Investigation of commercial-grade flatbed scanners and a medical-grade scanner for radiochromic EBT film dosimetry

The effectiveness of lower cost “commercial-grade” scanners for film dosimetry purposes was investigated. Characteristics of ISP EBT GAFchromic film were evaluated on the following commercial-grade flatbed scanners: Epson 750 Pro ($800), Microtek ArtixScan 1800f ($1500), and Microtek ScanMaker 8700 ($900). A Vidar Dosimetry Pro Advantage Red (>$10,000) was used to set the current standard benchmark of medical-grade film scanners. Analog to Digital (A/D) Scanner Value vs. Optical Density was performed twenty times over several weeks to get the mean and range of A/D values for each OD step. Repeatability of a scanner was tested by measuring the percent difference between the maximum and minimum A/D scanner value. The mean A/D value of each OD step, from a 3x3 mm^2 uniform area in the central region of the OD step after twenty scans, represents the OD step’s A/D value. Maximum distinguishable OD of each step was analyzed. Maximum distinguishable OD was defined as the last OD step whose range of A/D scanner values do not overlap with its neighboring OD step. Once overlap occurs the dose values become ambiguous. Optical Density vs. Dose was performed 24 hours after film shots to correlate A/D values with dose values. The A/D range at a specific OD step corresponds to a dose range (Tables 1, 2). A low range of dose values for a given OD is imperative for film dosimetry. Pass/fail criterion for a dose measurement relies on reducing equipment uncertainty as low as possible.

Table 1. Vidar dose uncertainty with respect to OD

OD	Range of A/D Value	Dose Range (cGy)	Dose Range difference %
0.05	64580	37.1	2.1
	64550	37.9	
0.2	62190	108.1	1.3
	62145	109.5	
0.35	59906	189.3	2.3
	59793	193.8	
0.49	57544	295.4	1.2
	57476	298.9	

Table 2. Microtek ScanMaker 8700 dose uncertainty with respect to OD

OD	Range of A/D Value	Dose Range (cGy)	Dose Range difference %
0.38	42080	145	20.8
	40208	183	
0.5	36033	276	16.9
	33964	332	

The actual dose delivered has a large dose uncertainty on the ScanMaker 8700 (Table 2). A failure to discriminate dose values accurately at relatively low optical density values demonstrates that the ScanMaker8700 is inadequate for medical applications.

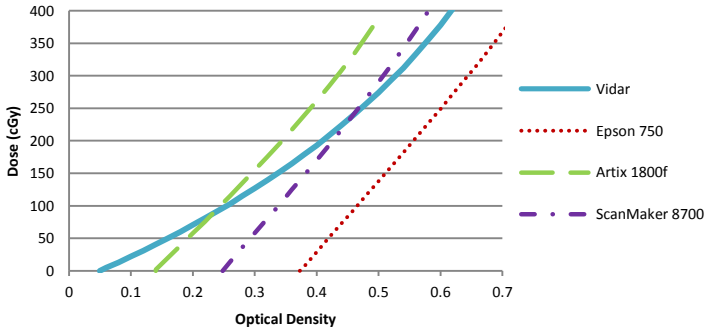

Figure 1. Dose curve vs. Optical Density

From Figure 1, the Vidar exhibited a dose curve that utilized a larger range of OD values than the other scanners, giving a more gradual change in dose with respect to a change in OD. The shallow slope curve characteristic helps achieve a smaller dose uncertainty with respect to OD. It is recommended that Vidar be used for medical film dosimetry.