Summary Report of the Specialist Workshop
"Towards safer and effective use of radiation in paediatric imaging"

Wednesday 16 June 2010
14:00-18:30h
Helsinki, Finland

The workshop “Towards safer and effective use of radiation in paediatric imaging” was co-organized by the World Health Organization, the Finish Radiation and Nuclear Safety Authority (STUK) and the Radiological Society of Finland. It took place in Helsinki, Finland, on 16th June 2010, as a side event during the Third European IRPA Congress. The workshop was co-chaired by Dr. Maria del Rosario Perez from WHO and Ms. Ritva Bly from STUK, who stressed on the importance of the topic and introduced the speakers.

The first speaker was Dr. Maria Blettner – epidemiologist and statistician from the Institute of Medical Biometric, Epidemiology and Informatics at the Medical University in Mainz, Germany who spoke about the Lifetime health risk of paediatric exposures to ionizing radiation. Dr. Blettner considered different types of late health effects – the mostly investigated cancer - thyroid, breast, brain, leukaemia and another effect of increasing interest - ocular effects, like cataract. She stressed that, in order to make correct estimates, the epidemiological studies of radiation exposure require large population size, long-term follow-up of cohort, well characterised dose-estimates for individuals and wide range of doses in order to estimate a dose-response relationship.

She made a review of the major studies of cancer risks following childhood therapeutic irradiation for benign diseases, based mainly on the works of Kleinernann (2006) and Sadetzki & Mandelzweig (2009). Most of them studied thyroid cancer at different age at irradiation with mean doses between less than 0,1 Gy and 7,8 Gy and found the Excess Relative Risk (ERR) to vary between 2.5 and 32 per Sv. More important, ERR found to increase with the decrease of age at exposure. Similar risk-age relationship was found for brain cancer.

Dr. Blettner reviewed then the major studies of cancer risk following diagnostic radiation exposure in childhood and adolescence included, following out the breast cancer in three cohorts (USA and Canada) after examinations for tuberculosis and scoliosis and leukaemia after diagnostic x-ray in three cohorts in Canada, China and USA. The ERR found to be between 0.4 and 3.6 per Gy for breast cancer and 1.04 – 2.0 per Gy for leukaemia.

Dr. Blettner concluded that from the reviewed studies of exposure with medium and low doses at childhood is evident that children are more susceptible to radiation-induced cancer and the main reasons are that their tissues are still growing and they have longer life expectancy during which oncogenic effects may occur. BEIR VII report states that there is no low-dose radiation “threshold” and cancer risk is decreasing with increasing age at exposure.

The main concern in last years is computed tomography because the number of CT scans increases in developed countries. According to Brenner et al. (2002), the paediatric CT also increases – from 4% of all CT scans in US in 1989 up to 8-11 of all scans in 2000. Doses to some of the organs at CT exams can be considerable - for a single neonate CT dose to the stomach can be 30 mSv at the abdomen CT and brain dose of 60 mSv at head CT. Brenner et al. (2007) demonstrated that organ doses from a single CT scan of new-born can be 4-5 fold higher than
doses for adult. Using the estimated lifetime risk from a single dose of radiation as a function of age at exposure (BEIR 2006), de Gonzales et al. (2009) found that mean lifetime cancer risk per 10 000 chest CT scans increases from 3 at age 70 for both male and female to 40 for female and 10 for male at age of 3. For the abdomen and pelvis CT the corresponding mean lifetime cancer risk found to be the same for male and female – 20 per 10 000. Stein et al. 2008 found age-related effect of a single pediatric head CT scan on tumor occurrence and fatality.

The results from the German Study with a cohort of 92957 patient (Hammer et al. 2009) did not found increased risk of childhood cancer after postnatal diagnostic X-ray exposure.

Dr. Blettner considered also results from the resent studies on ocular late health effects, mainly on the example of the retrospective study of Whelan et al. (2010) of a cohort of 14,362 survivors of childhood cancer, diagnosed and treated between 1970 and 1986. They found considerable increase of cumulative incidence of cataract after exposure of eye with a dose of more than 500 cGy but also slight increase of incidence even at lower doses but more studies on radiation induced cataracts are needed.

Dr Blettner concluded that whereas late health effects of moderate to high dose radiation are already established, health effects of low dose radiation, especially arising from exposure to medical CT need to be further investigated. Although individual cancer risks associated with CT scans are small, public health issue is the increasingly large pediatric population being exposed to these small risks.

The second speaker was Dr. Kimberly Applegate – pediatric radiologist, Professor of Radiology at the Emory University School of Medicine in Atlanta, USA, and a Vice chair of quality and safety of the Alliance for Radiation Safety in Pediatric Imaging-Image gently Campaign.

The first topic of the presentation of Dr. Applegate was “Radiation protection of embryo-foetus in diagnostic imaging”. She discussed which approach should be used to pregnancy screening and management for radiological exams. The survey by Lee et al. published in AJR 2006 among 91 academic radiology chairs demonstrated that informed consent regarding CT scans exist in 2/3 of departments, and radiology technologists were most likely to inform patients about CT and possible risks whereas ordering physicians were most likely to inform patients about CT’s purpose. 52% of sites provided verbal information and 5% provided information in written form. Possible allergic reaction to contrast agent was explained at 84% of sites, and possible radiation risk was explained at 15% of sites. Only 9% of sites informed patients of alternatives to CT.

An interesting survey published by Lazarus E et al. in Radiology (2009) followed out 5270 examinations performed in 3285 pregnant patients during a 10-year period, and found that the radiological utilization rate in pregnant patients increased by 107% from 1997 to 2006. The greatest increase was in CT - by 25% per year, nuclear medicine examinations by 12% per year, and conventional radiographic examinations an average by 7% per year.

Bardo et al. concluded in their paper published in Pediatr Radiol (2009) that current midline ovary shielding is “…ineffective given that the ovaries are almost always positioned laterally in the pelvis”. The recommendation is to shield laterally or abandon.

Dr. Applegate recommended when diagnostic exposure is needed for emergency purposes, and when informed consent is not applicable, to document the radiation dose and to create communication policy between Emergency and Radiology departments for positive pregnancy tests after imaging test performed. Variety of approaches can be used to clarify the pregnancy status - written consent, availability of signs in radiology departments in different languages, technologists to interview patients in a private area away from other Dr. Applegate stressed on the scenario with a minor scheduled for abdomen CT for pain when the technologist should approach patient and her mother in private and if child does not ask her mother to leave, it implies that she is comfortable with her present for questions, but if child asks mother to leave, the tech should acknowledge it or involve radiologist.
She presented the Guideline of the American College of Radiology for Management of the exposed patient who did not know she was pregnant and Managing the known pregnant patient.

Dr. Applegate summarized “The lessons learned”: Lesson 1: “Many patients do not need imaging”. Lesson 2: “Imaging protocols are important in all modalities”, Lesson 3: “Iodinated contrast for CT is OK but avoid gadolinium if possible”; Lesson 4 “Everyone is aware of fetal risk from radiation but everyone also knows how they want their patient imaged…so multidisciplinary guidelines are a good thing!”; Lesson 5: “Dose reduction opportunities exist for most modalities (e.g., limit views)” Lesson 6: Little controversy for ionizing radiation imaging outside of the abdomen; Lesson 7: “Value of US and if negative, non-gadolinium MRI in pregnant patients”. She concluded that radiologists should collaborate with clinicians and to educate them to minimize risks to fetus and mother.

In the second part of her presentation Dr. Kimberly Applegate outlined the Image Gently campaign as an Education, Awareness, and Advocacy Campaign to Promote Radiation Protection for Children. This campaign is an initiative of the Alliance for Radiation Safety in Pediatric Imaging targeted to public and health professionals and using Internet, radio, television, posters. 59 health care organizations/agencies participate in Image Gently on a voluntary basis, reaching out to all stakeholders. The primary objective of the Alliance is to raise awareness in the imaging community of the need to adjust radiation dose when imaging children with a goal to change practice.

The lecture of Dr. Cathy Owens from UK, representative of the European Society of Paediatric Radiology, was dedicated to Justification and optimization of paediatric CT.

She comprehensively and convincingly presented the algorithm for optimization of pediatric CT examination – “Fit to purpose”, refining scan parameters to patient weight and size, limiting use of double/ triple scanning, careful use of contrast agent, etc. The conclusion she made from the consideration of effective dose and image noise dependence on imaging parameters and reconstruction algorithms was that in order to optimize CT examination in best way one should know the CT equipment and post-processing algorithms and to use them properly.

Dr. Owens presented different techniques for patient dose reduction – dual energy CT, selective photon shields, prospective gating, etc. and demonstrated them on clinical cases. The principle in optimization, Dr. Owens stressed many times, should be to obtain images with enough quality for purpose, not the best image.

Jim Malone – Professor of Medical Physics from Trinity College, Dublin, Ireland, and consultant at IAEA, presented the content of the new IAEA Safety Report on Radiation protection in modern paediatric radiology. First, he explained why the new safety report was planed - because in mid nineties the increase in medical exposure was realized, and especially in children known to be more sensitive to radiation; special emphasis was given in a number of documents of the International commission on Radiation Protection (ICRP), of the European Union, enforcing in 1997 the Medical Exposure Directive, in the USA, and especially the IMAGE GENTLY campaign. The new IAEA document is intended to be used by clinician, technicians, manufacturers, and regulators, medical physicists et al in the process of regulation, standardization and best practice implementation. Within the Framework of Radiation Protection in Paediatric Radiology lie well known principles of Justification, Optimization (ALARA), using DRLs for patients and dose limits, constraints for comforters, carers and public exposure. In this chapter of the report are also considered unintended exposures, issues associated with pregnancy, research involving children and the very important part of education and training. Among them justification is found to be of increasing importance and that why IAEA carried out two multidisciplinary Consultations in 2007 and 2008, and in September 2009 a joint workshop with EC was performed attended by representatives of 40 countries. The conclusion from presentations was that there is a clear evidence of health professionals not being aware of dose and risk connected to radiological exams and 20 to 50% examinations are inappropriate. Prof. Malone stated on the importance of the 3 A’s – Awareness (Risk communication), Appropriateness (need of Referral or Appropriateness Guidelines), and Audit (Clinical Audit with justification as a key marker).
Separate chapters are dedicated to the main radiological examinations performed in childhood – conventional radiography, fluoroscopy and interventions, CT and nuclear medicine. Advice on how to optimise examinations for children is given in each section. For example, for general radiology, it is important to use standard projections, manual technique and a long focus to skin distance, to collimate the beam, to use the fastest film screen for majority and not normally to use ant scatter grid. Prof. Malone underlined the importance of quality assessment, quality assurance and dose assessment and noted that where monitored over the period, reference doses for adults have reduced by 2, but there is a lack of serious work in the paediatric area and this should be an essential part of audit. The use of fluoroscopy in children needs special justification and when consider such high dose procedure availability of records for previous exams is of big importance, as well as the use of referral guidelines is strongly recommended. Where appropriate, Ultrasound, MRI and other techniques without radiation should be used. Consent, implied or explicit is required for justification. Special attention in the report is given to CT in children, where doses are 100 to 250 higher than for chest X-ray. In this part are considered metrics for dose/risk estimation, equipment design and standards, criteria for accepting equipment, etc. In the conclusion Prof. Malone emphasized the importance of team approach to protect children. “The child is King/Queen”, he concluded.

The second session started with the presentation of Dr. Raija Seuri - pediatric radiologist from Helsinki University Hospital in Finland, presenting the Nordic and Baltic experiences of justification and optimization of paediatric CT. She presented data for Finland, where CT comprises 8.3% of all radiological examinations and 2% of all CT examinations are done to children, but in the Helsinki University Central Hospital/Hospital for Children and Adolescents in 42 400 pediatric radiological examinations were performed in 2009, and 2800 of them CT examinations (6.6%). Referral guidelenes for imaging exist in Finnish language. Dr. Raija Seuri presented analysis of justification of 163 CT examinations performed in a three-month period in 2009, including 67 thorax, 30 head and11 abdomen, and concluded that 13% of them were controversial or unindicated. Nordic CT-study performed in 2005-2008 included 5 hospitals from Finland, Sweden and Norway, 3 from Denmark and 1 from Iceland. The next Finnish-Baltic study performed in 2009-2010 included 5 university hospitals in Finland, 1 hospital in Estonia, 2 hospitals in Lithuania, with a total of 8 different kind of scanners. Data were collected applying standard questionnaire for patient age, weight, height, clinical indication, area scanned, applied scan parameters, and dose indicators provided by the CT scanner. For example, indications for chest CT were found to be detection, distribution, follow-up of tumours and metastasis survey; complicated infection (abscess, empyema), congenital anomaly and diffuse pulmonary parenhymal disease (HRCT). Indications for abdominal CT are tumour, primary of follow up, but she mentioned that in 2007 the last of the university hospitals in Finland canged to MRI for these patients. Infection was mensioned in several hospitals and inflammatory bowel disease in one. Trauma is an accepted indication for abdominal CT everywhere. Abdomen CT comprises only 1% of all CT examinations to children in Finland in 2008. Indications for head CT are trauma, tumour (replaced by MRI in Finland), headache, infection/abscess (possible to be replaced by MRI), Hypertension, genetic disorder, Hydrocephalus and ventricular size. Indications for head CT included trauma, tumour, which is mostly imaged with MRI in Finland; also headache as an indication means usually outruling a tumour. Infection and abscess were mentioned in a couple of hospitals and hypertension was the most common indication in one Baltic hospital, done to exclude elevated intracranial pressure as a reason for arterial hypertension in a child. Also genetic disorder was mentioned in one hospital. Hydrocephalus, the size of the ventricles is a frequent indication in many hospitals. The conclusion is that differences exist in indications between countries and hospitals in Scandinavia and Baltic countries. Headache as an indication varied and both hypertension and genetic disorder were only mentioned in one baltic hospital. The role of CT in tumour diagnostics and stageing both in brain and abdominal area is perhaps changing also in other countries than Finland. CT for acute abdomen is very rarely done in Finland, but was mentioned in some nordic hospitals and CT for inflammatory bowel disease and chest pain were mentioned in only one hospital each. The use of head CT for genetic disorder as well as
differences in abdominal imaging may be due to availability of MRI, but the difficulties to get MRI are not always absolute, they might also be the matter of motivation and will.

In both studies the imaging parameters including CTDI(vol) and DLP were collected to estimate the patient dose and to look at the optimization. She cited the recommendation of Shrimpton and Wall (Radiat. Prot. Dosimetry 2000) that irrespective of patient age and scan location, doses to all pediatric patients should be expressed in terms of absorbed dose to the standard head dosimetry phantom (16 cm in diameter) and commented that there is a known uncertainty in using dose-values provided by the scanner, as for most CT scanners pediatric trunk examinations is characterized by standard body dosimetry phantom (32 cm in diameter) that can underestimate the absorbed dose by a factor of 2. She showed a graph with dose values indicated for all head CT patients and commented that great variation in CTDI-values are seen, without national trends, but with big differences between different hospitals in the same country. Dr. Raija Seuri presented deeper analysis of scan parameters, telling about the level of optimization, and expressed her surprise of the use of high kV for abdominal CT, whereas there are a lot of articles suggesting the use of 100 kV. In the Nordic study also the effective dose was calculated for different age groups, and variations between 1.3 and 5.1 in ratio between observed maximum and minimum dose were found, indicating on the variation in optimization. The variation is biggest, 5.1, in whole body examinations and one reason for that could be, Dr. Seuri said, the lack of fine tuning of the imaging parameters in an emergency situation in the evening, when there can also be less experienced staff involved. In the end she gave an example for the effect of good optimization process done together with radiologists, medical physicists, radiographers and manufacturers representative. This is how it should be done, she said, not just “plug and play”, and concluded that optimization of pediatric ct is definitely challenging and it needs multiprofessional co-operation to find the right imaging parameters including those of image quality. She stressed on the importance of both smaller studies providing information for optimization and justification, but also international cooperation to create DRLs and to provide practical information for the users.

Ms. Johanna Mannila – radiographer from the Helsinki University Hospital, Finland, presented Good practice in the digital paediatric radiography. She discussed the role of proper radiography technique for imaging – use of proper positioning and immobilization, collimation of the beam, removing the grid and work without automatic exposure control to better adjust the exam parameters. She discussed the advantages of digital imaging but also challenges. On the question from the audience on the need of co-operation of the patient that is not easy in pediatric imaging, she agreed and concluded “Paediatric imaging is not for everybody”.

Optimization of protection in paediatric PET-CT was presented by Dr. Søren Holm from Rigshospitalet in Copenhagen, Denmark. He presented his hospital as one for patients who need highly specialized treatment and care and where 12,000 children < 15 years are admitted each year, and where 1200 paediatric nuclear medicine examinations are performed but only around 100 of them being paediatric PET/CT scans. Dr. Holm stressed that before doing optimization, exams should be justified and that paediatric oncological indications for PET/CT are diagnosis, biopsy guiding, staging, re-staging, planning of radiation therapy, looking at the therapy response, and follow up. He presented several example of the use of PET/CT.

Dr. Holm noted that before we even think of dose optimisation, we have to make sure that the examination will be completed, because if the examination is not completed, dose is wasted. The important points in this issue are availability and use of warm surroundings and clothes, dimmed light, quiet environment and entertainment, quiet relaxed breathing, proper immobilization and its comfort and security, participation of parents. The use of CT should be optimised – in some cases low dose CT of is needed only for attenuation correction (0.3 mSv) or for AC and “orientation” (1-2 mSv), but if full diagnostic CT is needed, dose can reach 5-15 mSv, that is even higher than the dose from typical PET (4 mSv). In this cases coordination with radiology department is important in order to avoid duplicate scans. One of the advantages of one session is that sedation is used once. In general the protocols used in Radiology are used in PET/CT, but choices may be limited by vendor’s software, compared to CT alone. Documentation of all
procedures is also part of the protection, in order to properly identify the exam, to adapt it to the height and weight, to take into account previous examination and treatment of the patient, possible reactions if contrast or anaesthesia is used and to make special attention to pregnancy issue. Then Dr. Holm went deeply into the image formation with PET and considered technical and physical factors influencing image resolution and noise. With the advent of LSO and other “fast crystals”, noise equivalent counts (NEC) shifted to higher value. The good news is, he said, that the count rate capability is not a limitation in paediatrics, but the bad news is (from a protection point-of-view) that you must set a limit, knowing it limits image quality. Guidelines exist by the European Association of Nuclear Medicine for F-18 FDG PET and PAET/CT imaging in paediatric oncology, and especially pediatric dosage charts, advising minimum activity of 70 MBq for FDG brain study. Applying the activity to effective dose coefficients from ICRP 80 publication, the recommended minimum activity reflects on the increase of effective dose for smaller children of less than 20 kg of weight. In contrary, in the Rigshospitalet they use FDG dosage of 3 MBq/kg, without lower limit, reflecting on lowering the effective dose for small children, without compromising diagnostic efficiency. Dr. Holm strongly advocates the use of a “Linear No Threshold” model and to calculate children’s dose by weight as a % of adult dose, because in small objects (patients), we get more counts and need less to maintain a given noise level. As a conclusion Dr. Holm used suggestion of Dobbeleir et al (2010) how to improve counts per voxel pointing out on the challanges – One way is to develop more efficient PET systems for children, but it will be much more expensive and time is needed; another way is to use higher doses that is not acceptable from radiation protection point of view; if increase scan time, this will require more frequent use of general anaesthesia which might well be more dangerous. Another way is to develop better reconstruction methods. “Is there a way out?”, Dr. Holm asked and concluded: “No, not really. It appears that any technological improvement in PET is likely to accentuate the problem rather than solve it. We need to negotiate what “acceptable” image quality is.”

The next speaker was Dr. Heljä Oikarinen – radiologist from Oulu University Hospital, Finland, who presented a survey at Oulu University Hospital on unjustified CT examination in young patients. They especially looked whether CT examinations done on patients younger than 35 years are justified and if not justified, which could be another, more justifiable modality? Altogether 148,988 examinations were performed in the Department of Diagnostic Radiology of Oulu University Hospital in 2005 and 11% of them were done using CT, and 14% of the CT examinations were done on patients under the age of 35 years. The main groups of examinations were CT of the head, thorax or lungs, lumbar (and sacral) spine, abdomen or upper abdomen, trauma, cervical spine, nasal sinuses and body (thorax and abdomen). 200 exams of 2367 were analysed by experienced radiology specialists applying the European Commission’s referral criteria for imaging. CTs of the thorax or lungs and body were excluded from the study because there is no good alternative for these examinations. They found different percentage of unjustified exams for different localisation - 77% of lumbar spine exams, 37 of abdomen, 36 of head, 20 % of nasal sinuses, and 0% of trauma. Totally 30 % of the CT exams were found to be unjustified. They concluded that most of these unjustified exams can be replaced by MRI, especially for lumbar spine and head. Symptoms of disk syndrome, suspicion of spinal stenosis and control of spinal lymphoma in young patients may indicate MRI. Trauma and control of fixation indicate CT. Look at the different age groups found that 11 % of the unjustified exams were performed for children of less than 15 years. Dr. Oikarinen presented also actions that were undertaken after the survey. They put special efforts on spreading the information for the project results and using it in educational process. The education consisted of the risks and doses of radiation, indications of different examinations, the process of justification and legislation on radiation protection. The radiology staff in other hospitals in Northern Finland were reached through videoconferences. They also provided info cards containing information on radiation and justification for the referring practitioners in the Oulu area and for the people working with radiation in the hospital, and this cards will be handed out to medical students every year. Among distribution of the EC referral criteria for imaging, they also made some new recommendations for the use of CT for the referring practitioners and the radiologists at the hospital. Their content is roughly the following: 1. MRI is the primary examination of the head. CT examination is only indicated in acute cases. 2. MRI is
usually the primary examination of the lumbar spine in young patients. 3. Clinicians are recommended to consult a radiologist before sending a request form for abdominal CT in the case of a young patient.

The study revealed that most of the unjustified cases could have been replaced by MRI. Shortage of MRI capacity may partly have contributed to the poor results of justification. They addressed this by purchasing a new MR system.

In the follow-up they found decrease in number of CTs of the lumbar spine for young patients, from 130 exams in 2005, to 24 in 2009. The ratio of examinations with radiation to examinations without radiation changed from 77:23 in 2005 to 75:25 in 2009.

Dr. Oikarinen concluded that education, use of recommendations and referral guidelines, and increased MRI capacity have improved justification and thus radiation protection of the patients.

The last presentation of Prof. Keith Horner from the School of Dentistry, University of Manchester, United Kingdom was dedicated to screening or selective imaging in pediatric dentistry: In the introductory part he mentioned that in developed countries 20% of X-ray examinations are performed by dentists, but this figure conceals considerable national variation, ranging from the highest (839 per 1000 population) in Japan to below 100 per 1000 for many countries. In the United Kingdom it was estimated in 2002 that over 9 million intraoral and over 3 million panoramic radiographs were taken annually. The usual practice of dental radiography is one of self-referral, in which the dentist decides radiography is necessary, selects a particular type of X-ray examination, performs the justification process and, often, also performs the examination. In most instances, an external influence on prescription of radiographic examinations is financial, through national or private health insurance schemes. A large proportion of examinations are performed in the paediatric age group, principally for the detection of dental decay (caries) and developmental anomalies. While most dental X-ray examinations have a very low radiation dose, the introduction of Cone Beam CT (CBCT) brings a higher dose range to dental imaging.

After refining what screening means, Prof. Horner explained how do screening criteria fit with paediatric dentistry, and pointed out that there are two broad categories of “common or disabling” conditions for which a dentist (or public health dental service) might choose to screen: dental caries and its sequelae and anomalies of growth and development of the dentition requiring orthodontic management. Considering both important applications, Prof. Horner concluded that radiographic screening can not be justified, the primary method of diagnosis is the clinical screening, after which special tests can be selected, and among them the most widely used special test remains imaging using X-rays.

Then Prof. Horner considered diagnostic tests for dental caries, stating that while there is a well understood body of evidence surrounding the use of bitewing radiographs for dental caries diagnosis, there is less evidence for the role of panoramic radiographs in this respect, because of their lower resolution and overlapping showed between teeth that obscure lesions. Nonetheless, while emphasising the need for individualised prescription of radiographs, US guidelines still recommend “posterior bitewings with panoramic exam” as appropriate at all paediatric ages subsequent to the eruption of the first permanent molar at around 6 years of age. The advent of CBCT to dentistry raises the potential of its use for the full range of diagnostic applications, including caries diagnosis. He emphasised that the CBCT systems available to dentists vary enormously in their imaging characteristics, and an important additional problem of using CBCT is the presence of artefacts from high atomic number dental restorations that will substantially reduce specificity. Because of these findings, the evidence-based guidelines on dental CBCT state that “CBCT should not be used as a routine method of caries detection and diagnosis” (SEDENTEXCT, 2009).

Considering diagnostic tests for anomalies of dental development, Prof. Horner stated that the evidence that panoramic radiography can identify dental anomalies should not be seen as a justification for imaging. Many anomalies are of purely documentary interest and the important aspect is whether the radiological findings influence management. Research suggests that in a
large proportion of cases the radiographic evidence makes no contribution to diagnostic thinking (Atchinson et al 1991; Han et al 1991). It is clear that, for some years, the research evidence has been against the concept of screening panoramic radiography of children for development of the dentition and orthodontic assessment, but in favour of clinical screening supplemented by radiographs when indicated. Nonetheless, the practice of radiographic screening and “routine” radiography persists amongst some dentists, particularly in the United States, possibly driven by fears of litigation if “something is missed”. In considering the use of CBCT in orthodontics he stated that the dose advantage seen with CBCT in respect to conventional CT means that CBCT may be preferred, but in contrast to this, the use of large volume (craniofacial) CBCT as a routine means of assessing growth and development of the dentition and the face in orthodontics causes concern. Compared with a “conventional” examination, using a panoramic and a lateral cephalometric examination, large volume CBCT gives a higher radiation dose, sometimes considerably so. The SEDENTEXCT Guideline document, based on systematic review, described the literature on this subject as “strong on hyperbole and short on evidence of significant clinical impact”. In the end, Prof. Horner reviewed the existing Referral criteria dealing with justification of radiology in dentistry, including paediatric uses in US and pointed out that many of these sets of referral criteria are expert panel based, rather than developed using a structured method of literature review, and this no doubt explains why different sets of referral criteria may disagree. In the UK, the Faculty of General Dental Practice produced evidence-based referral criteria for dental radiography in 1998, revised them in 2004 and is now working on its 3rd edition. These guidelines acted as the model for the development of the European Guidelines on Radiation Protection in Dental Radiology (EC, 2004), and the nowadays developing evidence-based guidelines on CBCT use in dentistry, including referral criteria (SEDENTEXCT, 2009).

Panel discussion on the topic “Improving radiation protection culture in paediatric patients: how to move forward” was co-chaired by Dr. Cathy Owens from the European Society of Paediatric Radiology and Prof. Seppo Soimakallio from Finland. All lecturers in the workshop participated in the panel. Prof. Soimakallio noticed the importance of the training in radiation protection for medical students that initiated a fruitful discussion on the role of the training, its frequency and if it should be obligatory for medical doctors. Dr. Raija Seuri explained that post-graduate training in radiation protection Is obligatory for every doctor in Finland. From the audience was given an example of educational campaign for parents after the increase use of antibiotics. Prof. Horner expressed his opinion that radiation protection training should be integrated in clinical education and training, not to be separated. Dr. Heljä Oikarinen said that medical students should pass practical training before graduating, including GPs. The opinion was expressed from the audience that the training should be always dedicated to particular practice and even department. Dr. Stelios Cristofidies, president of EFOMP, propose to use the positive US experience to start training at stage of clinical practicing when student can understand the need.

Another topic discussed was risk communication with public and the role of the press. Journalists sometime like negative news. Dr. Kimberly Applegate stated that sometimes even “bad news” if used in right way, can also help. She pointed out on the importance of safety culture. The Image Gently campaign is aimed at creation of safety culture and support of optimization process. Dr. Heljä Oikarinen proposed wide survey of justification to be initiated to provide evidence based referral criteria for imaging.

Rapporteur: Kimberly Applegate - Image Gently, USA
Co-rapporteur: Jenia Vassileva – NCRRP, Bulgaria