

Determination of Doses to Breast Cancer Patients during EBRT at KBTH¹Mvoufo, F., ^{1,2}Amoako, J.K., ¹Schandorf, C., ³Tagoe, S.N and ⁴Dery, T.B¹School of Nuclear and Allied Science, University of Ghana²Radiation Protection Institute, GAEC, Box LG 80, Legon, Accra, Ghana³Radiotherapy and Nuclear Medicine Centre, Korle Bu Teaching Hospital, Accra⁴Radiological and Medical Research Institute, GAEC, Box LG 80, Legon, Accra, GhanaEmail of Corresponding Author: joe.amoako@gmail.com

Abstract: The study focused on investigating the absorbed dose to fifty-one (51) selected breast cancer patients undergoing radiation treatment with Cobalt-60 source at the National Centre of Radiotherapy and Nuclear Medicine, Ghana using TLDs and a water phantom. The percentage deviation of the absorbed doses ranged from <0.1% - 5.7% and 0.3% - 9.2% for the lateral and medial irradiation of the breast respectively. The results obtained clearly show that, the overall limit of error required in dosimetry of $\pm 5\%$ was achieved in about 92.2% of the cases studied. Measurement and analysis of scattered radiation from patients show that the average scattered radiation is about 24%.

[Mvoufo, F., Amoako, J.K, Schandorf, C., Tagoe, S.N and Dery, T.B. **Determination of Doses to Breast Cancer Patients during EBRT at KBTH.** *J Am Sci* 2014;10(1):108-111]. (ISSN: 1545-1003). <http://www.jofamericanscience.org>. 19

Keywords: TLD, absorbed dose, irradiation, dosimetry

Background

Breast cancer which is ranged in the carcinoma group is now the most frequent cancer of women worldwide. Research shows that for women in developed countries, it account for 25 to 30% of cancer with an incident of about 100 per 100,000 women per year [CISN, 2011]. The main objective of this study was to verify the accuracy and precision of dose delivered to breast cancer patients undergoing EBRT. The treatment of patients using radiotherapy involves factors such as miscalibration, misinterpretation of results and patient movement which can lead to severe complications. Therefore doses delivered must be with optimal accuracy. Moreover, a small difference in the dose can make a big difference in the tumour control probability and for the avoidance of secondary induced cancer during breast cancer treatment.

Materials and Methods

The materials used in this study include the following: Cobalt-60 teletherapy unit with model number GWGP-80, water phantom of $20 \times 20 \times 10 \text{ cm}^3$ volumetric Polymethylmethacrylate (PMMA) with a reference field size of $10 \times 10 \text{ cm}^2$, Ionization Chamber which a cylindrical farmer chamber type model PTW30001, manufactured by PTW Freiburg with a 0.6 cm^3 volume, Electrometer of PTW UNIDOS model, TLD-100 which is made-up of Lithium Fluoride crystal chip doped with Titanium and Magnesium, Harshaw 6600 TLD reader, Thermometer and a Barometer.

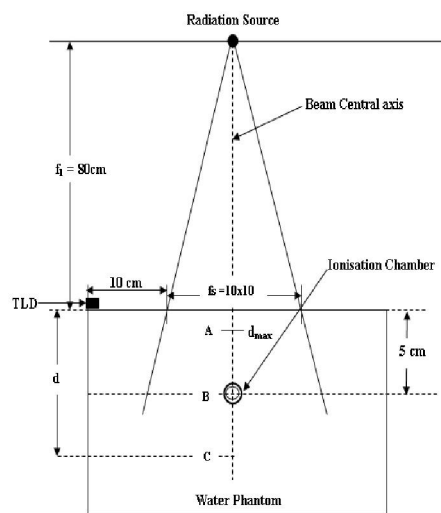


Figure 1: Schematic irradiation geometry used for beam calibration

Twenty-two (22) TLDs were used in the dose measurements. All the TLDs were calibrated and underwent sensitivity, reproducibility and linearity tests at the SSDL. TLDs with sensitivity within 5% standard deviation were selected and used for the study. The stability check source value was also determined to be 0.96% providing a good condition for the ionisation chamber to be used. The TLDs had dimensions of width, 4.2 cm, height, 3 cm and depth of 0.1 cm. The crystal chip however, had a diameter of 1 cm with an embedded hard metal chip material of $3 \times 3 \text{ mm}^2$. Consent form was given to each patient

for their approval to partake in the study. The peripheral dose measurement data was obtained by placing two TLDs: one during the lateral position treatment and the other during the irradiation of the breast on each patient. The TLDs were placed 10 cm from the edge of the field size of the patients to measure the scattered radiation during treatment. Figure 1 shows the setup for irradiation.

The TLDs were placed vertically at the end of the measured distance of 10 cm and tighten with a sellotape such that the chips for measuring the deep dose Hp (10) and the skin dose Hp (0.07) were in the direction of the beam. Other data such as the gender, height, age, prescribed dose and treatment time were obtained from the patients' medical record. A total of fifty-one patients of age ranging from 25-75 years old from various neighbouring African countries data were collected over a period of six (6) months at the Oncology Department of KBTH. Forty-seven (47) were women and four (4) were men with nineteen (19) and thirty-two patients with their left breast (Lf) and right breast (Rt) affected by the tumour respectively.

This first group of results was used to determine the scattered doses obtained during irradiation of the patient (TLD_{irr}). The absorbed dose calibration $D_{w;5}$ was determined following the protocol of the TRS398. The patient measured dose $D_{TLD;meas}$ was calculated using equation (1)

$$D_{TLD;meas} = D_{W;5} \times \frac{TMR_{(10 \times 10; d)}}{PDD_{(10 \times 10; 5)}} \times \frac{TLD_{irr}}{TLD_{cal}} \times 1.0125 \times \alpha \times CF_{f,s} \times CF_d \times CF_o \quad (1)$$

where $D_{TLD;meas}$ is the measured dose obtained experimentally which will be compared to the prescribed dose $D_{pres.}$, in cGy, $D_{W;5}$ is the absorbed dose to water obtained during the calibration of the ionization chamber in unit of cGy/min.

Results and Discussion

1. Age-group Distribution

A prospective study of the age range distribution conducted on the fifty-one breast cancer patients at the KBTH shown in Figure 2 indicates that, the age group with the highest breast cancer cases was between 46-49 years representing 37.25%.

The result is similar to data obtained from other sources (ACS, 2010) which indicated that, breast cancer cases are mostly common amongst the ages 40-55 years. In this case, 86.27% of the breast cancer patients were between the ages of 40-75 years while 13.73% of the patients were between the ages of 20-39 years. It is a clear indication that, breast cancer continues to affect the younger population and that the age group mostly affected in Ghana are 40-49 years in Ghana [Clegg et al., 2007]. Breast cancer among men is generally not common. In this study, only 4 out of the fifty-one breast cancer patients were men

representing 7.84%. International Statistics however indicate that breast cancer affects less than 1% of men worldwide [ACS, 2013]. The higher statistical value for men in this study may be due to the relatively low sample size. The highest male-to-female ratio of breast cancer reported in a geographic band of Africa was less than 6% two decades ago [Ndom et al., 2012]. Although studies of men with breast cancer are very small, when a number of these small studies are grouped together, a significant study can be conducted.

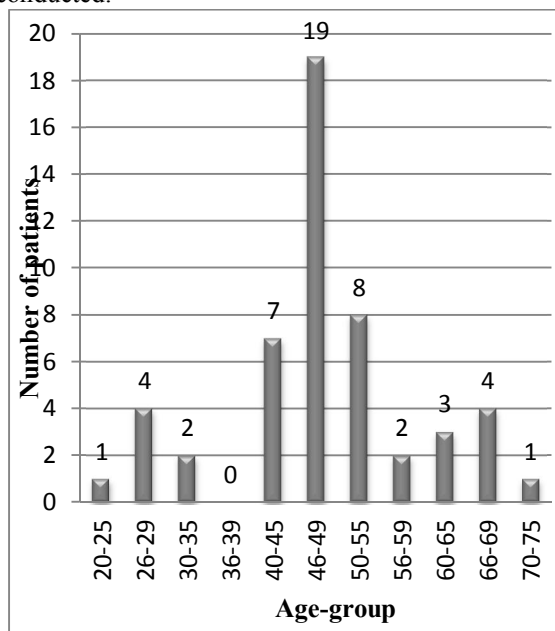


Figure 2: Age-group distribution of the patients

2. Patients Absorbed dose

Amongst the fifty-one breast cancer patients, forty (40) received a prescribed dose of 100 cGy while eight (8) and three (3) patients received prescribed doses of 133 cGy and 200 cGy respectively. Figure 3 shown the variation of the mean values of the prescribed dose.

Among the forty patients treated with 100 cGy during the lateral irradiation, only one patient (A25) recorded an absorbed dose which is approximately equal to the prescribed dose; two other patients (A5 and A15) recorded absorbed doses that were close to the prescribed dose with the exception of one patient (A11), who recorded an absorbed dose which falls outside the permissible deviation of $\pm 5\%$ the prescribed dose. For the medial irradiation, a similar trend was observed. This means that 97.5% of the patients treated with 100 cGy prescribed doses recorded values of absorbed dose which were within the permissible deviation of $\pm 5\%$. However, 100% of the entire patient treated with prescribed dose of 133 cGy during lateral and medial irradiation recorded

values of absorbed dose which were within the permissible deviation of $\pm 5\%$.

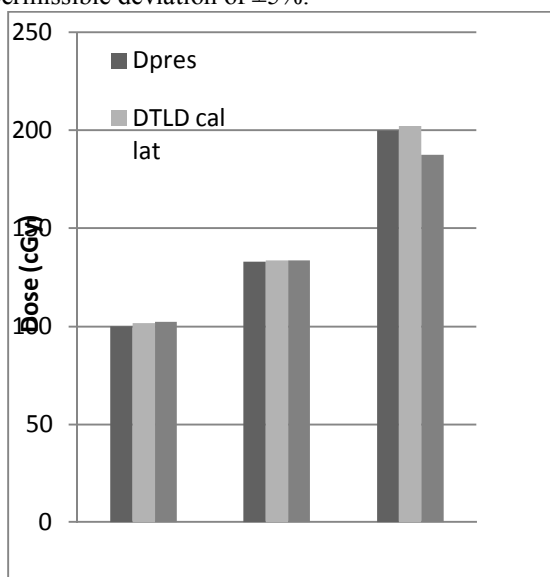


Figure 3: Variation of the mean values of the lateral and medial dose from the prescribed dose

For patients who were treated with a prescribed dose of 200 cGy, the lateral irradiation: two patients had absorbed doses higher than the prescribed dose with only one patient who recorded an absorbed dose lower than the prescribed dose while

for the medial irradiation all the three patients recorded absorbed doses less than the prescribed dose. Table 1 shows results of absorbed doses for the prescribed doses used in the study.

From Table 1 the mean absorbed dose values varied slightly with the prescribed doses expect for the medial dose which was lower than the prescribed dose. During treatment of patients, errors can occur at any stage of the process [IAEA, 1997]. In In-Vivo dosimetry, using TLDs, systematic errors that occur in radiotherapy are mainly due to human errors or equipment failure. In this study, systematic errors occurred due to human errors that is positioning of TLDs on patients and patient set-up before the treatment. These errors when accumulated may influence and lead to serious systematic errors in dose delivery causing potential failures in patients cure eventually could be lethal death of the patient. The percentage error acceptable for accurate and optimal delivery of radiation dose to a tumour is $\pm 5\%$. The percentage error in this study ranged from $< 0.1\%$ - 5.7% and 0.3% - 9.2% for the lateral and medial irradiation of the breast respectively (Table 1). Generally, 92.2% of the result had an error range of < 0.1 - 3.0% which is within the acceptable error limits of $\pm 5\%$. It was also observed that the higher the prescribed dose the gradually increase in percentage error.

Table 1: Mean values of the absorbed doses and their various mean Standard Deviations

Prescribed Dose (cGy) (Dpres)	Mean Absorbed dose (cGy)		Mean Standard Deviation (\pm)	
	Lateral ($D_{TLD;meas.med}$)	Medial ($D_{TLD;meas.lat}$)	Lateral	Medial
100.0	101.8	102.4	1.5	2.0
133.0	133.7	133.6	2.4	1.8
200.0	202.3	187.5	1.1	6.3

3. Patients' Scattered dose

Measurement and analysis of scattered radiation shows that the latter is far less than the absorbed dose for both lateral and medial irradiation. Table 2 show the comparison of the scattered radiation with absorbed dose for eight breast cancer patients. The average scattered radiation was about 24% of the absorbed dose. Similar variation was observed for prescribed doses of 100cGy and 200cGy.

Table 2: Scattered Radiation and Absorbed Dose to patients treated with prescribed dose of 133.0 cGy

Patient ID	Lateral Irradiation		Medial Irradiation	
	Scattered Dose(cGy)	Absorbed Dose(cGy)	Scattered Dose(cGy)	Absorbed Dose(cGy)
B1	30.9	130.3	34.5	136.2
B2	28.9	130.3	24.9	130.1
B3	23.6	128.5	18.9	127.5
B4	34.5	131.6	32.2	137.8
B5	25.2	134.3	22.9	130.5
B6	34.6	129.0	32.7	136.1
B7	45.3	133.3	43.6	138.5
B8	40.0	137.1	35.7	131.1

Conclusions

Absorbed dose to breast cancer patients undergoing External Beam was determined using the GWGP80 cobalt-60 Teletherapy unit and employing In-vivo dosimetry with TLD-100 to measure peripheral doses delivered to the patients during treatment. About 92.2% of the results of errors deviation were accurate within the limit of $\pm 5\%$. Higher errors were recorded from results obtained for the doses at 200 cGy prescribed dose. This may be due the sample size since only three (3) patients among the fifty-one were treated at 200 cGy prescribed dose; the larger the sample size, the less uncertainties. However, 80% of the forty (40) patients treated at 100 cGy prescribed dose had deviation between $< 0.1\%$ to 3.0% , and 95% of these errors recorded were within the overall limit for errors in radiotherapy. It can be generally concluded, that the level of accuracy in the computation of patient doses at the study centre was good. However, there is the need for constant verification of the dose delivered to patient.

Acknowledgements

I am grateful to the IAEA/AFRA and the Government of Cameroon for their great contribution and support. To Dr Augustin Simo, , and Dr. Saidou, Cameroon of National Radiation Protection Agency, Cameroon. Finally, to the staff of the National Centre for Radiotherapy and Nuclear Medicine (NCRNM), KBTH and Radiation Protection Institute (RPI), Ghana Atomic Energy Commission (GAEC) for making their facilities available for this research work.

12/11/2013

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References

1. ACS, (2013), Cancer Facts and Figures, American Cancer society, Inc, Atlanta
2. CISN (2011). Emerging solutions are out there. Cancer 101, who gets Cancer? Cancer Information Support Network. Retrieved on 15th September, 2011 from the World Wide Web:
<http://cisncancer.org/survivorship/index.html>
3. CISN (2011). What is cancer? Cancer Information Support Network. Retrieved on November 15th, 2011 from the World Wide Web:
<http://www.cisn.org/survivorship/index.html>
4. Clegg-Lamptey et Hodasi (2007). A Study of Breast Cancer in Korle Bu Teaching Hospital: Assessing the Impact of Health Education. Ghana Medical Journal (GMJ). Vol. 41 No. 2, Pp. 72-77.
5. IAEA (1997). Quality Assurance in Radiotherapy. IAEA-TECDOC-1040. International Atomic Energy Agency, Vienna.
6. Ndom P., Um G., Mbassi E., Eloundou A., Nasheed H. and Huo D. (2012). Characterization of Male Breast Cancer in Yaoundé, Cameroon and a Meta-Analysis of Literature in Africa. PubMed.gov. U.S. National Library of Medicine. National Institute of Health. Breast_ Vol. 21, No. 3, Pp. 237-41