DISMAL AWARENESS ABOUT RADIATION HAZARDS AMONG HEALTHCARE RADIATION WORKERS: POINT TO PONDER?

Nosheen Fatima,[1] Maseeh uz Zaman,[2] Amir Ali,[1] Asad Jalil,[1] Aitadal Moin,[1] Qurratulain,[1] Mishkat Ali Jafri[3]

[1] Department of Nuclear Medicine, Dr. Ziauddin Hospital, Karachi, Pakistan.
[2] Departmant of Radiology, Aga Khan University Hospital, Karachi, Pakistan.
[3] Pakistan Nuclear Ragulatory Authority (PNRA), Karachi, Pakistan.

PJR October - December 2015; 25(4): 154-159

ABSTRACT

OBJECTIVES: To find out core knowledge of healthcare radiation workers like physicians and technical staff including technologists, physicists and nurses and to measure knowledge-gained after attending a one day targeted symposium. **MATERIAL AND METHODS:** Fifty-five participants (21 physicians, 25 technologists, 5 physicists and 4 nurses) attended a one day symposium on ionizing radiation and its hazards for healthcare workers at a tertiary care hospital. The participants were registered from 18 different healthcare facilities having radiology, nuclear medicine and radiation oncology services. Participants were solicited to fill a questionnaire comprised of 15 questions focused upon basic of ionizing radiation, their interaction, biological effects and radiation protection methods before and after the completion of session. **RESULTS:** Mean scores of all participants in pre-session assessment was 45.472% which improved to 60.472% after attending session with a mean difference of 14.527% (*P* <0.0001). Physicians scored significantly better (pre: 54.238%, post: 67.333%) than technical staff (pre: 39.471%, post: 55.088%). Importantly the knowledge-gained after attending session was greater in staff (15.617%) than physicians (13.095%) but not statistically significant (*P* 0.1183). **CONCLUSION:** The level of knowledge about ionizing radiation hazards and radiation protection was not satisfactory in healthcare radiation workers. Physicians had significantly better pre and post session scores than technical staff but knowledge-gained after attending session was not significantly different. Lack of knowledge among radiation workers is a global issue and this is the time to revamp their training programs with a meaningful strategy and International Atomic Energy Agency (IAEA) must take the lead.

Introduction

Radiation based diagnostic imaging in radiology and nuclear medicine is considered as standard of care for diagnosis and management in modern medicine. According to a recent report of National Council for Radiation Protection (NCRP), during the last 30 years there has been a six fold rise in radiation exposure to Americans and this has raised serious concerns about stochastic effects of ionizing radiations.[1] The seminal reason for this unprecedented hike is the overwhelming use of computerized tomography (CT) and nuclear medicine (NM) procedures. Stochastic effects of radiation,especially the cancer risk and genetic abnormalities are the most feared and least understood as probability of these effects has a linear relation with dose and these outcomes usually take 1-2 decades to manifest.[2] This concept is considered

Correspondence : Dr. Nosheen Fatima
Department of Nuclear Medicine,
Dr. Ziauddin Hospital, Karachi, 74700
Pakistan.
Email: nosheen.fatima@ziauddinhospital.com

Submitted 15 August 2015, Accepted 9 September 2015

valid for both patients and for radiation workers as well. Considering the impact of this staggering trend, International Atomic Energy Agency (IAEA)[3] and other professional societies[4] have stressed upon the need of optimization-justification policy, following appropriate use criteria (AUC) and have also suggested various modifications in imaging protocols and hardwares to minimize radiation exposure to patients and technologists. Literature search show various studies from different part of world revealing limited knowledge of health care professionals about radiation risks incurred topatients and themselves during ionizing radiation based procedures and inability tocorrectly answer the patient's queries.[5] Data is very scanty about the awareness of Pakistani healthcare radiation workers about hazards of ionizing radiation.[6]

The purpose of this study was to find out core knowledge of healthcare radiation workers like physicians and technical staff including technologists, physicists and nurses and to measure knowledge-gained after attending a one day targeted symposium.

Material and Method

This prospective cross-sectional study was conducted upon the participants of a one day symposium focused upon radiation hazards and health care workers. This symposium was conducted on 16th May 2015 at Dr Ziauddin Hospital (North Campus) Karachi and was approved by department of continuing medical education and Radiation Safety Committee (RSC) of Ziauddin Hospital and University. Total 68 participants from 18 different healthcare facilities attended this academic event. A single best answer sheet (questionnaire) comprising of 15 questions focused upon basics of ionizing radiations, biological interaction, hazards, radiation dose limits and methods of radiation protection was designed (Appendix I). Participants were asked to fill the questionnaire at the start and after the completion of first 02 talks focused on issues asked in the questionnaire. Fifty five participants filled and submitted the questionnaire and out of these 21 (38%) were physicians, and 34 (62%) were technical staff (25 technologists, 05 physicists and 04 nurses) (Tab. 1).

Variables	N
Total participants	55
Doctors	21 (38%)
Technical staff	34 (62%)
-Technologist	25
-Physicists	05
-Nursing staff	04

Table 1: Study Demographics

Statistical analysis: Data from complete submitted questionnaire was transferred manually to Excel (Microsoft, Redmond, WA, USA) and then to Medcalc® statistical software version 11.3.10 and SPSS version 17.0 (SPSS, Chicago, IL, USA) for statistical analysis. Continuous variables were described by mean ± standard deviation (SD). Paired sample t-test was applied in order to estimate the statistical difference between pre and post session scores. The overall value for statistical significance was $P<0.05$.

Results

Total 55 healthcare workers (21 physicians and 34 technical staff) participated and overall % mean (± standard deviation; sd) correct answers in pre-session assessment was 45.472% ± 19.037. The overall % mean (±sd) correct answers in post-session assessment was 60.472% ± 19.809 with a mean difference between post-pre session of 14.527% at 95% CI (P <0.0001) (Fig. 1 and Tab. 2). Cohort of physicians

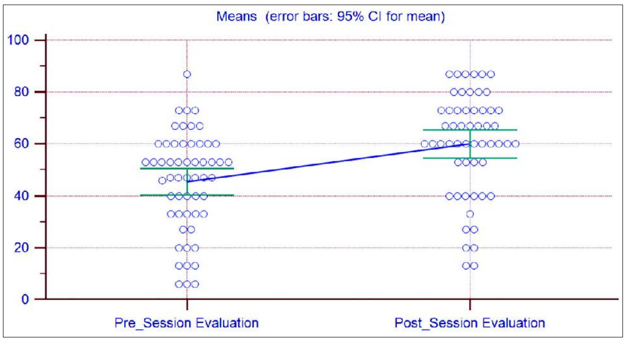

Figure 1: Dot plot comparison of pre and post session evaluation in all participants (n=55).

Subject	Pre-Session Evaluation (%mean ± SD)	Post-Session Evaluation (%mean ± SD	Mean difference Post – Pre Evaluation (95%CI)	Paired sample t-test value	Two tailed *P* value
Total participants n=55	45.472 ± 19.037	60.000 ± 19.809	14.527 (10.413 - 18.641)	7.080	<0.0001*
Doctors n=21	54.238 ± 14.247	67.333 ± 16.939	13.095 (7.678 - 18.512)	5.043	<0.0001*
Technical staff n=34	39.471 ± 19.047	55.088 ± 20.100	15.617 (9.717 - 21.517)	5.385	<0.0001*

**P* <0.05
SD=Standard Deviation
CI=Confidence interval

Table 2: Comparative analysis of pre and post session evaluation

scored 54.238 ± 14.247 in pre-session assessment while in post-session assessment their score was 67.333 ± 16.939 with a mean difference in post-pre session of 13.095% at 95% CI (*P* 0.0001) (Fig. 2).

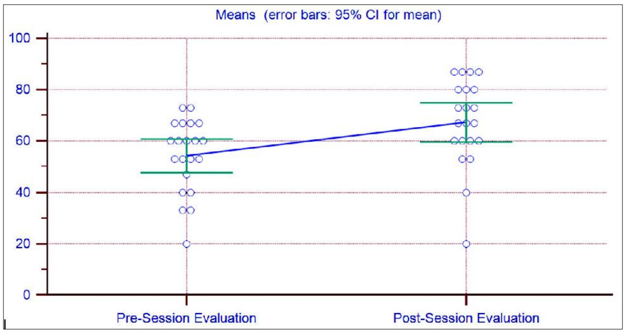

Figure 2: Dot plot comparison of pre and post session evaluation in doctors as participants (n=21).

Cohort of 34 technical staff scored 39.471 ± 19.047 in pre-session assessment while in post-session assessment their score was 55.088 ± 20.100 with a mean difference in post-pre session of 15.617% at 95% CI (*P* <0.0001) (Fig. 3). Inter-group analysis revealed that in pre-session assessment physicians

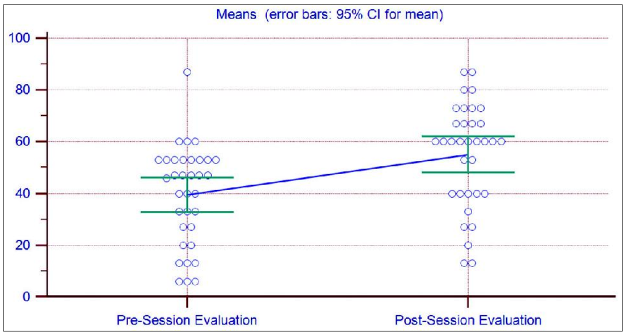

Figure 3: Dot plot comparison of pre and post session evaluation in technical staff as participants (n=34).

had significantly better scores than staff (54.235% vs. 39.471%; *P* 0.0150). In post-session assessment again physicians scored significantly better than technical staff (67.333% vs. 55.088%; *P* 0.0239). Importantly the difference between two assessments was greater in staff (15.617%) than physicians (13.095%) but it was not statistically significant (*P* 0.1183) (Tab. 3).

Variables	Doctors (n=21)	Technical staff (n=34)	t-test value	*P* value
Pre-Session Evaluation (%mean ± SD)	54.238 ± 14.247	39.471 ± 19.047	-2.514	0.0150*
Post-Session Evaluation (%mean ± SD)	67.333 ± 16.939	55.088 ± 20.100	-2.326	0.0239*
Mean difference Post – Pre Evaluation (95%CI)	13.095 (7.678 - 18.512)	15.617 (9.717 - 21.517)	1.588	0.1183

**P* <0.05
SD=Standard Deviation
CI=Confidence interval

Table 3: Comparative analysis of pre and post session evaluation in doctor versus technical staff.

Discussion

Our study shows an overall poor score of all participants and this reflects the suboptimal core knowledge of radiation healthcare workers about the ionizing radiation, its interaction and hazards and principles of radiation protection. This result is in concordance with a local study published in 2008 stated an overall < 60% success rate among interventional cardiologists who participated in a surveyabout radiation hazards and safe practice in catheterization laboratories.[6] In another recently published study from United States, the overall success rate of 92 participants (residents, fellows, staff radiologists and technologists) was 50%.[7] In present study as expected the success rate in pre-session assessment was significantly higher for physicians than technical staff. Basic reasonsfor this expected outcome are more extensive curriculum and better training of physicians at undergraduate and post-graduate levelscompared to technical staff in Pakistan. As a matter of fact, most of the diagnostic imaging centers in Pakistan do not have a structured training program for technologists. Furthermore, majority of technologists are inducted on the basis of their past experience of working at a diagnostic imaging facilities with least concern whether they have had studied science subjects in their high school or colleges.

The second aspect of our study was to assess the impact of one day symposium upon the core knowledge of participants. In post-session evaluation physician's score was significantly higher than the staff and this was due to higher pre-session score in former cohort. However, knowledge gained as assessed by post minus pre-session assessment scores was not statistically different in both cohorts. This implies that content of course was pertinent to knowledge gap between two cohorts despite of different levels of core knowledge. This aspect also draws our attention to serious flaws in curriculum and training programs of radiation healthcare workers in Pakistan.

This lack of knowledge of healthcare radiation workers about the ionizing radiation, their interaction, biological effect and radiation safety aspects depicted in our study is in concordance with many published studies from different parts of the world.[8,9,10] This fact elucidate that the radiation healthcare professionals are unable to effectively protect either themselves or their patients from deleterious potential hazardous effects of ionizing radiations. Furthermore large body of data from different parts of world signifies that problem is not regional rather global.

Major limitation of our study is small sample size. But it included participants from 18 institutes of Pakistan which indeed mitigates the numerical limitation. The other limitation is non-uniform academic and technical proficiency of participants. We were cognizant of this limitation and paid due attention while setting the questionnaire. Strength of our study is that data were collected in real time without any anonymity to avoid any ambiguity about professional background of the participants. Other strength of the our study is that questionnaire was designed to assess core knowledge about fundamental of ionizing radiations, their biological interaction and effects, radiation protection and knowledge about the local and international statutory bodies.

We strongly feel that it is time to revamp the curriculum of radiation biology and protection and serious and meaningful strategy should be designed to execute it. Since we feel this is a global issue, International Atomic Energy Agency (IAEA) must take the lead in this regard to design an appropriate curriculum and implementing in its member states to ensure better understanding among radiation workers about benefits and hazards of ionizing radiation. Impact of didactic educational sessions on enhancing the core knowledge of radiation workers as seen in our and other published studies also proves its utility as a robust educational instrument. We emphasize that every institute must organize education symposia on regular basis and participants must be awarded certification for a specified period and attending the next session for recertification. In this regards radiation safety or protection committee of the institute must take responsibility of the noble cause of inculcating culture of safe, effective and justified use of radiation in diagnostic imaging.

Conclusion

We conclude that the level of knowledge about ionizing radiation hazards and radiation protection was not satisfactory in healthcare radiation workers. Physicians had significantly better pre and post session scores than technical staff but knowledge-gained after attending session was not significantly different. Lack of knowledge among radiation workers is a global issue and this is the time to revamp their training programs in a meaningful strategy and International Atomic Energy Agency (IAEA) must take the lead.

Acknowledgment: Authors declare no financial or institutional conflict of interest.

Appendix I

Questionnaire (Correct answers are highlighted in *italics*).

Q.1 Electrometric radiations are

A. Charge-less, mass-less and travel in a tortuous way.
B. Charge-less with Carbon-12 atomic weight and travel at a speed of light.
C. *Mass-less, charge-less and travel at speed of light in vacuum.*
D. X-rays, gamma rays and beta particles are good examples.

Q.2. About particulate radiations all are true EXCEPT,

A. Greater production of ions and free radicals in a direct interaction.
B. *Are charged particles and less carcinogenic.*
C. Commonly used for therapy in nuclear medicine.
D. Less penetrating than electromagnetic radiations.

Q3. Regarding conventional radiology, all are false EXCEPT

A. X-rays are used for diagnostic purpose only.
B. Provides functional information only.
C. *Is a morphological imaging with diagnostic and therapeutic uses*
D. Long live isotopes are used as source of X-rays.

Q4. Regarding radiation exposure, all are true EXCEPT

A. *Medical exposure is the major source of exposure to general public.*
B. Scatter radiation in radiology is the major contributor to radiographers' exposure.
C. Exposure increases at high altitude.
D. Exposure is higher in fluoroscopic procedure and nuclear medicine therapy.

Q5. The 03 classes of radiation exposures are

A. Therapeutic, diagnostic and intervention.
B. Therapeutic, industrial and nuclear fall outs.
C. *Natural, occupation and medical.*
D. Occupational, industrial and medical.

Q6. Regarding the radiation protection, all are true EXCEPT

A. ALARA is the practicing rule.
B. *LAMA is the primary method to reduce exposure.*
C. Time, distance and shielding are the basic methods of protection.
D. Optimization and justification to avoid unjustified medical procedures.

Q7. Regarding shielding all are true EXCEPT

A. 10^{th} value layer (TVL) absorbs 90% of incident beam.
B. Lead aprons, lead goggle, thyroid shield are commonly used.
C. *Shielding of radiology procedure room is not recommended.*
D. Concrete is best material for imaging facility shielding.

Q.8 Possible outcome of radiation interaction with human cells; all true EXCEPT

A. Complete healing
B. Mutation
C. Cell death
D. *Mitosis*

Q.9 Regarding annual radiation dose limits; all are true EXCEPT

A. Annual dose limit for a radiation worker is 20 mSv.
B. *Annual Radiation dose to general public is 5 mSv.*
C. Radiation dose limit to a worker during pregnancy is 1 mSv.
D. There is no radiation dose limit for patient.

Q.10 Radiation interaction with living cell, all are true EXCEPT

A. Stochastic effects are chromosomal abnormalities and mutation.
B. Deterministic effects' severity increases with dose.
C. *Probability of stochastic effects has an inverse correlation with dose.*
D. Radiation workers in imaging fields are prone to have stochastic rather than deterministic effects.

Q.11 response of living cells to radiations, all are true EXCEPT

A. Tissues with high mitotic activity are more sensitive to radiation.
B. Tissues with high metabolic rate are more radiosensitive.
C. Immature cells (tissues) are more radiosensitive.
D. *Infants are least sensitive than adults to radiation.*

Q.12 Acute radiation syndrome (ARS); all are true EXCEPT

A. Consists of prodormal, latent and manifestation stages.
B. Consists of hematological, GI and CNS syndrome.
C. *Workers in imaging areas are prone to ARS.*
D. Survivors of ARS would have high probability of stochastic effects.

Q.13 Regarding radiation areas; all are true EXCEPT

A. In area with probability of radiation dose more than 6 mSv is defined as controlled area.
B. In are with probability of radiation dose between 1 to 6 mSv is defined as supervised area.
C. *Imaging area are neither controlled nor supervised areas.*
D. Hot waiting area in Nuclear Medicine is a controlled area.

Q.14 Regulatory body supervising the safe radiation practice in Pakistan is

A. Pakistan Atomic Energy Commission (PAEC).
B. International Atomic Energy Agency (IAEA).
C. *Pakistan Nuclear Regulatory Authority (PNRA).*
D. Pakistan Institute of Science and Technology (PINSTECH).

Q.15 Regarding radiation interaction with cell; all are true EXCEPT

A. *Direct interaction is the most common pathway.*
B. Indirect action is mediated by free radicals.
C. Direct interaction with DNA is the most lethal.
D. Interaction with DNA may result in mutation or cell death.

References

1. National Council on Radiation Protection and Measurements. Ionizing radiation exposure of the population of the United States: recommendation of the National Council on Radiation Protection and Measurements. Report No. 160, Bethesda, MD; NCRP, March 2009

2. Berrington de Gonzalez A, Mahesh M, Kim KP 2007 Projected cancer risks from computed tomographic scans performedin the United States in 2007 Arch. Intern. Med.**169:** 2071-7.

3. Justification of Medical Exposure in Diagnostic Imaging - Proceedings of an international workshop. IAEA Proceeding Series. wwwpub.iaea.org /MTCD/Publications/PDF/Pub1532_web.pdf

4. Cerqueira MD, Allman KC, Ficaro EP, Hansen CL, Nicholas KJ, Thompson RC 2010 Recommendations for reducing radiation exposure in myocardial perfusion imaging J. Nucl.Cardiol.**17:** 709-18.

5. Wong CS, Huang B, Sin HK, Wong WL, Yiu KL, Chu YiuChing T 2012 A questionnaire study assessing local physicians,radiologists and interns' knowledge and practice pertaining to radiation exposure related to radiological imaging Eur. J.Radiol. **81:** 24-8.

6. Rahman N, Dhakam S, Shafqat A, Qadir S, Tipoo FA 2008 Knowledge and practice of radiation safety among invasive cardiologists JPMA, **58:** 119-122

7. Ramanathan S, Ryan J2015 Radiation awareness among radiology residents, technologists, ellows and staff: where do we stand? Insights Imaging **61:** 33-9.

8. Arslanoðlu A, Bilgin S, Kubalý Z, Ceyhan MN, Ýlhan MN, Maral I 2007 Doctors' and intern doctors' knowledge about patients' ionizing radiation exposure doses during common radiological examinations Diagn. Interv. Radiol.**13:** 53-5.

9. Zhou GZ, Wong DD, Nguyen LK, Mendelson RM 2010 Student and intern awareness of ionizing radiation exposure from common diagnostic imaging procedures J. Med. Imaging Radiat. Oncol. **54:** 17-23.

10. Keijzers GB, Britton CJ 2010 Doctors' knowledge of patient radiation exposure from diagnostic imaging requested in the emergency department Med. J. Aust. **193:** 450-3.