Simplification of Transmission Factor Determination for I-131 Gamma Camera Based Internal Dosimetry with Co-57 Solid Flood Source

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INTRODUCTION

- Patients ≥55 years of age with active, relapsed or refractory acute myeloid leukemia (R/R AML) who have failed standard induction and salvage therapies do not routinely undergo allogeneic hematopoietic cell transplantation (HCT) due to their inability to receive myeloablative conditioning. The SIERRA trial (Iomab-B) is a prospective, randomized, phase 3, open-label, multicenter trial designed to address this significant unmet need.
- Iomab-B is an I-131 labelled anti CD45 antibody (Apamistamab), targeting cells with CD45 positive express. CD45 is expressed on hematopoietic cells, including leukemia cells, lymphoma cells and all immune cells. Preliminary clinical results have shown that targeted conditioning with Iomab-B can lead to successful engraftment.
- Clinical trial of Iomab-B calculates patient dosimetry following the MIRD schema with planar imaging. Transmission correction is performed with a flood source of the same isotope, I-131.
- However, preparation of I-131 filled flood sources presents unique operational challenges.
- Co-57 flood sources are widely available and easily handled.
- A sub-study has been designed to have patients' transmission correction determined with both I-131 and Co-57 flood sources.

Fig. 1 Fillable I-131 liquid flood source

Fig. 2 Co-57 flood source

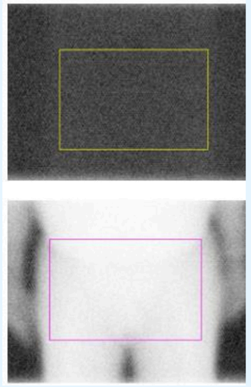

Fig.3 Example of anterior images of flood source without and with patient.

AIM

- Preliminary results from the sub-study patients were analysed, and feasibility of obtaining transmission factors with Co-57, rather than I-131 flood source, was investigated.

METHOD

- Transmission factors (T) were obtained from the anterior images of an I-131 and a Co-57 flood source with and without the presence of patients for both the abdomen and pelvis regions (Fig. 3) and expressed by the following equations.

$$T_{I-131} = \frac{I_{tr}(I-131)}{I_0(I-131)} = e^{-\mu(I-131)t} \quad \text{(Eq.1)} \qquad T_{Co-57} = \frac{I_{tr}(Co-57)}{I_0(Co-57)} = e^{-\mu(Co-57)t} \quad \text{(Eq.2)}$$

- The ratio of T_{I-131} to T_{Co-57} is defined as Transmission Ratio (TR) and follows an exponential relationship with thickness t, as shown in Eq. 3

$$TR = \frac{T_{I-131}}{T_{Co-57}} = \frac{e^{-\mu(I-131)t}}{e^{-\mu(Co-57)t}} = e^{-((\mu(I-131)-\mu(Co-57))t} \quad \text{(Eq.3)}$$

- The same procedure was performed with different thicknesses of tissue-equivalent phantoms (12-34 cm at 2 cm increments).
- TR vs. t curves were generated using phantom and patient data.
- Dose calculations were performed for 3 organs: liver, spleen, marrow. Using t measured on recent (<2 weeks) patient CT.
- Dosimetry using Co-57 (corrected with transmission ratio) and I-131 was compared, and the percent differences are reported.

RESULTS

- TR measured with solid water phantoms reflects the exponential relationship in Eq. 3. However, for the thickness range used in this work, a linear fit of TR vs. t has a similar coefficient of determination, r^2 as shown in Fig. 4(a).
- Therefore, a linear look-up curve for TR measured with patients (11 patients, 2 regions for each patients) was created based on patient thicknesses (Fig. 4(b)).

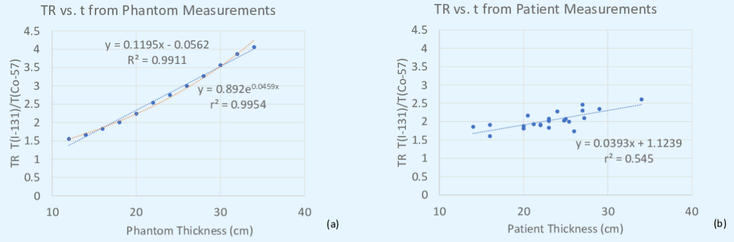

Fig.4 (a) TR determined at different phantom thicknesses; both linear and exponential fits are shown.
(b) TR determined from 11 patients, each with abdomen and pelvis regions measured separately; a linear fit is shown

- Transmission factor was determined from both the Co-57 measured T_{Co-57} and the TR looked up from Fig. 4(b) based on t. And this corrected transmission factor was used to perform dosimetry calculation retrospectively for the 11 patients.

- 10-20% uncertainty is generally acceptable for personalized internal dosimetry. The difference of dosimetry calculated between I-131 and Co-57 shown in Table 1 for the same 11 patients is well within the uncertainty.
- It should be noted that the transmission factor is a combined effect of energy (linear attenuation coefficient) and patient thickness. Both need to be carefully measured in order to obtain high accurate results.

Table 1. The % difference of calculated organ dose using Co-57 measured transmission vs. using I-131 measured transmission.

Patient #	Abdomen Thickness	Pelvis Thickness	Liver (% diff)	Spleen (% diff)	Marrow (% diff)
1	34 cm	26 cm	2.8	3.0	-8.7
2	27 cm	27 cm	5.8	5.7	2.0
3	23 cm	20 cm	1.5	1.3	-2.2
4	24 cm	22 cm	4.7	4.6	-2.6
5	25 cm	23 cm	-0.8	0.0	-4.6
6	16 cm	14 cm	4.1	3.8	4.7
7	20 cm	16 cm	-0.7	-0.9	-2.9
8	29 cm	21 cm	1.7	1.8	5.2
9	23 cm	22 cm	1.4	1.9	-2.5
10	27 cm	25 cm	-2.1	-2.4	-2.6
11	25 cm	21 cm	-4.3	-5.1	0.0
		Median	1.5	1.8	-2.5
		Mean	1.3	1.3	-1.3
		Range	-4.3 – 5.8	-5.1 – 5.7	-8.7 – 5.2

CONCLUSIONS

- Retrospective calculations with Co-57 measured transmission factors for I-131 labeled antibody dosimetry demonstrate the feasibility to replace I-131 flood source with Co-57 solid flood source.
- This could simplify the operation of determining patient transmission factors in clinic.

CONTACT INFORMATION

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SIERRA
Study of Iomab-B in Elderly Relapsed/Refractory AML