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Assessment of Radiographic Film Quality in Some Selected Hospitals in Benue State

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ABSTRACT

The essence of diagnostic radiology is to obtain a high quality image with low radiation dose to patient. Since radiology is aimed in producing images which provide adequate information for the clinical purpose with minimum radiation dose to the patient, we seek to assess the high image qualities that are produced in the darkroom. The processing time and the temperature, at which these films were processed, stored and also evaluated, were carried out in the darkroom. Agfa films were used throughout the procedure in four different hospitals, H-1, H-2, H-3 and H-4 and the processing chemicals were observed for the period of a month. Therefore, in H-1, the average temperature was found to be 29^{o}C, average temperature was 26^{o}C in H-2; in H-3, average temperature was 30^{o}C and the average temperature in H-4 was found to be 29^{o}C which all fall above the standard temperature limit (25^{o}C) as recommended by National Council on Radiation Protection (NCRP). From the experimental proceedings in the darkroom, the distance from safelight to workbench, it shows that H-1 and H-2 do not conform to the standard while H-3 and H-4 are in conformity. The result obtained from darkroom fog test shows that, the Optical Density Difference (ODD) for H-1, H-2, H-3 and H-4 was found to be 0.16, 0.07, 0.18 and 0.35 respectively, which were all found to be above the ICRP standard limit (0.05). This implies that, most hospitals in Makurdi operates below the set darkroom practices as recommended by NCRP and ICRP which affects the quality of image as a result of high temperature, poor concentration in processing chemicals and some effect of fogging in the darkroom which needs to be checked.

Keywords:
Darkroom,
Safelight,
Fogging,
Temperature.

INTRODUCTION

A diagnostic radiology facility is a facility whereby X-ray systems are used to irradiate any part of the human body for the purpose of diagnosis. In radiological procedures which involve the use of X-rays, both patients and staff are directly or indirectly exposed to varying degrees of radiation doses. The quality of information obtained from radiographs is dependent on a number of factors, such as processing chemicals, temperature, quality films and processing time which can lead to/affect the contrast, dynamic range, spatial resolution, noise, and artifacts

The essence of radiology is to produce images which provide adequate information for the clinical purpose with minimum radiation dose to the patient. In order to achieve adequate information and optimum performance, assessment of image quality must be made to balance against patient dose, since too low a radiation could be as bad as a too high radiation in this case, both quality assurance program and quality control measures must be ensured in every radiological facility (Dunn and Rogers, 1998; Watkinson, *et al.*, 1984).

The scope of this work depends on the size and type of the facility and the type of examination conducted. In each of these facilities, diagnostic quality assurance program is used as a tool of evaluation since the main goal of the program is to produce radiographs of consistent high quality (ICRP, 1990). Therefore, Patient radiographs can serve as a quality control check and should be factored into any departmental evaluation program as an evaluation tool. (Almin et al., 1996 and Beir, 1990). The research work also deals with mainly of X-ray systems, since it is a technique used in either monitoring or testing maintenance of the components of an X - ray system in most of the hospitals in Benue State (Geijer et al., 2001 and Verdonck et al., 2001).

The radiology darkroom is a tight light room with safe light and white light illumination. The over head white

light is located at the ceiling of the darkroom, and the safe light is located at about or not lowers than 1.3m from the working bench or processing tanks. It also contains thermostatically controlled water supply, thermometer, timer, film hangers, drying ranks and storage space. Since all radiographs are processed in the darkroom, the darkroom has become a major source of problem in any radiographic facility. When handling these radiographs in the darkroom, apart from the processing chemicals, when exposed to dust or dirt in the darkroom, it can result in artifacts in the radiographic image. In other to minimize artifacts or poor radiographs in the darkroom, every effort must be put in place to ensure a clean darkroom and the same amount of effort is required for cleaning the cassettes and screens

Artifacts in the radiological units are marks that are seen on a film that do not contribute to or decrease the diagnostic value of the film. They may in fact cause a misdiagnosis by either masking or imitating pathology. Due to the misdiagnosis of radiograph, artifacts must be kept to a minimum. Since most artifacts are caused as a result of improper film handling in the darkroom or processor problems, diagnostic quality assurance program can also be explore as a good tool of evaluation in which these artifacts can be minimized. But first and foremost, we will need to recognized and determined the sources of artifacts. The sources are categorized into four: 1. Darkroom problems, including, darkroom cleanliness, darkroom fog, and film handling. 2. Processor problems, including, light leaks, dirty rollers, and improper drying. 3. Cassette and screen problems, including dirt or dust, cracking, warping, and discoloration. 4. Patient caused artifacts, including, jewelry, clothing and hair mousse.

It has become a common phenomenon to see that patients are subjected into several repeat X - ray examination after the initial X - ray examinations are rejected due to: Improper practices in the darkroom where these radiographs are processed and store which lead to possible repeating of procedures which sometime result to additional cost, more time wasting, and excess dose of ionizing radiation, leading to various dose dependent and dose independent health problems including cancer. It is as a result of these that we seek to assess the radiographic film quality and also, improve on the quality and efficiency of radiology services in these facilities.

It is difficult to encourage a technician to perform a radiographic examination carefully on radiographs that has been damaged at the cause of processing in the darkroom, which also contribute to the number of film rejection. Therefore, there is need to know what are the conditions that darkroom work at best, factors that lower the efficiency of darkroom, and the hazards associated with radiographer, and the time of processing as an acceptable standard set by the world Health organization.

MATERIALS AND METHOD

Procedure for darkroom fog test

All safe lights in the darkroom were turned off for 5 minutes to allow for accommodation to take place. Light leaks from doors and pass boxes were checked and corrected before proceeding. In total darkness, the film was loaded into a cassette and taken into X-ray for exposure. The X-ray collimator light was collimated to the size of the cassette for better output. Still in total darkness, the exposed film was removed and placed on the table. Half of the film was covered with an opaque material while the other half was exposed. Safelights were turned on for 2 minutes then the film is processed. Using the densitometer, the density of the exposed portion of the film and the density of the unexposed portion of the film were measured. Darkroom fog is determined by subtracting the density measurement of the exposed area from the density measurement of the unexposed area.

Procedure for manual processing

Theoritically, film should be left in developer solution with the following temperature ranges: (a). Developer is 18°C and 19°C, the time explore is 7 minutes (b). Developer is 20°C and 21°C, the explore time is 5 minutes. (c). Developer is 22°C and 24°C, explore time is 4 minutes

In the darkroom, the processed films were removed from cassette and attached to film hanger. The films were immersed completely in developer agitated for the entire developing time. A timer was used to ensure accurate timing. When the developing time is completed, the films were carefully removed from developer tank and allow developer chemical to drain off then the films were immersed in wash tank for at least 30 seconds. The films were immersed in fixer tank for 5 to 10 minutes depending on the strength of the developer. After which the films were removed from fixer tank well drained and immersed in wash tank for 5 to 30 minutes. Then the films are removed and dried.

RESULTS AND DISCUSSION

Table 1: Result on Temperature/Time of Daily Processing In H-1.(AUGUST, 2016)

DAYS	FILMS	FILM SIZE	DEVELOPER TIME(s)	RINSER TIME/s	FIXER TIME/s	WASHER TIME/s	DEVELOPER TEMP (ºC)	FIXER TEMP (ºC)	TYPE OF EXPOSURE	kVp	MAs
1	FILM 1	12×10	5	5	900	120	29.4	29.2	Chest	70	12
2	FILM 2	14×14	5	5	900	120	29.4	29.1	Chest	72	12
3	FILM 3	12×10	7	5	1200	180	29.3	29.0	Skull	80	20
4	FILM4	14×14	10	5	1200	180	28.9	28.8	Chest	70	12
5	FILM5	12×10	15	5	1800	1800	28.8	28.8	Abdomen	80	20
6	FILM6	17×14	240	5	1920	900	28.8	28.7	Chest	82	15
7	FILM 7	14×14	60	5	1920	180	29.0	29.0	Chest	72	12
8	FILM 8	14×14	90	5	1980	420	28.8	28.9	Chest	72	13
9	FILM 9	17×14	120	5	2040	240	29.2	29.1	Chest	70	12
10	FILM 10	14×14	120	5	2100	240	29.1	29.1	Chest	72	10
11	FILM 11	14×14	120	5	2400	240	29.5	29.5	Feet	68	7
12	FILM 12	17×14	120	5	2520	240	29.4	29.2	Chest	72	13
13	FILM 13	14×14	120	5	2700	240	29.1	28.9	Chest	72	12
14	FILM 14	14×14	150	5	3000	300	29.2	28.9	Knee	58	7
15	FILM 15	14×14	180	5	3600	300	29.0	29.0	Chest	70	12

Table 2: Result on Temperature/Time of Daily Processing in H-2.(September, 2016)

DAYS	FILM	FILM SIZE	DEVELOPE TIME(s)	RINSE TIME/s	FIXER TIME/s	WASHER TIME/s	DEVELOPER TEMP (C)	FIXER TEMP (C)	TYPE OF EXPOSURE	kVp	mAs
1	1	14×14	55	5	720	18	28.1	28.0	Skull	70	50
2	2	14×17	10	5	60	600	27.9	27.8	Kneel	60	24
3	3	14×17	52	5	60	600	27.9	27.8	Chest	83	60
4	4	8×10	12	5	56	600	27.5	27.2	Skull	85	80
5	5	14×17	24	5	900	36	27.5	27.2	Leg	60	24
6	6	14×14	18	5	120	26	26.0	25.8	Kneel	60	24
7	7	14×17	30	5	120	28	26.1	25.9	Chest	70	50
8	8	8×10	21	5	480	50	25.7	25.7	Feet	58	50
9	9	7×14	26	5	360	780	25.5	25.4	Lumbosacral	96	80
10	10	7×14	40	5	780	1200	25.5	25.4	Thoracolumbar	98	80
11	11	12×10	180	5	1020	1200	25.5	25.4	Thoracolumbar	98	80
12	12	8×10	660	5	180	1200	25.2	25.0	Thoracolumbar	98	120
13	13	14×14	26	5	420	1200	26.6	26.3	Lumbosacral	80	100
14	14	14×17	40	5	780	1200	26.4	26.2	Chest	83	60
15	15	14×17	46	5	840	1200	26.2	26.0	Lumbosacral	83	126

Table 3: Result on temperature/time of daily processing in H-3.(October, 2016)

DAYS	FILM	FILM SIZE	DEVELOP TIME/s	RINSER TIME(s)	FIXER TIME/s	WASHER TIME	DEVELOP TEMP (C)	FIXER TEMP (C)	TYPE OF EXPOSURE	kVp	mAs
1	1	14×17	81	5	219	39	32.8	32.6	Chest	65	16
2	0- 2	14×17	120	5	321	29	32.7	32.6	Chest	65	16
3	3	14×17	91	4	243	10	32.7	32.5	Chest	65	16
4	4	14×17	47	4	211	15	32.5	32.3	Chest	65	16
5	5	14×17	120	4	120	12	31.9	31.8	Chest	65	16
6	6	14×17	109	4	71	21	31.6	31.6	Chest	65	16
7	7	14×17	60	4	151	69	32.0	31.8	Chest	65	16
8	8	14×17	134	2	99	67	32.1	31.8	Chest	65	16
9	9	14×17	51	2	62	65	31.8	31.6	Chest	65	16
10	10	14×17	112	2	62	69	31.2	31.0	Chest	65	16
11	11	14×17	41	3	123	75	30.8	30.6	Chest	65	16
12	12	14×17	73	4	101	91	30.5	30.4	Chest	65	16
13	13	14×17	60	3	263	75	30.5	30.3	Chest	65	16
14	14	14×17	55	2	113	90	30.3	30.1	Chest	65	16
15	15	14×17	40	2	321	98	30.3	30.3	Chest	65	16

Table 4: Result on Temperature/Time of Daily Processing in H-4 (November, 2016)

DAY	FILM	FILM SIZE	DEVELOP TIME/s	RINSER TIME/s	FIXER TIME/s	WASHER TIME/s	DEVELOP TEMP (C)	FIXER TEMP (C)	TYPE OF EXPOSURE	kVp	mAs
1	1	14×14	27	2	840	20	30.5	30.2	Fore arm	70	96
2	2	14×14	5	3	1020	15	30.3	30.2	Ankle	60	60
3	3	14×14	2	2	1200	15	29.5	29.3	Lumbosacral	65	160
4	4	10×12	7	2	900	17	29.7	29.6	Ankle	55	60
5	5	14×14	10	2	960	15	29.4	29.3	Kneel	60	40
6	6	14×17	5	3	900	17	29.2	29.1	Femur	55	50
7	7	14×14	4	2	900	17	29.2	29.0	Foot	55	40
8	8	10×12	8	2	660	20	29.1	28.9	Elbow	50	32
9	9	14×17	8	2	900	20	28.9	28.7	Femur	55	50
10	10	14×17	6	2	1020	15	29.3	29.2	Femur	60	50
11	11	14×14	10	3	900	20	28.9	28.8	Pelvic	72	96
12	12	10×12	12	3	900	20	28.8	28.7	Wrist	74	96
13	13	14×14	12	4	900	20	28.8	28.6	Fore Arm	60	40
14	14	14×17	10	4	1020	25	28.9	28.8	Femur	55	50
15	15	14×17	8	4	900	25	28.7	28.6	Foot	55	40

Experiment data for Darkroom Fog Check

The safelights in the darkroom were turned off before loading film in the cassette to ensure that, the radiograph did not see light before exposure and also to check if there is any leakage from any opening from anywhere. All X-ray films used in this work where gotten from respective hospitals as to know what actually causes fogging. The distance of safelight to work bench and the chemicals were measured respectively to ensure it meets the required standard. The values gotten for the various hospitals are shown below;

Table 5: Result for Darkroom Fog Test

hospitals	Optical densities of exposed films (OD)		Optical Density Difference (ODD)	Set value	Used Factor		Safelight to bench Dist.
	Covered portion	Uncovered portion			kVp	mAs	
H1	1.03	0.87	0.16	0.05	40	10	0.98m
H2	0.63	0.56	0.07	0.05	40	10	0.48m
H3	2.01	1.83	0.18	0.05	65	16	1.18m
H4	1.73	1.38	0.35	0.05	50	20	1.22m

Discussion

From the experimental work carried out in the darkroom processing, there exist a correlation among temperature, processing time and selection technique factors. The recommended temperature of solution for processing is within the range 20^{o}C and 25^{o}C.the National Council on Radiation Protection (NCRP) recommended temperature for Agfa is 24^{o}C. In Hosp.1 the average temperature was found to be 29^{o}C, average temperature was 26^{o}C in Hosp.2; in H-3, average temperature was 30^{o}C and the average temperature in hosp4 was found to be 29^{o}C. From the result gotten, it is seen that the processing temperature all falls above the standard temperature limit of the processing solutions which gives rise to poor image quality. This is as a result of poor ventilation and the absent of cooling system that will give the room the required temperature in H-1, H-2 and H-3 while H-2 has air conditioner but the temperature were not monitored by the darkroom attendant to give the accurate temperature required. Furthermore, it was seen in H-1 and H-4 that as the temperature increases, the lesser the time the film spent in the processing chemicals but in H-2 and H-3 it was seen that, when a wrong selection factor is used it affects the processing time not regarding the temperature of the chemicals, since the selection of technique factor depends on the anatomy or thickness of the patients which sometimes result into under-exposure or over-exposure therefore given rise to reject films.(*Stewart C. Bushong,* (2001)). It was also seen that, as the concentration of the chemicals degrades from highly concentrated averagely concentrated and weakly concentrated, the processing time increases.

From the experimental proceedings in the darkroom, the distance from safelight to workbench in H-1 was measured to be 0.98m, safelight to workbench in H-2 was found to be 0.48m, H-3 was seen to be 1.18m and the distance from safelight to work bench in H-4 was seen to be 1.22m. Furthermore, the result obtained from darkroom fog test shows that, the Optical Density Difference (ODD) for H-1 was found to be 0.16, ODD for H-2 was found to be 0.07, for H-3, ODD was found to be 0.18 and the ODD for H-4 was found to be 0.35. From the result, it shows that, H-1, H-2, H-3, and H-4 do not fall in conformity to the ICRP standard value (0.05). This could be as a result of light leakage from the position of the non-used air conditioners and the distance of the safelight to the workbench for H-1, light leakage from the opening between the darkroom and the x-ray unit, and the distance of the safelight to the workbench for H-2, and wrong safelight power or filtration paper used in the darkroom for H-3 and H-4.

CONCLUSION

From the result gotten it can be deduced for manual processing, the result gotten shows that H-2, H-3 and H-4 does not follow the processing standard as recommended by World Health Organization (WHO) due to wrong selection of technique factors by assuming the patients thickness without measurements, while H-1 was in conformity of the standard and the temperature of the processing solutions were seen to be very high when compared with ICRP and NCRP standards which indicate that the temperature of the processing tanks at the four (4) hospitals are not within the recommended standards. Apart from H-2 that has air conditioners; others don't have air condition or fan in the darkroom to regulate the room/chemical temperature. For a direct exposure of safelight to work bench as recommended by ICRP should not be lower than 4 feet (1.2m). From the experimental proceedings, it is seen from H-1 and H-2 that they do not follow the required recommended safelight distance as specified by ICRP while H-3 and H-4 were in compliance to the standard specification. From the result obtained from the darkroom fog test, it was found that they were above ICRP standard value

(0.05) which indicates the presence of darkroom fogging in the four hospitals.

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