A practical method for the reuse of nanoDot OSLDs and predicting calibration factors up to at least 50Gy

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Purpose: OSLDs are used to make in vivo measurements during special treatment such as Total Body Irradiation (TBI), Total Skin Electron Irradiation (TSEI) etc. Most users use screened OSLDs provided by Landauer Inc. and use the InLight microStar reader to convert the counts of an OSLD to dose. The uncertainty is ±5%. The microStar reader provides a non-linear dose calculation function that can read an OSLD with an accumulated dose up to 15Gy, but an OSLD is often discarded when it reaches 3Gy. In this study, we present an accurate method of reusing OSLDs up to at least 50Gy and may be applicable far above that dose.

Methods: We reuse 9 OSLDs to do TBI in vivo measurements in our clinic. Instead of using the calibration routine in the InLight microStar software (Landauer, Inc.), we anneal them with a fluorescent light source to less than 200 counts (~0.3 cGy), irradiate them with 50cGy, and use the hardware mode in the microStar software to read OSLDs to produce an OSLD serial number-specific calibration factor (CF). After TBI delivery, we read them in hardware mode and apply the calibration factor to get the dose. We refer to these steps as Cycle A: optical anneal – measure CF – in vivo measurement – read out. In this study the 9 OSLDs passed through up to 28 Cycle A's to nearly 50Gy total dose. We found that all OSLD's calibration factor change linearly with accumulated dose with the value of R^2 between 0.93 and 0.98 (Fig. 1).

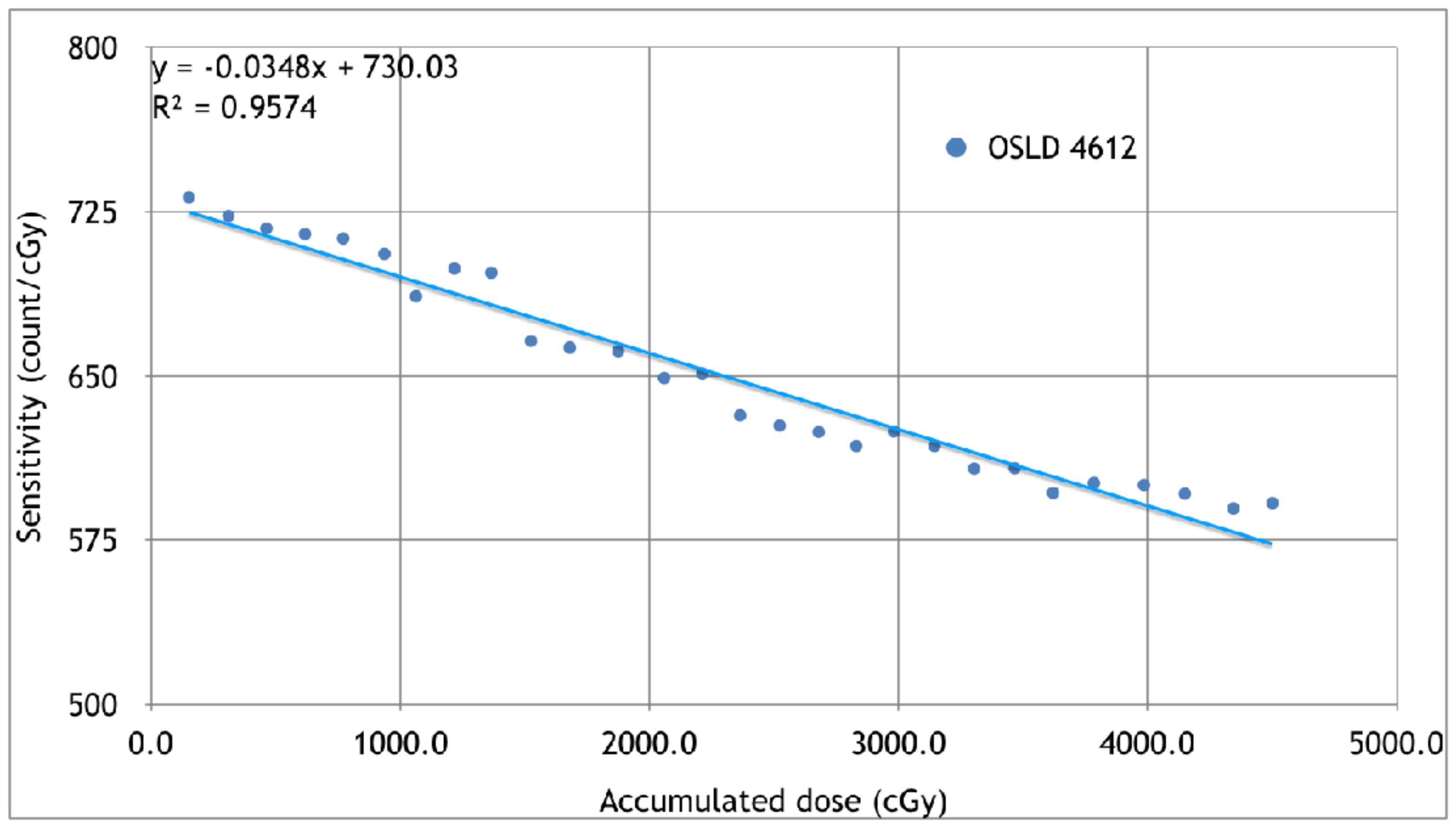

Fig. 1 The relationship of the measured calibration factors vs accumulated dose for one of the OSLDs (SN 4612), and a linear fitting curve.

Methods (continued): Although one can measure the calibration factor of an OSLD prior to each in vivo measurement, we propose a time-saving method to predict a calibration factor using Eq. 1. During the first 6 usages, each OSLD runs through Cycle A and we establish a linear fitting curve with the measured CFs. During the next three usages (7th to 9th usage), the OSLD is used with a new cycle without CF measurement: "anneal - calculate CF using Eq. 1 - in vivo measurement - read out", which is noted as Cycle B. During the subsequent three usages, the OSLD runs through Cycle A again and updates the linear fitting curve with measured CFs. Then the next three usages use Cycle B, followed by three usages using Cycle A, and so on.

$$CF_n = Dose_n \cdot slope + intercept \qquad \text{Eq. 1}$$

CF_n - Calibration factor for the nth usage; $Dose_n$ - Accumulated dose up to and including nth usage

slope - The value of the slope of the linear fitting curve; intercept - The value of the intercept of the linear fitting curve

Results: Fig. 2 shows the %difference of the predicted calibration factors compared to the measured calibration factors for one of the OSLDs when used with Cycle A, Cycle B, Cycle A, etc, and the %difference ranges from 0.08% and 3.86%. Among all the 9 OSLDs, a total of 78 calibration factors were predicted and retrospectively compared to the measured CFs. The average deviation is 1.50% ± 1.03% ranging from 0% to 3.86%.

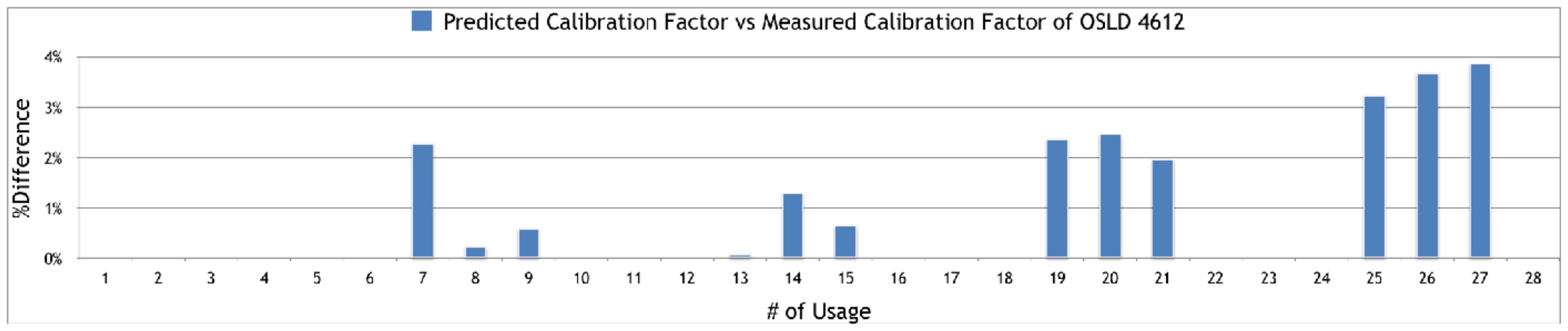

Fig. 2 The %difference of the predicted calibration factors compared to the measured calibration factors.

Conclusions:

We have shown that OSLDs can be reused up to very high doses when annealed and calibrated before each use. We also present a cost-saving and feasible method that permits the reuse of an OSLD up to at least 50Gy accumulated dose with minimal recalibration effort, and predict calibration factors with a precision of 4% better than the value one can achieve with the conventional batch calibration method.

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