IMPROVING RADIATION DOSE MEASUREMENTS FOR PRE-CLINICAL RADIOBIOLOGICAL STUDIES

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Needs and Challenges

Radiotherapy is currently one of the most cost-effective curative treatments for cancer (>50% of patients require radiotherapy at some time during their illness). Improvement of our understanding of radiation effects can make a major contribution and there are enormous potential benefits from combining radiotherapy with chemotherapy and molecular targeted drugs. This is leading to a large increase in the number of radiobiological experiments carried out in animal models. However, contrary to clinical practice, there are currently no regulations or directives to control the quality of radiation exposure in pre-clinical experiments and trials. Current radiobiological experiments rely on local expertise, available dosimetry equipment (rarely calibrated to traceable standards) and manufacturer information. Surveys have reported dosing errors up to 50% for studies where ICRU recommendations are <5%. The lack of standards and guidelines for assuring precision and accuracy of dose measurements undermines the reliability and reproducibility of the findings and leads to greater numbers of animals used.

Figure 1. Image of a Small Animal Radiation Research Platform (SARRP)

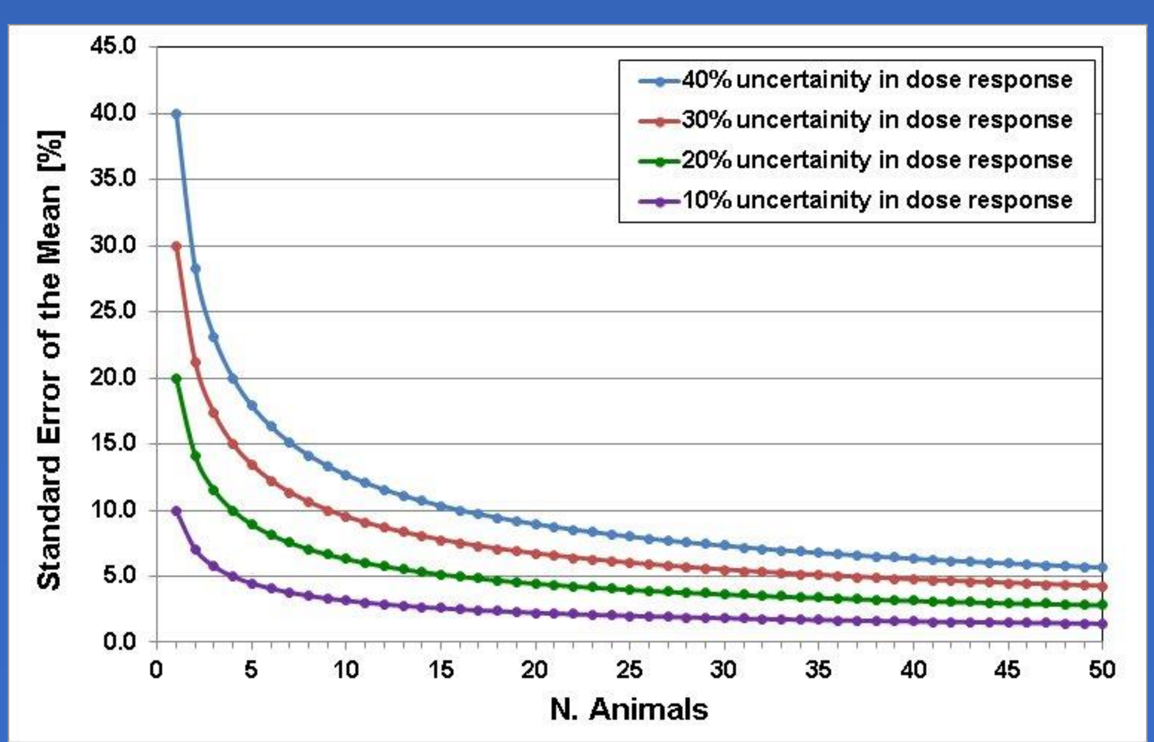

Figure 2. Graph showing the potential reduction in the number of animals used for radiation-biology studies as a function of an increased accuracy in radiation dosimetry

Figure 3
Participating UK centres:
- Institute Cancer Research
- University College London
- Beatson Institute - Glasgow
- Queen's University Belfast
- CRUK-MRC Oxford

Materials and Methods

Supported by InnovateUK and the NC3Rs, the National Physical Laboratory has established a dosimetry service for pre-clinical X-ray radiation units traceable to the UK national standard. The service is based on a anatomically correct tissue equivalent mouse phantom in which dosimeters can be inserted. The phantom and detectors can be irradiated following typical experimental procedures and the administered doses reported with uncertainty <2.7%.

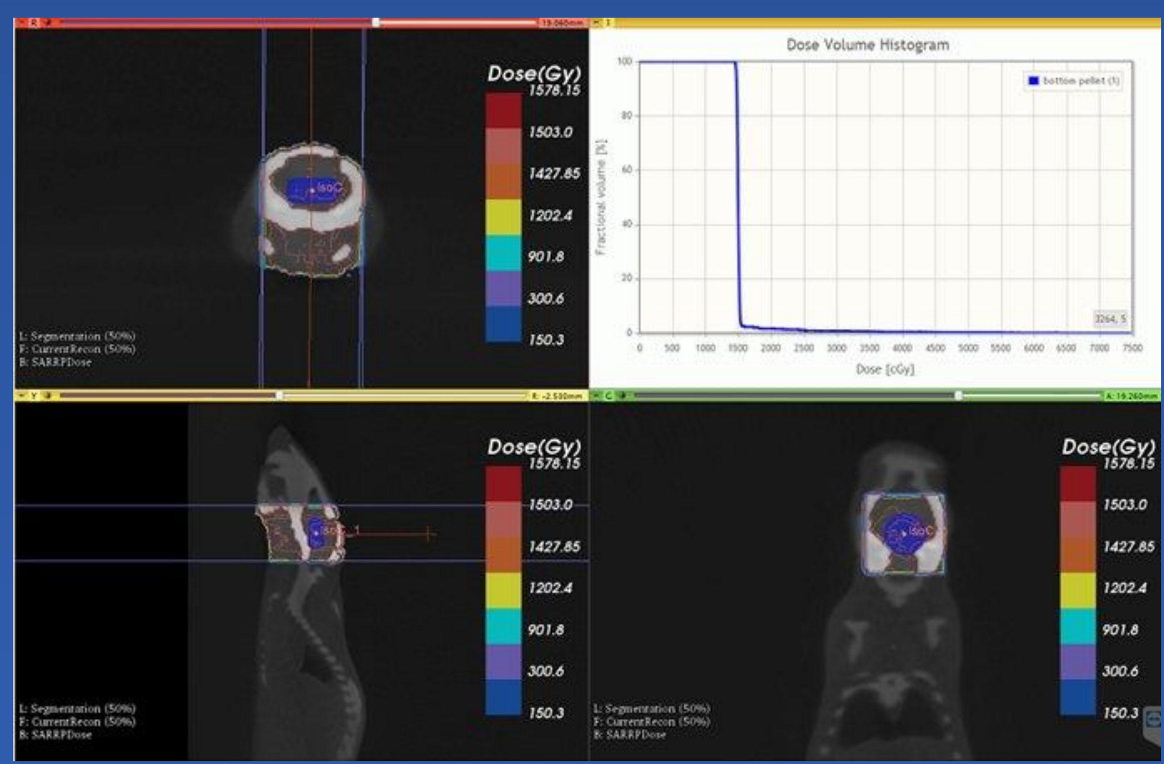

Figure 4. Representation of radiation treatment plan for small animal phantom

Results

Measurements performed at 5 leading UK radiobiological centres provides a snap shot of accuracy of the main UK radiobiological centres highlighting areas of concerns and providing solutions to reduce dosage errors and inter-centre variation to less than 5%.

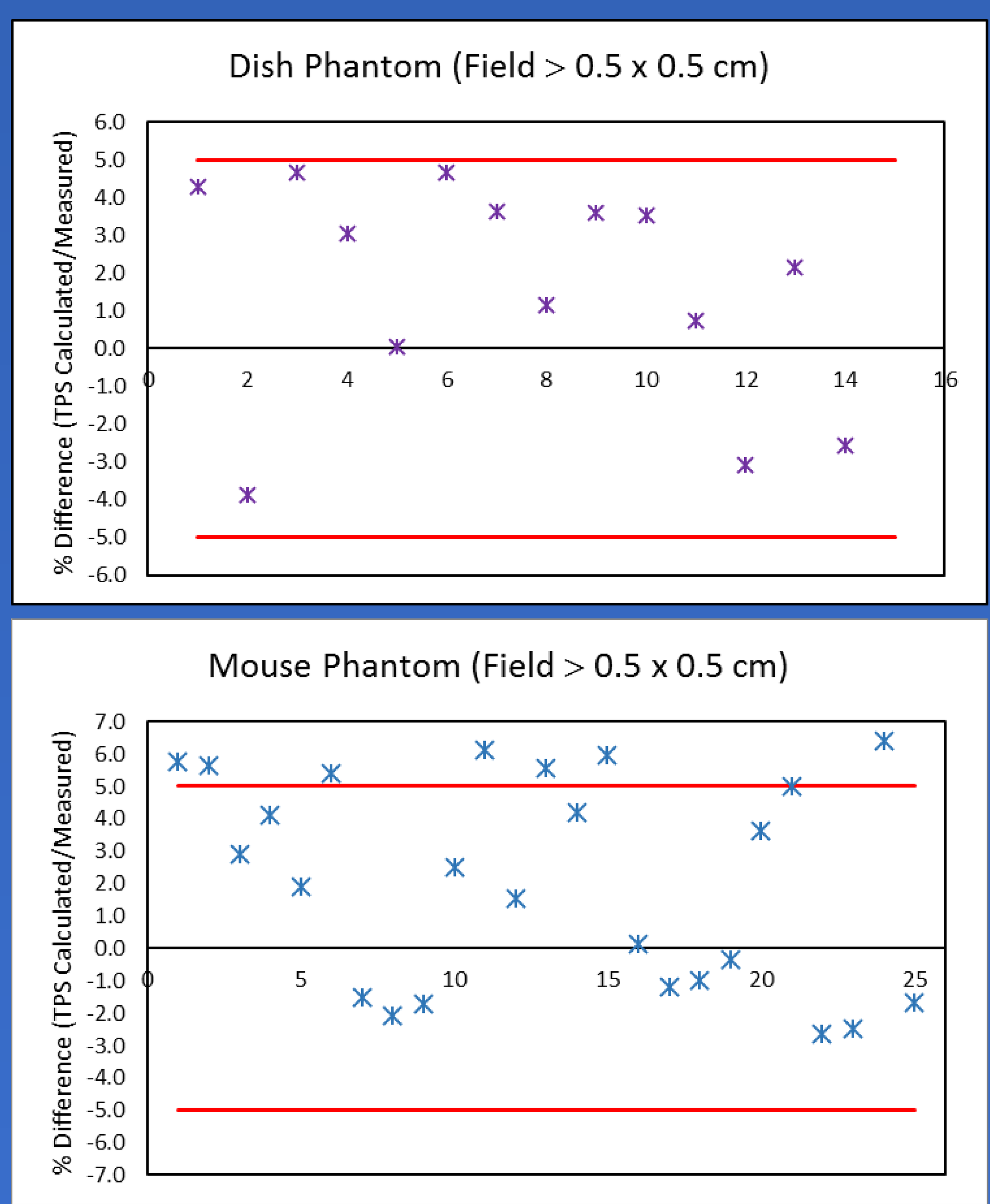

Figure 5-6. Variation in the dose delivered Vs dose planned for large (top) and small (bottom) collimators

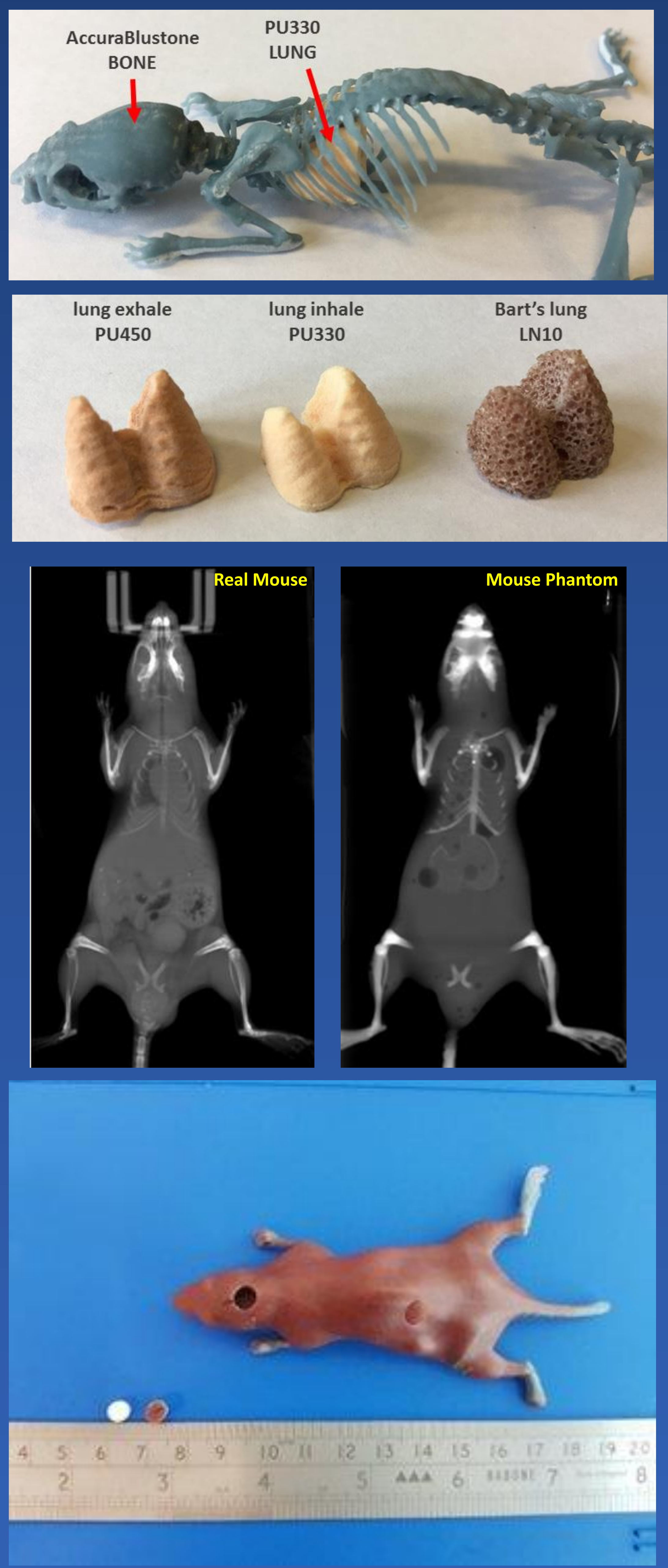

Figure 7. Details of the small animal phantom with alanine detector

Conclusions

This work is demonstrating how a well-designed dose verification procedure, based on suitable and reliable dosimeters and phantoms, can provide independent and accurate assessment of animal irradiation platforms resulting in a tool for implementing the recent recommendations on pre-clinical dosimetry.

Moreover, the results provide a degree of standardization which increases confidence for the comparison of the radiobiological studies performed at the 5 participating UK centres.

This dosimetry system could also be used for dose verification in simple x-rays cabinets, where TPS is not available.