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RESEARCH ARTICLE

PARENTAL AWARENESS - A PIVOTAL FACTOR FOR UNNECESSARY EXPOSURE OF CHILDREN TO HIGH ENERGY IONIZING RADIATIONS

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ABSTRACT

Background: The increased use of high energy radiations for diagnostic purposes is linked to many benefits and oncological risks among children. Parents and clinicians are the ones who primarily decide the treatment regimen for the pediatric patients. Because of unawareness, the parents insist the clinicians order radio imaging leading to unnecessary exposure of children to high energy radiations. The study was conducted as there is a paucity of information regarding parental awareness on the exposure of children to high energy radiations.

Aims: To find out the effect of parental awareness on the preventable exposure of children to high energy radiations.

Settings and Design: This population-based cohort study was conducted on 208 parents of children who presented to the OP or ED for any medical reason in a Tertiary Care Teaching Hospital in Riyadh, KSA.

Methods and Material: Tool by Kathy *et al*., 2013, [1] with prior written permission to reproduce, was modified to suit the study population was used to assess the parental awareness about the post-exposure risk of radiation to children.

Statistical analysis used: Data was analyzed using SPSS and relevant statistical tests were conducted.

Results: Majority of the parents (> 90 percent) was unaware of the consequences of unnecessarily exposing their children to high energy radiations and unnecessarily insists for radiographs. A Large proportion of the parents were unwilling to go for radiological examinations if they were informed about the risks.

Conclusions: Parent's awareness about the post-exposure risks significantly influences the decision for radio imaging.

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INTRODUCTION

The High resolution images with precise anatomical details steered significant increase in the use of Computed Tomography for diagnostic purpose (Brenner *et al*., 2001). CT imaging involves exposure to ionizing radiations of varying doses. These radiations can cause tissue damage leading to the production of free radicals that can damage the DNA resulting in alteration of genetic coding, leading to hereditary changes or cancer induction. Recent estimates of radiation exposure from imaging procedures in a large population of adults aged 18-64 years over a three-year period indicated that 19.4 percent were exposed to yearly effective dose ranging from 3-20mSv, 1.9 percent were exposed to 20-50mSv, and 0.2percent were exposed to over 50mSv (Wakeford, 2004).

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It was also reported that there is increased risk of developing cancer from a radiation exposure of 50-100mSv. The oncogenic effects of ionising radiations on children are higher owing to increased cell mitosis in their organs and tissues (Pierce *et al*., 2012). It is also due to the wider and increased cellular distribution of red bone marrow (Preston *et al*., 2012; Huda, 2002). The dose of radiation received by children are about 50 percent higher than those received by adults for the same acquisition protocols due to small body size and related attenuation. Mohiy *et al*. (2012); (Pearce *et al*., 2012) found that there was significant difference in radiation doses for the examinations of head, chest and abdomen of children aged 3-6 years in public paediatric hospitals in Australia and in KSA. The radiation doses used in KSA ranged from 27.6 to 197 mGY-cm and was significantly higher than that of Australia. Earlier studies (Lam, 2006) have warned that the use of CT >50 mGy in children might triple the risk of leukaemia and brain tumour later in life. Thirty three percent of all paediatric CT examinations are in children aged ten years or younger

(Applegate and Cost, 2012) who were incompetent to make decisions with respect to medical diagnostics and treatment as per World Medical Association[10].In such circumstances; the parents along with the clinician are the major decision makers. Shared decision making under similar conditions mainly depends on the awareness of the consequences and risk factors associated with exposure to even low doses of ionising radiations. In Saudi Arabia there is paucity of data on parental awareness to post exposure effects of ionized radiations on paediatric subjects. The specific objective of the study was to evaluate the cognizance of parents of paediatric patients with respect to the potential health risk of utilizing the ionised radiations for diagnosis and in medical interventional procedures.

Subjects and Methods

Locale of the study

The study was conducted in the paediatric outpatient clinic and emergency department of the 400 bed tertiary care teaching hospice in Riyadh province of KSA.

Selection of subjects

With approval from institutional review board, parents of the paediatric patients who presented to the outpatient or emergency department for any medical reasonduring the month of August /2015 were selected for this population based cohort study. Those parents who were not willing to provide written consent and those who were illiterate were excluded from the study. The awareness of the selected parents with respect the post exposure effects of ionizing radiations was assessed and those whose children underwent different imaging techniques were re sampled to form a subsample. The subjects in the sub sample who claimed that they knew about the ionizing radiations were sampled out to form the micro sample and were further followed up and evaluated to identify the major deciding factor for undergoing medical imaging which involves high energy radiations.

Tools and data collection techniques

The instruments used by Kathy *et al*. (Boutis *et al*., 2013). were adopted after written consent from the authors and were modified to suit to Saudi Arabian settings and to meet the objectives of the present study. At most care was given to safeguard cultural sensitivity. Focus was given to queries relating to cranial exposure of ionised radiations on paediatric patients along with demographic and personal characters and history of exposure to ionised radiations. The suitably structured and self-administered questionnaire with 23 closed questions was translated into Arabic and was validated for content and reliability by doing test- retest for reliability. The questionnaire was administered to the selected respondents after obtaining written informed consent. Parental awareness as a pivotal factor for exposure to ionizing radiations was assessed by considering the answer to the question about the degree of willingness of the parent to expose his/her child even if there is no need as per the clinician to conduct skull x ray. The need for providing awareness about post exposure risks of high energy radiations was studied by using five point Linkert scale administered to all the respondents selected for the study.

Analysis of Data

The collected data was compiled in spreadsheets with the use of pre-set numerical codes and it was edited to eliminate data errors and biases. The responses were summarized by using descriptive statistics. Categorical variables were summarized and reported as percentages and frequencies. Association between various parameters was done by using chi square test. All analyses were done using SPSS (version 16) for Windows (IBM SPSS Statistics, IBM Corporation, Armonk, NY).

RESULTS

For the study 208 parents had were enrolled, 56.2 percent of them were enrolled from Pediatric Emergency room and 43.8 percent from outpatient clinic.

Demographic features of the respondents

Saudi nationals formed the major portion (95.65 percent) of the respondents. Nationalities from other Arab countries formed 4.35 percent of the respondents. The demographic features of the respondents are detailed in Table 1.

Table 1. Demogrphic profile of the respondents (n=208)

Demographic profilen(%)	
Age	
18-30	101 (48.56)
30-50	100 (48.08)
>50	7 (3.36)
Gender	
Male	69 (33.17)
Female139 (66.83)	
Level of education	
Grade school (completed up to a maximum of 6)	20 (9.62)
High school (completed up to a maximum of grade 12)	80 (38.46)
University or college 108 (51.92)	
Nationality	
Saudi	199 (95.67)
Non –Saudi	9 (4.33)

Educational status of the respondents indicated that they had college level (51.92percent), high school level (38.46percent) and grade school level of education (9.62percent).

Awareness of the respondents about lifetime cancer risk

Awareness of the respondents with regard to lifetime cancer risk is provided in Table 2.From the table, it was observed that 57.21 percent of the respondents do not know about the lifetime cancer risk of CT while 53.80 percent of them were unaware about the cancer risk of Cranial X rays.43.79 percent of the respondents knew about the risk of brain CT with levels ranging from negligible to moderate risk levels whereas 46.2 percent of them indicated various risk levels for Cranial X rays.

Table 2. Awareness of the respondents with respect to lifetime cancer risk (N=208)

Lifetime cancer risk*	Details of respondents**	
	Responses by the respondents	
	Computed Tomography	X ray
Negligible risk(About 1 in 1000,000)	15 (7.20)	19(9.10)
Minimal risk(About 1 in 100,000)	27(12.96)	33(15.90)
Very low risk(About 1 in 10,000)	18 (8.64)	20(9.60)
Low risk(About 1 in 1,000)	16(7.68)	13(6.30)
Moderate risk(About 1 in 500)	13(6.34)	11(5.30)
Don't know about the risk	119(57.21)	112(53.80)
Total	208(100)	208(100)

**Source:www.radiologyinfo.org/en **Numbers in parenthesis indicate percentage*

Table 3. Parent's awareness about high energy ionizing radiations and cancer risk

Particulars of the question and responses Details of the respondents(n_2=69)*		
a. Awareness about differentiation of radiological investigation that their children undertook		
Differentiated X ray and CT	11 (15.90)	
Unaware about the difference	58 (84.10)	
b. Awareness about the equivalency of high energy ionizing radiations with that of Natural radiation from Sun**X Ray CT		
Natural radiation of less than a day	7 (10.14)10 (14.49)	
Natural radiation of few days	5 (7.24)[a] 4 (5.80)	
A couple of weeks	1 (1.45)	2 (2.90)
Natural radiation of 1 month	2 (2.90)	2 (2.90)
Natural radiation of 6 - 8 months	3 (4.35)	4 (5.80)[a]
Natural radiation of 3 – 4 years	3 (4.35)	1 (1.45)
Do not aware about the equivalency	48 (69.56)	46 (66.66)
c. Awareness about potential risk of cancer from high energy radiations** X RayCT		
Negligible risk(About 1 in 1000,000)	6(8.70)[a]	4(5.80)
Minimal risk(About 1 in 100,000)	12(17.40)	19(27.55)
Very low risk(About 1 in 10,000)	11(15.95)	12(17.40)[a]
Low risk(About 1 in 1,000)7	(10.15)	3(4.35)
Moderate risk(About 1 in 500)	6(8.70)	5(7.24)
Don't know about the risk	27(39.10)	26(37.70)

**Numbers in parenthesis indicate percentage ** *Source:www.radiologyinfo.org/en*

[a] *most correct estimate*

Table 4. Influence of parent's awareness on exposure of children to high energy radiations

Particulars	Details of responses(n=69)*	
	Yes	No
a. Going through the radiological tests even after knowing the post exposure risks to children	15(21.70)	54(78.30)
b. Parents insisting for radio imaging even if it is not required	30(43.48)	39(56.52)

**Numbers in parenthesis indicate percentage*

Table 5. Need for the provision of awareness about post exposure risks of high energy radiations

Responses with respect to the need for Pre exposure awareness about Post exposure risks		Details of the respondents*		
		N(208)**	n_1 (128)***	n_2(69)****
a.	Strongly Needed	147(70.70)	92(71.90)	47(68.10)
b.	Needed	33(15.90)	21(16.40)	12(17.40)
c.	Neither needed nor Not needed	5(2.40)	4(3.10)	4(5.80)
d.	Not needed	1(0.50)	01(1.40)	
e.	Do not know whether Needed or not	22(10.60)	11(8.60)	5(7.20)

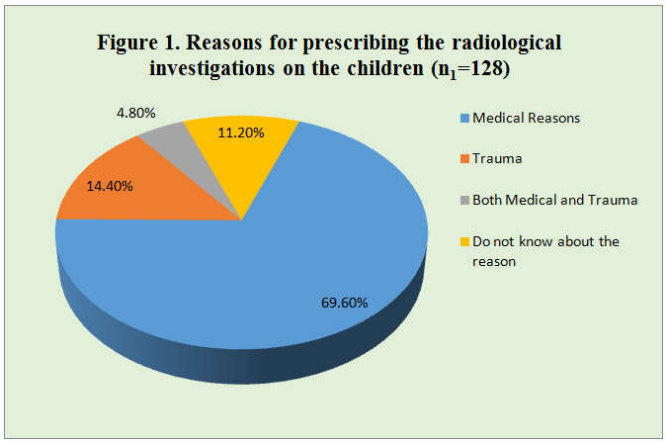
Numbers in parenthesis indicate percentages;Total Population of the study ;*** Those whose children had undertaken high energy radiations prior to the study; **** Those whose children had undertaken high energy radiations prior to the study and indicated that they have knowledge about high energy radiations.*

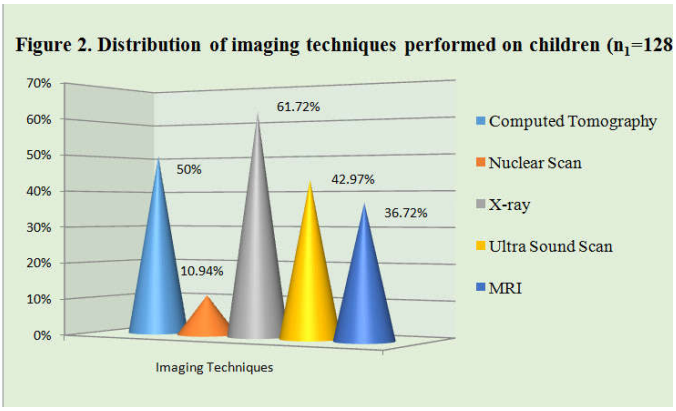
The children of 66.80 percent ((n_1 =128) of the selected respondents underwent various radio imaging procedures such as Computed Tomography, Nuclear Scan and X rays. They had also experienced with Magnetic Resonance Imaging and Ultra Sound imaging. The respondents reported various reasons for prescribing the radiological investigations on their children such as medical reasons, trauma, both medical and trauma reasons. Reasons for prescribing the radiological investigations on the children are shown in Figure 1. As detailed in the figure 11.20 percent of the respondents do not know about the exact reason for conducting radiological investigations on their children. Figure 2 details the distribution of imaging techniques performed on the children. From the figure it was observed that exposure to X rays is more frequent (61.72 percent) among the children than other methods such as computed tomography(50 percent) and nuclear scan (10.94 percent).

Parents' awareness about potential cancer risks of post radiation exposure

About53.90 percent (n_2=69) of the parents whose children underwent various imaging techniques indicated that they had knowledge about potential cancer risks of post radiation exposure formed the micro sample of size 69.Awareness of the respondents from the micro sample about high energy ionizing radiations and lifetime cancer risk for X ray compared to CT is provided in Table 3. On detailed evaluation, it was observed that the majority of the respondents (84.10 percent) from the micro sample, who indicated that they had knowledge about the ionizing radiations from X ray and CT was unaware about the difference between X ray and CT and the equivalency of high energy ionizing radiations such as x ray (69.56 percent) and CT (66.56 percent) with that of natural radiation from the sun (Table 3). About 10.19 percent and 28.99 percent respectively underestimated the equivalency of high energy radiations from X ray and CT as of the natural radiation of less than a day. The percentage of respondents who overestimated the equivalency of high energy radiations with that of natural radiation from sun formed 13.05 percent and 1.45 percent respectively for X rays and CT. Evaluation about the awareness of potential post exposure risk of high energy radiations from X ray and CT none under estimated the risk of X ray while 33.35 percent of the micro sample underestimated the potential cancer risk from CT. About 52.20 percent and 11.59 percent respectively of the

micro sample overestimated the potential cancer risk from X-rays and CT for children.





Influence of parent's awareness on exposure of children to high energy radiations

Table 4 indicates the influence of parent's awareness on exposure of children to high energy radiations. As per Table 4the respondents opined that they (78.30 percent) don't go through the radiological tests if they knew about the post exposure risks to children and 56.52 percent do not insist for radio imaging if it is not required. Chi square test indicated that parent's awareness about the post exposure risk significantly (χ^2_1= 17.52; p=0.001**)** influence their decision to undertake unnecessary radio imaging techniques for their children.

Need for providing awareness about post exposure risks of high energy radiations

Assessment of need for the provision of awareness about post exposure risks of high energy radiations before exposing the children to ionizing radiations for medical purpose is detailed in Table 5. The majority of the respondents (86.60 percent of the total population, 88. 30 percent from the subsample and 85.50 percent from the micro sample)felt that there is need for the provision of awareness about post exposure risks of high energy radiations to the children so that they can avoid unnecessary exposure. Chi square analysis of the data indicated that there is no significant difference between the respondents with respect to their strong demand for disclosing the details with respect to post exposure cancer risks of high energy radiations to the children (χ_8^2= 5.997; p=0.648).

DISCUSSION

The medical investigations based on high energy radiations among children have increased tremendously worldwide (Huda, 2002). The different types of imaging procedures have led to improvements in the diagnosis and treatment of numerous medical conditions. In the meantime, these types of exams expose patients to ionizing radiations, which may elevate a child's lifetime risk of developing cancer. (Larson *et al*., 2007) Hence, care should be taken to weigh the medical necessity of a given level of radiation against the risks (FDA, 2010). If proper precautions are not taken, patients may be exposed to radiation without clinical need. Elkhadir *et al* (2016) in 2016, found that 71.60 percent of the children underwent CT-brain do not confirm the reasons for exam and hence the children were given unnecessary exposure to radiation. Parental unawareness is one of the major factors leading to unnecessary exposure of ionizing radiations among children. The present population-based cohort study was an attempt to find out the effect of parental awareness on the preventable exposure of children to high energy radiations. The results of the study indicated that regardless of the level of education of the parents, more than 90 percent of the total population does not have awareness about lifetime cancer risk of CT and x ray to children. About 90.38 percent of the parents had the education from high school level to university or college level of education.

Studies done in the similar context in other geographical locations like Canada indicated that about 50 percent of the parents were unaware that ionizing radiations can increase a child's lifetime malignancy risk[1].The present level of prevalence of Arab parental awareness of the potential risk of cancer associated with CT can be equated with the situation in 2004 in European countries where Lee *et al* reported that 97 percent of the population were unaware. Another study by Larson *et al*[11] 87 percent of the respondents was unaware about possible malignancy risks. Since there is a lack of literature with respect to the awareness of cancer risks associated with high energy radiations among Arab parents, the present study may be a platform for discussing the issue in coming years. It was observed that the majority of the children were exposed to high energy radiations due to medical reasons and X-rays and computed tomography formed major imaging techniques performed on children. Even though 53.90 percent of the parents whose children were exposed to high energy radiations were claimed that they knew well about CT and X-ray, the majority of them were unaware about X-ray and CT and the equivalency of high energy radiations with that of natural radiation from the sun. The results of the study were on par with that of Katty *et al*. (Boutis *et al*., 2013), in that, the parents have a limited sense of the relative difference between X-rays and CT. This can result in an inappropriately equal level of concern about radiation exposure and potential malignancy risk when a physician recommends radiographs or CT. About 43.48 percent of the parents whose children have exposure to high energy radiations opined that they will insist the physician to order radiological examination even if it is not required as per medical opinion. In other words, their children were unnecessarily exposed to high energy radiations because of the parental decision due to unawareness. It was also found that 78.30 percent of the parents were not willing for radio imaging after getting awareness about post-exposure risks. Hence, the parent's awareness about the post-exposure risks significantly influences the decision for radio imaging. Approximately, more than 85 percent of the parents participated in the study would prefer to be informed about possible risks before their children undergo CT or radiographic examinations. In conclusion, even though there are many factors which can lead to unnecessary

exposure of high energy radiations to children, decisions due to parental unawareness about the possible risk of CT and X ray may make the parents to insist on the physician to order CT or X ray for their children. Since the children are incompetent to take decisions, parents along with clinicians had a major role in deciding the diagnostic tools and treatment regime for children. Hence the parents must be informed about the lifelong risks of malignancy, before exposing their children to ionized radiation. It should also be a part of medical ethics to be practiced.

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