Occupational External Radiation Dose to Personnel Involved in Veterinary Positron Emission Tomography (PET) Procedures

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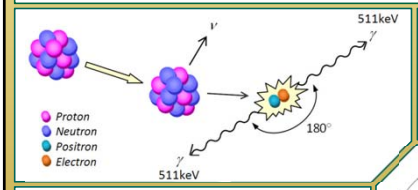
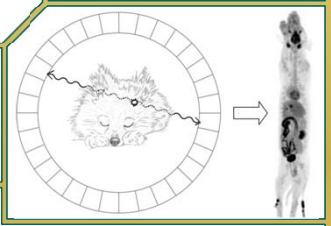
1. INTRODUCTION

Veterinary PET has increased dramatically in recent years



β^+ decay ⇒ positron-electron annihilation ⇒ coincident 511 keV photons

After radiopharmaceutical injection, coincident photon detection enables physiologic imaging of a patient



Darker portions of the resultant image indicate radiopharmaceutical accumulation

2. OBJECTIVES

Determine the real-time external, per-patient, radiation dose to staff working with veterinary PET/CT

Use staff dose data to optimize the imaging protocol

3. MATERIALS AND METHODS

Dosimetry: DMC 2000S EPDs by MGP Instruments, calibrated/read in $H_p(10)$, worn at chest or waist

Participants: nuclear medicine technologists, anesthesiology technologists, observer

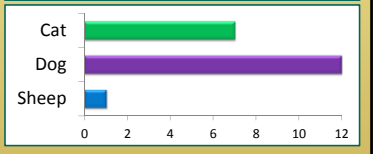
Data: collected for 20 of 25 scans conducted over 4 months

4. RESULTS

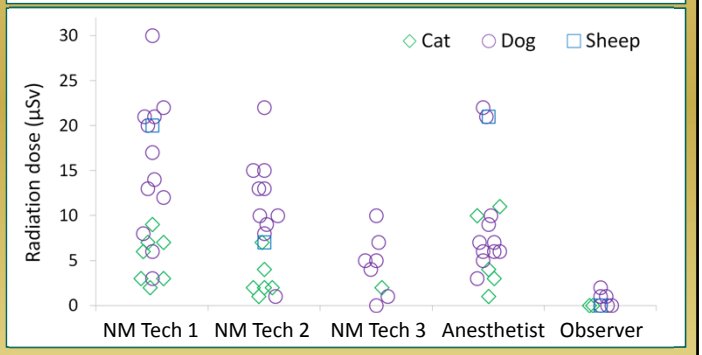
Patient mass (kg)

	Min	Max	Median
Cat	2.8	4.8	4.2
Dog	4.0	61.0	26.5
Sheep	76.4	76.4	76.4
All	2.8	76.4	25.5

Patient frequency



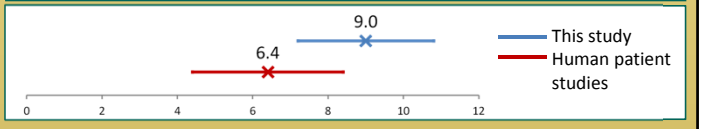
Individual doses to staff from patients



Average doses to staff per patient (µSv)

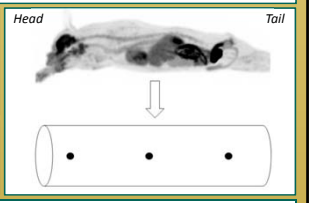
	NM 1	NM 2	NM 3	Anesthetist	Observer
Cat	5.3	3.0	2.0	5.8	0.0
Dog	15.6	11.6	4.6	9.3	0.7
Sheep	20.0	7.0	N/A	21.0	0.0
Overall	12.2	8.3	4.3	8.9	0.4
Cumulative	244	141	34	152	4
Est. annual dose	732	423	102	456	12

Overall average dose to staff per patient (µSv) with 95% CI



Protocol comparison using a dose model

^{18}F-FDG uptake is not uniform; model patient as 3 point sources within a soft tissue cylinder



Use model to calculate dose

$$H = \frac{\Gamma A B}{\lambda r^2 e^{\mu x}}\left(1 - e^{-\lambda t}\right)$$

Expected staff dose per patient (µSv) comparison

	Anesthesia induction	
	Pre Injection	Post Injection
Primary PET Technologist	21.8	44.6
Anesthetist	9.8	33.4

Expected doses consider an average dog (26 kg; 156 MBq injected, or 52 MBq per point source) and estimate technologist time with and distance to patient; in the equation above, H is dose, Γ is the gamma ray constant, A is activity, B is the build up factor, λ is the decay constant, μ is the linear attenuation coefficient, x is distance between source and surface, and t is time

5. CONCLUSIONS

Vet PET technologists receive slightly higher per patient radiation doses on average than human PET technologists

Injecting the radiopharmaceutical prior to anesthesia is expected to result in greater radiation dose to staff (per patient) than post-anesthesia injection

Extrapolated annual staff doses are < 1 mSv and thus are well below occupational dose limits (20 mSv) and also below dose limits for the general public (1 mSv)

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ACKNOWLEDGEMENTS

Seth Kantor of Palo Verde Power Generating Station; Jason Roudebush of CSU's Radiation Control Office; study participants; and the faculty and staff of the nuclear medicine, anesthesiology, and medical/radiation oncology sections of CSU's James L. Ross Veterinary Teaching hospital for their respective support of and contributions to this project

SELECTED REFERENCES

LeBlanc (2007); Lawrence (2010); Benator (2000); Phelps (2002); Workman (2006); Rinn (2004); Carson (2003); Chiesa (1997); Dalianis (2006); Demir (2010); Guillet (2010); Leide-Svegborn (2010); McCormick (1993); McElroy (1998); Roberts (2005); Robinson (2005); Selerstad (2007); ICRP 103 (2007)