Ausgewählte Beiträge in externen Fachzeitschriften / Abstracts

Ainsbury E.A.; Bakhanova, E.; Barquinero, J.F.; Brai, M.; Chumak, V.; Correcher, V.; Darroudi, F.; Fattibene, P.; Gruel, G.; Guclu, I.; Horn, S.; Jaworska, A.; Kulka, U.; Lindholm, C.; Lloyd, D.; Longo, A.; Marrale, M.; Monteiro Gil, O.; Oestreicher, U.; Pajic, J.; Rakic, B.; Romm, H.; Trompier, F.; Veronese, I.; Voisin, P.; Vral, A.; Whitehouse, C.A.; Wiesner, A.; Woda, C.; Wojcik, A.; Rothkamm, K.

Retrospective dosimetry techniques for external ionising radiation exposures

In: Radiation protection dosimetry 147 (2011), Nr.4, 573-592

The current focus on networking and mutual assistance in the management of radiation accidents or incidents has demonstrated the importance of a joined-up approach in physical and biological dosimetry. To this end, the European Radiation Dosimetry Working Group 10 on 'Retrospective Dosimetry' has been set up by individuals from a wide range of disciplines across Europe. Here, established and emerging dosimetry methods are reviewed, which can be used immediately and retrospectively following external ionising radiation exposure. Endpoints and assays include dicentrics, translocations, premature chromosome condensation, micronuclei, somatic mutations, gene expression, electron paramagnetic resonance, thermoluminescence, optically stimulated luminescence, neutron activation, haematology, protein biomarkers and analytical dose reconstruction. Individual characteristics of these techniques, their limitations and potential for further development are reviewed, and their usefulness in specific exposure scenarios is discussed. Whilst no single technique fulfils the criteria of an ideal dosemeter, an integrated approach using multiple techniques tailored to the exposure scenario can cover most requirements.

Beinke, C.; Oestreicher, U.; Riecke, A.; Kulka, U.; Meineke, V.; Romm, H.

Inter-laboratory comparison to validate the dicentric assay as a cytogenetic triage tool for medical management of radiation accidents

In: Radiation measurements 46 (2011), Nr.9, 929-935, doi:10.1016/j.radmeas.2011.05.038

Radiation accidents with exposure of human beings can assume huge dimensions concerning occurring health impairments and essential medical resources such as personnel, patient care management and appropriate medical facilities. Particularly in mass-casualty events, a rapid sorting and allocation of victims to treatment is needed and their classification in medical treatment groups has to be conducted as fast as possible. For triage purposes several approaches can be considered. Clinical signs and symptoms are extremely helpful in estimating radiation effects on an organ based level, whereas the assessment of radiation effects based on cytogenetic biodosimetry tools is the alternative approach. For both systems there are pros and cons with respect to the usefulness for specific applications, such as individual cases versus mass casualty screening or whole- versus partial-body exposures. Among the biodosimetry tools the dicentric chromosome assay (DCA) is considered as the “gold standard” for biodosimetry after an acute radiation exposure. Recently, steady progress in standardization and harmonization of the DCA has occurred, in order to enable the validated performance of the DCA in the frame of cooperative response of biodosimetry networks during a large scale radiological scenario. Using the DCA in triage mode which allows the stratification of radiation exposed victims into broad 1.0 Gy categories only 20-50 metaphase cells per subject are scored instead of the 500-1000 scored for routine analysis. Our data show that there are significant differences between the dicentric yields after 1.0 Gy and 3.0 Gy γ-ray ex vivo exposure of blood suggesting this assay as suitable for the distinction between high and low dosed exposed individuals. These preliminary findings indicate the usefulness of the DCA also for therapeutic decision making.

Birschwilks, M.; Gruenberger, M.; Adelmann, C.; Tapio, S.; Gerber, G.; Schofield, P.N.; Grosche, B.

The European radiobiological archives: online access to data from radiobiological experiments

In: Radiation research 175 (2011), Nr.4, 526-531

For financial and ethical reasons, the large-scale radiobiological animal studies conducted over the past 50 years are, to a large extent, unrepeatable experiments. It is therefore important to retain the primary data from these experiments to allow reanalysis, reinterpretation

and re-evaluation of results from, for example, carcinogenicity studies, in the light of new knowledge in radiation biology. Consequently, there is an imperative need to keep these data available for the research community. The European Radiobiological Archives (ERA) were developed to fulfill this task. ERA has become a unique archive, including information from almost all European long-term studies carried out between the 1960s and the 1990s. The legacy database was originally developed in a manner that precluded online use. Therefore, strong efforts were made to transform it into a version that is available online through the web. This went together with quality assurance measures, including first the estimation of the rate of non-systematic errors in data entry, which at 2% proved to be very low. Second, every data set was compared against two external sources of information. Standardization of terminology and histopathology is a prerequisite for meaningful comparison of data across studies and analysis of potential carcinogenic effects. Standardization is particularly critical for the construction of a database that includes data from different studies evaluated by pathologists in different laboratories. A harmonized pathology nomenclature with modern standard pathology terms was introduced. As far as possible, references for the various studies were directly linked to the studies themselves. Further, a direct link to the JANUS database was established. ERA is now in a position where it has the potential to become a worldwide radiobiological research tool. ERA can be accessed at no cost at https://era.bfs.de. An ID and password can be obtained from the curators at era@bfs.de.

Brix, G.; Lechel, U.; Petersheim, M.; Krissak, R.; Fink, C.
Dynamic Contrast-Enhanced CT Studies: Balancing Patient Exposure and Image Noise.
Invest Radiol, 2011; 46:
Objectives: To establish the essential basis for balancing the dose versus noise trade-off in dynamic-contrast enhanced (DCE) CT by means of a phantom study. *Materials and Methods*: Measurements were performed at a 64-section dual-source system using the default protocols for DCE imaging of the trunk and head. For three representative sections of an anthropomorphic phantom (head, upper abdomen, pelvis) transaxial dose distributions were measured by thermoluminescent dosimeters. The image noise was determined for 5 values of the current-time product (but otherwise identical parameter settings) and 4 pixel resolutions at a water-filled trunk and head phantom. *Results*: Highest exposures occurred at the periphery of the trunk and head with maximum skin entrance doses of about 300 mGy. Effective doses related to the three exposure scenarios were between 4 and 20 mSv, but were not at all predictive of local exposure levels. The image noise was inversely proportional to the square root of the current-time product and, with restrictions, to the pixel size. Noise levels determined for the standard settings were 13.8 HU (trunk) and 4.4 HU (head) and thus comparable with the contrast enhancement typically detected in tumours and ischaemic brain tissues, respectively. *Conclusions*: The opposing requirements of risk and noise limitation in DCE-CT cannot be balanced without substantially reducing the spatial resolution. But even so, local radiation exposures are rather high for a diagnostic procedure. Indications to perform a DCE examination should thus be strictly limited to patients who really benefit from it.

Carpentieri C., Zunic Z S, Carelli V, Cordedda C, Ferrigno G, Veselinovic N, Bossew P, Tollefsen T, Cuknic O, Vojinovic Z, Bochicchio F
Assessment of long-term radon concentration measurement precision in field conditions (Serbian Schools) for a survey carried out by an international collaboration
Radiat Prot Dosimetry (2011) 145 (2-3): 305-311
In an international collaboration, a long-term radon concentration survey was carried out in schools of Southern Serbia with radon detectors prepared, etched and read-out in Italy. In such surveys it is necessary to evaluate measurement precision in field conditions, and to check whether quality assurance protocols were effective in keeping uncertainties under control, despite the complex organisation of measurements. In the first stage of the survey, which involves only some of the total number of municipalities, paired detectors were exposed in each monitored room in order to experimentally assess measurement precision.

Paired passive devices (containing CR-39 detectors) were exposed for two consecutive 6-month periods. Two different measurement systems were used to read out CR-39s of the first and second period, respectively. The median of the coefficient of variation (CV) of the measured exposures was 8 % for 232 paired devices of the first 6-month period and 4 % for 242 paired devices of the second 6-month period, respectively. This difference was mainly due to a different track count repeatability of the two read-out systems, which was 4 and 1 %, respectively, as the median value of CV of repeated countings. The in-field measured precision results are very similar to the precision assessed in calibration conditions and are much lower than the room-to-room variation of radon concentration in the monitored schools. Moreover, a quality assurance protocol was followed to reduce extra-exposures during detector transport from Rome to schools measured and back.

Cruz-Suarez, R.; Noßke, D.; Souza-Santos, D.
Radiation protection for pregnant workers and their offspring: A recommended approach for monitoring
In: Radiation protection dosimetry 144 (2011), Nr.1-4, 80-84, doi:10.1093/rpd/ncq371
Radiation protection of pregnant workers and their offspring is an issue that has been referenced in the literature by the International Commission on Radiological Protection (ICRP), the International Atomic Energy Agency (IAEA) and other international institutions. Several documents of the ICRP address the issue of the protection of the pregnant workers. The new ICRP recommendations refer to the control of working conditions of a pregnant worker, after declaration of pregnancy, such that it is unlikely that the additional dose to the fetus will exceed about 1 mSv during the remainder of pregnancy. The IAEA Basic Safety Standards present similar recommendations. The IAEA is preparing a technical document that provides guidance on these issues.

De Cort M., Gruber V, Tollefsen T, P. Bossew and A. Janssens
Towards a European Atlas of Natural Radiation: goal, status and future perspectives.
Pres. and article, ICRER 2011 – International Conference on Radioecology & Environmental Radioactivity: Environment & Nuclear Renaissance, 9-24 June 2011, McMaster University, Hamilton, Canada.
Radioprotection (2011), 46 (6), 737-743
One of the tasks of the European Commission (EC) under the Euratom Treaty is to collect, validate and provide information about the levels of radioactivity in the environment. In order to offer to the public a more balanced view on the annual dose that it may receive from environmental radioactivity, a few years ago we decided to explore the feasibility of preparing a European Atlas of Natural Radiation. By now 21 European countries have already provided indoor radon data, and efforts continue to extend this information to more countries. In addition, we started to investigate the feasibility of a “geogenic radon map”, which would show “what earth delivers” in terms of potential radon hazard. In this paper we present the current state of the art of preparing the Atlas and provide detailed statistics for the results already obtained. The current efforts are still focussed on radon, but also progress on other components, such as cosmic rays and terrestrial gamma radiation, will be presented and discussed.

Di Giorgio, M.; Barquinero, J.F.; Vallerga, M.B.; Radl, A.; Taja, M.R.; Seoane, A.; De Luca, J.; Stuck Oliveira, M.; Valdivia, P.; Garcia Lima, O.; Lamadrid, A.; Gonzalez Mesa, J.; Romero Aguilera, I.; Mandina Cardoso, T.; Guerrero Carvajal, Y.C.; Arceo Maldonaldo, C.; Espinoza, M.E.; Martinez-Lopez, W.; Mendez-Acun, L.; Di Tomasso, M.V.; Roy, L.; Lindholm, C.; Romm, H.; Guclum, I.; Lloyd, D.C.
Biological dosimetry intercomparison exercise: an evaluation of triage and routine mode results by robust methods
In: Radiation research 175 (2011), 638-649
Well-defined protocols and quality management standards are indispensable for biological dosimetry laboratories. Participation in periodic proficiency testing by interlaboratory comparisons is also required. This harmonization is essential if a cooperative network is used to

respond to a mass casualty event. Here we present an international intercomparison based on dicentric chromosome analysis for dose assessment performed in the framework of the IAEA Regional Latin American RLA/9/054 Project. The exercise involved 14 laboratories, 8 from Latin America and 6 from Europe. The performance of each laboratory and the reproducibility of the exercise were evaluated using robust methods described in ISO standards. The study was based on the analysis of slides from samples irradiated with 0.75 (DI) and 2.5 Gy (DII). Laboratories were required to score the frequency of dicentrics and convert them to estimated doses, using their own dose–effect curves, after the analysis of 50 or 100 cells (triage mode) and after conventional scoring of 500 cells or 100 dicentrics. In the conventional scoring, at both doses, all reported frequencies were considered as satisfactory, and two reported doses were considered as questionable. The analysis of the data dispersion among the dicentric frequencies and among doses indicated a better reproducibility for estimated doses (15.6% for DI and 8.8% for DII) than for frequencies (24.4% for DI and 11.4% for DII), expressed by the coefficient of variation. In the two triage modes, although robust analysis classified some reported frequencies or doses as unsatisfactory or questionable, all estimated doses were in agreement with the accepted error of ±0.5 Gy. However, at the DI dose and for 50 scored cells, 5 out of the 14 reported confidence intervals that included zero dose and could be interpreted as false negatives. This improved with 100 cells, where only one confidence interval included zero dose. At the DII dose, all estimations fell within ±0.5 Gy of the reference dose interval. The results obtained in this triage exercise indicated that it is better to report doses than frequencies. Overall, in both triage and conventional scoring modes, the laboratory performances were satisfactory for mutual cooperation purposes. These data reinforce the view that collaborative networking in the case of a mass casualty event can be successful.

Eberlein, U.; Bröer, J.; Vandevoorde, C.; Santos, P.; Bardiès, M.; Bacher, K.; Noßke, D.; Lassmann, M.

Biokinetics and dosimetry of commonly used radiopharmaceuticals in diagnostic nuclear medicine - a review

In: European journal of nuclear medicine and molecular imaging 38 (2011), Nr.12, 2269-2281

The impact on patients' health of radiopharmaceuticals in nuclear medicine diagnostics has not until now been evaluated systematically in a European context. Therefore, as part of the EU-funded Project PEDDOSE.NET (www.peddose.net), the current knowledge on biokinetics and dosimetry of commonly used diagnostic radiopharmaceuticals is reviewed and summarized.

A detailed literature search on published biokinetic and dosimetric data was performed mostly via PubMed. In principle the criteria for inclusion of data followed the EANM Dosimetry Committee guidance document on good clinical reporting.

Data on dosimetry and biokinetics can be difficult to find, are scattered in various journals and, especially in paediatric nuclear medicine, are very scarce. The data collection and calculation methods vary with respect to the time-points, bladder voiding, dose assessment after the last data point and the way the effective dose was calculated. In many studies the number of subjects included for obtaining biokinetic and dosimetry data was fewer than ten, and some of the biokinetic data were acquired more than 20 years ago.

It would be of interest to generate new data on biokinetics and dosimetry in diagnostic nuclear medicine using state-of-the-art equipment and more uniform dosimetry protocols. For easier public access to dosimetry data for diagnostic radiopharmaceuticals, a database containing these data should be created and maintained.

Fink, C.; Krissak, R.; Henzler, T.; Lechel, U.; Brix, G.; Takx, R.A.P.; Nance, J.W; Abro J.A, Schoenberg, S.O, Schoepf, U.J

Radiation Exposure at Coronary CT Angiography: Second Generation Dual-Source CT versus 64-Section Single Source and First Generation Dual-Source CT.

AJR, 2011; 196:550-7

Purpose: To assess the radiation dose of different coronary CTA (CCTA) protocols comparing a second generation 128-section dual source CT (128-DSCT) versus a first generation

64-section DSCT (64-DSCT) and 64-section single source CT (64-SSCT). *Materials and Methods:* Scanner-specific dose coefficients were determined for a standard CCTA protocol by thermoluminescent dosimetry at an anthropomorphic phantom. Using these coefficients, the effective dose (ED) of different CCTA protocols (retrospectively gated, prospectively triggered, and prospectively triggered high-pitch) performed with 100 and 120 kV were estimated. Finally, different CCTA protocols performed in 43 patients at 128-DSCT were analyzed for ED, image quality, and signal-to-noise ratio (SNR). *Results:* Regardless of the CCTA protocol and CT system, the use of 100 kV lowered the ED by 40-50%. With retrospectively gated 120 kV CCTA, the ED ranged between 5.7-10.9 mSv and was approximately 50% lower with 64-SSCT than with both DSCT. With prospectively triggered 120 kV CCTA the ED ranged between 3.8-4.0 mSv. The lowest ED of all protocols (1.3 mSv) was observed in prospectively triggered high-pitch 100 kV CCTA using the 128-DSCT. Patient measurements showed similar dose reductions of prospective triggering and low kV settings without any influence on SNR or image quality. *Conclusion*: A combination of prospective triggering with low kV settings is an effective measure to reduce the ED of CCTA to values of 2-4 mSv independent of the scanner system. Further dose reduction to nearly 1 mSv can be achieved with high-pitch prospectively triggered CCTA.

Grosche, B.; Lackland, D.; Land, C.; Simon, S.; Apsalikov, K.; Pivina, L.; Bauer, S.; Gusev, B.

Mortality from cardiovascular diseases in the Semipalatinsk historical cohort, 1960-1999, and its relationship to radiation exposure

In: Radiation research 176 (2011), Nr.5, 660-669, doi:10.1667/RR211.1

The data on risk of mortality from cardiovascular disease due to radiation exposure at low or medium doses are inconsistent. This paper reports an analysis of the Semipalatinsk historical cohort exposed to radioactive fallout from nuclear testing in the vicinity of the Semipalatinsk Nuclear Test Site, Kazakhstan. The cohort study, which includes 19,545 persons of exposed and comparison villages in the Semipalatinsk region, had been set up in the 1960s and comprises 582,656 person-years of follow-up between 1960 and 1999. A dosimetric approach developed by the U.S. National Cancer Institute (NCI) has been used. Radiation dose estimates in this cohort range from 0 to 630 mGy (wholebody external). Overall, the exposed population showed a high mortality from cardiovascular disease. Rates of mortality from cardiovascular disease in the exposed group substantially exceeded those of the comparison group. Dose–response analyses were conducted for both the entire cohort and the exposed group only. A dose–response relationship that was found when analyzing the entire cohort could be explained completely by differences between the baseline rates in exposed and unexposed groups. When taking this difference into account, no statistically significant dose–response relationship for all cardiovascular disease, for heart disease, or for stroke was found. Our results suggest that within this population and at the level of doses estimated, there is no detectable risk of radiation related mortality from cardiovascular disease.

Guertler, A.; Kraemer, A.; Roessler, U.; Hornhardt, S.; Kulka, U.; Moertl, S.; Friedl, A.A.; Illig, T.; Wichmann, E.; Gomolka, M.

The WST survival assay: an easy and reliable method to screen radiation-sensitive individuals

In: Radiation protection dosimetry 143 (2011), Nr.2-4, 487-490doi:10.1093/rpd/ncq515

An easy, fast and reliable method was developed to screen hundreds of Epstein–Barr virus-transformed cell lines (lymphoblastoid cell lines, LCLs) for radiation sensitivity that were generated from lymphocytes isolated from young lung cancer patients. The WST-1 test explores the metabolic activity of the mitochondria as an indicator for the vital status of cells. Cell proliferation as well as indirect cell death can be quantified by this method on a large scale in microtiter plates. Cell survival was measured at 24- and 48-h post-irradiation with 10 Gy (^{137}Cs source) by the WST-1 assay and Trypan blue staining. To set up the experimental screening conditions and to establish a positive and a negative control, an ATM-mutated cell line from a radiation-sensitive ATM patient and an ATM proficient cell line from a healthy

brother were compared. An optimal differentiation between the two cell lines was demonstrated for 10 Gy and 24- and 48-h cell growth after irradiation. Upon screening 120 LCLs of young lung cancer patients under these conditions, 5 of them were found to be radiation sensitive to a high degree of statistical significance. The results have been confirmed by a second laboratory by means of Trypan blue testing. The WST-1 test represents an efficient and reliable method by means of screening for radiation-sensitive cell lines.

Kabai, E.; Hornung, L.;, Savkin, B. T.; Poppitz-Spuhler, A.; Hiersche, L.
Fast method and ultra fast screening for determination of 90Sr in milk and dairy products
Science of the Total Environment 410-411 (2011) 235–240, doi:10.1016/j.scitotenv.2011.09.052
In emergency situation or in case of defence against nuclear hazards, the rapid analysis of radioisotopes in food products is essential. Radiostrontium is one of the most interesting isotopes in case of emergency. The determination of radiostrontium in milk and dairy products plays an important role especially for infants.
The procedures described here were tested for fast determination of 90Sr. The typical chemical recovery of the proposed fast procedure for determination of strontium from milk and dairy products was 90% and the time needed for analysis was one working day. The achieved detection limit for milk is 0.8 Bq/l. An ultra fast screening method allows the determination of radiostrontium with quantitative recovery within 1 hour. The minimum detectable activity in this case is 230 Bq/l.

Leuraud, K.; Schnelzer, M.; Tomasek, L.; Hunter, N.; Timarche, M.; Grosche, B.; Kreuzer, M.; Laurier, D.
Radon, smoking and lung cancer risk: results of a joint analysis of three European case-control studies among uranium miners
In: Radiation research 176 (2011), Nr.3, 375-387, doi:10.1667/RR2377.1
A combined analysis of three case-control studies nested in three European uranium miner cohorts was performed to study the joint effects of radon exposure and smoking on lung cancer death risk. Occupational history and exposure data were available from the cohorts. Smoking information was reconstructed using self-administered questionnaires and occupational medical archives. Linear excess relative risk models adjusted for smoking were used to estimate the lung cancer risk associated with radon exposure. The study includes 1046 lung cancer cases and 2492 controls with detailed radon exposure data and smoking status. The ERR/WLM adjusted for smoking is equal to 0.008 (95% CI: 0.004–0.014). Time since exposure is shown to be a major modifier of the relationship between radon exposure and lung cancer risk. Fitting geometric mixture models yielded arguments in favor of a sub- multiplicative interaction between radon and smoking. This combined study is the largest case-control study to investigate the joint effects of radon and smoking on lung cancer risk among miners. The results confirm that the lung carcinogenic effect of radon persists even when smoking is adjusted for, with arguments in favor of a submultiplicative interaction between radon and smoking.

Lopez, M.A.; Balashazy, I.; Berard, P.; Blanchardon, E.; Breustedt, B.; Broggio, D.; Castellani, C.M.; Franck, D.; Giussani, A.; Hurtgen, C.; James, A.C.; Klein, W.; Kramer, G.H.; Li, W.B.; Marsh, J.; Malatova, I.; Noßke, D.; Oeh, U.; Phan, G.; Puncher, M.; Schimmelpfeng, J.; Vrba, T.
EURADOS coordinated action on research, quality assurance and training on internal dose assessment
In: Radiation protection dosimetry 144 (2011), Nr.1-4, 349-353, doi:10.1093/rpd/ncq435
EURADOS working group on 'Internal Dosimetry (WG7)' represents a frame to develop activities in the field of internal exposures as coordinated actions on quality assurance (QA), research and training. The main tasks to carry out are the update of the IDEAS Guidelines as a reference document for the internal dosimetry community, the implementation and QA of new ICRP biokinetic models, the assessment of uncertainties related to internal dosimetry

models and their application, the development of physiology-based models for biokinetics of radionuclides, stable isotope studies, biokinetic modelling of diethylene triamine pentaacetic acid decorporation therapy and Monte-Carlo applications to in vivo assessment of intakes. The working group is entirely supported by EURADOS; links are established with institutions such as IAEA, US Transuranium and Uranium Registries (USA) and CEA (France) for joint collaboration actions.

Marsh, J.; Blanchardon, E.; Gregoratto, D.; Hofmann, W.; Karcher, K.; Noßke, D.; Tomasek, L.

Dosimetric calculations for uranium miners for epidemiological studies

In: Radiation protection dosimetry 149 (2011), Nr.4, 371-383 doi:10.1093/rpd/ncr310

Epidemiological studies on uranium miners are being carried out to quantify the risk of cancer based on organ dose calculations. Mathematical models have been applied to calculate the annual absorbed doses to regions of the lung, red bone marrow, liver, kidney and stomach for each individual miner arising from exposure to radon gas, radon progeny and long-lived radionuclides (LLR) present in the uranium ore dust and to external gamma radiation. The methodology and dosimetric models used to calculate these organ doses are described and the resulting doses for unit exposure to each source (radon gas, radon progeny and LLR) are presented. The results of dosimetric calculations for a typical German miner are also given. For this miner, the absorbed dose to the central regions of the lung is dominated by the dose arising from exposure to radon progeny, whereas the absorbed dose to the red bone marrow is dominated by the external gamma dose. The uncertainties in the absorbed dose to regions of the lung arising from unit exposure to radon progeny are also discussed. These dose estimates are being used in epidemiological studies of cancer in uranium miners.

Masson O, Baeza A, Bieringer J, Brudecki K, Bucci S, Cappai M, Carvalho F.P. , Connan O, Cosma C, Dalheimer A, Didier D, Depuydt G, De Geer L.E., De Vismes A, Gini L, Groppi F, Gudnason K, Gurriaran R, Hainz D, Halld orsson O, Hammond D, Hanley O, Holey K, Homoki Zs, Ioannidou A, Isajenko K, Jankovic M, Katzlberger C, Kettunen M, Kierepko R, Kontro R, Kwakman P.J.M. , Lecomte M, Vintro L. Leon, Leppanen A.-P., Lind B, Lujaniene G, Mc Ginnity P, Mc Mahon C, Malá H, Manenti S, Manolopoulou , Mattila A, Mauring A, Mietelski J.W., Möller B, Nielsen S.P., Nikolic J, Overwater R.M.W., Pálsson S. E., Papastefanou C, Penev I, Pham M.K., Povinec, H. Ramebäck P.P., Reis M.C. , Ringer W, Rodriguez A, Rulík P, Saey P.R.J., Samsonov V, Schlosser C, Sgorbati G, Silobritiene B. V., Söderström C, Sogni R, Solier L, Sonck M, Steinhauser G, Steinkopff T, Steinmann P, Stoulos S, Sykora I, Todorovic D, Tooloutalaie N, Tositti L, Tschiersch J, Ugron A, Vagena E, Vargas A, Wershofen H, and Zhukova O.

Tracking of Airborne Radionuclides from the Damaged Fukushima Dai-Ichi Nuclear Reactors by European Networks

Environmental Science and Technology 45 (2011), 7670-7677, DOI: 10.1021/es2017158.

Radioactive emissions into the atmosphere from the damaged reactors of the Fukushima Dai-ichi nuclear power plant (NPP) started on March 12th, 2011. Among the various radionuclides released, iodine-131 (^{131}I) and cesium isotopes (^{137}Cs and ^{134}Cs) were transported across the Pacific toward the North American continent and reached Europe despite dispersion and washout along the route of the contaminated air masses. In Europe, the first signs of the releases were detected 7 days later while the first peak of activity level was observed between March 28th and March 30th. Time variations over a 20-day period and spatial variations across more than 150 sampling locations in Europe made it possible to characterize the contaminated air masses. After the Chernobyl accident, only a few measurements of the gaseous ^{131}I fraction were conducted compared to the number of measurements for the particulate fraction. Several studies had already pointed out the importance of the gaseous ^{131}I and the large underestimation of the total ^{131}I airborne activity level, and subsequent calculations of inhalation dose, if neglected. The measurements made across Europe following the releases from the Fukushima NPP reactors have provided a significant amount of new data on the ratio of the gaseous ^{131}I fraction to total ^{131}I, both on a spatial scale and its

temporal variation. It can be pointed out that during the Fukushima event, the ^{134}Cs to ^{137}Cs ratio proved to be different from that observed after the Chernobyl accident. The data set provided in this paper is the most comprehensive survey of the main relevant airborne radionuclides from the Fukushima reactors, measured across Europe. A rough estimate of the total ^{131}I inventory that has passed over Europe during this period was <1% of the released amount. According to the measurements, airborne activity levels remain of no concern for public health in Europe.

Noßke, D.; Blanchardon, E.; Bolch, W.E.; Breustedt, B.; Eckerman, K.; Giussani, A.; Harrison, J.; Klein, W.; Leggett, R.; Lopez, M.; Luciani, A.; Zankl, M.
New developments in internal dosimetry models
In: Radiation protection dosimetry 144 (2011), Nr.1-4, 311-320 doi:10.1093/rpd/ncq311
This paper describes new biokinetic and dosimetric models, especially those being developed by ICRP which will be used in the forthcoming documents on Occupational Intakes of Radionuclides. It also presents the results of a working group within the European project CONRAD which is being continued within EURADOS. This group is implementing the new models, performing quality assurance of the model implementation (including their description) and giving guidance to the scientific community on the application of the models for individual dose assessment.

Pölzl, C.
EMF recommendations specific for children?
In: Progress in Biophysics and Molecular Biology 107 (2011), Nr.3, 467-472
When discussing health risks for children due to electromagnetic fields it is crucial to translate scientific knowledge both into adequate protection and precautionary measures for the general public and, more particularly into specific recommendations for children. It is often aimed at influencing health-related attitudes and behaviour by means of information about health affecting behaviour, health risk factors, and health promoting possibilities. Children have to be treated differently from adults in addressing their ability and willingness to modify behaviour and their competence to comprehend cognitively the sense of behavioural recommendations. Research has shown that adults can be motivated to adjust their own behaviour in order to protect their children or to be role models for their children. Hence one way to modify children's behaviour is to address the parents and care persons. Generally education in the family, the social environment and in peer groups, nursery school and at school plays an important role in forming and influencing individual behaviour. The age of the target group has also to be taken into consideration. An important question is how to deal with scientific uncertainties when expressing EMF recommendations for children. Accentuating scientific uncertainties may under certain circumstances raise risk awareness. This can be an intended effect. But the expression of scientific uncertainties can also lead to unintended consequences in parent's behaviour or even senseless dealing with the respective EMF source. The paper points out relevant aspects of risk communication regarding EMF and children and suggests how recommendations for children might be designed.

Rimpler, A.; Barth, I.; Ferrari, P.; Baechler, S.; Carnicer, A.; Donadille, L.; Fulop, M.; Ginjaume, M.; Mariotti, M.; Sans Merce, M.; Gualdrini, G.; Krim, S.; Ortega, X.; Ruiz, N.; Vanhavere, F.
Extremity exposure in nuclear medicine therapy with ^{90}Y-labelled substances - Results of the ORAMED project
In: Radiation measurements 46 (2011), Nr.11, 1283-1286
^{90}Y-labelled radiopharmaceuticals offer promising prospects for radionuclide therapies of tumours, e.g. radioimmunotherapies (RIT), (EANM, 2007), peptide receptor radiotherapies (PRRT), (Otte et al., 1998), and selective internal radiotherapies (SIRT), (Salem and Thurston, 2006). ^{90}Y, an almost pure high-energy beta radiation emitter ($E\beta,max$ = 2.28 MeV), is a favourable radionuclide for therapeutic purposes. However, when preparing and performing these therapies, high activities of ^{90}Y (>1 GBq) are to be manipulated and technicians, physicians and nurses may receive high skin exposures to the hands.

If radiation protection standards are low, the exposure of staff can exceed the annual skin dose limit of 500 mSv. Within a particular work package (WP4) of the ORAMED project, comprehensive measurements in nuclear medicine departments of several hospitals in 6 European countries were carried out. The study focussed on ^{90}Y-labelled substances such as Zevalin® and DOTATOC to achieve a representative database on staff exposure. This paper summarises the most important results and conclusions for individual monitoring of skin exposure of staff.

Romm, H.; Wilkins, R.; Coleman, N.; Lillis-Hearne, P.; Pellmar, T.; Livingston, G.; Awa, A.; Jenkins, M.; Yoshida, M.; Oestreicher, U.; Prasanna, P.

Biological dosimetry by the triage dicentric chromosome assay: potential implications for treatment of acute radiation syndrome in radiological mass casualties

In: Radiation research 175 (2011), Nr.3, 397-404,doi:10.1667/RR2321.1

Biological dosimetry is an essential tool for estimating radiation dose. The dicentric chromosome assay (DCA) is currently the tool of choice. Because the assay is labor-intensive and time-consuming, strategies are needed to increase throughput for use in radiation mass casualty incidents. One such strategy is to truncate metaphase spread analysis for triage dose estimates by scoring 50 or fewer metaphases, compared to a routine analysis of 500 to 1000 metaphases, and to increase throughput using a large group of scorers in a biodosimetry network. Previously, the National Institutes for Allergies and Infectious Diseases (NIAID) and the Armed Forces Radiobiology Research Institute (AFRRI) sponsored a double-blinded interlaboratory comparison among five established international cytogenetic biodosimetry laboratories to determine the variability in calibration curves and in dose measurements in unknown, irradiated samples. In the present study, we further analyzed the published data from this previous study to investigate how the number of metaphase spreads influences dose prediction accuracy and how this information could be of value in the triage and management of people at risk for the acute radiation syndrome (ARS). Although, as expected, accuracy decreased with lower numbers of metaphase spreads analyzed, predicted doses by the laboratories were in good agreement and were judged to be adequate to guide diagnosis and treatment of ARS. These results demonstrate that for rapid triage, a network of cytogenetic biodosimetry laboratories can accurately assess doses even with a lower number of scored metaphases.

Sans Merce, M.; Ruiz, N.; Barth, I.; Carnicer, A.; Donadille, L.; Ferrari, P.; Fulop, M.; Ginjaume, M.; Gualdrini, G.; Krim, S.; Mariotti, M.; Ortega, X.; Rimpler, A.; Vanhavere, F.; Baechler, S.

Recommendations to reduce hand exposure for standard nuclear medicine procedures

In: Radiation measurements 46 (2011), Nr.11, 1330–1333,
doi:10.1016/j.radmeas.2011.07.011

The optimization of the extremity dosimetry of medical staff in nuclear medicine was the aim of the Work Package 4 (WP4) of the ORAMED project, a Collaborative Project (2008–2011) supported by the European Commission within its 7th Framework Programme. Hand doses and dose distributions across the hands of medical staff working in nuclear medicine departments were evaluated through an extensive measurement program involving 32 hospitals in Europe and 139 monitored workers. The study included the most frequently used radionuclides, ^{99m}Tc- and ^{18}F-labelled radiopharmaceuticals for diagnostic and ^{90}Y-labelled Zevalin® and DOTATOC for therapy. Furthermore, Monte Carlo simulations were performed in different predefined scenarios to evaluate separately the efficacy of different radiation protection measures by comparing hand dose distributions according to various parameters. The present work gives recommendations based on results obtained with both measurements and simulations. This results in nine practical recommendations regarding the positioning of the dosemeters for an appropriate skin dose monitoring and the best protection means to reduce the personnel exposure.

Sans Merce, M.; Ruiz, N.; Barth, I.; Carnicer, A.; Donadille, L.; Ferrari, P.; Fulop, M.; Ginjaume, M.; Gualdrini, G.; Krim, S.; Mariotti, M.; Ortega, X.; Rimpler, A.; Vanhavere, F.; Baechler, S.

Extremity exposure in nuclear medicine: preliminary results of a European study

In: Radiation protection dosimetry 144 (2011), Nr.1-4, 515-520, doi:10.1093/rpd/ncq574

The Work Package 4 of the ORAMED project, a collaborative project (2008–11) supported by the European Commission within its seventh Framework Programme, is concerned with the optimisation of the extremity dosimetry of medical staff in nuclear medicine. To evaluate the extremity doses and dose distributions across the hands of medical staff working in nuclear medicine departments, an extensive measurement programme has been started in 32 nuclear medicine departments in Europe. This was done using a standard protocol recording all relevant information for radiation exposure, i.e. radiation protection devices and tools. This study shows the preliminary results obtained for this measurement campaign. For diagnostic purposes, the two most-used radionuclides were considered: ^{99m}Tc and ^{18}F. For therapeutic treatments, Zevalin® and DOTATOC (both labelled with ^{90}Y) were chosen. Large variations of doses were observed across the hands depending on different parameters. Furthermore, this study highlights the importance of the positioning of the extremity dosemeter for a correct estimate of the maximum skin doses.

Stojanovska Z, Janusev J, Zunic Z., Bossew P, Tollefsen T and Ristova M

Seasonal indoor radon concentration in FYR of Macedonia

Radiation Measurements (2011), 46 (6–7), 602-610

This paper presents the results of the seasonal indoor radon concentration measurements in dwellings in all regions of the Former Yugoslav Republic (FYR) of Macedonia. The measurements were made in 437 dwellings using CR-39 track detectors over four successive three-month periods (winter, spring, summer and autumn) throughout 2009. The results of analysis of variance showed statistically significant differences between indoor radon concentrations in different seasons. The geometric mean values and geometric standard deviations of indoor radon concentrations in winter, spring, summer and autumn were obtained to be: 115 Bqm^{-3} (2.02), 72 Bqm^{-3} (1.97), 46 Bqm^{-3} (1.95), 92 Bqm^{-3} (2.02), respectively. The geometric mean values of spring, summer and autumn to winter ratios were found to be: 0.63 (1.50), 0.40 (1.81), and 0.80 (1.58), respectively. The results of the analysis of the variance showed statistically significant differences among the indoor radon measurements for the regions in different seasons. The influence of the factors linked to building characteristics in relation to radon measurements in different seasons was examined. The factors which enable a differentiation into subgroups (significance level $p < 0.05$) are the floor level, basement and building materials.

Taguchi S, Law R. M., Rödenbeck C, Patra P.K., Maksyutov S, Zahorowski W, Sartorius H and Levin I.

TransCom continuous experiment: comparison of ^{222}Rn transport at hourly time scales at three stations in Germany

Atmospheric Chemistry and Physics., 11, (2011) 10071-10084, doi:10.5194/acp-11-10071-2011

Fourteen global atmospheric transport models were evaluated by comparing the simulation of ^{222}Rn against measurements at three continental stations in Germany: Heidelberg, Freiburg and Schauinsland. Hourly concentrations simulated by the models using a common ^{222}Rn-flux without temporal variations were investigated for 2002 and 2003. We found that the mean simulated concentrations in Heidelberg are related to the diurnal amplitude of boundary layer height in each model. Summer mean concentrations simulated by individual models were negatively correlated with the seasonal mean of diurnal amplitude of boundary layer height, while in winter the correlation was positive. We also found that the correlations between simulated and measured concentrations at Schauinsland were higher when the simulated concentrations were interpolated to the station altitude in most models. Temporal variations of the mismatch between simulated and measured concentrations suggest that there are significant interannual variations in the ^{222}Rn exhalation rate in this

region. We found that the local inversion layer during daytime in summer in Freiburg has a significant effect on ^{222}Rn concentrations. We recommend Freiburg concentrations for validation of models that resolve local stable layers and those at Heidelberg for models without this capability.

Tollefsen T, Gruber V, Bossew P, De Cort M
Status of the European indoor radon map.
Radiat Prot Dosimetry (2011) 145 (2-3): 110-116
Since 2006 a European map of indoor radon (Rn) concentration is in the making. So far 20 countries have contributed with national data, allowing a fair coverage of parts of Europe. This paper presents the current (September 2010) state of the map, discusses its rationale, presents some statistical findings and addresses a few problems which arose during the work. It also briefly presents the European Atlas of Natural Radiation project, of which the Rn map will be part, and further, planned maps of environmental natural radioactivity.

Wilkins, R.; Romm, H.; Oestreicher, U.; Marro, L.; Yoshida, M.; Suto, Y.; Prasanna, P.
Biological dosimetry by the triage dicentric chromosome assay - Further validation of international networking
In: Radiation measurements 46 (2011), Nr.9, 923-928
Biological dosimetry is an essential tool for estimating radiation doses received to personnel when physical dosimetry is not available or inadequate. The current preferred biodosimetry method is based on the measurement of radiation-specific dicentric chromosomes in exposed individuals' peripheral blood lymphocytes. However, this method is labor-, time- and expertise-demanding. Consequently, for mass casualty applications, strategies have been developed to increase its throughput. One such strategy is to develop validated cytogenetic biodosimetry laboratory networks, both national and international. In a previous study, the dicentric chromosome assay (DCA) was validated in our cytogenetic biodosimetry network involving five geographically dispersed laboratories. A complementary strategy to further enhance the throughput of the DCA among inter-laboratory networks is to use a triage DCA where dose assessments are made by truncating the labor-demanding and time-consuming metaphase spread analysis to 20 – 50 metaphase spreads instead of routine 500 – 1000 metaphase spread analysis. Our laboratory network also validated this triage DCA, however, these dose estimates were made using calibration curves generated in each laboratory from the blood samples irradiated in a single laboratory. In an emergency situation, dose estimates made using pre-existing calibration curves which may vary according to radiation type and dose rate and therefore influence the assessed dose. Here, we analyze the effect of using a pre-existing calibration curve on assessed dose among our network laboratories. The dose estimates were made by analyzing 1000 metaphase spreads as well as triage quality scoring and compared to actual physical doses applied to the samples for validation. The dose estimates in the laboratory partners were in good agreement with the applied physical doses and determined to be adequate for guidance in the treatment of acute radiation syndrome.

Walsh, L.; Kaiser, J.
Multi-model inference of adult and childhood leukaemia excess relative risks based on the Japanese A-bomb survivors mortality data (1950-2000)
In: Radiation and environmental biophysics 50 (2011), Nr.1, 21-35, doi:10.1007/s00411-010-0337-6
Some relatively new issues that augment the usual practice of ignoring model uncertainty, when making inference about parameters of a specific model, are brought to the attention of the radiation protection community here. Nine recently published leukaemia risk models, developed with the Japanese A-bomb epidemiological mortality data, have been included in a model-averaging procedure so that the main conclusions do not depend on just one type of model or statistical test. The models have been centred here at various adult and young ages at exposure, for some short times since exposure, in order to obtain specially computed childhood Excess Relative Risks (ERR) with uncertainties that account for correlations in the

fitted parameters associated with the ERR dose–response. The model-averaged ERR at 1 Sv was not found to be statistically significant for attained ages of 7 and 12 years but was statistically significant for attained ages of 17, 22 and 55 years. Consequently, such risks when applied to other situations, such as children in the vicinity of nuclear installations or in estimates of the proportion of childhood leukaemia incidence attributable to background radiation (i.e. low doses for young ages and short times since exposure), are only of very limited value, with uncertainty ranges that include zero risk. For example, assuming a total radiation dose to a 5-year-old child of 10 mSv and applying the model-averaged risk at 10 mSv for a 7-year-old exposed at 2 years of age would result in an ERR = 0.33, 95% CI: -0.51 to 1.22. One model (United Nations scientific committee on the effects of atomic radiation report. Volume 1. Annex A: epidemiological studies of radiation and cancer, United Nations, New York, 2006) weighted model-averaged risks of leukaemia most strongly by half of the total unity weighting and is recommended for application in future leukaemia risk assessments that continue to ignore model uncertainty. However, on the basis of the analysis presented here, it is generally recommended to take model uncertainty into account in future risk analyses.

Walsh, L.; Dufey, F.; Möhner, M.; Schnelzer, M.; Tschense, A.; Kreuzer, M.
Differences in baseline lung cancer mortality between the German uranium miners cohort and the population of the former German Democratic Republic (1960–2003)
In: Radiation and environmental biophysics 50 (2011), Nr.1, 57-66, doi:10.1007/s00411-010-0332-y
A previous analysis of the radon-related lung cancer mortality risk, in the German uranium miners cohort, using Poisson modeling techniques, noted internal (spontaneous) rates that were higher on average than the external rates by 16.5 % (95 % CI: 9 %; 24 %). The main purpose of the present paper is to investigate the nature of, and possible reasons for, this difference by comparing patterns in spontaneous lung cancer mortality rates in a cohort of male miners involved in uranium extraction at the former Wismut mining company in East Germany with national male rates from the former German Democratic Republic. The analysis is based on miner data for 3,001 lung cancer deaths, 1.76 million person-years for the period 1960–2003, and national rates covering the same calendar-year range. Simple ‘‘age–period–cohort’’ graphical analyses were applied to assess the main qualitative differences between the national and cohort baseline lung cancer rates. Some differences were found to occur mainly at higher attained ages above 70 years. Although many occupational risk factors may have contributed to these observed age differences, only the effects of smoking have been assessed here by applying the Peto–Lopez indirect method for calculating smoking attributability. It is inferred that the observed age differences could be due to the greater prevalence of smoking and more mature smoking epidemic in the Wismut cohort compared to the general population of the former German Democratic Republic. In view of these observed differences between external population- based rates and internal (spontaneous) cohort baseline lung cancer rates, it is strongly recommended to apply only the internal rates in future analyses of uranium miner cohorts.

Weiss, W.
The global dimensions of atmospheric radioactivity detection - Experience and conclusions after the Fukushima Daiichi nuclear power plant accient
In: CTBO Spectrum (2011), Nr.17, 27-29
There are good reasons why data from the International Monitoring System (IMS) network could significantly improve the basic understanding of the global transportation and mixing of radionuclides in the atmosphere and contribute to the mitigation of the radiological consequences during a large-scale nuclear accident. This is one important result of many analyses of the accident at the Fukushima Daiichi nuclear power plant published six months after the release of radionuclides from the plant in March 2011. For example, the Fukushima data set could help meteorologists and climate researchers to further develop their models and to better understand how air circulates nearer to the surface. UNSCEAR would like to use the unique data set from the IMS radionuclide network for its work. Taking into account the

common roots and the mutual interests of UNSCEAR and the CTBTO, it would be more than desirable if an agreement for data sharing between CTBTO and UNSCEAR could be established in the near future.

Zhang K, Feichter J, Kazil J, Wan H, Zhuo W, Griffiths A. D., Sartorius H, Zahorowski W, Ramonet M, Schmidt M, Yver C, Neubert R. E. M. and Brunke E.-G.
Radon activity in the lower troposphere and its impact on ionization rate: a global estimate using different radon emissions
Atmospheric Chemistry and Physics, 11, (2011) 7817-7838, doi:10.5194/acp-11-7817-2011
The radioactive decay of radon and its progeny can lead to ionization of air molecules and consequently influence aerosol size distribution. In order to provide a global estimate of the radon-related ionization rate, we use the global atmospheric model ECHAM5 to simulate transport and decay processes of the radioactive tracers. A global radon emission map is put together using regional fluxes reported recently in the literature. Near-surface radon concentrations simulated with this new map compare well with measurements. Radon-related ionization rate is calculated and compared to that caused by cosmic rays. The contribution of radon and its progeny clearly exceeds that of the cosmic rays in the midand low-latitude land areas in the surface layer. During cold seasons, at locations where high concentration of sulphuric acid gas and low temperature provide potentially favourable conditions for nucleation, the coexistence of high ionization rate may help enhance the particle formation processes. This suggests that it is probably worth investigating the impact of radon-induced ionization on aerosol-climate interaction in global models.

Ziegelberger, G.; Dehos, A.; Grosche, B.; Hornhardt, S.; Jung, T.; Weiss, W.
Childhood leukemia - Risk factors and the need for an interdisciplinary research agenda
In: Progress in Biophysics and Molecular Biology 107 (2011), Nr.3, 312-314
The International Agency for Research on Cancer (IARC) has classified high as well as low-frequency fields as “possibly carcinogenic to humans” (Group 2B). For high frequency fields the recent assessment is based mainly on weak positive associations described in some epidemiological studies between glioma and acoustic neuroma and the use of mobile and other wireless phones. Also for lowfrequency fields the evidence is based on epidemiological findings revealing a statistic association between childhood leukemia (CL) and low-level magnetic fields. The basic findings are already 10 years old. They have since been supported by further epidemiological studies. However, the knowledge on the main/crucial question of causality has not improved. This fact and in addition the small, but statistically significant increased incidence of CL in the surrounding of German nuclear power plants have motivated the German Office for Radiation Protection (BfS) to work toward a better understanding of the main causes of CL. A long-term strategic research agenda has been developed which builds on an interdisciplinary, international network and aims at clarifying the aetiology of childhood acute lymphoblastic leukemia.