

# A Study on Teaching Methodologies of Radiobiology To Allied Health Care Students

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**Abstract-** This study aimed to compare the teaching methodologies of radiobiology to allied health care students. Allied health care students and staff are directly or indirectly involved in the clinical and research activities. A proper knowledge in radiobiology is very essential especially for radiography and nursing students. There are various teaching methodologies like a black board (lecturing), power point presentations; case discussions, group discussions with video clipping related to radiobiology. Each of the teaching methodology is effective in a particular group. **Materials and methods:** Four different teaching methodologies were used to teach radiobiology in four different categories namely under graduate Radiography students, Diploma Radiography students, Undergraduate nursing students and Diploma nursing students. All were exposed to all types of teaching methodology. An evaluation was done by performance based and choice based evaluation system. **Results:** Case discussion was most popular choice of under graduate Radiography students and Diploma Radiography students. Among Undergraduate nursing students and Diploma nursing students' video discussion was best in terms of performance and choice. **Conclusion:** Radiobiology covers more about abstract issues and it requires more of discussion for better understanding and clarification.

**Keywords-** Radiobiology, teaching methodologies, allied health care students.

## I. INTRODUCTION

Radiobiology is a field of clinical and basic medical sciences that involves the study of the action of ionizing radiation on living things, especially health effects of radiation. Basic radiation biology concepts include the traditional assumptions of Bergonie and Tribondeau, who stated in 1906 that any cells that are immature, undifferentiated and actively dividing (i.e., stomach mucosa, basal layer of skin, stem cells) are more radiosensitive. They respond by exhibiting some effect from radiation exposure that causes cell injury or death. Cells that are mature, differentiated and not actively dividing (i.e., neurons) are more radio resistant. A cell that is radiosensitive would be more

inclined to die after exposure to ionizing radiation than a radio resistant cell<sup>1</sup>. Although new terms such as “more or less radio responsive” are now being used, the basic tenets of their hypothesis hold true for living tissue reactions to ionizing radiation<sup>2</sup>. Therefore, cells undergoing active mitosis are more likely to have an effect from ionizing radiation, and stem cells (bone marrow, stomach mucosa, germ layer of the skin) are much more radiosensitive than neurons, which either never replicate or do so very slowly. Experiments in fruit flies and mice have shown that the effects of ionizing radiation can cause mutations in progeny, but these mutations are not specific to radiation. Such mutations are similar to ones that have already been found to occur spontaneously in nature. Furthermore, the experiments showed that the effects of ionizing radiation depend on total dose and exposure rate. A large dose given in a short amount of time is more damaging than the same dose given over a longer period of time<sup>3</sup>.

The interaction of radiation with cells is a probability function. Because cellular repair usually takes place, permanent damage will not necessarily result from an interaction of ionizing radiation with living tissue. Energy deposition to a cell occurs very quickly, in some 10–18 s, with the energy being deposited in the cell in a random fashion. All interactions happen on a cellular level, which in turn may affect the organ and the entire system. In addition, there is no unique cellular damage associated with radiation. Any damage to a cell due to radiation exposure may also happen due to chemical, heat, or physical damage. After radiation exposure to a cell, there is a latent period before any observable response. The latent period could be decades for low radiation doses, but only minutes or hours for high radiation exposure. These basic generalizations form the foundation on which radiation biology is based<sup>4</sup>.

The interaction of radiation is of two types a) Direct interaction and b) Indirect interaction

### Direct Interaction

In direct interaction, a cell's macromolecules (proteins or DNA) are hit by the ionizing radiation, which

affects the cell as a whole, either killing the cell or mutating the DNA<sup>2</sup>. There are many target and cell survival studies that show that it is harder to permanently destroy or break double-stranded DNA than single-stranded DNA. Although humans have 23 pairs of double-stranded chromosomes, some cells react as if they contain single-stranded, non-paired chromosomes and are more radiosensitive. Many different types of direct hits can occur, and the type of damage that occurs determines whether or not the cell can repair itself. Generally, if a direct hit causes a complete break in the DNA or some other permanent damage, the cell dies immediately or will die eventually<sup>5</sup>. However, humans have an abundance of cells and somatic cellular reproduction (mitosis) is always occurring to replace cells that die. Therefore, it is only when this system of replacing cells falters that radiation effects are seen. This occurs at higher doses of radiation.

Actively dividing cells are more radiosensitive than no dividing cells. There are 4 phases of mitosis: M Phase, in which cells divide in 2; G1 Phase (gap one), in which cells prepare for DNA replication; S Phase, in which DNA doubles by replication; and G2 Phase (gap two), in which cells prepare for mitosis. Of these, M phase, in which the chromosomes are condensed and paired, is the most radiosensitive. More DNA is present in one area at this point in the cycle, which is why it is theorized that this is the most radiosensitive time. It is also thought that increased chromatin in cancer cells is why these cells, which have unusually high mitotic rates, are more radiosensitive than normal cells<sup>6</sup>.

#### Indirect Interaction

The other type of interaction is indirect cellular interaction. Indirect interaction occurs when radiation energy is deposited in the cell, and the radiation interacts with cellular water rather than with macromolecules within the cell. The reaction that occurs is hydrolysis of the water molecule, resulting in a hydrogen molecule and hydroxyl (free radical) molecule. If the 2 hydroxyl molecules recombine, they form hydrogen peroxide, which is highly unstable in the cell. This will form a peroxide hydroxyl, which readily combines with some organic compound, which then combines in the cell to form an organic hydrogen peroxide molecule, which is stable. This may result in the loss of an essential enzyme in the cell, which could lead to cell death or a future mutation of the cell<sup>5</sup>. Antioxidants, about which there has been much research and publicity, block hydroxyl (free radical) recombination into hydrogen peroxide, preventing stable organic hydrogen peroxide compounds from occurring. This is one way in which the body can defend itself from indirect radiation interactions on a cellular level, and is one reason that antioxidants have

received so much attention recently as a cancer prevention agent<sup>7</sup>.

Teaching and learning are the two sides of the same coin. There are various teaching methods like lectures, power-point presentations, group discussion, seminars, role play, film or documentary presentations, case discussions etc.<sup>8</sup>. Each of them has their own advantages and disadvantages<sup>9</sup>. The teaching methodology to be used also depends on the topic to be covered; i.e. for a particular topic a particular methodology may be effective. The effectiveness of teaching is dependent on individual interest, but more over the methodology used is also important<sup>10</sup>. The most accepted criterion for measuring good teaching is the amount of student learning that occurs. Teaching in the absence of learning is talking; effective teaching is that which produces beneficial and purposeful student learning through the use of appropriate procedures<sup>11</sup>. Students are most qualified sources to report on the extent to which the learning experience was productive, informative, satisfying and worthwhile. A meta-analysis of 41 researches provides validity that, student ratings tend to be reliable, valid, unbiased and useful<sup>12</sup>. Health care professionals are the ones who are constantly exposed to various issues related with radiobiology. Particularly the nurses had good knowledge towards ionizing radiation during theatre and ward radiography and this was influenced by the level of education<sup>13</sup>. In this study, the group includes under graduate Radiography students, Diploma Radiography students, Undergraduate nursing students and Diploma nursing students. The ability to understand the concepts of radiobiology varies in each of these health care students. There is a need for identifying the proper teaching methodology for each of this group; hence the present study was undertaken.

## II. MATERIALS AND METHODS

The study population was divided into four groups which included participants from different categories like namely under graduate Radiography students, Diploma Radiography students, Undergraduate nursing students and Diploma nursing students from the institute of health sciences. A group consisted of ten candidates each from each category, It included ten undergraduate radiography students, ten diploma radiography students, ten undergraduate nursing students and ten diploma nursing students (N=40). Boys and girls were equally distributed in each group. A total of 160 participants were included in the study.

Four different teaching methodologies used in the study were Black board /lecturing, Power-Point presentations, Case discussions and video film clippings followed by discussions. Lecture is a talk or a verbal presentation given by

a lecturer, trainer or a speaker to an audience. This method is economical, can be used for a large number of students, material can be covered in a structured manner and the teacher has a great control of time and material. Power-point presentations make use of computer and LCD-projector, material to be covered is restricted. Discussion is a free verbal exchange of ideas between group members or teacher and students. In case discussion a case related to the topic is explained followed by discussion. In film discussion a film or documentary related to the topic is screened for 25 minutes, followed by discussion on the ethical issues related. An evaluation was done by two types of analyses i.e. performance based and choice based. Performance based evaluation, scores of pre and post evaluation test were taken into consideration to access the performance.<sup>14,15</sup> Pre and post evaluation tests were done with the help of questionnaires designed in each of the topics. The topic to be taught was not informed to the participants. Pre-evaluation test was given simultaneously to all the groups i.e. all the 160 members had to take the pre-evaluation test at the beginning of the day. Post evaluation was done immediately at the end of their respective classes. The type and number of questions asked in the pre and post evaluation test were same, the time duration of the class was restricted to forty five minutes only which was followed by post evaluation test for fifteen minutes. The questions asked were of multiple choice and of yes/no type. The questions were displayed on the screen using LCD projector. Improvement was calculated based on difference in pre and post evaluation scores<sup>15</sup>. A choice based evaluation was done on the last day, after exposing all the candidates to different teaching methodologies. In this system the candidates were asked to rate different methods of teaching used by their teachers on a scale of 14, one being the least important and 4 being the most important teaching method. The results of the study were compiled and analyzed by percentage method<sup>16,17</sup>.

### Study permission

The permission to carry out the study was obtained from the institute managements. Each participant signed a written informed consent as a pre request to participate the study.

### Results

**Table 1-A: Result of Performance based evaluation of Undergraduate Radiography students ‘**

| Teaching Method       | Average Post-evaluation score | Average Pre-evaluation score | Difference between average pre and post evaluation score | Percentage of improvement (%) |
|-----------------------|-------------------------------|------------------------------|--|-------------------------------|
| Lecture               | 14.025                        | 9.65                         | 4.375  | 21.87                         |
| Power point           | 14.050                        | 9.55                         | 4.5  | 22.50                         |
| Case discussion       | 14.55                         | 10.10                        | 4.45   | 22.25                         |
| Video film discussion | 14.15                         | 9.20                         | 4.95   | 24.75                         |

**Table 1-B: Result of Performance based evaluation of Diploma Radiography students**

| Teaching Method       | Average Post-evaluation score | Average Pre-evaluation score | Difference between average pre and post evaluation score | Percentage of improvement (%) |
|-----------------------|-------------------------------|------------------------------|--|-------------------------------|
| Lecture               | 15.7                          | 12.45                        | 3.25   | 16.25                         |
| Power point           | 15.85                         | 12.40                        | 3.45   | 17.25                         |
| Case discussion       | 15.55                         | 12.55                        | 3.00   | 15.0                          |
| Video film discussion | 15.85                         | 11.85                        | 3.00   | 15.0                          |

**Table 1-C: Result of Performance based evaluation of Undergraduate Nursing students**

| Teaching Method       | Average Post-evaluation score | Average Pre-evaluation score | Difference between average pre and post evaluation score | Percentage of improvement (%) |
|-----------------------|-------------------------------|------------------------------|--|-------------------------------|
| Lecture               | 9.00                          | 6.00                         | 3.00   | 15.00                         |
| Power point           | 8.75                          | 5.50                         | 3.25   | 16.25                         |
| Case discussion       | 9.75                          | 6.00                         | 3.75   | 18.75                         |
| Video film discussion | 10.25                         | 6.25                         | 4.00   | 20.0                          |

**Table 1-D: Result of Performance based evaluation of Diploma Nursing students**

| Teaching Method       | Average Post-evaluation score | Average Pre-evaluation score | Difference between average pre and post evaluation score | Percentage of improvement (%) |
|-----------------------|-------------------------------|------------------------------|--|-------------------------------|
| Lecture               | 5.62                          | 3.37                         | 2.25   | 11.25                         |
| Power point           | 6.00                          | 3.25                         | 2.75   | 13.75                         |
| Case discussion       | 4.87                          | 3.12                         | 1.75   | 8.75                          |
| Video film discussion | 7.75                          | 3.25                         | 4.50   | 22.50                         |

### Results of the performance based evaluation:

The major improvement in performance was seen by Undergraduate radiography students. It was above 20% with all teaching methodology used, Maximum with video film discussion (24.75) and minimum with lecture class (21.87). The other two teaching methods showed almost same improvement (22.5). The improvement percentage in Diploma radiography students was less but almost in the same range with different methods. It was highest with power-point (17.25), followed by a lecture (16.25), while it was 15% with case discussion and video film-discussion. In this category it was noted that the pre-evaluation scores were in higher range compared to other categories. So the relative improvement was less. Among the Undergraduate nursing students highest improvement (20%) was seen with video film-discussion followed with case discussion (18.75) and power-point (16.25). They showed less improvement with lecture classes (15%). As nursing students had limited knowledge on radiobiology their pre-evaluation scores were less compared to Radiography students. Diploma nursing students had very low improvement compared to other categories. The pre-evaluation scores were least as they had no knowledge about radiobiology. The improvement percentage were 8.75 with case discussion, 11.25 with lectures and 13.75 with power-point presentations but video film discussion brought about marginal improvement of 22.5%

**Table 2: Shows results of choice based evaluation**

| Teaching Methods                   | Lecture |    |    |    | Power point |    |    |    | Case discussion |    |    |    | Video film & discussion |    |    |    |
|------------------------------------|---------|----|----|----|-------------|----|----|----|-----------------|----|----|----|-------------------------|----|----|----|
|                                    | 1       | 2  | 3  | 4  | 1           | 2  | 3  | 4  | 1               | 2  | 3  | 4  | 1                       | 2  | 3  | 4  |
| Undergraduate Radiography Students | 13      | 12 | 8  | 7  | 8           | 11 | 16 | 5  | 16              | 15 | 5  | 4  | 3                       | 2  | 11 | 24 |
| Diploma Radiography Students       | 8       | 8  | 13 | 11 | 8           | 14 | 15 | 3  | 18              | 9  | 7  | 6  | 6                       | 9  | 5  | 20 |
| Undergraduate Nursing Students     | 9       | 13 | 8  | 10 | 9           | 8  | 14 | 8  | 8               | 5  | 13 | 14 | 14                      | 13 | 5  | 8  |
| Diploma Nursing Students           | 4       | 8  | 8  | 20 | 6           | 8  | 16 | 10 | 12              | 14 | 10 | 4  | 18                      | 10 | 6  | 6  |

**Table 3: Shows Scores and percentage share of different teaching methods**

| Teaching Methods                   | Lecture |         | Power point |         | Case discussion |         | Video film & discussion |         |
|------------------------------------|---------|---------|-------------|---------|-----------------|---------|-------------------------|---------|
|                                    | Score   | Share % | Score       | Share % | Score           | Share % | Score                   | Share % |
| Undergraduate Radiography Students | 111     | 27.75   | 102         | 25.5    | 123             | 30.75   | 64                      | 16.00   |
| Diploma Radiography Students       | 93      | 23.25   | 107         | 26.75   | 119             | 29.75   | 81                      | 20.25   |
| Undergraduate Nursing Students     | 101     | 25.25   | 99          | 24.75   | 87              | 21.75   | 113                     | 28.25   |
| Diploma Nursing Students           | 76      | 19.00   | 90          | 22.50   | 114             | 28.50   | 120                     | 30.00   |
| All candidates                     | 381     | 23.81   | 398         | 24.87   | 443             | 27.69   | 378                     | 23.63   |

**Table 4: Shows Conclusion of result**

| Sl.no. | Category                           | Best teaching methodology based on |                                   |
|--------|------------------------------------|------------------------------------|-----------------------------------|
|        |                                    | Performance evaluation             | Choice evaluation                 |
| 1      | Undergraduate Radiography Students | Video film followed by discussion  | Case discussion                   |
| 2      | Diploma Radiography Students       | Power point                        | Case discussion                   |
| 3      | Undergraduate Nursing Students     | Video film followed by discussion  | Video film followed by discussion |
| 4      | Diploma Nursing Students           | Video film followed by discussion  | Video film followed by discussion |

**Results of choice based evaluation:**

Table showing the preferences given by different categories for different teaching methods Scoring was calculated based on the preferences given by the candidates. It was calculated on allocation of points i.e. the 1st preference was allotted four points, three points for 2nd preference, two points for 3rd preference and one point for 4th preference. The sum obtained was the overall score for each methodology under each category. The majority of the Undergraduate radiography students preferred case discussions which accounted for highest score of 123, lectures were their second choice to score 111 followed by PowerPoint in 102. Film discussion was their last choice. Diploma radiography students also liked case discussions very much, power point and lectures were subsequent choice and film-discussion was the last choice. Film discussion was a popular choice among the nursing students. Undergraduate nursing students hated the case discussions while diploma nursing students did not like lectures the most.

**III. DISCUSSION**

In our study the participants were exposed to all the four different types of teaching methodology. The topics chosen were also of similar category there is every possibility of bias as a particular topic is taught effectively by a particular method. To overcome this we had opted for a two way evaluation system i.e. performance based and choice based evaluation system as compared to some of the studies. The performance based evaluation took into consideration the performance of candidate in pre and post evaluation. In choice based evaluation system we gave freedom to the candidates to grade the teaching methodology. When overall results were taken into consideration it was found that film discussion and case discussion as teaching methodology is a most effective means of learning compared to the lectures and power point presentations. Discussion involves more participation; learning is more effective and develops creativity among participants. This may be contradictory to some of the studies conducted on teaching methodologies<sup>9</sup>. Lecture as a teaching method creates new ideas, are good for large class but useful only when the concept and views of the topic are clear. Radiobiology has more of abstract concepts. In this study, case discussions and film presentations followed by discussion fared well mainly because they provide a platform for better understanding of abstract concepts in a simplified way. Radiobiology as such need not be restricted to health care; it involves various fields so there is need to evaluate similar studies in other areas. In our study only four teaching methods were tried, this study can be improved upon by experimenting with other methods of teaching.

**IV. CONCLUSION**

In my study I found that lectures and power point presentations are not much importance in imparting the knowledge of radiobiology. The concepts involved in radiobiology are abstract and it requires more of discussion for better understanding and clarifications. The topics of radiobiology must be reserved for panel discussions in the CME and workshops, so as to improve the knowledge of radiobiology among medical and paramedical personnel.

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