Reducing Dental X-Ray Chemical Use

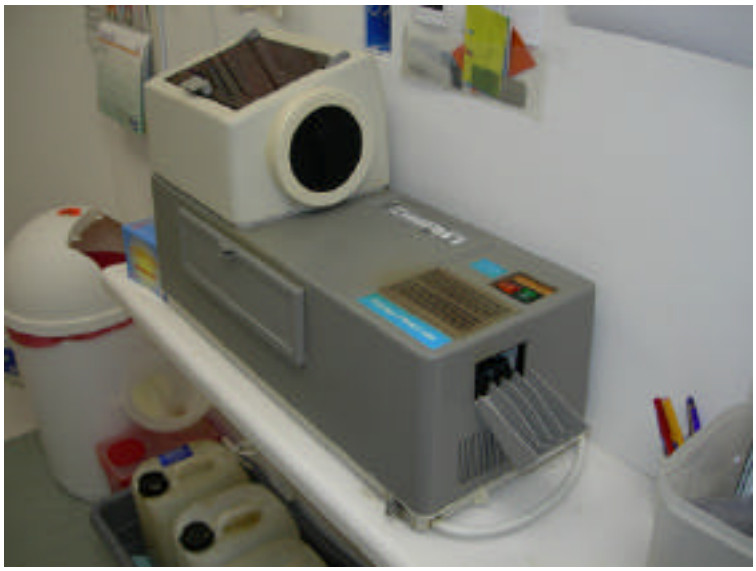
A Pollution Prevention Perspective

In Brief

We conducted a survey of dental radiography in the San Francisco area. This survey was part of a cooperative project sponsored by the California Dental Association, local dental societies, city agencies, and the US Environmental Protection Agency. Our dental co-researchers who responded to the survey told us:

- average number of exposures = 70 / dentist / week;
- spoiled exposures = 2 / dentist / week, or about 3%, with main causes being patient movement, film orientation, and developing problems; and
- developer and fixer use on average = 0.5 oz each / exposure.

These responses give us clues on how dental practices can reduce their radiographic chemical use



- Check developer & fixer use. If significantly above 0.5 oz per exposure, then investigate why. Also, check product mixing instructions to assure that you are following manufacturer guidelines;
- Decrease spoiled exposures by resolving film orientation and film processing issues; and
- If feasible, change to digital radiography.

The last two of these approaches have the important added benefit of decreasing patient and staff exposure to x-ray emissions.

The Details

1 How many radiographic images do dental practices typically make each week? As shown by the table, the average is 70 images per dentist.

Survey Results: Radiographic Images Made

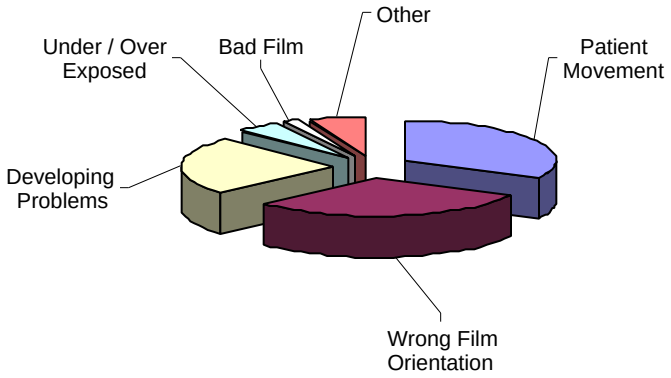
	X-Ray Images / Week		
	Minimum	Average	Maximum
Regular	0	115.6	650
Panoramic	0	1.1	18

	Weekly X-Ray Images Per Dentist		
	Minimum	Average	Maximum
Regular	0	70.2	500
Panoramic	0	0.6	10

2 How many spoiled radiographic images occur? On average, 3.3%.

Individual offices report that from 0% to 29% of their x-ray images are spoiled. The pie chart below shows that patient movement, wrong film orientation, and film developing problems account for most of these spoiled exposures.

Survey Results: Causes of Spoiled X-Ray Exposures



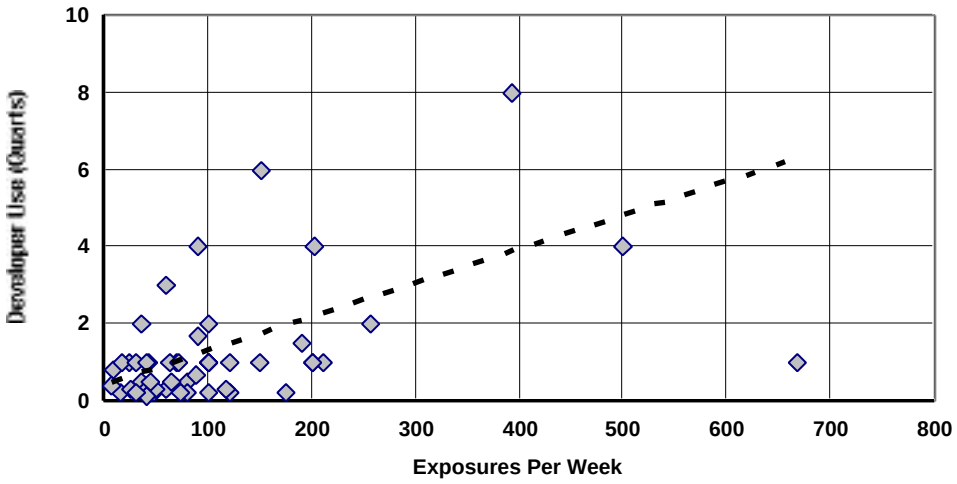
3 What chemicals do dental practices use to process radiographic film?

Most offices purchase pre-packaged film developer and fixer, and replace these in their film processors either weekly or on some other routine schedule. Some practices also use special maintenance products.

The following table and chart show that there is significant variation in the amounts of these chemicals that the survey respondents use. Further, the average use of 0.5 ounce of developer or fixer per image is significantly more than the 0.1 ounce per image guideline recommended by many film processor vendors.

Survey Results: Radiographic Chemical Use

	Film Processing Chemical Use		
	Minimum	Average	Maximum
Total Amounts Per Office (Ounces/week)			
Developer	0.1	43	384
Fixer	0.1	40	384
Actual Amounts Per Image (Ounces/Image)			
Developer	0.001	0.51	3.2
Fixer	0.001	0.48	3.2
Typical Manufacturer Guideline (Ounces/Image)			
Developer	0.09	0.10	0.21
Fixer	0.09	0.10	0.21



Note: Chart for fixer use is similar.

4 What are the health, safety, and environmental hazards of typical film processing chemicals?

Product Material Safety Data Sheets (MSDSs) and other literature list the following typical ingredients and hazards for film developer and fixer.

Typical Hazards of Radiographic Chemicals

		Typical Amounts		Hazards [1]	
Ingredient	CAS	Wt. %	g/Exp.	Human	Enviro
Developer					
Potassium Hydroxide	1310-58-3	2%	0.010	Severe Eye	High pH
Sodium Sulfite	7757-83-7	8%	0.041	Allergen/Sens	
Hydroquinone	123-31-9	2%	0.010	Tox/Sens	Aq Tox
Glutaraldehyde	111-30-8	3%	0.015	Eye/Skin/Aller [2]	
Fixer					
Ammon. Thiosulfate	7783-18-8	15%	0.071		
Sodium Sulfite	7757-83-7	2%	0.010	Allergen/Sens	
Acetic Acid	64-19-7	3%	0.014	Eyes	

[1] Legend
g/Exp = grams per exposure
Tox/Sens = Toxic / Sensitizer
Aq Tox = Aquatic Toxicity

Other Notes
[2] Possible mutagen - CA DPR Tox Data Summary 139 (2002)

These ingredients pose modest to significant worker health hazards, making it advisable for a person handling film processor chemicals to wear gloves & goggles, and to have a good supply of fresh air. Persons with asthma and other sensitivities should take particular care to limit their exposure.

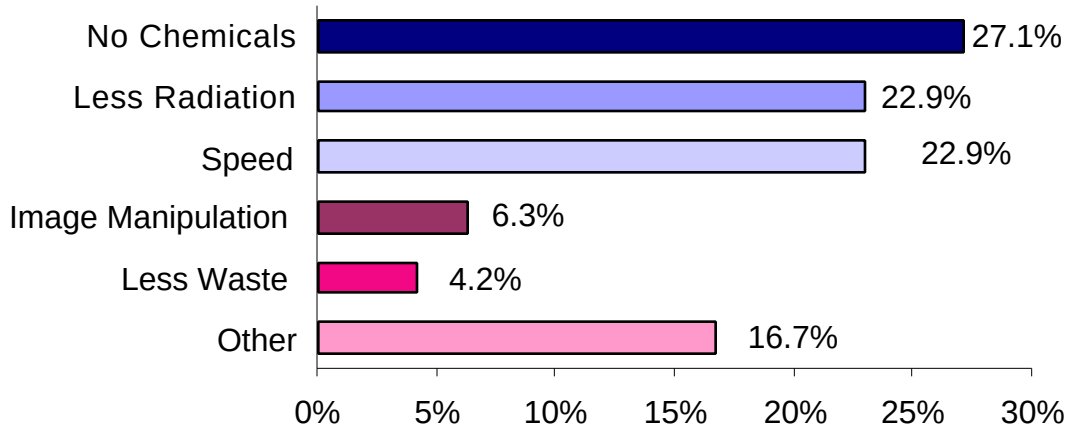
5 How many dental practices use digital radiography? About 28%.

Twenty-three percent of the survey respondents use only digital radiography, while an additional 5% are 'in transition' and use both digital and film.

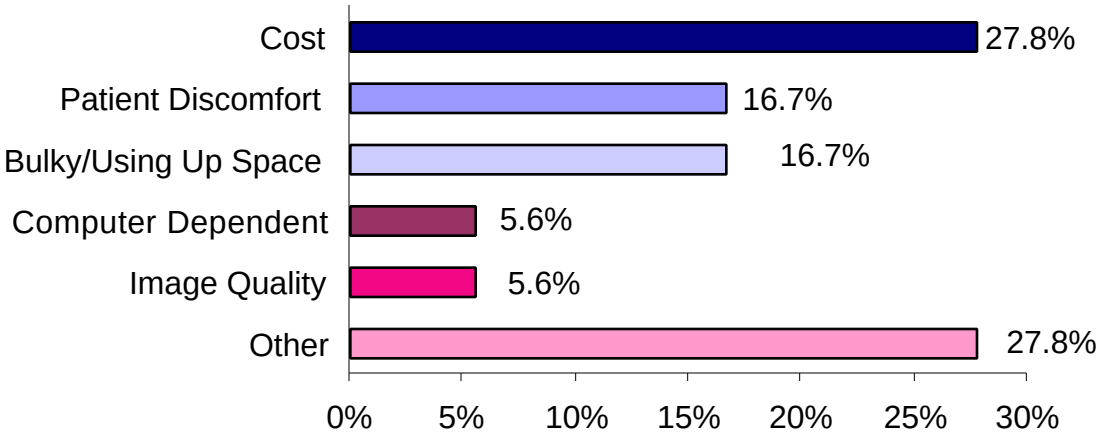
Nineteen percent of the surveyed offices say that they are seriously considering making the change to digital within the next 2 years.

Most of the survey respondents appear quite knowledgeable about digital radiography, and have opinions about the pros & cons of such systems.

Advantages of Digital Radiography
(Comments made by % of survey respondents)



Disadvantages of Digital Radiography
(Comments made by % of survey respondents)



How To Reduce Your X-Ray Chemical Use

Take a quick inventory of your radiographic film and processing chemicals, and estimate the amounts of each product that you use each week.

You may discover old, outdated products in your storage area. Dispose of these properly (e.g., unused developer with hydroquinone is a hazardous waste), and in the future buy just the amount that matches your consumption. Results to expect: You can reduce your chemical use by up to perhaps 10%, depending upon the details of how your practice has been ordering supplies.

If you use more than the average amounts of developer and fixer that we found to be typical (i.e., 0.5 liquid ounce of each per exposure), then consider extending the time between chemical changes in your processor.

- First check that you are following the chemical replenishment directions from the manufacturer. For example, the maintenance manual for one popular processor says to change the chemistry every 2 weeks or after 300-350 exposures, which ever comes first.

- If you are consuming more than these guidelines, then consider changing your chemistry less often. Of course, take care not to go so far that image quality is degraded.

Results to expect: The outcome will vary with the specifics of your situation, but you may see a reduction of up to perhaps 50% in developer and fixer use.

Estimate the number of radiographic images that your office spoils each week, and identify the most common causes.

If your image spoilage rate is above 3%, carefully evaluate how you take exposures and process the film.

Operator refresher training and attention to processor maintenance and chemistry replenishment will significantly decrease spoilage.

Results: You can reduce your spoiled images by 50% to 60% by eliminating operator exposure errors and processing problems.

As a final step, consider converting to digital radiography. Many offices make such a change when either installing or upgrading a computer system used for managing patient records, practice finances, and other data.

Where To Get More Information

Dental supply vendors and manufacturers usually have MSDSs and other product literature available for downloading on their websites.

Digital radiography is discussed in vendor literature, society journals, and trade magazines. It also is very helpful to visit the practice of an associate who has already converted from film to digital.

Health, safety, and environmental issues related to specific ingredients of radiographic processing chemicals may be researched via the following:

http://www.soeh.ubc.ca/research/Report_2001/radiog.pdf
http://atsdr1.atsdr.cdc.gov/toxfaq.html
http://toxnet.nlm.nih.gov/
http://ehp.niehs.nih.gov/docs/montharch.html
http://www.state.nj.us/health/eoh/rtkweb/rtkhsfs.htm
http://www.osha-slc.gov/SLTC/dentistry/index.html

About The Project

The project team worked under a grant from Region IX of the US Environmental Protection Agency. Co-researchers include staff from: California Dental Association; Cities of San Francisco, Palo Alto, and Richmond; Mid-Peninsula Dental Society; San Francisco Dental Society; Union Sanitary District; and the University of Nevada - Reno.

The project goals are to identify, characterize, and quantify chemicals used by dental professionals for radiography, infection control, and restorative work.

In late 2004 the project team mailed, FAXed, and hand-delivered a 2-page survey about dental radiography to 450 dental offices in the San Francisco Bay Area. Just over 100 dental practices chose to participate in the project, for a response rate of about 25%.

We invite your comments. http://www.westp2net.org/studies.cfm

Revision 1: November 2005: Changed top graph on Page 5.