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The Modular Remote Afterloader: A New Approach for Distributing Yb-169 to Enable Clinical Intensity Modulated Brachytherapy

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INTRODUCTION

To introduce the modular remote afterloader (MRA) approach to the cost-effective distribution of ^{169}Yb, which has a 93 keV average γ-ray energy, to clinics for intensity modulated brachytherapy.

The conventional distribution model where an engineer travels onsite to perform ^{169}Yb source changes is a costly proposition for ^{169}Yb distribution since its 32-day half-life requires more than double the source-change frequency of conventional ^{192}Ir.

The MRA is proposed to address this challenge.

METHOD

An MRA was designed with a removeable briefcase-sized cartridge and a wheel-mounted base that receives the cartridge.

The cartridge is easily shippable and contains a guidewire-mounted ^{169}Yb source with an activity of up to 54 Ci. The guidewire and source are loaded in a shielded safe, which contains the guidewire drive components that extend and retract the source.

The base contains the electronics and power supplies for controlling the components in the cartridge.

RESULTS

A block diagram of the MRA showing the base and cartridge (**Figure 1a**), and a diagram of the cartridge and guidewire control mechanism (**Figure 1b**). The cartridge is removable from the MRA base. The guidewire can be secured and the loading port/connector plugged to enable the safe shipment of the cartridge to and from the clinic.

The distribution model for the cartridge is similar to that of ^{99m}Tc generators (^{99}Mo "cows"), which are used to transport the same order of magnitude of 100 keV-range γ-ray emitters and managed almost completely by clinic staff as opposed to vendor engineers. The guidewire drive system shown in **Figure 1b** consists of 4 multi-axis rollers, 2 redundant drive motors, and 2 encoders, which control the angular orientation of a barrel that rotates the carriage

The carriage drives the guidewire, which has a locking-tab protruding lateral to the wire axis at the proximal end of the wire. When the cartridge is attached to the MRA base (**Figure 1a**), electrical control of the guidewire drive system is established with the receiver, and the loading port / connector adjoins with the tube leading to the delivery channel. Transfer tubes for radiation delivery are connected to the respective channels.

The central operating principle of the guidewire drive system is that the locking tab at the proximal end of the guidewire is driven along a single helical guide tube by the carriage. The helical guide tube has a central lumen with a diameter of 2 mm and a keyway removed from it that subtends an axial angle of approximately 30° along the entire length of the helical guide tube.

The keyway rotates helically about the helical guide tube to prevent the guidewire from mechanically falling out of the tube, which would occur if there was no helical keyway "wrapping" about the tube.

Additional detail on the delivery and source change process will be presented at the meeting if the abstract is accepted.

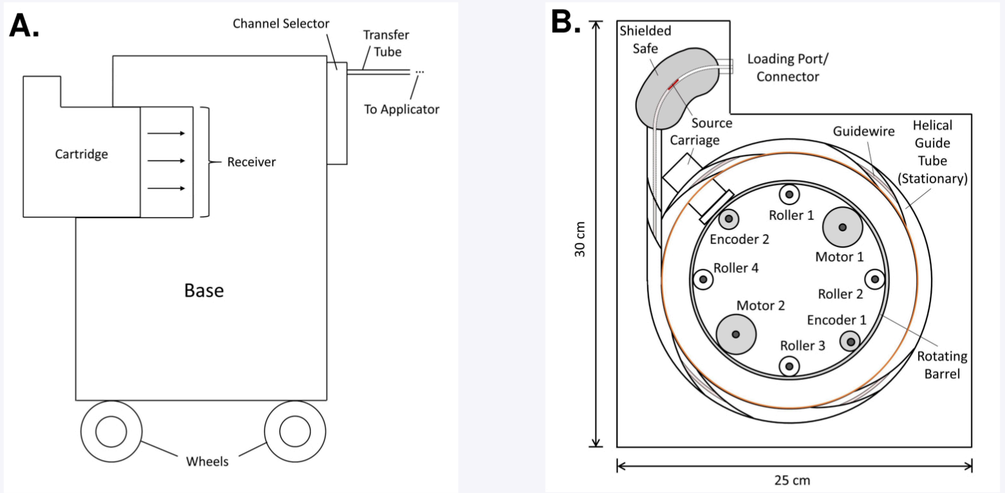

Figure 1: (a) *Simplified block diagram of the modular remote afterloader (MRA).* ***(b)*** *MRA cartridge containing the guidewire-mounted radiation source, the shielded safe, and the guidewire drive system. The helical guide tube has three 360° wrappings.*

The displayed wrapping is the final rotation prior to the loading port/connector, through which the source exits the cartridge for treatments. The carriage as shown is on the first wrapping in the helical guide tube coil since the source is fully retracted and inside the shielding.

CONCLUSIONS

The MRA approach is possible since a cartridge containing both the source safe and mechanical drive components can be made small and light enough for ^{169}Yb.

Onsite engineers would not be required for all source changes, dramatically reducing the cost of ^{169}Yb distribution but would still be needed for onsite preventative maintenance and repairs.

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Conflict of Interest:

RTF is the President of pxAlpha, LLC, which is developing an RSBT delivery system.