Perceptions of radiologic technologists on automatically-processed radiographic images with different time settings

Student Researchers: Gerald Michael V. Adorna, Gian Paulo R. Bagtas, Socrates Jovito A. Medrano, Erlinda C. Mendoza & Kenneth R. Sandoval

Faculty researchers: Ruben G. Talag & Roilan Z. Plandez

ABSTRACT

Good radiographic film quality is important to patients, radiologic technologists and medical doctors as poor image quality may mean repeat procedure and health safety risks brought about by radiation for individuals exposed to radiologic procedures. One solution to ensure good image quality is by use of automatic processing equipment. This study aimed to determine the radiographic image quality in automatic processing with different time settings, their efficiency and problems encountered in use of such equipment.

Research design was descriptive with the use of a researcher-constructed questionnaire as data gathering instruments. Respondents were 50 radiologic technologists from eight hospitals from the cities/locales of Batangas, Lipa and Sto. Tomas. Statistical tools used were frequency, weighted mean and analysis of variance (ANOVA).

Findings of the study revealed that most of the radiologic technologists used the 60 second time setting and least used in automatic processor with speed of 120 seconds. Data also revealed that the three time settings were found efficient in terms of developer. The 60 second and 120 second time settings were assessed as efficient in terms of developer. The 60 setting was assessed as very efficient as to its fixer, while as to water, the three time settings of automatic processing equipment were cited to be very efficient. No significant difference was noted on the assessment on the three time settings indicating that all of them were efficient considering aspects of developer, fixer, and water.

As to problems in film processing while using a time setting it was revealed that the 90 second and 120 second time settings often and always presented problems in the developer, fixer and washing. Highly significant differences were noted in the assessment on the processing aspects among the three time settings.

Implications of the results indicate that the 60 second time setting is the most viable time setting for automatic radiologic procedures for image processing.

Keywords: automatic processing, three time settings, processing time, image quality

INTRODUCTION

The importance of good quality radiographic image is always emphasized in radiologic settings. With good quality image, there is the assurance that the patient will be given the appropriate medical intervention by the medical doctor who would provide the medication. Also, it means reduced exposure to radiation which happens when radiologic procedure has to be repeated because of poor image quality (Lymberis, 2004).

Because of this, quality control is always pushed in radiologic procedures. It is meant to improve performance of x-ray units having improved image quality and reduction of radiation dose to patients and staff (Gunn, 2002).

According to Hutchison (1997), processing apparatus includes a plurality of processing tanks with a separate film transport and agitating assembly for each tank. It entails strict regulations of chemical concentration, temperature, time and physical movement. In whatever way this is done, first-rate radiographs require a high degree of consistency and quality control.

Film processing is one of the important factors influencing quality and assurance of radiologic procedures. Film processing must be done properly to develop the image, wash out left-over processing chemicals, and to assure shelf life of the radiograph. The objective of processing is to produce a radiograph adequate for viewing and to prepare the radiograph for storage. According to automatic processing machine of the present invention, the technical task can be solved as a matter of course, and moreover no requirement for piping, no discharging of waste solutions of processing and its small size will result in exhibiting such effects that it can be installed on a floor of higher stage and be stored for years (Kobayashi 2007; Harvey 1998; and Kaufmann, 200).

Poor film processing affects image quality and amount of radiation a patient receives. One way of improving the quality is by use of automatic film processors. These kinds of film processors improve the consistency of film development, time and maintain a constant development temperature (Sniureviciate, 2005). When the processing conditions are not good, there will be significant effects to image quality. Under-processing will reduce contrast while over-processing will increase fog which decreases contrast. These concerns are addressed by automatic processing equipment.

The automatic processor is the essential piece of equipment in every x-ray department. The automatic processor will reduce film processing time when compared to manual development by factor of four (Brink 1992; Schmidt 2006; and Skubic, 1998). To monitor the performance of the processor, optimum temperature mechanical checks, chemical and sensitometric checks should be performed for developer and fixer. Chemical checks involve measuring the pH values of the developer and fixer as well as both replenishers. Also, the specific gravity and fixer silver levels must be measured.

Automatic film processors develop radiographs more quality than manual processing with consistently good results if the chemicals are maintained. A series of rollers are inside the unit to guide the film through the chemicals. The processor uses a heating element to keep the solutions at a constant temperature, usually 85°F to 105°F (Bai 2006; Legg 2006; Hills, 1993). This higher temperature shortens the time needed for processing. The two most frequent causes of failure in automatic processors are dirty rollers and expired chemicals (Suleiman, 1998).

Automatic processors are of several types, and they are usually named according to the time it takes to fully process the film, often called the dry-to-drop time. There is the 60-second: a newer type of processor that can process up to 350 films per hour; the 45-second: the newest type of processor, it requires special film and chemistry to function properly and 90-second, also called a fast-access processor because the film is available in 90 seconds and the processor has a capacity of 300 films per hour.

In these processors, processing time can be varied according to the type of film used. In other words, the radiographer may select a 90-second processing time, a 180-second processing time and so on. Extended processing used in mammography may increases the film contrast.

Good processing is important as radiographic appearance is affected when there is inadequate processing. There will be a decrease in density, or increase in density, pinkish stain (dichroic fog), brown stain (thiosulfate stain), emulsion removed by developer, milky appearance, streaks, water spots and scratches in the film (Buckland, 1988).

There are varied automated processors. The Konica SRX – 101A is a super rapid film processor for tabletop applications. It can work in different speeds and be set from within the processor. It stabilizes developer and dryer temperature and has automatic replenishment.

The Konica SRX – 101A is a super rapid film processor and has processing speed of 60, 90 and 120 seconds. It can be used for mammographic images. It automatically replaces developer and fix solution and rollers are continually washed.

SRX 701 is a super rapid film processor for high volume applications for trauma, emergency and special procedures suites. Its circuitry regulates vital functions including temperature suitability, replenishment, processing cycle section, among others (Amber Diagnostics, online 2010).

Radiologic film quality and acceptability needs a radiograph that is produced on correct density, required film, proper quality indicator is used and so is the required sensitivity level. It is important that the radiograph does not contain processing and handling artifacts that could affect details of interest (NDT, Resource Center, 2010).

Film processing and speed of processing will affect the quality of film produced. Alsubael (2009) looked into the factors influencing image quality in primary health care clinics in Riyadh. Results revealed factors which affected film image quality were film type, chemical storage conditions and film processing. Processing of poor image quality were because of low quality darkroom and processing conditions, process related artifacts, film fogs and low contrast values.

Yoshikawa et al. (2009) conducted a study on apparatus for continuously processing. This automatic processor has a developing tank filed with a developer. The study revealed that in a memory, five programs for conducting various types of replenishments of the developer with chemicals (A, B, and C) are previously stored. The area of photosensitive materials brought into the automatic processor are detected by a sensor and in accordance with the area, the chemicals are delivered to the developing tank. By variably determining the mixing ratios according to the respective purposes of the replenishments, the replenishments can be attained under optimum conditions.

The concern of the study of Gallagher (2010), was the choice of film for ultrasound imaging. According to Gallagher (2010), there is a need to be careful in choice of film for permanent recording of ultrasound images. X-ray film was said to have the advantage as it reproduces the full range of grey tones displayed on the monitor and is also relatively cheap. In X-ray departments it can also be processed in conventional automatic processors.

Barclay (2010) conducted a study on speedier production of the finished radiograph. This was done in an effort to speed up production of the finished radiograph. It wanted to find out the difficulties that have been encountered in making a machine for rapid drying (five minutes). One solution was to have good rollers and a good film surface.

The work of Mori et al. (2010) focused on the method of drying photographic light-sensitive materials in automatic processor which comprise a dry-processing portion. This method comprises drying steps and drying the photographic light-sensitive material to an extent that 65% of the moisture content of the photographic material just after squeezing is dried out; and subsequently, drying the photographic light-sensitive material at a temperature which is set based on temperature and humidity conditions of an area where the automatic processor is installed. In the high temperature color development processing of color photographic materials, the formation ofreticulation and scratches on the surfaces of the photographic film is prevented and drying can be performed in a shortened period of time at a high temperature. The study further showed that drying that is done at a high temperature and color photographic materials such as bleach solution containing a metal complex of an organic acid, the bleach solution or does not give rise to environmental pollution and can easily be regenerated for use.

These studies show film processing is an important factor in producing good radiologic quality image. This study was also directed into this concern. There are very limited studies on film processing covering use of time settings of automatic processing equipment. The researchers wanted to find out the time setting used in radiologic procedures, the efficiency of the time settings from which a comparison was done and the problems encountered in processing using the said time setting.

The researchers believe that this study will give new information on auto-processing processing equipment and find ways on how to use the different time settings.

MATERIALS AND METHOD

*Respondents.*The study made use of 50 radiologic technologists from eight hospitals in cities/locales of Batangas, Lipa and Sto. Tomas. They comprise the total population of radiologic technologists in the said locales.

*Instrument and Data Collection.*A questionnaire was used to gather data.This was face and content validated by the research adviser and radiographers not involved in the study. Items for the questionnaire were taken from radiology books and the readings on radiography. The questionnaire had five parts. It covered questions on speed of film processing equipment used covering 60, 90 and 120 second time settings. Parts II, III and IV were questions on comparison of efficiency among the three time settings as to developer, fixer and water. And Part V included questions on the determination of common problems in processing.

Data were gathered by the researchers by visiting hospitals and requesting permission from the hospital director to administer the questionnaire and have the assistance of radiographers as respondents of the study.

Data Analysis. The results of the survey were statistically treated using frequency, weighted mean and analysis of variance (ANOVA).

RESULTS

1. Automatic Processing Equipment Time Setting Used

As shown in Table 1, most or 27 or 54 percent used automatic processing equipment with 60 second time setting. Seventeen of the respondents or 34 percent used a 90 second time setting while six or 12 percent used a 120 second time setting.

Table 1. *Automatic Processing Time Setting Used*

Time Setting	f	%
60 seconds	27	54
90 seconds	17	34
120 seconds	6	12
TOTAL	**50**	**100**

2. Efficiency of the Three Time Settings

*As to developer.*Results from Table 2 shows that as to developer, the detail and resolution of the 60 second time settingwere assessed as very efficient as reflected in 4.58 and 4.65 while density and contrast of the 60 second time setting were cited as efficient as shown I n 4.29 and 4.41 weighted means.

The 90 second time setting's resolution was assessed as very efficient as seen in 4.57 weighted mean while detail, contrast and density of the 90 second time setting were assessed as efficient.

The 120 second time setting was assessed efficient considering density, detail and resolution with weighted means of 4.00 and 4.30 while contrast was said to be very efficient.

Table 2. *Efficiency of the Three Time Settings As to Developer*

	WM	**VI**	**WM**	**VI**	**WM**	**VI**
Developer						
Density	4.29	E	4.25	E	4.00	E
Contrast	4.41	E	4.38	E	4.60	VE
Detail	4.58	VE	4.40	E	4.30	E
Resolution	4.65	VE	4.57	VE	4.00	E
Composite Mean	**4.48**	**E**	**4.44**	**E**	**4.23**	**E**

WM-Weighted Mean VE-Very Efficient
VI-Verbal Interpretation E-Efficient

*As to fixer.*As cited by respondents, as f or the hypo-retention, stability of Emulsion and clearing agent, the 60 second time setting was efficient as reflected in weighted means of 4.12, 4.46 and 4.41.

Table 3 also shows that the 90 second time setting was considered as very efficient when it comes to clearing agent, weighted mean of 4.72 and efficient when it comes to hypo-retention and stability of emulsion.

The 120 second time setting was assessed to be very efficient as to clearing agent and efficient when hypo-retention and stability of emulsion are considered

Table 3. *Efficiency of the Three Time Settings As to Fixer*

	WM	VI	WM	VI	WM	VI
Fixer						
Hypo-retention	4.12	E	4.44	E	4.00	E
Stability of Emulsion	4.46	E	4.44	E	4.20	VE
Clearing Resolution	4.65	VE	4.57	VE	4.00	E
Composite Mean	**4.48**	**E**	**4.44**	**E**	**4.23**	**E**

WM-Weighted Mean VE-Very Efficient
VI-Verbal Interpretation E-Efficient

As to water. Table 4 shows that all of the three time settings were described as very efficient when absence of chemical stain and drying were considered. These
had weighted mean values ranging from 4.56 – 4.60 and 4.56 – 4.81.

Table 3. *Efficiency of the Three Time Settings As to Water*

WM	VI	WM	VI	WM	VI
Water					
Absence of chemical stain	4.59	VE	4.56	VE	4.60	VE
Drying	4.81	VE	4.75	VE	4.56	E
Composite Mean	**4.70**	**VE**	**4.66**	**VE**	**4.58**	**VE**

WM-Weighted Mean VE-Very Efficient
VI-Verbal Interpretation E-Efficient

3. Comparison of Efficiency of Three Time Settings

There was no significant difference in the assessment of the radiologic technologists on the efficient of automatic processing equipment of three time settings as shown in f-value of 1.08 which was lower than the tabular f-value of 3.44. This means that the different time setting cited in the study have no significant difference in terms of producing a quality radiograph.

4. Common Problems in Processing using the Three Time Settings

It was assessed that of the three time settings, the 60 second time setting sometimes manifested problems in the developer, showing black circular spots, or yellow or brown spots, weighted means of 3.30 and 3.33; the fixer

sometimes had black circular spot or yellow or brown spots, weighted means of 3.00 and 3.30 while in washing, sometimes a problem were presence of multi-colored stain; 3:30 or having milky white film, 3.06.

Table: *Comparison of Efficiency of Three Time Settings ANOVA*

Source Of	Sum of Square Variatione	f-valu	f-tabular	P-value	Sig
Between Groups	0.13	1.08	3.44	0.36	NS
Within Groups	1.31				
Total	**1.44**				

Sig – Significance

Considering the same aspects, these problems were often manifested in the 90 second time setting with the developer (weighted means of 3.80 and 3.84), fixer (3.76 and 3.70) and washing (3.89 and 3.70).

The problems were always present in the developer, fixer and washing of the automatic processing equipment with 120 second time setting as shown in weighted means ranging from 4.40 – 4.80.

Table 6. *Common Problem in Processing*

	WMVIWMVIWMVI					
Developer						
Black circular spots	3.30	S	3.80	O	4.60	A
Yellow or brown spots	3.33	S	3.84	O	4.40	O
Fixer						
Black circular spots	3.00	S	3.76	O	4.80	A
Yellow or brown spots	3.30	S	3.70	O	4.67	A
Washing						
Multi-colored stain	3.30	S	3.89	O	4.80	A
Milky white Film	3.06	S	3.70	O	4.60	A
Composite Mean	**3.21**	**S**	**3.78**	**O**	**4.65**	**A**

WM-Weighted Mean A-Always
VI-Verbal Interpretation O-Often
S-Sometimes

5. Comparison of Common Problems in Processing

Table 7 shows that there were highly significant different in the assessment on problems in processing as shown in f-value of 190.45 which were higher than f-tabular value of 3.66. This implies that there is a highly significant relationship between the time settings used by the respondents of the encountered problems in film processing.

Table 7. ***Comparison of Common Problems in Processing***

Source of Variation	Sum of Square	f-value	f-tabular	P-value	Sig
Between Groups	6.22	190.45	3.68	<0.001	HS
Within Groups	0.25				
Total	6.47				

Sig- Significance

DISCUSSION

Good radiographic images are a requirement in radiographic procedures. One of the factors influencing good image quality image is the quality of film processing. In this study, the aspects of film processing considering developer, fixer and water were assessed side by side with time settings of the automatic processors.

This was what Barclay (November 2010) and Yoshikawa et al. (2009) did in their study when they conducted their work to experiment on the speed and processing rates of automatic processors. This only shows that speed is a concern also on film processing.

Results showed that generally the respondents used the 60-second setting possibly because it is only for the past years were hospitals able to avail of automatic processor.

Generally, according to the radiologic technologists the three time setting are actually efficient considering the aspects of the developer, such as density, contrast, detail and resolution.

This means that these three time settings can effectively convert the hidden image in the film into a visible image. The developer reduces the metallic silverthrough its developer chemicals. Therefore, the darkness and details can be very visible similarly, the three time settings are also cited to be efficient when it comes to hypo-retention, stability of emulsion and cleaning agent. This means that the automatic processing equipment is able to make the

emulsion permanent. It is because the fixer has a fixer solution which contains an acidifier, cleaning agent, hardener, preservatives and water, therefore, image remains fixed and does not get washed out.

Also, the three time settings were found very efficient on the aspect of water in terms of absence of chemical stain and drying. This means that the automatic processing equipment is able to very efficiently fry films. This is because of the fast film processing. It also means that because fast processing time, the film is easily dried.

For Lymberis (2004), good film processing means safer practice for both patients and doctors. This is because they will have reduced danger of exposure to radiation. Gunn had stated quality control is needed so that there would be improved performance of x-ray units.

However, there are differences in the assessment of the radiologic technologists when it comes to problem on film processing the three time settings. Based on their assessment, there are little problems on film processing when the 60- second time setting is used. This is because the film processing is faster, therefore, there are fewer problems on chemical solutions; the longer the time setting, the more problems on film processing may follow. The slow film processing may cause other problems like artifacts. For example, the longer the time of film processing, when the automatic processor stops, there are density lines across the film.

There will be problems of brown stain due to much air mixed with the solution or multi-colored stain because of poor rinsing. Also, there will be milky white film because of incomplete washing time. In other words, poor film processing affects quality of films.

According to Buckland (1988), radiographic appearance is affected if film processing is inadequate. Film will have brown, stains, densities with poor images, milky appearance and streaks.

CONCLUSION

Majority of the radiologic technologists use the 60 second time setting of the automatic processing equipment; least use is the 120 second time setting. On the other hand, radiologic automatic processors of different time settings are efficient aids to production of quality radiographic images.

It was found out that there are no significant differences in the assessment of the radiologic technologists on the efficiency of the time settings of the automatic processing equipment. With regard to the 60 second time setting, sometimes it has problems in the developer, fixer and washing while the 120 second time settingalways manifests problems on these. Lastly, the

assessments of radiologic technologist highly differ significantly on the problems encountered during film processing with respect to the different time settings.

RECOMMENDATIONS

It is recommended that a follow up experimental study be conducted to determine the efficiency of the different time setting on actual film images for a specific procedure as mammography, etc.

REFERENCES

Absubael, Omar. "Analysis of X-ray film Quality in Primary Health Care Clinics in Riyadh" Science Alert, 2009.

Bai, J. "Development of the Automatic Dental X-ray Film Processor."Wannan Medical College.2006.

Barclay, A.E. "Speedier Production of the Finished Radiograph." The medical Schools, Cambridge. (online). Retrieved: November 10, 2010.

Buckland, J.C. " A New High-Definition of X-ray Processing Unit." United Medical and Denta Schools of Guy's and St. Thomas' Hospitals, London. 1988.

Gallagher, S.F. "The Choice of Film for Ultrasound Imaging."Departments of medical Physics and Diagnostic Radiology, The London Hospital.Retrieved: November 10, 2010.

Gunn, C. Radiographic Imaging: A Periodical Approach.3rd Ed., Churchill, Livingstone London.2002.

Hills, T. H. "A New Apparatus for Automatic Film Processing."
Department of diagnostic Radiology, Guy's Hospital, London 1993.

Hutchison, William Joseph. "Rotary film Processing Apparatus." 1997.
http://www.amberusa.com/newprocessors. Retrieved: November 10, 2010.

Kauffmann, Kenneth M. "Automatic Inverse Fix Replenisher Control." 2000.

Kobayashi, Kazuhiro, Koboshi, Shigeharu, Kuse, Satoru, Miyaoka, Kazuyoshi, Kurematsu, Masayuki. "Automatic Processing machine for Light-Sensitive color Photographic Material. 2007.

Koboshi, Shigeharu, Kurematsu, masayuki. "Method of Processing Silver Halide Color Photographic Material." 2006.

Legg, L.M. Quality Control of the Automatic Processor. Richmond, Virginia. 2006.

Lymberis, C. "Automatic film Processors' Quality Control Test in Greek Military Hospitals," European Journal of Radiology. Sept. 1, 2004.

NDT, Resource Center, 2010.

Schmidt, R.A. "Evaluation of Radiographs Developed by a New Ultrarapid film Processing System.' 2006.

Skubic, S.E. 'Value of Increasing Film Processing Time to Reduce Radiation Dose During Memmography." 1988.

Sniureviciute, M. and D. Adliene, Problems with film Processing in Medical X-ray imaging in Lithuania. 2005.

Suleiman, O.H. "Automatic Film Processing: Analysis of Nine Years of Observations.' Rockville, MD. 1998.
www.ndt.org/radiography/Tech
Calibration.Retrieved November 10, 2010.
Yoshikawa, Shoichi, Awazu, Yasunobu, Nishimura, Eiiji. "Method of and Apparatus for Supplying Replenishes to Automatic Processor. 2009.