شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم

بسم الله الرحمن الرحيم

HANAA ALY

شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

HANAA ALY

شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

HANAA ALY

Failure Mode and Effect Analysis for Three Dimensional Radiotherapy at Ain Shams University Hospital

A Thesis

Submitted for partial fulfilment of Master degree in Clinical Oncology and Nuclear Medicine

By

Gehad Sobhy Muhammad El-Benbawy

M.B.B.,CH, 2016

Under Supervisor of

Prof. Dr. Iman Aly Sharawy

Professor of Clinical Oncology and Nuclear Medicine

Faculty of Medicine, Ain Shams University

Dr. Khalid Nagib Abdel Hakim

Assistant Professor of Clinical Oncology and Nuclear Medicine

Faculty of Medicine, Ain Shams University

Dr. Ghada Refaat Meckawy

Lecturer of Oncology and Nuclear Medicine

Faculty of Medicine, Ain Shams University

Faculty of Medicine

Ain Shams University

2022

بسم الله الرحمن الرحيم

قالوا

سبحانك لا علم لنا إلا ما علمتنا إنك أنت العليم الحكيم

صدق الله العظيم

سورة البقرة الآية: ٣٢

Acknowledgments

First and foremost, I feel always indebted to **Allah**, *the* ***Most Beneficent*** *and* ***Merciful*** *who gave me the strength to accomplish this work,*

My deepest gratitude to **Prof. Dr. Iman Aly Sharawy,** *Professor of Clinical Oncology and Nuclear Medicine, Faculty of Medicine, Ain Shams University, for her valuable guidance and expert supervision, in addition to her great deal of support and encouragement. I really have the honor to complete this work under her supervision.*

I would like to express my great and deep appreciation and thanks to **Prof. Dr. Hatem Mohamed Abdalla,** *Professor of Clinical Oncology and Nuclear Medicine, Faculty of Medicine, Ain Shams University, for his meticulous supervision, and his patience in reviewing and correcting this work.*

I must express my deepest thanks to **Dr. Khalid Nagib Abdel Hakim,** *Assistant Professor of Clinical Oncology and Nuclear Medicine, Faculty of Medicine, Ain Shams University, for guiding me throughout this work and for granting me much of his time. I greatly appreciate his efforts.*

I can't forget to thank with all appreciation **Dr. Ghada Refaat Meckawy,** *Lecturer of Oncology and Nuclear Medicine, Faculty of Medicine, Ain Shams University, whom tirelessly and freely gave comments on various drafts of this piece of work. She really provided me a great support.*

Special thanks to my **Parents** *and all my* **Family** *members for their continuous encouragement, enduring me and standing by me.*

✍ ***Gehad Sobhy Muhammad El-Benbawy***

List of Contents

Subject *Page No.*

List of Abbreviations

Abbr.	Full-term
ACR	**:** American College of Radiology
ASTRO	**:** American Society for Therapeutic Radiology and Oncology
AAPM	**:** American Association of Physicists in Medicine
BEVs	**:** Beam's eye views
CNS	**:** Central Nervous System
CRT	**:** Conformal radiation therapy
CT	**:** Computer tomography
CTV	**:** Clinical target volume
D	**:** Lack of detectability
DRR	**:** Digitally reconstructed radiograph.
DRR	**:** Digitally reconstructed radiographs
DVH	**:** Dose Volume Histogram
EPID	**:** Electronic Portal Imaging Device
ESTRO	**:** European Society for Therapeutic Radiology and Oncology
EU BSS	**:** European Union Basic Safety Standards
FMEA	**:** Failure Modes and Effects Analysis
FMECA	**:** Failure mode effects and criticality analysis
FTA	**:** Fault tree analysis
GTV	**:** Gross tumour volume
HACCP	**:** Hazard analysis and critical control points
HFMEA	**:** Healthcare Failure Modes and Effects Analysis

IAEA	: International Atomic Energy Agency
ICRP	: International Commission on Radiological Protection
ICRU	: International Commission on Radiological Units
IGRT	: Image Guided Radiotherapy
ILS	: Incident learning system
IM	: Internal margin
IMRT	: Intensity modulation radiation therapy
ITV	: Internal Target Volume
IVD	: In-vivo dosimetry
MLC	: Multi-leaf collimator
MPRs	: Multi-planar reconstructions
MRI	: Magnetic resonance imaging
MUs	: Monitor units
NTCP	: Normal tissue complication probability
NTCP	: Normal tissue complication probability
O	: Occurrence
OARs	: Organs at risk
OD	: Optical density
PET	: Positron emission tomography
PRV	: Planning organ at risk volume
PTV	: Planning target volume
QM	: Quality management
RCA	: Root cause analysis
ROSIS	: Radiation Oncology Safety Information System
RPN	: Risk Priority Number

RT	: Radiotherapy
RT	: Radiation Technician.
RTPS	: Radiation treatment planning system
RTT	: Radiation therapy technologist
RVS	: Record and verify system
S	: Severity
SAD	: Source axis distance
SAFRON	: Safety in Radiation Oncology database
SBRT	: Stereotactic body radiation therapy
SPECT	: Single photon emission computed tomography
SSD	: Source skin distance
TCP	: Tumour control probability
MLC	: Multi-leaf collimator
TG100	: Task group 100
TLD's	: Thermo-luminescent dosimeters
TPS	: Treatment Planning System
TV	: Treated volume
3-D CRT	: Three dimensional conformal radiotherapy
3-D	: Three dimensional radiotherapy

List of Tables

List of Figures

Introduction

The increasing complexity of modern radiation therapy planning and delivery challenges traditional prescriptive quality management (QM) methods, such as many of those included in guidelines published by organizations such as the AAPM, ASTRO, ACR, ESTRO, and IAEA. These prescriptive guidelines have traditionally focused on monitoring all aspects of the functional performance of radiotherapy (RT) equipment by comparing parameters against tolerances set at strict but achievable values. Many errors that occur in radiation oncology are not due to failures in devices and software; rather they are failures in workflow and process. A major source of quality and safety impairment arises from weakness or variability in radiotherapy processes. Whereas, for example, there are a limited number of linear accelerator designs, there is very little standardization of processes between radiotherapy clinics. The wide variability in processes requires a much higher degree of customization that has to be carried out by those with intimate knowledge of the processes themselves. A structured methodology for analyzing clinical processes and for developing clinic- and site–specific quality management programs that more effectively and efficiently address work practices in individual clinics is needed ***(Huq et al., 2016).***

Moreover, radiotherapy technology advancements have led to an increase in the use of computers and associated electronic processes. However, the 2009 International Commission on Radiological Protection (ICRP) Report 112 indicates that new types of incidents are occurring due to increased sophistication of treatment processes and the omnipresence of computers with increasingly complicated software ***(Ortiz-Lopez et al., 2009).***

The report highlights the need to not only learn from incidents but also to continuously and proactively anticipate potential errors and likelihood of their occurrence. The key advantage of using a proactive risk assessment is in identifying and anticipating potential errors and taking action before a radiation incident occurs. Failure Modes and Effects Analysis (FMEA) is a structured and logical analysis of a process to identify steps which are associated with the highest risk ***(Huq et al., 2016).***

The benefits and feasibility of FMEA for radiotherapy intensity modulation radiation therapy (IMRT), stereotactic body radiation therapy (SBRT) and brachytherapy practices have previously been described. Radiotherapy process mapping and FMEA will assume more central roles in optimization of clinical processes to produce maximum safety and quality of patient care ***(Mayadev et al., 2015).***