TAJ June 2004; Volume 17 Number 1

ISSN 1019-8555
The Journal of
Teachers Association
RMC, Rajshahi

Original Article

Study of Workplace Radiation Dose Rate during the Brain Scanning Procedures

M M Ahasan[1], S M Badruddoza[2], A K Paul[3], S K Dey[4], F U Ahmed[5]

Abstract

Radiation dose rate in the gamma camera workplace were measured during brain scanning procedures using a dose of 15-20 mCi ^{99m}Tc-pertechnetate ($^{99m}TcO_4^-$) given intravenously to each patient. The study based on randomly selected 20 patients duly registered for brain scan at Centre for Nuclear Medicine & Ultrasound (CNMU), Rajshahi. Radiation dose rate at the patient-handling place and computer-operating place were measured by a high sensitive portable dose ratemeter and a NaI detector. Brain imaging procedures were usually done two hours post injection. Radiation dose rate at the patient-handling place found to be 20±4μSvhr^{-1} and the computer-operating place were 2±0.4μSvhr^{-1}. Patient skull surface doses were measured also and found to be 120±24μSvhr^{-1} (one hour post injection) and 80±13μSvhr^{-1} (two hours post injection). The results showed that the radiation dose rate in the gamma camera workplace during brain scanning procedures found to be nearly 6 to 60 times higher than the background level. The research goals of the study were to measure the workplace radiation level during brain scanning procedures and sketched some special remedial measures to reduce the radiation exposure rate in the gamma camera work environment.

TAJ 2004; 17(1) : 27-30

Introduction

Various imaging procedures like brain, bone, liver, thyroid and kidney, etc are usually performed using nuclear medicine techniques. Gamma camera and $^{99m}TcO_4^-$ (usually called ^{99m}Tc) are the principal tools for these diagnostic procedures. Gamma camera is a very high expensive, sensitive and massive instrument. ^{99m}Tc is currently by far the most popular radionuclide for imaging studies in nuclear medicine. During the decay of ^{99m}Tc, one internal conversion electron is produced for every 11 gamma rays of 140 keV[1]. Therefore, it is a relatively 'pure' source of γ (gamma) rays used for brain imaging[2]. During the period of brain imaging, emitted gamma radiation from the patients pollute the workplace and consequently the scientific workers are exposed in many way. Gamma ray penetrates easily to the body tissue and potentially causes harm. Therefore, it has some risk from radiation hazards. Any radiation dose, no matter how small, may result in human

[1] Senior Scientific Officer, Centre for Nuclear Medicine & Ultrasound, Rajshahi.
[2] Associate Professor, Department of Pathology, Rajshahi Medical College, Rajshahi.
[3] Senior Medical Officer, Centre for Nuclear Medicine & Ultrasound, Khulna.
[4] Senior Medical Officer, Centre for Nuclear Medicine & Ultrasound, Faridpur.
[5] Director & CMO, Centre for Nuclear Medicine & Ultrasound, Rajshahi.

health effects, such as cancer and hereditary genetic damage. A standard for optimizing patient care and minimizing radiation dose rate in the workplace are mandatory to maintain. The aim of the study was to find the situation of radiation hazards level in the gamma camera workplace during brain imaging procedures and made the increased awareness to the people those are involved with the gamma camera practices.

Materials and methods

The measurement was performed for randomly selected 20 patients of dose 15-20 mCi ^{99m}Tc-pertechnetate ($^{99m}TcO_4^-$) given intravenously to each patient duly registered at CNMU, Rajshahi for brain scan. Brain imaging procedures were usually done two hours post injection. During the period of brain imaging, the radiations doses rates at patient handling place (around 0.3-0.5m distance from the patient) and computer-operating place (1.5m distance) were measured by a highly sensitive portable DOSE RATEMETER [Model: DRGE-31] and a NaI detector. Patient skull surface doses were also measured at the four positions and finally the results were averaged. The skull surface dose rates were measured one and two hours post injection. The background radiation was measured in the absence of patients and subtracted in all measurements independently.

Results

Radiation dose rate at the patient handling place found to be 20±4μSvhr^{-1} whereas at the computer operating place found to be 2±0.4μSvhr^{-1}. Patient skull surface doses found to be 120±24μSvhr^{-1} (one hour post injection) and 80±13μSvhr^{-1} (two hours post injection). The detailed results are furnished in the table-1.

Table 1: Showing the radiation dose rate in the gamma camera workplace during brain scanning procedures using a dose of 15-20 mCi ^{99m}Tc-pertechnetate ($^{99m}TcO_4^-$) given intravenously to each patient.

No. of Patient	Radiation dose rate at the patient handling place (Around 0.3-0.5m distance from the source) μSvhr^{-1}	Radiation dose rate at the computer operating place (Around 1.5m distance from the source) μSvhr^{-1}	Patient skull surface dose rate (One hour post injection) μSvhr^{-1}	Patient skull surface dose rate (Two hour post injection) μSvhr^{-1}
1.	25	2.3	140	95
2.	24	2.5	150	88
3.	16	1.5	110	64
4.	20	2.3	150	77
5.	24	1.9	130	98
6.	19	1.4	130	67
7.	23	1.7	150	84
8.	15	1.8	80	87
9.	16	2.4	140	75
10.	20	2.2	90	72
11.	23	1.5	100	90
12.	17	1.9	90	80
13.	23	2.5	80	65
14.	15	1.5	100	62
15.	24	2.1	120	98
16.	17	2.5	130	64
17.	25	2.4	140	92
18.	23	1.3	130	70
19.	15	2.8	100	73

20.	16	1.5	140	80
Mean±SD	20±4	2.0±0.4	120±24	80±13

Discussion

Monitoring of low dose radiation level are easy but the assessment technique is very complex and very often the implied doses are small. During the period of brain scan with 15-20mCi ^{99m}Tc, gamma camera rooms are classified as controlled area where other patients, non-radiation workers and public are not allowed. The dose rate in controlled areas should not be more than $10\mu Svhr^{-1}$[1,3]. Through out the observation in our study, the dose level in the gamma camera room varies from 2 to $120\mu Svhr^{-1}$ during brain scan, there need some shielding and special mitigation measures. In the present study, we found the radiation dose rate around $20\mu Svhr^{-1}$ at the patient handling position and $2\mu Svhr^{-1}$at the computer-operating place during the brain scan. In our previous study, we found that radiation dose rate varies from 10 to $30\mu Svhr^{-1}$ at the middle position in the hot lab[4]. Average occupational dose surveyed in U.S.A. for medical use radioactive material workers were 0.22rem (2.2mSv), and 94% of medical workers had an annual dose of less than 0.5rem (5mSv)[5]. Through out our observation in our centre, we have found that the average occupational doses for nuclear medicine workers were 1.9±0.5mSv and most of the workers have an annual dose of less than 5mSv.

A licensee must conduct its activities in the department such that the external dose rate in an unrestricted area is less than 0.002rem/hr ($20\mu Svhr^{-1}$) [6]. According to ALARA concept, this limit should be optimized in nuclear medicine activities. A gamma dose rate of $0.5\mu Svhr^{-1}$ for a working year (2000 hr) would lead to an annual effective dose of about 1mSv, and this dose rate or some multiple of it might be adopted as an action level[7]. Most of the practices, doses received by occupational workers are well below the appropriate limits in the BSS. The Standard sets the effective occupational dose limit at 20mSv per year, averaged over a period of 5 consecutive years. The public dose limit is set at 1mSv in a year. But in nuclear medicine activities, although the radiation hazards associated with MPD limits in the regulations are very small, they are not assumed to be totally risk free. ALARA (As Low As Reasonably Achievable) program is the best way for nuclear medicine practices. ALARA is a program to restrict actual occupational exposures to less than 10% of Maximum Permissible Dose (MPD). Risks associated with radiation exposure cannot be eliminated but can be restricted by practicing safety culture in nuclear medicine[8].

For maintaining ALARA principle, occupational exposures can be reduced by a) using shielding, b) reducing the time of exposure, and c) increasing the distance from the source. Although there is potential radiation exposure during the patient handling period, this can be kept to a minimum by the use of shielded syringes, gloves, and other protective devices and adherence to strict radiation safety guidelines. It is feasible to make an appropriate lead barrier (lead glass sheet) around the computer-operating place by spending some money. The radiation exposure rate in the gamma camera workplace can be reduced by taking the following remedial actions: a) the distance between computer operating place and patients position should be increased, or b) a suitable lead barrier (lead glass sheet) around the computer-operating place should be setup. To increase the distance between computer-operating place and patients position is a very hard task because of gamma camera room design. The room design or structure cannot be changed easily; it is requires sufficient fund as well as the decision higher authority.

Conclusion

Risks associated with radiation exposure cannot be eliminated during brain imaging procedures with ^{99m}Tc in the gamma camera workplace but can be restricted by practicing safety culture. To minimize the dose rate at the patient-handling place is very difficult but at the computer-operating place, it can be keep nearly to zero by taking the remedial measures.

References

1. Jocelyn Towson. DAT-Programme for Nuclear Medicine Technologists: Basic Physics, Module 1, Unit 1, P 13.
2. Sorenson J A & Phelps M E. Physics in Nuclear Medicine, 2nd Ed. W B Saunders, 1987: 29.
3. Jocelyn Towson. DAT-Programme for Nuclear Medicine Technologists: Radiation Safety-Part 1, Module 1, Unit 2a, P 8.
4. Ahasan MM. Assessment of radiation dose in nuclear medicine hot lab. Iranian Journal of Radiation Research, Sep 2004: 2(2).
5. US Nuclear Regulatory Commission. Occupational radiation exposure, NUREG-0714, Washington, DC, 1979: 12-13.
6. Henkin R. E. Nuclear Medicine, Vol-I, Mosby-Year Book Inc., Missouri, 1996: 30-39.
7. Occupational Radiation Protection. IAEA Safety Standards Series No. RS-G-1.1, 1999.
8. Ahasan M M & Dey S K. Radiation Risk & Protection in Nuclear Medical Centres. Bangladesh Journal of Nuclear Medicine, Vol.2 no.2 July 1999: 52-54.

All correspondence to:
M Monjur Ahasan,
Senior Scientific Officer
Centre for Nuclear Medicine & Ultrasound
(Rajshahi Medical College Hospital Campus)
Post Box 35, Rajshahi 6000, Bangladesh
E-Mail: cnmuraj@bttb.net.bd