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Long-term reliability of optically stimulated luminescence dosimeters

Tanya Kairn^{1,2}, Samuel Peet^{1,2}, Liting Yu^{1,2}, Scott Crowe^{1,2}

1. Royal Brisbane and Women's Hospital, Brisbane, Australia

2. Queensland University of Technology, Brisbane, Australia

t.kairn@gmail.com



Aims & objectives

Optically stimulated luminescence dosimeters (OSLDs) can be used as accurate and re-usable dosimeters for radiotherapy applications [1-11].

OSLDs have been observed to decline in sensitivity with repeated use [1, 4, 12].

Is the decline in OSLD sensitivity associated with a decline in reliability?

In other words, **can correction factors be used to negate the decline in OSLD sensitivity, without detrimentally affecting measurement accuracy?**



Materials and methods

Three batches OF OSLDs: Landauer nanodots (Landauer, Glenwood, USA)

- 1 batch purchased in 2012
- 1 batch purchased in 2014
- 1 batch purchased in 2016

All repeatedly re-used in a mature in vivo dosimetry programme,
over a period of up to five years

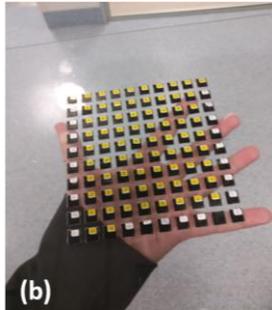




Materials and methods

The consistency of the response of all OSLDs in the three batches were evaluated over repeated irradiation-readout-bleaching cycles:

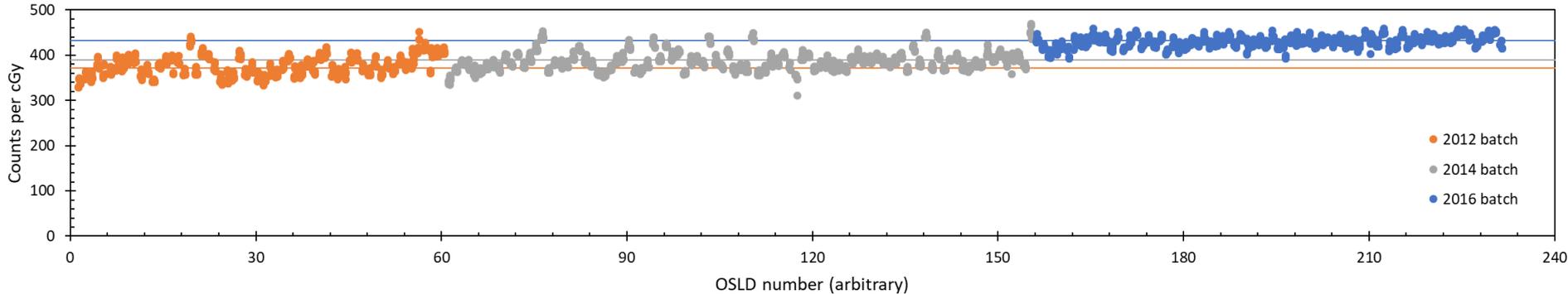
- Irradiation: 105 cGy delivered using a 12 MeV electron beam from a Varian iX linear accelerator, to OSLDs in pre-fabricated array between slabs of water-equivalent plastic
- Readout: Landauer Microstar OSLD reader, stimulating luminescence with 532 nm (green) light
- Annealing (optical bleaching): 3 hour exposure in Gammasonics Manual OSL Annealing Lightbox





Results & discussion

OSLD dose response, plotted as number of counts per cGy of delivered dose:



Mean response of OS LDs from 2014 batch = 89% of mean response of OS LDs from 2016 batch.

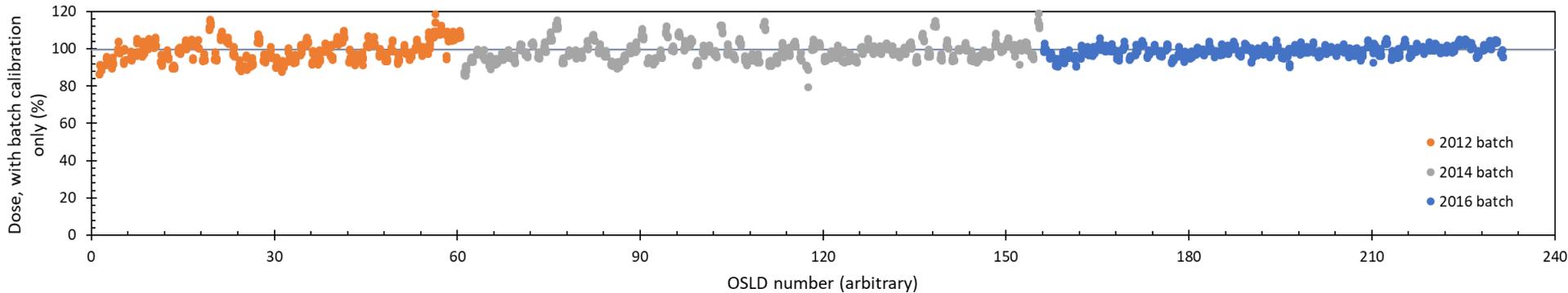
Mean response of OS LDs from 2012 batch = 86% of mean response of OS LDs from 2016 batch.

This is a useful long-term validation of the OS LD sensitivity decrease that was predicted by several short-term response studies [1, 4, 12].



Results & discussion

OSLD dose response, plotted as measured dose as a percentage of delivered dose, with batch calibration applied:



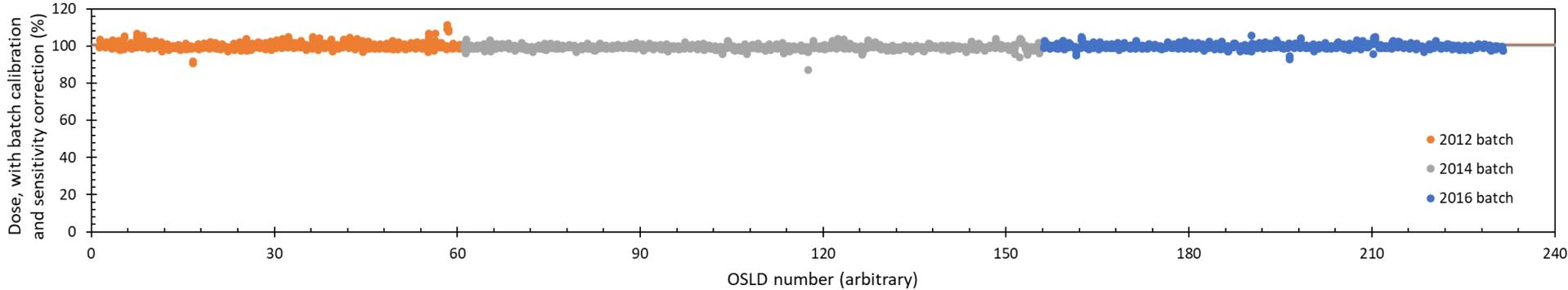
Measurements appear unacceptably variable, due to response variations of individual OSLD chips [13].

Standard deviations calculated over repeated irradiation-readout-bleaching cycles = 6.1%, 5.6% and 2.9% for batches of OSLDs from 2012, 2014 and 2016, respectively.



Results & discussion

OSLD dose response, plotted as measured dose as a percentage of delivered dose, with batch calibration and locally-measured sensitivity correction factor applied:



Measurement accuracy improved, with minimal dependence on age and previous irradiation history.

Standard deviations calculated over repeated irradiation-readout-bleaching cycles = 2.0%, 1.3% and 1.3% for batches of OS LDs from 2012, 2014 and 2016, respectively.



Conclusion

Three batches of OSLDs that had been repeatedly re-used in a mature in vivo dosimetry programme have been found to be capable of providing radiotherapy dose measurements with similar levels of accuracy, despite the batches' varying ages and levels of previous accumulated dose. To achieve this result, it was necessary to measure and apply a local sensitivity correction factor to each OSLD reading. If this extra step is included in the OSLD measurement process, then it may be possible to use the same OSLDs repeatedly and reliably for years, without needing them to be retired and replaced.

Summary: **Can correction factors be used to negate the decline in OSLD sensitivity, without detrimentally affecting measurement accuracy? Yes they can and yes they should.**



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Conflict of interest

The authors declare that they have no conflict of interest.