Purpose

$^{90}$Y microspheres radioembolization is an emerging treatment modality for treatment of liver malignancies [1]. Radioembolisation involves placing a radioactive material, tiny resin or glass beads called microspheres directly at the tumor site under the guidance of interventional radiology technique. With better understanding to the dose-response of the treatment, there is a trend to administer higher $^{90}$Y radioactivity for better patient efficacy [1], raising the concern in occupational radiation dose received by medical personnel caring for this new patient service [2]. Although there are local guidelines and regulations regarding the safety use of radioisotopes in hospitals, any practical means to further reduce occupational radiation dose to staff and exposure to nearby individuals is highly desirable in order to comply with the “as low as reasonably achievable” (ALARA) principle [3].

Images for this section:

Fig. 1: A lead lined blanket is used to cover the thorax and abdominal region of patient undergone Y90 radioembolization.
Methods and materials

Y90 is pure #-emitting isotope of average energy of 0.9 MeV, a maximum radiation range of 11 mm in tissue and of half life of 64 hours. Following treatment of $^{90}$Y microspheres, patients become a source of radiation that could potentially affect other persons around them via Bremsstrahlung emission [4]. Therefore safety precautions must be considered to keep the dose to other individuals as low as reasonably achievable. Because Bremsstrahlung emission is in the form of #-radiation, lead apron type blanket is useful to reduce the bremsstrahlung radiation.

A lead lined blanket of size 60 cm x 64 cm, weight 4 kg and of lead equivalence of 0.5 mm has been routinely used to cover the patient abdomen and thorax region after radioembolization procedure in our institution. Patients were tolerable to the size and weight of the blanket. This kind of blanket is commercially available and as presented in this report, it was made from a retired lead apron. The blanket is warped with sterilized plastic bag and its weight is tolerable to patient.

Radiation dose rates at 10 cm above patient abdomen surface and at the position of interventional radiologist pressing the puncture site were measured with a calibrated radiation survey meter (Fluke, model 451P, OH, USA) with and without the blanket in place (Table 1).

Wilcoxon’ t-test for paired samples was used to compare the difference in the measured dose rates when using the lead lined blanket or not. The software used was Statistica version xx (StatSoft, Tulsa, OK, USA). Values of p # 0.05 were considered to be statistically significant

Results

Table 1 shows the dose rates, normalised by the patient administered $^{90}$Y microsphere radioactivity, measured at the position of the interventional radiologist and at 10 cm above the patient abdomen with and without being covered by the lead lined blanket. There has been a dose reduction of a factor of > 2 with the use of the blanket. At the radiologist
position during pressing the puncture site after radioembolisation, the average dose rate
has been measured as 1.32 µSv/(hr GBq). The average infused Y90 radioactivity for
our patients is 2.1 GBq. The radiologist thus received 0.92 µSv during pressing the
puncture site on his hands and arms that are not radiation shielded by lead apron. Since
the radiologist wears a lead apron of the same lead equivalence of the lead lined a
blanket, he actually would receive a body dose of 0.4 µSv under his lead apron due
to the Bremsstrahlung radiation from the patient after radioembolisation, comparable to
the hourly background radiation rate of about 0.3 µSv in our institution area. The same
radiation dose measurements have been calculated for nurses and porters nursing and
transporting the patient respectively after ⁹⁰Y radioembolisation treatment with the use
of the blanket (Table 2), showing occupational dose is indeed very minimal.

While radiation safety considerations in ⁹⁰Y radioembolisation have been described
in detail for patient dosimetry accuracy, interventional radiology room radiation
contamination prevention and scenarios for radioemolised patients in contact with their
family [5], there is not much available in literature for dose reduction for medical
professionals involved in the procedure. Using a blanket type lead apron of 0.5 mm
lead equivalence with size and weight tolerable to patient comfort, it has been shown
that the Bremsstrahlung radiation emitted from patient can be reduced by more than
a factor of 2 in order to comply with the ALARA principle in radiation protection. This
dose reduction is useful for the concern to administer higher ⁹⁰Y radioactivity for better
patient treatment efficacy. Generally, there are local recommendations and regulations
regarding the safety use of unsealed radioactive substance in hospitalization and on
patient release. Our institutional radiation safety regulation requires ⁹⁰Y treated patients
of greater than 1.5 GBq should be accommodated in a single room ideally with private
toilet facility. Sometimes this cannot be achieved due to insufficient isolation ward or
there is no such facility in some hospitals but ⁹⁰Y radioemboliation has to be performed.
We attempt to solve this resource problem by allocating the ⁹⁰Y treated patient at a
corner bed in a common ward. To justify that other patients at the vicinity of the ⁹⁰Y
radioemboised patient would be exposed unnecessarily, the lead lined blanket is used
to cover the radioembolised patient abdomen. The exposure rate at 1m is calculated to
be 1 µSv/hr (assumed 2.1 GBq infusion). If the distance between the ⁹⁰Y patient and the
patient adjacent to him is maintained at 2 m, the exposure rate would then be 0.25 µSv/hr
which is about the same background radiation level in our institution area. In other words,
the ⁹⁰Y patient would not expose unnecessarily radiation exposure to the next patient if
a lead lined blanket and distance as far as 2 m are followed.
Indeed, $^{90}\text{Y}$ microspheres treated patients represent an even lower radiation safety risk for nearby individuals because there is no biologic elimination of $^{90}\text{Y}$ as the microspheres remain fixed in liver, tumor and lung [4-5]. There are two types of $^{90}\text{Y}$ microspheres commercially available, namely glass microspheres and resin microspheres [6-7]. The glass spheres are not known to be present in any body fluid, whereas trace amounts of $^{90}\text{Y}$ radioactivity may be excreted in the urine of resin microsphere treated patients for the first 24 hours. Therefore for glass microsphere treated patients, they can use the toilet facility in the common ward as usual because their urine would not contain any radioactive content. For resin microsphere treated patients, they are advised to flush the toilet twice after use. In other words, radioembolised patients can use common toilet facility as other non-radiation patients do.

**Images for this section:**

**Fig. 1:** A lead lined blanket is used to cover the thorax and abdominal region of patient undergone Y90 radioembilization.
Table 1: Normalized average dose rate measured at the interventional radiologist performing puncture site pressing and at 10 cm above patient abdomen with and without the blanket used.

<table>
<thead>
<tr>
<th>Use of lead-lined blanket</th>
<th>Normalized average dose rate [μSv/nGy]</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Radiologist position</td>
<td>At 10 cm above patient abdomen</td>
</tr>
<tr>
<td>No</td>
<td>2.91</td>
<td>8.41</td>
</tr>
<tr>
<td>Yes</td>
<td>1.32</td>
<td>3.10</td>
</tr>
<tr>
<td>p-value</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
</tr>
</tbody>
</table>
Table 2: Occupational dose estimation per procedure with the use of blanket covered on patient thorax and abdomen after 90Y microspheres radioembolisation; interventional radiologist has the role of puncture site pressing; nurse has the role of patient transfer from X-ray couch to patient stretcher; porter has the role of transporting the patient from interventional radiology room to ward. The estimated time is referred to our institution workflow.
Conclusion

A simple but practical measure of using a lead lined blanket not only further reduces occupational dose to personnel providing patient service for the radioembolisation procedure but also solves limited resource of isolation ward.

Personal information

aM Law, akK Wong, aWK Tso, bV Lee, bMY Luk

aDepartment of Radiology and bClinical Oncology, Queen Mary Hospital, Hong Kong

References

6. TheraSphere Yttrium-90 microspheres [Instructions for use], Ottawa, ON, Canada.
7. SIR-Spheres Microspheres [Packing insert], North Sydney, NSW, Australia.