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Technical Note

One dose does not fit all

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To compute the radiation dose to the human body and to an individual organ from internal and external radiation sources requires information on several anatomical and physiological parameters of the exposed individual. The human body varies in size and weight from one individual to the other. Total body weight of human is indeed a reflection of genetic makeup, intake of nutrition value, calorie consumption, life style (active or passive), culture and weather.

ORGAN WEIGHT

In radiation therapy, no human individual parameter such as organ weight (OW), body weight (BW), height (H), surface area (SA) and age have ever been taken into consideration. Akber[1] has shown that radiation tolerance dose (TD50) of normal human organs varies as a function of organ weight. By ignoring the organ weight, we are ignoring the organ metabolism.

Organ weight in old patients in particular and in the general patient population can be estimated by using the equation below.

$$\text{ORGAN WEIGHT (OW)} = \frac{\text{OW (ref)}}{\text{BW} \times \text{Age} \times \text{H} \times \text{SA (ref)}} \times \text{BW} \times \text{Age} \times \text{H} \times \text{SA}$$

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Reference man	Reference female
Age = 16–20 years	Age = 20–30 years
BW = 70 kg	BW = 58 kg
H = 170 cm	H = 160 cm
SA = 18,000 cm^2	SA = 16,000 cm^2

International Commission on Radiological Protection Report 23 provided the organ weights of the reference male and female.[2] SA can be computed from the chart based on heights and weights.[2] The end value of organ weight will determine the TD50. Organ metabolism will dictate the body metabolism and complications due to the assumption that one dose fits all can be avoided.

Dose volume histogram (DVH) is a point dose calculation of organ dose based on the treatment plan. However, in DVH, organ weight, body weight, age and gender differences are not taken into consideration. Let us assume we have a perfect DVH. Does this mean that the cancer will be cured because of perfect DVH? Absolutely not. DVH has little or no influence on the efficacy of cancer treatment.

We also demanded that linear accelerators should provide high energy X-ray beams. The industries provided 25 + MV X-rays and failed to make any impact on cancer treatment. With gantry rotation, 6 MV X-rays are the preferred choice of X-ray energy for cancer treatment. This initiated new sets of technologies available

at our disposal. This includes X-knife, cyber knife, Tomo therapy, etc., with little impact on cancer treatment. We have Co-60 and then Gamma Knife. We then demanded electron, neutron and proton beams. Now the buzzword is carbon-ion therapy. Even with the introduction of cone-beam CT and other imaging modalities to align the radiation beam with tumors in real time, our cancer cure rate has not improved significantly.

Cell cycles

Like organ weight, the variation of cell cycle is ignored in all modalities of cancer treatment. During radiation treatment, we have no clue what cell phase of the cell cycle we are treating. Akber[3] has shown that using the NMR T1 values against mean lethal radiation dose (Do) in different phases of the cell cycles of Hela cells, one can pinpoint the mitotic phase. Using this methodology,[3] it is feasible to pinpoint our treatment of cancer patients when cells are in mitotic phase.

These two factors if implemented will provide us a new perspective and the efficacy of cancer treatment. Furthermore, chemotherapy and radio immunotherapy will be greatly benefited if we also take these two factors into consideration at the time of treatment.

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