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Impact of PDSA Quality Improvement Model for Radiotherapy Application in Kenya

by

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A thesis submitted in partial fulfillment for the degree of Master of Science in Nuclear Science in the Institute of Nuclear Science and Technology in the University of Nairobi.

Declaration

This thesis is my original work and has not been submitted for a degree in any other university

Signature …………………………… Date……………………………

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This thesis has been submitted for examination with our knowledge as university supervisors

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Dedication

In memory of my father Mr. Flavian Kioko Kisenga who despite many odds struggled to ensure I got the best education and succumbed to cancer of the stomach in my formative years in Medical School.

To you, I dedicate this study knowing that you could have benefited from radiotherapy.

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List of Abbreviations

ASARA:	As Soon As Reasonably Achievable
BCS:	Breast Conservation Surgery
BTS:	Breakthrough Series
BPR:	Business Process Re- engineering
CED:	Cause and Effect Diagram
CHART:	Continuous Hyper fractionated Accelerated Radiation Therapy
CT:	Computed Tomography
CTC:	Cancer Treatment Centre
Gy:	Gray (Radiation dose absorbed per unit mass)
IACR:	International Association of Cancer Registries
IAEA:	International Atomic Energy Agency
IGRT:	Image Guided Radiotherapy
IHI:	Institute of Health Improvement
IMRT:	Intensity Modulated Radiotherapy
JCCO:	Joint Council of Clinical Oncology
PDSA:	Plan Do Study Act.
TQM/QI/CQM:	Total Quality Improvement / Quality Improvement / Continuous Quality Improvement
WHO:	World Health Organization

Definition of Key Concepts

Radiotherapy - Branch of oncology which uses radioactive substances or radiant energy to treat cancer.

Radiotherapy Delay- Any wait from diagnosis of cancer to the initial delivery of radiotherapy. For the purpose of this study a delay will be defined as the interval from the patient's first visit to Gaborone Oncology to the start of the radiotherapy treatment.

Treatment Outcome- A term referring to assessment of the results or consequence of management and procedures used in combating a disease in order to determine the efficiency, effectiveness, safety and how practical an intervention is.

Local Failure -An unsuccessful result or consequence of management and procedure in combating a disease which is confined to a single area. In this study, disease refers to cancer.

Recurrence -The point when cancer cells from the primary cancer are detected following the primary treatment for the cancer.

Quality Improvement -A team effort of identifying opportunities for improvement, measuring performance, and involving the frontline providers and staff members to find ways to improve performance.

Improvement Model - Method for systemic change to achieve an improvement.

A Process - Series of events that produce a result.

Process Management Tools -The ensemble of activities of planning and monitoring the performance of a process

Hawthorn Effect -Refers to the tendency of some people to perform better when they are participating in an experiment or being observed.

Cancer Treatment Centre -Centre in Kenyatta National Hospital

Abstract

Cancer, a non-communicable disease, is a growing global health issue and it is the second cause of premature deaths globally with more than half of all cancers occurring in the developing countries. Every year in Kenya over 39,000 people are diagnosed with cancer and of these about 27,000 die as a result of the disease. Majority of cancer patients present at advanced stages of the disease which makes their survival dismal resulting to an unprecedented increase in demand for radiotherapy services. Existing evidence in Kenya as in most developing countries indicate that due to the unacceptable long waiting time to radiation therapy. Most cancer patients do not benefit from treatment and palliative applications of radiotherapy which can improve their survival. Radiobiological principles suggest that a delay in starting radiotherapy may have a negative impact on local tumor control. To cope with this growing demand for radiotherapy, modern improvement models need to be studied and adopted into radiotherapy departments. The PLAN- DO-STUDY- ACT (PDSA), is a model which can be explored and possibilities of improvement done to improve the ever elusive survival of cancer patients in Kenya. The PDSA model showed significant reduction in radiotherapy delays at Kenyatta National Hospital, Cancer Treatment Centre.

This study aimed to determine the causes of radiotherapy delays, and to develop and implement improvements for reducing radiotherapy delays in patients' referred for radiotherapy at the Kenyatta National Hospital Cancer Treatment Centre in Kenya. A retrospective survey was conducted for six months to establish the causes of radiotherapy delays for patients referred for radiotherapy treatment of head and neck, breast and cervix which are the commonest cancers diagnosed in Kenya. The PDSA model for improvement was then implemented and monitored for evidence of improvement from May to December 2013. The results showed a decrease in radiotherapy delays in head and neck, breast and cervix cancers from an average delay time of 18.5 days in May 2013 to 8.6 days by December 2013.

Chapter 1
Introduction

1.0 Background

Cancer is defined by World Health Organization (WHO) as a generic term encompassing a large group of diseases in which cells grow out of control (Boyle et al., 2008). It is a disease that results from failure of the mechanisms that regulate normal cell growth and cell death leading to uncontrollable proliferation of cells, destruction of neighboring tissues and spread of the disease to other parts of the body (IAEA ., 2003). Cancer is also a multifaceted disease known to be caused by both internal and external risk factors such as tobacco, alcohol, numerous chemical substances, radiation, some infectious organisms (schistosomiasis, human papilloma and hepatitis viruses), inherited genetic mutations, hormone imbalances, immune and some metabolic disorders. These causative factors may act alone, together and/or in sequence to trigger or promote the development of cancer after varying periods of time for different types of cancers (Danaei et al., 2005).Studies indicate that it is possible significantly to reduce the effects of cancer on the society if effective actions are put in place to control risk factors associated with cancer, introduce measures for early detection and offer good care to those affected (Ferlay et al., 2007).

Cancer is a growing global health issue and many developing countries are ill prepared to deal with the ever-increasing cancer burden owing lack of knowledge, awareness and perceptions which often delay diagnosis. Due to these factors, when treatment is offered, it is mainly palliative. Cancer kills more people each year than HIV/AIDS, malaria and tuberculosis combined (Ferlay et al., 2007; Boyle et al., 2008). It is estimated cancer will kill more than 10 million people a year by 2020. Worldwide it is also estimated there will be 26 million cases of cancer and 17 million deaths are expected by 2030 (Boyle et al., 2008). More than 75 % of new cancer cases and deaths will be in the developing countries, where unfortunately more than 70 % are diagnosed too late and therefore inaccessible to treatment (Matthers., 2006).

Table 1 Global Burden of Cancer; Estimated (2008) and projected (2030) cancer cases and deaths for all cancers and both sexes by WHO region

Region	2008		2020 *		2030**	
	Cases $*10^6$	Deaths $*10^6$	Cases $*10^6$	Deaths $*10^6$	Cases $*10^6$	Deaths $*10^6$
World	12.4	7.6	20.0	12.9	26.4	17.0
Africa (AFRO)	0.7	0.5	1.2	0.9	1.6	1.3
Europe (ERO)	3.4	1.8	4.1	2.6	5.5	3.4
East-Mediterranean (EMRO)	0.5	0.3	0.9	0.6	1.2	0.9
Pan-America (PAHO)	2.6	1.3	4.8	2.3	6.4	3.1
South-East Asia (SEARO)	1.6	1.1	2.8	1.9	3.7	2.6
Western Pacific (WPRO)	3.7	2.6	6.1	4.4	8.1	5.9

No change in current rates. ** With 1 % annual increase in rates

Statistics for the African continent are reported to have a large measure of inaccuracy due to inadequacy in population based cancer registries (WHO., 2008). It is estimated that there were 871 000 incidences of cancer in 2008 (353 000 in men and 518 000 in women) with a total of 518 000 (252 000 in men and 266 000 in women) deaths from cancer. The cancer incidence in Africa varies from the global incidence and this could be attributed to causative factors which are different from region to region or country to country. Nasopharyngeal cancers (NPC) accounts for 5.1 per cent of all deaths in Africa (WHO., 2002) with elevated rates reported in southern Africa, and Northern Africa particularly in Tunisia and Algeria (Jemal et al., 2011). A recent report by Barton (Barton et al., 2006) gives the yearly breakdown of incidence of NPC in Africa to be 2640 in East Africa, 388 in Central Africa, 2816 in Northern Africa, 343 in Southern Africa, 1964 in Western Africa and the total in all Africa to be 8151.

The global statistics, as shown in table 1, indicate an upward trend in the incidence of cancer. In Kenya, a controlled policy document released in 2011 and available at the study site, indicates that cancer causes 7% of total national mortality every year and ranks third as a cause of death after infectious diseases and cardiovascular diseases. Although population based data do not exist in the country, it is estimated that the annual incidence of cancer is about 39,000 new cases and the annual mortality to be over 27,000 with over 60% of those affected below the age of 70 years (National Cancer Control Strategy., 2016)

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1.1 Problem Statement

The most current information regarding cancer incidence in Kenya is available in grey literature mainly from institutional documentation sourced from the Department of Health Information in Kenyatta National Hospital (KNH). Further, Kenya does not have a national cancer registry and the only available information is from the main hospitals in Nairobi dating back to year 2000 (Wanja .,2010).In 2010 unpublished cancer data reported by the Kenyatta National Hospital's (KNH) Health Information Department, cancer killed approximately 18,000 people in Kenya in 2005. It indicates that new cases of cancer attended increased tremendously by over 50 per cent, from 11254 cases in 2004 to 22130 cases in 2013.

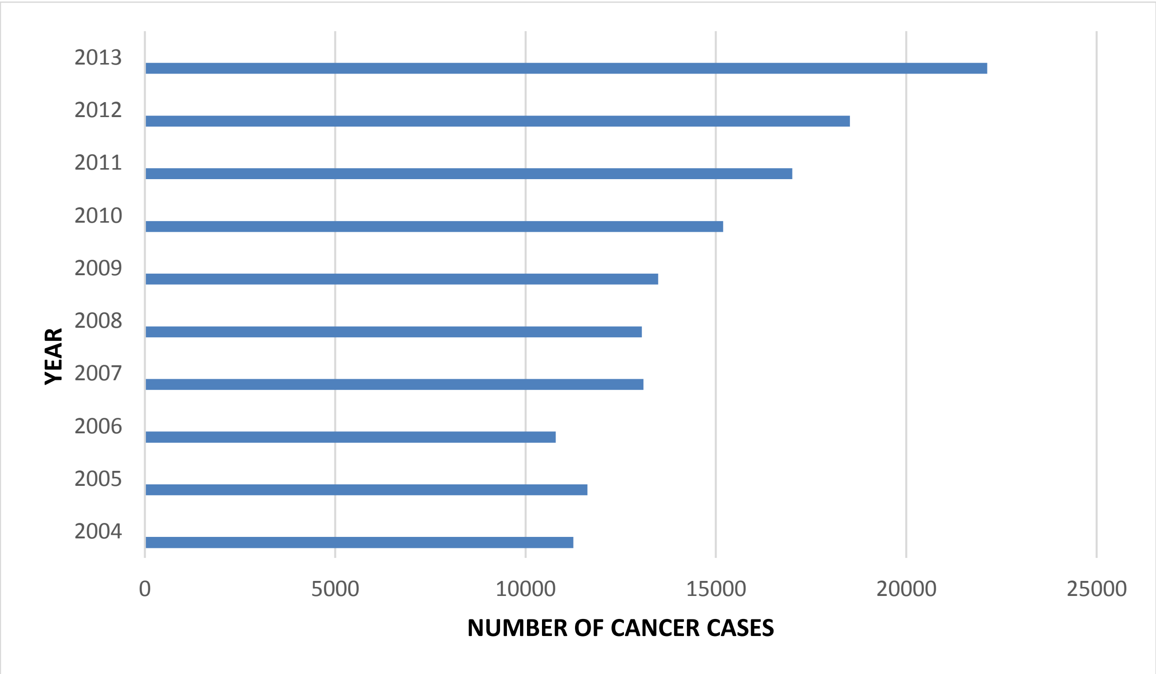

Figure 1: Attendance trends at KNH Cancer Treatment Centre from 2004-2013 (KNH Statistics, 2013)

The old cases morbidity trend recorded a 14 per cent increase from 1499 cases in 2004 to 1927 cases in 2008. Generally, cancer of the cervix had the highest incidence followed by that of cancer of the breast while cancer of the nasopharynx ranked third. Nasopharyngeal cancers (NPC) makes up the largest proportion of reported cases of cancer in Kenya, males constituting about 14.8% of the total number of reported cases (Wanja ., 2010).

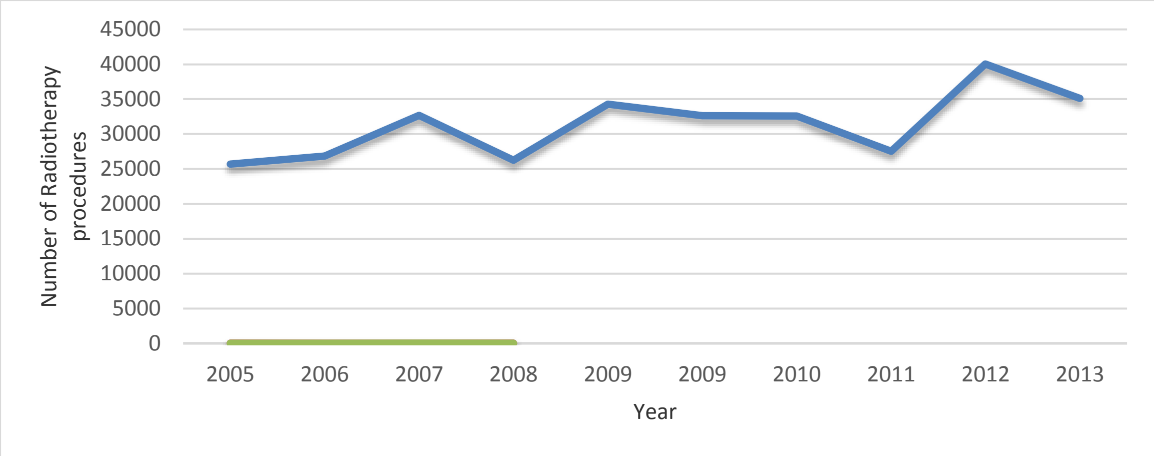

Figure 2: Number of radiotherapy treated cancers at KNH CTC (KNH statistics 2013).

This may not be representative of the incidence in the country because many patients may not make it to the point of treatment in the Nairobi due to financial constraints and the booking system in an already congested facility. Unfortunately, these patients do not have access to immediate radiation therapy services due to inadequate availability of treatment facilities in Kenya, typical of developing countries as evidenced by several authors (IAEA., 2003; Salminen et al., 2005; Barton et al., 2006; Levin et al., 2001).

1.2 Justification of the study

In recent years studies and reports have shown an increased demand of radiotherapy services in developing countries which have radiotherapy centers (Robinson et al., 2005). According to Dodwellet al (2006) in facilities offering radiotherapy services, increased demand continues to cause delay in initiating treatment for patients referred from peripheral facilities particularly. The prevailing increase in the demand for radiotherapy services have resulted into significant delays in the commencement of radical radiotherapy (Mackillop et al., 1999).

Published studies on the medical application of ionizing radiation on cancer tissue (radiobiology), show that a delay in starting radiotherapy can be detrimental to the outcome of cancer treatment such as tumor control (Mackillop., 2007). Apart from the radiobiological aspect, delayed radiotherapy causes increased psychological distress in patients waiting for treatment, as well as in the staff providing the services (Lehman et al ., 2004).The growing demand for radiotherapy services has resulted in many radiotherapy departments finding it difficult to manage and maintain treatment delays within the acceptable standards (Jensen et al., 2007). Pioneers of quality improvement in healthcare services recommend the use of modern quality improvement models to assist with providing better healthcare (Berwick., 1996).

To cope with the increasing demand for radiotherapy, therefore, modern quality improvement models need to be evaluated and adopted in radiotherapy departments. The Plan–Do-Study-Act (PDSA) model for improvement is an example of such models that make use of experiments to demonstrate potential for improvement (Langley et al., 1996).The PDSA model works by temporarily implementing and following or monitoring a change that results from its application a particular set-up. The impact of the change can be assessed in the follow-up and continuously modified for the better. One of the important aspects of this model is that it encourages use of small scale changes before they are finally applied to the whole system (Langley et al., 1996). In this way less time, money and risk is guaranteed. The model is thus an ideal improvement tool especially in healthcare settings because it enables less disruption to the patients' treatment and staff work routine compared to approaches where new ideas are implemented without testing (Berwick., 1996). Most importantly the model provides team effort in testing and developing ideas; as a result, changing the process is less disruptive to service provision and more acceptable to health workers (Langley et al., 1996).

1.3 Scope of the study

In the last few years, great publicity over the need for improvement of cancer treatment in Kenya has dominated the media. Radiotherapy which is the mainstay of cancer treatment and palliation, are mainly based in Kenyatta National Hospital Cancer Therapy Centre (CTC). Kenyatta National Hospital Radiotherapy Unit is the only public facility (at the largest national referral and teaching hospital in Kenya) with the capacity to provide radiation therapy services to patients with cancer. The department was started in 1968 and currently has two cobalt-60 isocentric treatment units. In addition, one conventional Simulator, one high dose rate (HDR) brachytherapy unit, one low dose rate (LDR) brachytherapy unit and a treatment planning system (TPS) are available, though currently non-functional apart from the simulator. The two cobalt-60 units are the only treatment machines for external beam radiation therapy and serve the entire country and often neighboring countries, the units therefore are put to use for treatment for a period of 13 to 15 hours daily.

The radiotherapy department depends on laboratories which are also utilized by the other departments in the hospital and occasionally from private facilities for customized blocks. The

CTC staffs includes 6 medical oncologists, 4 pediatric oncologists, 4 radiation oncologists, 2 medical physicists, 5 radiation therapy technologists and 3 oncology nurses. Since the establishment of the CTC the number of new cancer patients seen has increased as indicated by the commonly treated tumors head and neck, breast and cervix cancers as illustrated below (Figure 2 and 3).

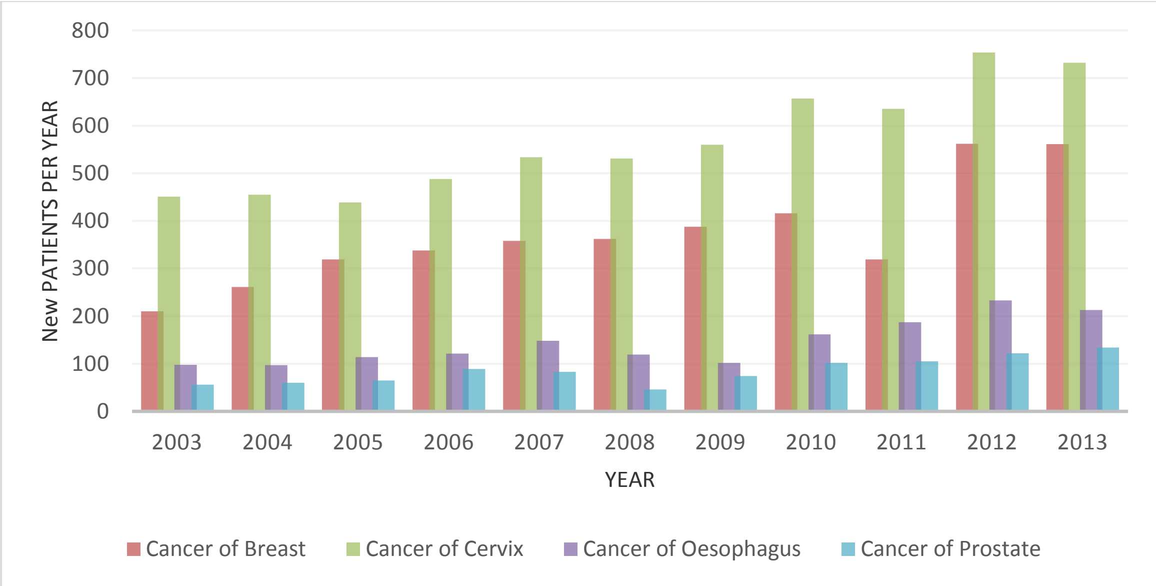

Figure 3: Number of new cancer patients seen between the years 2003 and 2013 at KNH CTC (KNH statistics 2013).

In light of the yearly increase in the number of cancer patients seen or referred to KNH, the need to review radiotherapy delays was recognized. It has been reported that radiotherapy delays can adversely affect treatment outcome of cancer patients (Mackillop 2007). Due to its guaranteed ability of providing low risk of normal work disruption, less time consuming and low cost (Berwick., 1996), the PDSA model for improvement was applied to address unacceptable radiotherapy delay.

The weekly treatment schedules are from Monday to Friday treating an average of 80 patients daily on each unit. One of the units has been in use for approximately 17 years while the second unit, which was used for this study, was commissioned in April 2011. The patients are initially sent for consultation to the oncologist who decides on the required radiotherapy management of the disease .The patient is then sent for treatment simulation and, or CT scanning where appropriate. The department uses a shared CT scanner with all other departments of Kenyatta

National Hospital, unlike other developed countries where radiotherapy department has its own CT scanner(s).Therefore patients that require CT radiotherapy treatment planning are scanned in the radiology department and images sent to the treatment planning system in oncology department.

Radiotherapy plans are either planned using two or three dimensional treatment plans. All radiotherapy treatment doses are planned using a computerized treatment planning system. In the case of three dimensional CT plans, treatment tumor volumes (planning target volumes) are drawn in by the oncologist and critical structures (organs at risk of damage if a certain level of radiation dose is exceeded) are outlines on the CT images. Where appropriate and if used in the patient's treatment plan, accessories such as customized lead blocks and bolus are ordered for the patient. At the moment the department does not have a lead block cutter for customized treatment planning and therefore relies on an outsourced block cutter laboratory. In the case of contour plans, pre-treatment simulation films are used to outline the planning target volumes and the organs at risk. A treatment planning digitizer is used to enter the contour outline in the planning system. At CTC, cervix and breast cancer patient's radiotherapy treatment is planned using a patient contour outline which is fed into the radiotherapy planning system. In certain cases for breast cancer patients, CT planning may be used in patients who have not undergone mastectomy (patients with a full breast).

In the case of two dimensional plans, a simple phantom image is created with parameters obtained from the patient's simulated measurements and the plan done using these parameters. Two dimensional treatment planning is mainly used for a single field or a two opposing field plans. Most head and neck cancers patients that do not require a CT scan are planned with two dimensional plans using opposing neck fields and a single anterior neck field.

After the radiotherapy treatment planning process, quality assurance and treatment plan checks are carried out and the final treatment plan is sent to the treatment unit. The patient is then informed of when to come for first radiotherapy treatment setup checks and the start of radiotherapy.

1.4 Research Problem

Studies have documented that radiotherapy delays are common the world over (Mackillop et al. ,1999) and Kenya is no exception. Mackillop (2007) and Lehman et al. (2004) have shown that radiotherapy delay can have a negative radiobiological and psychological effect on the patient. According to Berwick (1996), using the PDSA model for improvement has proved to work in healthcare settings to reduce treatment delays. However, limited information has been published on reducing treatment delays within radiotherapy departments (Powell et al. 2008). This research attempts to reduce radiotherapy delays from the patients' first visit to radiotherapy unit to the start of initial treatment within good practice standards according to the JCCO (1993).

1.5 Objectives of the study

1.5.1 General Objective

The main objective of the study was to develop and implement a PDSA model to reduce radiotherapy delays for cancer patients between time of referral to radiotherapy department and when radiotherapy treatment is initiated.

1.5.2 Specific objectives

- To measure the baseline delay time in radically treated head and neck, breast and cervix cancers.
- To explore and describe the causes of radiotherapy delay from patient's referral to radiotherapy unit and the initial start of radical radiotherapy in head and neck, cervix and breast cancers.
- To develop processes which address the causes of the established radiotherapy delay by using the PDSA model for improvement
- To implement the process developed using PDSA model for improvement, and
- To validate the effectiveness of the PDSA model for improvement.

Chapter 2
Literature Review

2.0 Introduction

Radiotherapy uses high energy beams of radiation called X-rays to treat disease. X-rays were discovered over one hundred years ago, and since then, radiation has been used in medicine for diagnosis and treatment of cancers (Levin et al., 2001). In the treatment of cancers, radical radiotherapy is intended to destroy the cancer in the treated area consequently curing the cancer (Rubin, 1993). Many people with cancer will have radiotherapy as part of their treatment which can be given either externally, outside the body or internally, within the body (Levin et al. ,2001).

Radiotherapy delay is defined as any wait from diagnosis of cancer to the initial delivery of radiotherapy. The Joint Council of Clinical Oncology (JCCO ., 1993) recommends two weeks as acceptable practice to plan and start radiotherapy. For the purpose of this study a delay will be defined as the interval from the patients' first visit to KNH CTC to the start of the radiotherapy treatment. Mackillop (2007) explains that a delay in starting radiotherapy may affect treatment outcome by allowing production of cancer cells within the intended radiotherapy treatment field thus leading to a decrease in the chances of controlling a tumor. Mackillop (2007), in fact, states that" the probability of controlling a tumor is inversely related to the number of clonogenic cells it contains such that a relatively small increase in tumor cell number may have a relatively large effect on probability of tumor control." In order to increase the chances of controlling tumors, radiotherapy management therefore requires that the treatment be started as soon as possible.

The PDSA cycle, also known as the Shewart cycle or Deming cycle as stated by Cass et al. (2003) was originally developed by Walter A. Shewart in the late 1920's and in 1950 Edward Deming simplified the PDSA cycle to illustrate the continuous improvement process. Langley et al. (1996), have since devised a widely utilized version called the PDSA model for achieving changes that ultimately lead to improvements. Use of the PDSA cycle is a way of testing an idea by putting a change into effect on a temporary basis and learning from its potential impact. This approach is quite different from the approach traditionally used in healthcare settings, where new ideas are often introduced without sufficient testing.

2.1 Effects of Radiotherapy Delay on Cancer

Mackillop (2007) and Mackillop et al. (1996) have suggested that a delay in starting radiotherapy may cause tumor cell proliferation or permit tumor spread beyond the intended treatment area. Evidence has shown that when radiation treatment of cancers is delayed, it will impart negatively on the probability to control the disease progression or even cure (Leon et al 2003). In a study by Mackillop et al. (1996) it has been highlighted that the consequences of delayed radiotherapy are related to the tumor volume doubling time and the growth rate of the tumor. Therefore, for a fast growing tumor, even a short delay time in starting treatment can result in adverse effects (Mackillop ., 2007; Wyatt et al., 2003).

Malignant head and neck, breast and cervix cancers are regarded as fast growing tumors when compared to other tumors like prostate cancers. By comparing tumor volume doubling times in these fast growing cancers, Wyatt et al. (2003) have reported that a delay of 1 to 2 months may have a have a profound negative effect on treatment outcome. Furthermore, depending on tumor volume doubling time, radiotherapy delays of up to 4 weeks may result in loss of local tumor control of between 8 and 20 percent (Jensen et al. 2007; Mackillop et al. 1996).The risk of local tumor recurrences also increases with extended radiotherapy delay time (Chen et al., 2008). For this reason, it is recommended that radiotherapy delay should be kept as short as clinically possible in these tumors. Therefore reducing radiotherapy delays is vital so as to increase survival of cancer patients as well as to alleviate psychological stress in both the patients and staff providing them care.

Differences in the negative effects of radiotherapy delays in different tumour types have been reported, such that some cancers have worse prognosis compared to others in same delay duration. Vieta et al (2000) have reported of a 2 percent increased incident of death in glioma patients for each wait day from referral to a radiotherapy department to start of treatment. Irwin et al. (2007) have also reported that a 6 weeks radiotherapy delay results in a significant reduction of patient survival in grade 3 and 4 astrocytoma. O' Rourke et al. (2000) have reported that in lung cancers radiotherapy delay time of 54 days results in the cancer being incurable. In this study, O' Rourke et al; (2000) reported of median increase of 19 percent and mean increase 56 percent in tumor volumes during these waiting times.

Little information is reported on the psychological effects of radiotherapy delay. However, psychological distress on the cancer patients waiting for treatment cannot be ignored (Lehman et al. ,2004). Souza et al. (2001) have reported that radiotherapy delay can be psychologically devastating for patients and prolongation of symptoms can lead to unnecessary suffering. Due to the current and readily available literature most radiotherapy patients are now aware of the negative effects of long radiotherapy delay times on their chances of cancer survival.

A study on breast cancer patient's attitudes on radiotherapy delays, Pala et al. (1997) highlighted that when patients on a waiting list were told that a delay might increase chances of disease local recurrences, the maximum acceptable time patients were prepared to wait was reduced from 7 to 3.7 weeks. Furthermore, Budischewski and Frischbeck (2006) noted low scores in the Happy Mood Scale and the Emotional Function Scale when patients were placed onto a waiting list for radiotherapy. In some cases low scores were indicative of patients needing psychosocial care.

Medical staff providing a service to radiotherapy patients cannot be exempted from the effects of radiotherapy delays. Radiation oncologists are aware that long radiotherapy delays are unacceptable and can affect cancer patient's treatment outcome (Mackillop et al. 1996; JCCO 1993). Leon et al. (2003) and Mackillop et al. (1996) have suggested that the pressure on radiotherapy departments in trying to reduce radiotherapy delays can lead to a decrease in the technical quality of radiation oncology. Therefore managing radiotherapy delays would assist to alleviate the pressure on the staff as well as reduce psychological distress on the cancer patients.

2.2 Mechanisms of Increasing Radiotherapy Effectiveness

Apart from reducing radiotherapy delays other mechanisms such as compensating for radiotherapy gaps (interruption between treatments) or hyper fractionation and Continuous Hyper fractionated Accelerated Radiotherapy CHART (increasing the number of radiotherapy fractions and reducing the radiation dose per fraction with two to three fractions given daily) to increase radiotherapy effectiveness can be initiated. The JCCO (1993) has reported that worldwide only about a third of radiotherapy patients complete their treatment in the prescribed time, with the remainder taking longer due to interruptions. This worsens outcome of radiotherapy treatments with an average calculated loss of tumor control probability of 1.6 percent per day of treatment prolongation (Hendrey et al, .1996). Dubray et al. (1992) have reported that for breast cancers a loss of control of 3 percent has been shown for each day of protraction between external beam radiotherapy and brachytherapy. These missed fractions can be compensated for by treating the patients twice daily or continue the treatment over the weekend (Burnet et al ., 2000). However, treating patients twice a day will require additional treatment equipment and treatment over weekends requires extra salary costs for staff treating over the weekend.

Hyper fractionation has also been shown to improve treatment outcome in radiotherapy treatments. Horiot et al. (1992) have reported of 49 percent improvement in five year local control in head and neck cancer in a hyper fractionation trial. CHART which includes reducing the overall treatment time as well as hyper fractionation has been shown to deliver a 43 percent increase in two year survival for lung cancers. However due to limited resources CHART may not be feasible in many radiotherapy departments.

2.3 Possible Reasons of Radiotherapy Delay

The main cause of radiotherapy delay worldwide has been an imbalance between supply and demand for radiotherapy services (Mackillop 2007). Dodwell and Crellin (2006), report that between 1970 and 1980, improvements in chemotherapy was thought to diminish radiotherapy usage, thus until recently there has been little investment in radiotherapy services. Conversely in recent years it has been shown that chemotherapy does not usually ensure long term local control in most tumors and in many situations radiotherapy offers local control and survival rates similar to surgery (Burnet et al., 2000).

In addition to the minimum investments made to radiotherapy services, the incidence of cancer has continued to rise with many cancers becoming common among the aging population (Mackillop., 2007; Souza et al., 2001). It has also been estimated that52 percent of all cancer patients will require radiotherapy at one point or another in the course of their disease (Durosinmi-Etti et al., 1991). Cancer awareness campaigns and screening programs are becoming prominent in many countries and Dodwell and Crellin (2006) have also suggested that improved cancer awareness and screening programs increases the use of radiotherapy.

In Africa the incidence of cancers has further increased due to the prevalence of Acquired Immune Deficiency Syndrome (AIDS) which is caused by the Human Immunodeficiency Virus (HIV). Recent studies have suggested that HIV/AIDS patients are at risk of developing certain cancers (Mbulaiteye et al. 2003). To make matters worse in the African situation, according to an International Atomic Energy Agency IAEA report (2003), most developing countries have few radiotherapy facilities which are further ill equipped and fail to cope with this current demand for radiotherapy.

The crisis of radiotherapy delay has also been reinforced due to improved multidisciplinary management of cancers and advanced radiotherapy pre-treatment planning procedures that have developed over the years (Radiotherapie Onze Zorge .,2000). New imaging modalities that provide efficiency and accuracy for treatment planning and delivery are now available. However, with these new advancements more time is now required in the treatment planning process. Mackillop (2007) points out that the sequential short delays in pre-treatment imaging and consultation with other specialists may also add to the total delay time. Furthermore all radiotherapy departments have departmental protocols and technical applications that they need to follow when planning radiotherapy treatments. Probst et al. (2003) conducted a survey in the UK which indicated that protocol restriction and technical application of treatment had an influence on radiotherapy planning and treatment delays.

A shortage of radiotherapy staff such as radiation therapists, oncologists and medical physicists worldwide also causes radiotherapy delay. In Canada, Souza et al. (2001) have reported that poor remuneration of staff leads to other centers employing radiotherapy staff to supplement for their own shortages. In the United Kingdom, Dodwell and Crellin (2006) have reported that, irrespective of funding available for the purchase of new radiotherapy equipment, many radiotherapy centers are still unable to meet the demands due to staff shortages. Durosinmi-Etti et al. (1991) points out that in most African countries training of radiotherapy staff can be costly as they need to be trained abroad. This is evident in Botswana as there is not yet a medical radiotherapy training Centre in the country.

Staffing levels in radiotherapy departments will also depend on the skills of various professionals within radiotherapy departments and the changing roles of these professionals as they develop their skills to meet the evolving needs of the services required. Khan (1994) has outlined the following as the minimum requirements for clinical radiation therapy staffing;

- One chief (head) radiation oncologist with an additional staff radiation oncologist for each 200 to 300 patients treated annually and there should be no more than25 to 30 patients under treatment by a single physician.
- At least one radiation physicist per Centre, for up to 400 patients seen annually. Treatment planning staff which includes a dosimetrist (treatment planning radiation therapist) or physicist assistance one per 300 patients treated annually.

- Two radiation therapists per megavoltage unit up to 25 patients treated daily and four per megavoltage unit for 50 patients treated per unit with at least one radiation therapy supervisor.
- Two radiotherapy simulation staff for every 500 patients simulated annually. One nurse per Centre for up to 300 patients treated annually and an additional one per 300 treated annually.
- One equipment maintenance engineer per two megavoltage units or one megavoltage unit and a pre-treatment simulator.
- Other complementary staff such as dieticians, social workers and physical therapists may be employed as per needed services.

However with the new and advanced precision methods of delivering radiotherapy that have emerged, such as Intensity Modulated Radiation Therapy (IMRT), Stereotactic Radio-surgery and Radiotherapy (SRSR) and Image Guided Radiation Therapy (IGRT), higher staff levels may be needed in radiotherapy departments due to more time required in preparation of these techniques (Meyer et al,.2007).

Personal medical treatment financing can also create a delay for patients to start radiotherapy treatment. For patients treated in the private sector, medical care can be expensive and in private radiotherapy healthcare services, patients are expected to pay fully for the services (Bloor 2008). Whether patients have public or private medical insurance, most patients will be expected to top up costs when treated in private healthcare (Gubb, 2008). Therefore in a situation where a patient may need to prepare personal finance or obtain medical insurance treatment approval, delaying starting radiotherapy treatment can be expected.

Poor management decisions in both public and private radiotherapy departments may also affect radiotherapy delay. Souza et al. (2001) have suggested that funding to operate cancer treatment facilities should take into account depreciation of equipment, increase in the number of patients and any other changes that may arise in the services provided. Slow responses to funding decisions and previous planning recommendations on purchase of equipment and recruitment of staff have also shown to cause radiotherapy delays (Mackillop ., 2007; Souza et al., 2001).

2.4 Radiotherapy Delay Time

Recommended targets have been set by the JCCO on what is considered as acceptable radiotherapy delay time. The JCCO (1993) cautions that while aiming to achieve the targets for recommended delay, it should not be at the expense of time taken to explain and counsel the patients and their relatives. Similarly the staff education of radiotherapy and time for effective clinical audit and research must be maintained while adhering to their commended targets. The recommended waiting times as outlined by the JCCO (Table2) suggest that for radical radiotherapy, even that which involves complex treatment planning, a two week wait is considered good practice (JCCO 1993). The committee on standards of the Canadian Association of Radiation Oncologists also recommends that the interval between patient referral and consultation and between consultation and initial radiotherapy should both not exceed 2 weeks (Mackillop et al. 1994). In analyzing head and neck tumors, Fortin et al. (2002) have suggested that patients should start radiotherapy treatment within 20 to 30 days after evaluation by a radiation oncologist. Chen et al. (2008) also points out that local tumor control can be achieved in head and neck cancers by maintaining waiting times of up to 6weeks. Wyatt et al. (2003) has analyzed cervix, breast and head and neck cancer showing that a radiotherapy delay of 1 to 2 months has an unfavorable effect on treatment outcome. As there is no threshold to which delay may be considered safe, Mackillop (2007) recommend that radiotherapy delays should be As Short As Reasonably Achievable (ASARA). This is modeled on the ALARA (As Low As Reasonably Achievable) principle which guides risk management in the field of radiation protection. The dangers of waiting for radiotherapy definitely seems evident to the staff directly dealing with cancer patients (Mackillop. ,2007). However to avoid these treatment delays radiotherapy departments require adequate resources in order to provide efficient service while maintaining acceptable treatment delay times (JCCO., 1993).

The rate at which the incidences of cancer are escalating and the need for radiotherapy staff and equipment are already serious constraints to treating cancer patients in most African countries. Therefore the practicality of reaching the set targets by the JCCO in most African countries like Botswana can be a challenge. However most of these problems are further escalated because health and cancer control policies have not yet been implemented in these countries (Durosinmi-Etti et al., 1991). By implementing cancer control policies, international radiotherapy treatment standards and recommended targets set by international organizations such as the JCCO could be easily achieved.

Table 2 Standards for waiting times for cancer treatment set by JCCO (1993)

	Good Practice	Maximum acceptable
For urgent radiotherapy/ chemotherapy	24 Hrs.	48Hrs.
For Palliative radiotherapy (According to severity of Symptoms)	48Hrs.	2 Wks. (For non-severe symptoms)
For radical radiotherapy involving complex treatment planning	2 Wks.	4 Wks.*

***Where additional specialized staging process are necessary**

In summary, healthcare services have become more complex in recent years and the demand for radiotherapy in treatment of cancer has increased such that most radiotherapy departments are facing the challenge of keeping up with this demand. Due to the complexities of current healthcare services, modern models of systemic improvement such as the PDSA model need to be accepted and adapted in radiotherapy departments. The PDSA model for improvement is reliable and improvement change can be done in routine work setting.

2.5 Quality Improvement Models for Improving Radiotherapy Delay

Quality improvement (QI) also interchangeably called Continuous Quality Improvement (CQI) or Total Quality Management (TQM) is defined as "a complete management philosophy that focuses on continuous improvement by applying scientific models to gain knowledge and control over variations in work process" (Tindel and Stewart., 1993).Many quality interventions used in healthcare have been drawn from quality models or tools that were first used in manufacturing industries (Powell et al., 2008). A variety of quality improvement models are available that can assist to bring about quality improvements. The choice of the improvement model will generally depend on what improvements the organization is trying to achieve and the manager's preference.

According to Roland (2001), strategies that combine an audit with feedback and computerized prompts or academic detail tend to be more effective. In healthcare the main aims of improvement are to provide safety, effectiveness, be patient centered, efficient and timely in providing services and ensuring equitability of all patients receiving the services (Schille., 2007). Therefore, improvement models in healthcare should use strategies that strive to achieve these six aims of improvement. Powell et al. (2008) identifies five key models for improvement; Total Quality Management (TQM), Business Process Re-engineering (BPR), Lean Thinking Model, Six Sigma and the PDSA model for improvement.

TQM whose emphasis is on quality as an ongoing activity aimed at continuous quality improvement focused on the needs of internal and external customers was originally developed in Japan in the 1950's and its use in healthcare increased in the 1990's(Tindel and Stewart ., 1993). TQM has been adopted in healthcare, however, Powell et al. (2008) has suggested that it provides little impact on the work of medical staff due to problems with embedding its core approach in healthcare organizations.

However, TQM has contributed greatly in redesign initiatives such as redesigning patient care pathways (Powell et al., 2008). BPR which emerged in the United States of America in the 1990's emphasizes on a radical "clean break" approach to organizational change and like TQM has also contributed to redesign initiatives (Powell et al., 2008).The Six Sigma although used in industry since 1980's is a newer approach in healthcare and it uses measurable based strategy for process improvement and problem reduction completed through the use of two Six Sigma methods (Sehwail and DeYong ., 2003). The two methods in this model can be used in an improved or existing system or in a new process procedure. According to Powell et al. (2008) the Six Sigma has been applied to a limited extent in healthcare although it has potential for wider application. Sehwail and DeYong (2003) recommend its use when defects or variations need to be improved in a system. However Six Sigma requires statistical expertise along with the collected data (Powell et al ., 2008).

Lean thinking was developed in the 1950's by Toyota and its emphasis is to streamline processes to provide what the internal and external customers want with minimal waste, efforts and costs (Powell et al .,2008). This approach has been used in healthcare settings with some success in reducing waste and appears to be useful in streamlining processes in support departments rather than mainstream clinical services (Powell et al .,2008).

Developed countries involved in restructuring of their healthcare systems have realized that clinical practice improvement often centers on a particular aspect of clinical care or disease (Bloomfield and Logan 2003). Because of this, they have become aware that redesign principles when applied across whole delivery systems can have huge positive effect in healthcare (Bell et al. ,2006). With this in mind the PDSA model for improvement has become widely accepted as a method to use for sustainable healthcare improvements.

2.6 PDSA Model as a Quality Improvement Model

PDSA stands for **Plan** – the change to be implemented; **Do** – carry out the test or change; **Study** – test before and after the change and reflect on what was learnt; **Act** –plan the next cycle or full implementation of plan. It is a model for testing ideas that one thinks may create an improvement and can be used to test ideas for improvement quickly and easily. Implementing the PDSA model to improve radiotherapy delays at KNH CTC required this kind of collaboration thus making an action research approach a more appropriate design for the research.

In this research, before testing if the PDSA model reduced radiotherapy delays, a survey to determine causes and prevailing length of radiotherapy delays was carried out. After establishing the causes and length of the radiotherapy delays, strategies to address the causes and suggestions of how to reduce the radiotherapy delay time were made and implemented using the PDSA model for improvement. During the PDSA intervention, data were collected that showed progress of changes in radiotherapy delays. The intervention strategies were adopted or rejected and the cyclic process continued until improvement in radiotherapy delay time was achieved.

In order to understand the problem of radiotherapy delay and create intervention strategies, it was necessary to employ process management tools to assist in exploring the causes of radiotherapy delay. Domingo (2000) explains that most process management tools, such as flow charts, Pareto analysis graphs and cause and effect diagrams used in the service industries to solve quality improvement problems can be successfully applied in healthcare. In this research, flow charts, cause and effect diagrams and Pareto analysis graphs were utilized to identify and explore the causes of radiotherapy delays. These process management tools also helped to assist in planning the improvement process.

After identifying the causes of radiotherapy delays, strategic plans were implemented using the PDSA model for improvement. In the course of the intervention, the PDSA model for improvement was implemented across the department as a whole. However data were collected and analyzed only for the selected sample group as they represented a true reflection of the patients treated radically with radiotherapy at the Centre.

Based on action research studies definition by Carr and Kemmis (1986), action research requires a record of how the change implemented affected the practice. Therefore data collection methodologies that monitor the impact of the change should be used. In this research, run charts were used to monitor the data monthly and show the progress of the improvement process. The final conclusion of this research was formulated based on the results shown on the run charts.

The PDSA model for improvement consists of two parts.

The first part: the thinking part. As shown in Figure 2 the model for improvement, consist of three fundamental questions to guide improvement to work. The second part: the doing part, as shown in Figure 2 by Langley et al. (1996) is made of rapid small Plan Do Study Act cycles to test and implement change in real work settings. The cycles guide the test of change and determine if the change is an improvement.

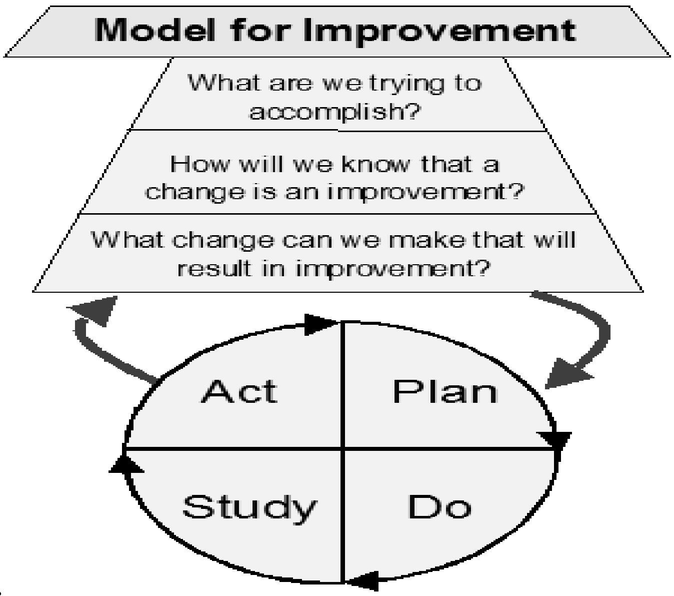

Figure 4: The PDSA model for improvement (Langley et al. 1996)

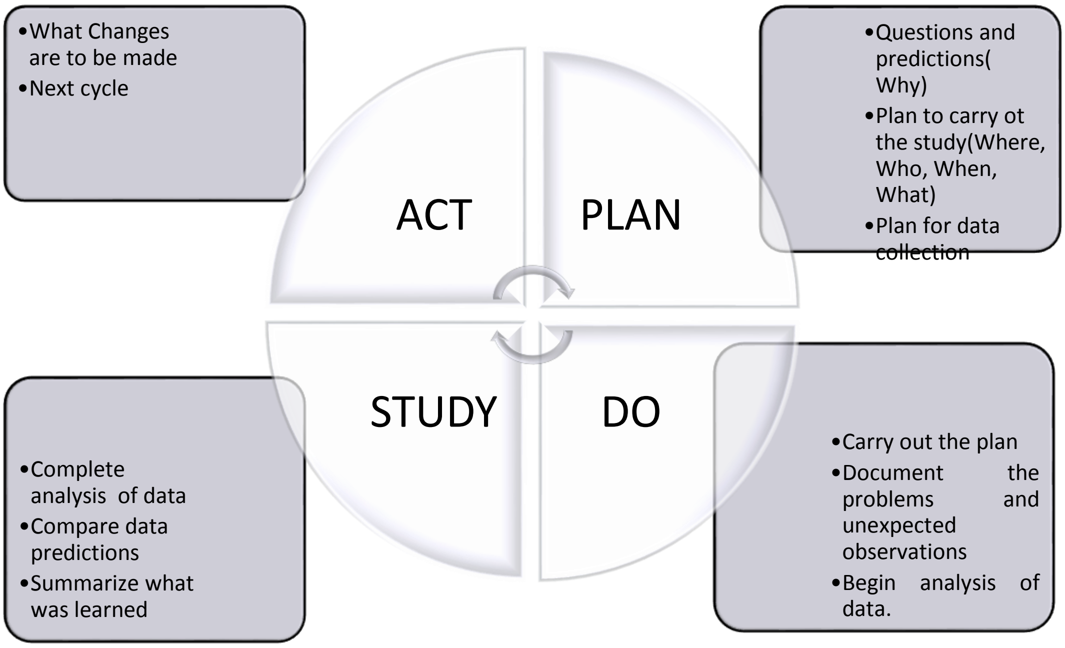

Figure 5: PDSA Cycle (Langley et al 1996)

As already described, PDSA cycles are able to test ideas by putting changes into effect on a small scale and learning from their impact in that situation. Berwick (1996) describes the cycles as "inductive learning, the growth of knowledge through making changes and reflecting on the consequences of those changes". As shown in Figure 4, the process progresses from hunches, theories and ideas to actual changes that result in improvement.

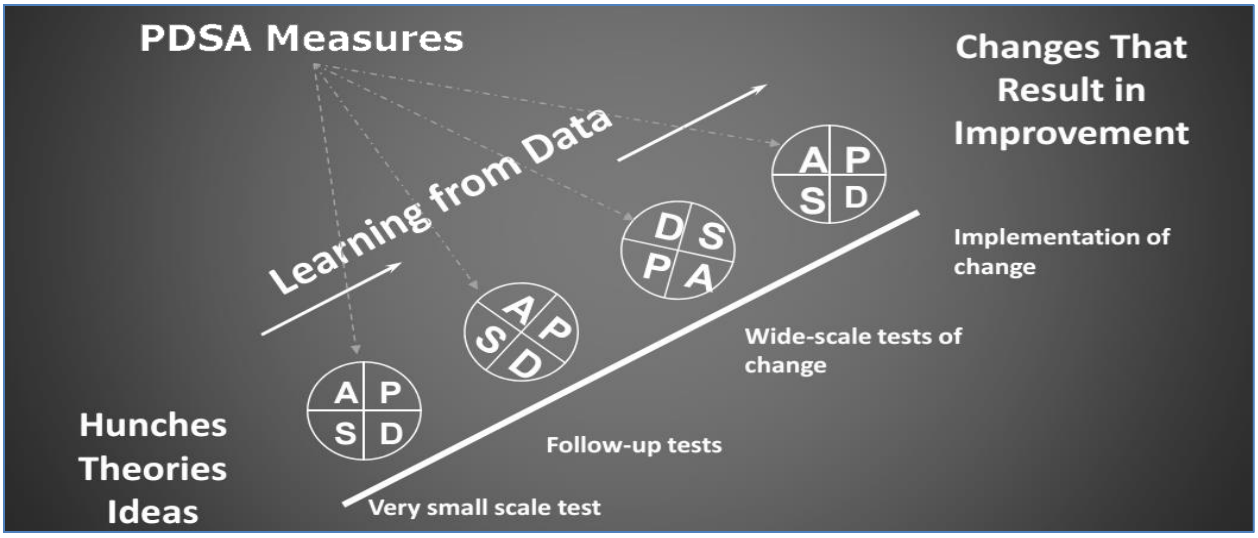

Figure 6: Repeated PDSA Cycles (Langley et al. 1996).

Radiotherapy delay was identified as cause for concern about 20 years ago (Mackillop; 2007). The main reason for this concern is that sufficient evidence showing that radiotherapy delay can cause cancer progression and render it incurable has emerged (Barrete.t al. 2004). The decrease in cure rates and overall patient survival benefits due to radiotherapy delays defeats the sole purpose of radical radiotherapy. In a study on the relationship between radiotherapy waiting time and treatment outcome, Chen et al. (2008) have suggested that the negative effects of the prevailing radiotherapy delays may be sufficient to cancel out the positive effects of many advances in radiotherapy.

As a result of the known negative effects of radiotherapy delays, addressing the causes of radiotherapy delay has become a priority in many radiotherapy centers worldwide. A survey conducted by Mackillop et al. (1996), showed that there is ample evidence that radiotherapy departments are active in trying to manage radiotherapy delays. Kerr et al. (2002) have suggested that healthcare providers should consider adopting quality improvement models in order to deal with the dynamics of these radiotherapy delays.

A quality improvement model refers to purposeful changes in administration or clinical methods of an organization (Koeck .,1998). Therefore a quality improvement model will initially look at the service delivered and how it can be improved (Bloomfield and Logan 2003). Quality improvement models are now widely being applied in several healthcare organizations. Moreover engaging in quality improvement initiatives provides healthcare workers with a deeper understanding of the care process and how to improve it (Lynn et al., 2007). This makes the improvement process more effective. Kerr et al. (2002) have reported that modern improvement models have the advantage of providing a flexible system of testing, adapting and implementing change and can therefore be easily used in current rapidly changing and complex healthcare processes. Kerr et al. (2002) further suggest that the improvement models are able to provide a definition of best practice which teams can aim to achieve and also promote shared learning between teams.

According to Berwick (1996), in order to improve healthcare, intervention methods for systemic change such as the PDSA model for improvement are needed. Therefore when dealing with radiotherapy delays, discussions and active interventions are necessary to enable improvements. Achieving improvements in radiotherapy delays will ultimately result in improved cancer care and better patient survival.

Improving cancer care is one of the major priorities in oncology healthcare service .Healthcare has changed over the years due to the complex changes in healthcare practice (Koeck; 1998). As a result of these changes, high cost in managing a healthcare organization is inevitable. In order for a healthcare system to provide high quality of care while maintaining costs, better organizational structures and process are required (Bloomfield and Logan 2003). Bell et al. (2006) have suggested that to achieve sustainable quality improvements small scale incremental changes introduced from available data that can easily measure performance are essential. Therefore a method of systemic change such as the PDSA model for improvement is necessary .Langley et al. (1996) have created the PDSA model that can assist HealthCare organizations to create changes that guarantee improvement. It involves the use of formal cycles of action and reflection which are unusual in routine daily work. The advantage of the PDSA model, besides it not being focused on low costs, is that it also focuses on the process and outcome of care while engaging all professionals involved, thus ensuring team efforts (Bell et al. 2006; Bloomfield and Logan .,2003).

In using the PDSA model for improvement, healthcare organizations will usually start by examining operational data and determining where the quality of care may be compromising patient outcome of care (Walske and Freeman ., 2002). Upon identifying the area of improvement, the healthcare team will embark on a series of PDSA cycles. A PDSA cycle will thus involve a process of identifying a problem and a potential solution, experimenting with the solution, through measuring, evaluating, and modifying the solution until the ideal results are achieved (Langley et al., 1996).

Berwick (1996) recommends that it is better to use small but clever and informative PDSA cycles that start within days or hours, then the large scale lessons will develop as the small cycles run cumulatively to each other. This has made the PDSA model a commonly used quality improvement approach in healthcare as it provides for rapid improvement changes (Cleghorn and Headrick., 1996).

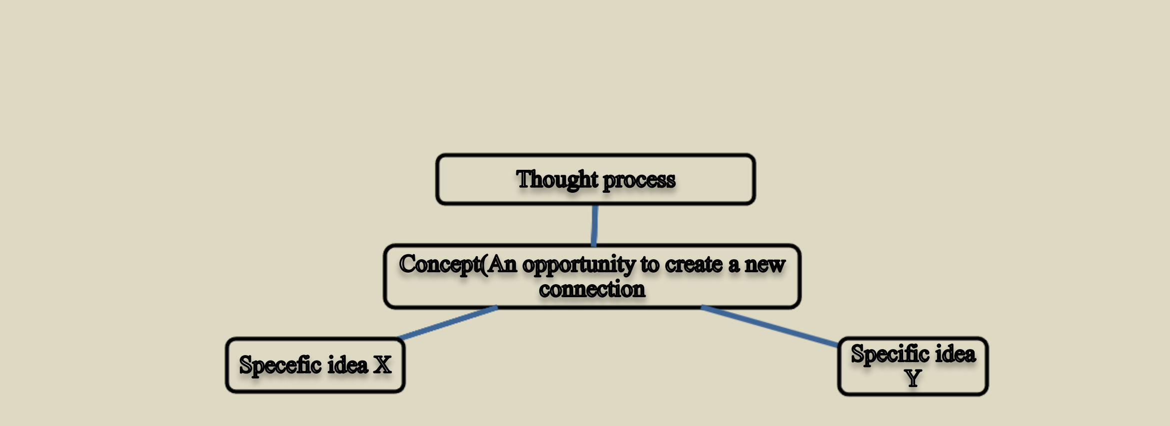

Figure 7: A change concept (Langley e.t al.1996).

The process starts from a change concept as in Figure 2.1. The change concept will aim to answer the question of what changes need to be made to lead to improvement. An idea can come from different sources such as critical and creative thinking about a current system, observations, a hunch, scientific literature or gained insight from different situations (Plesk .,1999).The PDSA model involves a trial and learning approach in which a hypothesis or suggested solution for improvement is made and testing is carried out on a small scale before any changes are made to the whole system (Berwick .,1996). As illustrated in Figure 2 the four steps of Plan Do Study Act are carried out through a performance process over a course of small cycles which eventually lead to improvements. In certain instances where a different approach is required sequential PDSA cycles can be used as indicated in Figure 2. Multiple changes can also be conducted to achieve maximized improvement as indicated in Figure 7

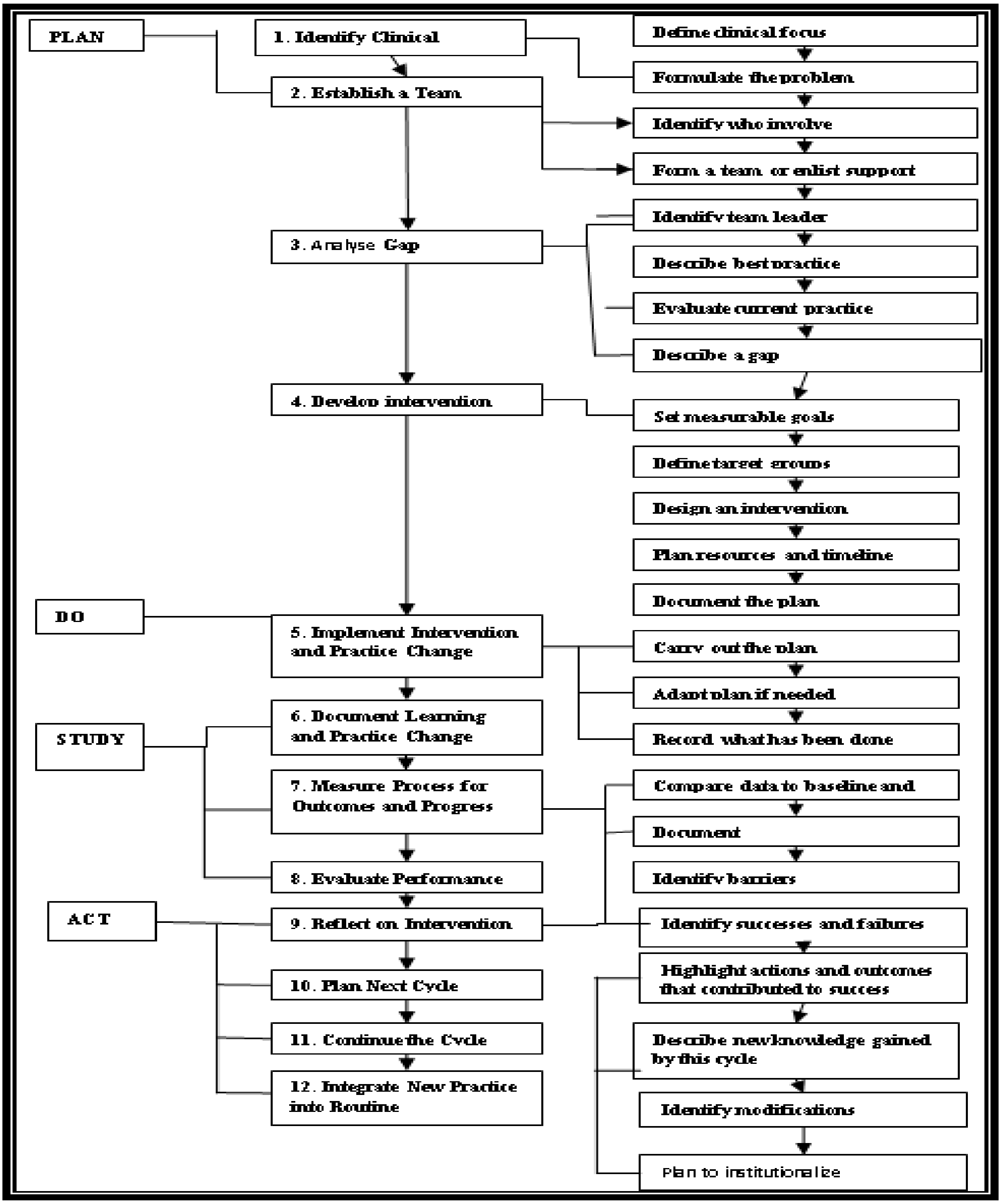

Figure 8: PDSA improvement model

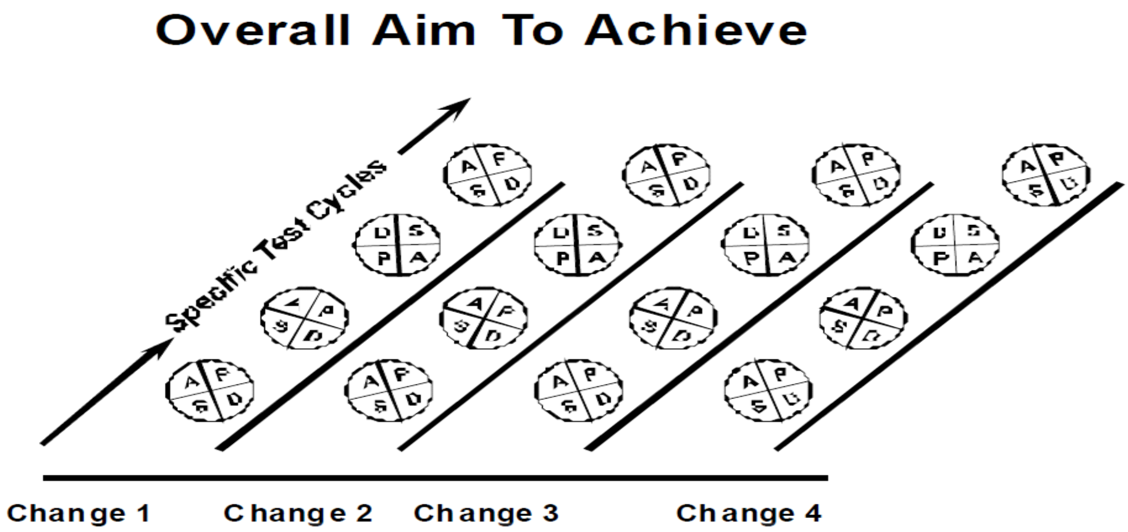

Figure 9: Multiple PDSA cycles (Langley et al, .1996).

2.7 The Breakthrough Series (BTS)

In line with the principles of the PDSA model for improvement the Institute of Health improvement (IHI) have also introduced a breakthrough series (BTS) method to assist healthcare organizations enhance improvements. Therefore discussions on quality improvement and sustained improvement cannot be completed without mentioning the BTS.

The vision of BTS is that "sound science exists on the basis of which the costs and outcome of current healthcare practices can be greatly improved, but much of this science lies fallow and unused in daily work thus creating a gap on what is known and what needs to be done" (IHI BTS innovations 2003). The BTS aims to assist organizations create structures to close this gap.

BTS involves a short term learning system that will bring together a large number of teams who seek improvements in a focused area. Breakthrough improvements are aimed to be accomplished within a specified and short period thus creating dramatic and lasting improvements in healthcare organizations. As indicated by the IHI BTS innovations (2003) and shown in Figure 2, the key elements of BTS include identifying areas of improvement and identifying experts in relevant disciplines to spearhead the improvement process. At the beginning of the process teams are selected and learning sessions on improvement are conducted. The teams then test the suggested improvements in their departments using the model for improvement. Upon completion, results, measurement and evaluation are presented. For improvement to be successful in collaborative projects, the four key habits of viewing clinical practice as a process, encouraging evidence based practice, collaborative learning and encouraging change also need to be encouraged within organizations (Plesk .,1999).

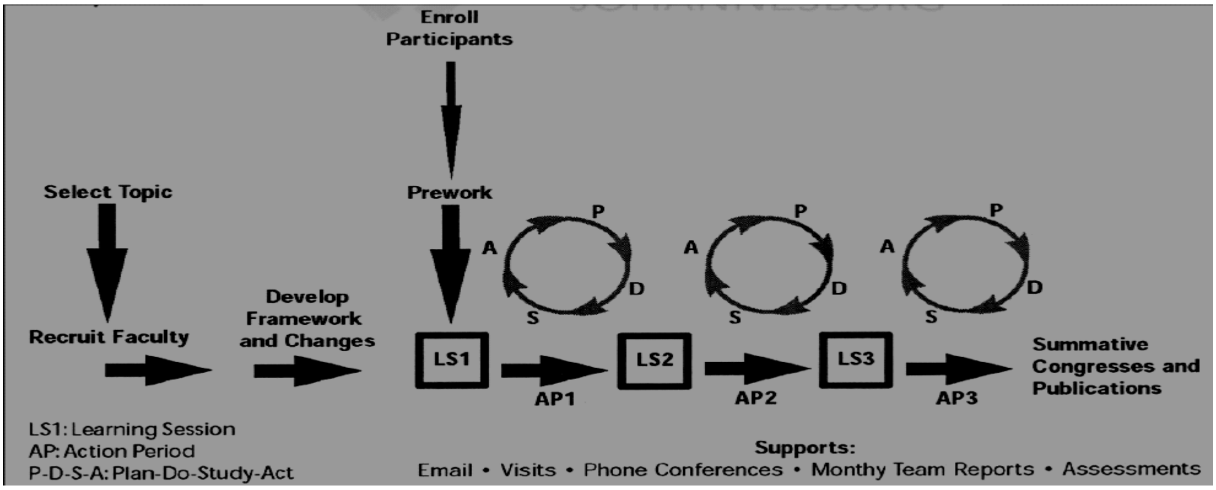

Figure 9 BTS (IHI BTS series innovations 2003).

2.8 Measuring Effectiveness of Change with the PDSA Model

Berwick (1996) has stated that "all improvements require change, but not all change will result in an improvement". Therefore it is important to know if a change has led to improvement. Measurements to show effectiveness of a change can assist to indicate if a particular change led to improvement and how much improvement was made.

Using the PDSA model for improvement as shown in Figure 2.6, measurements for effectiveness of change can be explained. Berwick (1996) explains that the initial question of setting aims should be time specific and measurable. In this stage improvement should be intended. Therefore in order to develop an intended plan of improvement, flow charts and patient map process tools are essential to help understand the current process. Plesk (1999) also recommends the use of cause and effect analysis in order to understand the process as a system of causal factors. A cause and effect diagram (CED) can be constructed around a clinical area of interest or a problem area. To help identify factors that may cause a problem, a broad range of categories such as people, equipment, supplies, information, measurement and environment should be considered (Plesk .,1999). This assists to show factors that can lead to better care or that cause the outlined problem and need to be improved on.

In the second question, quantitative measures which will help to determine if a specific change actually led to an improvement must be identified. After measurements are agreed on, it is important to define a starting point or baseline for the improvement process (Berwick., 1996). This will require data collection before starting the improvement process and can be useful to determine positive accepts of improvement. At this point it is recommended that a target for improvement should also be set (Plesk., 1999).

The final question should then identify what changes will result in an improvement. The PDSA cycles are then improvement should be monitored on a regular basis. Plesk (1999) recommends the use of constant data collection and charting the process of improvement with use of a run or line graph. After completion of testing the changes and learning from the changes, they can be implemented permanently and on a broader scale.

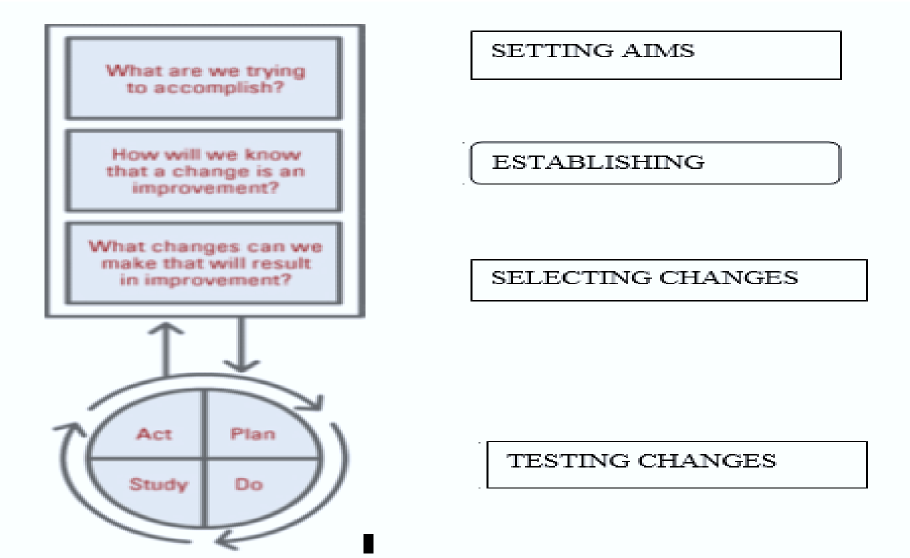

Figure 10: Changes using the PDSA model for improvement (The Institute of Health improvement 2003

2.9 Using the PDSA Model for Improvement in Healthcare

Healthcare providers worldwide are beginning to understand that the PDSA model is an ideal and simple system to improve quality as it provides efficiency in their systems while maintaining costs. Therefore the PDSA model is now being used in many areas of healthcare. In radiotherapy departments, Kerr et al. (2002) have suggested that there has been slow progress in showing improvement using the PDSA model probably due to staffing problems. PDSA model has not only been used in some radiotherapy departments but also in other healthcare improvement projects with successful results (Berwick .,1996).

In an effort to reduce radiotherapy delays after surgery for breast cancer, five departments in the French Ministry of Health acted by redesigning their organization while implementing the PDSA model for improvement (Woynar et al., 2007). The background to the intervention was based on Huang et al. (2003), where it has been reported that an interval of over 8 weeks between surgery and radiotherapy increases risk of recurrences in early breast patients. Woynar et al. (2007) undertook an organizational audit focusing on the treatment process, patient flow, and staffing and equipment capacity. In order to balance the department's capacity and demand, weekly allocation of staff and standardized treatment process and patient programs were implemented. In this study improvements were achieved with no additional equipment costs or extra staffing. The time from first appointment to a radiation oncologist to start of treatment was reduced from 4.9 weeks to 2.3 weeks.

In Norway at the Haukeland hospital, Plessen and Aslaksen (2005) used the PDSA model and reported appointment waiting time in lung cancer patients reduced significantly. Simple changes of rescheduling and rearrangement of the process steps were made to achieve improvement. The intervention used involved direct observation, use of run charts, flow charts and meetings with patients and families to get feedback.

In this study through patient feedback and active staff performance, patient waiting time and better patient appointment flow was successfully achieved. The hospital additionally managed to redesign their waiting area and improve chemotherapy documentation due to the same intervention.

In the UK, Kerr et al. (2002) tested the PDSA model finding within a year, improvements in patients waiting times and waiting lists. In this project it was also noted that they could not be certain that their intervention actually caused improvements because it was designed as a randomized trial. Furthermore, teams run in to problems because meetings held concentrated more on the theoretical than the clinical practical aspect of the model. As a result, most senior clinicians were skeptical about the PDSA model. However projects teams applied methods in line with the PDSA model for improvement and changes took place. At the beginning of the project, Kerr et al., (2002) mapped cancer paths for each tumor type and measured the baseline activities such as waiting times and percentage of booked investigations. By using this baseline data relative changes were shown throughout the networks that used the PDSA model.

Other areas of healthcare have also shown improvement by using PDSA model. Varkey et al. (2007) used PDSA cycles to enhance medication reconciliation (the process of ensuring the most complete and accurate list of medication across the continuum of care) in an out patients clinic. In this study changes were made to the medication reconciliation processes on the basis of lessons learned from each previous cycle and by the end of one month a new medication process was standardized and implemented in the clinic. Van Teil et al. (2003), have also reported that by using PDSA cycles, compliance with infection control measures can be improved. Their study intervention consisted of training nursing and medical staff in the use of PDSA cycles and feedback of a measured baseline.

In a project to reduce feeding tubes in patients with dementia, Monteleoni and Clark (2004) reported that after using the PDSA model there was a great reduction in the use of feeding tubes. In this study a retrospective chart review of all the patients receiving feed tubes was conducted. After implementing the PDSA model, a second review chart was conducted to review improvement. Team efforts were essential for change to take place. Margolis et al. (2004) introduced the PDSA model in 44random practices and reported that continued education combined with process improvement methods was effective in increasing rates of delivery of preventative care to children.

In a project designed to encourage surfactant treatment in preterm infants, Horbar et al. (2004) used the PDSA model and showed improvement in management of the infants. Surfactant which is produced after the 35th week of gestation in a fetus is a surface active lipoprotein that serves to decrease the surface tension of fluids within the alveoli of the lungs and permits pulmonary tissue to expand during inspiration and prevents alveoli from collapsing and sticking together after each breath. In their study Horbar et al. (2004) included audit and feedback, quality improvement training and follow up support which changed the behavior of the healthcare professionals and promoted evidence based practice.

On a wider scale, collaborative improvement projects within the healthcare system have been implemented in countries that target to improve cancer care. Most collaborative projects utilize the PDSA model and BTS with successful results because they focus to produce and sustain improvement in a short period (IHI BTS innovation 2003). The Institute of Health improvement (IHI BTS innovation 2003) has reported of projects tested by cancer collaborative services in the UK in 1999. In these projects, teams tested 4,400 changes between September 1999 and August 2000, involving1000 patients. Sixty five percent of the projects showed at least 50 percent reductions in delay to starting of first treatment. In an Australian collaborative project Bartlett et al., (2002) reported improvement or achieved target in clinical and operational projects. These projects relied on shared knowledge, innovation and teams working together in a supportive environment to achieve their targets. In Sweden, a collaborative project to increase patient access to healthcare professionals was conducted achieving success in 40 percent of the projects in 2006.

All these healthcare projects indicate that by using the PDSA model in a collaborative effort can result in improvement. The projects reported required redesigning of systems, learning from the processes but most importantly, team efforts.

Chapter 3
Methodology

3.1 Introduction

This research was conducted to determine if implementing the PDSA model for improvement can effectively reduce radiotherapy delays from the time of a patient's referral to Kenyatta National Hospital CTC to the start of radiotherapy. In the research, implementation of the PDSA model in radically treated head and neck, breast and cervix cancer patients was analyzed as they constitute the most commonly radiotherapy treated cancers at KNH CTC (KNH statistics ., 2013).

3.2 Research Design

This research was an action research design involving a collaborative inquiry and was conducted in two phases: a retrospective and a prospective phase. By doing this it was possible to allow action (change, improvement) and research (understanding, knowledge) to be achieved at the same time.

3.3 Retrospective Phase

During the retrospective phase of this research, a survey of all head and neck, breast and cervix cancer patients who were treated radically at CTC from January to December 2013 was conducted. The retrospective survey examined radiotherapy delays using data from treatment charts in these previously treated patients. This was carried out so as to define the baseline delay times for the study.

3.4 Study Population

The study population included all cancer patients who came for cancer treatment in both of the Cobalt 60 treatment rooms. In the retrospective survey, radiotherapy delay time in a total of 145 patients comprising of 68 cancers of cervix patients, 37 cancer of breast patients and 40 head and neck patients who were treated radically was analyzed. The mean delay time and possible causes of radiotherapy delay was documented for each of the above tumor types.

A Microsoft excel data collection sheet that consisted of patients' first visit date, radiotherapy start date, total delayed number of days and possible causes of delay, was used to collect data for each patient in the retrospective survey. As suggested by Plesk (1999) the target for improvement was set based on the JCCO (1993) recommendation of an acceptable two weeks (14 days) wait from patients' first oncologist visit to start of any radical radiation treatment.

The possible causes of delay were reviewed in the retrospective survey for each patient by analyzing each patient's treatment chart with the aid of process management tools.

3.5 Sampling Method

A purposive sampling strategy was used to select the respondents. This strategy was chosen because other types like the random sampling or systematic sampling could have been time consuming, yet the time schedule was very limited.

3.6. Inclusion/ Exclusion criteria

All patients that were able to read and write that were treated between 8.00 a.m. and 4.00 p.m. were interviewed. Excluded will be all in-patients, patient under 18 years and those above 80 years. Those excluded may not be in a position to give proper judgment due to the preferential treatment they may be accorded.

3.6.1. Process Management Tools

Evan and Lindsay (1999) define process management as the planning and administering of activities necessary to achieve a high level of performance in a process, therefore identifying opportunities for improving quality. An "as is" flow chart, cause and effect diagram, Pareto analysis diagram and run charts were used in the research.

3.6.2 As Is Flow Chart

A flow chart is a pictorial presentation describing a process being studied (Plesk 1999). Before improvements can be implemented, it is important to show the current process and where improvement may be needed. A flow chart promotes a better understanding of a process which is a prerequisite for improvement (ISO 9001:2000 QM5 documentation course 2005). Therefore to understand the current process at KNH CTC, a patient's "as is" flow chart from first visit to the department to the start of radiation treatment was developed. This helped to highlight areas that caused delays within the process.

3.6.3 Cause and Effect Diagram

A cause and effect diagram (CED) is a tool used for systematically identifying and presenting all possible causes of a particular problem in graphical form (Swinton; 2006). As indicated in diagram 3.1 the possible causes are presented at many levels of detail in connecting branches. An outer branch is a cause of the inner branch attached to it. All the causes are indicated on the left of the graph that lead to the main effect indicated on the right. The cause and effect diagram is therefore a helpful tool for identifying the root cause of a problem (Doggett 2004). In order to reduce radiotherapy delays, the causes of the delays needed to be recognized and understood.

Therefore root cause analysis was performed. Doggett (2004) describes a root cause analysis as a process of identifying causal factors using a structured approach with techniques designed to provide a focus for identifying and resolving problems. Doggett (2004) has suggested that the cause and effect diagram works by breaking down potential causes into more detailed categories so that they can be organized and related into factors that help identify root causes. It therefore easily identifies cause categories, and is easy to read and use. For this reason the cause and effect diagram was the preferred tool for root cause analysis.

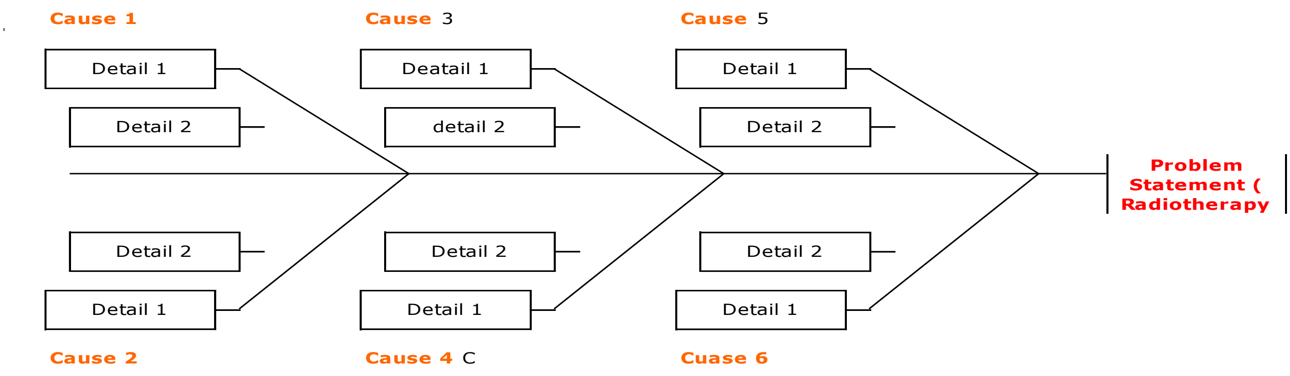

Figure 11: Cause and effect Diagram.

3.6.4 Pareto Analysis

A Pareto analysis is a statistical technique that can be used to select a limited number of tasks that will produce a significant overall effect (Logan 2002). In order to target the causes that affect most radiotherapy delays, a Pareto analysis was performed.

According to Hackman and Wagema (1995) a Pareto analysis identifies the factors that contribute to a problem and distinguish the “vital” few from the “trivial” many. The Pareto rule suggests that a large number of the problems (80%) are produced by a few key causes (20%) (Logan 2002).

In carrying out the Pareto analysis in this research, the frequency of each cause category identified from the CED was placed in order of magnitude of effect. The percentage of the total that each cause category represents and the cumulative percentage for each category (working from the largest to the smallest) were calculated.

The cause categories (20%) that affected most of the radiotherapy delays (80%) were therefore identified in this process. According to Logan (2002: 1-7), once the 20% cause categories that are causing 80% of the problem are identified, they can be addressed and remedied thus efficiently obtaining quality. In the research the "vital" few causes (20%) that caused the majority of radiotherapy delays were targeted for improvement.

3.6.5 Run Chart

A run chart is a graph of data over time and an important and ideal tool in performance improvement (Evan and Lindsay 1999). The run chart monitors performance of a process over time to detect trends. In this study, run charts were developed to monitor changes in radiotherapy delays, after implementing the PDSA model. A run chart allows the team to compare performance before and after implementation of a solution to measure its impact. By using run charts it was possible to compare changes from the baseline data before PDSA model implementation to improvements after PDSA implementation.

3.7 Prospective Phase

After identifying the major causes of radiotherapy delays and the "vital few" that caused the majority of these radiotherapy delays, the prospective phase was implemented from May 2013 to December 2013. In this phase the PDSA model for improvement was implemented to a total of 105 head and neck, breast and cervix cancer patients' radically treated at KNH CTC. Before implementing the PDSA cycles, meetings among teams involved in the change process were held. The three questions of the PDSA model for improvement were answered as follows:

- What are we trying to accomplish? This was the overall aim: to reduce radiotherapy delays.
- How will we know that a change is an improvement? This was achieved by measuring time taken in days from the patients' first visit to the department to the start of treatment.
- What changes will we make that will lead to improvement? This was achieved by implementing changes to the "vital few" categories obtained from the Pareto analysis diagram.
- Plan, Do, Study and Act cycles were then conducted until improvement was reached.

Each cycle was documented as follows:

PLAN: Each implemented cycle aimed to achieve the overall aim which was to reduce treatment delays. Specific aims of each cycle were documented.

DO: What was going to be done in each cycle to achieve the specific and overall aim, which teams will be involved and when the change should take place were also highlighted.

STUDY: Predicted and unpredicted results were studied from each cycle. This helped to determine what would be targeted for improvement in the next cycle.

ACT: The changes were adapted, rejected or modified as required for the next cycle.

As recommended by Langley et al. (1996), to maximize achieving improved results multiple cycles running parallel to each other were used. Based on the data collected from the Pareto analysis diagram at CTC, changes were targeted to the vital few categories that caused most of the delay using PDSA cycles.

3.8 Data Processing and Analysis

In this study, quantitative data were collected and computed for interpretation by documenting the total delay in days for each patient from the patient's first visit to the department to the start of treatment. From the collected data the mean delay time in days was calculated for head and neck, breast and cervix patients using a Microsoft excel sheet. The mean delay time of each tumor type was used as the baseline for improvement (Appendix 1).

In the prospective phase, after implementing changes with the PDSA model for improvement, data were again collected monthly in the selected sample group and computed to show the improved results (Appendix 2). In order to evaluate the effectiveness of the changes made, a monthly run chart using Microsoft excel was used to indicate the progress of improvement. Improvement takes place over time and one of the benefits of a run chart is that it is able to determine when changes are improvements by displaying a pattern of data that can be observed as changes are being made. For this reason a run chart was the ideal tool to monitor progression of improved radiotherapy delays in this research. Progress in improvement was monitored monthly from May 2013 to December 2013. The baseline delay time obtained from the retrospective survey in radical head and neck, breast and cervix cancer patients was used as the start point for improvement. A target of reducing and maintaining radiotherapy delays to below 14 days as recommended by JCCO (1993) was also set on the run chart.

3.9 Ethical Considerations

Ethical considerations refer to ensuring that all research participants are aware and agree to participation in the research (Denscombe 2003) thus providing their consent to the research. Ethics will also consider that permission has been granted by an ethics committee and that participant's confidentiality and data privacy is taking into account (Denscombe 2003). Since this research did not require patients' participation or any treatment manipulation, patients' consent was not required.

However ethical permissions to conduct the study were obtained and granted from the Kenyatta National Hospital, ethics committee and the head of department at CTC before the research was conducted. All the patients' documents were also considered as confidential and anonymity was assured by allocating research numbers to each patient's records. The purpose of quality improvement projects in healthcare is to improve practice and assist in areas where patient's treatment may be compromising outcome (Walshe and Freeman 2002). Reducing radiotherapy delays increases the patients' tumor control, reduces patients' psychological effects and therefore enhances radiotherapy treatment outcome (Mackillop 2007).

Chapter 4

Results and Discussion

4.1 Retrospective Phase

4.1.1 Head and Neck Cancers Results

The retrospective survey for head and neck cancers was conducted on a total of 40 patients treated between January and December 2013. The graph in Figure 11 below indicate the results of the total number of patients treated during this period with the maximum radiotherapy delay time at 310 days and the minimum radiotherapy delay time at 4 days. The mean radiotherapy delay time (baseline delay) was 17.5 days with 47.5percent of these patients starting their treatment 14 days and beyond. Of the group of patients who received treatment at 14 days and beyond, 26.3 percent of delays were due to delayed manufacturing and delivery of customized blocks, 31.6 percent of delays were due to complex treatment plans or contours, 31.6 percent of delays were due to departmental booking problems. The remaining 10.5 percent of delays were either due to delays in lack of finances or a delay in consultations (due to incomplete medical reports such as lack of histology reports or resend to referral doctor for other management before radiotherapy such as dehydration, anemia and other medical conditions). Other radiotherapy delay causes included treatment machine service or break downs.

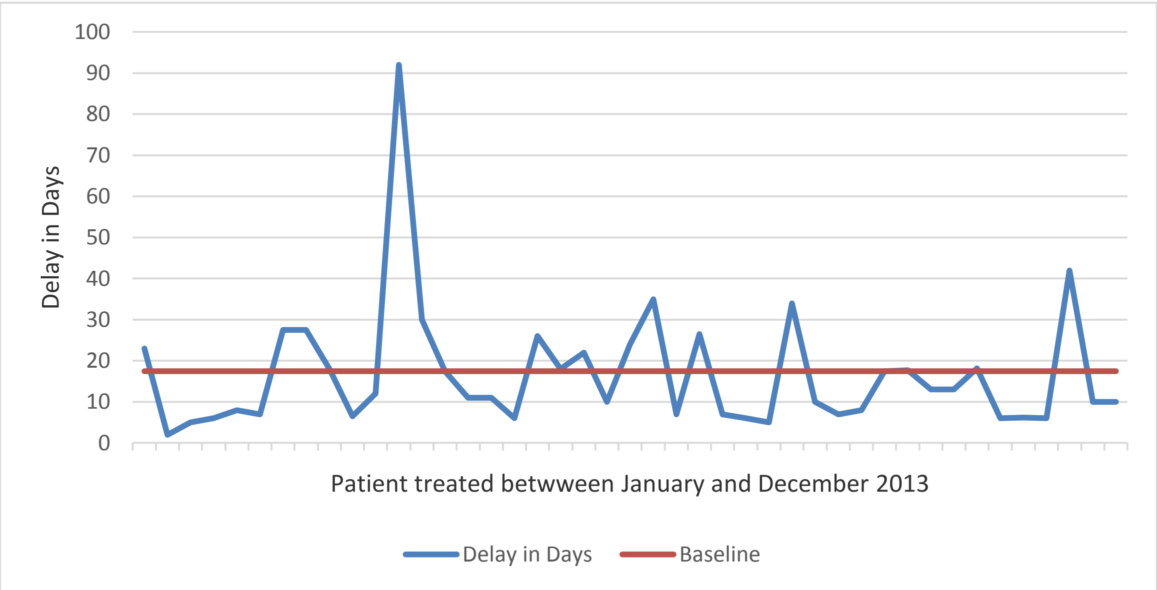

Figure 12: Retrospective survey of head and neck cancer patients treated at KNH Radiotherapy Unit between Jan. and Dec. 2013.

4.1.2 Breast Cancers Results

The retrospective survey for breast cancer was conducted on in a total of 37 patients treated in between January and December 2013. The graph in Figure 4.2 below indicates the results of the total number of patients treated during this period with the maximum radiotherapy delay at 75 days and minimum radiotherapy delay at 3 days.

The mean radiotherapy delay time (baseline delay) was 17.6 days with 48.6 percent of these patients starting their treatment 14 days and beyond. Of the group of patients who received treatment 14 days and beyond, 35.3 percent were delayed due to departmental booking problems, 23.5 percent were delayed due to lack of finance. Another 23.5 percent of delays were due to re-simulations (re- plan) or doctors consultations and 17.6 percent of delays were due to machine service or break downs.

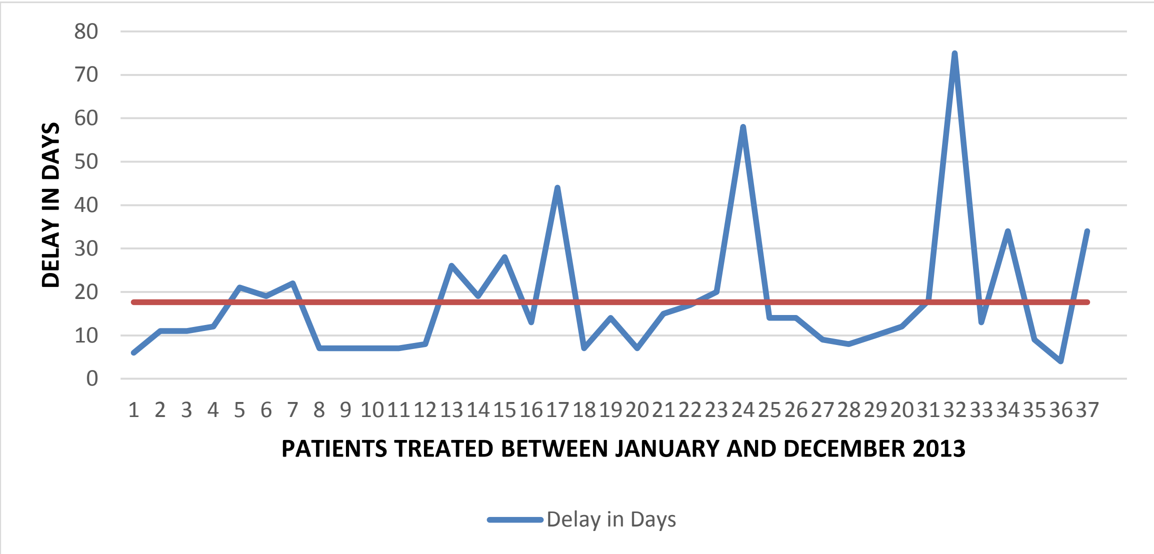

Figure 13 Retrospective survey for breast cancer patients treated between January and December 2013 at KNH Cancer Treatment Centre.

4.1.3 Cervix Cancer Results

The retrospective survey for cervix cancer was conducted on a total of 68 patients treated in 2013. The mean radiotherapy delay time (baseline delay) was 7.4 days with10.3 percent of these patients starting their treatment 14 days and beyond. The graph in Figure 13 below indicate the results of the total number of patients treated during this period with the maximum radiotherapy delay at 21 days and minimum radiotherapy delay at 0 days. Within the delayed cervix patients, 57.2 percent of delays were due to delayed doctor consultations (incomplete medical report or no histology), 28.5 percent were delayed due to departmental booking problems and 14.3 percent were delayed due to machine service or break down.

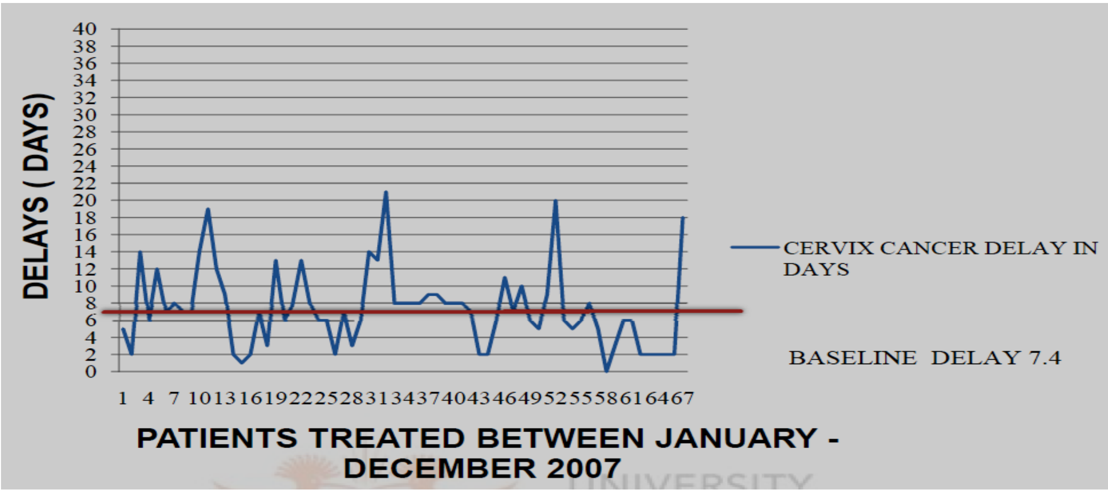

Figure 14: Retrospective survey for cervix cancer patients treated between January and December 2013 KNH CTC.

4.2 Process Management Tools Results

As explained earlier the process management tool was implemented to identify opportunities or areas for improvement (Evan and Lindsay 1999).

4.2.1 The As Is Flow Chart

The purpose of using an “as is” flow chart was to identify areas for improvement and causes of radiotherapy delay in the patients’ process from the patients first visit to CTC to the start of radiotherapy. A high level flow chart is indicated below with each delayed stage below. The delay areas are indicated in color.

Figure 15: Radiotherapy Booking Process

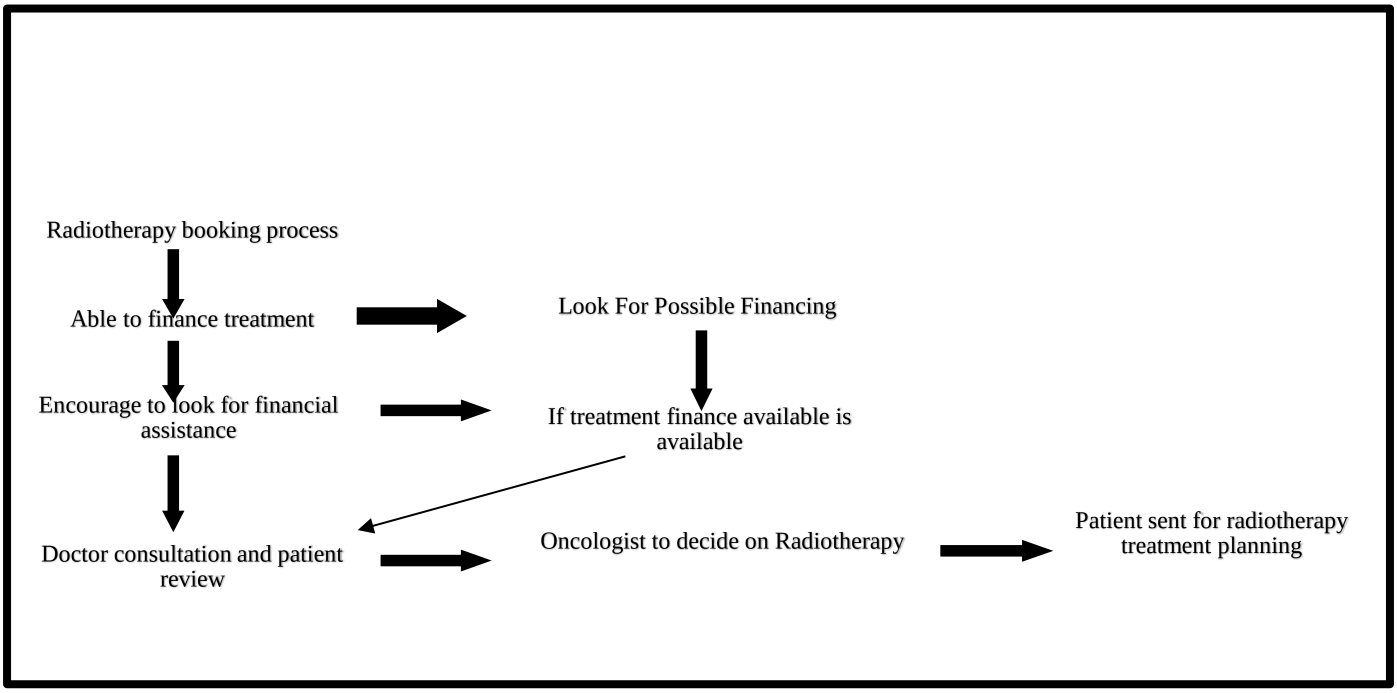

Figure 16 Radiotherapy booking process in CTC KNH

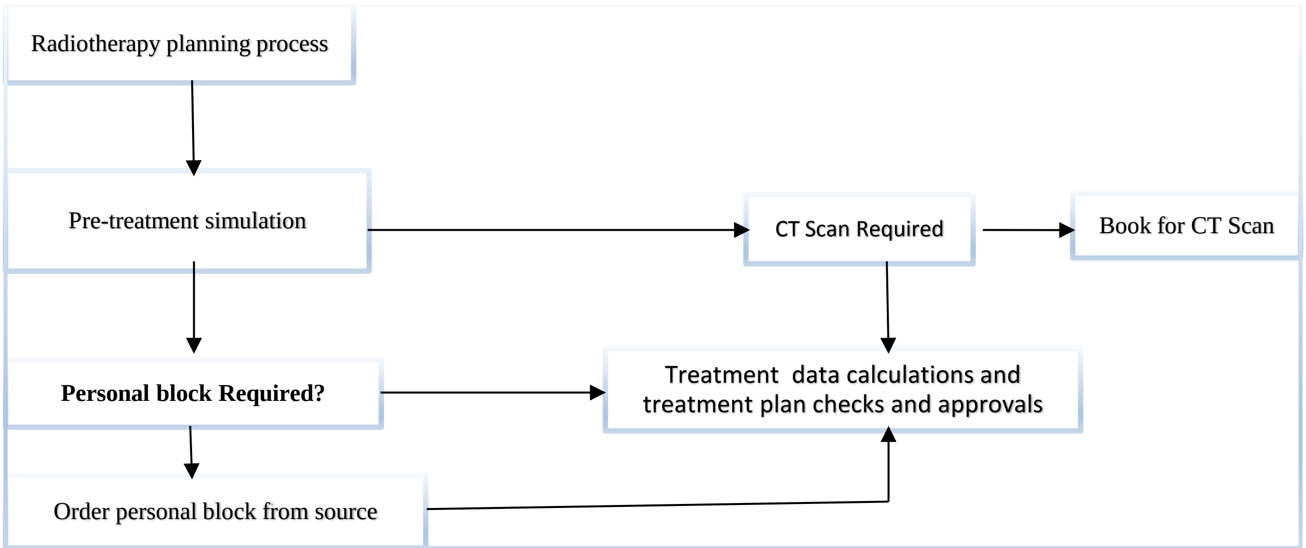

Figure 17: Radiotherapy booking process in KNH CTC

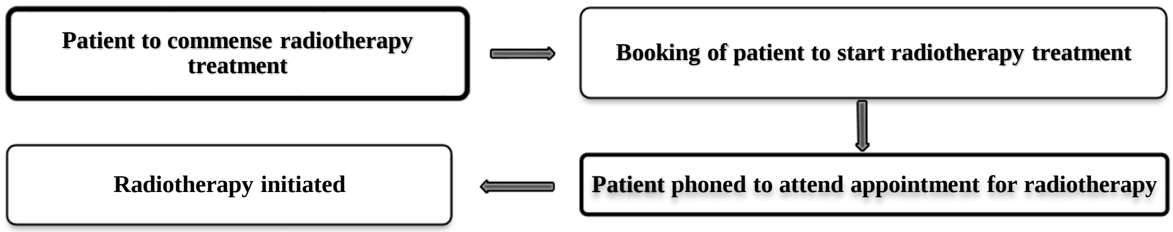

Figure 18: Patient treatment process in KNH CTC

From the flow chart, the following causes of radiotherapy delays were identified:

- Delays due to patients seeking finances for their treatment either from their medical aid, or personal finances.
- The delays taken by the oncologist to decide on a course of treatment in instances where multidisciplinary consultation was required.
- Delays due to patients' waiting for customized blocks to be made, mounted and to be ready for the patients' treatment.
- Delays due to contour and CT plans, including outlining treatment volumes, computer treatment planning to re simulation of completed plans and to the start of treatment.
- Delays in communications of radiotherapy appointment dates for patients to start treatment after completion of the treatment planning process.
- Equipment service and unavailable staff either due to leaves, sick-off, or training also contributed to radiotherapy delays of appointment bookings.

4.2.2 The Cause and Effect Diagram

In order to understand the causes of the radiotherapy delays, a root cause analysis was performed. In identifying the root causes, a cause and effect diagram was created. The cause and effect diagram in Figure 4.6 outlines the major causes and underlying causes of the radiotherapy delays found at KNH CTC. The six major causes of radiotherapy delays were identified as: Decision Making, Treatment Finance, CT/Contour Plans, Customized Block Making, Patient Booking, Equipment and Staffing.

The root causes of Decision Making contributed to 14.1 percent of the causes of radiotherapy delay and were as follows: Delay in Oncologists' consultation with other referral doctors and discussions among departmental oncologists on the preferred radiotherapy management. In certain instances patients were referred to the department with inadequate medical notes from their referral doctors thus contributing to delays in the consultation process. Other causes of delay included changes in radiotherapy management that resulted in re-simulation of the treatment plan.

The root causes of Treatment Financing contributed to 14.1 percent of the causes of radiotherapy delays and were as follows: Delays in preparing medical aid motivation letters in order to assist the cancer patients obtain approval from their medical aid. The time the patient's medical aid required to approve funds for radiotherapy also contributed to the delay. In patients on NHIF medical aid cover, delay by government to authorize approval for treatment also added to radiotherapy delay. Patients without medical aid needed to look for personal financing, thus also adding to the radiotherapy delay time.

The root causes in pre-treatment CT and contour plans contributed to 15.6percent of the radiotherapy delays and were as follows: Delays in booking patients for CT scan after CT simulations and delays due to CT plan and contouring, such as outlining of tumor volumes, organs at risk and other anatomical structures. Oncologist consultations with the radiologist on CT tumor volumes also contributed to CT plan delays.

The root causes in Block Making contributed to 7.8 percent of the delay and were as follows: Delays by couriers to deliver blocks to department (Block where imported from outside Kenya) and delays in arrangement of blocks according to planned treatment after delivery to the department.

The root causes in patients booking contributed to 42 percent of the causes of radiotherapy delay were found to due to the following: Incorrectly documented radiotherapy start dates. No documentation of radiotherapy commencement date and incorrect patient telephone numbers or other contact details.

The root causes in equipment and staffing contributed to 6.3 percent of the radiotherapy delays and was as follows:

Equipment service and break downs and radiotherapy staff taking off work (leave) days.

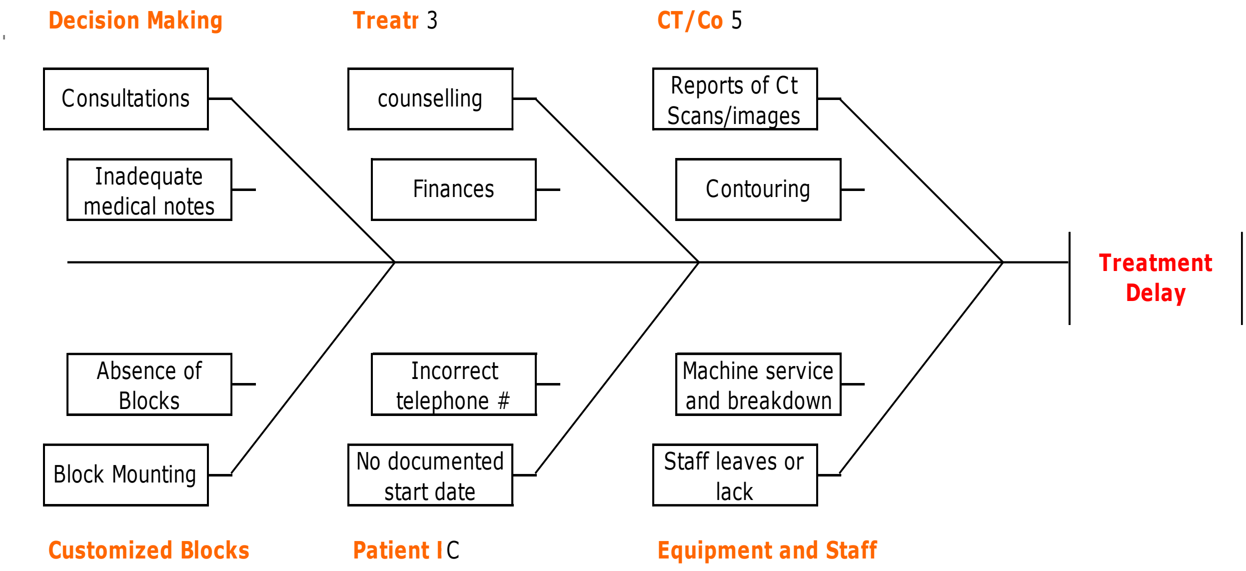

Figure 19: Cause and Effect Diagram at KNH CTC

4.2.3 The Pareto Analysis Diagram

A Pareto analysis diagram was developed to display graphically the major causes of the radiotherapy delay and to identify the major causes of the radiotherapy delays for targeting improvements at the study site. The Pareto analysis diagram is presented in Figure 4.7 below. The Pareto diagram indicates the frequency in percentage of all the major causes of delay for the combination in all the three radically treated tumor type.

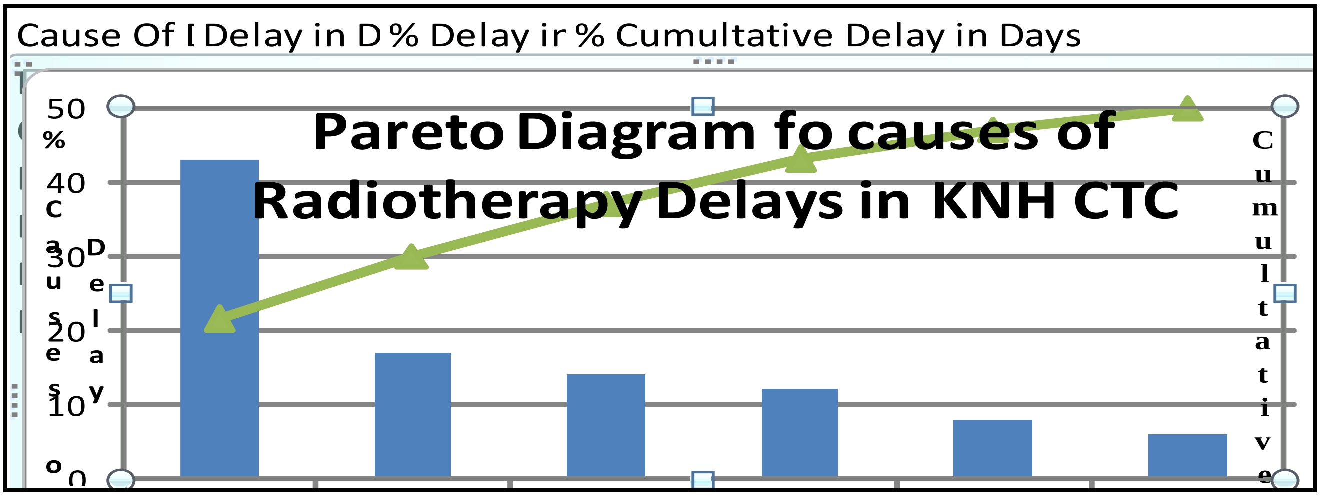

Figure 20: Pareto diagram of KNH CTC

As indicated in Figure 4.7, the frequency in causes of delay were found to be 42.1percent due to departmental bookings, 15.6 percent due to CT and contour plans, 14.1percent for each of finance and oncologist decision making, 7.8 percent due to customized block manufacturing and 6.3 percent due to machine service and break down. The "vital few" causes of delays from the Pareto analysis were patients' bookings, CT and contour plans. The PDSA model for improvement was planned to target these radiotherapy delay causes.

4.3 The Prospective Phase

In the prospective phase, PDSA cycles were implemented to a total of 109 radically treated patients between May and December 2013 (22 Head and Neck, 24 Breast and63 cervix patients). In this phase, monthly run charts were documented to show any improvement in radiotherapy delays. The target was set at 14 days according to the JCCO recommendations.

4.3.1 Change 1: Patients' Booking Process

The specific aim of this change was to ensure that all pre-irradiation treatment procedures are targeted to meet the patients' appointed start date. The team involved in the change included the in-charge radiation therapist at treatment planning, pre-treatment simulation and treatment delivery units. Three cycles were implemented in this change as shown in Table 3

Table 3: PDSA cycles made in appointment booking process

CYCLE 1 June to August 2013	**Give radiotherapy start date at day of pre-treatment simulation. Ensure given start date is adhered to**
PREDICTED/UNPREDICTED OUTCOME	**As predicted patients started treatment on the appointed date. An unpredicted outcome arose when customized shielding blocks were required. It was difficult to give and maintain the appointed start date as shielding blocks were imported outside Kenya**
CYCLE 2 September to October 2013. Block cutter installed at the Radiotherapy unit in September	**Repeat cycle 1 with block cutter at Radiotherapy Unit premises. The cycle was repeated to show the changes in radiotherapy delays if there are no delays of making and couriering customized blocks from outside the country.**
PREDICTED/UNPREDICTED OUTCOME	**An unpredicted outcome was that the customized blocks were still not delivered to the radiotherapy department in time for the treatment start date, thus affecting the appointed bookings.**
CYCLE 3 October to December 2013	**Document start date for block cutter laboratory.**
PREDICTED/UNPREDICTED OUTCOME	**As predicted appointment dates were maintained.**

4.3.2 Change 2: CT/Contour Planning Process

The specific aim of this change was to reduce radiotherapy delays in complex treatment planning procedures. The team involved in the change included the in-charge radiation therapists at treatment planning and pre-treatment simulation units, the medical physicist and Oncologists. Four cycles were implemented in this change.

Table 4: PDSA Cycles made to CT/ Contour planning process

CYCLE 1 May to June 2013	**Oncologists to draw tumor volumes on same day as pre-treatment simulations.**
PREDICTED/UNPREDICTED OUTCOME	**The number of days for complex treatment planning was reduced. An unpredicted outcome occurred when pre-reatment CT simulations and CT scans were not booked to take place on the same day, thus increasing the delay time.**
CYCLE 2 June to July 2013	**To book all Pre-treatment simulations and CT scans on the same day for all CT plans.**
PREDICTED/UNPREDICTED OUTCOME	**As expected the number of days between pre-treatment CT simulation and CT planning scans reduced to one day. An unexpected outcome developed in certain instances when pre-treatment simulations were booked to take place late in the afternoon therefore not allowing for the planning CT scan to be performed on the same day.**
CYCLE 3 July 2013	**Repeat cycle 2 with a modification to ensure pre-treatment simulations are booked in the morning thus allow for planning CT scan to be performed on the same day.**
PREDICTED/UNPREDICTED OUTCOME	**As predicted the number of days between pre-treatment CT simulation and CT planning scans reduced to one day. An unpredicted outcome developed, when a radiologist was required to assist in drawing tumor volumes which caused delays in starting the treatment planning process and ultimately caused treatment delays.**
CYCLE 4 July to August	**Radiologist to outline visible tumor volumes in the radiology department for the Oncologist at the time of the planning CT scan. This intervention was practical to achieve as all CT scans are performed in the radiology department.**
PREDICTED/UNPREDICTED OUTCOME	**As predicted, the number of days taken for tumor volume delineation and treatment planning of complex plans reduced**

4.4.3 Change 3: PDSA Cycles Made to Improve financial aid

The specific aim of this change was to reduce the time it takes to receive medical aid approval of the radiation therapy treatment and to receive payment for private patients on medical aid cover. The team involved in this change included the control radiation therapist and the radiation therapist in- charge of treatment planning. Three cycles were implemented in this change.

Table 5: PDSA Cycles made to improve Medical Aid Response

CYCLE 1 July to September	**Send patient treatment letter for medical aid. A copy given to the patient so that they contact medical aid directly (to show urgency).**
PREDICTED/UNPREDICTED OUTCOME	**The patients influence helped to speed up the medical aid response. Unexpectedly some medical aids still did not respond on time even with motivation letters. If patients medical aids exhausted patients are forced to look for personal means to finance treatment thus delay is inevitable. In certain instances medical aid were not sent on time from the KNH CTC.**
CYCLE 2 September to December	**Ensure that all medical aid motivation letters are sent to the appropriate office on time.**
PREDICTED/UNPREDICTED OUTCOME	**As predicted reducing the time patients medical aid motivation letter spends within department assisted in reducing delays. Unexpectedly it was also noted that not all staff members were confident with preparing medical aid motivation letters and treatment quotations for patients. Thus delays still occurred if staff members who knew how to prepare the motivation letter and quotation were unavailable.**
CYCLE 3 December 2013	**Relevant staff to undergo in house training on medical aid motivations and treatment quotations.**
PREDICTED/UNPREDICTED OUTCOME	**Reducing the time patients' medical aid motivation letter spends within the department assisted in reducing delays.**

4.3.4 Monthly Results for Improvement in Each Cycle Change

The changes in radiotherapy delay were documented for each cycle as follows:

May to June 2013: The changes done during this period were: the oncologist drawing tumor volumes on the same day as pre-treatment simulations for CT and contour plans. These changes therefore mainly affected patients whose radiotherapy treatment management included use of contours or CT scans. The average radiotherapy delays in days for each patient's tumor type were as follows: breast cancer patients 21.9 days, head and neck cancer patients 17.8 days and cervix cancer patients 15.9 days. The total average delay being 18.5 days.

June to July 2013: The changes done in this period were: to book all pre-treatment simulations and CT scans on the same day, to give patients the radiotherapy start date at the day of their pre-treatment simulation and ensure the date is adhered to. This change affected all the patients in the study. The average radiotherapy delays in days for each patient's tumor type were as follows: breast cancer patients, 14 days, head and neck cancer patients 21.5 days and cervix cancer patients 11.9 days. The total average delay being 15.8days.

July to August 2013: The changes done in this period were: modifying CT booking so that they are done in the morning thus ensuring that both pre-treatment CT simulations and CT scans are done on the same day. This also ensured that tumor volumes for CT scans are drawn in on the same day as the CT scan. The changes were further modified that the radiologist outlines visible tumor volume in the Radiology Department.

Preparing treatment motivation letters for private patients and giving a motivation letter copy to patients and advising them to follow through the motivation letter with their medical aid was also done during this period. During this period, giving of radiotherapy start date at same day of pre-treatment continued to be monitored. This change affected all the patients in the study. The average radiotherapy delays in days for each patient's tumor type were as follows: breast cancer patients, 9 days, head and neck cancer patients 23.7 days and cervix cancer patients 7.3 days. The total average delay being 13.3 days.

August to September 2013: In this period sending medical aid motivations continued to be monitored. A block cutter was also installed at the CTC premises. Sending of patient's customized blocks to the new block cutter laboratory was also monitored. The other changes as above were also continued. It is also important to note that during this period the treatment planning digitizing system developed a fault and the department resorted to planning contour patients manually.

The average radiotherapy delays in days for each patient's tumor type were as follows: breast cancer patients, 13.6 days, head and neck cancer patients 11 days and cervix cancer patients 17.5 days. The total average delay being 14 days. Installation of the block cutter laboratory showed a significant decrease in radiotherapy delay in head and neck cancer patients. This was most likely due to the fact that most head and neck cancers patients require individual customized lead blocks for their radiation treatment.

On the other hand, during this period the average radiotherapy delays for breast and cervix cancer patients showed a significant increase. This was most likely due to the problem with the treatment planning digitizing system as most breast and head and neck cancer patients are planned with a contour and planning digitizer.

September to October 2013: During this period a change to medical aid process was made by improving on the time medical aid motivations are sent to the appropriate office. Improvement in radiotherapy delays due to installation of the block cutter lab continued to be monitored. The other changes as above were also continued. This change affected all the patients in the study. The average delays in days for each patient's tumor type were as follows: breast cancer patients, 18.2 days and cervix cancer patients 8.4 days. There were no head and neck cancer patients who could have been included in the study during this time. The total average delay was 13.3 days.

October to November 2013: During this period an improvement was done by giving the block cutter laboratory the patient's radiotherapy start date. The other changes as above were also continued. This change affected all the patients in the study. The average radiotherapy delays in days for each patient's tumor type were as follows: breast cancer patients 4 days, head and neck cancer patients 10.5 and cervix cancer patients 11.6 days. The total average delay was 8.7 days.

November to December 2013: During this period the only modified change was to ensure that all relevant radiotherapy staff in the department undergoes in-house training on how to prepare medical aid motivations. The other changes as above were also continued. This change affected all the patients in the study. The average radiotherapy delays in days for each patient's tumor type were as follows: breast cancer patients 10 days and cervix cancer patients 7.3 days. There were no head and neck cancer patients who could have been included in the study during this time. The total average delay was 8.6 days. The graph in Figure 21 below shows the changes in delays in days after implementing the PDSA changes.

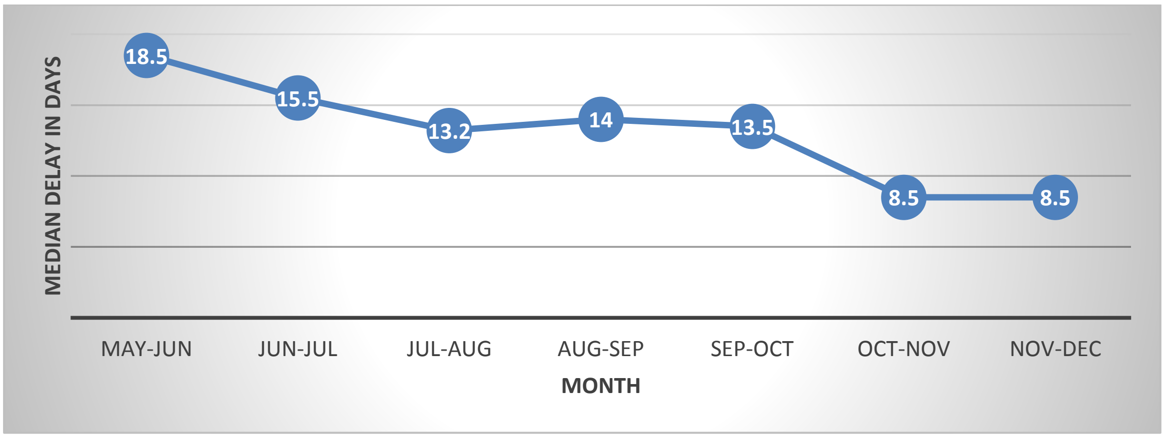

Figure 21: The average monthly delay in days after PDSA implementation in KNH CTC.

4.4 Run Charts Results

The run charts were monitored for each tumor type with the baseline as the start point and two weeks (14 days) as the set target.

4.4.1 Head and Neck Cancer Patients' Run Chart

The results of the head and neck run chart are indicated in the graph in Figure 21 below. As mentioned earlier, the PDSA cycles were implemented on 22 head and neck cancer patients seen between May and December 2013. In these patients twelve (54.5percent) received their treatment below the set target of 14 days. However ten patients (45 percent) still received their treatment above the set target of 14 days. The highest delay was 48 days in one patient who was sent back to referral clinic for dental assessment before radiotherapy. The other nine patients (40 percent) were delayed due to CT/ contour plans or customized block making which were still imported from Netherlands. Between August and December 2013 after a block cutter was installed at KNH cancer Centre and PDSA cycles change to the CT and contour plans process, no head and neck patients were delayed beyond 14 days

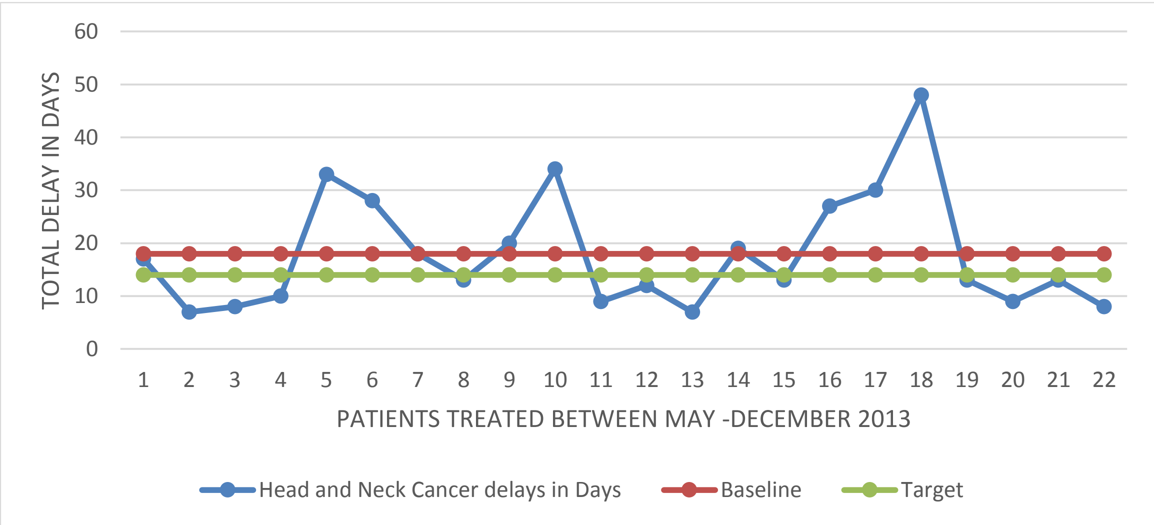

Figure 22: Head and Neck cancer run chart for radiotherapy delays in KNH CTC 2013.

4.4.2 Breast Cancer Patients' Run Chart

In breast cancer patients the PDSA cycles were implemented on a total of 24 breast patients treated between May and December 2013 as indicated in Figure 4.10 below. In these patients after implementing the PDSA cycles, eighteen (81.8 percent) patients started their radiotherapy below the set target of 14 days. However six (25 percent) patients started radiotherapy above the set target of 14 days. The highest delay was 81days in one patient who was delayed due to medical aid response and the patient's preference to prolong start of radiotherapy. Four (16.6 percent) patients were due to delays in medical aid response, and one due to departmental bookings. Among these four patients, three were also delayed in the month of September 2013when the radiotherapy treatment planning digitizer at KNH CTC developed a fault and a manual approach of planning the breast patient had to be initiated.

During this period the radiotherapy staff also had to learn how to use the manually implemented system. Most breast cancer patients are planned with a contour outline and planning digitizer at KNH CTC. One breast patient was eliminated from the study because she was found to have pneumocystis carinii pneumonia (PCP) during the planning stage and had to be sent for treatment for this before starting radiotherapy.

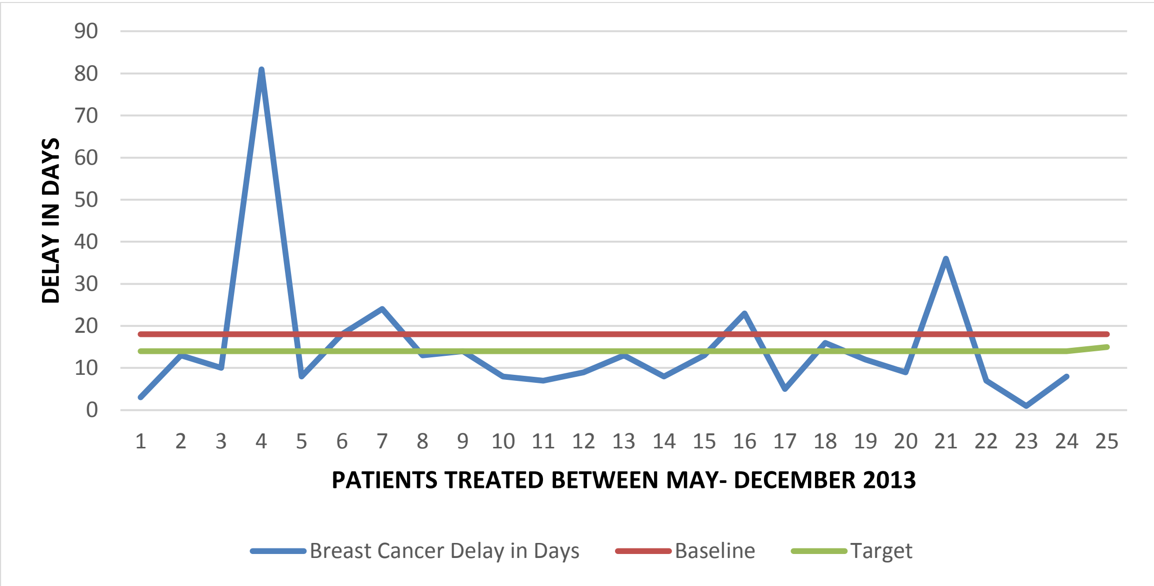

Figure 23: Breast cancer run chart for radiotherapy delays at KNH CTC.

4.4.3 Cervix Cancer Patients Run Charts

In cervix cancer patients the PDSA cycles were implemented on a total of 63 patients as indicated in Figure 4.11 below. After implementing the PDSA cycles, fifty- three (84.1percent) patients started their treatment below the 14 day target. However, ten (15.9percent) cervix patients started their treatment above 14 days. Among the patients that started treatment above the set target five (8.1 percent) patients delayed due to medical aid cover with one patient being denied medical aid cover due to shortage of funds.

Motivation for government financial assistance was done for the patient to start radiotherapy. Two of these patients were further delayed due to the treatment planning digitizer having a fault in September 2013Similar to breast cancer patients most cervix patients are also planned with a contour and treatment planning digitizer at KNH CTC. Therefore learning and adapting to the manual planning system for cervix cancer patients was also done. The other 5 patients were delayed due to departmental booking systems at the beginning of the PDSA implementation process. The baseline delay for cervix patients was already below the 14 days target in the retrospective survey. The PDSA cycles were therefore mainly implemented to maintain the delay time below 14 days in these patients.

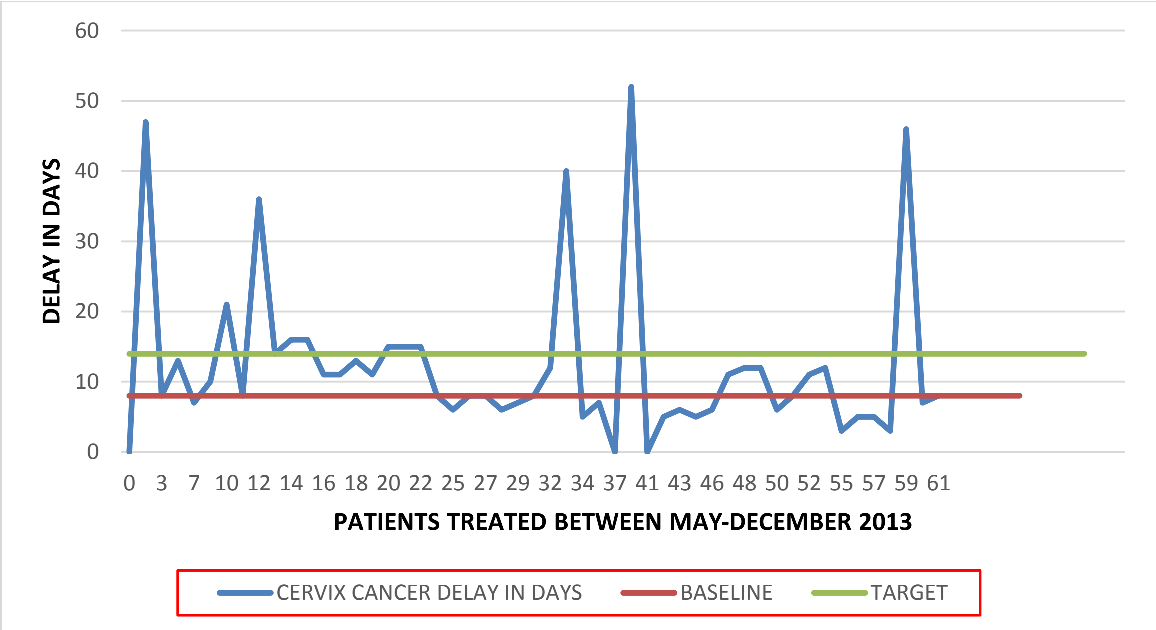

Figure 24: Cervix cancer run chart for radiotherapy delays in KNH CTC

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4.5 Results Discussion

The results from the study indicate that implementing PDSA cycles reduced radiotherapy delays at KNH, radiotherapy unit in head and neck, breast and cervix cancer patients. However, there were certain areas that did not produce acceptable reductions in radiotherapy delay.

According to the results at radiotherapy department even after implementing the PDSA cycles 8.1 percent cervix cancer patients and 16.6 percent breast cancer patients still received their treatment beyond the acceptable 14 days mark. These radiotherapy delays were caused by financial reasons especially for patients who were not automatically covered under any medical aid.

The results are in line with comments by Bloor (2008) and Gubb (2008) who suggest that radiotherapy treatment is expensive and that for patients who may need financing or need to obtain insurance cover approval for their treatment, radiotherapy delays could be expected.

Radiotherapy delays also arose in breast and cervix cancer patients when the planning digitizer developed a fault and the department had to resort to using manual digitizing to plan these patients while waiting for purchase of a new digitizing system. Mackillop (2007) and Souza et al. (2001) have highlighted that slow responses to funding decisions and previous planning recommendations on purchase of equipment could also be contributory factors in radiotherapy delays.

In head and neck cancers 40 percent of the patients were still delayed after implementing the PDSA cycles due to the CT planning process or delay in customized block preparation and deliveries. These results are in line with suggestions by Mackillop (2007) who points out that the sequential short delays in pre-treatment imaging may also add to the total delay time. In this study, installing a block cutter laboratory within the KNH CTC premises led to significant reductions in radiotherapy delays especially in head and neck patients. This highlights the importance of adhering to planning recommendations on required equipment as suggested by Mackillop (2007) and Souza et al. (2001).

Overall implementation of the PDSA cycles showed significant reduction in radiotherapy delays at KNH CTC. In head and neck cancer patients 54.5percent received their treatment below 14 days compared to 45 percent who received treatment above 14 days. In breast cancer patients 81.8 percent received their treatment below 14 days compare to 18.2 percent who received treatment above 14days. In cervix cancer patients 83.6 percent received their treatment below 14 days compare to 16.1 percent who received treatment above 14 days.

4.6 Limitation of Study

The research at KNH CTC had certain limitations. Although the results indicated that implementing the PDSA model improved radiotherapy delays at the cancer unit, it was impossible to rule out the Hawthorne Effect on the result of the study. According to Leonard and Masutu (2006) the danger of the Hawthorne Effect is that results are temporary and once the study is completed people tend to return to normal behavior. In spite of this, since the Hawthorne Effect is always on the side of better performance (Leonard and Masutu 2006) it may have been beneficial for achieving improvement. Furthermore, each PDSA cycle that was accepted was made as standard procedure in the department. Making the accepted PDSA cycle change standard could reduce the Hawthorne Effect.

Due to continuous increase in the number of cancer patients seen at cancer unit sustainability of these results requires continuous data collection. As stated in the introduction and shown with KNH CTC statistics the number of new patients seen is continuing to increase and expected to increase even more in the coming years. Souza et al (2001) have suggested that funding to operate cancer treatment facilities should take into account depreciation of equipment, increase in the number of patients and any other changes that may arise in the services provided.

The Centre currently has 2 cobalt machines and few staff from inception in the year 1998. Due to the noted increase in number of cancer patients at the Centre and future expected increase, outdated equipment and same number of staff may not be sufficient to provide services. Therefore although the results at the cancer unit showed that staffing was in the least causes of delay, the near future may indicate contrary results. According to Khan (1994), staffing recommendations and looking at the staffing levels and the number of patient increase from 2004 to 2013, this is one area the Centre will have to look at.

Chapter 5

Recommendation and Conclusion

5.1 Recommendations

In this study it was not possible to significantly reduce radiotherapy delays due to financial reasons using the PDSA model. Other quality improvement models or strategies could therefore be recommended in improving radiotherapy delays in this area just access to medical cover through National Health Insurance Fund (NHIF). It would further be recommended that more education on importance of starting radiotherapy be introduced to medical aid organizations.

Due to the increased awareness of cancer and availability of treatment at KNH, the number of new cancer patients seen will continue to rise. The expected increase may not be able to be sustained with the available equipment and manpower currently at Radiotherapy Unit. The department will in future need to look at increasing equipment capacity such as installing linear accelerators and more staff to manage these linear accelerators.

Other mechanism of increasing radiotherapy effectiveness such as giving treatment twice daily, treating over weekends or hyper fractionation schedules can be used (Burnet et al., 2000; Horiot et al., 1992). At present at Radiotherapy Unit patients is done once a day and therefore by treating over the weekend can compensate for any radiotherapy gaps and to ensure that treatment is completed within the prescribed time. Due to the improved radiotherapy delays using the PDSA model and ensuring that patients receive their radiotherapy treatment within the prescribed time the researcher believes that radiotherapy outcome will be greatly improved in the radically treated patients. However, to validate this statement follow-up post-radiotherapy research needs to be conducted. Furthermore, due to the limited number of staff coupled with the continuous increase in number of patients seen at the Centre sustaining twice daily treatments or treatment over the weekend may become a challenge in future.

This study definitely showed that use of the PDSA quality improvement intervention can assist in reducing delays in radiotherapy departments. However other quality improvement models such as the Six Sigma, Total Quality Management (TQM), Business Process Re-engineering (BPR) and Lean Thinking Model have been used in healthcare services. Depending on area of improvement required these models have shown success in healthcare. Radiotherapy departments should encourage use of these models to increase impact of quality improvement initiatives.

5.2 Conclusion

Several studies have shown that reducing radiotherapy delays can achieve an improvement in radiotherapy treatment outcome. Therefore reducing radiotherapy delays is one of the major concerns in most radiotherapy departments. The increased demand for radiotherapy services has resulted in many radiotherapy departments finding it difficult to maintain radiotherapy delays within acceptable limits (Jensen et al., 2007). The JCCO recommends that for radical radiotherapy, even that which involves complex treatment planning; a two week delay is considered good practice (JCCO1993). The committee on standards of the Canadian Association of Radiation Oncologists recommends that the interval between patient referral and consultation and between consultation and initial radiotherapy should both not exceed 2 weeks (Mackillop et al. 1994). Mackillop (2007) further suggest that as there is no threshold level on which radiotherapy delay may be considered safe, radiotherapy delays should be kept as short as reasonably achievable (ASARA). Therefore in order to maintain radiotherapy delays within acceptable standards, radiotherapy departments need to explore a variety of options that can assist in this area.

Quality improvement initiatives or systems that can be of benefit are available. Berwick (1996) highlights that to achieve improvement a method for systemic change is needed. The PDSA model for improvement is an example of such systemic change which has been proven to work in healthcare improvement as well as in assisting in reducing radiotherapy delays in radiotherapy departments (Woynar et al. 2007; Kerr et al. 2002). The PDSA model has shown to be ideal in healthcare because it can be easily implemented in routine work setting using small scale changes. This way less time, money and risk is guaranteed. Langley et al. (1996) also highlight that there is often less resistance to change when using the PDSA model because it encourages team effort in developing a change of ideas.

Due to its guaranteed ability of providing low risk of normal work disruption, less time consuming and low cost (Berwick 1996), the PDSA model was the ideal model chosen for this research. The research at Radiotherapy Unit showed that implementing the PDSA model reduced radiotherapy delays from the patients' first visit to CTC to the start of initial treatment within good practice standards according to the JCCO. The results showed a decline in radiotherapy delays in radically treated head and neck, breast and cervix cancer patients within

6 months (average delay of 18.5 days in May 2008 to 8.6 days by December 2013 after implementing the PDSA model. As head and neck, breast and cervix cancer patients are the most treated cancer at CTC achieving reduced radiotherapy delays in these cancer patients implies reducing radiotherapy delays in the majority of radically treated patients at the Centre.

However other factors may have influenced the study. Customized blocks are imported from outside the Kenya, and during early stages of the study they were not supplied. By installing a block cutter laboratory within the Radiotherapy Unit premises can lead to significant reductions in radiotherapy delays especially in head and neck patients. Radiotherapy delays were also significantly increased in breast and cervix cancer patients when the planning digitizer developed a fault and the department had to resort to using manual digitizing to plan these patients while waiting for purchase of a new digitizing system. It was also not possible to rule out the Hawthorne effect in the study, where the staff involved in improvement could have worked more efficiently because they were being observed.

Despite this the study still showed that the PDSA model can be used to improve radiotherapy delays in radiotherapy departments. Powell et al (2008) highlights that no quality improvement model is more superior over another and the choice will depend on the objectives that are to be achieved. The choice of using the PDSA model in this study was due to the fact that changes in the PDSA are done on a small scale therefore it is easier to control risk and normal work disruption.

Furthermore, minimum time and little financial investment are needed when using the PDSA model. The PDSA model could also be easily designed to fit a set of local circumstances at the CTC. The researcher would however still encourage and recommended more research on the other quality improvement models in reducing radiotherapy delays in radiotherapy departments.

The researcher is aware that reducing radiotherapy delays is only one mechanism of increasing radiotherapy effectiveness. Burnet et al. (2000) suggest that compensation of gaps that occur during radiotherapy treatment or use of altered fractionation schedules such as hyper fractionation and continuous hyper fractionated accelerated radiotherapy (CHART) can also increase the effectiveness of radiotherapy. Therefore reducing radiotherapy delays combined with other mechanism of improving radiotherapy effectiveness could greatly improve treatment outcome in radically treated head and neck, cervix and breast cancer patients.

The aim of the study at KNH CTC was to develop and implement improvements for reducing radiotherapy delays between the patients referral to a radiotherapy department to the start of radical radiotherapy by using the PDSA model for improvement. Mackillop (2007) also highlights that it is logical to start to start any kind of oncology treatment as soon as possible so as to minimize psychological distress for cancer patients and maximize possible tumor control. Through implementing the PDSA model this study was able to reduce and maintain radiotherapy delays to within the standards set by the JCCO.

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Appendices

Appendix 1: Retrospective Survey Data Collection Sheets

Table 6: Breast Cancer retrospective data collection sheet.

Research Number	Date Of Referral	First treatment Date	Delay In Days	Reason For Delay	County/Hospital Of Referral
BR14/01	17-Jan-2013	24-Jan-2013	7	Routine Plan	Public
BR14/02	25-Jan-2013	05-Feb-2013	10	Bookings	Public
BR14/03	25-Jan-2013	05-Feb-2013	10	Bookings	Public
BR14/04	24-Feb-2013	7-Mar-2013	7	Routine Plan	Public
BR/14/05	24-Feb-2013	15-Mar-2013	15	Bookings	Public
BR14/06	6-Mar-2013	25-Mar-2013	19	Waiting histology + Staging	Public
BR14/07	9-Jul-2013	31-Jul-2013	22	Routine Plan	Private
BR14/08	13-Mar-2013	19-Mar-2013	6	Routine Plan	Public
BR14/09	13-Mar-2013	19-Mar-2013	6	Routine Plan	Public
BR14/10	11-Apr-2013	18-Apr-2013	7	Routine Plan	Public
BR14/11	11-Apr-2013	19-Apr-2013	8	Routine Plan	Public
BR14/12	26-Apr-2013	18-Apr-2013	7	Routine Plan	Public
BR14/13	12-Apr-2013	2-May-2013	20	Re simulation + Re Plan	Public
BR14/14	24-Jan-2013	15-May-2013	19	Bookings	Public
BR14/15	9-May-2013	6-Jun-2013	27	Re simulation + Re Plan	Public
BR14/16	15-May-2013	28-May-2013	13	Bookings	Public
BR14/17	9-Nov-2012	22-Jan-2013	73	Bookings + Communication	Public
BR14/18	4-Jun-2013	12-Jun-2013	8	Routine Plan	Public

BR14/19	25-Jun-2013	9-Jul-2013	14	Bookings	Public
BR14/20	3-Jul-2013	10-Jul-2013	7	Routine Plan	Public
BR14/21	9-Jul-2013	24-Jul-2013	15	Machine Service	Public
BR14/22	10-Jul-2013	26-Jul-2013	16	Machine Service	Public
BR14/23	10-Jul-2013	30-Jul-2013	20	Machine Service	Public
BR14/24	18-Dec-2012	4-Feb-2013	46	Medical Aid	Private
BR14/25	11-Jul-2013	25-Jul-2013	14	Bookings	Public
BR14/26	2-Aug-2013	14-Aug-2013	12	Bookings	Public
BR14/27	7-Aug-2013	15-Aug-2013	8	Routine Plan	Public
BR14/28	9-Oct-2013	16-Oct-2013	7	Routine Plan	Public
BR14/29	29-Oct-2013	9-Nov-2013	10	Bookings	Public
BR14/30	1-Nov-2013	12-Nov-2013	11	Bookings	Public
BR14/31	1-Nov-2013	20-Nov-2013	19	Bookings	Public
BR14/32	5-Nov-2012	9-Jan-2013	64	Medical Aid + Communication	Public
BR14/33	14-Nov-2013	27-Nov-2013	13	Bookings	Public
BR14/34	27-Dec-2012	31-Jan-2013	34	Medical Aid	Private
BR14/35	12-Nov-2013	4-Dec-2013	22	Bookings	Public
BR14/36	26-Nov-2013	29-Nov-2013	3	Routine Plan	Public
BR14/37	12-Dec-2012	16-Jan-2013	34	Review by oncologist	Public
	MEAN		17.65		

Table 7: Cervix cancer retrospective data collection Sheet

Research Number	**Date Of Referral**	**First treatment Date**	**Delay In Days**	**Reason For Delay**	**County/Hospital Of Referral**
CX14/01	4-Jan-2013	9-Jan-2013	5	Routine Plan	Public Patient
CX14/02	8-Jan-2013	10-Jan-2013	2	Routine Plan	Public Patient

CX14/03	16-Jan-2013	30-Jan-2013	14	Dr consults + Low HB	Public Patient
CX14/04	17-Jan-2013	23-Jan-2013	6	Routine Plan	Public Patient
CX/14/05	25-Jan-2013	7-Feb-2013	12	Bookings	Public Patient
CX14/06	5-Feb-2013	12-Feb-2013	7	Routine Plan	Public Patient
CX14/07	6-Feb-2013	14-Feb-2013	8	Routine Plan	Public Patient
CX14/08	7-Feb-2013	14-Feb-2013	7	Routine Plan	Public Patient
CX14/09	12-Feb-2013	19-Feb-2013	7	Routine Plan	Public Patient
CX14/10	13-Feb-2013	27-Feb-2013	14	Bookings	Public Patient
CX14/11	16-Feb-2013	5-Mar-2013	19	Awaiting Histology	Public Patient
CX14/12	19-Feb-2013	1-Mar-2013	12	Routine Plan	Public Patient
CX14/13	19-Feb-2013	28-Feb-2013	9	Routine Plan	Public Patient
CX14/14	13-Mar-2013	15-Mar-2013	2	Routine Plan	Public Patient
CX14/15	19-Mar-2013	20-Mar-2013	1	Routine Plan	Public Patient
CX14/16	26-Mar-2013	28-Mar-2013	2	Routine Plan ΔPalliative	Public Patient
CX14/17	16-Apr-2013	23-Apr-2013	7	Routine Plan	Public Patient
CX14/18	16-Apr-2013	19-Apr-2013	3	Routine Plan	Public Patient
CX14/19	24-Apr-2013	7-May-2013	13	Bookings	Public Patient
CX14/20	8-May-2013	14-May-2013	6	Routine Plan	Public Patient
CX14/21	14-May-2013	22-May-2013	8	Routine Plan	Public Patient
CX14/22	15-May-2013	18-May-2013	13	Bookings	Public Patient
CX14/23	29-May-2013	7-Jun-2013	8	Routine Plan	Public Patient
CX14/24	29-May-2013	5-Jun-2013	6	Routine Plan	Public Patient
CX14/25	6-Jun-2013	12-Jun-2013	6	Routine Plan	Public Patient
CX14/26	14-Jun-2013	20-Jun-202013	6	Routine Plan	Public Patient
CX14/27	26-Jun-2013	28-Jun-2013	2	Routine Plan	Public Patient
CX14/28	18-Jun-2013	25-Jun-2013	7	Routine Plan ΔPalliative	Public Patient

CX14/29	22-Jun-2013	25-Jun-2013	3	Routine Plan	Public Patient
CX14/30	29-Jun-2013	5-Jul-2013	6	Routine Plan	Public Patient
CX14/31	9-Jul-2013	23-Jul-2013	14	Bookings	Public Patient
CX14/32	13-Jul-2013	26-Jul-2013	13	Bookings	Public Patient
CX14/33	23-Jul-2013	14-Aug-2013	21	Dr consults sent for U/S	Public Patient
CX14/34	23-Jul-2013	1-Aug-2013	8	Routine Plan	Public Patient
CX14/35	23-Jul-2013	1-Aug-2013	8	Routine Plan	Public Patient
CX14/36	23-Jul-2013	31-Jul-2013	8	Routine Plan	Public Patient
CX14/37	23-Jul-2013	1-Aug-2013	8	Routine Plan	Public Patient
CX14/38	23-Jul-2013	2-Aug-2013	9	Routine Plan	Public Patient
CX14/39	23-Jul-2013	2-Aug-2013	9	Routine Plan	Public Patient
CX14/40	23-Jul-2013	1-Aug-2013	8	Routine Plan	Public Patient
CX14/41	23-Jul-2013	1-Aug-2013	8	Routine Plan	Public Patient
CX14/42	7-Aug-2013	15-Aug-2013	8	Routine Plan	Public Patient
CX14/43	13-Aug-2013	20-Aug-2013	7	Routine Plan	Public Patient
CX14/44	20-Aug-2013	22-Aug-2013	2	Routine Plan	Public Patient
CX14/45	20-Aug-2013	22-Aug-2013	2	Routine Plan	Public Patient
CX14/46	21-Aug-2013	27-Aug-2013	6	Routine Plan	Public Patient
CX14/47	31-Aug-2013	11-Sep-2013	11	Delayed Financial Assistance	Public Patient
CX14/48	13-Sep-2013	20-Sep-2013	7	Routine Plan	Public Patient
CX14/49	18-Sep-2013	27-Sep-2013	10	Bookings	Public Patient
CX14/50	19-Sep-2013	24-Sep-2013	6	Routine Plan	Public Patient
CX14/51	19-Sep-2013	24-Sep-2013	5	Routine Plan	Public Patient
CX14/52	21-Sep-2013	30-Sep-2013	9	Routine Plan	Public Patient
CX14/53	11-Oct-2013	17-Oct-2013	20	Dr consults + Low HB	Public Patient
CX14/54	11-Oct-2013	22-Oct-2013	6	Routine Plan	Public Patient
CX14/55	11-Oct-2013	16-Oct-2013	5	Routine Plan	Public Patient
CX14/56	16-Oct-2013	22-Oct-2013	6	Routine Plan	Public Patient
CX14/57	31-Oct-2013	8-Nov-2013	8	Routine Plan	Public Patient
CX14/58	9-Nov-2013	14-Nov-2013	5	Routine Plan	Public Patient

CX14/59	15-Nov-2013	15-Nov-2013	0	Emergency	Public Patient
CX14/60	19-Nov-2013	22-Nov-2013	3	Routine Plan	Public Patient
CX14/61	27-Nov-2013	3-Dec-2013	6	Routine Plan	Public Patient
CX14/62	27-Nov-2013	3-Dec-2013	6	Routine Plan	Public Patient
CX14/63	3-Dec-2013	5-Dec-2013	2	Routine Plan ∆Palliative	Public Patient
CX14/64	17-Dec-2013	19-Dec-2013	2	Routine Plan	Public Patient
CX14/65	18-Dec-2013	20-Dec-2013	2	Routine Plan	Public Patient
CX14/66	17-Dec-2013	19-Dec-2013	2	Routine Plan	Public Patient
CX14/67	17-Dec-2013	19-Dec-2013	2	Routine Plan	Public Patient
CX14/68	19-Dec-2012	7-Jan-2013	18	Service	Public Patient
	Mean		7.37		

Table 8 : Head and Neck cancer retrospective data collection sheet

Research Number	**Date Of Referral**	**First treatment Date**	**Delay In Days**	**Reason For Delay**	**County/Hospital Of Referral**
HN/01	3-Jan-2013	24-Jan-2013	21	Blocks	Public Patient
HN/02	4-Jan-2013	31-Jan-2013	4	Routine Plan	Public Patient
HN/03	9-Jan-2013	30-Jan-2013	7	Routine Plan	Public Patient
HN/04	22-Jan-2013	20-Feb-2013	9	Routine plan	Public Patient
HN/05	23-Jan-2013	21-Feb-2013	7	Routine Plan	Public Patient
HN/06	24-Jan-2013	28-Feb-2013	27	Bookings	Public Patient
HN/07	25-Jan-2013	21-Feb-2013	27	CT Plan	Public Patient
HN/08	8-Feb-2013	28-Feb-2013	20	CT Plan	Public Patient
HN/09	14-Feb-2013	21-Feb-2013	7	Routine Plan	Public Patient
HN/10	7-Mar-2013	21-Mar-2013	14	Bookings	Public Patient
HN/11	26-Mar-2013	26-Jun-2013	92	Bookings Dr. re-assessment	Public Patient, Dental assessment

HN/12	2-Apr-2013	2-May-2013	30	Finances, Blocks	Public Patient
HN/13	10-Apr-2013	23-Apr-2013	14	Blocks	Public Patient
HN/14	13-Apr-2013	23-Apr-2013	10	Bookings	Public Patient
HN/15	2-May-2013	8-May-2013	6	Routine Plan	Public Patient
HN/16	3-May-2013	30-May -2013	27	Blocks	Public Patient
HN/17	3-May-2013	14-May -2013	11	Bookings	Public Patient
HN/18	8-May-2013	30-May -2013	22	CT Plan	Public Patient
HN/19	14-May-2013	24-May -2013	10	Bookings	Public Patient
HN/20	4-Jun-2013	28-Jun-2013	35	Bookings	Public Patient
HN/21	4-Jun-2013	27-Jun-2013	23	Bookings	Public Patient, treatment incomplete
HN/22	5-Jun-2013	13-Jun-2013	7	Routine plan	Public Patient
HN/23	26-Jun-2013	23-Jul-2013	27	Bookings	Public Patient
HN/24	26-Jun-2013	3-Jul-2013	8	Routine plan	Public Patient
HN/25	3-Jul-2013	10-Jul-2013	7	Routine plan	Public Patient
HN/26	20-Jul-2013	25-Jul-2013	5	Routine plan	Public Patient
HN/27	25-Jul-2013	28-Aug-2013	34	Bookings	Public Patient
HN/28	6-Aug-2013	16-Aug-2013	10	Bookings	Public Patient
HN/29	13-Aug-2013	20-Aug-2013	7	Routine plan	Public Patient
HN/30	9-Oct-2013	17-Aug-2013	8	Routine plan	Public Patient
HN/31	22-Oct-2013	8-Nov-2013	16	CT Plan	Public Patient
HN/32	8-Nov-2013	22-Nov-2013	17	Bookings	Public Patient
HN/33	8-Nov-2013	20-Nov-2013	13	Delay in Waiver approval	Public Patient
HN/34	19-Nov-2013	7-Jan-2014	19	Blocks	Public Patient
HN/35	21-Nov-2013	26-Nov-2013	6	Routine plan	Public Patient

HN/36	22-Nov-2013	28-Nov-2013	6	Routine plan	Public Patient
HN/37	6-Dec-2013	17-Jan-2014	42	Bookings	Public Patient
HN/38	23-Nov2013	18-Dec-2013	26	Blocks	Public Patient
HN/39	6-Aug-2013	16-Aug-2013	10	Bookings	Public Patient
HN/40	20-Aug-2013	30-Aug-2013	10	Bookings	Public Patient
	MEAN		17.5		

Appendix 2: Prospective Data Collection Sheet (After PDSA implementation)

Table 9: Cervix cancer prospective data collection sheet.

Cervix				
Data Collection Monthly Chart May – June 2013				
Research Number	Date Of Referral	Date Of First Treatment	Time Interval In Days	Reason For Delays
GPH CACX 01	6-May-2013	23-Jun-2013	47	Financial aid
GPH CACX 02	25-May-2013	11-Jun-2013	14	Acceptable
GPH CACX 03	11-Jun-2013	19-Jun-2013	8	Acceptable
GPH CACX 04	13-Jun-2013	16-Jun-2013	13	Acceptable
GPH CACX 05	12-May-2013	22-May-2013	10	Acceptable
GPH CACX 06	26-May-2013	3-Jun-2013	7	Acceptable
GPH CACX 07	13-Jun-2013	23-Jun-2013	10	Acceptable
GPH CACX 08	16-Jun-2013	24-Jun-2013	8	Acceptable
GPH CACX 09	2-Jun-2013	13-Jun-2013	11	Acceptable
GPH CACX 10	27-May-2013	18-Jun-2013	21	Bookings

GPH CACX11	9-Jun-2013	17-Jun-2013	8	Acceptable
GPH CACX 12	5-May-2013	11-Jun-2013	36	Financial aid
GPH CACX 13	27-May-2013	11-Jun-2013	14	Acceptable
		Mean	15.9230762	

Cervix				
Data Collection Monthly Chart June – July 2013				
Research Number	Date Of Referral	Date Of First Treatment	Time Interval In Days	Reason For Delays
GPH CACX 14	23-Jun-2013	9-Jul-2013	16	Booking
GPH CACX 15	16-Jun-2013	2-Jul-2013	16	Booking
GPH CACX 16	26-Jun-2013	7-Jul-2013	11	Acceptable
GPH CACX 17	26-Jun-2013	7-Jul-2013	11	Acceptable
GPH CACX 18	20-Jun-2013	3-Jul-2013	13	Acceptable
GPH CACX 19	3-Jul-2013	14-Jul-2013	11	Acceptable
GPH CACX 20	26-Jun-2013	8-Jul-2013	12	Acceptable
GPH CACX 21	23-Jun-2013	8-Jul-2013	15	Booking
GPH CACX 22	2-Jul-2013	8-Jul-2013	7	Acceptable
GPH CACX 23	30-Jun-2013	8-Jul-2013	9	Acceptable
GPH CACX 24	23-Jun-2013	8-Jul-2013	15	Booking
GPH CACX 25	2-Jul-2013	8-Jul-2013	7	Acceptable
Mean			11.92	

Cervix
Data Collection Monthly Chart July – August 2013

Research Number	Date Of Referral	Date Of First Treatment	Time Interval In Days	Reason For Delays
GPH CACX 26	19-Aug-2013	27-Aug-2013	8	Acceptable
GPH CACX 27	28-Jul-2013	6-Aug-2013	8	Acceptable
GPH CACX 28	21-Aug-2013	27-Aug-2013	6	Acceptable
GPH CACX 29	21-Aug-2013	28-Aug-2013	7	Acceptable
GPH CACX 30	6-Aug-2013	13-Aug-2013	7	Acceptable
GPH CACX 31	8-Aug-2013	13-Aug-2013	8	Acceptable
MEAN			7.33333	

Cervix				
Data Collection Monthly Chart August – September 2013				
Research Number	Date Of Referral	Date Of First Treatment	Time Interval In Days	Reason For Delays
GPH CACX 32	3-Sep-2013	15-Sep-2013	12	Acceptable
GPH CACX 33	4-Sep-2013	17-Sep-2013	13	Acceptable
GPH CACX 34	5-Aug-2013	15-Sep-2013	40	Lacking Financial aid- Waiver sent to Social worker
GPH CACX 35	19-Sep-2013	24-Sep-2013	5	Acceptable
GPH CACX 36	5-Sep-2013	22-Sep-2013	17	Financial aid
GPH CACX 37	18-Sep-2013	23-Sep-2013	5	Acceptable
GPH CACX 38	23-Sep-2013	23-Sep-2013	0	Acceptable , Emergency
GPH CACX 39	3-Sep-2013	15-Sep-2013	12	Acceptable
GPH CACX 40	15-Sep-2013	9-Sep-2013	54	Medical aid + Planning digitizer down
MEAN			17.56	

Cervix				
Data Collection Monthly Chart September – October 2013				
Research Number	Date Of Referral	Date Of First Treatment	Time Interval In Days	Reason For Delays
GPH CACX 41	23-Sep-2013	7-Oct-2013	14	Acceptable
GPH CACX 42	2-Oct-2013	2-Oct-2013	0	Acceptable
GPH CACX 43	2-Oct-2013	7-Oct-2013	5	Acceptable
GPH CACX 44	2-Oct-2013	8-Oct-2013	6	Acceptable
GPH CACX 45	9-Oct-2013	14-Oct-2013	5	Acceptable
GPH CACX 46	16-Oct-2013	22-Oct-2013	6	Acceptable
GPH CACX 47	2-Oct-2013	13-Oct-2013	11	Acceptable
GPH CACX 48	2-Oct-2013	14-Oct-2013	12	Acceptable
GPH CACX 49	16-Oct-2013	22-Oct-2013	6	Acceptable
GPH CACX 50	2-Oct-2013	13-Oct-2013	11	Acceptable
GPH CACX 51	25-Sep-2013	8-Oct-2013	13	Acceptable
GPH CACX 52	2-Oct-2013	15-Oct-2013	13	Acceptable
GPH CACX 53	2-Oct-2013	29-Oct-2013	8	Acceptable
MEAN			8.46	

Cervix				
	Data Collection Monthly Chart October – November 2013			
Research Number	Date Of Referral	Date Of First Treatment	Time Interval In Days	Reason For Delays
GPH CACX 54	5-Nov-2013	17-Nov-2013	12	Acceptable
GPH CACX 55	24-Nov-2013	1-Dec-2013	7	Acceptable
GPH CACX 56	17-Nov-2013	20-Nov-2013	3	Acceptable
GPH CACX 57	12-Nov-2013	17-Nov-2013	5	Acceptable
GPH CACX 58	26-Nov-2013	1-Dec-2013	5	Acceptable
GPH CACX 59	17-Nov-2013	20-Nov-2013	3	Acceptable

GPH CACX 60	5-Nov-2013	19-Nov-2013	40	Financial aid
MEAN			15.9230762	

Cervix				
Data Collection Monthly Chart November – December 2013				
Research Number	Date Of Referral	Date Of First Treatment	Time Interval In Days	Reason For Delays
GPH CACX 61	1-Dec-2013	8-Dec-2013	7	Acceptable
GPH CACX 62	15-Dec-2013	23-Dec-2013	8	Acceptable
GPH CACX 63	9-Dec-2013	16-Dec-2013	7	Acceptable
MEAN			7.333333333	

Table 10: Breast cancer prospective data collection sheet

Breast				
Data Collection Monthly Chart May-June 2013				
Research Number	Date Of Referral	Date of First Treatment	Time Interval In Days	Reason for Delay
GPH BREAST/01	16-Jun-2013	16-Jun-2013	3	Acceptable
GPH BREAST 02	19-May-2013	2-Jun-2013	13	Acceptable
GPH BREAST/03	12-May-2013	22-May-2013	10	Acceptable
GPH BREAST/04	20-Mar-2013	11-Jun-2013	81	Medical aid + patient Counseling
GPH BREAST/05	16-Jun-2013	24-Jun-2013	8	Acceptable
GPH BREAST/06	27-May-2013	18-Jun-2013	21	Bookings
GPH BREAST/07	27-May-2013	23-Jun-2013	26	Bookings
GPH BREAST/08	26-May-2013	9-Jun-2013	13	Acceptable
	Mean		21.875	

Breast

Data Collection Monthly Chart June-July 2013				
Research Number	Date Of Referral	Date of First Treatment	Time Interval In Days	Reason for Delay
GPH BREAST/09	23-Jun-2013	7-Jul-2013	14	Acceptable
GPH BREAST/ 10	25-Jun2013	2-Jul-2013	9	Acceptable
	Mean		11.5	

Breast				
	Data Collection Monthly Chart August-September 2013			
Research Number	Date Of Referral	Date of First Treatment	Time Interval In Days	Reason for Delay
GPH BREAST/11	19/08/2014	27/08/2014	8	Acceptable
GPH BREAST /12	06/08/2014	20/08/2014	9	Acceptable
GPH BREAST/13	30/07/2014	13/08/2014	13	Acceptable
GPH BREAST/14	19/08/08	27/08/2014	8	Acceptable
	Mean		9	

Breast				
Data Collection Monthly Chart August-September 2013				
Research Number	Date Of Referral	Date of First Treatment	Time Interval In Days	Reason for Delay
GPH BREAST/15	25/08/2014	08/009/2014	13	Acceptable
GPH BREAST /16	15/08/2014	08/09/2014	23	Acceptable
GPH BREAST/17	03/09/2014	08/09/2014	5	Acceptable
GPH BREAST/18	25/	08/09/2014	5	Acceptable
	Mean		13.6	

Breast

Data Collection Monthly Chart September -October 2013				
Research Number	Date Of Referral	Date of First Treatment	Time Interval In Days	Reason for Delay
GPH BREAST/19	19/08/2014	27/08/2014	8	Acceptable
GPH BREAST /20	06/08/2014	20/08/2014	9	Acceptable
GPH BREAST/ 21	30/07/2014	13/08/2014	13	Acceptable
GPH BREAST/22	19/08/08	27/08/2014	8	Acceptable
	Mean		9	

Breast				
Data Collection Monthly Chart October-November 2013				
Research Number	**Date Of Referral**	**Date of First Treatment**	**Time Interval In Days**	**Reason for Delay**
GPH BREAST/24	19/08/2014	27/08/2014	8	Acceptable
GPH BREAST /25	06/08/2014	20/08/2014	9	Acceptable
GPH BREAST/26	30/07/2014	13/08/2014	13	Acceptable
GPH BREAST/27	19/08/08	27/08/2014	8	Acceptable
	Mean		9	

Breast				
Data Collection Monthly Chart 2013				
Research Number	Date Of Referral	Date of First Treatment	Time Interval In Days	Reason for Delay
GPH BREAST/ 28	19/08/2014	27/08/2014	8	Acceptable
GPH BREAST /29	06/08/2014	20/08/2014	9	Acceptable
GPH BREAST/30	30/07/2014	13/08/2014	13	Acceptable
	Mean		9	

Table 11: Head and Neck cancer prospective data collection sheet

Head/ Neck Data Data Collection Monthly Chart May – June 2013				
Research Number	**Date of Referral**	**Date of first Treatment**	**Time Interval in Days**	**Reasons for delay**
GPH H/N 01	3-Jun-08	20-Jun-08	17	
GPH H/N 02	7-May-08	14-May-08	7	
GPH H/N 03	6-May-08	14-May-08	8	
GPH H/N 04	9-Jun-08	19-Jun-08	10	
GPH H/N 05	26-May-08	23-Jun-08	27	
GPH H/N 06	20-May-08	23-Jun-08	33	Blocks delay
GPH H/N 07	3-Jun-08	23-Jun-08	20	
GPH H/N 08	6-May-08	19-May-08	13	
GPH H/N 09	27-May-08	23-Jun-08	26	
GPH H/N 10				
	Mean		17.8888889	

Head/ Neck Data Data Collection Monthly Chart June-July 2013				
Research Number	Date of Referral	Date of first Treatment	Time Interval in Days	Reasons for delay
GPH H/N 14	24-Jun-2013	28-Jul-2013	34	Booking
GPH H/N 15	7-Jul-2013	16-Jul-2013	9	Acceptable
	Mean		21.5	

Head/ Neck Data Data Collection Monthly Chart July- August 2013				
Research Number	**Date of Referral**	**Date of first Treatment**	**Time Interval in Days**	**Reasons for delay**
GPH H/N 14	15-Aug-13	27-Aug-03	12	Acceptable
GPH H/N 15	21-Aug-13	28-Aug-13	7	Acceptable
GPH H/N 16	16/07/2014	5-Aug-13	19	Booking
GPH H/N 17	04/08/2014	27-Aug-13	23	Booking
GPH H/N 18	08-July/2014	5-Aug-13	48	Booking
GPH H/N 19	08July-2014	26-Aug-13	30	Dental assessment
GPHN H/N 20	30/07/2014	30-Aug-13	30	booking
	Mean		24.714	

Head/ Neck Data				
Data Collection Monthly Chart September-October 2013				
Research Number	Date of Referral	Date of first Treatment	Time Interval in Days	Reasons for delay
GPH H/N 14	3-Sep-13	16-Sep-13	13	Acceptable
GPH H/N 15	9-Sep-13	18-Sep-13	9	Acceptable
	Mean		11	

Head/ Neck Data				
Data Collection Monthly Chart Oct–November 2013				
Research Number	**Date of Referral**	**Date of first Treatment**	**Time Interval in Days**	**Reasons for delay**
GPH H/N 14	5-Nov-13	18-Nov-13	12	
GPH H/N 15	3-Nov-13	11-Nov-13	7	Acceptable
	Mean		10.5	Acceptable