Radiography Open

ISSN: 2387-3345 Volum 3, No 1 (2017) http://dx.doi.org/10.7577/radopen.1994

Awareness regarding radiation knowledge among clinicians practicing in Bharatpur, Nepal

Author:
Jayanti Gyawali[1], Mukesh Mallik[2], Deepak Adhikari[2], Sanjay Sah[2], Pooja Shah[3], Surendra Maharjan[4]

[1]Martyrs Memorial Institute of Science and Technology (MMIST), Kathmandu, Nepal
[2]Chitwan Medical College, Chitwan, Nepal [3]Kathmandu School of Medical Technology (KSMT), Kathmandu, Nepal [4]National Academy of Medical Science (NAMS), Bir Hospital, Kathmandu, Nepal

Corresponding author: Jayanti Gyawali (jayantigyawali@gmail.com)

PEER REVIEWED ARTICLE

Keywords: radiation knowledge, radiologists, knowledge, radiation responsibility

Abstract

Missed lung lesions are one of the most frequent causes of malpractice issues, caused by several reasons; among them suboptimal radiography. When radiographers interpret acquired images of a patient, an acceptance or rejection must be decided. When a retake is required, radiographers need to know how to improve the image quality. Improvements in image quality properties as contrast, sharpness and noise often lead to improved perception, which in turn should enable more information to the observer and also allow computer-assisted detection (CAD) to be more successful.

Introduction

Numerous attempts of radiation protection is inserted all across the globe since the inception of x-radiation for medical purpose.[1] The highest radiation exposure to human beings from ionizing radiation comes from medical exposure.[2] Further, the application of radiation in medicine has been increasing exponentially and the radiation going unmonitored with no standard Radiation Protection Act in Nepal; it has become a demanding task to ensure the radiation safety of radiation professionals and patients. Moreover, there is no exact report in Nepal regarding the victims of

radiation injuries, radiation-induced cancer patients and other adverse effects until present.
It is pleasing to notice the incomparable mission of International Atomic Energy Agency (IAEA) and International Commission on Radiation Protection (ICRP) to educate radiation workers, medical professionals, patients as well as public. Clinical professionals are competent in estimating clinical benefits to an individual patient from a radiological procedure.[3] However, it is highly important to undertake the associated radiation risk. The radiation protection principles, as laid down by ICRP are justification and optimization.[4] Justification requires that the benefit for the patient always outweigh the adjunct risk and the net benefit should be positive. Justification comes under the domain of referring physicians. On basis of papers that has been published so far, 20-40% of CT scans could be avoided if clinical decision guidelines were followed, although some studies provide still bigger data.[5] Again, the magnitude of inappropriate radiological examinations in Nepal is missing. About 3.6 billions diagnostic radiological examinations are performed globally, every year, and if we take an average of 30%, it amounts to 1.08 billion examinations per year. Such a huge figure demands international attention and action.[6] Meanwhile, we aim to bring a snapshot of the status of radiation practice and the level of awareness of radiation protection among clinicians through a questionnaire survey.

Methods

A cross-sectional hospital-based study was carried out in three hospitals, namely Chitwan Medical College (CMC), College of Medical Sciences (CMS) and BP Koirala Memorial Cancer Hospital (BPKMCH). The study was conducted from June to August 2015 in Bharatpur sub-metropolitan city of Chitwan, Nepal. All the clinicians willing to participate were included whereas those uninterested ones were excluded. Random sampling technique was adopted to select the respondents from each three hospitals. Self-administered semi-structured questionnaire survey was designed after reviewing a number of literatures related to this study. The survey was divided into three sections, viz. socio-demographic characteristics (age, gender, academic qualification, specialization, work experience and attendance of training course on radiation protection), current practice of radio-diagnosis and knowledge regarding radiation protection. There were 20 questions, 10 covering practical aspects of radiological examinations and another 10 determining the level of knowledge regarding radiation protection. After informed consent of the respondents was obtained by clarifying the objectives, the questionnaire was administered to the clinicians. They were also assured that the questionnaire will be kept strictly confidential, and the exercise is wholly voluntary and the individuals are free to discontinue at any point of time of data collection. Participants were handed out the hardcopy survey by the author herself and are requested to complete within twenty minutes. Each correct answer was assigned 1 score and there was no negative markings for wrong answers.

Ethical consideration

The ethical approval was obtained from Institutional Review Board (IRB) of CMC. The admini-strative approval was obtained from the concerned authority of both CMS and BPKMCH as well.

Data analysis

Data; mean score of knowledge and the practice of respondents from three hospitals; were analyzed by SPSS version 20, Chicago, USA. Terms were descriptive statistics. Analysis of variance test analyzed the mean difference in the knowledge and practice score of three hospitals, and p-value <0.05 were considered statistically significant. Correlation between knowledge and practice were calculated, and subjected to test at 5% level of significance.

Results

The findings of the study are presented into three parts. They are socio-demographic characteristics of respondents, current practice of respondents and knowledge regarding radiation protection of the respondents. In this study, there were 60 participants (44 male and 16 female) with mean age 32.30±6.40 years, maximum 52 and minimum 24. There were 24 participants from CMC and 18 from both CMS and BPKMCH. There were 30 (50%) respondents in ≤30 year age group, 24 in (31-40) years followed by 6 in >40 years age group. The maximum number of participants was from Bachelor of Medicine and Bachelor of Surgery (MBBS) 21, followed by Surgery 12, Obstetrics/Gynecology 7, Orthopedics 6, Oncology 4, Ear Nose and Throat (ENT), General Physician (GP) and Psychiatry 3 and Pediatrics 1. The majority of individuals were MBBS graduates 21 whereas residents, postgraduates and PhD graduates were 6, 32 and 1 respectively. There were equal number of candidates in <2 years and 2-4 years grouping of work experience, each 23 whereas in >4 years, there was only 14. Majority of participants (42/60) had not attended any kind of training of radiation protection whereas remaining others had taken it. Among 18 clinicians who have attended the training, 7 individuals have participated in 1 day training and 6 clinicians have taken part in 1 week training respectively.

Table 1: Socio-demographic characteristics

	Frequency	Percentage
Name of Hospital		
CMC	24	40
CMS	18	30
BPKMCH	18	30
Total	60	100

Table 1 (continued): Socio-demographic characteristics

	Frequency	Percentage
Age group		
≤30 years	30	50
31-40 years	24	40
>40 years	6	10
Total	60	100
	Frequency	Percentage
Gender		
Male	44	73
Female	16	27
Total	60	100
Specialization		
Ear Nose Throat (ENT)	3	5
Surgery	12	20
General Physician	3	5
BSc of Medicine and Bachelor of Surgery (MBBS)	21	35
Oncology	4	7
Obstetrics/ Gynecology	7	12
Orthopedics	6	10
Pediatrics	1	2
Psychiatry	3	52
Total	60	100
Qualification		
BSc of Medicine and Bachelor of Surgery (MBBS)	21	35
Resident	6	10
Postgraduate	32	53
PhD	1	2
Total	60	100

Experience		
<2 years	23	38
2-4 years	23	38
>4 years	14	23
Total	60	100
Training		
Yes	18	30
No	42	70
Total	60	100
Duration of Training		
1 day	7	12
2 days	2	3
3 days	1	2
1 week	6	10
2 weeks	2	3

Current practice of radio-diagnosis

It was resulted that 19 were referred on requirement of radiation dose; six on the basis of impact on treatment, three on the basis of diagnostic advantage followed by 32 referrals according to the wish of the patient. It was identified that 32(53%) were unaware of referral practice or they neglect the referral guidelines. Most of the clinicians opted to work in CT scan (60%), Ultrasonography (USG) (58%) and Radiography (56%), followed by Magnetic Resonance Imaging (MRI) at 20%. Few preferred Fluoroscopy (10%), Mammography (8%) and Dental Radiography (2%). Radiography, CT scan and Mammography utilize ionizing radiation whereas MRI uses radio waves and USG works with sound waves. Surprisingly, 10% and 5% of the participants had misconception that MRI and USG are safe during pregnancy period. This depicted that they lack knowledge of application of non-ionizing radiation in MRI and USG. 33% of the clinicians referred cases just to satisfy patients whereas 67% stated that they had referred for radiological investigations not to fulfill the desire of the patients. For breast nodule in 25 years old female, 43% responded with USG and 57% preferred Mammography. It may be noticed; that 34 physicians were unaware of the correct choice of modality for a breast nodule. Mammography is useful examination above 35 years of age. It uses x-radiation and is not preferred in young females owing to the adverse effects of radiation on reproductive health. It was accounted that 55/60 respondents preferred USG abdomen over obstetric scan for complains of abdominal pain in first trimester of pregnancy. Again, 28% had good perception about imaging modality required for USG suspicious of Common Bile Duct (CBD) calculus, as their preference was Magnetic Resonance Cholangio-Pancreaticography (MRCP). MRCP is MR technique for the visualization of hepatobiliary and pancreatic system.

On its counterpart, Endoscopic Retrograde Cholangio-Pancreaticography (ERCP) is an invasive procedure. 28% were less sensitive about the radiolucent nature of the CBD calculus and responded with CT scan (25%) and abdominal radiography (3%). Similarly, 7% would like to perform USG abdomen although repetitive scans do not add diagnostic value.

Table 2: Current practice of radio-diagnosis

	Frequency	Percent
Condition for referral		
Wish of the patient	32	53
Impact on treatment	6	10
Impact on diagnosis	3	5
Total	60	100

Table 2 (continued): Current practice of radio-diagnosis

Preferred working modality of clinicians		
Radiography	34	57
CT Scan	36	60
Ultrasound	35	58
Mammography	5	8
Fluoroscopy	6	10
MRI	12	20
Dental Radiography	1	2

Not preferred for pregnant women		
Radiography	42	70
CT Scan	46	77
MRI	6	10
Mammography	13	22
Ultrasound	3	5
Total	60	100

Referral to satisfy patient		
Yes	20	33
No	40	67
Total	60	100

Modality for Breast Nodule in a 25 years female		
Mammography	34	57
Ultrasonography	26	43

Modality for pregnant women in first trimester with abdominal pain		
Obstetric Ultrasonography	5	8
Abdominal Ultrasonography	55	92

Preferred Modality for suspicious Common Bile Duct (CBD) calculus diagnosed in Ultrasound		
CT Scan	15	25
Endoscopic Retrograde Cholangio-Pancreaticography (ERCP)	22	37
Magnetic Resonance Cholangio-Pancreaticography (MRCP)	17	28
USG	4	7
Abdominal Radiography	2	3
Total	60	100

Knowledge regarding radiation

To our best surprise, 8% of the participants had misperception regarding the hazardous effects of radiation usage in MRI. 88% of the respondents clearly marked that fetus as the most radiosensitive age group. Similarly, again, there were 88%, who correctly resolved the most radiosensitive period of pregnancy as first trimester. Intestine with the most rapidly proliferating cells are the most radiosensitive organ identified by only 2%. Majority of the individuals misinterpreted intestine with

gonads (50%) and thyroid (43%). Fewer people also replied with skin (5%). The so-called 'ten day rule' of menstruation period, means ten days from the 1st to the 10th day of menstruation. Only 28% had clear idea about this rule, whereas other 72% were blind to it. The knowledge about radiation measurement was assessed by asking the dose equivalence of number of chest radiographs for the dose of one CT chest. Only 5% became able to give correct answer with 400 chest x-rays. Other 95% could not materialize on this topic. It was pleasing to notice that 90% of the participants had quite good knowledge that radiation has both genetic and carcinogenic effects. Nonetheless, it was quite disappointing to note that 32% had misconception that x-ray room emits x-radiation after x-ray examination. Further, the knowledge on radiation level of different modalities was monitored. Only 27% could properly arrange CT scan, fluoroscopy, mammography and general radiography in ascending order, on basis of radiation dose emitted by them. It was imperative that 73% had poor knowledge regarding radiation dose imparted by these modalities.

Table 3: Current practice of radio-diagnosis

	Frequency	Percentage
Hazardous investigation due to diagnostic radiation		
Radiography	42	70
CT	52	87
MRI	5	8
Fluoroscopy	30	50
Most radiosensitive age group		
Child	7	12
Fetus	53	88
Total	60	100

Table 3 (continued): Current practice of radio-diagnosis

	Frequency	Percentage
Sensitive period during pregnancy		
First trimester	53	88
Second trimester	7	12
Total	60	100
Radiosensitive organ		
Intestine	1	2
Thyroid	26	43
Skin	3	5
Gonads	30	50
Total	60	100
Ten days rule		
Within 10 days of menstruation	17	28
After 10 days of menstruation	17	28
Before 10 days of menstruation	6	10
In between 10-20 days of menstruationes	20	33
Total	60	100

Table 3 (continued): Current practice of radio-diagnosis

One CT chest equals how many chest x-rays		
100	35	58
300	10	17
400	3	5
500	12	20
Total	60	100

Radiation Effects		
Mutation	3	5
Carcinoma	3	5
Both	54	90
Total	60	100

Objects in x-ray room emit x-radiation		
Yes	19	32
No	41	68

Arrangement of modalities from lower to higher		
Correct	16	27
Incorrect	44	73

Table 4: Mean knowledge score and practice score obtained by the respondent

Domain	Mean score	SD	Range	Percentage
Knowledge	6	1.49	0-12	53
Practice	5	1.67	0-9	61

Table 4 shows the mean knowledge score was found being 6.25 with the standard deviation of 1.49 (6.25±1.49 S.D). The maximum score is ten and the minimum score is three out of 12. Similarly, the mean practice score obtained by the respondent was 5.45 with the standard deviation of 1.67 (5.45±1.67 S.D). The maximum score is 9; and the minimum score is 2 out of 9.

Table 5: Mean difference in knowledge score in three different hospitals

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.40	2	1.70	.759	.473
Within Groups	127.85	57	2.24		
Total	131.25	59			

Table 5 shows the mean difference in knowledge score in three hospitals is statistically non-significant ($p>0.05$) *i.e.* the knowledge level of physicians in all three hospitals is similar.

Table 6: Multiple comparisons of three hospitals

Dependent Variable: Knowledge score Bonferroni						
(I) hospital	(J) hospital	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper
CMC	CMS	.06944	.46697	1.000	-1.0824	1.2213
	BPKMCH	-.48611	.46697	.907	-1.6380	.6658
CMS	CMC	-.06944	.46697	1.000	-1.2213	1.0824
	BPKMCH	-.55556	.49921	.811	-1.7870	.6758
BPKMCH	CMC	.48611	.46697	.907	-.6658	1.6380
	CMS	.55556	.49921	.811	-.6758	1.7870

Table 6 shows the pair wise comparisons of different hospital and it revealed that there is no significant difference in knowledge scores in each pair ($p>0.05$).

Table 7: Mean difference in practice score in three hospitals

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	23.906	2	11.953	4.834	.012
Within Groups	140.944	57	2.473		
Total	164.850	59			

Table 7 shows the mean difference in the practice score of three different hospitals undertaken by using ANOVA in SPSS. The mean difference in three different hospitals is found statistically significant ($p<0.05$) i.e. among three hospitals, there is one or more combination where one hospital is superior in practice score.

Table 8: Multiple comparison of three hospitals
Dependent Variable: practice score Bonferroni

(I) hospital	(J) hospital	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CMC	CMS	.61111	.49031	.653	-.5983	1.8205
	BPKMCH	-1.00000	.49031	.138	-2.2094	.2094
CMS	CMC	-.61111	.49031	.653	-1.8205	.5983
	BPKMCH	-1.61111*	.52416	.010	-2.9041	-.3182
BPKMCH	CMC	1.00000	.49031	.138	-.2094	2.2094
	CMS	1.61111*	.52416	.010	.3182	2.9041
* The mean difference is significant at the 0.05 level.						

Table 8 shows the pair wise comparisons between two different hospitals. It revealed that the mean difference in practice scores of CMS and BPKMCH is significant ($p<0.05$) i.e. the practice in BPKMCH is superior to that in CMS.

Table 9: Correlation between knowledge and practice

Correlation between	Correlation coefficient	p – value
Knowledge and practice	0.396	0.002*

Table 9 shows the correlation between mean knowledge score and practice score of the respondents. Karl Pearson's Correlation Coefficient ($r=0.396$) revealed that there is weak positive correlation between knowledge and practice but was found statistically significant at 0.05 level ($p=0.002$).

Discussion

This was the ever first prospective multihospital survey, in Nepal, among referring physicians that assessed the knowledge and current practice regarding radiation protection. The study comprised of their understanding about radiological examinations, radiation doses, radio-sensitivity, and exposure during pregnancy and their current practice of referral practice. The mean knowledge score was only 52% and the mean current practice was 61%. The difference in the mean score of knowledge and practice might have resulted due to clinician's habituation with the practice. However, they have not updated their knowledge regarding radiation protection. It is clear that majority of patients (53%) were referred according to their will. Clinicians did not undertake the radiation dose delivered to the patient; in addition they were also less conscious about the importance of radiological investigation for proper treatment and management strategies. One-third of the referrals were accounted to satisfy the patient, which contradicted 53% referrals of patient's own will. This signifies that clinicians really do not care whether they are satisfied or not. Haphazard and unjustified radiological examination not only irradiates patients with unnecessary dose but it also produces huge financial burden to the families of the patients. This study further showed that clinicians have not updated themselves on advancement in imaging modalities. Magnetic Resonance Cholangio-Pancreaticography (MRCP) was preferred by 28% clinicians; among patients with USG suspected common bile duct (CBD) calculus. As CBD calculus is radiolucent in nature due to its high cholesterol content, it is not preferred modality for USG suspected CBD calculus. ERCP, preferred by 37%, although is a standard investigation to diagnose CBD calculus is not yet a good option as ERCP is an invasive method.

MRCP preferred by only 28% of clinicians is a non-invasive method and do not use ionizing radiation as well. Accordingly, MRCP is the best preferred modality for USG suspected CBD calculus. To our best surprise, 8% of clinicians have misperception that MRI utilizes ionizing radiation and possess adverse

consequences to human health. Similarly, 32% believed that objects in the x-ray room emit X-radiation after termination of X-ray exposure. This study also revealed that clinicians are also not aware about radio sensitivity and its hazard towards organs. The intestine with the most rapidly proliferating cells, is the most radiosensitive organ but was identified correctly by only 2% (n=1) respondent among 60 respondents. Most of the respondents had misconception that gonads and thyroid are most radiosensitive organs. Half of the respondents *i.e.* 50% (n=30) gave their response as gonads while 43% (n=26) the thyroid. Most often in informal talks or jokes cracked among clinicians' mostly associate radiation and sterility. It may be that people are more attentive towards the social understanding, which is sterility in our context. Thus, this might be the reason of half of the respondents to give their response as gonads. However, it is demonstrated that the clinicians are not aware about the ten days rule. Only 28% could answer it correctly. It means the majority of respondents would refer the female patients for the radiological investigations associated with ionizing radiation without asking their last menstrual period. This referral pattern not only degrades the present health status of the fertile population of the country due to primary effect of radiation, but also may lame our future generation because of genetic effects. Thus, this paper has elucidated the need to inform referring clinicians about the rapidly advancing field of imaging through workshops and Continuing Medical Education (CME) programs.

Radiation protection in medicine acquire the concepts of justification and optimization. Numerous papers in medical databases address the knowledge of radiology professionals regarding radiation protection and its practical implementation. However, there are only plenty of papers relating perception of radiation protection among referring physicians. Borgen and Stranden[7] conducted a questionnaire survey in Norway among 46 radiologists and 36 radiographers. They concluded that radiographers estimated the highest proportion of referrals most unlikely to affect treatment. Radiologists and radiographers possess better radiation knowledge than referring clinicians. Borgen, Stranden and Espeland[8] conducted a questionnaire survey in Norway among 213 clinicians. Their mean radiation knowledge score was 43%. They stated that limited radiation knowledge and usage of guidelines indicated suboptimal justification of referrals. When justifying an imaging procedure, weighting of radiation dose hold a significant role than detailed radiation knowledge.
Bautista et al[9] carried out a similar study among 126 physicians (59 residents and 67 attending physicians). They investigated the utility of American College of Radiology (ACR) appropriateness criteria by referring physicians' decision-making about imaging in the management of their patients[10] and they depicted low utilization of ACR guidelines. The guidelines use evidence-based criteria designed by expert panels in diagnostic imaging, interventional radiology and radiation oncology. Malone et al[11] (2014) also identified there is a need for improved communication both within professions and between

professionals on one hand and between professionals and the patients on the other. They concluded that justification would be facilitated by three "A's", namely: Awareness, Appropriateness and Audit.

Nepal became a member of International Atomic Energy Agency (IAEA) in 2008.[12] Although there are web-forums, internet based online learning courses and trainings available from IAEA; the bandwidth of such activities has probably not become satisfactory for a range of developing nations like Nepal. This, in turn supplemented by less maintenance of the radiologic equipment is an additional threat to the secure use of equipment, and for justifying doses. Physicians cannot know for sure if the equipment is okay, and whether the professional work is at good standard. It means even though their knowledge is adequate, there are other parts of the chain that could need for being optimized. Medical doctors are registered under Nepal Medical Council (NMC) in Nepal.[13] There are also national organizations of medical doctors, i.e., Nepal Medical Association (NMA)[14], Nepal Radiologist's Association (NRA)[15] and others should take prompt action to increase the awareness regarding radiation. This study depicts the immediate need to establish a national radiation protection authority, increase the level of knowledge and to regulate the use of radiation in Nepal, also emphasized by Bhatt et al[16] and Subedi et al[17]. Again, the international societies should take better care for the security of physicians and patients till the establishment of radiation act in Nepal. We recommend organizing workshops and training programs regarding radiation protection targeting medical doctors from national and international authorities. The referral guidelines for imaging are illustrated by European Commission (EC).[18]

In order to increase the awareness of clinicians about the radiation protection and radiological imaging methods, this subject should be included during both undergraduate and graduate level in medical schools. Awareness by means of education is the most important factor for proper justification of radiological examinations. It is necessary to introduce standard referral guidelines to reduce the patient's dose in medical exposures. The presence of the easily visible documents within the working offices of the physicians, emphasizing the content of the ionizing radiation over the course of radiological imaging procedures, may be a practical solution when ordering radiological studies. To update clinicians with appropriate knowledge and practice, Continuing Medical Education (CME) programs and workshops should be conducted at governmental or institutional level. Furthermore, National Radiation Protection Act is an urgent need in Nepal.

Conclusion

A study carried out among practicing clinicians of different hospitals on awareness regarding radiation protection revealed that the mean knowledge score was only 52% and the mean current practice was 61%. There is no significant ($p>0.05$) difference in knowledge of clinicians practicing in different hospitals. However, the mean difference in practice scores of different hospitals is significant ($p<0.05$) i.e. hospitals with large volumes of radiological investigation (in our context, a specialized cancer hospital) had better practice as compared to other hospitals. We found that knowledge of clinicians on the awareness of the hazardous of imaging modalities due to radiation safety and its biological effects is lacking. This leads to unnecessary exposure and potentially perilous consequences. Although practice is better in comparison to knowledge, this result might have been due to the clinician's habituation with the practice. However, they have not updated their knowledge regarding radiation protection.

Appendix

Questionnaire Survey

Section A

Code	
Age	
Sex	
Working department	
Working experience	
Highest educational degree	
Specialization	

Attendance of any lecture/training about radiation protection: Yes / No

If yes, please specify:

a.	Duration your study
b.	Formal training provided by INGO/NGO etc.
c.	Symposium or CME
d.	Others

Section B

Current practice of radio diagnosis

1. All of the following are considered when a patient is being referred for imaging except

a.	Radiation dose to patient
b.	Patient's wish
c.	Impact on treatment
d.	Impact on diagnosis

2. Which of these radiological modalities do you work with routinely?

a.	Radiography	e.	MRI
b.	Mammography	f.	Dental Radiography
c.	Fluoroscopy	g.	USG
d.	CT scan	h.	If any other ……

3. Which of the following radiological investigation/s is not preferred for pregnant women due to radiation safety?

a.	USG
b.	Radiography
c.	CT scan
d.	MRI
e.	Mammography

4. Do you refer cases for radiological investigation just to fulfill patient's satisfaction? Yes / No

5. A 25 years female comes with breast nodule, which imaging modality would you recommend?

6. Women at her first trimester comes with complaint of abdominal pain.

Which radiological investigation do you prefer?

7. Which imaging modality would you prefer to the patient with USG suspicion of CBD calculus?

Section C

Knowledge regarding radiation protection

1. Which of these investigation methods are hazardous due to diagnostic radiation?

a.	Radiography
b.	CT
c.	MRI
d.	USG
e.	Fluoroscopy

2. Which of the following age group is most radiosensitive?

a.	Child
b.	Adult
c.	Old population
d.	Fetus

3. Most sensitive period during pregnancy is…

a.	First trimester
b.	Second trimester
c.	Third trimester
d.	None of the above

4. Which of the following organ is most radiosensitive?

a.	Intestine
b.	Thyroid
c.	Skin
d.	Gonads

5. What does ten days rule suggest for radiological investigation?

a.	Within ten days of menstruation
b.	After 10 days of menstruation
c.	Before ten days of menstruation
d.	In between 10-20 days of menstruation

6. One CT chest equals to how many chest X-rays?

a.	100
b.	300
c.	400
d.	500

7. What are the effects of radiation?

a.	Mutation
b.	Carcinoma
c.	Both
d.	None

8. Which of the following cell is most radiosensitive?

a.	Epithelial cell
b.	Nerve cell
c.	Muscle fibred
d.	Gastro-intestinal stem cell

9. After completion of x-ray examination, do objects in the x-ray room emit radiation? Yes / No

10. Arrange the following radiological investigation technique, from lower radiation to higher radiation?

CT
Mammography
General radiography
Fluoroscopy

References

[1] Rehani MM, Holmberg O, López PO, Mettler F. International action plan on the radiation protection of patients. Radiation Protection Dosimetry. 2011 Sep 1;147(1-2):38-42. https://doi.org/10.1093/rpd/ncr259

[2] Rehani MM. The IAEA's activities in radiological protection in digital imaging. Radiation Protection Dosimetry. 2008 Mar 1;129(1-3):22-8. https://doi.org/10.1093/rpd/ncn155

[3] Rehani MM, Berris T. International Atomic Energy Agency study with referring physicians on patient radiation exposure and its tracking: a prospective survey using a web-based questionnaire. BMJ open. 2012 Jan 1;2(5):e001425. https://doi.org/10.1136/bmjopen-2012-001425

[4] International Commission on Radiological Protection (ICRP). The 2007 Recommendations of the International Commission on Radiological Protection. ICRP Publication 103. Ann ICRP 2007;37.2010;(2–4):1–332

[5] Brenner DJ. Medical imaging in the 21st century—getting the best bang for the rad. N Engl J Med 2010;362:943-5. https://doi.org/10.1056/NEJMe1000802

[6] United Nations. Scientific Committee on the Effects of Atomic Radiation. Report of the United Nations Scientific Committee on the Effects of Atomic Radiation, Volume I: Report to the General Assembly, Scientific Annexes A and B. UNSCEAR Report 2008, United Nations, New York, 2008.

[7] Borgen L, Stranden E. Radiation knowledge and perception of referral practice among radiologists and radiographers compared with referring clinicians. Insights into imaging. 2014 Oct 1;5(5):635-40. https://doi.org/10.1007/s13244-014-0348-y

[8] Borgen L, Stranden E, Espeland A. Clinicians' justification of imaging: do radiation issues play a role?. Insights into imaging. 2010 Jul 1;1(3):193-200. https://doi.org/10.1007/s13244-010-0029-4

[9] Bautista AB, Burgos A, Nickel BJ, Yoon JJ, Tilara AA, Amorosa JK. Do clinicians use the American College of Radiology Appropriateness Criteria in the management of their patients?. American journal of roentgenology. 2009 Jun;192(6):1581-5. https://doi.org/10.2214/AJR.08.1622

[10] American College of Radiology. ACR Appropriateness Criteria®. http://www.acr.org/secondarymainmenucategories/quality_safety/app_criteria.aspx (accessed 26 Jan 2012).

[11] Malone J, Guleria R, Craven C, Horton P, Järvinen H, Mayo J, O'reilly G, Picano E, Remedios D, Le Heron J, Rehani M. Justification of diagnostic medical exposures: some practical issues. Report of an International Atomic Energy Agency Consultation. The British journal of radiology. 2012;85(1013):523-8. http://doi.org/10.1259/bjr/42893576

[12] List of IAEA Member States. [Internet]. [Cited 2010 June 16]. Available from: http://www.iaea.org/About/Policy/MemberStates/index.html

[13] Nepal Medical Council. 2017. http://www.nmc.org.np/

[14] Nepal Medical Association. 2017. http://www.nma.org.np/index.php

[15] Nepal Radiologist Association. 2017. http://nra.com.np/ .

[16] Bhatt CR, Widmark A, Shrestha SL, Khanal T, Ween B. Occupational Radiation Exposure in Health Care Facilities. Kathmandu University Medical Journal. 2013 May 1;10(3):48-51.

[17] Subedi KS, Shrestha AB, Sharma P. Status of Radiation Safety and Emerging Challenges in Radiology in Nepal Calling for Strong Safety Measures. Journal of Radiology & Radiation therapy. 2013. 1:1106.

[18] European Commission. Radiation protection 118: Referral guidelines for imaging. Mar. 200