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Research Article

Creating a Spreadsheet for Calculating Therapeutic Radiation Doses Delivered by Electron and Photon Beams of Varied Intensities

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Abstract

The main concern and goal for oncologist and physicist in cancer treatments is accurate radiation therapy, dose calculation, and quality control. Where treatment planning systems (TPS) are not accessible, the global usage of Radiation Therapy Machines such as ^{60}Co and LINAC (Old) necessitates an accurate and quick External Beam Radiation Therapy (EBRT) machine dose evaluation. A medical physicist or a dosimetrist are not always available at cancer treatment centers. For this, we created the "Mithu" spreadsheet, which allows Radiation Oncologists, Physicists, and Radiotherapy Technologist to easily calculate treatment time (TT) or Monitor Unit (MU) using simple Microsoft Excel spreadsheets. Calculate Cobalt-60 (^{60}Co) and LINAC Machine actual dose rate for source to surface distance (SSD) and Source to Axis Distance (SAD) to construct a treatment planning system for 2D or Emergency plan and Dosimetry. Percentage depth dose (PDD) and Tissue Maximum Ratio (TMR) were taken from the British Journal of Radiology (BJR) supplement 25 in the spreadsheet. Machine commissioning data were used to calculate Treatment (Time or MU) output factor, wedge factor, and tray factor. Another significant and fundamental element for radiotherapy TT or MU calculations is the equivalent square field. The dose rate of the Linac Machine is precisely calibrated by Physicists and remains constant, with no degradation. However, because the yearly decay constant is 0.131 (ln2/HL) and the source decays 1.09 percent every month, the ^{60}Co dose rate always decreases or fluctuates. Some significant Excel features including HLOOKUP, VLOOKUP, EXACT, and the logical function if-Else were employed to construct this spreadsheet, which has reduced the man-made hand calculation mistake by 99 percent. This "Mithu" Spreadsheets were used to calculate the ^{60}Co Machine-based Radiotherapy treatment plans for around 2000 patients. We found that the computed ^{60}Co dose varies by 1% whereas the calculated LINAC MU varies by <1.5 percent, which is a tolerable range in radiotherapy.

Key Words: *EBRT, PDD, TMR, Dose, QA, MU, TT, Treatment Planning System, Spreadsheets, Physicist, Oncologist*

Introduction

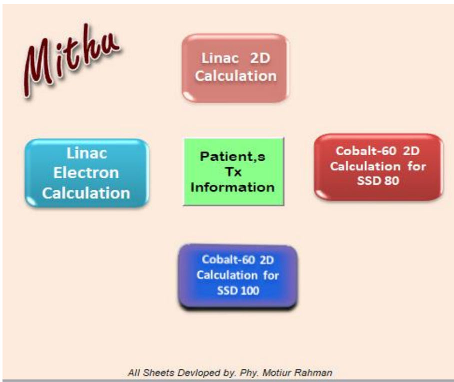
For dosimetry purpose most of the radiotherapy center follow IAEA Code of Practice based on standards of absorbed dose to water called TRS-398. IAEA developed Worksheets in MS Excel for the Codes of Practice for dose determination with therapeutic beams TRS-398. Anyone can be using this worksheet from this link http://www-naweb.iaea.org/nahu/DMRP/codeofpractice.html. The "Mithu" spreadsheet was made for a radiation facility that didn't have a treatment planning system. In crowded government and private radiotherapy centers in South Asia and Africa, Medical Physicists can save patients dose calculation time. Another purpose is that in some Asian and African countries, medical physicists are not recruited in government hospitals, that’s why radiation oncologists and Radiotherapy technologists calculate treatment doses manually.

As a result, there is a probability to increase treatment dose calculation error. Spreadsheet "Mithu" will be the best option for calculating treatment doses quickly. The manual dose calculation is based on the treatment machine’s PDD, TMR, Output factor, and so on. For manual dose calculation and equipment acceptance most of the physicist follow British Journal of Radiology (BJR-25). Another benefit of these Mithu spreadsheets is that they can display the 25-day treatment dose schedule, which is the same as the LINAC plan for all days, but ^{60}Co is different due to its decay activity. One physicist must know how much dose exits from the machine at a specified distance called the source to surface distance before applying the dose to the cancer patient. The majority of linear accelerators have SSD 100cm, whereas the majority of 60Co machines use SSD 80 cm, but SSD 100 ^{60}Co machines are available on the market. D-Max is the amount of surface dose accumulated after a hit (ϒ-ray or X-ray) at a point inward from the surface. spreadsheet "Mithu" will be useful in verifying the TPS System. We know 6MV photon beam has 67% dose and 60Co has 56% dose at 10 cm depth for 10x10cm collimator jaw setup, according to BJR Suplimentary-25 data table. So, if we want to deliver a dose of 200cGy at a depth of 10 cm, we'll need to deliver 298.5 cGy (Beam is calibrated at 1 MU = 1cGy).

So, in TPS, we can expect the same dose in a same depth. If the TPS dose differs by more than 2% from our Spreadsheet "Mithu," then commissioning must be reviewed again. Photon (X-ray) and Electron (e-) therapy treatment options are available on the majority of dual energy Linacs. So, for electron therapy, we'll need to know the cutout factor, energy verses collimator jaw setting, output factor, and % depth dose, all of which will be determined during commissioning. This option is available in the spreadsheet "Mithu" for calculating dose for electron treatment. In a radiotherapy center, the patient database is recorded for the future. So, physicists can readily say how many patients will be treated per year or month. It is possible to determine which organs (sites) are treated the most and which patients are treated the most on a demographic basis.

The heart of this Spreadsheet "Mithu" is the admin panel. After commissioning, every date for Cobalt-60, LINAC, and Electron dose calculation must be entered into the admin panel. This Spreadsheet "Mithu" is available for download at "https://usaupload.com/6sRu/TCC_Cancer_TX_Time_Calculation@motiur_Ver.3_SSD100.xlsm " where it can be used on any website.

Figure 1: Main panel of Spreadsheet "Mithu"



Material and Methods

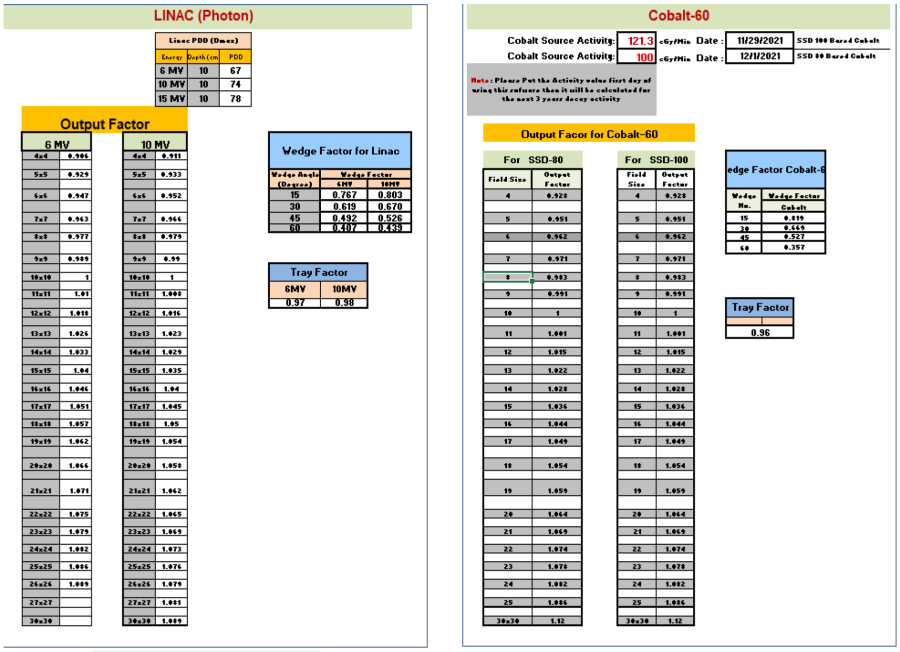
Microsoft Excel & Visual Basic software, machine specific data for absolute dosimetry, output factor, wedge factor, tray factor, etc. are vital instruments in the current study and development. PDD and TMR tables for ^{60}Co and Linac (6 and 10 MV) beams were taken from BJR Suppl. 25(1996). Some crucial and most commonly used functions are HLOOKUP (), VLOOKUP (), Exact (), and the logical functions IF, OR, AND. We utilize HLOOKUP () and VLOOKUP () to extract data from the table. HLOOKUP looks for values in table rows, while VLOOKUP looks for values in table columns. The results of HLOOKUP () and VLOOKUP () are same, but the table is arranged differently. EXACT function is used to compare two strings.

The IF function allows you to compare two values, such as =IF (Something is True, then do something, otherwise do something else). Although AND, OR, and NOT are independent functions, they are combined in this IF statement. =IF (OR (Something is True, something is False), Value if True, Value if False) Microsoft Visual Basic is a set of tools included in Microsoft Office. Simply turn on the developer option from the file options menu in Microsoft Excel. Absolute dosimetry also uses TRS-398 data and formula. As a result, the goal of this work can be used as a guide for any user who wants to construct spreadsheets in their own way for machine treatment time/MU verification of quality performance when utilizing it at any Cancer Treatment Center (CTC).

The admin panel (also known as the Administration Panel) is the most important tool in any radiotherapy program. Though "Mithu" is an excel spreadsheet, we created a separate sheet within "Mithu" that can be referred to as an admin panel for entering fundamental machine-specific data prior to employing these spreadsheets in their cancer therapy center. This admin sheet will serve as a hub for all other user sheets. So, if you only enter the basic data once, like output factor, wedge factor, machine calibration value (1 MU =?) or ^{60}Co dose rate input, it will be quite simple to use these spreadsheets.

For the ^{60}Co time calculation worksheet, computer date and time is a highly significant and sensitive topic. Because the activity of radioactive sources decreases with the passage of time (Figure2).

Figure 2 Admin panel arrangement for the "Mithu" software



Radiotherapy treatment plan: In-house radiotherapy treatment planning system "Mithu" has been developed for Linac 6MV and 10MV photon energy emergency radiotherapy plan MU calculations, as well as ^{60}Co radiation therapy 2D treatment plan treatment time calculations. Commercial treatment planning systems can also be easily cross-checked. For selected data, the "List" function from the Data Menu was used inside the treatment planning excel spreadsheets.

For example, in our Linac Spreadsheets, we can alter the energy and method by pressing on the energy cell and selecting energy; similarly, we can change the treatment technique, Tx Area, Machine, Physicist, and oncologist by pressing on the energy cell and selecting energy Figure 3,4.

Figure 3: Linac 2D treatment planning Spreadsheets which can be used for 6 & 10 MV photon dose calculation both for SSD &SAD method.

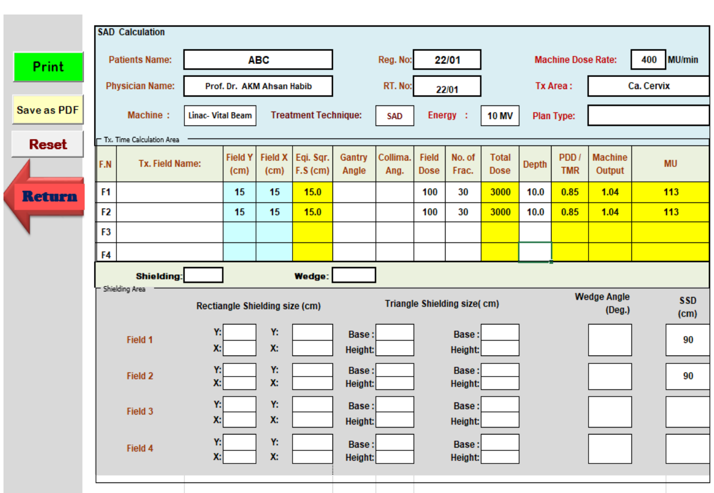
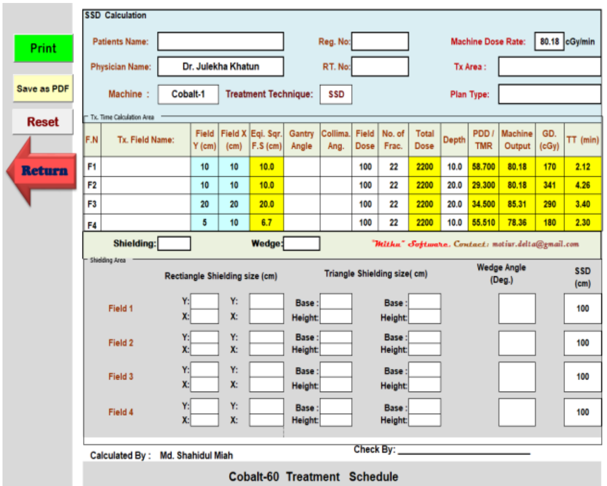


Figure 4: ^{60}Co treatment planning Spreadsheets. Can perform treatment time or dose calculation.



Results & Discussion

Figures 3 and 4 demonstrate the applications of in-house Spreadsheets that have been used for radiotherapy patient treatment plan dose computation since 2012. The man-made hand calculation inaccuracy was reduced by 99 percent using this spreadsheet. This "Mithu" program has been used to calculate around 2000 patients' ^{60}Co Machine based Radiotherapy treatment plans at Rajshahi Medical College and Hospital, Rajshahi, National Institute of Cancer Research Hospital, Dhaka, Dhaka Medical College and Hospital, Dhaka, and Delta Hospital Ltd., Dhaka. An equivalent square or rectangular fields table was released by the Hospital Physicist Association1 Central Axis Depth dose data for radiotherapy (BJR Suppliment-11) for exact treatment. Tables 2 and 3 demonstrate that the computed MU divergence between the Commercial TPS and the Commercial TPS is less than 1.5 percent for 6 and 10 MV photon beams. (Table1)

Table 1: 6MV, 10x10 cm field size has been calculated at various depths using Commercial TPS system and “Mithu” spreadsheet and their deviation.

Treatment Depth (cm)	**Eclipse Planning System Data**		**“Mithu” Planning System Data & Result**		**Deviation ±Δ%**
	% DD	Calculated MU	% DD	Calculated MU	
5	86.55	231	86.9	230	0.41
10	67	299	67.5	296	0.85
15	51.2	391	51.7	387	0.94
20	38.9	514	39.3	509	1.01

Conclusion

On the market are modern radiation therapy quality assurance (QA) devices and treatment planning systems. However, where TPS is not available and a Medical Physicist is not appointed for quality treatment that center can use this for reference. Some government hospitals or radiation therapy clinics in South Asia and Africa use ^{60}Co and Linac machines but physicist is not appointed Like Bangladesh. In addition to QA, an in-house radiotherapy treatment planning system has been developed for quality and accurate dose delivery in radiation therapy. This section discusses how to ensure high-quality radiation therapy. When physicists and dosimetrists are not available, this will be a valid solution. So that treatment can be delivered without errors. It will be helpful in some busy centers for saving physicist time and patients waiting for radiation card calculation & preparation. (Table 2)

Table 2: 10MV, 10x10 cm field size has been calculated at various depths using Commercial TPS system and "Mithu" spreadsheet and their deviation.

Treatment Depth (cm)	**Eclipse Planning System Data**		**"Mithu" Planning System Data & Result**		**Deviation ±Δ%**
	% DD	Calculated MU	% DD	Calculated MU	
5	91.6	218	91.4	219	0.30
10	73.5	272	73	274	0.69
15	58.2	344	57.8	346	0.68
20	46	435	45.6	439	0.96

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