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Risk perception among the workers in radiotherapy facilities located in North Eastern States, India

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Abstract

In the radiotherapy practice, regulator defines risk in terms of physically measurable quantities and attempt to implement the results obtained from the risk assessment of this practice, using quantitative approach. Although such approach has significantly brought down radiation dose, injuries and fatalities to the workers as compared to the radiotherapy practices before World War II, the objectivity concept of risk that limits the assessment regarding physically measurable quantities is widely urged throughout the world. This study examined how the risk associated with radiotherapy practice has been perceived, and experienced by both professional and non-professional workers in the radiotherapy facilities located in Manipur, Meghalaya, and Assam. This study found that professional and non-professional workers exhibited different risk perception on the same physical risk. Such different risk perceptions influenced the establishment of radiological protection systems in the facility. Non-professional workers are more likely to be the affected group in a facility having weak radiological protection systems.

Key words: radiotherapy; radiological protection; risk perception.

Introduction

The radiotherapy practices began shortly after the discovery of radiation, even without knowing fundamental features of radiation, such as the characteristics of radiation, their ways of interaction with human tissue and harmful effects resulting from such interaction. Since radiation could not be detected with human sense organs and effects were not observed immediately, it was perceived to be almost no risk among the radiation workers in early days. Even, the radiation workers exposed their hand for focussing on X-ray beam and calibration of X-ray tubes [1]. The calibration of X-ray tubes was based on skin reddening of their hands exposed to radiation which is nowadays considered as radiation accidents. Such perception towards radiation led to over exposure of many radiation workers. Due to such practices, within six months of the introduction of those practices in health care, many incidents of experiencing radiation injuries to their body had been reported in USA, UK, Austria, Germany [2,3]. L.G. Stevens, the English Physician, reported the practical experience of radiation injuries in the British Medical Journal, 1896. In Germany, Leppin reported burning of his left hand, which was used as a testing object for the X-ray tube. Such cases of radiation injuries to the radiation workers continued expanding, and within six years, fatality and incidence of cancer were reported elsewhere. The occurrence of radiation accidents and new findings on the stochastic effects of radiation had shifted the initial perception, ideas, and experience of radiation risk [4]. After the death of Clarence Dally due to radiation injuries during the development of the Edison X-ray tube, Thomas Alva Edison perceived radiation risk as: "*Don't talk to me about X-rays, I am afraid of them*" [4]. German Roentgen Society, also erected a monument, 'X-ray and radium martyrs' in Hamburg in 1936 to commemorate the hundreds of radiation workers in medical practices who lost their lives due to radiation injuries [5].

To reduce the risk in this practice, international organisations like International Atomic Energy Agency (IAEA) and International Commission on Radiological Protection (ICRP) published the safety standards. The ICRP also recommended dose limits for workers and public. These safety standards and dose limits were derived from the risk assessment in this practice using technical approach. However, many researchers mainly from social sciences criticised such risk assessment approaches [6,7]. They urged that technical risk assessment approach fail to explain social factors, which defined the risk. They observed that technical approach itself had many limitations on estimating the effect of low radiation. The risk as defined by natural science underwent amplification and attenuation process in line with the risk perception of individuals and other social factors [6-8]. Risk perception is also viewed as a multidimensional concept which is more context sensitive than physical risk [9]. Many individuals, including experts, used this risk perception as an economical

and useful tool for the immediate assessment of risk, even though sometimes it led to severe and systematic errors in their estimated risk [10]. Renn *et al*. in their studies on the functional relationship between physical consequences of 128 hazardous activities and risk perception, also observed that physical risk was shaped by the risk perceptions of the individuals [11]. Sometimes, even the scientist rated the risk of the same physical event in different degree of severity based on their risk perceptions [12].

The radiation accidents in radiotherapy practices during 1945-2010 also revealed that sometimes radiation accidents were associated with the lack of communication, working behaviour of the radiation workers and risk perceptions of managements and their pressure on the continuation of works despite failure in safety systems [13-16]. In India also, there were reports about workers receiving an excessive radiation dose, occurrences of radiation injuries and non-compliances of the regulatory requirement in facilities [13,17]. However, there were limited studies on the risk encountered by the workers in the facilities. Further, the available literature revealed about the professional workers in the facilities mainly. These appear to be silent about non-professional workers, who were exposed to ionising radiation while performing auxiliary works in the facility.

This paper studied about how the workers perceived risk in the radiotherapy facilities, using a multidisciplinary approach. In this paper, facility means radiotherapy facility. The professional workers are the workers who got specific degree and training on radiological safety in radiotherapy practice. They include oncologists, radiological safety officers (RSO), medical physicists and radiotherapy technologists. The non-professional workers mean workers who are not trained on radiological safety. They include nurses, plumbers, electricians, ward boys, and sweepers. Regulator shall mean Atomic Energy Regulatory Board, Government of India, Mumbai. The equipment shall mean radiation generating equipment.

Materials and Methods

Study Site

This study was carried out in four radiotherapy facilities located in North East India. The facilities were located in Imphal (Manipur), Guwahati (Assam), Jorhabat (Assam) and Shillong (Meghalaya). The average distances between the centres are within 10 – 600 km. The distance of these facilities from the headquarter of Atomic Energy Regulatory Board, Mumbai is about 2500 – 3000 km.

Method

The study adopted a mixed method to understand the risk perceptions of workers. This method consisted of quantitative and qualitative study. The study considered two types of workers: professional and non-professional workers. The radiation oncologist, radiological safety officer, medical physicists and radiotherapy technologists were selected from the professional workers. The workers in the non-professional workers included nurse, electrician, ward boy and cleaner. Eighteen professional workers and twelve non-professional workers participated in the study. The academic purpose of the study was explained to the workers, and then consents were taken. The respondents were coded to protect their identity.

Quantitative Study

The study used eight hypothetical risk scenarios as given in **Table 1**. The respondents were asked to rate these risk scenarios, using 7 risk characteristics as listed in **Table 2**. A rating scale, having 5 points was used for rating the hypothetical risk scenarios. The range of response scale was 1-5, as given below:

1 - almost none, 2 - low, 3 - moderate, 4 - high, 5 - very high. The similar scale was used in the measurement of risk characteristics elsewhere [18,19].

Qualitative Study

The working behaviour of the workers was observed, and observation was noted. The in-depth interview followed it. The workers were interviewed regarding the observed working behaviour, knowledge of ionising radiation, safety procedures, trust and communication mechanisms among worker, administrator, employer, supplier, and regulator. An audio recording of the interview was carried out with prior consents from the workers. Also, notes were taken during the interview.

Qualitative data were analysed using the inductive method of thematic analysis approach [20]. In the process, identities of the worker and their institutes were removed.

Table 1. Hypothetical risk scenarios

	Risk scenarios	Code
1.	Working in the facility without personal monitoring device (PMD)	A
2.	Working in the facility with an expired personal monitoring device (PMD)	B
3.	Working in the facility with the PMD of another worker	C
4.	Working in a teletherapy unit and brachytherapy unit without area zone monitor	D
5.	Working in a teletherapy unit and brachytherapy unit without survey meter	E
6.	Working in the facility without a pocket dosimeter	F
7.	Working in a facility without getting proper training about radiation	G
8.	Standing near a transport package containing 1000Ci of Co-60	H

Table 2. Perceived risk characteristics

Characteristics	Code
Dread	DR
Anxiety	AN
Immediate injuries to health	IH
Probability of fatality	FA
The probability of late effect to health	LH
Controllability at the individual level	CI
Desire to continue	DC

Analysis and Result

Quantitative Study

The mean score of 7 risk characteristics across 8 risk scenarios rated by professional and non-professional workers are given in **Table 3** and **Table 4** respectively. The professional workers exhibited medium dread in the risk scenarios: A,B, and C. The risk scenarios: D,E,F, and G were rated high dread.

The 16 professional workers rated very high on dread, anxiety, immediate injuries to health, fatality and late effect regarding the risk scenario: standing near the transport package containing 1000 Ci of the source. Majority of workers did not wish to continue risk scenarios.

The non-professional workers exhibited different risk perceptions from the professional workers. They exhibited low to medium risk perceptions on the 8 risk scenarios. They rated low to the risk characteristics dread, anxiety, immediate injuries to health, the probability of fatality and probability of late effect to health in the risk scenario G: working in a facility without getting proper training about radiation. They also exhibited low anxiety, the probability of fatality and probability of late effect to the risk scenario, A: Working in the facility without personal monitoring device (PMD). They rated moderate to dread, anxiety and immediate effect on health in the risk scenarios, C: Working in the facility with the PMD of another worker. The non-professional workers had a high preference for continuation in the eight hypothetical risk scenarios.

Table 3. Means for 7 risk characteristics across 8 hypothetical risk scenarios (professional workers n = 18). Scale: 1 - almost none, 2 - low, 3 - moderate, 4 - high, 5 - very high

Risk scenarios	Mean of risk characteristics						
	DR	AN	IH	FA	LH	CI	DC
A	3.2	3.1	4.3	2.5	4.1	1.7	2.4
B	3.2	4.5	2.1	2	2.3	1.7	2.3
C	2.5	3.9	3.2	1.5	2.3	1.6	2
D	3.7	2.2	3.2	2.9	2.9	1.3	2.2
E	3.7	2.1	4.1	3.5	3.2	1.6	1
F	3.5	2.9	3.9	4	2.3	1.7	1.9
G	3.5	3.9	3.2	3.9	3.2	2.6	2.5
H	4.9	4.8	4.8	4.8	4.2	2.5	1

Table 4. Means for 7 risk characteristics across 8 hypothetical risk scenarios (non-professional workers n = 12)

Risk scenarios	Mean of risk characteristics						
	DR	AN	IH	FA	LH	CI	DC
A	2.5	2	2	2.4	2	3	4.5
B	2.4	2.3	2.5	2	2	3	4
C	3	2.5	2.6	2	1.5	3	4
D	2	2	2.5	2.5	2	3	4
E	2.5	3	2.4	2	1.5	2.5	4
F	2.4	3	2.5	2.5	2	2.5	4.8
G	2.1	2.4	2	2	2	2.6	4
H	1.8	2.5	3	2	2	2.5	4

Qualitative study

It was observed that many workers did not wear personal monitoring device (PMD) during the work procedures. It was due to the factors like non- availability of the devices, expiry of the device and working behaviour of the worker, etc. Regarding anxiety level, a radiotherapy technologist said:

> *Although, I was not in favour of wearing an expired personal monitoring device, I was compelled to use it. It increased my anxiety levels.*

Other professional workers, who used an expired PMD or other's PMD, had similar views. Although the professional workers were aware of the risk associated with the risk scenarios: A-H, it was observed that many of them were engaged in these risk scenarios. It could be due to the continuation of existing work culture, hierarchy effect, lack of proper management of the facility and slow decision making process for procurement of required instruments, etc. Such work practice increased dread and anxiety level among the worker.

The non-professional workers had lack of knowledge about radiological protection, regulatory requirements, and differentiation of different types of risk scenarios. They had lack of awareness level of use PMD, survey meter, and pocket dosimeter. A non-professional worker expressed about the use of such instruments as:

> *I do not know why I was asked to wear personal dose monitoring device.*

This idea was a common finding among the non- professional workers. Among the non-professional workers, female nurses showed high anxiety and dread across the 8 hypothetical risk scenarios. They concerned about late effects of radiation. This finding is in agreement with the finding in other studies that female nurses perceived high risk [21]. Their phobia about radiation was established through the falling of negative image of effects of ionising radiation in mind, and not getting specific training course on radiation protection. However, other non-professional worker considered working in a radiotherapy facility as low risk. A sweeper opined about the risk of working in a radiotherapy facility as:

> *I am happy for getting a job in this facility, as it is safer than working in another medical department, where the chances of getting an infection are high in cleaning the room.*

The low risk perception of non-professional workers except nurse was derived from the inexperience of illness or incidence of cancer among their co-workers during their long term exposure in this field. The non-professional workers had low awareness about radiological protection. They acquired the knowledge on radiological protection from the professional workers. The majority of non-professional workers could not attend any awareness programme on radiological protection.

Discussion

The professional and non-professional workers exhibited a sharp difference in the risk perception. The professional workers derived the risk perception from practical experience in practice, and knowledge gained through their academic courses, books, and participation in workshop, conferences, and seminars. Although professional workers were aware of the physical risk associated with working in a facility without adequate safety systems, the majority of them continued to work in the risk scenarios. This finding is in line with the reported poor radiological protection in another study [22]. The working in a radiotherapy facility without / malfunctioned radiation detection systems such as radiation zone monitor, survey meters, and PMD, etc. had increased the risk perceptions of workers. The PMD used in the facilities serve a purpose for estimating the radiation dose received by the workers. Such dose records are essential for making a decision when it crosses the regulatory dose limit of workers. The use of expired PMD and someone else's PMD exploited the safety of workers. If a worker uses PMD of another worker, it could cause serious error in the decision making process. In such case, the worker who exposed to the radiation during a radiological emergency, more than regulatory dose limit could be deprived of the regulatory decisions.

Many of the workers experienced such risk scenarios. These could be due to hierarchy system, and existing work practice of the institution. Some professional workers also exhibited low risk perception in the risk scenarios, which were supposed to be high risk. Their perception was established by the inexperience of radiation injuries or fatality during prolong use of that particular practice without safety systems. Such workers posed a significant threat in establishing a robust radiological protection system in the facility. It mainly affected the non-professional workers who did not know basic radiological protection systems. The non-professional workers were also, unable to differentiate the different risk scenarios. They were assigned to work in this field without imparting training program. This category of worker is likely to be primary victim among the workers in a facility having weak radiological protection system. The nurses exhibited the different attitude about radiation risk, unlike other non-professional workers. They were more concerned about harmful effects of radiation. The nurses felt that the knowledge about radiological protection acquired during their training courses were not enough to work in a radiation facility. They preferred to get proper training about radiological protection before working in a facility. This finding supports the earlier studies that nursing textbook did not provide proper information about radiation [23]. It could be one of the reasons why nurses felt fear and worry about radiation[24].

Conclusion

The unique characteristic of ionising radiation such as the inability to detect it through human sense organs and its possible effects became a source of serious error in the risk perception of individual workers. Non-professional workers except nurses rated low perceived risk to the risk scenarios, which were supposed to be high risk. The institution may initiate periodic conduct of awareness programme about radiological safety, and institutional risk assessment programme. It could be useful for the institution if the awareness programme covers both professional and non-professional workers and administrators who involve in the decision making the process for the establishment of radiological protection systems in the facility.

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