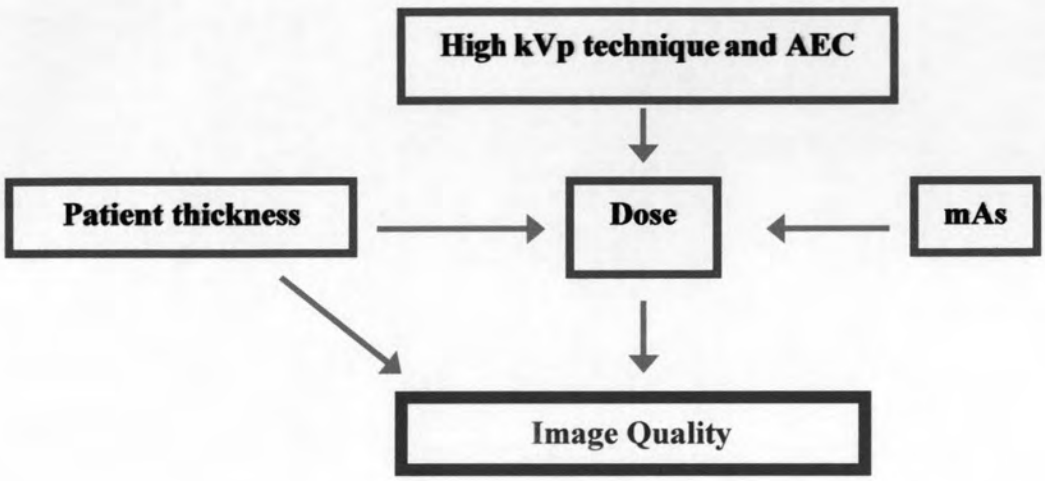
CHAPTER 3

RESEARCH METHODOLOGY

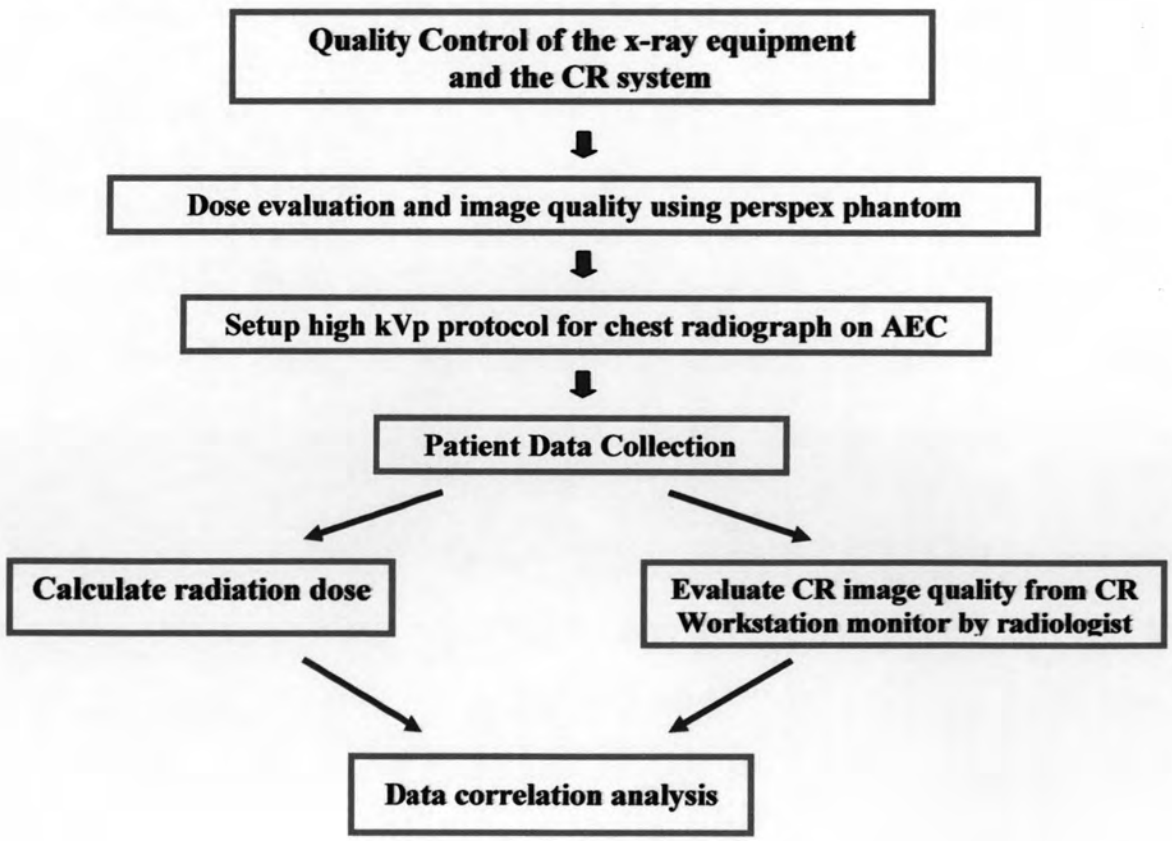
3.1 Conceptual framework



3.2 Research design

This is the experimental study, prospective study design.

3.2.1 Research design model



3.3 Research questions:

Primary research question

- Can the high kVp technique for chest PA maintain the optimal image quality on monitor of CR system?

Secondary research question

- Are there any other factors affecting the image quality of high kVp technique in CR system (e.g. pathology)?

3.4 The Sample

3.4.1 Target population: All patients who are requested for chest PA which would be exposed by CR system.

3.4.2 Sample population: All patients who are requested for chest PA which would be exposed by CR system at Emergency room that meet the following eligible criteria for the period of 2 months.

3.4.3 Eligible criteria:

3.4.3.1 Inclusion criteria for patients

1. The patient with examination that is chest PA radiographic projection.
2. The patient must be able to control the movement during examination.
3. The patient's age is between 18 to 75 years old.

3.4.3.2 Exclusion criteria

Missing data transferred to Picture Archiving and Communications System (PACS) of Department of Radiology King Chulalongkorn Memorial Hospital, Thai Red Cross Society.

3.4.4 Sample size estimation:

1. The data is the continuous data.
2. The sample population is independence, prospective data.

By formula;

$$n = \frac{Z^2_{\alpha/2}\sigma^2}{d^2}$$

n = Sample size

$Z_{\alpha/2} = 1.96$

σ^2 = Variance (0.65)

d = Acceptable error (1/8)

So; Sample Size (n) for 95% confidence interval = 160 examinations

Experimental Maneuver

The data is collected at Mongkutpecharat Building (Emergency room No.1), Department of Radiology, King Chulalongkorn Memorial Hospital, Bangkok, with a computed radiography system.

3.5 Materials

3.5.1 The Computed Radiography (CR) system is manufactured by Fuji Corporation, Tokyo, Japan Model Fuji FCR XG 5000

Figure 13. Fuji FCR XG 5000

3.5.2 Imaging plates sized 35x43 cm. Standard ST-VN speed

Figure 14. Fuji Standard ST-VN speed

3.5.3 X-ray machine, Unit of Emergency Room No.1 manufacturer of Toshiba Medical System Model KXO-80G / DT-BTH / DST-100A

Figure 15. Toshiba Model KXO-80G / DT-BTH / DST-100A

3.5.4 PMMA phantom 11 plates each plate size is 30x30x1 cm.

3.5.5 Dosimeter

A. Manufacturer Victoreen Model 4000M+, USA

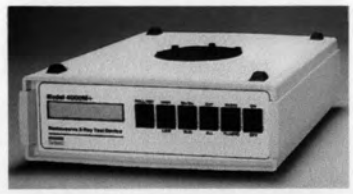


Figure 16. Victoreen 4000M+

B. Dose Area Product (DAP) meter, Manufacturerd by PTW Freiburg Model Diamentor-E, Germany

Figure 17. DAP meter PTW Diamentor-E

3.5.6 High resolution monitor of 3 Mega pixel format BarCo, Belgium

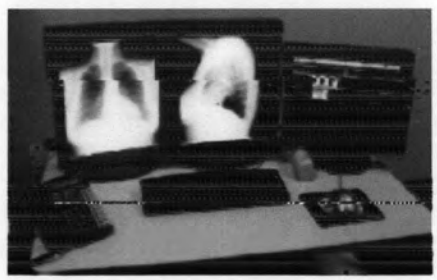


Figure 18. Barco monitor

3.5.7 Test pattern Leeds phantom Model TOR 18 FAGIL, Leeds, UK

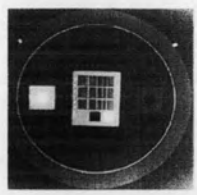


Figure 19. TOR 18 FAGIL

3.5.8 Accessories

A. Tape measure

B. Body caliper

3.5.9 Patient data on chest radiography

3.6 Method:

1. Perform quality control of the x-ray equipment and the CR system.(AAPM protocols)
2. Attach DAP Meter in front of the x-ray tube collimator to record the DAP dose in cGy. cm^2
3. Perform phantom studies using high kVp (120-150 kVp) technique on increasing thickness (5 levels; 11-14, 15-18, 19-22, 23-26, 27-30 cm.). Attach Leeds test pattern at the middle part of PMMA phantom.

Figure 20. Perspex phantoms with test objects

4. Collect the data of phantom study as details in Table 1.
5. Record DAP readout on phantom study.
6. Calculate ESD from output exposure by the following formula.

$$\mathbf{ESD = R_{100} . \quad (100 / (FDD - T))^2 . mAs . BSF}$$

Where ESD is entrance surface dose, mGy

T is the sum of the phantom (patient) thickness and the phantom (patient)-to-imaging plate distance

R_{100} is the radiation output (mGy. mAs^{-1}) at 100 cm from the tube focus to radiation detector at the tube potential used for the examination.

FDD is the focus to detector distance.

BSF is the back scatter factor. Record the result in table 1.

7. Assess the high contrast resolution by counting the group of line pairs for high

Table 1. Summary data of dose and average score of image quality of the phantom

PMMA Thickness (chest thickness) cm.	kVp	mAs	DAP	ESD	*S-value	Image Quality	
						**High contrast resolution	***Low contrast resolution
5 (11-14)	**120**						
	130						
	140						
	150						
7 (15-18)	**120**						
	130						
	140						
	150						
8 (19-22)	**120**						
	130						
	140						
	150						
10 (23-26)	**120**						
	130						
	140						
	150						
12 (27-30)	**120**						
	130						
	140						
	150						

* **S-value;** Sensitivity number to provide an estimate of the incident exposure on the IP transmitted through the object.

** **High contrast resolution**; Group of line pair per mm, of lead bars of different width and spaces between the bars of equal size [12].

*** **Low contrast resolution**; Number of circles to differentiate regions of gray level of different contrast.

8. Set up the exposure table protocol from the result of phantom study to use with patient of various thicknesses.

9. Collect the patient data using the setup protocol. For each patient, the following parameters were recorded: HN, sex, age, weight, height, chest thickness, FDD (Focus-to-detector distance), kVp and mAs.

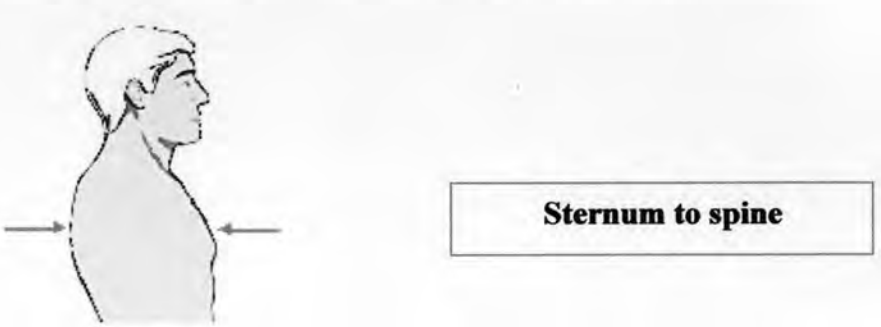


Figure 21. Patient chest thickness measurement

10. Score image quality based on the Commission of the European Communities criteria (CEC) by the qualified radiologists from dedicated monitor.

Table 2. Score image quality based on the Commission of the European Communities (CEC) criteria

Image criteria	*Score
Visually sharp reproduction of the vascular pattern of the lungs, particularly the peripheral vessels	
Visually sharp reproduction of the trachea and proximal bronchi	
Visually sharp reproduction of the borders of the heart and the aorta	
Visually sharp reproduction of the diaphragm and lateral costophrenic angles	
Visualization of the retrocardiac lung and the mediastinum	
Visualization of the spine through the heart shadow	
Small round details in the whole lung, including the retrocardiac areas: High contrast: 0.7 mm; low contrast: 2 mm diameter	
Linear and reticular details out to the lung periphery: high contrast:0.3 mm; low contrast: 2 mm in width	
Total	

* Rate image score: 0, 0.5, 1 where 0 = not fulfilled, 0.5 = partly fulfilled, 1 = fulfilled

11. Analysis the image quality and correlate with the patient dose.
12. Obtain protocol on high kVp technique for various patient thicknesses.
13. Compare the average ESD to the Dose Reference Level (DRL)

3.7 Outcome to be measured

Main outcome: The primary outcome is the high kVp technique and the optimal image quality, based on the CEC criteria.

Secondary outcome: The patient skin dose from chest radiography CR system at optimal image quality.

3.8 Data collection

The radiation dose and image quality obtained by calculation and scoring image quality based on the CEC criteria.

3.9 Data analysis

3.9.1 Summarization of data

The image quality and radiation dose data of patient are the continuous numerical data; Percentage and Range are analyzed.

3.9.2 Data presentation

The table, bar diagram and line graph will be presented.

3.8.3 Problem from protocol deviation

Missing data transferred to Picture Archiving and Communications System (PACS).