Yttrium-90 radiotherapy dosing calculator: Improving a liver tumor treatment process with a mobile application

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Learning objectives

There are two main objectives that this poster aims to accomplish related to Yttrium-90 (TheraSpheres®, Nordion, Ottawa, ON, Canada) transcatheter radioembolization liver tumor treatment:

1. To describe the need for a more customizable tool to improve workflow in dosimetry calculations.

2. To highlight advantages of a mobile application that calculates precise dose activity sizes and corresponding administration times, and can be easily shared among team members involved in the radioembolization procedure.
Background

Yttrium-90 radioembolization is an emerging interventional oncology therapy option. Treatment success involves proper calculation of dose activity sizes and administration time schedules. The current manufacturer dosing calculation software (Fig. 1 on page 4) takes inputs of target dose to be delivered and patient characteristics, i.e. liver volume and lung shunt fraction. The software then outputs an array of dose-delivered values corresponding to specific days and times [1]. There are several limitations of this system:

1. The times displayed for treatment each day are limited to 4-hour increments between 8am and 8pm.

2. Analogous dose-delivered values often do not exactly match with the target radiation dose required for successful treatment.

3. There is no feature that allows the input of a desired treatment time to output a corresponding custom dose activity size.

As a result, interpolation is necessary to estimate the Y-90 administration time that yields the appropriate radiation dose. In addition, the software is bound to a computer, which limits accessibility and mobility. To improve workflow in the dosimetry process, a more customizable calculation program was developed as a mobile device application.

Programming of the app was done in Objective-C using Xcode/iOS developer (Apple Computers, Cupertino, CA, USA). Primary use of the application is on iPhone® and iPad® devices. Algorithms are based on open-source software and literature provided by Nordion, Inc. The application was tested in the iOS Simulator and user feedback was obtained from radiologists, engineers, and nuclear medicine specialists.
**Fig. 1:** Current manufacturer (Nordion) dosing calculation software

© TheraSphere Yttrium-90 Glass Microsphere Treatment Window Illustrator. Nordion Inc., Ottawa, Ontario, Canada
Imaging findings OR Procedure details

Two main features of the mobile application provide precision and customization:

- Input of desired Y-90 administration time to determine the exact dose activity size required to yield the intended radiation dose.
- Input of a custom dose activity size to calculate the specific treatment day and time so that target radiation dose is delivered.

The following is an outline of the iOS app:

1. Upon launching the app, the main screen displays as shown in Fig. 2 on page 6. The medical professional can view instructions on how to operate the app with step-by-step directions by clicking the info button in the bottom right corner. This displays the info screen as seen in Fig. 3 on page 6.

2. To calculate the dosing, on the main screen, the patient characteristics must be inputted. These include the radiation dose to be delivered, the lung shunt fraction, and the target liver volume of the patient. A sample case is shown in Fig. 4 on page 7.

3. Next, the medical professional can choose either of the following: A) set a desired day and time for Y-90 administration or B) set a custom dose activity size to be used for the treatment (in GBq). Below is a description for options A and B.

4. Option A: When the "Set Day and Time" button is selected, the app prompts selection of the desired Y-90 administration day and time on scroll wheels. Fig. 5 on page 8 shows a sample case. The output screen will display the calculations of the precise dose activity size needed to yield the target radiation dose at the selected day and time. In addition, alternative administration times, corresponding to two of the standard dose activity sizes (3, 5, 7, 10, 15, or 20 GBq) closest to the calculated dose activity size, are also calculated. These outputs are illustrated in Fig. 6 on page 9.

5. Option B: When the "Set Custom GBq" button is selected, the app prompts input of a custom dose activity size to be used in the treatment. Fig. 7 on page 10 shows a sample case. The output screen will display the appropriate day and time to administer Y-90 so that the target radiation dose is delivered based on the custom dose activity size. Alternative administration times, corresponding to the two standard dose activity sizes closest to the input custom dose activity size, are also calculated. Fig. 8 on page 11 exemplifies these outputs.
Fig. 2: Main screen on startup

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Fig. 3: Info screen

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**Fig. 4:** Input of patient characteristics

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Fig. 5: Input of day and time

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**Fig. 6:** Output screen from day and time input

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**Fig. 7:** Input of custom dose activity size

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**Fig. 8:** Output screen from input of custom dose activity size

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Conclusion

This dosing calculator provides a customizable, user-friendly tool to improve workflow and mobility in the Yttrium-90 treatment process. The app allows versatility in the dosimetry procedure with the ability to calculate administration schedules from standard and custom dose activity inputs, as well as suggest dose activity sizes corresponding to a desired day and time for the procedure. This software can improve the workflow of daily tasks for medical professionals involved in Y-90 radioembolization liver tumor treatment.
References

1. TheraSphere Yttrium-90 Glass Microsphere Treatment Window Illustrator. Nordion Inc., Ottawa, Ontario, Canada
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