 3 years, in master degree 2 years and 4 years in part-time study form in bachelor degree. The graduates of study programme Midwifery can achieve a bachelor degree only.

Conditions for admission to the study programmes Nursing and Midwifery are: Secondary education completed by GCE, entrance test from biology as well as secondary nursing school and 3 year practice in the branch is mandatory in part-time study form.

The contents of both study programmes consist of nursing, medical-nursing, preclinical and clinical educational subjects,

social sciences applied into nursing and additional educational subjects which complete graduates' profile.

The study of Nursing and Midwifery programmes in bachelor degree is completed by "Bachelor examination" which consist of bachelor paper discussion as well as practical and theoretical nursing examination.

The study of Nursing programme in master degree is completed by "State examination" which consist of thesis discussion, theoretical nursing examination and examination from mandatory-eligible subjects.

Pregraduate education of Nursing and Midwifery programmes at Medical Faculty corresponds according to special provisions to requirements for coordination of education for needs of mutual recognition of special qualifications within EU.

The Medical Faculty has been also activated the postgraduate study programme in specialization Nursing since school year 2005/2006.

XXIXth DAYS OF MEDICAL BIOPHYSICS

Discrimination method of measurement impedance for medical diagnostic

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Studying of dielectric properties of biological materials have more than 80 years history. One from these electrical properties is impedance (Z). Utilization of alternating harmonic high fre-

quency signal provides the measurement of frequency independent ohmic component as well as frequency dependent capacitance component – reactance (jX). Due to the impedance is pos-

sible to characterize various dielectric properties of biological structures. For laboratory investigation methods is essential low perturbation measurement. Discrimination method in opposite to bridge compensation method it provide.

Motivation: Aim of this work is design and verification of electric properties measurement method. For suggested method was used sensor suitable for monitoring of cultured milk production technology based on noble cultivation of *Lactobacillus Acidophilus* and *Lactobacillus Bulgaricus*.

We have investigated the dependence of the impedance change as a function of the bacterial cultivation. Measurement was executed on 15 LA samples, $\eta=15$, in nurid solution (milk) of acidity pH from 6.0 to 4.5. The measurement was realized in constant laboratory microclimatic conditions. The discrimination method in opposite to bridge compensation method is comparative measurement. Idea of this method the is based on the modification of bridge arrangement of ohmic elements R1,R3 and impedance elements Z2, Z4 in referent branches and in comparison branches, respectively. If R1, R3 are high resistivity elements, then currents I1, I3 are very small and neglectable. In this condition we can simplify original bridge circuit to two-branches setup. In their node is situated the measuring apparatus, the null indicator (realized by mean value instrument – milivoltmeter). We supply alternating harmonic voltage

to impedance's branches Z2, Z4. These signals have equal amplitude and opposite polarity (phase shift in time domain $\phi=0$ and $\phi=\pi$). Applied frequency band was in the range of a dispersion. Impedances Z2, Z4 were realized by two identical cells with nurid solution (referent and measuring) in capacitance arrangement. To measurement cell was applied selected bacterial culture.

Obtained experimental results shows suitability of designed method. Bacterial cultivation provides increasing of the capacitance's reactance in comparison with referent cell. For supply voltage $U_{ef}=5V$ the impedance change measured by the null indicator was in range from 10^2-10^3 mV. The measurements were executed in 2, 4 and 6 hour of cultivation process. Lactic acid generation is driven by cultivation process, what is observable on pH change. In consequence of this process decreases the real component of impedance Z2.

The presented method allow essential quantitative measurement of bacteria cultivation. Furthermore, for simplicity of experimental setup is appropriate for certain microbiological tests, e.g. bacteriometry, as a low-cost method. Results show high reproducibility, high sensitivity as well as time stability. Modifications of this method have various applications in the field of medical diagnostic.

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XXIXth DAYS OF MEDICAL BIOPHYSICS

The enhancement of practical training in medical biophysics

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The continuous improvement of the practical part of the medical biophysics course is one of the most important working activities of our department already for many years. During this academic year further essential renewal was realized. The innovation of a laboratory for practical training in medical biophysics at the Medical Faculty in Hradec Kralove (Charles University in Prague) was the main aim of our endeavour. The syllabus was adjusted too. Within this project two brand new practical themes were designed, developed, and implemented in the practical part of this course: the first one, which was entitled "Eye as an optical system", and the second one, which was entitled "Measurement of stress-strain curves of the nitinol stent". Both these tasks are based on an active application of biophysical principles. The statistical methods, effective use of computers, database handling and automated measurement and data acquisition are integrated in these tasks. The students of medicine also have opportunity to work with the modern diagnostic and measuring devices. In the first task they have hands on experience using automated computer-

ized perimeter and refractometer. They must examine a full visual field and, in turn, compare sensitivities in the central and peripheral field using the two-sample t-test. By means of our own software they must determine minimal angle resolution of eyes to design a corrective lens and to calculate limit of the stereoscopic vision.

In the second task a special measuring system is used. It can measure elongation of the stent, force, temperature, and it also has a contactless measurement of the stent diameter. A stress-strain curves of the nitinol stent and change of mechanical properties after temperature induced phase transformation are investigated.

The third practical task was extended: "ECG recording and blood pressure measurement" was completed with a blood pressure simulator. The simulator helps to resolve the uncertainties during teaching students to take blood pressure. That is, which sound to listen for.

At the end of this project the response of the students was evaluated. The voluntary and anonymous questionnaire was used.

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