

Introductory information regarding eye plaque procedures to ensure knowledgeable and informed responses to questions during radiation safety consultation for eye plaque patients.

Meant to supplement the radiation safety information sheet by consolidating information and frequently asked questions with answers. Please continue adding to this document any questions that arise that are not addressed.

Iodine-125	<p>Half-life of 59.43 days. Emits photons with effective energy of 28 keV. TVL 55 mm Water, 0.059 mm Pb (ABS 2013) Decays by electron capture to a metastable Tellurium-125, which immediately undergoes gamma decay. Gamma emissions include 35.5 keV (25%), 27.2 keV (39.2%), and 27.4 keV (73.2%). Produced in a nuclear reactor, where Xenon-124 undergoes neutron capture, becoming Xenon-125, which then undergoes electron capture to become Iodine-125.</p>
Seed Construction – Best 2301	<p>5mm length, 0.8mm diameter, double wall titanium encapsulation. Internal tungsten marker, 3.75mm long with a diameter of 0.25 mm. Tungsten marker coated with an organic matrix (polystyrene) containing I-125, approximately 0.1mm thick. Active length is then 3.95mm.</p>
Plaque Construction	<p>Seeds are superglued to the gold plaque and then covered with an acrylic polymer. PMMA – polymethyl methacrylate.</p>
Exposure to Surrounding Individuals	<p>Time, distance, and shielding to achieve ALARA. Inverse square law for distance. Gold and lead eye patch for shielding. Recommend eye patch and 6 feet minimum distance to reduce exposure to background rates. Applies to family and pets. Other visitors are discouraged - minors and pregnant women, especially. Plaque placement / tumor location dictate point of highest exposure and area shielded by gold plaque. *SEE BELOW FOR IN DEPTH EXPOSURE COMPARISONS</p>
Ocular Melanoma Epidemiology	<p>Intraocular cancers are rare, with approximately 2000 new cases annually, roughly 7 in every 1 million people. Most ocular melanomas occur in the uveal tract, the vascular layer that includes the choroid (pigmented layer under retina), the ciliary body (muscle that changes the size of the pupil and shape of lens), and the iris. 98% in Caucasians. Mean age of incidence at 60 years. Not the same disease as skin melanoma. Untreated mortality is 31% at 5 years. Eye plaque brachytherapy provides an organ-preserving alternative to enucleation (removal of the eye), and achieves equivalent survival rates. Plaque radiotherapy all cause mortality rate is 18% at 5 years.</p>
COMS (Collaborative Ocular Melanoma Study)	<p>Study started by National Eye Institute in the mid-1980s</p>

	<p>comparing eye plaque brachytherapy to enucleation - findings released in 2001.</p> <p>COMS - Prescribe to tumor apex or 5 mm height, whichever larger (UCLA - minimum tumor height of 2mm, plus a sclera thickness of 1 mm and a plaque height of 2 mm – resulting in a minimum prescription height of 5 mm). Standard dose of 85 Gy (updated from 100 Gy), delivered in 5-12 consecutive days.</p> <p>Recommend dose rate between 0.42 and 1.0y Gy/hr.</p> <p>Calculations according to TG-43 with point source approximation</p> <p>COMS - Plaque size to extend beyond basal extent by at least 2 mm (UCLA - 3 mm margins).</p>
Silicone Oil Shielding	<p>Added to vitreous space of the eye with an oil where carbon base is replaced with silicon, increasing the effective Z and providing additional shielding beyond the tumor.</p> <p>For lateral plaque placement, the oil is shown to reduce radiation dose to ocular structures at the anterior-posterior ocular axis by 35%.</p> <p>Patients treated with silicone oil replacement have shown reduced retinopathy.</p> <p>Oil is flushed away with saline after plaque removal.</p>
Epilation (Hair Loss)	<p>Most patients lose eye lashes, but not eyebrows.</p> <p>*** PERMANENT? ***</p>
Vision Loss	<p>Depends on tumor size and proximity to the fovea.</p> <p>Radiosensitive critical structures include lens, fovea, and optic nerve.</p> <p>From COMS, 43-49% of patients have substantial impairment in visual acuity at 3 years after Tx.</p> <p>At 30 months, 52% of patients reported decreasing visual acuity in the treated eye.</p>
Comparison of I-125 with Palladium-103	<p>See TG-129.</p> <p>Pd-103 half-life = 17 days, mean energy of 21 keV.</p> <p>TVL 30 mm Water, 0.026 mm Pb.</p> <p>Often used for LDR - permanent prostate seed implants.</p> <p>Decays by electron capture to Rhodium-103, emitting gamma rays.</p>

COMPARING EQUIVALENT DOSES & RISKS

Exposure Time:		Days	Hours	Total (hr)	
		7	0	168	
Max Exposure Rate mR/hr		Accumulated Exposure mR		Time to Receive 20 mR hr	
@ 3 ft	@ 6ft	@ 3 ft	@ 6ft	@ 3 ft	@ 6ft
0.100	0.025	16.800	4.200	200.0	800.0
0.200	0.050	33.600	8.400	100.0	400.0
0.300	0.075	50.400	12.600	66.7	266.7
0.400	0.100	67.200	16.800	50.0	200.0
0.500	0.125	84.000	21.000	40.0	160.0
0.750	0.188	126.000	31.500	26.7	106.7
1.000	0.250	168.000	42.000	20.0	80.0
1.250	0.313	210.000	52.500	16.0	64.0
1.500	0.375	252.000	63.000	13.3	53.3
2.000	0.500	336.000	84.000	10.0	40.0
2.500	0.625	420.000	105.000	8.0	32.0
3.000	0.750	504.000	126.000	6.7	26.7
3.500	0.875	588.000	147.000	5.7	22.9
4.000	1.000	672.000	168.000	5.0	20.0
4.500	1.125	756.000	189.000	4.4	17.8
5.000	1.250	840.000	210.000	4.0	16.0

UCLA Survey Report displays time estimate to receive 20 mR

According to the Annual Dose Limits to a "Visitor", as compared to a member of the public [10 CFR 20.1301](#)

Exposure Limits to the Public

1.00 mSv/yr or 0.02 mSv/wk
100.00 mrem/yr or 2.00 mrem/wk

Exposure Rate Limits to the Public

0.02 mSv/hr
2.00 mrem/hr

Exposure Limits to Visitors*

5.00 mSv/yr *NO PREGNANT WOMEN
500.00 mrem/yr *NO CHILDREN UNDER AGE OF 18

Release of Individuals Containing Implants of Byproduct Material

[10 CFR 35.75](#)

Limit of exposure to any other individual for authorizing release of patient

5.00 mSv or 500.00 mrem

Threshold exposure to any other individual, if expected to exceed, requires written instructions on minimizing exposure to other individuals as low as reasonably achievable

1.00 mSv or 100.00 mrem

Lifetime Risk of Cancer		
Population	Risk of Developing Cancer (%)	Risk of Dying from Cancer (%)
Men	42.05	22.62
Women	37.58	19.13

*cancer.org

Common Sources of Radiation Exposure	Dose (mrem)*	Time to Equivalent Natural Background Radiation		Excess Relative Risk of Cancer Death (%)**	Excess Absolute Risk of Cancer Death (%)		Reduction in Life Expectancy	
					Men	Women		
Eating 1 Banana	0.01	17.0	minutes	0.00005	0.000011	0.000010	0.72	seconds
Hand/Foot XR	0.5	14.1	hours	0.0025	0.00057	0.00048	36.0	seconds
Dental XR	1.5	1.8	days	0.008	0.0017	0.0014	108.0	seconds
Trans-Continental Flight (NY to LA)	2.5	2.9	days	0.013	0.0028	0.0024	3.0	minutes
Safe Drinking Water (EPA)	4.0	4.7	days	0.020	0.0045	0.0038	4.8	minutes
Chest XR	10.0	11.8	days	0.050	0.011	0.0096	12.0	minutes
Cosmic Radiation (Sea-Level)	30.0	5.0	weeks	0.15	0.034	0.029	36.0	minutes
From Your Body (Food & Water)	40.0	6.7	weeks	0.20	0.045	0.038	48.0	minutes
Abdomen XR	60.0	2.3	months	0.30	0.068	0.057	1.2	hours
Pelvis XR	70.0	2.7	months	0.35	0.079	0.067	1.4	hours
Mammogram	72.0	2.8	months	0.36	0.081	0.069	1.4	hours
Cosmic Radiation (Denver)	80.0	3.1	months	0.40	0.090	0.077	1.6	hours
Annual Public Limit (NRC)	100.0	3.9	months	0.50	0.11	0.096	2.0	hours
Head CT	200.0	7.7	months	1.00	0.23	0.19	4.0	hours
Radon in the Avg. U.S. Home	228.0	8.8	months	1.14	0.26	0.22	4.6	hours
Avg. Annual Dose (U.S.) due to All Natural Sources	310.0	1.0	years	1.55	0.35	0.30	6.2	hours
Avg. Annual Dose (U.S.) due to All Man-Made Sources	310.0	1.0	years	1.55	0.35	0.30	6.2	hours
Nuc Med Exam	400.0	1.3	years	2.00	0.45	0.38	8.0	hours
Avg. Annual Dose for U.S.	620.0	2.0	years	3.10	0.70	0.59	12.4	hours
Chest CT	700.0	2.3	years	3.50	0.79	0.67	14.0	hours
Full Body CT	1000.0	3.2	years	5.00	1.13	0.96	20.0	hours
Annual Occupational Limit (NRC)	5000.0	16.1	years	25.0	5.66	4.78	4.2	days

*Approximate Effective Dose to the Whole Body

**Assuming an average value of 5% per Sievert (ignores age)

***Estimates a reduction in life expectancy of 1.2 minutes per 1 mrem dose