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Research Article

Measurement of Radiation Doses in Computed Tomography (CT) and Estimated Radiological Risk of Cancer

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Abstract

The abundant observance of CT in medical diagnosis delivers higher radiation doses to patients than other radiological imaging systems which is a great concern for the increased radio sensitivity of certain tissue and radiation related cancer. In the present measurement, we have investigated patient effective doses by CT examination to Neck, Lung, Abdomen and Pelvis and a comparison is also made for the contribution of doses with digital radiography (X-ray) using Alderson Rando Phantom at the tube potential 80 kV-120 kV. Effective Dose (ED) measured using Entrance Surface Dose (ESD) for Neck were ranged from 0.30 mSv to 0.69 mSv, for Lung 0.65 mSv to 1.66 mSv, for Abdomen 0.99 mSv to 3.07 mSv and for Pelvis 1.16 mSv to 3.32 mSv, and the corresponding ED_{DLP} measured using dose-length product were ranged from 0.45 mSv to 1.52 mSv for Neck, 1.99mSv to 6.76 mSv for Lung, 2.14 mSv to 7.51 mSv for Abdomen, 1.70 mSv to 5.95 mSv for Pelvis which lie within the reference level established by some other international institutions. From the present study it is found that CT doses is remarkably higher than digital X-rays i.e. for example; CT dose is 6.2 times higher than that of digital radiography at the same tube voltage 120 kV X-rays for neck imaging. The estimated risk factor and incident per population for both X- ray and CT are presented. It is observed that risk factor decreases with the increase of age and risks were increased with the increasing number of exposure.

Keywords: Computed tomography, Ionizing radiation, Effective dose, Radiation risk.

Abbreviations: CT: Computed Tomography; ED: Effective Dose; DLP: Dose length product; ESD: Entrance Surface Dose; NMPI: Nuclear Medical Physics Institute; IPEM: Institute of Physics and Engineering in Medicine

Introduction

The use of computed tomography (CT) techniques in diagnostic radiology imaging procedures has increased rapidly worldwide over the past three decades because of its splendid technological progress and remarkable performance. Now CT is a standard modality in assessing a variety of disorders in patients as well as for cancer detection, surveillance, and evaluation of trauma and CT will continue to provide remarkable advantage to modern medical treatment and the advantage derived by the patient will go far beyond the small risk associated with any properly conducted imaging modality [1]. The X-ray beam based CT typically deliver doses that are substantially greater than those received from conventional radiographic technique and the growing use of CT procedures is a topic of widespread concern. Issues of concern is the increased radio-sensitivity of certain tissues and a longer lifetime for radiation-related cancer [2]. Due to the disproportionately high amount of radiation used, CT accounts for more probable induced cancers than any other medical imaging modality [3]. Most imaging procedures have a relatively low risk but the risk associated with medical imaging procedures refers to possible long-term or short term side effects [4]. Possibility of harm could estimate by quantifying the radiation received by patients who is undergoing radiological examinations. In radiography, the sensitivity of the organs and tissues which being irradiated during the radiographic projections depend on the Entrance Surface Dose (ESD) to patient [5]. As the risk of cancer accumulates with the patient's lifetime accumulation of radiation exposure the effective dose calculation helps to quantify stochastic risk of carcinogenesis. During diagnosis, in order to lessen extraneous radiation to patients, it is necessary to determine what amount of radiation exposure has occurred [6]. Now a day, Cancer is treated as one of the most dangerous health issues and is a leading cause of death worldwide accounting for an estimated 9.6 million deaths in 2018. Approximately 70% of deaths from cancer occur in low- and middle-income countries [7]. Radiation exposure from medical imaging may be responsible for 1-3% of cancers worldwide [8]. Account for this issue, researchers all over the world observed the radiation dose of patient for computed tomography (CT) scan of different organs of human body using different types of dosimeters and different methods. In this study, Alderson Rando human phantom is used in lieu of actual patients and real time dosimeters are used for dose measurement and cancer risk are calculated by using web based risk calculator. The main examinations focused on this study are the calculation of effective dose from ESD and stochastic risk of cancer. The aim of the present study is to monitor the effective dose of the patients during diagnosis within the recommended value of International Atomic Energy Agency (IAEA) to keep the patient dose as low as possible, and the estimation of the fatal cancer risk and to compare with published literature on patient dosimetry.

Materials and Methods

This study includes commonly performed medical diagnostic Neck, Lung, Abdomen and Pelvis CT scans examination and digital X-ray examinations. For CT scan examination, Philips Ingenuity TT PET/CT of 128 slices is used which is located at NMPI, AERE. In lieu of actual patients Alderson Rando human phantom, which comprises ingredients similar to human tissue used to investigate the effect of radiation beams on human beings, has been used. The X-ray examination was performed at Ahsania Mission Cancer and General Hospital, Dhaka. Radiographic factors included tube potential (kVp), exposure setting (mAs), and focus to skin distance (FSD) that were used normally in each radiology room by radiographers for average size adult patients (with weights between 60-80 kg according to the European guideline) for only suitable diagnostic quality images as distinct by the radiologist. Dosimetry protocols proposed by IAEA international code of practice TRS 457 and by the report no. 77, Institute of Physics and Engineering in Medicine (IPEM) were used to measure the quality control parameters [4,9]. Electronic personal dosimeters (EPD) of Polimaster (PM1610) series and IBA Kermax-Plus Tino DDP (M: 120-131 Tino) provide measurement of dose equivalent [10,11]. Calibration factors for all the dosimeters are used in this experiment and these were multiplied with the dosimeter values to get the corrected dose. IBA Kermax-Plus Tino DDP dosimeter was placed on the selected target organ to do CT scan and at the same time pocket dosimeters were placed on the other concerned organs to measure the scattered dose. CT was performed for Neck, Lung, Abdomen and Pelvis. While one of them was selected as target organ other three were considered as organs at risk. The whole process was repeated for three different tube voltages 80 kV, 100 kV and 120 kV. Quality control tests such as Computed Tomography Dose Index (CTDI) (volume), mAs (mili ampere second), DLP (Dose Length Product) were also observed from the CT machine for different CT examinations. Entrance dose has been observed through direct measurement. Doses were observed for target organ as well as associated scatter dose for other organs.

The tissue weighting factor is a relative measure of the risk of stochastic effects that might result from irradiation of that specific tissue. It accounts for the variable radio sensitivities of organs and tissues in the body to ionizing radiation. The radiation weighting factor is the value selected for a specified type and energy of the radiation. The probability of stochastic radiation effects depends not only on the absorbed dose, but also on the type and energy of the radiation causing the dose. Determination of Effective Dose (ED) has been defined by the ICRP as the sum of the weighted equivalent doses to specified organs and provides a useful measure of radiation risk (ICRP, 2007) [12].

$$E = \sum_{\mathrm{T}} \mathrm{W}_{\mathrm{T}} \mathrm{H}_{\mathrm{T}} = \sum_{\mathrm{T}} W_{T} \sum_{\mathrm{T}} W_{R} D_{T,\mathrm{R}} \text{ .... } (1)$$

where, W_T is the tissue weighting factor, and H_T is the equivalent dose in that tissue or organ. $D_{T,\mathrm{R}}$ is the mean absorbed dose in tissue T, due to radiation R. W_{R} is the radiation weighting factor [12].

In this study, Conversion Coefficients were used that are derived in National Radiological Protection Board (NRPB), UK to relate measured entrance surface dose (ESD) and ED [13]. The formula given below:

ED (mSυ) = Entrance Surface Dose (mGy) × CC ESD (mSυ/mGy) .... (2)

where, the symbol has their usual meaning. $\mathrm{CC}_{\mathrm{Entrance}}$ dose was used from the table presented in report of NRPB [13]. To determine the Effective dose ($\mathrm{ED}_{\mathrm{DLP}}$) from Dose Length Product, DLP and $\mathrm{CTDI}_{\mathrm{vol}}$ for each CT examination were noted from CT machine. Then $\mathrm{ED}_{\mathrm{DLP}}$ was calculated from the product of DLP and the body region-appropriate DLP to ED conversion coefficient, k. This is the following method to estimate $\mathrm{ED}_{\mathrm{DLP}}$

$$\mathrm{ED}_{\mathrm{DLP}} = \mathrm{k} \times \mathrm{DLP} \text{ .... } (3)$$

Where, k is coefficient factor for the anatomic region scanned [14].

Measurement of the Entrance dose for X-ray contained diagnostic X-ray examinations namely; Neck X-ray, Lung X-ray, Abdomen X-ray and Pelvis X-ray. In this study, Alderson Rando human phantom (male) is also used in all cases instead of real patients. Same dosimeters and same procedures were followed in X-ray examination like CT examination. In all cases tube voltages are taken as 80 kV and 100 kV.

To find the estimated radiological risk of cancer a website X-RayRisk.com was used. This is an educational website that focuses on estimating this risk (https://www.xrayrisk.com/about.php) [15]. One of the site's main features is a web based calculator that allows users to track their imaging history and estimate their personal risk, while providing answers to frequently asked questions. There are no published studies that prove the direct causality between medical imaging and increased cancer risk. Most of the evidence on radiation-induced cancer risk comes from 4 groups: Japanese atomic bomb survivors, medically exposed populations, occupationally exposed groups, environmentally exposed groups. Present data on radiation exposure and cancer risk are coming from the above mentioned sources. The assumed increased risk of cancer from low dose medical exposure (CT scans and X-rays) is based on individuals exposed to high doses (atomic bombs and nuclear accidents). The linear no threshold model is the theory that the increased risk holds true at these lower doses and is the currently adopted model for calculating radiation risk.

Results and Discussion

In CT examination, exposure conditions are quite different from other conventional diagnostic examinations. It is therefore very important to provide information on patient dose from CT examinations. Entrance dose for Neck, Lung, Abdomen and Pelvis CT were noted down for voltages 80 kV, 100 kV, and 120 kV respectively. Effective dose was estimated from entrance surface dose multiplied by NRPB conversion coefficients (Equation 2) which were shown in (Table 1). Effective Doses (ED) were also measured from DLP (Equation. 3) for CT to learn the total dose deposited to the patient body which is demonstrated in (Table 2). The comparison between ESD based ED and DLP based ED was also observed to justify the proximity of dose received by the patient which were shown in (Table 3). Digital X-ray examinations were held for the same organs to calculate effective dose were shown in (Table 4). Fatal cancer risks for different organs in CT and X-ray examinations were displayed for both single scan and double scan in (Tables 7-8).

Table 1: Effective Dose from CT usingIBA Kermax Plus Tino dosimeter for target organ and personal dosimeters for associated exposed organs at 80 kV, 100 kV and 120 kV.

Target organ	Voltage(kV)	Scan Time (sec)	Effective Dose (µSv)			
			Neck	Lung	Abdomen	Pelvis
Neck	80	2.5	304.16	7.27	1.05	0.29
Lung		3.9	43.57	651.1	17.64	1.63
Abdomen		4	1.36	35.28	990.92	27.76
Pelvis		3.8	0.38	5.03	54.79	1162.08
Neck	100	2.2	614.68	23.13	3.34	0.87
Lung		3.5	101.49	1147.3	43.03	4.99
Abdomen		3.7	38.28	85.94	1987.44	73.25
Pelvis		3.5	1.13	13.28	106.68	2008.96
Neck	120	2.2	648.8	30.42	5.89	1.73
Lung		3.5	82.29	1657.6	67.06	9.24
Abdomen		3.7	7.34	125.81	3068.38	120.15
Pelvis		3.5	2.02	22.06	289.41	3324.16

Table 2: Effective Dose from DLP at Neck, Chest, Abdomen and Pelvis region for different tube voltage using IBA Kermax Plus Tino dosimeter.

Anatomic Region	Voltage (V)	Scan Time (sec)	CTDIvol (mGy)	DLP (mGy *cm)	Conversion Coefficient, k (mSv/(mGy*cm))	Effective Dose, ED_{DLP} = k × DLP (mSv)
Neck	80	2.5	3.8	85.6	0.0052	0.45
	100	2.2	7.9	179.1	0.0051	0.92
	120	2.2	13.1	297.4	0.0051	1.52

Lung	80	3.9	3.8	135.6	0.0147	1.99
	100	3.5	7.9	280.9	0.0144	4.05
	120	3.5	13.1	466.5	0.0145	6.76
Abdomen	80	4	4.8	141.5	0.0151	2.14
	100	3.7	9.9	295.3	0.0151	4.46
	120	3.7	16.4	490.6	0.0153	7.51
Pelvis	80	3.8	4.8	132.9	0.0128	1.7
	100	3.5	9.9	277.6	0.0127	3.53
	120	3.5	16.4	461	0.0129	5.95

Table 3: Comparison of Effective Dose based on Entrance Surface Dose (ESD) and Effective Dose based on Dose –Length Product (DLP) using IBA Kermax Plus TINO DDP.

Target Organ	Tube Voltage (kV)	Effective Dose (From DLP to ED conversion factor method) (mSv)	Effective Dose (NRPB Calculation method) (mSv)
Neck	80	0.46	0.3
	100	0.93	0.62
	120	1.53	0.69
Lung	80	1.98	0.65
	100	4.1	1.15
	120	6.81	1.66
Abdomen	80	2.17	0.99
	100	4.52	1.99
	120	7.5	3.07
Pelvis	80	1.74	1.16
	100	3.58	2.01
	120	5.95	3.32

Table 4: Effective Dose (μSv) calculated from digital diagnostic X- Ray using IBA Kermax Plus TINO DDP at 80 kV and 100 kV.

Target Organ	Voltage (kV)	Effective Dose (μSv)			
		Neck	Lung	Abdomen	Pelvis
Neck	80	97	0.78	0.33	0.15
Lung		2.34	297	1.73	0.53
Abdomen		0.2	2.38	412.44	2.13
Pelvis		0.13	1.12	8.25	486.56
Neck	100	100.92	0.98	0.39	0.19
Lung		2.7	310.5	2.52	0.6
Abdomen		0.28	3.96	431.06	2.48
Pelvis		0.09	1.2	6.7	513.28

Table 5: Comparison between the effective doses of CT and X-ray at 80 kV, 100 kV using IBA Kermax Plus TINO DDP for different organs.

Organs	Voltage (kV)	Using IBA Kermax Plus TINO DDP		Comparison of doses in percentage (%): $\frac{M_1}{M_2}\times100\%$
		Effective dose from CT (mSv) (M_1)	Effective dose from X-ray (mSv) (M_2)	
Neck	80	0.3	0.097	309.28
Lung		0.65	0.3	216.67
Abdomen		0.99	0.41	241.46
Pelvis		1.66	0.49	338.78

Neck	100	0.62	0.1	620
Lung		1.15	0.31	370.97
Abdomen		1.99	0.43	462.79
Pelvis		2.01	0.51	394.12

Table 6: Comparison of the effective doses (ED) of CT examinations at tube voltage 120 kV for selected organs worldwide.

Organs	Present Work (Effective Dose in mSv)		Previous Works (Effective Dose in mSv)			
	From ESD	From DLP	D. Hart et al NRPB W4 [13]	AAPM 96[16]	Eugene C.Lin, Md [17]	Tsapaki et al [18]
Neck	0.69	1.53	4	1-2	2	-
Lung	1.66	6.81	8	5-7	7	10.9
Abdomen	3.07	7.5	10	5-7	10	7.1
Pelvis	3.32	5.95	10	3-4	10	9.3

Table 7: Approximate risk factors for patients of different ages from effective doses originating from Neck, Lung, Abdomen and Pelvis CT using IBA Kermax Plus TINO DDP at 80 kV, 100 kV and 120 kV.

Tube Voltage (kV)	Organ	Effective Dose from ESD (mSv)	Age 25		Age 40		Age 55		Age 70	
			Risk factor (%): incident per population		Risk factor (%): incident per population		Risk factor (%): incident per population		Risk factor (%): incident per population	
			Number of CT		Number of CT		Number of CT		Number of CT	
			1	2	1	2	1	2	1	2
80	Neck	0.3	0.003118 1:32072	0.006235 1:16038	0.002064 1:48450	0.004128 1:24225	0.001366 1:73206	0.002732 1:36603	0.000904 1:110619	0.001809 1:55279
	Lung	0.65	0.006537 1:15298	0.013074 1:7649	0.004327 1:23111	0.008655 1:11554	0.002865 1:34904	0.005729 1:17455	0.001896 1:52743	0.003793 1:26364
	Abdomen	0.99	0.009956 1:10044	0.019912 1:5022	0.006591 1:15172	0.013182 1:7586	0.004363 1:22920	0.008726 1:11460	0.002888 1:34626	0.005777 1:17312
	Pelvis	1.16	0.011666 1:8572	0.023331 1:4286	0.007723 1:12948	0.015445 1:6475	0.005112 1:19562	0.010225 1:9780	1.69×10^{-3} 1:59102	0.006769 1:14773
100	Neck	0.62	0.006235 1:16038	0.01247 1:8019	0.004128 1:24225	0.008255 1:12114	0.002732 1:36603	0.005465 1:8298	0.001809 1:55279	0.003618 1:27640
	Lung	1.15	0.011565 1:8674	0.02313 1:4323	0.007656 1:1306	0.015312 1:6531	0.005068 1:19732	0.010136 1:9866	0.003355 1:29806	0.00671 1:14903
	Abdomen	1.99	0.020013 1:4997	0.040025 1:2498	0.013248 1:7548	0.026497 1:3774	0.00877 1:11403	0.017541 1:5701	0.005806 1:17224	0.011612 1:8612
	Pelvis	2.01	0.020214 1:4947	0.040428 1:2474	0.013381 1:7473	0.026763 1:3737	0.008858 1:11289	0.017717 1:5644	0.005864 1:17053	0.011728 1:8527
120	Neck	0.69	0.006939 1:14411	0.013878 1:7206	0.004594 1:21768	0.009187 1:10885	0.003041 1:32884	0.006082 1:6442	0.002013 1:49677	0.004026 1:24839
	Lung	1.66	0.016694 1:5990	0.033388 1:2995	0.011051 1:9049	0.022103 1:4524	0.007316 1:13669	0.014632 1:6834	5.81×10^{-3} 1:17224	0.009686 1:10324
	Abdomen	3.07	0.030874 1:3239	0.061748 1:1619	0.020438 1:4893	0.040877 1:2446	0.01353 1:7391	0.02706 1:3695	7.67×10^{-3} 1:13033	0.017914 1:5582
	Pelvis	3.32	0.033388 1.2995	0.066776 1:1498	0.022103 1:4525	0.044205 1:2262	0.014632 1:6834	0.029264 1:3417	0.009686 1:10324	0.019372 1:5162

Table 8: Approximate risk factors for patients of different ages from effective doses originating from Neck, Lung, Upper Abdomen and Pelvis X-ray using IBA Kermax Plus TINO DDP at 80 kV and 100 kV.

Tube Voltage (kV)	Organ	Effective Dose from ESD (mSv)	Age 25		Age 40		Age 55		Age 70	
			Risk factor (%): incident per population		Risk factor (%): incident per population		Risk factor (%): incident per population		Risk factor (%): incident per population	
			Number of CT		Number of CT		Number of CT		Number of CT	
			1	2	1	2	1	2	1	2
80	Neck	0.097	0.000975 1:102564	0.0001951 1:51256	0.000646 1:154799	0.001292 1:77399	0.000427 1:234192	0.000855 1:116959	7.00×10^{-5} 1:1428571	0.000566 1:176678
	Lung	0.3	0.003017 1:33146	0.006034 1:16573	0.001997 1:50075	0.003994 1:25038	0.001322 1:75643	0.002644 1:37821	1.05×10^{-3} 1:95238	0.001751 1:57110
	Abdomen	0.41	0.004123 1:24254	0.008246 1:12127	0.00273 1:36630	0.005459 1:18318	0.00181 1:55340	0.00361 1:27670	0.001196 1:83612	0.002392 1:41806
	Pelvis	0.49	0.004928 1:20292	0.009855 1:10147	0.003262 1:30656	0.006524 1:15328	0.00216 1:46296	0.004319 1:23154	0.00143 1:69930	0.002859 1:34977
100	Neck	0.1	0.001006 1:99404	0.002011 1:49727	0.000666 1:150150	0.001331 1:75131	0.000441 1:226757	0.000881 1:113507	0.000292 1:342466	0.000584 1:171233
	Lung	0.31	0.003118 1:32072	0.006235 1:16038	0.002064 1:48450	0.004128 1:24225	0.001366 1:73206	0.002732 1:36603	0.000904 1:110619	0.001809 1:55279
	Abdomen	0.43	0.004324 1:23127	0.008649 1:11562	0.002863 1:34928	0.005725 1:17467	0.001895 1:52770	0.00379 1:26385	0.001255 1:79618	0.002509 1:39857
	Pelvis	0.51	0.005129 1:19497	0.010258 1:9748	0.003395 1:29455	0.006791 1:14725	0.002248 1:44484	0.004495 1:22247	0.001488 1:67204	0.002976 1:33602

For CT examinations mentioned, Effective Dose were ranged from 0.30 mSv to 0.69 mSv for Neck, 0.65 mSv to 1.66 mSv for Lung, 0.99 mSv to 3.07 mSv for Abdomen and 1.16 mSv to 3.32 for Pelvis. From the present measurement, it could be summarized that the values of scattered doses were far below the considerable level. For all CT examination, ED_{DLP} (result from DLP to ED conversion factor) were ranged from 0.46 mSv to 1.53 mSv for Neck, 1.98 mSv to 6.81 mSv for Lung, 2.17 mSv to 7.50 mSv for Abdomen, 1.74 mSv to 5.95 mSv for Pelvis. (Table 3) showed a comparison among ED and ED_{DLP}. It is observed that same tube voltage E_{DLP} overestimates ED. (Table 7) showed cancer risk factors that were calculated using ED through the risk calculator. As Alderson Rando human phantom was used in this study, age of the patient was assumed. To understand the impact of age on dose, age 25, 40, 55 and 70 were considered in this experiment. It is observed that risk factor decreases with the increase of age. Risks were found considering the number of scan as 1 (single exposure) and 2 (double exposure). It is evident that risks were increased with the increasing number of exposure. In case of Pelvis CT, 3.32 mSv ED was found. Considering the patient as male of age 25 years and experienced two pelvis CT scans in his whole life span then the associated risk of cancer is 1 among 1498 population and the risk factor is 0.067% which is observed as the highest among all. The second highest risk is observed for Abdomen. ED was found 3.07 mSv. At the age length of 25, if the patient is scanned a double abdomen CT, then the probable risk of having cancer is 1:1619 and risk factor is 0.062%. X-ray radiography was done for the same organs and dose calculations were shown in (Table 4). The comparison between the patient doses for both CT and X-ray was shown in (Table 5). For Neck, CT dose were 6.2 times higher than digital X-ray at tube voltage 100 kV. A comparison of present measurement with internationally recognized data for CT doses is presented in (Table 6). It is difficult to compare the present data with reference data since almost each study has considered the different phantom or irradiation conditions. Though the measured CT doses were found much higher than X-ray but the fact of assurance is that, it is still within the prescribed range. The proper risk of fatality from CT is a burning context of dispute. Accurate carcinogenic risk from low doses of ionizing radiation involves uncertainty. Although it is generally well accepted that there is a meaningful risk from doses greater than 100 mSv, there is debate regarding the risk from lower doses [19,20] but still this is a probability of low dose cancer risk by ICRP-99 [21].

Conclusions

Radiation exposure to the patients undergoing medical diagnostic procedure is one of the greatest contributors to the radiation dose received by human body [22]. The Computed tomography (CT) provides valuable information in medical diagnostic imaging techniques that undoubtedly has been beneficial for patients, but radiation exposure is an important issue in CT technology because of the vulnerable impact of ionizing radiation on the organs [23]. Mainly The present work concentrates on the study of measurements of CT doses and then estimation of fatal cancer risk. According to the estimation by the International Agency for Research on Cancer (IARC), the cancer-related death rate in Bangladesh will increase to 13% by 2030 [24]. To realize the effect of exposure deeply both male and female patients should be taken in consideration but in this research only male human phantom has been used. Different dosimeters, dose and risk calculators and different human phantoms have been used worldwide. In our experiment, Alderson Rando is used which is an adult and male phantom of fixed geometry so patient size, mass and associated facts are out of consideration. It is observed from the present research that cancer risk factors are found greater for younger patients than older ones and double exposure from a CT scan has almost double probability of Cancer than single exposure. The radiation dose levels imparted in CT overcome those from conventional radiography. The results of this study would be beneficial to minimize patient radiation doses and would be used as the value for the quality assurance in optimizing the patient dose in radiology examination.

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References

1. Thierry Chef I, Dabin J, Friberg EG, Hermen J, Istad TS, et al (2013) Assessing Organ Doses from Pediatric CT scans-A Novel Approach for an Epidemiology Study (the EPI-CT Study). Int J Environ Res Public Health 10(2): 717-728.
2. Pearce MS, Salotti JA, Little MP, McHugh K, Lee C, et al (2012) Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: A retrospective cohort study. Lancet 380(9840): 499-505.
3. (2019) Radiological Society of North America, Inc. (RASNA) Radiation Dose in X-Ray and CT Exams, Reviewed 1-5.
4. (2007) International Atomic Energy Agency (IAEA); Dosimetry in Diagnostic Radiology: An International Code of Practice, Technical Reports Series 457.
5. Fujibuchi T, Kato H, Hashimoto M, Abe Y, Kikawa T (2006) Characteristic evaluation of a real-time silicon dosimeter and measurement of entrance surface dose at radiography. Nihon Hoshasen Gijutsu Gakkai Zasshi 62(7): 997-1004.
6. Sorop I, Dadulescu E (2011) Assessment of entrance surface doses for newborn babies with an intensive care unit. Roma Rep Phys 63(2): 401-410.
7. World Health Organization (WHO) Cancer (March 2021).
8. González ABD, Darby S (2004) Risk of cancer from diagnostic X-rays: estimates for the UK and 14 other countries, The Lancet 363(9406): 345-351.
9. Ranallo FN (1998) Recommended standards for the routine performance testing of diagnostic x-ray imaging systems, IPEM Report No 25(8): 1556-1557.
10. User manual Step Sensortechnik und Elektronik Pockau GmbH, X-ray and gamma ray dosimeter: Polimaster.
11. (2021) User manual Kermax plus Tino, IBA Dosimetry GmbH.
12. (2007) International Commission on Radiological Protection (ICRP), The 2007 Recommendations of the International Commission on Radiological Protection; ICRP publication no 103, Ann ICRP 37 (2-4): 1-332.
13. Hart D and Wall BF (2002) Radiation Exposure of the UK population from Medical and Dental X-ray Examinations, National Radiological Board (NRPB-W-4) Report :1-41.
14. Deak PD, Smal Y, Kalender WA (2010) Multi-section CT Protocols: Sex and age-specific conversion factors used to determine effective dose from Dose Length Product. Radiology 257(1): 158-166.
15. American Society of Radiologic Technologist (ASRT); X-ray Risk, Radiation and Medical Imaging.
16. (2008) American Association of Physicists in Medicine (AAPM); The measurement, reporting, and management of radiation dose in CT, Report of AAPM Task Group 23 of the diagnostic imaging council CT committee, Report No 96.
17. Eugune C and Lin MD (2010) Radiation Risk from Medical Imaging, Mayo Clin Proc 85(12): 1142-1146.
18. Tsapaki V, Kottou S and Papadimitriou P (2001) Application of European Commission reference dose levels in CT examinations in Crete, Greece, Brits Jour of Radio 74: 836-840.
19. Brenner DJ, Doll R, Goodhead DT, Hall EJ, Land CE, et al (2003) Cancer risks attributable to low doses of ionizing radiation: assessing what we really know, Proc Natl Acad Sci USA 100(24): 13761-13766.
20. Dauer LT, Brooks AL, Hoel DG, Morgan WF, Stram D et al Review and evaluation of updated research on the health effects associated with low dose ionizing radiation, Radi Prot Dosi 140(2): 103-136.
21. (2005) The International Commission on Radiological Protection (ICRP); Low-dose extrapolation of radiation-related cancer risk, Annals of ICRP, ICRP Publication 99, Elsevier, 35(4).
22. Colang JE, Killion JB, Vano E (2007) Patient dose from CT: A literature review, Radiologic Technology 79(1): 17-26.
23. Vafaei A, Khosravi N, Barjouei NS, Gholizadeh N, Sadeghi AO, et al. (2019) Radiation organ dose measurement and cancer risk estimation in CT examination on trauma patients, Mid East Jour Canc 10(3): 206-213.
24. Hussain SA, Sullivan R (2013) Cancer control in Bangladesh. Japan J Clin Oncol 43(12):1159-1169.