# ASSESSMENT OF PERCEPTION OF EFFECTS OF RADIATION AMONG POSTGRADUATES AND CONSULTANTS OF KLE HOSPITAL, BELAGAVI

**By**

**REG NO: BS0120012**

# Dissertation

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*In partial fulfilment*

*of the requirements for the degree of*

**M.D.**

**IN**

**RADIO-DIAGNOSIS**

**DEPARTMENT OF RADIO-DIAGNOSIS,**

**JAWAHARLAL NEHRU MEDICAL COLLEGE,**

**BELAGAVI, KARNATAKA**

**JUNE/JULY – 2023**

**KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH BELAGAVI, KARNATAKA**

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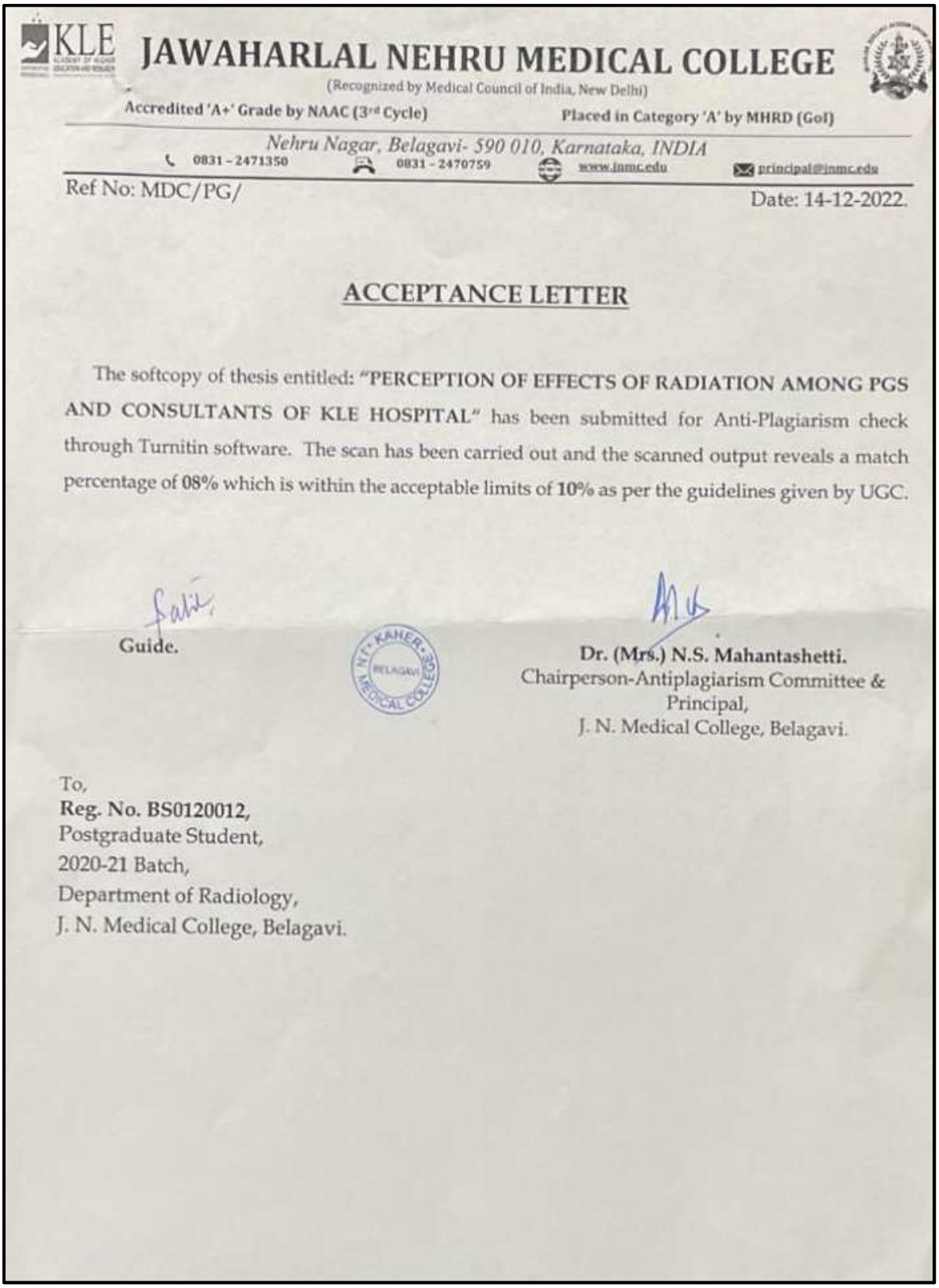

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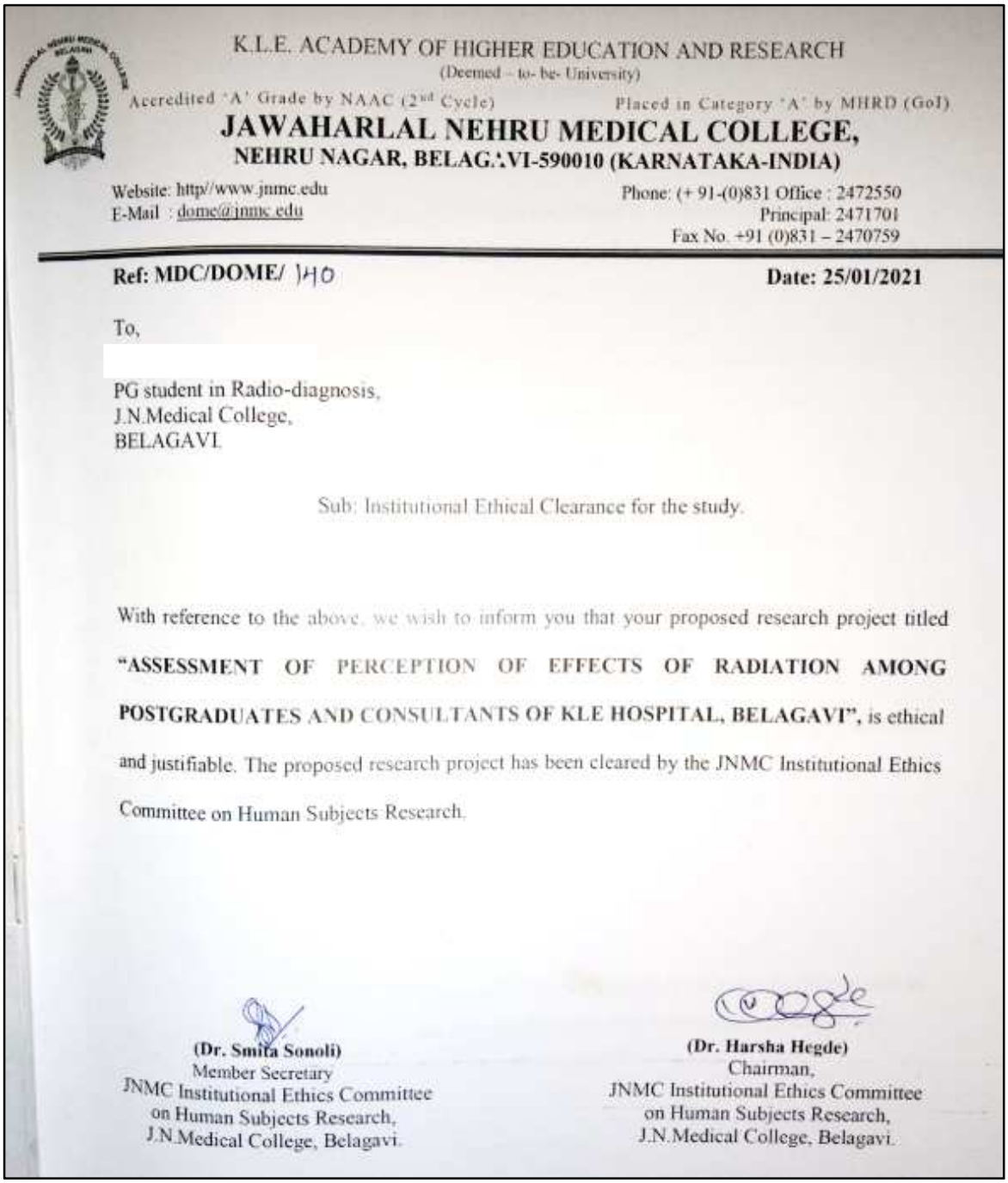

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# ABSTRACT

**BACKGROUND:** We observed that few research studies have also examined radiation safety awareness among healthcare professionals in Asia-Pacific countries. One such study, conducted among medical and dental practitioners in India found comparatively poor awareness about radiation hazards. Hence, the present study was conducted to understand the radiation awareness among consultants and postgraduates of KLE hospital and also to understand the need for improving the awareness.

**METHODOLOGY:** We had included 100 doctors working in the unit of radio-diagnosis. The preformed questionnaire including the basic demographic details of the participants and the questions related to knowledge, attitude and practice about various modalities of the radiology and protection from radiation was asked in the form of multiple-choice questions. All the participants had been requested to fill their valuable response.

**RESULTS:** Response rate of our study was 100%. Majority of them were aged between 36 to 45 years with male predominance. On analysing the occupation, we found that, Postgraduate students were the higher incidence (38%) of participants. The source of current knowledge obtained was widely varied. The knowledge about the radiation and risk of radiation was comparatively better among senior consultants and the above hierarchy than postgraduates and junior consultants. Rate of correct answers was higher among those updates their knowledge by CMEs and workshops.

**CONCLUSION:** Hence, there is need for regular educational programmes in order change the attitude and practice towards the risk reduction by radiation.

**KEY WORDS:** Radiation, Radiation safety, Doctors, Knowledge on Radiation safety.

## LIST OF ABBREVIATIONS

| | |
|---|---|
| ALARA | As-Low-As-Reasonably-Achievable |

| | |
|---|---|
| CT | Computerized topography |
| ICRP | International Commission on Radiological Protection |
| kV | Kilo voltage |
| MRI | Magnetic resonance imaging |
| mSv | Millisieverts |
| μSv | Microsieverts |
| PG | Post graduate students |

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# INTRODUCTION

Radiation is energy movement that comes from radioactive sources in nature or from man-made. The major sources of human exposure to natural background radiation include cosmic rays, air, food or water. Man-made sources contribute to 18% exposure to ionizing radiation.[1,2]

Ionizing radiation is widely used in terms of X ray, computerized topography (CT), ultrasonography and Magnetic resonance imaging (MRI) to diagnose many diseases and relevant hazards are known to be as an important limitation of its application. This medical imaging is considered the 'eyes' of the medicine. [1]

It is believed that the awareness of ionizing radiation dose value is one of the main stages not only in patient radiation protection but also the healthcare workers. The widespread use of radiation for medical diagnosis ensures that diagnostic medical radiology represents by far the most significant man-made source of exposure to ionizing radiation for population in the western world and also the developing countries.[2,3]

The US National Council on Radiation Protection and Measurement had reported that medical X-rays and nuclear medicine account for 15% of all radiation exposures. In the UK, estimated 100-250 deaths occur each year from cancers directly related to medical exposure to radiation. [4]

It has been estimated that over 70% of the world population is exposed to medical X-rays annually, and about 95% of all man-made radiation is from diagnostic X-rays. [5]

Both ionizing and non-ionizing radiations are used for in medical practice. Several studies have demonstrated that exposure to medical radiation ranges from skin allergy to increase in the risk of bone marrow suppression, cataract, infertility, birth deformities, and several types of cancer, especially thyroid carcinoma.[6] The threshold dose varies across radiation-related diseases. For instance, 100–200 mGy is found to be associated with teratogenic effects and cancer, whereas 500 and more mGy is associated with cataracts. [7]

Hence, the awareness, knowledge and the attitude towards radiation hazards management and protective measures play an important role in reducing radiation exposure among healthcare workers.[7]

A general principle of radiation protection, proposed by the International Commission on Radiological Protection (ICRP), suggests that the radiation protection is based on three principles:

1. Justification
2. Optimization: Should be optimized to as low as reasonably achievable (ALARA) and
3. Limitation of the radiation dose.

Above are the foundation of radiation protection strategies.

Healthcare personnel's knowledge about radiation hazards and protection has been tried to study extensively but there are inconsistent and unsatisfactory observations across different medical subspecialties. Based on a reported cross-sectional study, Nigerian radiologists, radiotherapists and dentists have been found to

demonstrate satisfactory levels of knowledge about radiation hazards and the use of personal protective devices. [8]

This could be contrasted against the findings of another study that was conducted among paediatric residents and fellow students in Italy. The study reported that only 27% of the participants correctly answered questions that assessed knowledge about radiation protection such as ALARA. In those studies, most of participants of the Nigerian study had been working in a radiology department, while the Italian study participants were paediatric residents and fellows.[10]

These contrasting findings might be attributable to differences, not only between the two study samples but also might vary with the demographic areas.

Research studies have also examined radiation safety awareness among healthcare professionals in Asia-Pacific countries. One such study, conducted among medical and dental practitioners in India found comparatively poor awareness about radiation hazards.[11]

Hence the present study was conducted to analyse the awareness of radiation and its hazards among the postgraduate students and consultants.

# OBJECTIVE

To understand the radiation awareness among consultants and postgraduates of KLE hospital and also to understand the need for improving the awareness

# REVIEW OF LITERATURE

## HISTORICAL DEVELOPMENT IN RADIOLOGY AND RADIATION TOXICITY

Radiation was discovered in the late 19th century. However, people were not initially aware of the damage radiation exposure and radioactive rays could cause. Acute effects of radiation exposure were first seen in 1896 when Nikola Tesla purposefully subjected his fingers to X-rays and reported that this caused burns to develop, although at the time he attributed the burns to ozone.[12]

The mutagenic effects of radiation were not realized until decades later. The genetic effects and increased cancer risk associated with radiation exposure were first recognized by Hermann Joseph Meller in 1927. Muller went on to receive the Nobel prize in 1946 for his research. Radiation poisoning was the cause of the aplastic anemia that eventually killed Curie.[12,13]

In 1932, a famous American socialite called Eben Byers died after ingesting large amounts of radiation over the course of several years. This death and many others among radiation enthusiasts sparked intrigue over the effects of consuming radiation-containing products and they were eventually removed from the market. The gravity of the effects caused by radiation were not fully understood until the 1940s.[14] Two scientists from the USA died in 1946 after working with fissile materials without using protective clothing or shielding. The Hiroshima bombing also caused wide-scale radiation poisoning and the actress Midori Naka, present during the bombing, was studied extensively for radiation poisoning. Her death in 1945 was the first to be officially documented as having been caused by radiation poisoning. At the time, this radiation poisoning was referred to as Atomic bomb disease.[15]

## RELEVANT DEFINITIONS

**Medical radiation:** Medical radiation refers to a procedure that is performed with the involvement of emitting radiant energy in the form of waves or particles.

**Radiation exposure:** Radiation exposure refers to being subjected to radiant energy in the form of waves or particles. Medical radiation exposure has a relevant biological effect on humans from being subjected to x-rays and gamma rays, which are secondary to ionization.[16]

The average radiations doses associated with radiographs (X ray) are very low and range from 0.001 mSv to 0.1 mSv. However, these doses could rapidly increase when multiple radiographs have to be taken. The average effective dose related to radiography has been steadily decreasing since the 1970s due to better X-ray equipment and improvement of radiation protection guidelines.[17]

The average effective dose due to CT examinations is by far the highest. The radiation dose varies between 2.1 mSv and 31 mSv. On average, this is about 150 times higher than doses used in radiography examinations. Furthermore, these doses are very dependent on the settings that are used during CT examinations[18]. Radiation doses increase with increasing field of view (FOV), tube voltage (kV), and the tube current-exposure time product (mAs). Furthermore, multiple scans are often required during patient follow-up, which causes the radiation burden to increase rapidly. The average effective dose related to CT examinations has been increasing, and is now about six times higher than in the early 1970s.[19]

Dose optimization is directly linked to the ‘as-low-as-reasonably-achievable’ (ALARA) principle. It focusses on minimizing radiation exposure to the patient. Thus,

the IR dose that is used should be balanced between ALARA and the required image quality for the intended use. The IR dose, as well as the image quality, mostly depend on the FOV, kV and mAs.[20]

## TYPES OF RADIATION USED

### Ionizing radiation[21,22]

- Ionizing radiation has many beneficial applications. These are used in medicine, industry, agriculture and research. With increasing uses of ionizing radiation there is a need of safe use policies and practicing safety measures.
- The population radiation dose contribution from all artificial sources from medical uses is 98%. This represents 20% of the total population exposure. Annually more than 3600 million diagnostic radiology examinations are performed, 37 million nuclear medicine procedures are carried out, and 7.5 million radiotherapy treatments are given worldwide.
- Not all medical imaging uses radiation. Ultrasonography and Magnetic resonance imaging are safe. X-ray films, Angiography/fluoroscopy, Computed tomography, Nuclear medicine (including positron emission tomography) imaging modalities are risky and should be used only when benefits outweigh the risks.
- Radiation damage to tissue and/or organs is radiation dose dependent. The international (SI) unit of measure for absorbed dose is the Gray (Gy). The various factors for potential damage from an absorbed dose are the type of radiation and the sensitivity of different tissues and organs.
- Equivalent dose is the measure of the biological effect, which depends on the amount of the absorbed dose & the sensitivity in living cells caused by

different type of radiations. The unit of equivalent dose is the Sievert (Sv). Practically smaller units such as millisieverts (mSv) or microsieverts (μSv) are used.

***The typical effective doses in various imaging modalities in mSv are:***

(i) X-ray examinations- Limbs and joints <0.01, Chest (PA) 0.015, Abdomen 0.4, Lumbar spine 0.6

(ii) Computed Tomography (CT) scans- head 1.4, chest 6.6, abdomen/pelvis 6.7

(iii) Radionuclide studies- Lung ventilation 0.4, Lung perfusion 1, Bone 3, PET (Positron Emission Tomography) head 7, PET-CT 18.

All those ordering these should take into consideration these values, & especially decide on clinical impact of the investigation.

**RISK REDUCTION STATEGIES FOR IONISING RADIATION[22-26]**

Rationale use demands using radio-imaging only when definitely indicated. Hnec, it is always better to have awareness regarding few aspects of the radiations and follow the following strategies in order to avoid the risk;

- Decreasing unnecessary diagnostic radiation and still obtaining diagnostic images is an art, and needs to be perfected and practiced by all.
- Imaging modality correct selection is the responsibility of the ordering physician.
- CT is inferior to MRI as it does not detect as many abnormalities as MRI.

- MRI detects the subtle changes in detail. CT involves ionizing radiation, while MRI does not. Therefore, appropriate decisions should be made. Other clinical dictum is to not to order radio-imaging if report not likely to affect management.

- Reducing radiation exposure is multi-faceted. CT contributes for 24% of all radiation exposure and uses almost half of manmade radiation.

- Hence in CT scans the scanning range should be limited to only the area pinpointed clinically. Multiphase scanning should only be judiciously used when necessary. The latest CT scanners provide images with greater detail, with multi-planar and reconstruction in 3-dimensions of the acquired data.

- Radiologist should tailor the examination for individual paediatric patients,[23] using the least parameters of exposure.

- Ultrasonography is safe, widely available, and accurate, and has significant potential for widespread clinical application.

- Dual-energy x-ray absorptiometry (DEXA) measures body tissue composition, and is a useful technique for monitoring long-term nutritional progress.[24,25]

- Quantitative ultrasound (QUS) is a useful technique with potential to replace DEXA scans for osteoporosis.

- It has been usefully demonstrated that quantification of muscle wasting in intensive care patients by a limited bedside ultrasound examination predicts total body composition. The reliability of this, both intra & inter operator, is excellent.[26]

## NON-IONISING RADIATION

Radio waves & micro-waves are used primarily in TV broadcasting, tele-communications including mobile phones, & radar for air/sea navigational aids. Ultra-Violet radiation from sun needs special consideration especially for our troops. UV radiation has been the part of diagnostic as well as therapeutics in the field of medicine.

## RADIOWAVES[27,28]

Mobile phone use is ubiquitous. With increasing use the electromagnetic (EM) fields produced by mobile phones use needs consideration.

- **Short-term effects:** Non-ionizing radiation is the part of the EM spectrum which does not has sufficient energy to cause ionization. The frequencies which mobile phones use is low, and most of this energy is absorbed by the skin and other superficial tissues. The rise in temperature in the brain or any other organs of the body is negligible. The effects of radiofrequency fields on brain electrical activity, cognitive function, sleep, heart rate and blood pressure has been investigated by a number of studies in volunteers.

- Till date, there is no consistent evidence of adverse health effects if exposure to radiofrequency fields is at levels below those causing tissue heating. Further, research has not been able to provide support for a causal relationship between exposure to EM fields and self-reported symptoms, or "EM hypersensitivity"

- **Long-term effects:** Epidemiological research studying potential long-term risks from radiofrequency exposure has been mostly towards brain tumours and mobile phone use. The largest study till date has been Interphone, carried

out retrospectively as case-control study on adults, and coordinated by the IARC.

- Design was to determine whether there are links between use of mobile phones and head and neck cancers in adults. Based largely on these data, IARC has classified radiofrequency EM fields as *possibly* carcinogenic to humans (Group 2B), a category used when a causal association is considered credible, but when chance/bias/confounding cannot be ruled out with reasonable confidence.[27,28]

## HEALTH RISKS ASSOCIATED WITH MEDICAL DIAGNOSTIC PROCEDURES

### EFFECT OF RADIATION ON CELLS[29]

As we all know, Radiation therapy was initiated in 1895 with the discovery of X-rays by the physicist Wilhelm Conrad Roentgen. It has been widely used for diagnostic and therapeutic purpose. Radiation therapy is a highly effective tool in cancer treatment widely used for a variety of malignant tumours. Approximately 50% of all cancer patients undergo radiation treatment, resulting in a cure rate of about 40%.

Radiation is used to destroy tumour cells with high physical energy sufficient to overcome the electron binding energy at an atom or a molecule. The ionizing radiation used for cancer treatment is largely based on the rationale that rapidly proliferating cancer cells are more sensitive to DNA damage responses than normal cells. [30,31]

Normal cells neighbouring the tumour inevitably receive a considerable dose of ionizing radiation. This exposure can cause damage to healthy tissues, which may appear immediately or later, if the patient survives. Although radiation therapy prolongs patient survival, normal tissue damage caused by radiation remains an important clinical concern.

It is therefore important to address or prevent cell cytotoxicity from normal tissue damage because the severity of radiation-induced toxicity can be worse than the initial lesions treated. The pathogenesis of normal tissue response to radiation is complex and involves different mechanisms such as DNA damage repair, cell death, inflammation, angiogenesis and matrix remodelling, depending on the radiation dose and time course. [32]

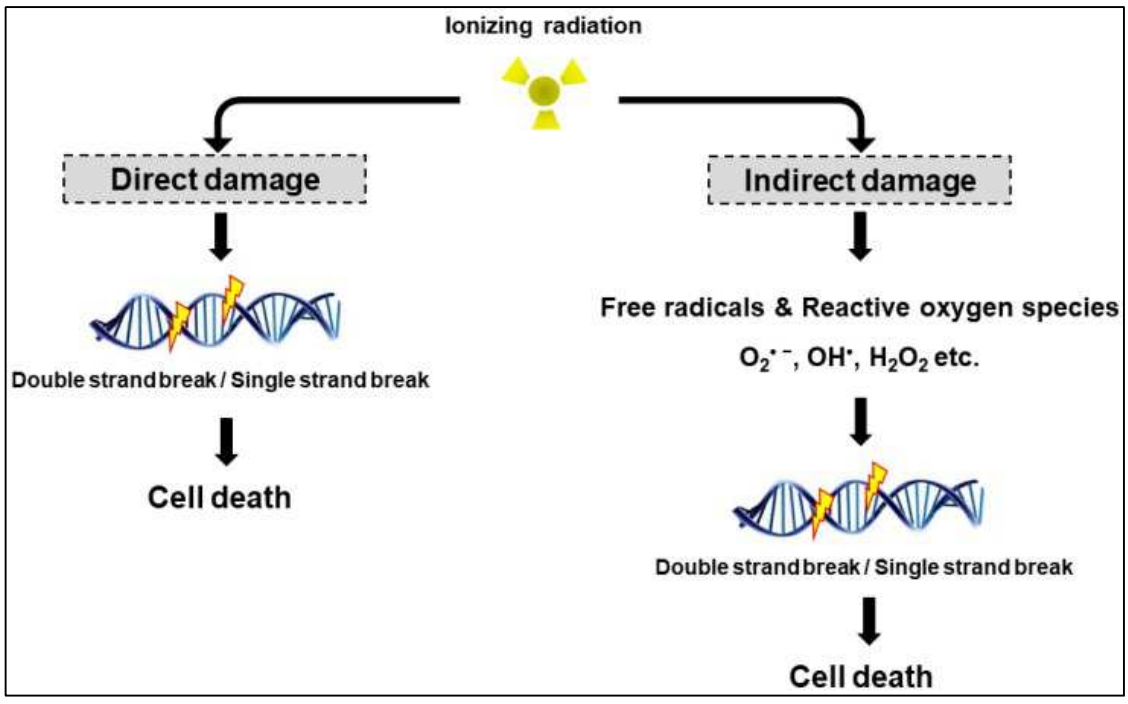



**Figure 1: Schematic representation of direct and indirect damage of DNA by radiations**

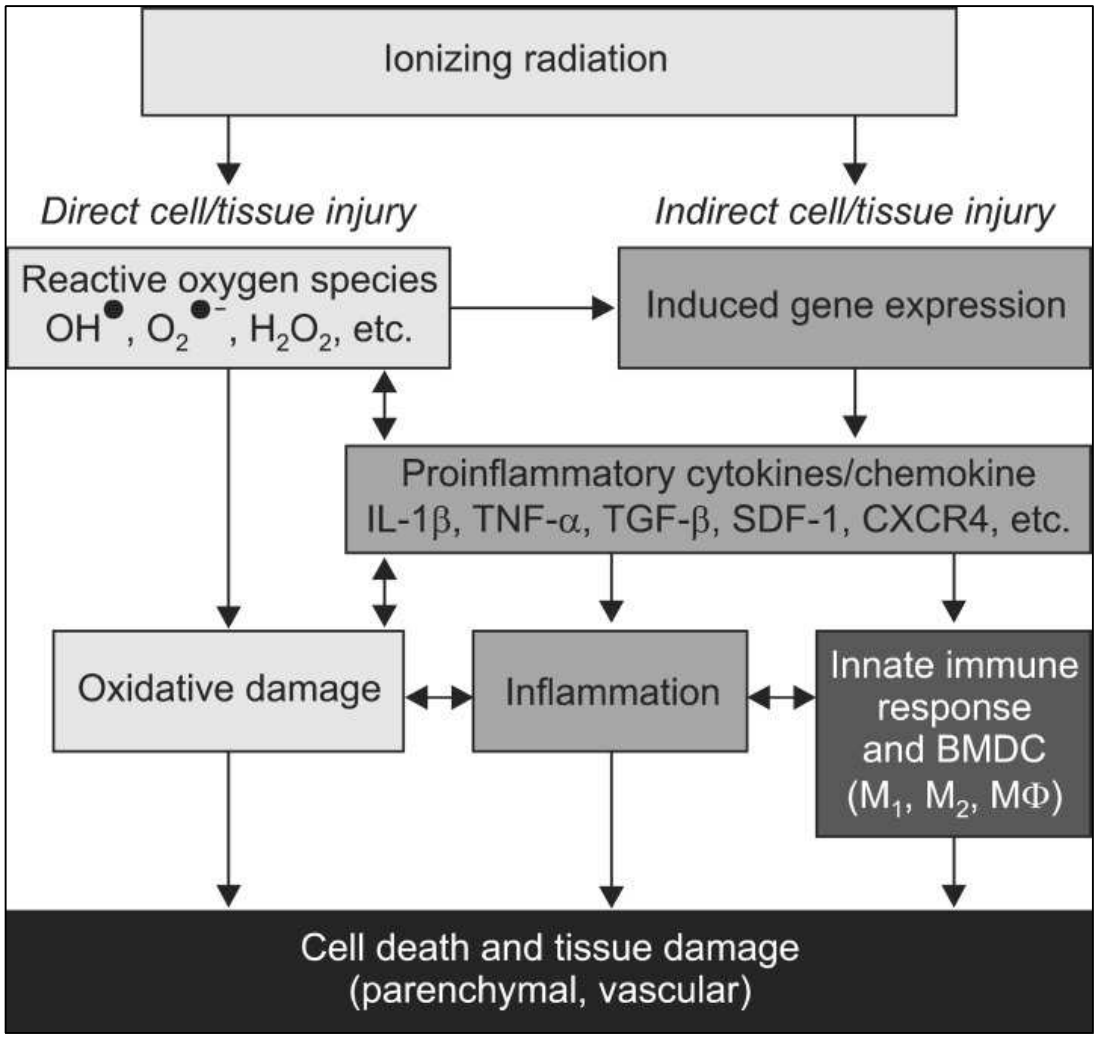



**Figure 2: Schematic representation of cell death and tissue damage**

Ionizing radiation causes cell death, both parenchymal and vascular, by multiple mechanisms. Historically, the direct cytotoxicity of radiation was the first identified pathway leading to tissue injury. More recently, another pathway involving inflammation has been identified. A third pathway has been studied in the last few years that implicates the innate immune response including bone marrow-derived cells (BMDC) and both $M_1$ and $M_2$ macrophage (MΦ) in resultant tissue damage. Arrows represent influence of one mechanism on another and suggest potential targets for interfering with the process.[33]

## EFFECT OF RADIATION ON SKIN

Acute radiation damage to the skin is manifested by early erythema and dry or moist desquamation, in part due to depopulation of the acutely responding basal epithelial cells. Such acute skin reactions usually subside over the course of time. However, some moist lesions subsequently progress into sub-acute and late phases of skin injury. Injuries to the skin may cover small areas but extend deeply into the soft tissue, even reaching underlying muscle and bone. The basal layer is repopulated through proliferation of surviving clonogenic cells; consequently, the symptoms that follow vary from dry desquamation or ulceration to necrosis depending on the radiation dose. Late effects, typically months to years post exposure, occur at doses greater than a single dose of 20-25 Gy or fractionated doses of 70 Gy or higher. [35,36]

The major underlying histopathological findings at the chronic stage include teleangiectasia, dense dermal fibrosis, sebaceous and sweat gland atrophy, loss of hair follicles, and with higher doses, increased melanin deposition or depigmentation and skin ulcers.

Although the specific cellular mechanisms associated with radiation-induced skin injury remain poorly understood, the pathologic effects seen in the irradiated skin are thought to result from the loss of stem and progenitor cells of the basal and dermal layers and multi-cellular interactions through a variety of inflammatory mediators leading to fibrotic processes.[36]

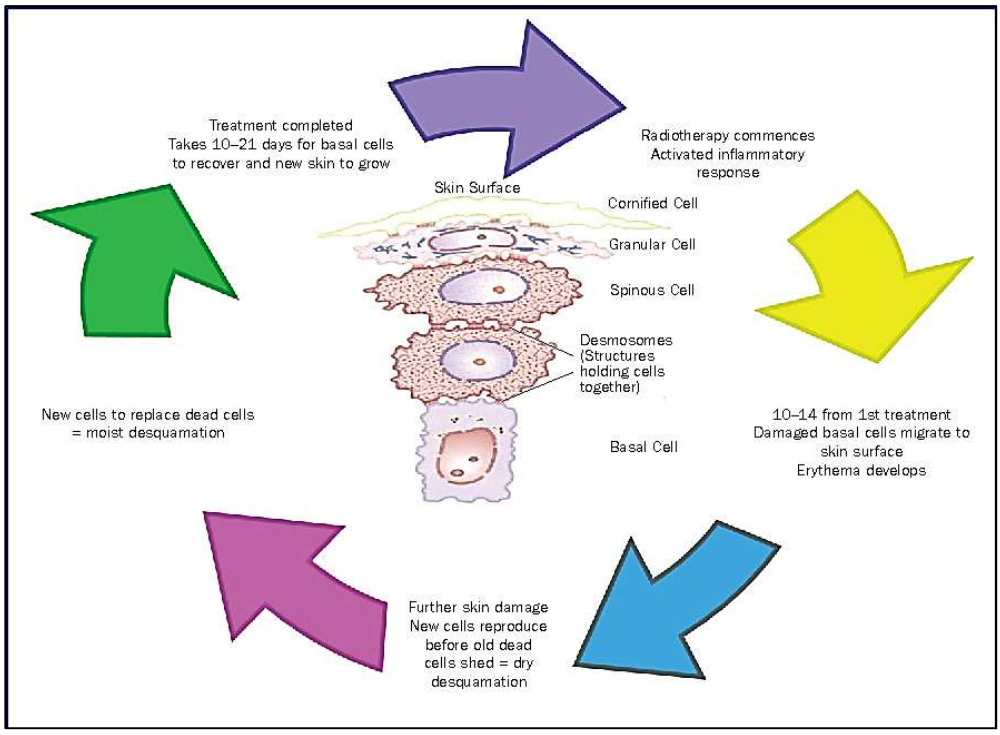
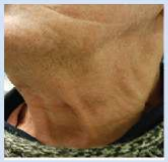
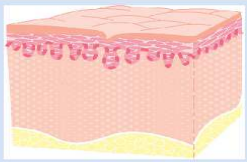
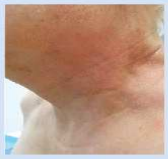
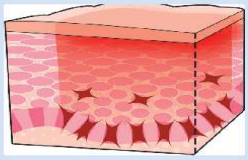
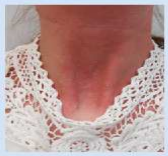
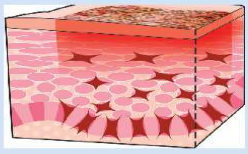
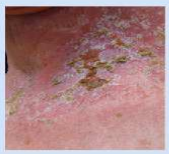
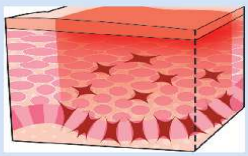
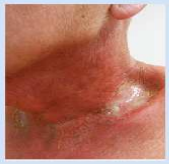
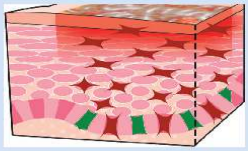



**Figure 3: Schematic representation of radiation induced skin injury**

| Assessment/observation | Effects of radiotherapy on skin cells | Rationale |
|---|---|---|
|  RTOG 0—no visible change to skin |  | To promote hydrated skin and maintain skin |
|  RTOG 1—Faint or dull erythema. Mild tightness of skin and itching may occur |  | To promote hydrated skin, patient comfort and maintain skin integrity. To treat itchy skin. To reduce pain, soreness and discomfort |
|  RTOG 2—Bright erythema/dry desquamation. Sore, itcy and tight skin |  | As RTOG 1 |
|  RTOG2.5—Patchy, moist desquamation. Yellow/pale green exudate. Soreness with oedema |  | To promote comfort. Reduce risk of complications of further trauma and infection. To reduce pain, soreness and discomfort |
|  RTOG 3—Confluent moist desquamation. Yellow/pale green exudate. Soreness with oedema |  | To promote comfort. Reduce risk of complications of further trauma and infection |
| RTOG 4— Ulceration, bleeding, necrosis (rarely seen) | | |

Images reproduced with permission from Audrey Scott

**Figure 4: Grading of radiation induced skin damage[37]**

## EFFECT OF RADIATION ON GASTROINTESTINAL DAMAGE

Symptoms and signs of radiation-induced gastrointestinal (GI) injury may occur during/or after radiotherapy. The most significant symptoms of acute GI toxicity include nausea/vomiting, diarrhea, increased stool frequency, decreased food intake, fluid and electrolyte loss, and abdominal and rectal pain. Chronic GI injury develops usually 3-4 months after the completion of radiation exposure. The symptoms vary from changes in the bowel habit, diarrhea, fecal incontinence, pain and blood loss, depending on the dose and volume of radiation exposure to the intestine.[38]

The intestinal epithelium is a highly regenerative tissue, fueled by multiple stem and progenitor cell populations at the base of the crypts of Lieberkuhn. The pathophysiology of GI injury involves dynamic interactions among the intestinal vasculature, epithelial stem cells and stromal elements including resident and infiltrating macrophages and mast cells. Microvascular injury, injury mediated by endothelial apoptosis, plays a significant and early role in the development of the acute phase of the GI injury. Vascular ischemia contributes to secondary enterocyte depletion, mucosal barrier breach, bacterial translocation, and structural damage of the intestine. Delivery of anticoagulant agents during and after high dose radiation exposure results in reduction of intestinal damage and accelerated epithelial regeneration.

The hallmark of the initial phase of GI injury involves the activation of ROS and their ability to stimulate transcription factors and pro-inflammatory cytokines, while the ulcerative phase is a manifestation of depopulation of the epithelial crypt stem and progenitor cells.[38,39]

## EFFECT OF RADIATION ON LUNG

Radiation-induced lung injury has generally been divided into 2 sub-syndromes: pneumonitis and chronic fibrosis. Pneumonitis is characterized by acute inflammation arising within the first 3 months of radiation exposure and carries a risk for significant pulmonary complications leading to respiratory distress and organ failure. [40]

Radiation-induced fibrosis is a delayed response to radiotherapy that may develop months to years following the radiation exposure and culminates in progressive obliterative fibrosis, leading to respiratory dysfunction and decreased quality of life. Radiation pneumonitis is primarily treated with steroids. However, a retrospective study of 385 lung cancer patients with lung injury after radiation found that 16 (4.2%) died of radiation pneumonitis or steroid-induced complications, with a median survival of 45 days. [40,41]

Fibrosis is caused by excessive accumulation of collagen and other extracellular matrix components. The myofibroblast is a key cell which mediates fibrosis when activated. Myofibroblasts are widely believed to differentiate from local tissue mesenchymal cells, including fibroblasts, or through an epithelial/endothelial-mesenchymal transition from epithelial and endothelial cells. Bone marrow stem cell derived fibroblast-like cells in circulation are also an important source of myofibroblasts.[40,42]

As demonstrated with other tissues and organs being irradiated, chronic oxidative stress has been observed in irradiated lung tissue after completion of radiotherapy in lung cancer patients. Inflammatory cells have been hypothesized to be a primary source of ROS in irradiated lung through activation of NADPH oxidase;

however, non-inflammatory cells can also produce ROS. Chronic late effects of lung injury develop from dynamic interactions involving excessive ROS production, inflammatory cytokines and infiltration of bone marrow-derived stem and progenitors cells into the injured tissue. [43,44]

## EFFECTS OF RADIATION ON CENTRAL NERVOUS SYSTEM[45]

Clinical responses of the brain to either partial or whole brain radiation may be grouped as acute, early delayed, and late delayed effects. Acute effects occur during and/or shortly after the radiation exposure and are characterized by symptoms of fatigue, dizziness, and signs of increased intracranial pressure.

The acute effects are considered to be secondary to edema and disruption of the BBB. Early delayed effects occur 6-12 weeks post-irradiation and usually show reversible symptoms including generalized weakness and somnolence, in part resulting from a transient demyelination. It is, however, the late effects that may lead to severe irreversible neurological consequences.

Clinical effects associated with late damage to the brain range from minor-to-severe cognitive deficits to focal or diffuse necrosis of the brain parenchyma. Late radiation necrosis may be associated with focal neurological signs, such as seizures, dysfunction of the cranial nerves, and increased intracranial pressure caused by persistent vasogenic edema resulting from BBB damage. Late radiation induced white matter necrosis can be detected using MRI where it manifests as diffuse non-specific changes in the white mater.

Since the normal brain tissue tolerance is directly related to the volume and dose of tissues being irradiated, smaller incremental exposures of the normal tissue

are routinely used for clinical radiotherapy. The dose volume histogram is a useful guide in estimating the volume of normal tissues being exposed. Nevertheless, long-term functional changes following whole brain irradiation occur routinely in adults and can be more pronounced in young children, particularly when radiation is used during the developmental stages of neural tissues. Treatment-related late effects with cognitive development and learning capability as well as neuroendocrine functions are common among childhood cancer survivors.

## EFFECTS OF RATIATION ON NEUROGENESIS AND COGNITIVE IMPAIRMENT

Though the brain is traditionally regarded as a highly radioresistant organ, progenitor populations in the subventricular zone (SVZ) and in the subgranular zone (SGZ) of the dentate gyrus persist well into adulthood and are known to be extremely radiosensitive.

These progenitor populations represent unique sources of neurogenesis in the post-natal mammalian brain and have been consistently implicated in learning and memory function. In particular, neural progenitors in the SGZ have been shown to participate in the consolidation of spatial memory, and both their proliferation and subsequent survival are increased proportional to memory demands.[46]

These newly-formed neurons migrate into the adjacent dentate granule cell layer where they mature to become indistinguishable from preexisting dentate granule cell neurons.[47] This maturation requires several months during which these neurons are hyperexcitable and hyper-inducible with respect to activity-induced cytoskeleton associated protein (Arc), which plays a critical role in memory consolidation.

Neurogenesis within the SGZ is significantly impaired following whole brain irradiation (WBI) doses of 5 Gy and is effectively eliminated following WBI doses above 10 Gy. Within this dose range, impaired neurogenesis reflects both the loss of some of the neural progenitors and a disruption of neurogenic signalling within the SGZ microenvironment required for neuronal fate determination among the surviving progenitors. The resultant loss of hippocampal neurogenesis is associated with reduced learning-induced Arc expression and, at later time-points, impaired consolidation of long-term potentiation (LTP) and behavioural learning.[48]

Few recent researches have shown that functional impairment following the ablation of hippocampal neurogenesis is transient and that within 6 weeks the loss of neurogenesis is compensated by changes in the structure and dynamics of mature neurons within the dentate gyrus. Thus, while impaired hippocampal neurogenesis may play an important role in the development of radiation-induced cognitive impairment, chronic neuroinflammation may adversely affect neuronal function by other means at later post-irradiation time points.[49]

**Effects of radiation on Salivary Glands**: Salivary gland irradiation may result in cell death by apoptosis, manifesting as swelling and tenderness after the first dose of treatment, progressing to xerostomia and subsequent severe dental caries and osteonecrosis, difficulty wearing dentures, eating and speech difficulties. Recovery of salivary gland function, if occurs, takes months or years.[50,51]

**Heart** - Radiation injury to the heart can manifest as acute pericarditis, pericardial effusion, constrictive pericarditis, valvular dysfunction, conductive system dysfunction, and myocardial fibrosis. Radiation therapy increases the risk of ischemic heart disease by causing myocardial microvascular disease or macrovascular coronary

artery stenosis. Majority of the acute morbidity is related to concomitant use of chemotherapy and hormonal therapy; therefore, individualized treatment plans help minimize the risk of acute cardiac effects. Myocardial nuclear imaging studies before radiation therapy (RT) can aid in risk stratification and guide radiotherapy dosing and technique. Long-term effects of radiation cardiotoxicity manifest approximately ten years after RT and contribute to high mortality in younger women diagnosed with breast cancers.[52,53]

**Urinary Tract** - RT can cause varying degrees of irritation and functional impairment of bladder transitional epithelium and mucosa. Acute presentation varies from mild dysuria, increased frequency, urgency, microscopic haematuria to urinary incontinence, gross haematuria, and bladder necrosis. Chronic effects include detrusor dysfunction, urge incontinence, hydronephrosis, mucosal ulceration, and fistula formation. Treatment is symptomatic with pain management, anticholinergics or antispasmodics, cranberry juice, hyperbaric oxygen, or surgical interventions for late complications.[54]

**Gonads -** Irradiation to ovaries leads to infertility or premature ovarian failure even at low doses with increased sensitivity with advancing age. For women under 40 with a strong desire to preserve fertility, the ovarian transposition procedure can reduce the risk of irradiation. Long-term management is a hormone replacement therapy for menopausal symptoms. Radiotherapy may result in impotence and testicular dysfunction in males. Patients undergoing radiotherapy should be offered sperm or egg cryopreservation options before undergoing RT.[55]

**Cervicitis and Vaginitis -** Acute symptoms of mucositis include erythema, ulceration, exudative changes, serous discharge, and increased predisposition to infection. Full-

thickness ulceration may be seen with brachytherapy for cervical cancers. Late side effects include fistulas (rectovaginal or rectovesical), vaginal stenosis, and vaginismus. Treatment is conservative for mild symptoms; persistent non-healing mucositis, ulcers, or fistulas can be treated with hyperbaric oxygen or pentoxifylline, and mechanical dilatation for vaginal stenosis.[56]

**Primary Cancers and Their Associated Secondary Malignancies**

- Hodgkin disease - Breast, lung, thyroid, stomach
- Breast - Lung, leukaemia, opposite breast
- Testis- Leukaemia, lymphoma, pelvic malignancy, bone, and soft tissue sarcoma
- Cervix - Bladder, rectum, leukaemia, sarcoma
- Childhood cancers - Thyroid, breast, leukaemia, sarcoma

**REDUCING THE RADIATION INDUCED ADVERSE EFFECTS**

1. Identification of patients at risk of complications and initiation of appropriate therapy (low BMI increases the risk of diarrhoea while high BMI patients are at greater risk of skin and mucosal complications).

2. Oral hygiene instruction for all patients receiving head and neck irradiation. Consultation with a dentist and treatment of periodontal disease before radiotherapy can minimize the risk of jaw osteoradionecrosis. Use of bland rinses, cryotherapy, mucosal protective agents, antiseptic mouthwashes, topical analgesics, and anti-inflammatory agents or growth factors as necessary.

3. Regular assessment and monitoring of high-risk patients can reduce long-term sequela in these patients and improve the overall quality of life. Dietary modifications that alleviate symptoms include avoiding spicy or acidic foods, caffeine, alcoholic beverages, alcohol-containing mouthwashes, and sharp foods (e.g., chips, popcorn).

4. Nutritional assessment and dietary consult can improve the healing of damaged tissues. It is especially important in patients with cancer cachexia compounded by radiotherapy-associated fatigue, loss of appetite, alterations in taste sensations, and mucositis.

5. Wound care interventions for skin ulcers with hydrocolloid dressings and regular cleaning and hyperbaric oxygen therapy for refractory cases.

6. The use of probiotics reduces radiation enteritis symptoms, and dietary modifications such as a low-residue diet with no grease, spices, and adequate fiber intake can reduce symptoms of proctitis.

7. Vaginitis douches with dilute hydrogen peroxide use for cleaning and prevention of infection following pelvic irradiation.

8. Smoking cessation is a critical intervention to reduce the risk of secondary lung cancer in patients who receive mediastinal radiotherapy for Hodgkin disease. Some studies suggest up to a 20-fold increase in risk compared to non-smokers.

**Awareness of effects of radiation among healthcare professionals**

**Khamtuikrua C et al,** had conducted a questionnaire-based study to examine awareness about radiation hazards and knowledge about protection methods among the anaesthesia personnel and surgical subspecialists of a quaternary care academic center.

In their study, 270 potential participants were emailed and invited to respond to an online questionnaire and the response rate was 79.3%. Of which, 214 participants (69.2%) were females and the mean age of the participants was 34.8 years. Most of the participants (63.1%) considered radiation exposure that occurs as a part of daily work to be very harmful; 86.4% and 78.5% reported that they always wore a lead apron and a thyroid shield when working in an environment that entails radiation exposure, respectively. The mean score for knowledge about radiation hazards and protection was $6.4 \pm 2.0$ (maximum possible score = 15). Hence, they suggested that there is a need to improve anaesthetic personnel and surgical subspecialists' knowledge about radiation protection, especially with regard to the use of lead goggles and harmful doses of radiation. [58]

Another study by **Paolicchi F et al** had evaluated the radiation protection basic knowledge and dose assessment for radiological procedures among Italian radiographers. They recruited 780 participants in their study. They found that 12.1 % of participants attended radiation protection courses on a regular basis. Despite 90 % of radiographers stating to have sufficient awareness of radiation protection issues, most of them underestimated the radiation dose of almost all radiological procedures. About 5 % and 4 % of the participants, respectively, claimed that pelvis magnetic resonance imaging and abdominal ultrasound exposed patients to radiation. On the

contrary, 7.0 % of the radiographers stated that mammography does not use ionising radiation.

About half of participants (50%) believed that radiation-induced cancer is not dependent on age or gender and were not able to differentiate between deterministic and stochastic effects. Young radiographers (with less than 3 years of experience) showed a higher level of knowledge compared with the more experienced radiographers.

By their findings, they concluded that substantial need for radiographers to improve their awareness of radiation protection issues and their knowledge of radiological procedures. Specific actions such as regular training courses for both undergraduate and postgraduate students as well as for working radiographers must be considered in order to assure patient safety during radiological examinations.[59]

**Ramanathan S et al,** also had investigated and compared the knowledge of radiation dose and risk incurred in common radiology examinations among radiology residents, fellows, staff radiologists and technologists. They had obtained a total of 92 responses. 17 questions, yes or no form had given to all the recruited population.

They reported that the mean score was 8.5 out of 17. Only 48 % of all participants scored more than 50 % correct answers. Only 23 % were aware of dose from both single-view and two-view chest X-ray; 50–70 % underestimated dose from common studies; 50–75 % underestimated the risk of fatal cancer. Awareness about radiation exposure in pregnancy is variable and particularly poor among technologists. A statistically significant comparative knowledge gap was found among technologists.[60]

**Wong CS et al** had assessed the knowledge and practice pertaining to radiation exposure related to radiological imaging among medical doctors, in relation to specialty and year of experience. They used the questionnaires as recommended by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) were distributed to doctors in tertiary hospitals by convenience sampling.

93 questionnaires were sent out and 40 interns, 24 clinicians and 18 radiologists had returned their answers. Radiologists had the significantly least deviation from correct answers compared to interns (p=0.018) followed by the physicians (p=0.046). More-experienced doctors also performed better than the less-experienced (p=0.027). 12/80 (15%) and 4/80 (5%) failed to recognize MR and US as radiation-free modalities. Only 10/80 (12.5%) knew the risk of carcinogenesis from abdominal CT and only 4/81 (5%) will discuss radiation-related hazard with patients routinely.[61]

Another Nigerian study by **Eze CU et al** aimed at assessing the knowledge and radiation protection practices among radiographers. 93% of the study population had returned their answers. Average score on assessment of knowledge was 73%.

Thirty-seven respondents (92.5%) in the five centres indicated that they know that increase in KV increased the energy of the x-ray beam and thus reduces both skin and absorbed doses. 28 (70%) respondents agreed that using light beam diaphragm (LBD) reduces the field size and positioning aids such as immobilisers and straps, especially in paediatric radiography.

Thirty-four respondents (85%) know that justification and optimization are essential principles in radiation protection, while 30 respondents (62.5%) believe there is a need for diagnostic x-ray facilities to have written 'operating procedures and local rules to serve as guides for radiographers.

Thirty respondents (63%) said that a radiologist is statutorily responsible for ordering the repeat of radiographs adjudged to be of sub-optimal diagnostic quality whereas 34 respondents (85%) believe that quality assurance tests on x-ray machines and accessories are essential parts of radiation protection practices. Twenty-one respondents (53%) said that all designated personnel must wear radiation monitoring badges while working.[62]

Also, a study by **Yurt A et al** evaluated the knowledge and perception and mitigation of hazards involved in radiological examinations, focusing on healthcare personnel by questionnaire-based study.

Overall 92 participants had participated in the study. Their level of knowledge about ionizing radiation and doses in radiological examinations were found to be very weak. The number of correct answers of physicians, nurses, medical technicians and other personnel groups were 15.7±3.7, 13.0±4.0, 10.1±2.9 and 11.8±4.0, respectively. In the statistical comparison between the groups, the level of knowledge of physicians was found to be significantly higher than the level of the other groups ($p=0.005$).[63]

**Rose et al** had conducted the similar study by recruiting, radiologists, radiology fellow students, adult cardiologists, adult cardiology fellows and the paediatric cardiologists with the incidence of 29.6%, 24.1%, 18.5%, 6% and 7% respectively. They found that postgraduates and fellows had frequent opportunities to attend the

conferences, CMEs and other educational programmes. Hence, they had better knowledge updates regarding the radiology and its hazards than the other staffs. [64]

**Abdallah Y et al,** had conducted the similar study was conducted among 250 participants; 75% (188) were men and 25% (62) were women, and 78% of the participants scored 18.5 out of 20. The scores of the participants on radiation dose, ALARA principles, international and national radiological regulations, and radiation exposure risks were 19.7 ± 4.1, 16.8 ± 4.1, 18.3 ± 4.05, 16.2 ± 3.6 and 19.1 ± 5.3, respectively. A total of 87.2% (218) of the participants were aware of radiation protection procedures and optimization. Their study revealed that 87.2% had "excellent" radiation protection knowledge. The participants with good to fair knowledge accounted for only 4.4%.[65]

Another editorial report by **Ravikanth R et al [66]** had stated that though the majority of clinicians have better knowledge about the radiation and its hazards, many are failed to follow that in their day to day practice.

# MATERIALS AND METHODOLOGY

We had conducted a cross sectional questionnaire-based study to assess the awareness of radiation, its hazards and precautions taken by the post graduate students and consultants at our hospital.

**Study type:** Cross-sectional

**Study duration:** 18 months

**Study place:** KLE's Dr. Prabhakar Kore Hospital and MRC, Belagavi

**Study sample:** Post graduates and consultants of KLE's Dr. Prabhakar Kore Hospital and MRC, Belagavi

**Sample size:** The minimum sample size formula based on prevalence rate is;

$\mathbf{n = Z_\alpha^2\ P(1\text{-}P)/d^2}$ where,

P is the percentage of prevalence

d is the percentage likely difference in the prevalence.

zα is linked with the level of significance.

For 5% level of the significance zα = 1.96.

Ref: With P = 66.13% and d = 15% of P = 9.92%

The sample size is 87 to make the study more confirmative, the sample size will be raised to 100. A set of questionnaire was provided to all the volunteers.

**Inclusion criteria**

- Individuals of either gender aged more than 18 years
- All the postgraduate students, junior and senior consultants at KLE's Dr. Prabhakar Kore Hospital and MRC, Belagavi

**Exclusion criteria**

- Those who are not willing to participate in the study

**STUDY PROTOCOL**

After obtaining the ethical committee clearance, 100 postgraduate students and consultants, who were interested in being part of the study were taken verbal consent to participate in the study.

Pre formed questionnaire was given to all the participants and requested them to give there valuable opinion by answering the questions.

They were even free of not answering if any questions seems to be uncomfortable to their knowledge.

All the responses were obtained and tabulated in Microsoft excel. Subjected for analysis.

## STATISTICAL ANALYSIS

Since the study is of observational study the plan of analysis was as follows. For the continuous quantitative variables mean and standard deviation will be calculated. For the purpose of comparison if the data is divided into two groups with respect to certain qualitative characteristic, the continuous variables will be compared using suitable tools of statistics like student's unpaired t-test. The pre and post treatment measures will be compared using student's paired t-test.

Discrete variables were represented by mean and standard deviation. The categorical data will be expressed in terms of rates, ratios and percentages. The association between the outcome, clinical and demographic characteristics will be tested using Chi-square test, test of proportion or Fisher's exact test. For discrete variables nonparametric tests will be used. Apart from the above suitable tools like ANOVA, correlation, regression etc., will be used according to the need. Suitable graphs will be used to depict the comparison. For all the tests the value of p less than 5% (0.05) will be considered significant

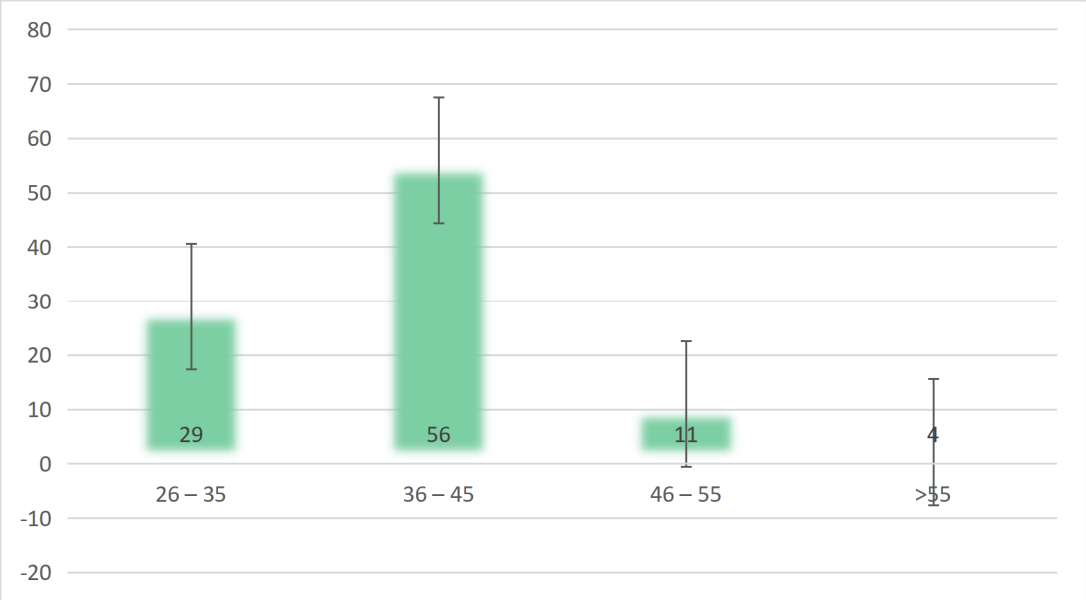
# RESULTS

All the recruited study population had given their responses without un answering any question. Hence, the response rate was 100%. All the obtained responses are analysed and represented as table and graphs below.

**Table 1: Distribution of age of the participants**

| Age in years | Number of participants |
|---|---|
| 26 – 35 | 35 |
| 36 – 45 | 50 |
| 46 – 55 | 11 |
| >55 | 4 |

Average age of the recruited study population was 40.13±10.1 years. Majority of them were aged between 36 to 45 years accounting for about 50% of the study population followed by 35% of them were aged between 26 to 35 years. 11% and 4% were aged between 46 to 55 years and > 55 years respectively.

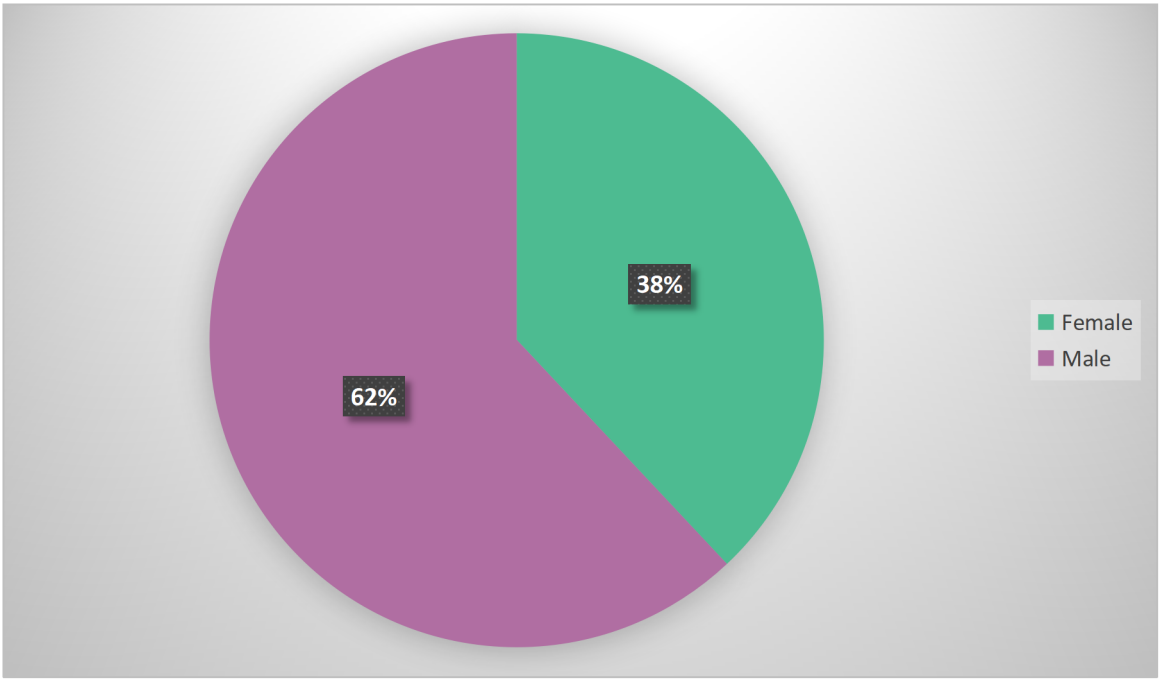



**Graph 1: Distribution of age of the study participants**

**Table 2: Distribution of gender**

| Gender | Number of participants |
|---|---|
| Female | 38 |
| Male | 62 |

Out of 100 participants in our study, 38 of them were females and the rest 62 were males. There was significant difference between the gender.

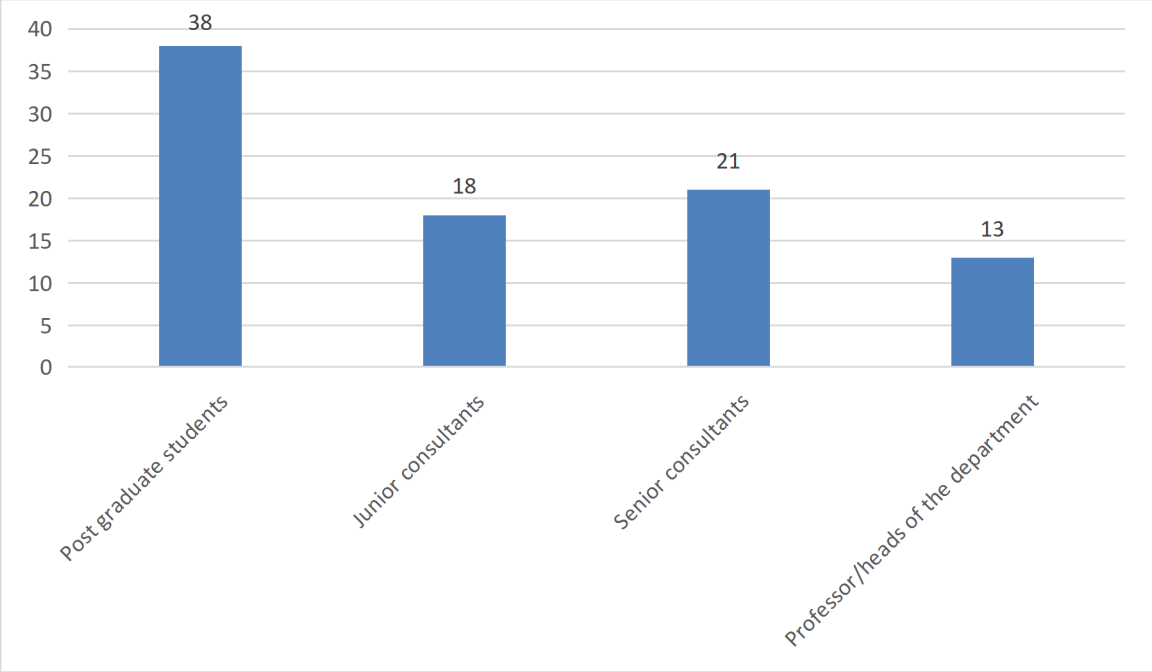



**Graph 2: Pie chart illustrating the distribution of gender**

**Table 3: Distribution of participants based on their occupational grade**

| Occupational grade | Number of participants |
|---|---|
| Post graduate students | 38 |
| Junior consultants | 18 |
| Senior consultants | 21 |
| Professor/heads of the department | 13 |

We found that majority, 38% of the study participants were postgraduate (PGs) students followed by 21% senior consultants. 18% and 13% were junior consults and professor/head of the departments. There was no significant difference in the distribution of occupational hierarchy.




**Graph 3: Distribution of occupational hierarchy**

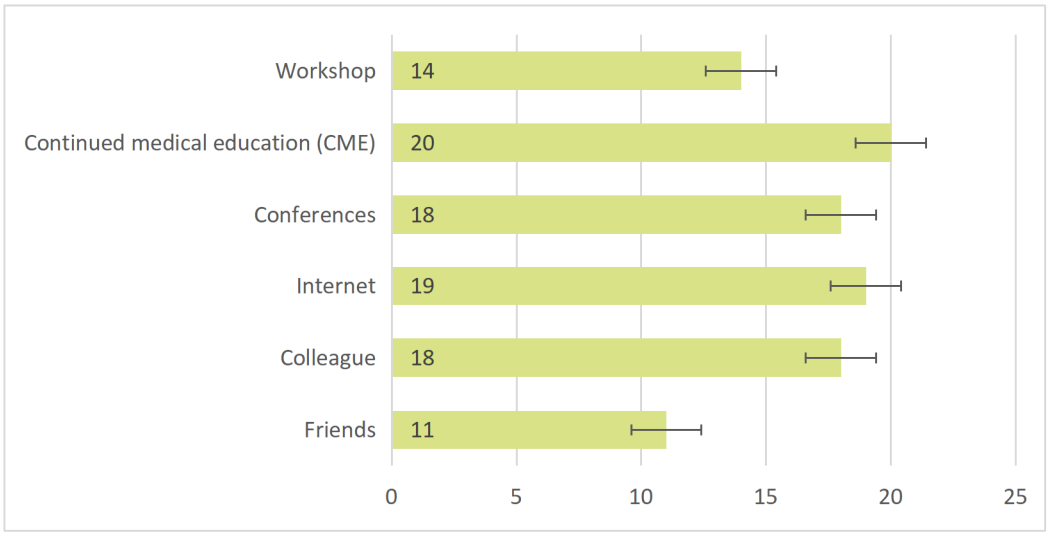
## AWARENESS OF RECENT ADVANCES IN RADIOLOGY

**Table 4: Keeping themselves updated about the current trends of radiology**

All the 100 participants have mentioned that they are updating their knowledge in radiology as and when the recent guidelines are available.

| The source of current updates | Number of participants gaining knowledge from that source |
|---|---|
| Friends | 11 |
| Colleague | 18 |
| Internet | 19 |
| Conferences | 18 |
| Continued medical education (CME) | 20 |
| Workshop | 14 |

Of all the study population, 20% and 19% of them were updating their current knowledge by attending CMEs and via internet access. 18% each were gaining their knowledge by their Colleagues and attending conferences. 14% and 11% each were by attending the workshop and conversing with their friends.

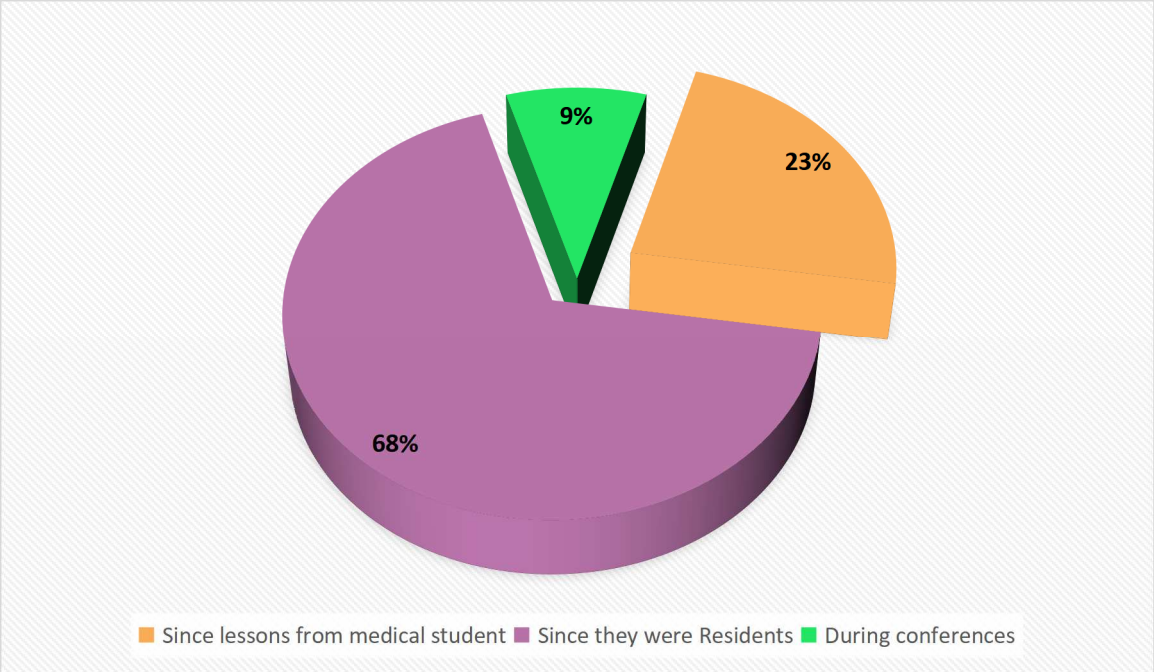



**Graph 4: distribution of source of current updates**

**Table 5: Since when the participants have their interest in field of radiation protection**

| Time sequence | Number of participants |
|---|---|
| Since lessons from medical student | 23 |
| Since they were Residents | 68 |
| While attending conferences | 09 |

Almost 68% of them had developed their interest in the field of radiation protection since they were residents followed by 23% of them when they started their residency and 9 participants had developed interest after attending various conferences.




**Graph 5: The stage where the study participants developed interest in radiation protection**

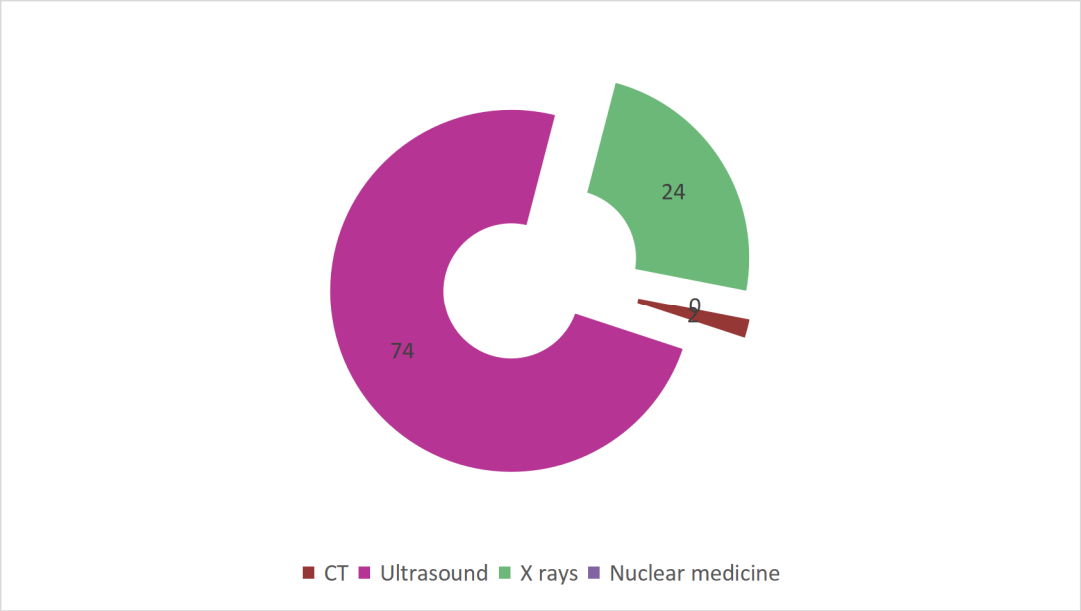
## ASSESSMENT OF KNOWLEDGE/AWARENESS ABOUT DIFFERENT MODALITIES IN RADIOLOGY

**Table 6: Types of imaging modalities not using ionising radiation**

| Imaging modalities | Response obtained by the participants |
|---|---|
| CT | 2 |
| Ultrasound | 74 |
| X rays | 24 |
| Nuclear medicine | 0 |

p 0.01

74% of the doctors were aware that ultrasound was the imaging modality which is not using ionising radiations. Whereas 24% were thinking that X ray were that radiological imaging technique with non-ionising radiation. The rest 2% had mentioned CT as the modality not using ionising radiation. The number participants responded with correct answers was significant.

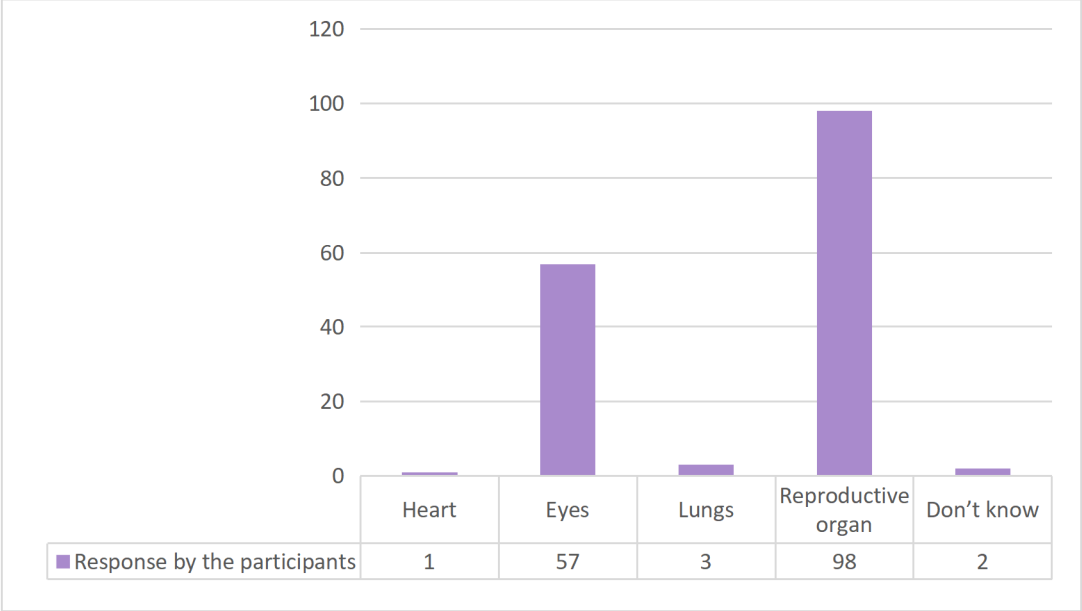



**Graph 6: Opinion on which modality will not be using ionising radiations**

**Table 7: Part of the body highly sensitive to the ionising radiation**

| Organ system | Response by the participants |
|---|---|
| Heart | 1 |
| Eyes | 57 |
| Lungs | 3 |
| Reproductive organ | 98 |
| Don’t know | 2 |

We had found mixed response for the above statement and many had selected more than one response. 98% of them responded that reproductive organs are the highly sensitive part of the body that could be affected with the ionising radiations followed by 57% had responded that eyes and reproductive organs both as their opinion. 3% and 1 individual had thought that it could be lungs and heart too. Whereas 2 person had reported that they are not sure of the answer.



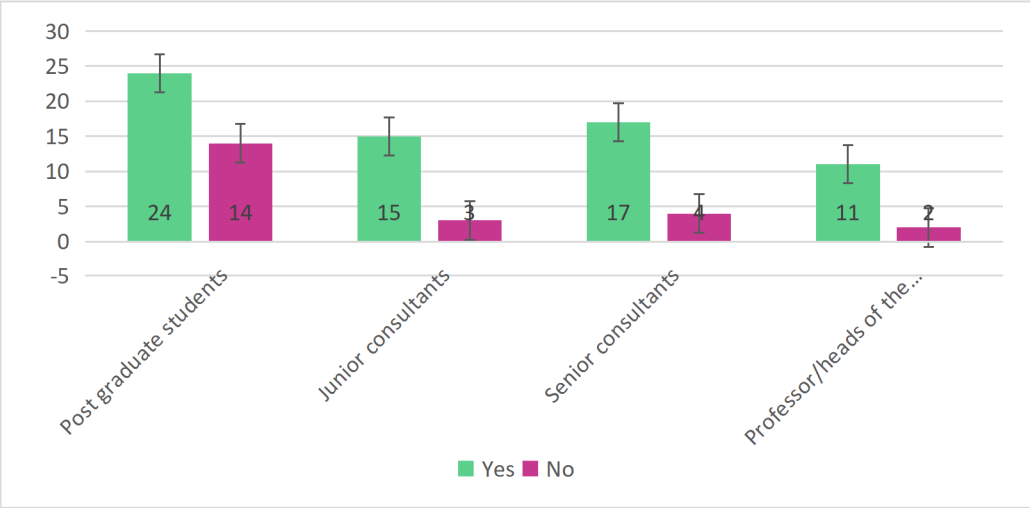

**Graph 7: Illustrating the distribution of response to organ sensitive for ionising radiation**

**Table 8: Distribution of knowledge about stochastic and non-stochastic effects of radiation**

We had observed wide variation in response to this particular objective. Hence, had compared the distribution of response based on their occupational hierarchy.

| Occupational grade | Total participants | Response | |
|---|---|---|---|
| | | Yes | No |
| Post graduate students | 38 | 24 (63.1%) | 14 (39.9%) |
| Junior consultants | 18 | 15 (83.33%) | 3 (16.67%) |
| Senior consultants | 21 | 17 (80.95%) | 4 (19.05%) |
| Professor/heads of the department | 13 | 11 (84.61%) | 2 (15.39%) |

We found that almost all senior consultants and professors/heads of the department were aware of the stochastic and non-stochastic effect of the radiation. Only 2, 3 and 4 doctors from junior consultant, senior consultant and professor/ head were not aware of this effect. Whereas we can see from the above table that out of 38 post graduate student, 24 (63.1%) of them knew about stochastic effect of radiation and the rest did not.

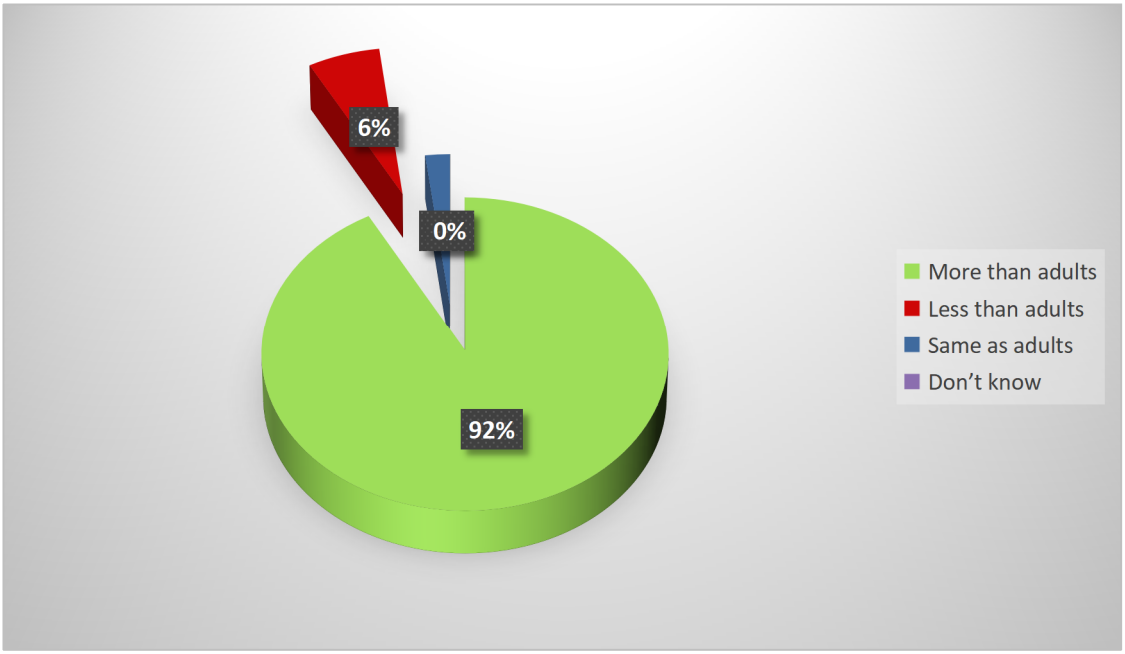



**Graph 8: Response about awareness of the stochastic effect of ionising radiation**

**Table 9: Response about the level of sensitivity in paediatric age group**

| Level of sensitivity in paediatric age group | Number of responses |
|---|---|
| More than adults | 92 |
| Less than adults | 6 |
| Same as adults | 2 |
| Don't know | 0 |

Out of 100 study participants, 92 of them answered that paediatric age group is more sensitive than adults followed by 6 of them mentioned that they are less sensitive than adults and the rest had assumed that they are almost similar sensitivity as adults.




**Graph 9: Response for the level of sensitivity of paediatrics patients**

**Table 10: Radiological Examination implying the higher level of radiation**

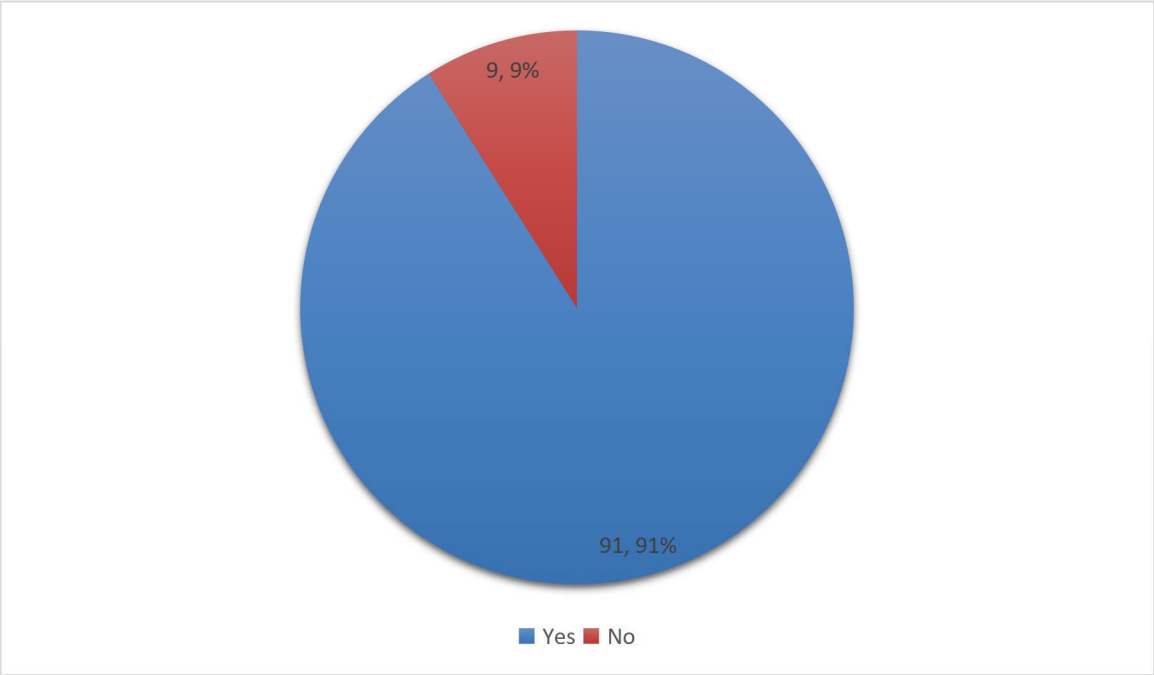
| Modality | Number of responses |
|---|---|
| CT head | 62 |
| CT abdomen | 10 |
| Colour doppler | 08 |
| TC 99 scintigraphy | 11 |
| Don’t know | 9 |

For the above question, 62% of the participants answered that CT head is the examination which implies the higher level of radiation followed by 11% as TC 99 scintigraphy. 10%, 9% and 8% of the study participants answered that CT abdomen, do not know the exact answer and colour doppler as their response.

**Table 11: Suggesting the CT for patients with no findings on USG**

| Response | Number of participants selecting the particular response |
|---|---|
| Yes | 91 |
| No | 09 |

Almost 91% of them think that it is better to subject the patients for CT when they do not find any findings on USG.

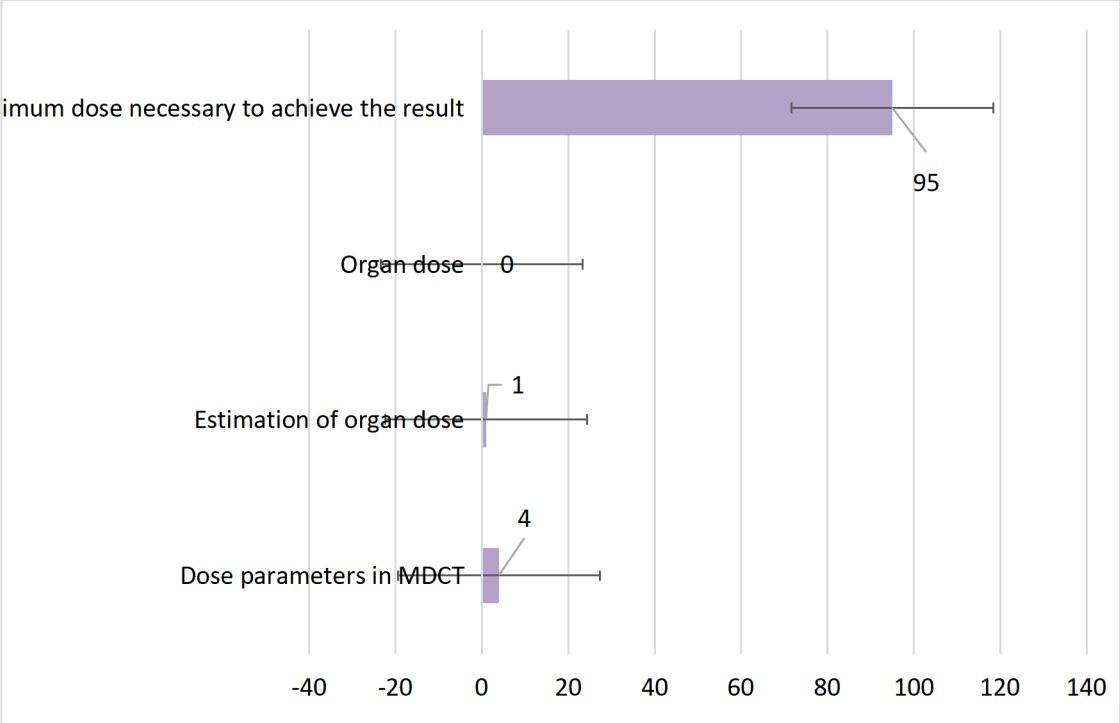



**Graph 10: Suggesting CT for the patients with no USG finings**

**Table 12: ALARA refers to which of the given options**

| Options given | Number of responses |
|---|---|
| Dose parameters in MDCT | 4 |
| Estimation of organ dose | 1 |
| Organ dose | 0 |
| Minimum dose necessary to achieve the result | 95 |

We observed that 95% of the doctors knew that ALARA is Minimum dose necessary to achieve the result. Whereas 4% of them were thinking that it was the dose assessment used for MDCT. One person was thinking it was estimation of the dose for organs.




**Graph 11: Distribution of response about ALARA**

**Table 13: Best screening modality for diagnosing Ca breast**

| Screening modality | Number of responses |
|---|---|
| Mammography | 100 |
| Biopsy | - |
| FNAC | - |

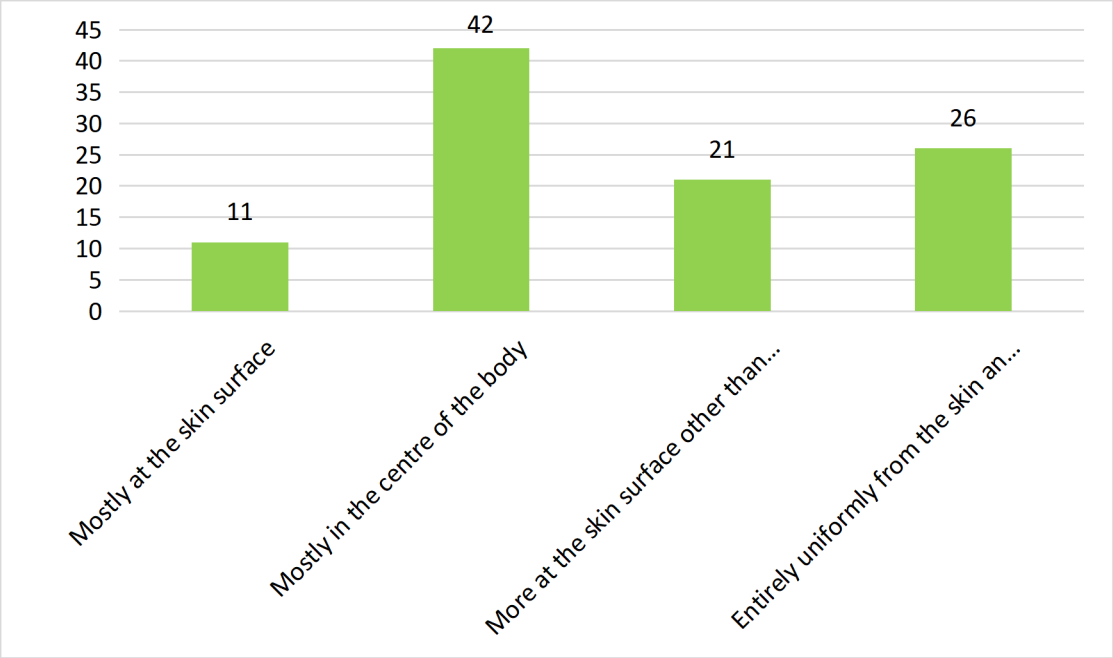
100% of the study participants responded that mammography is the best screening modality.

## AWARENESS ABOUT THE RADIATION PROTECTION ASPECT

**Table 14: Distribution of radiation from CT in the patient's body**

| Part of body | Number of responses |
|---|---|
| Mostly at the skin surface | 11 |
| Mostly in the centre of the body | 42 |
| More at the skin surface other than centre | 21 |
| Entirely uniformly from the skin and the centre of the body | 26 |

Table 1 explains that 42% of the doctors had thought that radiation from CT will accumulated mostly in the centre of the body followed by 26% had considered that entirely uniformly from the skin and the centre of the body. 21% and 14% had answered that radiations will be mostly accumulated in skin surface other than centre and at skin surface only respectively.

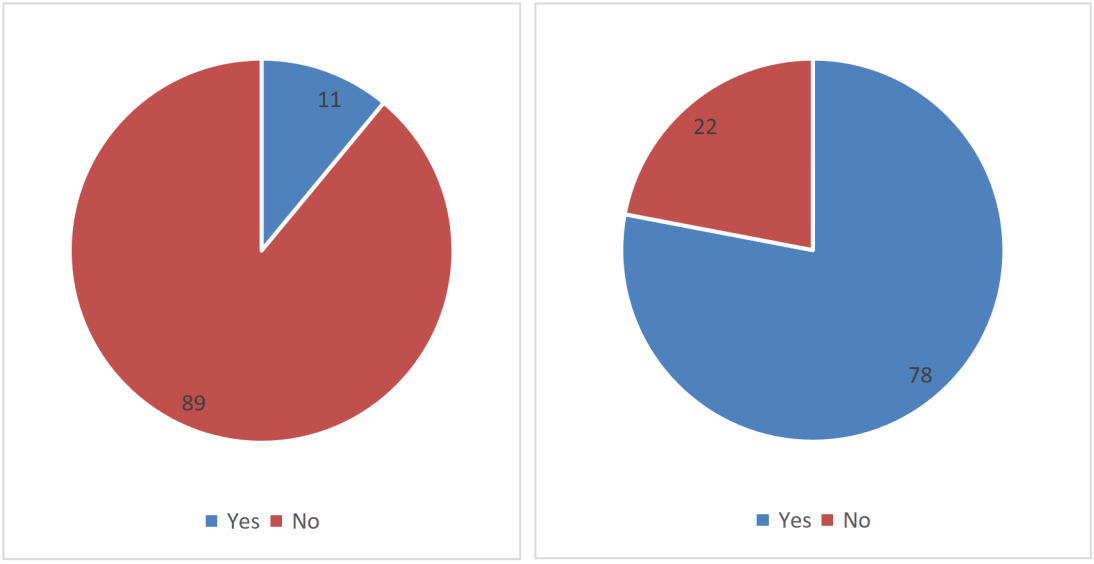



**Graph 12: Distribution of participants answer regrading the distribution radiation produced by CT**

**Table 15: Prescribing X ray for the pregnant and paediatric patients**

| For pregnant women | Number of responses |
|---|---|
| Yes | 11 |
| No | 89 |
| **For paediatric patients** | |
| Yes | 78 |
| No | 22 |

For the question we asked would they prescribe the X ray investigation for pregnant women, 89% them responded that they would not prefer and the rest 11 had responded by answering yes. For paediatric patients, 78% of them responded Yes, they would prescribe.

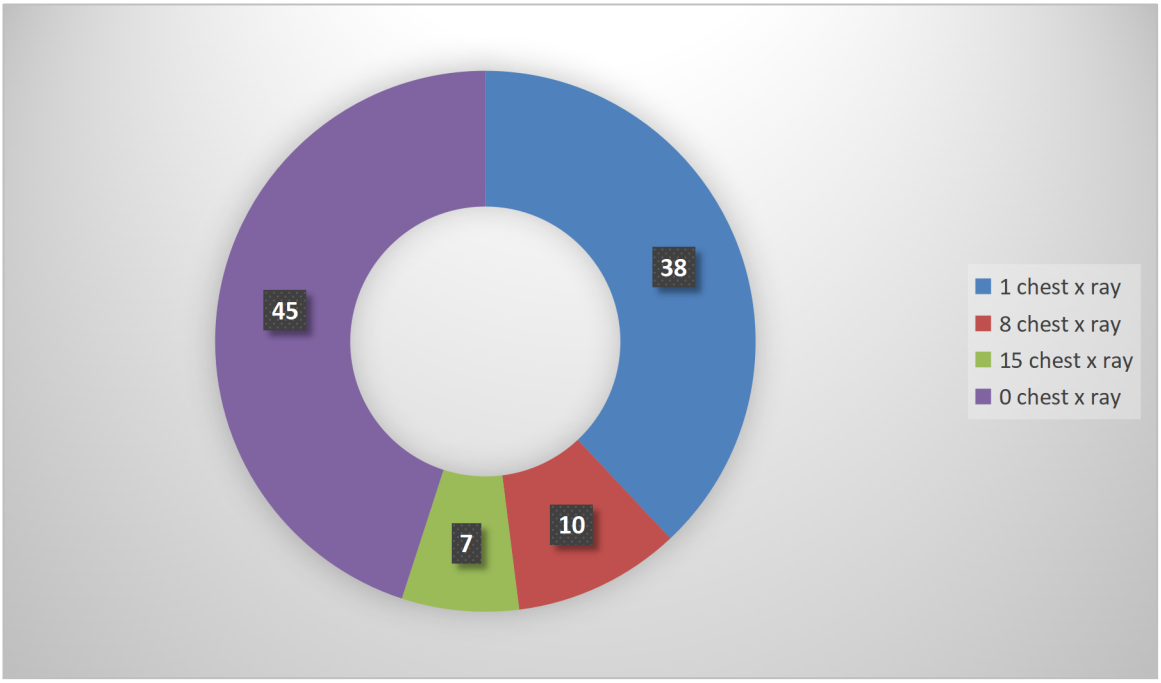



**Graph 13A, B: Represents the responses obtained for conducting X ray among pregnant and the paediatric age group respectively**

**Table 16: Radiation does in babies subjected for MRI in terms of X ray**

| Dose | Number of responses |
|---|---|
| 1 chest x ray | 38 |
| 8 chest x ray | 10 |
| 15 chest x ray | 7 |
| 0 chest x ray | 45 |

45 out of 100 students had reported that radiation from MRI is equivalent to 0 X rays. Whereas 38, 10 and 7 patients had reported that it might be equivalent to 1 chest X ray, 8 chest xray and 15 chest x ray respectively.

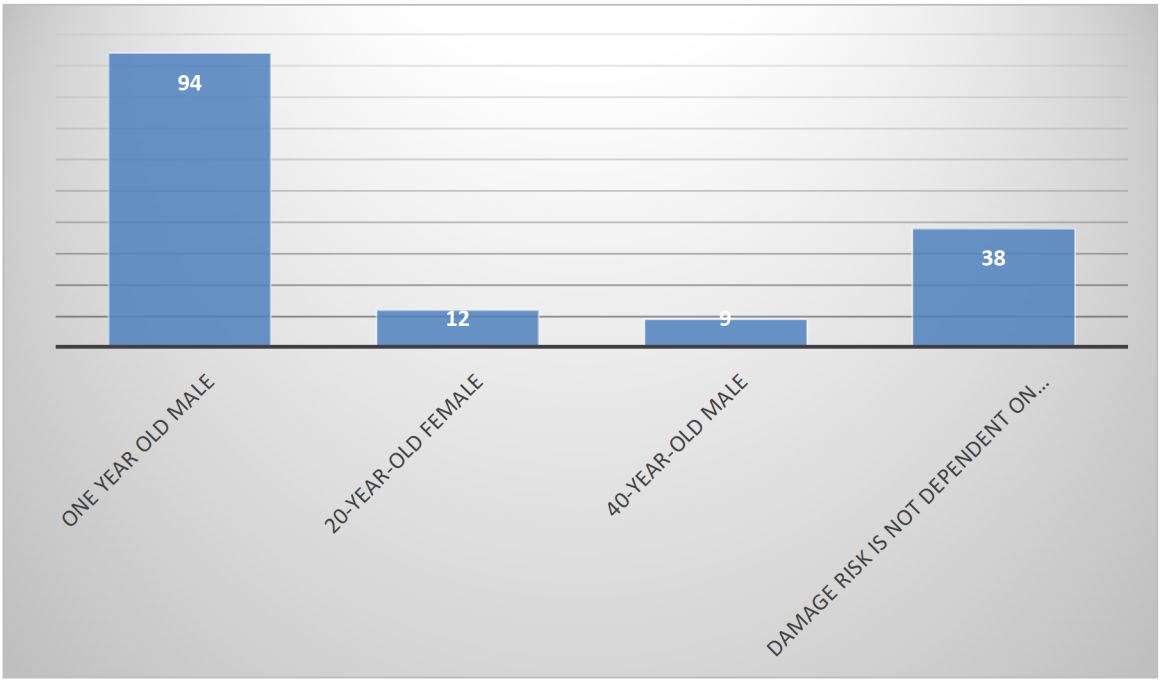



**Graph 14: Distribution of responses for the radiation from MRI in terms of chest X ray**

**Table 17: The most sensitive age group for radiation**

| Age group | Responses obtained |
|---|---|
| One year old male | 38 |
| 20-year-old female | 12 |
| 40-year-old male | 9 |
| Damage risk is not dependent on patient's age and sex | 94 |

Majority of the study participants were not sure of the exact answer for the above statement. Hence, they had provided multiple answers for the same. 94% of them had responded that one year old male would be at higher risk, followed by 38% answered damage risk is not dependent on patient's age and sex. 12% and 9% of them answered that 20-year-old female and 40 year old male are higher risk.




**Graph 15: Distribution of response for the highly sensitive age and gender group**

## ANALYSIS OF ATTITUDE AND PRACTICE TOWARDS THE KNOWLEDGE OF RADIATION PROTECTION

**Table 18: Providing the patient about relevant information regarding the calculated risk and benefit of radiation**

| Provides the knowledge | Number of responses |
|---|---|
| Yes | 76 |
| No | 24 |

76 out of 100 participants mentioned that they provide the relevant information regarding the calculated risk and benefits of the radiation.

**Table 19: Judging the prescribed radiological examination providing the necessary information**

| Provides the knowledge | Number of responses |
|---|---|
| Yes | 82 |
| No | 18 |

As per the obtained response, 82% of them judge whether the prescribed radiological examination provides the necessary information about the exposed patient and the rest are not following it.

**Table 20: Is it necessary to take protective measure such as thyroid collar and lead apron in every patient undergoing exposure**

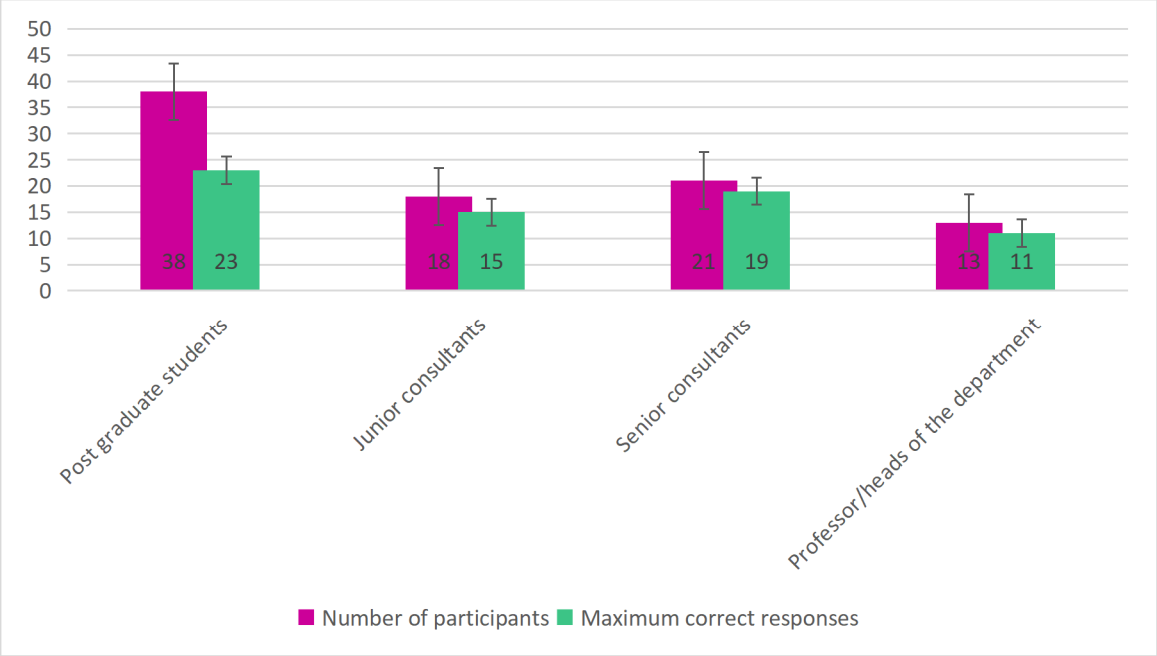
| Necessity of thyroid collar and lead apron in the patients each time | Number of responses |
|---|---|
| Yes | 68 |
| No | 32 |

Out of 100 participants, 68 of them answered that it is necessary to protect the patient with thyroid collar and lead apron each time they are exposed to radiation and the rest 32 thought that it is not necessary.

**Table 21: Number of participants provided the maximum correct answers**

| Occupational grade | Number of participants | Maximum correct responses |
|---|---|---|
| Post graduate students | 38 | 23 (60.52%) |
| Junior consultants | 18 | 15 (83.33%) |
| Senior consultants | 21 | 19 (90.47%) |
| Professor/heads of the department | 13 | 11 (84.61%) |

We observed that out senior consultants were the highest number of participants provided the right answer 19/21 (90.47%) followed by 11/13 (84.61%) of the professors and head of the departments. 23/38 (60.52%) and 18/15 (83.33%) of the PG students and junior consultants had given the correct answers respectively.




**Graph 16: Number of participants provided the accurate response based on the professional grading**

**Table 22: Distribution of participants providing the accurate answers based on the source of their knowledge**

| The source of current updates | Number of participants gaining knowledge from that source | Number of participants given accurate answers |
|---|---|---|
| Friends | 11 | 6 (54.54%) |
| Colleague | 18 | 7 (38.88%) |
| Internet | 19 | 8 (42.1%) |
| Conferences | 18 | 11 (61.11%) |
| Continued medical education (CME) | 20 | 17 (85%) |
| Workshop | 14 | 12 (85.71%) |

We could observe from the above table that maximum number of the participants provided the correct responses had updated their knowledge from CMEs and workshops.

# DISCUSSION

As we all know, radiation is the form of energy obtained from the movement of radioactive sources either natural or man-made. Ionising radiations are widely used in health care system, specially by the department radiology in the form of X rays, CT, MRI and ultrasonography. While these have various advantages in the field of diagnosis and also therapeutics, they also have their own disadvantages ranging from minor superficial skin injury to the various cancerous conditions. Hence, the knowledge of radiation and its hazards are very important for all the consulting doctors and budding specialists.

Hence, we had conducted a questionnaire based cross-sectional study to analyse the awareness of radiation protection and also their attitude towards it in their daily practice. **Ravikanth R et al** had mentioned in their article that majority of the clinicians were aware of radiation hazards but were not appropriate about the awareness about radiation dose delivered by different imaging modalities and they had also stated that there is need for such awareness studies in order to analyse the knowledge regarding the same to strengthen the doctors in this regard.[66]

In the present study, we had conducted 100 participants including post graduate students, junior and senior consultants and also the professors/ head of the departments.

All the recruited study population had given their responses without un answering any question with the response rate of 100%. Whereas the response rate was 79.3% in **Khamtuikrua C et al.** this could be due their virtual approach towards

the participants. They had mailed their questionnaire whereas our study was face to face approach and we had waited till the participants had completed their response. [58]

**DEMOGRAHIC DETAILS**

In our study, the average age of the recruited study population was 40.13±10.1 years. Majority of them were aged between 36 to 45 years accounting for about 50% of the study population followed by 35% of them were aged between 26 to 35 years. 11% and 4% were aged between 46 to 55 years and > 55 years respectively. Whereas 34.75±8.56 years was the average of study participants in **Khamtuikrua C et al.**[58]

Out of 100 participants in our study, 38 of them were females and the rest 62 were males. There was significant difference between the gender. Even **Khamtuikrua C et al.** had reported the male predominance in their study.[58]

**Rose A et al** was another cross-sectional study with similar objective who had reported that median age of their study participants being 41 years with male predominance.[64]

In the present study, 38% of the study participants were postgraduate (PGs) students followed by 21% senior consultants. 18% and 13% were junior consults and professor/head of the departments. There was no significant difference in the distribution of occupational hierarchy. Whereas, radiologists, radiology fellow students, adult cardiologists, adult cardiology fellows and the paediatric cardiologists with the incidence of 29.6%, 24.1%, 18.5%, 6% and 7% respectively, were the study participants in **Rose A et al. [64] Abdallah Y et al[66]** was another study which had assessed awareness of radiation hazards by recruiting 250 health care professionals by the department of radiology. Postgraduate students were also part of their study as

ours. Even they had observed male predominance as our study. This could be due to the males being epidemiological more in the world as well as Indian population.

## AWARENESS OF RECENT ADVANCES IN RADIOLOGY

All the 100 participants have mentioned that they are updating their knowledge in radiology as and when the recent guidelines are available.

Of all the study population included in the present study, 20% and 19% of them were updating their current knowledge by attending CMEs and via internet access. 18% each were gaining their knowledge by their Colleagues and attending conferences. 14% and 11% each were by attending the workshop and conversing with their friends. Almost 68% of them had developed their interest in the field of radiation protection since they were residents followed by 23% of them when they started their residency and 9 participants had developed interest after attending various conferences. Whereas **Abdallah Y et al** had assessed that 50% of their participants had scaled their knowledge as moderate level regarding the radiological hazard. Majority of them had gained the knowledge by reading the contents from various sources. [65]

## ASSESSMENT OF KNOWLEDGE/AWARENESS ABOUT DIFFERENT MODALITIES IN RADIOLOGY

74% of the doctors were aware that ultrasound was the imaging modality which is not using ionising radiations. Whereas 24% were thinking that X ray were that radiological imaging technique with non-ionising radiation. The rest 2% had mentioned CT as the modality not using ionising radiation. The number participants responded with correct answers was significant.

In our study, we found mixed response for the above statement and many had selected more than one response. 98% of them responded that reproductive organs are the highly sensitive part of the body that could be affected with the ionising radiations followed by 57% had responded that eyes and reproductive organs both as their opinion. 3% and 1 individual had thought that it could be lungs and heart too. Whereas 2 participants had reported that they are not sure of the answer. **Abdallah Y et al.,** reported that almost all their study participants were aware of the global questions regarding the radiation but only 30% of them knew the medical radiation doses.[65]

In the present study, senior consultants and professors/heads of the department were aware of the stochastic and non-stochastic effect of the radiation. Only 2, 3 and 4 doctors from junior consultant, senior consultant and professor/ head were not aware of this effect. 38 post graduate student, 24 (63.1%) of them knew about stochastic effect of radiation and the rest did not.

Out of 100 study participants, 92 of them answered that paediatric age group is more sensitive than adults followed by 6 of them mentioned that they are less sensitive than adults and the rest had assumed that they are almost similar sensitivity as adults.

78% answered that TC 99 scintigraphy implies the higher level of radiation followed by 56% them responded that its colour doppler. 35 and 24 had given the opinion that CT abdomen and CT head as the modalities implying the higher-level radiation respectively. Rest 2% did not know which one could be the appropriate answer.

Almost 91% of them think that it is better to subject the patients for CT when they do not find any findings on USG.

We observed that 95% of the doctors knew that ALARA is Minimum dose necessary to achieve the result. Whereas 4% of them were thinking that it was the dose assessment used for MDCT. One person was thinking it was estimation of the dose for organs. Similar to our observation, in **Abdallah Y et al** also, 90% of the study population had adequate knowledge about ALARA.[65] 100% of the study participants responded that mammography is the best screening modality.

In contrast to our observation, **Goula A et al.,** reported that level of overall knowledge of health professionals regarding radiation protection safety was not satisfactory.[67]

**AWARENESS ABOUT THE RADIATION PROTECTION ASPECT**

In our study, for the question we asked would they prescribe the X ray investigation for pregnant women, 89% them responded that they would not prefer and the rest 11 had responded by answering yes. We found that majority of them had substantiated their answer about prescribing X ray in pregnant women that, as X rays are the least radiation producing compared CT and MRI, they prefer X ray as their choice if at all any radiological examination required.

By this we can observed that almost all the participants were aware of the risk of radiation in pregnant women. Even in **Abdallah Y et al.,** 95% of the study participants knew the risk of radiation in pregnant women. As few of their participants were technicians, whether they prescribe the investigation was not suitable question. [65]

For paediatric patients, 78% of them responded Yes, they would prescribe. We all know that respiratory infection has been the most common diseases that could be observed among the children and also many children might even present with the metal foreign body insertion or the orthopaedic indications for the radiological examination. So, in such cases it will be necessary to prescribe the X ray for them.

Majority of the study participants in our study were not sure of the exact answer for the above statement. Hence, they had provided multiple answers for the same. 94% of them had responded that damage risk is not dependent on patient's age and sex, followed by 38% answered that one-year-old male was at higher risk. 12% and 9% of them answered that 20-year-old female and 40-year-old male are higher risk. Similar to this finding, **Goula A et al** reported that females and employees with a lower level of education had more misconceptions about radiation and radiation protection. Whereas in our study, the lack of awareness was not limited to any age of gender distribution. [67]

## ANALYSIS OF ATTITUDE AND PRACTICE TOWARDS THE KNOWLEDGE OF RADIATION PROTECTION

76 out of 100 participants mentioned that they provide the relevant information regarding the calculated risk and benefits of the radiation.

As per the obtained response, 82% of them judge whether the prescribed radiological examination provides the necessary information about the exposed patient and the rest are not following it.

Out of 100 participants in the present study, 68 of them answered that it is necessary to protect the patient with thyroid collar and lead apron each time they are

exposed to radiation and the rest 32 thought that it is not necessary. But we did not assess their practice, hence assume that all those 68% of them would be using the thyroid collar and apron each time they are subjecting the patients for radiation. The rest 32 of them need to practice it. That is what our participants might have mentioned. **Abdallah Y et al.,** also reported that 88% of the participants had answered correctly about the common protective measures but their concern was about using protective measures among clinicians and technicians.[65] Similarly, **Khamtuikrua C et al.** had assessed the practice about protection and they found that 86.4% and 78.5% of them reported that they always wore a lead apron and a thyroid shield when working in environments that entailed radiation exposure, respectively. However, only 31.3% of them reported that they wore lead goggles in such work environments.[58]

The present study analysed that the occupational grades more the senior consultants have been given the correct/ accurate responses than PGs and junior residents. Also, we observed that those gained knowledge by attending CMEs and workshops had highest positive/accurate response. Hence, we can assess that as the experience in the field of radiology increase and the recent updates will from the standard resource, there will be better knowledge among the doctors. With respect to this, we had come across the study by **Rose et al.,[64]** the qualitative survey which was part of CME, reported that radiologists had the better knowledge followed by radiology and cardiology fellow students. But the cardiology staffs were the one who were lacking the formal knowledge about radiation and its hazards and the reason behind it was fellow students were having more opportunities of attending the conferences, CMEs and workshops than the staffs and hence their knowledge on recent updates was higher. Hence, they recommended the need for awareness

programmes in the form of any educational programme, which was also the suggestion mentioned by **Ravikanth R et al.**[66]

Another significant finding was noticed by **Goula A et al,** which stated that there was some amount of emotional aspects involved in education about the risk of radiology.[67]

With this we can assess that the formal radiological and radiation protection knowledge was higher among the senior consultants and professor/heads than junior consultants and the postgraduate students but the attitude towards the same was not satisfactory. The better explanation to the patient regarding risk was radiation was not delivered. This could be due to the increase in patient: clinician ratio, which might have not provided them the enough time to converse with the patients.

# CONCLUSION

Response rate of our study was 100%. Majority of them were aged between 36 to 45 years with male predominance. Postgraduate students were the higher incidence (38%) of participants. The source of current knowledge obtained was widely varies among the recruited study population, majority of them being obtained by attending CMEs. The knowledge about the radiation was better among senior consultants and the above hierarchy than postgraduates and junior consultants but delivering the knowledge about radiation risk to patients was not satisfactory. Hence, there is need for regular educational programmes in order change the attitude and practice towards the risk reduction by radiation.

Maximum correct response was obtained by professors and HODs, followed by senior residents. Also, the rate of correct answers was higher among those updates their knowledge by CMEs and workshops.

**STRENGTH OF THE STUDY**

- We had included multi-dimensional questions including the formal knowledge about the radiation and its hazards till the delivery of knowledge to the patients.
- Response rate was 100%

**LIMITATIONS**

- As we had included the non-radiological department participants, they were lacking the formal/technical knowledge about the radiation and its risks.

# SUMMARY


- The present study was conducted to understand the radiation awareness among consultants and postgraduates of KLE hospital and also to understand the need for improving the awareness.
- We had included 100 doctors working in the unit of radio-diagnosis.
- The preformed questionnaire including the basic demographic details of the participants and the questions related to knowledge, attitude and practice about various modalities of the radiology and protection from radiation was asked in the form of multiple-choice questions.
- All the participants had been requested to fill their valuable response.
- Response rate of our study was 100%.
- Majority of them were aged between 36 to 45 years with male predominance.
- On analysing the occupation, we found that, Postgraduate students were the higher incidence (38%) of participants.
- The source of current knowledge obtained was widely varied among the recruited study population, majority of them being obtained by attending CMEs.
- The knowledge about the radiation was better among senior consultants and the above hierarchy than postgraduates and junior consultants but delivering the knowledge about radiation risk to patients was not satisfactory.
- Maximum correct response were obtained by professors and HODs, followed by senior residents. Also, the rate of correct answers was higher among those updates their knowledge by CMEs and worskshops.
- Hence, there is need for regular educational programmes in order change the attitude and practice towards the risk reduction by radiation.

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# ANNEXURES – I

# QUESTIONNAIRE

1. AGE
2. GENDER
3. POSTGRADUATE/JUNIOR CONSULTANTS/SENIOR CONSULTANTS /PROF/HOD
4. Do you keep updated yourselves about the current trends in radiology? If yes, then choose;
   a) Friends
   b) Colleagues
   c) Internet
   d) Conferences
   e) Continued medical educations
   f) Others, specify…….
5. Radiation protection is/was your filed of interest since;
   a) During lessons as medical student
   b) During lessons as resident
   c) During conferences
6. Do you provide the patients the relevant information regarding the calculated risk and benefits of ionising radiations?
   a) Yes
   b) No

7. Types of imaging modalities which do not use ionising radiation?
    a) CT
    b) USG
    c) X rays
    d) Nuclear medicine
8. The following human organ highly sensitive to ionizing radiation;
    a) Heart
    b) Eyes
    c) Lungs
    d) Reproductive organs
    e) Don’t know
9. The sensitivity level of radiation exposure in the paediatric compared to adult patient is;
    a) More than adults
    b) Same as adults
    c) Less than adults
    d) Don’t know
10. Do you judge whether the prescribed radiological examination will provide the necessary information about the exposed individual?
    a) Yes
    b) No
11. Do you have knowledge of stochastic and non- stochastic effect of radiation?
    a) Yes
    b) No

12. Is it necessary to take protective measures such as thyroid collar and lead apron in every patient undergoing exposure?
    a) Yes
    b) No
13. Which radiation among the below implies higher radiation dose?
    a) CT head
    b) CT abdomen
    c) Colour doppler
    d) TC 99 scintigraphy
    e) Don't know
14. Is weight an important parameter that effects patients' radiation dose?
    a) Yes
    b) No
15. In case, there is no finding on USG, is it necessary to send a patient for CT?
    a) Yes
    b) No
16. ALARA dose refer to?
    a) Dose parameters in MDCT
    b) Estimation of organ dose
    c) Organ dose
    d) Minimum dose necessary to achieve the result
17. Would you prescribe an X ray investigation for pregnant and paediatric patients?
    a) Yes
    b) No

18. How is radiation dose distributed in the patient's body in CT

    a) Mostly at skin surface

    b) Mostly in the centre of the body

    c) More at the skin surface than the centre

    d) Entirely uniformly from the skin and the centre of the body

19. Which is the radiation dose radiation dose subjected to a baby who undergoes an MRI (In terms of number of chest X ray)

    a) 1 chest X ray

    b) 8 chest X ray

    c) 15 chest X ray

    d) 0 chest X ray

20. Which of the following patient is more sensitive to ionising radiation?

    a) One year old male

    b) 20-year-old female

    c) 40-year-old male

    d) Damage risk is not dependent on the patient's age and gender

21. What is the best screening modality for diagnosing breast cancer?

    a) Mammography

    b) Biopsy

    c) FNAC

# ANNEXURES – II

## KEY TO MASTER CHART

| | | |
|---|---|---|
| Y | : | yes |
| N | : | No |
| PG | : | Post graduates |
| JC | : | Junior consultants |
| SC | : | Senior consultants |
| HOD | : | Head of the department |
| Prof | : | Professor |

# ANNEXURES – III - MASTER CHART

Question numbers in the below data sheet are in order with the above questionnaire

| SL NO | AGE | SEX | Q3 | Q4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17A | 17B | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 32 | F | PG | FRIENDS | A | Y | A | B,D | A | Y | N | Y | A | Y | N | D | Y | Y | A | A | D | A |
| 2 | 45 | M | SC | INTERNET | B | Y | C | B,D | A | Y | Y | N | A | Y | Y | D | N | N | B | A | A,D | A |
| 3 | 28 | F | JC | COLLEAGUES | B | Y | B | B,D | C | Y | Y | Y | A | Y | Y | D | N | N | D | B | C,D | A |
| 4 | 42 | M | SC | CONFERENCE | B | Y | B | D | A | Y | Y | Y | A | Y | Y | D | N | N | B | D | C,D | A |
| 5 | 27 | M | JC | CME | B | Y | B | B,D | A | Y | N | Y | E | Y | Y | D | N | N | A | A | B | A |
| 6 | 37 | M | PG | INTERNET | A | N | B | D | A | Y | Y | N | E | N | Y | D | Y | Y | C | D | D | A |
| 7 | 37 | M | PG | COLLEAGUES | B | Y | A | D | A | Y | Y | Y | B | Y | Y | D | N | N | B | C | A,D | A |
| 8 | 31 | F | PG | FRIENDS | B | Y | B | C,D | A | Y | N | Y | A | Y | N | D | N | N | A | B | D | A |
| 9 | 44 | M | SC | CME | A | Y | C | B,D | A | Y | N | Y | D | Y | Y | D | N | N | B | D | D | A |
| 10 | 36 | M | PG | WORKSHOP | A | Y | B | B,D | A | Y | Y | Y | A | Y | Y | D | N | N | B | A | B,D | A |
| 11 | 35 | F | PG | CONFERENCE | B | Y | B | B,D | A | Y | N | Y | C | Y | Y | D | N | N | A | D | B,D | A |
| 12 | 39 | F | PG | WORKSHOP | A | N | B | B,D | A | Y | N | N | B | N | Y | D | N | N | C | B | D | A |
| 13 | 29 | M | PG | INTERNET | B | Y | B | B,D | A | Y | Y | N | A | Y | Y | D | N | N | B | D | D | A |
| 14 | 56 | M | PROF | CME | B | Y | C | B,D | A | Y | Y | Y | B | Y | Y | D | N | N | C | A | A,D | A |
| 15 | 33 | M | PG | WORKSHOP | B | Y | B | D | A | Y | Y | Y | D | Y | Y | D | N | N | D | C | C,D | A |
| 16 | 36 | M | PG | COLLEAGUES | A | N | B | B,D | A | N | Y | Y | E | Y | N | D | N | N | A | B | A,D | A |
| 17 | 29 | F | PG | COLLEAGUES | A | N | B | C,D | A | Y | N | N | A | Y | Y | D | N | N | A | D | A,D | A |
| 18 | 37 | M | PG | CME | A | Y | B | B,D | A | Y | Y | Y | A | Y | Y | D | Y | Y | B | D | A,D | A |
| 19 | 30 | M | PG | INTERNET | C | Y | C | C,D | A | Y | N | N | A | N | Y | D | N | N | C | A | C,D | A |
| 20 | 56 | M | PROF | CONFERENCE | B | Y | B | B,D | A | Y | N | Y | A | N | Y | D | N | N | B | D | D | A |
| 21 | 34 | M | PG | WORKSHOP | A | Y | B | B,D | A | Y | Y | Y | E | Y | Y | A | N | N | B | B | A,D | A |
| 22 | 37 | F | PG | COLLEAGUES | B | N | B | B,D | A | Y | N | N | B | Y | Y | D | N | N | C | D | D | A |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | 35 | M | PG | CME | B | Y | C | B,D | A | Y | Y | Y | D | Y | Y | D | N | N | B | A | C,D | A |
| 24 | 47 | M | PROF | INTERNET | B | Y | B | D | A | N | Y | Y | C | Y | Y | D | N | N | A | B | C,D | A |
| 25 | 43 | F | SC | WORKSHOP | B | Y | C | D | A | Y | Y | Y | A | Y | Y | D | N | N | C | D | D | A |
| 26 | 28 | F | JC | FRIENDS | B | Y | B | B,D | A | Y | Y | Y | A | Y | N | D | N | Y | D | A | B,D | A |
| 27 | 60 | M | HOD | INTERNET | B | Y | B | E | A | Y | Y | N | C | Y | Y | D | N | Y | D | A | D | A |
| 28 | 30 | M | PG | CONFERENCE | A | Y | B | B,D | A | Y | N | N | A | Y | Y | D | N | Y | D | D | A,D | A |
| 29 | 39 | M | JC | CONFERENCE | C | Y | B | D | A | Y | N | Y | C | N | Y | D | N | Y | B | B | A,D | A |
| 30 | 51 | F | HOD | INTERNET | B | N | B | B,D | A | Y | Y | Y | A | Y | Y | D | N | Y | D | A | B | A |
| 31 | 28 | F | JC | FRIENDS | B | Y | C | B,D | A | Y | Y | Y | A | Y | Y | D | Y | Y | A | A | A,D | A |
| 32 | 36 | M | PG | WORKSHOP | A | Y | B | D | A | N | Y | N | E | Y | Y | D | N | Y | C | A | A,D | A |
| 33 | 27 | M | JC | INTERNET | B | Y | B | B,D | A | N | Y | Y | A | Y | Y | D | N | Y | D | A | D | A |
| 34 | 57 | F | HOD | CONFERENCE | A | Y | B | B,D | A | Y | Y | Y | A | Y | Y | D | N | Y | D | D | D | A |
| 35 | 31 | F | PG | COLLEAGUES | A | Y | B | D | A | Y | N | N | A | Y | Y | D | N | Y | B | C | A,D | A |
| 36 | 37 | M | PG | INTERNET | B | Y | C | D | A | Y | Y | Y | A | N | Y | D | N | Y | C | D | D | A |
| 37 | 30 | M | PG | CME | B | Y | B | B,D | A | Y | N | Y | A | Y | Y | D | N | Y | A | A | A,D | A |
| 38 | 55 | F | PROF | COLLEAGUES | A | Y | B | E | A | Y | Y | Y | B | Y | Y | D | N | Y | D | D | A,D | A |
| 39 | 28 | M | JC | FRIENDS | B | Y | B | B,D | A | N | Y | N | D | Y | Y | D | N | Y | C | D | D | A |
| 40 | 39 | F | PG | CONFERENCE | A | Y | B | D | A | Y | N | Y | A | Y | Y | D | Y | Y | B | B | D | A |
| 41 | 29 | M | PG | WORKSHOP | C | Y | B | B,D | A | N | Y | Y | E | Y | Y | D | Y | Y | D | A | D | A |
| 42 | 41 | M | SC | INTERNET | B | N | C | B,D | A | N | Y | N | A | Y | Y | D | N | Y | C | A | C,D | A |
| 43 | 32 | F | PG | CONFERENCE | B | N | B | B,D | A | Y | N | Y | A | N | Y | D | N | Y | D | D | A,D | A |
| 44 | 38 | F | JC | FRIENDS | B | Y | B | D | A | Y | Y | Y | A | Y | Y | D | N | Y | A | D | D | A |
| 45 | 33 | M | PG | CME | A | Y | B | B,D | A | N | Y | N | A | Y | Y | D | N | Y | C | D | D | A |
| 46 | 42 | M | SC | INTERNET | B | Y | B | D | A | Y | N | Y | A | Y | Y | D | N | Y | B | A | D | A |
| 47 | 45 | M | SC | INTERNET | A | Y | C | D | A | Y | Y | Y | A | Y | Y | D | Y | Y | C | A | D | A |
| 48 | 35 | M | PG | CME | C | N | B | D | A | Y | N | Y | D | Y | Y | D | N | Y | D | D | D | A |
| 49 | 41 | F | SC | COLLEAGUES | A | Y | B | D | A | N | Y | N | A | Y | Y | D | Y | Y | D | D | D | A |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 50 | 36 | M | PG | CONFERENCE | A | N | B | B,D | A | Y | Y | Y | E | N | Y | D | N | Y | B | B | D | A |
| 51 | 29 | M | PG | INTERNET | B | Y | C | B,D | A | Y | N | Y | B | Y | Y | D | N | Y | A | D | A,D | A |
| 52 | 49 | M | PROF | WORKSHOP | A | N | B | B,D | A | Y | Y | Y | A | Y | Y | D | N | Y | B | D | D | A |
| 53 | 36 | F | PG | COLLEAGUES | A | Y | B | D | A | Y | Y | N | A | Y | Y | D | N | Y | B | A | B,D | A |
| 54 | 33 | M | PG | INTERNET | B | N | B | B,D | A | Y | Y | Y | A | Y | Y | D | N | Y | C | D | A,D | A |
| 55 | 38 | F | PG | CONFERENCE | A | Y | B | B,D | A | N | Y | Y | D | Y | Y | D | N | Y | C | D | A,D | A |
| 56 | 35 | F | PG | COLLEAGUES | B | N | C | D | A | Y | Y | Y | A | Y | Y | D | N | Y | B | A | D | A |
| 57 | 41 | M | SC | CME | B | Y | B | D | A | Y | N | N | A | Y | Y | D | N | Y | B | D | D | A |
| 58 | 30 | F | PG | CME | C | Y | B | B,D | A | N | Y | Y | C | Y | Y | D | N | Y | C | D | D | A |
| 59 | 40 | F | PG | INTERNET | A | N | C | B,D | A | Y | Y | Y | A | Y | Y | D | N | Y | B | A | A,D | A |
| 60 | 28 | F | JC | FRIENDS | B | Y | C | A | A | Y | Y | Y | A | N | Y | D | N | Y | D | A | B | A |
| 61 | 39 | M | PG | CME | B | N | B | D | A | Y | Y | Y | D | Y | Y | A | N | Y | B | D | A,D | A |
| 62 | 37 | F | PG | INTERNET | B | Y | B | D | A | Y | Y | N | A | Y | N | B | N | Y | C | B | A,D | A |
| 63 | 29 | M | PG | COLLEAGUES | B | Y | B | B,D | A | Y | Y | Y | E | Y | Y | D | N | Y | B | D | A,D | A |
| 64 | 42 | M | SC | CONFERENCE | B | N | C | B,D | A | Y | Y | Y | B | Y | Y | D | N | Y | C | A | D | A |
| 65 | 30 | F | PG | CONFERENCE | B | Y | C | B,D | A | N | Y | N | A | Y | Y | D | N | Y | B | C | D | A |
| 66 | 45 | M | SC | WORKSHOP | B | Y | C | B,D | C | Y | Y | Y | A | Y | Y | D | N | Y | D | D | D | A |
| 67 | 36 | F | PG | INTERNET | C | N | B | B,D | A | Y | Y | Y | B | Y | Y | D | N | Y | B | A | D | A |
| 68 | 33 | M | PG | FRIENDS | B | Y | B | B,D | A | Y | Y | Y | A | Y | Y | D | N | Y | B | D | A,D | A |
| 69 | 39 | F | JC | FRIENDS | B | Y | B | B,D | A | Y | N | N | A | Y | Y | D | N | Y | C | D | D | A |
| 70 | 45 | M | SC | CME | B | N | B | B,D | A | Y | Y | Y | C | Y | Y | D | N | Y | B | A | A,D | A |
| 71 | 30 | M | PG | INTERNET | B | Y | C | B,D | A | Y | Y | Y | A | Y | Y | D | Y | Y | B | C | A,D | A |
| 72 | 39 | M | PG | COLLEAGUES | B | Y | B | D | B | Y | Y | Y | D | N | Y | D | N | Y | D | D | D | A |
| 73 | 44 | F | SC | CONFERENCE | B | N | B | B,D | A | N | Y | N | A | Y | Y | D | N | Y | B | D | A,D | A |
| 74 | 37 | M | PG | CME | C | Y | B | B,D | A | Y | Y | Y | A | Y | Y | D | N | Y | D | A | C,D | A |
| 75 | 28 | M | JC | FRIENDS | B | Y | C | B,D | B | N | Y | Y | C | Y | Y | A | N | Y | B | A | B | A |
| 76 | 36 | M | PG | CONFERENCE | B | Y | B | B,D | A | Y | Y | N | A | Y | Y | D | N | Y | C | A | D | A |

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 | 52 | M | SC | INTERNET | B | Y | B | B,D | A | Y | Y | Y | A | Y | Y | D | N | Y | B | D | A,D | A |
| 78 | 38 | F | PG | WORKSHOP | B | Y | C | D | A | Y | Y | Y | D | Y | N | D | Y | Y | D | D | B,D | A |
| 79 | 38 | M | JC | COLLEAGUES | B | N | B | D | A | Y | Y | N | A | Y | Y | D | N | Y | B | A | A,D | A |
| 80 | 48 | M | PROF | CONFERENCE | B | Y | B | D | B | Y | N | Y | A | Y | Y | D | N | Y | D | D | D | A |
| 81 | 27 | F | JC | WORKSHOP | B | Y | B | B,D | B | Y | Y | Y | A | Y | Y | D | N | Y | D | D | A,D | A |
| 82 | 41 | F | SC | CONFERENCE | B | Y | C | B,D | A | Y | Y | N | A | N | Y | D | N | Y | B | A | C,D | A |
| 83 | 39 | M | JC | COLLEAGUES | B | Y | B | D | A | N | Y | Y | E | Y | Y | D | N | Y | D | A | A,D | A |
| 84 | 38 | F | PG | CME | B | N | B | D | A | Y | Y | N | A | Y | N | A | N | Y | B | C | D | A |
| 85 | 50 | M | HOD | CME | C | Y | B | B,D | B | Y | Y | Y | A | Y | Y | D | N | Y | B | A | D | A |
| 86 | 42 | F | SC | WORKSHOP | B | N | B | D | A | N | Y | Y | A | Y | Y | D | N | Y | D | D | D | A |
| 87 | 28 | M | JC | FRIENDS | B | Y | B | B,D | A | Y | Y | N | B | Y | Y | D | N | Y | D | D | A,D | A |
| 88 | 49 | M | SC | CME | B | Y | B | D | A | Y | N | Y | A | Y | Y | D | N | Y | B | A | B | A |
| 89 | 45 | F | PROF | CONFERENCE | B | Y | C | B,D | A | Y | Y | Y | A | Y | Y | D | N | Y | C | D | D | A |
| 90 | 47 | M | SC | CME | B | Y | B | B,D | A | Y | Y | N | A | Y | N | D | N | Y | B | A | A,D | A |
| 91 | 40 | M | JC | COLLEAGUES | B | Y | B | D | B | Y | Y | Y | A | Y | Y | D | N | Y | B | D | A,D | A |
| 92 | 50 | F | PROF | WORKSHOP | C | Y | B | D | A | Y | Y | N | C | Y | Y | D | N | Y | D | D | D | A |
| 93 | 52 | M | HOD | CME | B | N | C | D | A | N | Y | N | A | N | Y | D | Y | Y | B | A | A,D | A |
| 94 | 32 | M | PG | CME | B | Y | B | B,D | A | N | Y | Y | A | Y | Y | D | N | Y | D | D | B,D | A |
| 95 | 40 | F | JC | CONFERENCE | B | Y | B | D | A | Y | Y | Y | D | Y | N | D | N | Y | B | A | B | A |
| 96 | 38 | M | JC | COLLEAGUES | B | Y | C | D | A | Y | Y | N | A | Y | Y | D | N | Y | B | D | A,D | A |
| 97 | 45 | F | SC | COLLEAGUES | B | Y | B | D | A | Y | Y | N | A | Y | Y | D | N | Y | C | A | D | A |
| 98 | 36 | M | PG | CME | B | Y | B | B,D | A | Y | Y | Y | D | Y | Y | D | N | Y | B | C | A,D | A |
| 99 | 37 | M | PG | WORKSHOP | B | N | B | D | A | Y | Y | N | A | N | Y | D | N | Y | D | A | A,D | A |
| 100 | 44 | M | SC | COLLEAGUES | B | Y | B | D | A | Y | Y | Y | B | N | Y | D | N | Y | B | D | A,D | A |