

1.1 Introduction

The processing area (still commonly called darkroom) remain however central feature of any imaging department. Most of modern medical department use automatic processer and most of this is daylight processer (John ball&Tony Price -1995-page 173).

The function of radiographic darkroom is to protect the film from white light and ionizing radiation during handling and processing. After a film has been exposed to light or ionizing radiation (such as in a cassette during a radiographic examination) it can be as much as more sensitive to subsequent as unexposed film. This means that any accidental exposure from an unwanted source (such as a dark room light leak) can destroy a diagnostic image. Film can also be affected by excess heat, humidity, static electricity, pressure, and chemical fumes. All of this variable must be carefully controlled to obtain a diagnostic quality image. The most common result if they are not controlled is the presence of fog on the manifest image fog is define as non informational density that occurs because silver grains are formed that don't represent any anatomic structure within the patient. It should also be cleaned, well ventilated, well organized, and safe. Eating, drinking, and smoking must be prohibited in darkroom, because bits of food or ashes from cigarettes can get into image receptors as they are being loaded and unloaded. This can cause artifacts on the Image that could mimic pathologies (especially in mammography cassette) or otherwise degrade the diagnostic quality of the image. Counter tops or other work surfaces and rubber floor mats should be grounded, to reduce the risk of static electricity. Imaging films are sensitive to some portion of the visible light spectrum; this light creates artifacts that appear on the processed images (Jeffrey Papp -2002-page 27).

Quality Assurance (QA): The overall management program in place to ensure that a comprehensive range of quality control activities work effectively. Quality control (QC): The means by which each area of interest is monitored and evaluated (Peter J Lloyd -2001-page 1).

A quality control program must be implemented and systematically followed to ensure proper processing of radiographic film. A good quality control program should include steps for monitoring all of the equipment and activities required for the production of quality radiographic image (Terri L.Fauber, EdD, and Rt(R) (M) -2009- Page221).

1.2 Problem

The problem of the study in spite of the increased interest of the department, technologists and student, it has been seriously noticed that there are lots of problem arising from the dark room work, however, there are lots of processing faults (fogs) which we would like to shed light on thus as regard to darkroom QC programs.

1.3 Objectives

1.3.1 General objective

To assess darkroom quality control testes in certain Khartoum state hospitals.

1.3.2 Specific objective

The Specific objectives of this study are to:

1. Apply test for radiation and white light and safelight fog.
2. Test white light leakage to the darkroom by inspection.

1.4 Significance of the study

The study is dedicated entirely to highlight the essential role of darkroom quality control tests to reduce the fogs and obtain high quality images to minimize patient dose and cost.

1.5 Areas of the study

The darkroom of x-ray department in:

Ear, nose and throat (ENT) hospital.

Al-turkey educational hospital.

Al-shab technique hospital.

1.6 Duration of study

This study was conducted in the hospitals during the period from 10 of Jun 2014 to 21 of Jun 2014.

1.7 Methodology of the study

The method of this study is by applying practical tests for darkroom by testing, white light leakage, light fogging, safelight and radiation leakage. The data collected using data sheet and analyzed using simple analysis methods (tables).

1.8 The outline of the study

This study contains five chapters:

Chapter one: Introduction.

Chapter two: Theoretical background and previous study.

Chapter three: Materials and methods.

Chapter four: Results.

Chapter five: Discussion, conclusion, and recommendations.

1.9 The references

Appendix

2.1 Theoretical background

2.1.1 Introduction

How film is handled in the darkroom can have a profound effect on the radiographs produced in a department .Common hazards to radiographic quality that can be found in the darkroom are white-light exposure, safelight exposure, ionizing radiation exposure and other potential hazards .Radiographic quality cannot be achieved when film is improperly stored, mishandled before or after exposure, or incorrectly processing (Terri L.Fauber, EdD, Rt(R) (M) -2009-Page 219,220).

Function of day light processing area are loading /un loading of cassettes by processing equipment , care and maintenance of electronic and processing equipment , storage on unexposed film , silver recovery and site for replenisher tanks or automixer (John ball&Tony Price -1995-Page 175-Para 1).

1.1.2 The Ideal Darkroom

2.1.2.1 The Darkroom design



Fig (2-1) Darkroom component (Lecture note)

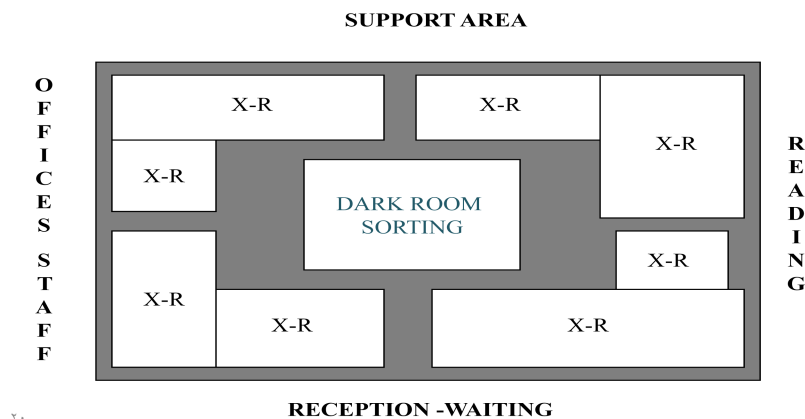


Fig (2-2) Darkroom design (Lecture note)

2. 1. 2.1.1 Location

- Centrally sited and serviced by hatches from the adjacent imaging rooms.
- Sited away from the damp or hot areas.
- Accessible in terms of power and water supplies.
- Adjoining a viewing area / room where processed films can be checked and sorted.

(John ball&Tony Price -1995-Page 175-Para 3).

2.1.2.1.2 Size

A darkroom which is to be in a constant used and where one full-time technician is to be employed requires a minimum floor area of 10m² and a ceiling height of around 2.5-3m.

The size is depending on:

- Staff and type of processing, the size of room work 24hrs must be 100foot square (10m²).
- However where this room is used in frequently and for short periods room its size may well reduced. (John ball&Tony Price -1995-Page 175 -Para 4)

2.1.2.1.3 Type of entrance

2.1.2. 1. 3.1 Single - door system

Where access is via a single door, precautions need to be taken in order to ensure that the door is capable of totally excluding light and cannot be opened inadvertently whilst films are being handled. It relatively in expensive, and economical in term of space used. The disadvantage is preventing other entrance during the work and emergency event for technologist (John ball&Tony Price -1995-Page 177 -Para3).

2.1.2.1.3.2 Double-door system

Each door should be sturdy in structure and well fitting, in order to exclude all light when closed. But the disadvantage is the two doors can be open at the same time, and it needs a large space (John ball&Tony Price -1995-Page 177 -Para 4).

2. 1.2.1.3.3 Labyrinth

A typical labyrinth for a darkroom consists of two parallel passages and a facing wall. The door in the baffle wall provides direct access if moving pieces of equipment in or out, and is useful in the event of an emergency. Permit entrance of number of workers at any time, need large space also. (John ball&Tony Price -1995-Page 17 8-Para 1)

2. 1.2.1.3.4 Rotating-door system

One type of design employs a metal cylinder with an opening in its side for entry / exit. It's one big advantage lies in the fact that it does not require a large floor area for installation (John ball&Tony Price -1995-Page 175-Para 2) .

2. 1.2.2 Darkroom Construction

2. 1.2.2.1 Wall / ceiling

The wall and ceiling should be Light color so as to reflect as much light as possible onto working surfaces. A high level of reflected light means that it may be possible to work with fewer safelights and in addition the defuse illumination so created will improve working conditions. Easy to wipe over and keep clean, The ceiling not more than 4m if we use indirect safelights and paint of the roof must produce no flakes (John ball&Tony Price -1995-Page 176 -Para 3).

2. 1.2.2.2 Floors

A light-colored material will be an advantage to militate against the low-light working conditions. The floor must be chemical resistant, made from asphalt or porcelain easy to clean (John ball&Tony Price -1995-Page 176-Para 2).

2.1.2.3 Radiation protection

The location of the ideal darkroom will inevitably mean that some walls are shared with adjoining radio-diagnostic rooms and, in the interests of both darkroom staff and film material alike, such wall must be adequately protected from penetration by x-ray radiation. The darkroom must be no receive any radiation (John ball&Tony Price -1995-Page 175-Para 1).

2.1. 2.4 Ventilation and heating

Where ventilation may be poor and humidity is allowed to raise heat loss from the processor will be inefficent and a general increase on processor temperature may occur. As a consequence, films may show increase density and fog. Increase humidity may cause inadequate film drying.

This problem can be prevented by ensuring:

- Relative humidity is maintained at around 40-60%.
- A minimum of ten air changes per hour.
- Room temperature maintained between 18 and 20c.

All of these conditions can be achieved by using a good air-conditioning system an extractor fan to obtain fresh and filtered air from outside. (John ball&Tony Price -1995-Page 176-Para 4).

2.1.2.5 Fire safety

Ideally, all darkrooms should provide with an alternative exit, which should be indicated clearly and left unobstructed at all times (John ball&Tony Price -1995-Page 178-Para 3).

2.1.2.6 Darkroom illumination

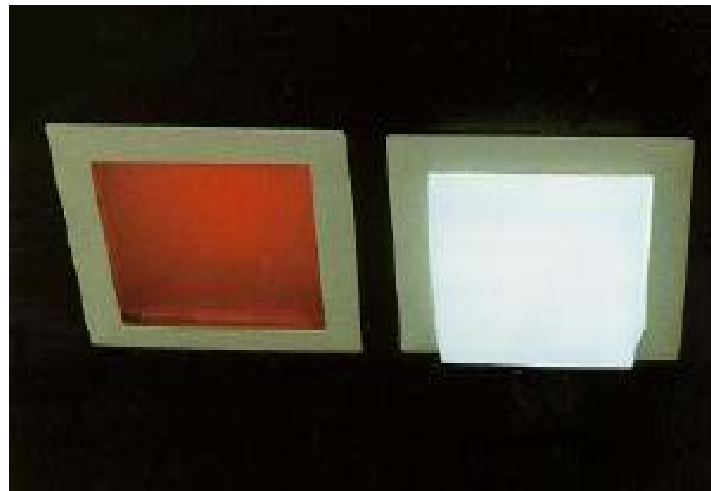


Fig (2- 3) Darkroom illumination (Lecture note)

2.1.2. 6.1 White lighting

White lighting is necessary for the following tasks, Inspection and maintenance of cassettes and screens, Cleaning of work surfaces and floors and Servicing of equipment.

White lighting should be:

- Sited close to the ceiling to avoid the casting of strong shadows.
- Moderate in intensity (e.g. 60 W tungsten, or 30 W fluorescent) in order to make visual accommodation under safelights easier.
- Preferably centrally placed, unless the size of the darkroom necessitates additional fixtures, in which case they should be sited over the main working areas. (John ball&Tony Price -1995- page 179-para1)

2.1.2.6.2 Safe lighting

Loading and unloading x-ray cassette all day in complete darkness would not make for easy or pleasant working conditions. Whilst all film materials would instantly be fogged if exposed to white light, safe lighting (John ball&Tony Price -1995- page 179-para 2) .

When white light is passed through colored filters, certain wavelengths (or colors) are absorbed by the filters, whilst those wavelengths which correspond to the color of the filters will be transmitted. Making the correct selection of safelight filter mean choosing a filter which will transmit a color to which the film is relatively unresponsive, whilst stopping all light to which the film is most sensitive(John ball&Tony Price -1995- page 179-para 3).

2.1.2.6.2.1 Types of safelighting

Direct safelighting, with this form illumination, light from the safe lamp falls directly on to the work surface. Such illumination should be sited a minimum distance of 1.2m from the working surface, and is the best type of lighting for film loading and unloading areas(Johnball&TonyPrice-1995-page184-para3).

Indirect safelighting, is intended to provide general illumination of the darkroom. The safe lamp directs the light towards the ceiling, which consequently should be painted in a light color in order to reflect light back into the room. These lamps should be suspended at least 2.1m above floor level (John ball&Tony Price -1995- page 185 -para 1) .

2.1.2.7 Darkroom equipment

2. 1.2.7.1 Automatic processor

The main advantage of placing a processor with only the feed tray inside the darkroom. Where a processor is sited inside a darkroom, problems will occur in providing adequate ventilation and in ensuring that heat and fumes are ducted

away from the processor (John ball&TonyPrice-1995-page 186 -Para3)



Fig (2- 4) Automatic processor (Lecture note)

2. 1.2.7.2 Cassette hatches

These allow easy transport of film cassettes between radiographic rooms and darkroom .One door of the hatch is lined with a 2mm thickness of lead, sense it may need to open directly into a radiographic room. The opposite door opens into the darkroom. And it well be contain marker (exposed and unexposed) (John ball&Tony Price - 1995-page 187 –para 2)

2. 1.2.7.3 Film hoppers

Unexposed films intended for immediate use in reloading cassette are most conveniently kept in a hopper under the loading bench. Each compartment accommodated different sized films (John ball&Tony Price - 1995-page 18 7 –para 3).

2. 1.2.7.4 Loading bench \cupboards

A darkroom loading bench should consist of a workbench and generous cupboard space (John ball&Tony Price - 1995-page 187 –Para 4).

2. 1.2.7.5 Manual processing

2. 1.2.7.5.1 The Dry Side

Various components of dry side of a darkroom are: loading bench, compartments for cassettes, film bin, storage for reserve film, brackets for film hangers wastepaper receptacle. The length of the loading bench depends upon the volume of work and the available space. The bench top covering should be linoleum or Formica and the color chosen should allow the objects used on the bench to be readily distinguishable under safelight illumination. Separate compartments for storing every size of cassette are essential and they should be made no deeper than the width of the cassette. Film hanger are the best kept on brackets above the loading bench, each size of hanger having a separate pair of (Satish K .Bhargava -2001-Page160-Para 5)



Fig (2-5) Dry bench (Lecture note)

2.2.2.7.5.2 The Wet Side

The processing chemicals are available as dry powders or as liquid solutions and made up to the proper volume by the addition of water according to the instructions printed on the label. A thermometer is used to determine the temperature of the developing solution and to check the temperature of water used to prepare the solutions. The processing tanks comprise the major equipment of the wet side of darkroom. The simplest type consists of a three compartment tank, one end-compartment being used for developing and the opposite one for fixing. The middle compartment serves both to rinse and wash the films and should be supplied with running water. However, if volume of work is more, both compartments can be separated. Stainless steel of the proper composition is the best material for processing tanks.

A more satisfactory arrangement consists of a large insulated stainless steel, double-compartment master tank. The stainless steel insert tanks are placed in one of the compartments, the first insert being the developing tank and the other, the fixing tank. Water between the inserts in this compartment serves both to rinse the films and to control the temperature of solutions. The other main compartment serves as the washing tank. Various types of drying devices help speed up the drying of films (Satish K. Bhargava -2001- Page 160-Par 5)

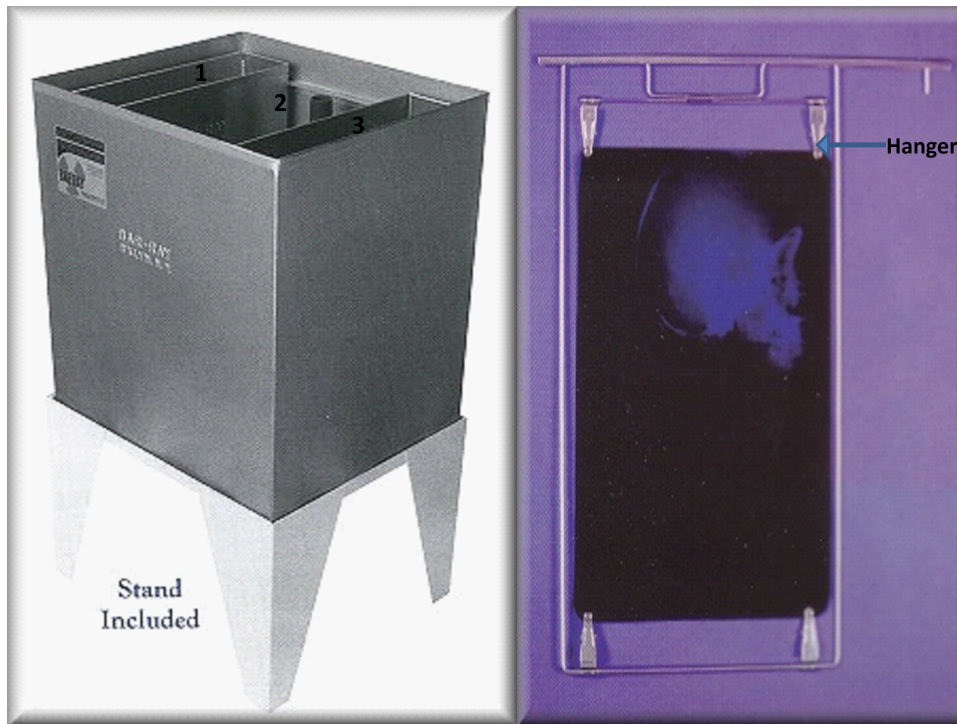


Fig (2-6) Wet bench (1: developer, 2: water, 3: fixer) (Lecture note)

2.1.3 Darkroom quality control (QC)

Quality assurance(QA) in diagnostic radiology is all-encompassing management program used to ensure excellence in healthcare through the systemic collection and evaluation of data .The primary objective of a QA program is the enhancement of patient care, this is includes patient selection parameters and scheduling ,management techniques ,departmental policies and procedures technical effectiveness and efficiency, inservice education, and image interpretation with timeliness of reports .The main emphasis of the program is on the human factors that can lead to variations in quality care.

The QC is the part of QA assurance program that deals with techniques used in monitoring and maintenance of the technical elements of the systems that affect the quality of the image. Therefore quality control is the part of QA program that deals with instrumentation and equipment. (Jeffrey Papp -2002-page 4).

2.1.3.1 Darkroom quality control tests

2.1.3.1.1 White light leakage test

- Frequency of test
 - 6 monthly.
 - After work has been carried out on the darkroom.
 - As necessary.

- Equipment required
 - Insulation tape to temporary cover holes.
 - Chalk to mark holes.

- Method
 - Turn on all lights in areas adjacent to the Darkroom.
 - Switch off all darkroom lights, including safelights.
 - Ensure that any doors are closed.
 - Remain in the darkroom for 10 minutes to allow the eyes to get used to the dark.
 - Look around the darkroom for signs of white light leaks.
 - Pay particular attention to doors, windows extractor fans, air vent and entry of pipes.

(Peter J Lloyd -2001-page 79, Para 2)

2.1.3.1.2 White light fogging test

- Frequency of test
 - 6 monthly.
 - As necessary.

- Equipment required
 - 1 sheet of new 18 x 24 cm film.
 - 1 sheet of 18 x 24 cm card.

- Method
 - Turn on all lights on areas adjacent to darkroom.
 - Switch off darkroom lights including safelights.
 - Place the film on the workbench.
 - Cover half of the film with the sheet of card.
 - Leave for 3 minutes
 - Process the film.

- Evaluation
 - If the density of the uncovered part of the film is greater than the covered part, then some fogging has occurred.

- Action
 - Seal any areas of light leakage.
 - Repeat the white light leakage test.

(Peter J Lloyd- 2001- page 79, Para 3).

2.1.3.1.3 Safelight efficiency test

There are two methods

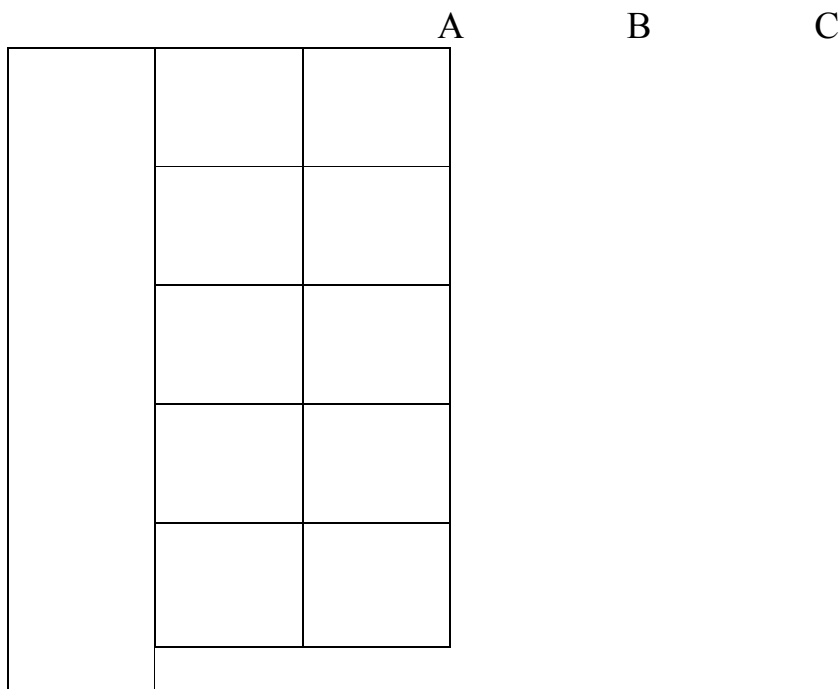
Method "1"

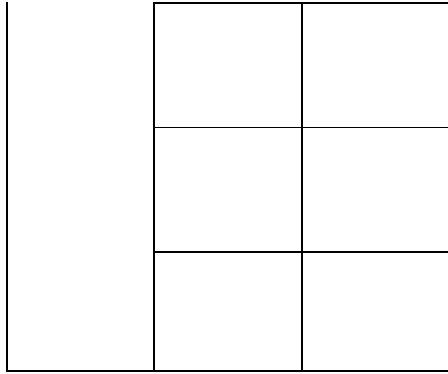
- Frequency of test
 - 6 or 12 monthly.

- Equipment required
 - One 24 x 30 cm cassette loaded with new film.
 - Two sheets of 24 x 30 cm cards.
 - One timing clock or watch with second hand.
 - One 24 x 30 cm sheet of lead or lead rubber.

- Method

- Unload the cassette in the darkroom in total darkness.
- Place cassette face up on the X-ray table.
- Set a FFD (SID) of 100 cm.
- Cover one third of the cassette with lead rubber, lengthways (area C).
- Collimate to the uncovered area of the cassette.
- Expose the film using a minimum exposure (suggested exposure 45 kV 2 MAS).
- Place the film on the workbench.
- Cover one third of the exposed side of the film with the sheet card, lengthways (area A).
- Cover areas B and C of the film, horizontally, with the second sheet of card, except for a 3 cm strip at the top.
- Switch on the safelights.
- Start clock immediately.
- Wait 30 seconds.
- Move second sheet of card down 3 cm (the first sheet of card must remain in place throughout).
- Wait 30 seconds.
- Repeat this process every 30 seconds until the bottom of the film is reached.
- Switch off the safelights immediately.
- Process the film.





4 min

3 min 30 sec

3 min

2 min 30 sec

2 min

1 min 30 sec

1 min

30 sec

Fig (2-7) Diagram of the test film image (Peter J Lloyd -2001)

Section A- Sensitised by radiation, not expose to safelights.

Section B- Sensitised by radiation, exposed to safelight in 8 strips varying in length of exposure from 30 seconds to 4 minutes.

Section C-Not Sensitised by radiation.

- Note
 - Exposed to safelight in 8 strips varying in length of exposure from 30 seconds to 4 minutes.
 - Identify the strip in Section B which has a noticeable increase in density compared to its equivalent strip in Section C.
 - Double check by comparing B with A.
 - Note the safelight exposure time of this strip.
 - This exposure time is the extreme limit of film handling time.
 - 3 minutes is considered to be the limit of acceptable film- handling time.

(Peter J Lloyd -2001-page 79 para 5 ,page 80).

Method "2"

In a good darkroom place unexposed film on the table with the metal piece (coin) on it .Exposed the film to the safelight with this coin and different timing for 30 sec, 1 minute, 2 minutes and 4 minutes at different places. Note time of exposure, where the outline of the coin is just visible on the process film .This is the maximum time that is the film can with stands from the safe lights without fog.

.(Satish K .Bhargava -2001-Page 180).

2.1.3.1.4 Darkroom Radiation leakage test

In the absence of a more accurately made check ,the entry of ionizing radiation into a darkroom can easily proved by placing a coin on an envelope –wrapped film and fixing the latter to the suspect wall of the room ,the coin should lie week perhaps but the period certainly should be longer than that for which any film would remain in the vicinity during the normal occurrences of work : in this connection the susceptibility of stored film materials should not be overlooked .In a room which is not sufficiently protected ,a faint image of the coin will be apparent on the test film after processing.

(D.NOREEN CHESNEY &MURIEL O.CHESENEY- 1981- page 247).

2.3.1.5 Daily and Weekly Darkroom QC

- Objective
 - Keep the darkroom clean and processing optimized.

- Frequency
 - Daily - Check developer temperature.
 - Daily - Check developer, rinse, and fixer levels.

- Daily - Clean processor feed tray, counter tops.
- Weekly - Clean darkroom.
- Equipment required
 - Non-mercury thermometer.
 - Mop.
 - Non-abrasive, liquid cleaning solutions.
 - Damp, lint-free cloths.
- Steps
 - Daily: If manual processing, developer temperature must be measured with non-mercury thermometer for correlation with the time-temperature chart.
 - If auto processing, measure the temperature with a non-mercury thermometer to verify that the developer is operating within the temperature range established by the manufacturer, and that the display, if applicable, is accurate. It may not be necessary to physically measure the temperature daily if the processor passes the daily QC test.
 - Daily: If manual processing, replenish following the chemistry manufacturer guidelines.
 - Replace rinse water.
 - If auto processing, follow the processor manufacturer recommendations regarding replenishment.
 - Daily: Clean processor feed tray and counter top.
 - Weekly: Damp mop darkroom floor. Clean counters, cabinets, and anywhere else dust may accumulate.
 - Clean film hangers.

(John Winston, et al-2001)

2.1.3.1.6 Developer

The chemical treatment that converts the latent film image into a visual image.

1.1.21.1.1 Developer temperature and development time

Development time and temperature directly affect the density, contrast and amount of base fog of a radiograph.

Follow manufacturer's time/temperature recommendations.

Use manufacturer's time/temperature adjustment graph when necessary, the time/temperature graph is not available it will be necessary to carry out a test to determine the correct development temperature.

- Frequency
 - As required.

- Equipment required
 - Six sensitometry test strips.
 - Thermometer (not mercury).
 - Six film clips or safety pins.
 - Developer stirring rod.
 - Timing clock.
 - Densitometer.

- Method
 - This test can only provide a development time for one temperature level.

 - If a range of temperatures prevail then this test must be repeated for each temperature.
 - First, regularly check the developer temperature.
 - Determine the prevailing temperature.
 - Before commencing the test, stir the developer and check the temperature.
 - In safelight conditions number the test strips in pencil, 1 to 6.
 - Attach the test strips to the film clips (or safety pins) and suspend in the developer.
 - All strips must enter the developer at the same time.
 - Start the time clock immediately.
 - After 30 seconds remove test strip 1, rinse and place in fixer.
 - After a further 30 seconds (one minute of development) remove test strip 2, rinse and place in fixer.
 - Repeat this process every 30 seconds until all test strips are in the fixer.
 - Fix, wash and dry test strips.

- Evaluation

- Arrange strips on a viewing box, side by side, in numerical order, with all unexposed steps at the same end.
- Study the unexposed steps.
- Identify the strips that do not show any base +fog level increase.
- Study the middle density steps and identify the strips which do not show a density level increase.
- The most suitable development time, at the temperature used, is the time that gives maximum density but shows no increase in base fog.
- A densitometer may be used to determine density levels if available.
- If a range of temperatures need to be investigated to determine the best development time for each, the test is repeated for each temperature and the result charted or a graph produced.

(Peter J Lloyd -2001- page 86)

1.1.21.1.2 Developer activity test (Elementary method)

- Frequency of test
 - Daily.
- Equipment required
 - One sensitometric strip.
 - Sensitometric strips from previous tests.
 - Graph paper.
- Method
 - Stir developer.
 - Check temperature of developer.
 - Adjust temperature to pre-determined standard if necessary.
 - When temperature is correct, develop the test strip.
 - Mark the strip with the date.
- Evaluation
 - Compare the test strip with the control strip.
 - The equivalent steps should have the same density.
 - This confirms consistent developer activity.
 - If the strips are not comparable, adjust them until they are.
 - If adjustment has been necessary, count the number of steps difference between the two strips.

One step difference = acceptable.

Two steps difference = acceptable but be warned.

Three steps difference = unacceptable take action.

- If the test strip is moved up, compared to the control strip, the result is regarded as positive.
- If the test strip is moved down, compared to the control strip, the result is regarded as negative.
- Graph the results.

(Peter J Lloyd -2001- page 88, para1).

1.1.21.1.3 Developer activity using a hydrometer test

- Frequency of test
 - Daily.
- Equipment required
 - Hydrometer (a hydrometer designed for testing car batteries can be used, but the scale will need to be extended).
 - Manufacturers recommended specific gravity for the developer being tested.
- Method
 - Place the hydrometer in the developer. It will float.
 - Note the reading on the scale at the level of the developer surface.
- Evaluation
 - The specific Gravity reading should be within plus or minus 0.004 of the manufacturer's recommendations.
 - If the reading is lower than that recommended, the developer is over diluted.
 - If the reading is higher than that recommended, the developer is too concentrated.
- Action
 - If too concentrated add water.
 - If too dilute add replenisher or replace the Developer.

(Peter J Lloyd -2001- page 88,para2-page89,para1).

2.1.3.1.6.4 Developer activity using pH paper (litmus paper) test

Can be used for freshly mixed developer, but is more useful to show contamination or oxidation.

- Frequency of test
 - Daily.

- Equipment required
 - PH paper (litmus paper).

- Method
 - Hold a strip of test paper in the developer for approximately 10 seconds.
 - Observe color change.
 - Compare with control strip.

- Evaluation
 - Note manufacturer's recommended pH range (usually around 10.0 to 10.5).
 - Compare test strip reading to recommended range.
 - A reading of more than 0.4 below manufacturer's recommendations suggests contamination.
 - A reading of 0.8 below suggests oxidation.

- Action
 - Replace developer if readings are too high or too low.

(Peter J Lloyd -2001- page 89,para 2).

1.1.21.1.5 Developer replenisher

Replenisher is the chemistry added to the developer to maintain its volume and activity.

- Replenisher is generally more active than the original developer.
- Mix according to manufacturer's instructions.
- Have a quantity of replenisher mixed and stored in darkroom for convenient use.

- Add replenisher when developer level falls.
- Do not allow level of developer to fall below the top of films.

(Peter J Lloyd -2001- page 89,para3).

1.1.21.7 Rinse

The process of using clean water to wash residual developer from the film, so avoiding contamination and reduction in efficiency of the fixer.

Separate rinse water tanks between developer and fixer should have running water.

Static rinses should have the water changed regularly

Agitate films vertically in static rinses.

Rinse for 15 seconds. (Peter J Lloyd -2001- page 89,para 4-page90,para 1).

1.1.21.8 Fixer

- Dissolves off all unwanted film emulsion.
- Makes image permanent .
- Fixing temperature and fixing time, although important, are not as critical as those of the developer.

1.1.21.81 Clearing time

- The time it takes to clear the film (dissolving off the unwanted film emulsion).
- Can take from 30 seconds, but should not be more than 2 minutes.
- The film may be viewed in white light once it has fully cleared.

1.1.21.82 Permanent fixing

- This is usually twice the length of the clearing time.
- It is recommended that all films be fixed for at least 4 minutes to avoid image deterioration later.
- Remove films from the fixer as soon as adequately fixed, as excessive time in the fixer will remove the image.

(Peter J Lloyd -2001-page 90,para 2).

2. 1.3.1.8.3 Fixer activity using hydrometer test

Specific gravity of the fixer is an indicate on of its activity, specific gravity of fixer should be in the region of 0.004 (see manufacturers recommendations).

- Frequency of test
 - Daily.
- Equipment required
 - Hydrometer.
- Method
 - Place the hydrometer in the fixer.
 - Note the reading at the surface of the fixer.
- Evaluation
 - Specific gravity reading should be within plus or minus 0.004 of manufacturers recommendations.
 - Specific gravity should be in the region of 1.110.
 - A high specific gravity reading-not dilutes enough.
 - A low specific gravity reading-too dilute.
- Action
 - Dilute if specific gravity reading too high.
 - Add undiluted fixer if specific gravity too low.

(Peter J Lloyd -2001- page 90 ,Para 3).

1.1.21.84 Silver estimation test

Indicates level of silver concentration in fixer solution.

- Frequency of test
 - Daily.
- Equipment required
 - Silver estimation paper.
- Method

- Place paper in fixer.
- Compare with control.
- Take reading.

- Evaluation
 - Below 2 gm/I is over replenished.
 - Above 6 gm/I Is under replenishment.

- Note:
 - Freshly mixed fixer will have a zero reading.

- Action
 - Below 2 gm/l add water.
 - Above 6 gm/l add undiluted fixer.

(Peter J Lloyd -2001- page 90,para 4).

2.1.3.1.9 Wash

The use of clean water to wash all residual fixer from the film, so avoiding the deterioration of the image over time.

Wash films for 20 minutes in running water, at a rate of four exchanges an hour, in order to ensure satisfactory long term storage of radiographs.

Should there be a need to conserve water, then slower flow rates and shorter wash times can be used, but it must be remembered that the washing process will be less efficient and radiographs will deteriorate quicker during storage. Consideration should be given to manual vertical agitation when water flow is slower, or wash times shorter, than recommended, in order to improve the washing efficiency.

Where there are no facilities for a running water wash, it is recommended that radiographs remain in the water tank for 2 hours, and then given 30 seconds of manual, vertical agitation.

Water level must be above top of film hangers to ensure hangers are completely washed. (Peter J Lloyd -2001- page 90,para 5).

1.1.21.81 Hypo retention test

- This test indicates the amount of residual thiosulphate remaining in the film emulsion, after film processing has been completed. An indication of adequate/inadequate washing.
 - An excessive amount of residual thiosulphate in a film emulsion may cause a brown stain to appear on the film.
- Frequency of test
 - Weekly.
 - As necessary.
 - Equipment required
 - Hypo (thiosulphate) retention test fluid.
 - Test strip.
 - Radiographs to be tested.
 - Method
 - Put a drop of test fluid on the surface of the film well clear of the image.
 - Wait for one or two minutes.
 - Evaluation
 - Inspect the moistened area.
 - Compare color with test strip.
 - Action
 - If color indicates a high level of thiosulphate, check wash water flow and washing time.
 - Adjust and re test.

(Peter J Lloyd -2001- page 91, para 2).

1.1.21.9 Drying

To remove all moisture, harden the Image and make the radiograph durable.
Drying cabinet or air drying.

Ensure that films are fully dried before removing from the hangers.

(Peter J Lloyd -2001- page 91, para 3).

1.1.21.10 Processing routine

- The method by which films are processed in order to produce high quality images.
- Method
 - Stir solutions.
 - Take the developer temperature. Read while thermometer is still in developer.
 - Check correct development time at this temperature. Refer to manufacturer's time/temperature graph or your own time/temperature chart.
 - In safelight conditions load film into hanger.
 - Keep fingers to edge of film only.
 - Ensure correct tension of film in hanger.
 - Set timer for correct developing time.
 - Lower hanger and film into developer.
 - Hold hanger so that fingers do not come into contact with developer.
 - Agitate film in vertical direction two or three times to remove air bubbles and distribute developer evenly over the film.
 - Place hanger in developer so that film is fully immersed developer should not be drained back into the developer).
 - Lower film into rinse for 15 seconds (agitate if rinse is static).
 - Lift films from rinse and allow to drain back into the rinse (rinse water should not be drained into the fixer as this will result in dilution of the fixer)
 - Lower film into the fixer.
 - Agitate two or three times.
 - Ensure that film is fully covered by fixer.
 - The film may be viewed in white light conditions once it has cleared.
 - Leave film in fixer for at least 4 minutes to fully fix.
 - Lift film from fixer and transfer directly to wash (exhausted fixer from the film should not be allowed to drain back into the fixer tank).
 - Leave in running water for 20 minutes.
 - Lift film from wash and allow draining back into the wash tank.
 - Place film in drying cabinet or on an air drying rack.

(Peter J Lloyd -2001- page 92,93).

1.1.21.11 Mixing chemicals

- Check that tank sizes are standard and that the manufacturer's quantities are correct for your tanks.
- Mix according to manufacturer's instructions.
- Follow manufacturer's safety precautions.
- Use different stirring rods/paddles for developer and fixer.
- Wear protective clothing.
- Check that room ventilation is adequate.
- Minimize splashing.
- Ensure that fixer does not contaminate developer.
- Clean up any spills immediately.

(Peter J Lloyd -2001- page 85).

2.2 Previous Study

T.B Van et al,(2009) was studied Analysis of X -ray Film Quality in Primary Health Care Clinics in Riyadh ,The relationship between image quality and processing conditions was assessed in a survey of 26 primary health care clinics in Riyadh city .Each clinic equipped with a basic x-ray room and dark room that has a small table-top automatic processor . Rooms were evaluated for the quality of safe light, light leakage, storage of films and chemicals and processor temperature setting. A relationship was obtained between the quality of these parameters and the analysis of characteristic curves (H and D curves) of images produced at each

facility. Base plus fog indexes in 50% of clinics were found to be above normal values. The result showed that image quality is negatively affected when the above conditions are unsatisfactory, even though the x-ray machine, cassettes and films used are in good condition. He concluded, image quality can be improved significantly by applying quality control principles related to darkroom conditions.

Van Kreveld, et al, (2005) had measured the darkroom illumination. The study has been made of the requirements that darkroom lamps used in the developing of negatives, have to satisfy in point of quality. Firstly the sensitivity of the eye to contrasts under darkroom conditions has been determined for the different colours from green to dark red. Secondly the sensitivity of different photographic emulsions has been measured through the whole visible spectrum. From these measurements the optimum light for orthochromatic and panchromatic emulsions has been computed. Further the energy of a darkroom lamp causing an inadmissible decrease in photographic contrast, and from this the "quality" of an arbitrary darkroom lamp has been calculated.

J.B. Tuffy et al, (2004) was studied safelight handling times in darkroom, The evaluation it was found the safelight illumination should be enough visibility for the technician in the darkroom to handle and process film whilst resulting in minimum detrimental effect to unprocessed film. Safelight handling times (maximum time for which a film can be exposed to safelights without any appreciable degree of fogging) should always exceed film handling times. Previous worker have not considered this relationship. This investigation therefore is aimed to specifically measure and define the safelight handling time and film handling time in seven Dublin hospitals.

Causal agents for unacceptable safelight handling times were sought.

3.1 Materials

Dental films.

Coins.

Cassettes (24cm x 30cm).

Double emulsion films (24cm x 30cm and 18cm x 24cm).

Card sheet.

Darkroom with manual processing.

Data sheets (Appendix)

3.2 Methods

3.2.1 Study design

Experimental study of darkroom quality control tests.

3.2.2 Study area

Some Hospitals darkrooms in Khartoum state which include:

Ear, nose and throat (ENT) hospital.

Al-turkey educational hospital.

Al-shab technique hospital.

3.2.3 Data collection

Results were taken by applying practical tests for darkroom by testing white light leakage, white light and safelight fog, and radiation leakage in some hospitals and using data sheet.

3.2.4 Data analysis

Analysis of data was done using tables.

3.2.5 Study duration

From 10 of Jun 2014 to 21of Jun 2014.

This chapter explain the results of white light leakage test, white light fogging test, darkroom safelight test and radiation leakage test in ENT hospital(A), Al-turkey educational hospital(B) and Al-shab technique hospital(C). And these results were shown in following tables:

4.1 The results of white light leakage test:

Table No.(4.1):Illustrates white light leakage by inspection in the hospitals

The hospitals	White light leakage
A	Exhaust fan
B	Door
C	Door

4.2 The results of white light fogging test:

Table No. (4.2): Illustrates white light fogging test in the hospitals

The hospitals	The density of uncovered part of the film related to the cover part
A	Same
B	Same
C	Greater

4.3 The results of darkroom safelight test:

Table No. (4.3): Illustrates the different in optical density between the areas exposed to safelight and areas exposed to safelight and radiation in the hospitals

The hospitals	Time							
	4min	3min 30 sec	3min	2min 30 sec	2min	1min 30sec	1min	30sec
A	1	1	1	1	1	1	2	2
B	2	2	2	2	2	2	2	2
C	1	1	1	1	1	1	1	2

The different in optical density (by inspection): 1= Yes, 2= No

4.4 The results of darkroom radiation leakage:

Table No. (4.4): Illustrates the darkroom radiation leakage

The hospitals	The appearance of coin on film after processing
A	2
B	2
C	2

The appearance of coin on film: 1= Yes, 2= No

5.1 Discussion:

This study designed to assess the darkroom quality control tests (white light leakage, white light fog, safelight and radiation leakage), the white light leakage was tested in three hospitals (ENT, Al-turkey and Al-shab):

Table (4-1) shows that there was leakage from exhaust fan in ENT and from the door in Al-turkey and Al-shab.

Table (4.2) shows that there was no fog on the film in ENT and Al-turkey but the film was affected (fog) in Al-shab.

Table (4.3) shows that there was no difference in optical density in Al-turkey , but there was difference in optical density in ENT (4 min to 1 min 30 sec) and Al-shab (4 min to 1min).

Table (4.4) shows that there was no appearance of coin on the film in all hospitals (ENT, Al-turkey and Al-shab).

5.2 Conclusion

This study concluded that there were difference in the results of the hospitals darkrooms under the study.

The main findings of this study were:

ENT hospital, the white light leakage from the exhaust fan but not affect (fog) the film, the safelight was acceptable and well protected from the radiation leakage (75% correct).

Al-turkey hospital, the white light leakage from the door but not affect (fog) the film, the safelight was proper and well protected from the radiation leakage (100% correct).

Al-shab hospital, the white light leakage from the door but affect (fog) the film, the safelight was in proper and well protected from the radiation leakage (25% correct).

3.5 Recommendations

The researchers recommended the following:

- Seminars and lectures about quality control program for technologists, radiologists and for all personnel in radiology department.
- Regular darkroom quality control tests should be obtained for all darkrooms under the study.
- The Computer Radiography (CR) and Digital Radiography (DR) should be available in x-ray departments to reduce the faults.
- Documentation for all darkroom previous studies.

References

D.NOREEN CHESNEY & MURIEL O. CHESNEY, 1981, Radiographic Imaging,
Fourth Edition, BLACKWELL SCIENTIFIC PUBLICATION.

John ball & Tony Price, 1995, Chesneys' Radiographic Imaging, Sixth
Edition, Blackwell Wissenschafts verlag, Kurfurstendamm.57, 10707 Berlin,
Germany.

Jeffrey Papp, 2002, QUALITY MANGMENT in imaging sciences, Second Edition,
Deborah L. Vogel.

John Winston ,et al, 2001, QUALITY CONTROL RECOMMENDATIONS for DIAGNOSTIC RADIOGRAPHY, volume 3,Conference of Radiation Control Program Directors,Ins.

Lectures notes.

Peter J Lloyd , 2001, Quality assurance work book for radiographers & radiological technologists, World Health Organization(WHO).

Satish K .Bhargava , 2001, Text book of Radiology for Resident and Technition, Second Edition, Satish Kumar Jain for CBS Publishers &Distributors.

Terri L.Fauber, EdD, and Rt(R) (M) , 2009, Radiographic Imaging & Exposure, Third Edition, Jeanne Wilke.

Data sheet

Hospitals	White light leakage test	white light fogging test	safelight test	radiation leakage test
ENT hospital				

Al-turkey educational hospital				
Al-shab technique hospital				