

**Deanship of Graduate Studies
Al-Quds University**



**Evaluation of the Medical Imaging Services at
Governmental Hospitals-Gaza Governorates**

Maher D. Suleiman

MPH Thesis

Jerusalem-Palestine

1438 / 2017

**Evaluation of the Medical Imaging Services at
Governmental Hospitals-Gaza Governorates**

Prepared By

Maher Daher Suleiman

Bachelor of Medical Imaging – Al-Azhar University
Gaza, Palestine

Supervisor: Dr. Yasser S. Al-ajerami
Associate Professor Applied Medical Sciences/Al-Azhar
University - Gaza, Palestine

A Thesis Submitted in Partial Fulfillment of Requirements
for the Degree of Master of Public Health/Epidemiology -
Al- Quds University

1438-2017

Dedication

To the greatest man I have in my life, the light of my life... my lovely father

To the biggest heart with the most loving care, who sacrificed a lot for me to become what I am now, my mother

To my wife who supported me through each step of the way and for being the greatest source of inspiration for me...

To the light of my eye...my kids “Miasser, Kateralnada and Daher”

To all those who encouraged, supported, and helped me all the way.

I dedicate this research for all of them ...

Maher Daher Suleiman

Declaration

I certify that this thesis submitted for the degree of master is the result of my own research, except where otherwise acknowledged, and that this thesis or any of its parts has not been submitted for higher degree to any other university or institution.

Signed:

Maher D. Suleiman

Date: -----/-----/-----

Acknowledgment

I express my praise and gratitude to Allah who granted me the strength, patience and capability to complete this research.

I owe heartfelt thanks and gratitude to my academic supervisor Dr. Yasser Al-ajerami, who exerted a lot of his time, knowledge, efforts and patience in supervising this research and encouraging me to do the best.

Sincere thanks and recognition are extended to Dr. Yehia Abed, Dr. Bassam Abu Hamad, Dr. Sammy Al Agha and Dr. Khitam Abu Hamad for his immense contribution, guidance and support.

I would like to thank all academic and administrative staff of the School of Public Health, Al-Quds University for their guidance and collaboration.

Special thanks and appreciation are sent to my friends and colleagues Basel Mohamed Abed-Elkader Khadar, Mohammed Alkahlot, Ziad Alawuor, Wael Yousef and Hesham Ahmed for their special and valuable support.

I would like to thanks all health professionals who participated in this study for their cooperation and participation in this study.

Maher Daher Suleiman

Abstract

Medical imaging services are the key tool to diagnose many diseases and have an important role in monitoring treatment and predicting outcome. This field includes many modalities like Conventional Radiology, Fluoroscopy, Computed Tomography, Magnetic Resonance Imaging and Radioscintigraphy...etc. Since the discovery of X-ray by Roentgen in 1895, progressions of international standards seek to improve medical imaging services. Patient convenience and accessibility should be an integral part of the planning and design of departments. Availability of equipment and qualified staff increase safety, outcome and quality of patient's services.

Triangulated study design was used. For the quantitative part; 170 Radiologic Technologists completed questionnaires with 95.5% response rate. The researcher used arbitrated checklist to evaluate medical imaging facilities. Census study conducted on all Radiologic Technologists and medical imaging departments at six main governmental hospitals in the Gaza Strip. In addition, three key informant interviews with Radiologic Technologists manager were conducted.

Researcher have directly interviewed 170 participants (82% Males; 75% younger than 40; 85% have bachelor degree and 86.5% permanent employment). Findings revealed that 143 of Radiologic Technologists having Thermoluminescence Dosimeters, but only 80 holding it. The majority of participants have good training courses. There was shortage in number of radiographic equipment and Radiologic Technologists. Four of sixth of hospitals provided with Computed Radiography. Statistically significant relations between participants years' experience and holding Thermoluminescence Dosimeters ($p=0.033$); number of exams and patient waiting time in Conventional Radiography ($p=0.000$). Generally, medical imaging departments that followed standard in structure, occupational safety and reception services were 90%, 70% and 27%, respectively. In Conventional Radiography, 45%, 64% and 83% of structure, occupational safety and essential supplies of imaging rooms were adapted to standard, respectively. Regarding to fluoroscopic rooms, 79%, 82% and 68% of structure, occupational safety and essential supplies were followed the standard, respectively. The Computed Tomography and Magnetic Resonance Imaging departments showed that "60%, 78% and 91%" and "86%, 100% and 90%" followed standard regarding to their structures, occupational safety and essential supplies, respectively.

An improvement in human resources among medical imaging facilities was clearly observed after 1996. There is a good tendency to replace traditional radiography by Computed Radiography. Finally, frequent training courses were conducted in all medical imaging fields except Magnetic Resonance Imaging. On other side, shortage in number of radiographic machines and Radiologic Technologists at all governmental hospitals was observed. All departments revealed clear defect in structure, design and essential supplies. Critical readings were observed respecting to insufficient radiation protection tools and holding of Thermoluminescence Dosimeters.

Table of Contents

Dedication	I
Declaration	II
Acknowledgment	III
Abstract	IV
Table of Contents	V
List of Tables.....	VIII
List of Figures	X
List of Annexes	X
List of Abbreviations.....	XI
Chapter (1): Introduction.....	1
1.1 Background	1
1.2 Justifications of the study.....	2
1.3 Problem statement.....	3
1.4 General objective	4
1.4.1 Specific objectives	4
1.5 Context of the study	4
1.5.1 Demographic context of Palestine	5
1.5.2 Demographic context of Gaza Strip.....	5
1.5.3 Socio-economical context	5
1.5.4 Palestinian health care system.....	6
1.5.5 Governmental hospital service	7
1.6 Operational definitions.....	7
Chapter (2): Conceptual framework and literature review	10
2.1 Conceptual framework	10
2.1.1 Human resources	11
2.1.2 Equipment	11
2.1.3 Design	12
2.2 Literature review	12
2.2.1 Introduction	12
2.2.2 Human resources	12
2.2.2.1 Radiologic Technologist	12

2.2.2.2	Experience of Radiologic Technologists	13
2.2.2.3	Certificates of Radiologic Technologists	14
2.2.2.4	Training and developments	16
2.2.3	Structure and design	18
2.2.3.1	Location of medical imaging services.....	18
2.2.4	Equipment	19
2.2.4.1	Conventional Radiography.....	19
2.2.4.2	Fluoroscopy.....	19
2.2.4.3	Computed Tomography	20
2.2.4.4	Magnetic Resonance Imaging	20
2.2.4.5	Darkroom	21
2.2.4.6	Protection tools.....	22
2.2.5	Shielding of medical imaging department	24
2.2.6	International standards	25
2.2.6.1	Radiological Protection Institute of Ireland (RPII 09/01).....	25
2.2.6.2	Australasian Health Facility (Australasian HFG)	25
	Chapter (3): Methodology	27
3.1	Introduction	27
3.2	Study design	27
3.3	Study population	27
3.4	Sampling method	28
3.5	Study setting.....	28
3.6	Study period	28
3.7	Eligibility criteria	28
3.7.1	Inclusion criteria.....	28
3.7.2	Exclusion criteria	29
3.8	Ethical and administrative considerations.....	29
3.9	Study instruments.....	29
3.10	Pilot study.....	31
3.11	Response rate	31
3.12	Data collection	31
3.13	Validity and reliability	32
3.13.1	Face validity	32

3.13.2	Content validity	32
3.13.3	Reliability	33
3.14	Data management and analysis	34
3.14.1	Quantitative part.....	34
3.14.2	Qualitative part.....	34
3.15	Limitations of the study	35
	Chapter (4): Results and discussion	36
4.1	Introduction	36
4.2	Descriptive statistics.....	36
4.2.1	Demographic characteristics	36
4.2.2	Radiation monitoring	39
4.3	Evaluation of medical imaging equipment in medical imaging departments at governmental hospitals	41
4.3.1	Availability of medical imaging equipment.....	41
4.3.2	Number of daily examinations to the number of Radiologic Technologists	45
4.3.3	Numbers of CT and MRI machines per 1 000,000 inhabitants, 2015.....	49
4.3.4	Inferential statistical analysis	50
4.3.4.1	Pearson correlation tests.....	50
4.3.4.2	Chi square test	53
4.4	Medical imaging departments design checklist	53
4.4.1	General information about departments.....	53
4.4.2	Conventional Radiography design checklist.....	58
4.4.3	Darkroom design checklist.....	61
4.4.4	Fluoroscopy design checklist	64
4.4.5	Computed Tomography design checklist.....	66
4.4.6	Magnetic Resonance Imaging design checklist	68
	Chapter (5): Conclusion and recommendations.....	71
5.1	Conclusion.....	71
5.2	Recommendations	75
5.3	Recommendations for further studies	75
	References	76
	Annexes.....	83
	Summary in Arabic	106

List of Tables

Table (4.1):	Distribution of RTs by characteristics variables.....	36
Table (4.2):	RTs distribution among medical imaging departments at governmental hospitals	39
Table (4.3):	RTs having TLD badge	39
Table (4.4):	RTs who holding and checking TLDs	40
Table (4.5):	Training courses.....	40
Table (4.6):	Frequency of functioning medical imaging equipment at governmental hospitals	41
Table (4.7):	Clarify image types, machine types and manufacture product of medical imaging machines at governmental hospitals	42
Table (4.8):	X-ray machines existing at governmental hospitals compared to the international standards	44
Table (4.9):	Number of daily examinations to the number of RTs in Conventional Radiography	45
Table (4.10):	Number of daily examinations to the number of RTs in Fluoroscopy	46
Table (4.11):	Number of daily examinations to the number of RTs in CT	47
Table (4.12):	Number of daily examinations to the number of RTs in MRI.....	48
Table (4.13):	The correlation between different variables (Annual breakdowns, Examinations appointments and Patient waiting time) and imaging machines	50
Table (4.14):	The relationship between RTs experience and holding of TLDs	53
Table (4.15):	General information about structure at medical imaging departments.....	54
Table (4.16):	General informatio about reception services and OHS at medical imaging departments	56
Table (4.17):	Checklist about structure and essential supplies of Conventional Radiography at governmental hospitals	58
Table (4.18):	Checklist about occupational health safety Conventional Radiography at governmental hospitals	60
Table (4.19):	Checklist about structure and OHS of Darkrooms at governmental hospitals	62

Table (4.20): Checklist about essential supplies in Darkrooms at governmental hospitals.....	63
Table (4.21): Checklist about structure and essential supplies of Fluoroscopy at governmental hospitals.....	64
Table (4.22): Checklist about occupational health safety of Fluoroscopy at governmental hospitals.....	65
Table (4.23): Checklist about structure and essential supplies of CT at governmental hospitals.....	66
Table (4.24): Checklist about occupational health safety of CT at governmental hospitals.....	67
Table (4.25): Checklist about structure, services, OHS and essential supplies of MRI at governmental hospitals.....	68
Table (4.26): Summarize the conducted checklists in different sections of Medical Imaging Departments.....	70

List of Figures

Figure (2.1):	Conceptual framework-self developed.....	10
Figure (4.1):	Distribution of RTs due to gender.....	37
Figure (4.2):	Distribution of RTs educational qualifications	38

List of Annexes

Annex (1)	Map of Palestine	83
Annex (2)	Location map of Gaza strip.....	84
Annex (3)	Distribution of six main governmental hospital in the GS	85
Annex (4)	Ethical approval from Helsinki committee - Gaza governorate	86
Annex (5)	Al-Quds University approval latter	87
Annex (6)	MOH ap proval latter.....	88
Annex (7)	Explanation about the study to the participants (English and Arabic)	89
Annex (8)	The Questionnaire.....	91
Annex (9)	Medical imaging department design checklist.....	93
Annex (10)	Key informant interview- English	99
Annex (10)	Key informant interview- Arabic.....	100
Annex (11)	Questionnaire review experts	101
Annex (12)	Characteristics of the key informants	101
Annex (13)	Evaluation of Conventional Radiography in governmental hospitals	102
Annex (14)	Evaluation of Fluoroscopy in governmental hospitals	103
Annex (15)	Evaluation of Computed Tomography in governmental hospitals.....	104
Annex (16)	Evaluation of Magnetic Resonance Imaging in governmental hospitals..	105

List of Abbreviations

ALARA	As Low As Reasonably Achievable
ARRT	American Registry of Radiologic Technologists
ASRT	American Society of Radiologic Technologists
AusHFG	Australasian Health Facility Guidelines
BIR	British Institute of Radiology
CD	Compact Disc
CR	Computed Radiography
CT	Computed Tomography
EGH	European Gaza Hospital
ENT	Ear, Nose and Throat
ESWL	Extracorporeal Shock Wave Lithotripsy
GDP	Gross Domestic Product
GS	Gaza Strip
HCPC	Health and Care Professions Council
ICRP	International Commission on Radiological Protection
ICU	Intensive Care Unit
KII	Key Informant Interview
MIA	Medical Imaging Administration
MOH	Ministry of Health

MRI	Magnetic Resonance Imaging
NCRP	National Council on Radiation Protection
NGOs	Non-Governmental Organizations
NHS	National Health Service
OECD	Organisation for Economic Co-operation and Development
OHS	Occupational Health Safety
PCBS	Palestinian Central Bureau of Statistics
PVC	Polyvinyl Chloride
RF coils	Radiofrequency coils
RPII	Radiological Protection Institute of Ireland
RT	Radiologic Technologist
SPSS	Software Statistical Package of Social Science
TLD	Thermoluminescence Dosimeter
UNRWA	United Nations Relief and Works Agency
WB	West Bank
WHO	World Health Organization

Chapter (1): Introduction

1.1 Background

After the discovery of X-ray by Roentgen in 1895, immense growth was realized in medical imaging modalities. This progress facilitates detection and characterization of different diseases inside human body (Krupinski and Jiang, 2008). Medical imaging or radiography is a photographic process used to image anatomic structures. Instead of visible light, radiography utilizes X-ray energies, which penetrate the body. These energies are absorbed at different rates by different tissue densities and are particularly effective for imaging bone and dense tissues (Siegel et al, 2008).

New knowledge in radiographic imaging is being developed at an increasingly rapid rate and the medical imaging services have expanded dramatically (European Society of Radiology, 2010). Furthermore, the medical imaging services are now the key tool to diagnose many diseases and have an important role in monitoring treatment and predicting outcome. The medical imaging service can comprise methods relying on both ionizing and non-ionizing radiations, covering Conventional Radiography, Fluoroscopy, Nuclear Medicine, Computed Tomography, Mammography, Interventional Radiology, Bone Densitometry, Ultrasonography and Magnetic Resonance Imaging and others (Pereira et al, 2015).

The medical imaging services may be performed in several hospital areas, dependent upon the type or volume of examination required, and may be used in selected instances for imaging of patients. Patient convenience and accessibility should be an integral part of the planning and design of the medical imaging department. A high percentage of the volume of this service will consist of hospitals/flexibility and adaptability should be a main consideration when planning the facility in order to accommodate constant upgrades in equipment technology (Bowen et al, 2008).