

Materials and methods. According to European and Bulgarian legislation each X-ray has to be equipped with enough protection clothing. Every year these clothing have to be examined for defects which could lead to over exposure of the staff. A simple method for testing and rejection of the clothing was presented from Brian Philips et al. This method comprises several steps for examination together with rejection criteria for lead apron, thyroid shield and Gauntlet.

Results. Because of the daily use in most of the clothes defects were observed. The size of some of the defects could cause overexposure and overrun of the year dose limit of 20 mSv. Therefore these clothes were rejected and replaced with new.

Conclusions. Examination of the lead clothing must be included in every quality assurance program. This will keep the occupational exposure below the year effective dose limit.

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Automated dose tracking in CT of the chest

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Purpose. To present a detailed optimization process of automated radiation dose tracking data in standard CT chest examination for multi detector computed tomography (MDCT). Tasks resulting from such a goal are related with correct processing of collected data, deep analysis and interpretation of the data, identification of incorrect clinical practice and to compare the results with another radiology department practice.

Materials and methods. A single retrospective study was conducted involving regular enrolled patients for routine CT chest examination in Acibadem City Clinic Tokuda Hospital. All MDCT exams were performed on a 64-detector row computed tomography (LightSpeed VCT, GEHC) without any iterative reconstructions. The tube voltage (kV), slice thickness (mm), rotation time (s/rot) and table speed (mm/s) were periodically altered parameters according to radiation dose reduction without compromising the quality of the image. In the course of the study a web-based dose management software was used (DoseWatch, GEHC) which allows all MDCT chest examinations to be properly tracked and radiation doses to be collected.

Results. After the step by step optimization the CTDI_{vol} and DLP were decreased to 9,20 mGy and 373,77 mGy.cm respectively while maintaining good diagnostic image quality. In comparison with Acibadem City Clinic Cancer Centre (Optima CT660, SS40 ASIR, GEHC) these values are slightly higher which is explained by the fact that in Optima CT660 an iterative reconstruction algorithm was systematically used (CTDI_{vol}6,43 mGy and DLP 265,2 mGy.cm).

Conclusions. The CT chest radiation dose was reduced with 56% (CTDI_{vol}) and 63% (DLP) with preserving the diagnostic image quality. A significant CT chest dose reduction was achieved even without using any iterative reconstruction algorithm.

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An approach of modelling of irregular masses

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The goal of this study is to create and evaluate a methodology for generation of realistic 3D computational models of breast tumours with irregular shapes.

Methods. The methodology for the creation of breast masses consists of two steps: (a) creation of the initial diffusive tumour shape, by choosing Brownian motion or nearest neighbour random walk algorithm, (b) creation of a solid tumour shape by applying a set of 3D filters, and morphological operations. The initial models were smoothed by applying a set of image processing methods. Thereafter, projection images of these 3D lesions were generated by using an in-house developed software, capable to simulate the X-ray transport through the computational phantoms. Subsequently, a technique for embedding the simulated masses in patient mammography images was developed and applied.

Results. Thirty irregular masses with different sizes and shapes were generated, and projection images were simulated. The realism of the projected masses on patient images was evaluated by comparison of extracted features, such as the exponential parameter of the power spectrum, fractal dimension and other statistical parameters to these extracted from patient data. The obtained results confirmed that the methodology is capable of producing realistic 3D tumour models with user defined sizes and irregular shapes.

Conclusions. The methodology will be used to generate unique and realistic in shape and size computational models of breast adenoma, intraductal papilloma, cysts and duct hyperplasia. These computational models are stored in an open source database to be used by all professionals working toward the creation of new technologies for breast-screening and diagnosing.

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Breast awareness mobile application

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The main purpose of this work is to present the development of a mobile application to assist the women with breast cancer prevention. The mobile application is implemented using React Native - a JavaScript framework for building natively rendering mobile applications for iOS and Android. The RESTful API is implemented using Node.js - an open-source, asynchronous, event driven, cross-platform JavaScript run-time environment. MongoDB - a NoSQL, document-oriented database is used as a database. The platform starts with a questionnaire related to the user and her family. After the quiz, the application assesses the user's risk of breast cancer and provides advices how often a specialist should be visited. The questions, as well as all other information supplied by the application, are currently under review and evaluation by radiologists. Under development is as well a system for archiving the user's medical examination results. In addition, all the necessary information about prophylaxis, self-exam, symptoms, stages, risk factors, etc. is provided in an interactive way. For instance, there is a dedicated panel for implementing a breast self-exam, which is important action towards finding first signs of any breast abnormality. The provided drawings and running text assist the users to easily perform this

breast self-check, looking for any changes in the size, shape, color, any distortion, swelling, etc. With the final implementation of this mobile application, it is expected the Bulgarian users to get more informed about the importance of breast screening and understand the importance of breast prevention activities.

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3D printing of anthropomorphic breast phantoms dedicated to research of X-ray image modalities

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Physical phantoms are a basic tool for the assessment and verification of performance standards in daily clinical practice of X-ray imaging modalities. Most of the physical phantoms have a homogeneous background with inserted test objects. For research purposes, many of the existing phantoms should be developed to a next degree of sophistication in order to mimic the real objects more closely in terms of radiographic and anatomical properties. The development of 3D printing technologies opens potentially new possibilities for phantom manufacturing. The aim of this study is to explore the absorption properties of common 3D printing materials such as resins, PLA, ABS, etc. and to estimate their potential for production of the anthropomorphic phantoms. To achieve this goal, step-wedge phantoms were computationally modeled and then manufactured using two popular 3D printing technologies: stereolithographic and fused-deposition modeling. X-ray images of the phantoms were acquired, using monochromatic beam at ID17, ESRF, Grenoble for three energies – 30 keV, 45 keV and 60 keV. Experimental data were further processed to obtain the linear attenuation coefficients of these materials. Comparison with theoretical data for the linear attenuation coefficients for breast tissues was performed. Based on the results, several breast anthropomorphic phantoms were manufactured. Finally, a practical approach for printing anthropomorphic phantoms has been established and verified. From the studied materials, most of the resins, Hybrid, PET-G show absorption properties close to the glandular tissue, while ABS shows absorption characteristics close to those of the adipose tissue. It allows the production of complex shapes, which are very advantageous for the case of breast phantoms.

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Protection of personnel and patients in diagnosis and therapy with ionizing and non-ionizing radiation

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Most of the sources used in physiotherapy use pulse magnetic fields; spark-discharges; radiofrequencies (RF); direct and low-frequency electric currents, electrical pulses; ultraviolet (UV) and

infrared (IR) radiation; broad-spectrum lamps; lasers. The most relevant diagnostic sources are MRI scanners emitting static magnetic field, low-frequency fields, RF. The exposure of medical personnel to NIR depends on the type of transmitter, irradiation power, mode of operation, specific application, access of medical personnel to the treatment zone, shielding of the source and workplace, time duration of exposure.

Devices for electric current therapy like pulses, ionophoresis therapy, vacuum therapy, emit magnetic field less than several μT . The devices for subthermal therapy emit RF energy up to 9,8 W/kg, compared to 0,4 W/kg basic restriction for whole body exposure. The average daily dose of the staff at 10 patients per day is 18,356 (V/m)²·h. The dose of medical personnel in protective chambers averaged per patient is $W_E = 23,88$ (V/m)²·h.

Regard to MRI equipment, the basic restrictions for static magnetic field for normal operating conditions exceed the action values for people at specific risk, also for risk of attracting ferromagnetic materials. In the case of the use of optical sources, power densities exceed the exposure limit values, and therefore the permissible stay is limited to minutes and seconds, and in some cases it is inadmissible. In cosmetic centers, sanatoriums and SPA centres, power densities are significant and some of them are not controlled (tanning beds and IPL systems).

The laser systems applied in physiotherapy are mainly class 3R (visible range), which only pose a risk to the eyes, in some cases 1C. For some procedures, lasers of class 3B are also used which cause risk to the eye by intra-beam viewing as well as diffuse reflected radiation. In cosmetic centers where specific lamps and high class (4) lasers are used, there is a risk for serious skin burns and eye damage.

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Professional realization of specialists in medical sanitary physics and sanitary engineering

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In Bulgarian legislation there are basically two medical specialties for physicists and engineers:

- *medical radiological physics*
- *medical sanitary physics*

In addition, for engineers, architects, environmentalists, the main medical specialty is:

- *Sanitary engineering.*

Here, we focused only on the specialties *medical sanitary physics* and *sanitary engineering* that are important for the prophylactic medicine.

These training courses last for 3 years, and trainees receive the highest degree of competence in the field of *measurement and exposure assessment of physical factors, risk evaluation and management, possible health effects of ionizing and non-ionizing radiation, methods for prevention*. Simultaneously, they are trained in the field of *occupational and environmental health concerning human exposure to physical factors*. Such, they are the best specialists for medical units dealing with imaging and medical treating using non-ionizing radiations (NMR, ultrasound, UV and IR radiation), for the health control bodies of the working and living environment, for ecological expertises, for occupational health services. Unfortunately, most of them are re-qualified as medical radiological physicists and other professions or they are leaving the country because of better incomes and respect.