A QUALITY IMPROVEMENT MODEL TO ADDRESS DELAYS IN COMMENCEMENT OF RADIOTHERAPY IN BOTSWANA

A dissertation submitted to the Faculty of Health Sciences, University of Johannesburg, in fulfillment of the requirement for the Master of Technology: Radiography- Therapy by

Catherine Chilute Chilanga

(Student number 200830370)

Supervisor: Mrs. H Lawrence

Co- supervisor: Mr. R Makufa

Gaborone Botswana 2010
ABSTRACT

The recent increase in demand for radiotherapy services has led to significant delays in commencement of radical radiation treatment in most centres. Radiobiological principles suggest that a delay in starting radiotherapy may have a negative impact on tumour local control. To cope with the growing demand for radiotherapy, modern improvement models need to be accepted and adapted in radiotherapy departments. The PLAN DO STUDY ACT (PDSA) model is an example of such an improvement model which explores new possibilities of improvement through experimentation.

This study aimed to determine the causes of radiotherapy delays, and to develop and implement improvements for reducing radiotherapy delays from patients’ referral to a radiotherapy department to the start of radiotherapy at Gaborone Oncology in Botswana. The objectives were to determine the causes of radiotherapy delays, develop and implement improvements of reducing radiotherapy delays using the PDSA model for improvement, and evaluate the effectiveness of the model. Patients who had received radical radiotherapy for head and neck, breast and cervix tumours were analysed as they are the commonly treated cancers at Gaborone Oncology.

A retrospective survey was conducted for one year to establish the causes of radiotherapy delays from patient referral to the department to the start of radiation treatment. The PDSA model for improvement was then implemented and monitored for evidence of improvement from May to December 2008. The PDSA model showed significant reduction in radiotherapy delays at Gaborone Oncology. 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 2008 to 8.6 days by December 2008.

KEY WORDS: Radiotherapy Delay; PDSA model; Quality improvement.
In memory of my mother

Mrs. Mable Wyness Chilanga,

1945 -1992
ACKNOWLEDGEMENTS

Research supervisor, Mrs. H. Lawrence: The University of Johannesburg: Research co-supervisor, Mr. R. Makufa - Medical Physicist: The Life Healthcare Gaborone Oncology. The Life Healthcare Hospital, Gaborone, particularly oncology staff: Oncologists, Dr. M Heunis and Dr. J Kasese, Radiation Therapists and Oncology clerks.
# ABSTRACT

# DEDICATION

# ACKNOWLEDGEMENTS

## 1 CHAPTER 1 INTRODUCTION

1.1 Introduction

1.2 Description of Radiotherapy Delay and PDSA Model for Improvement

1.2.1 Radiotherapy Delay

1.2.2 The Plan Do Study Act (PDSA) Model for Improvement

1.2.3 The PDSA Cycle and How It Works

1.3 Background to study

1.4 Radiotherapy Management Process at Gaborone Oncology

1.5 Research Problem

1.6 Research Aims and Objectives

1.6.1 Aim

1.6.2 Objectives

1.7 Definition of Key Concepts

1.8 Abbreviations

1.9 Conclusion

## 2 CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

2.2 Effects of Radiotherapy Delay in Cancers

2.2.1 Effects of Radiotherapy Delay in Head and Neck Cancers

2.2.2 Effects of Radiotherapy Delay in Breast Cancers

2.2.3 Effects of Radiotherapy Delay in Cervix Cancers

2.2.4 Effects of Radiotherapy Delay in Other Malignant Cancers

2.2.5 Other Mechanisms of Increasing Radiotherapy Effectiveness

2.3 Psychological Effects of Radiotherapy Delay
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.4 The Possible Causes of Radiotherapy Delay</td>
<td>25</td>
</tr>
<tr>
<td>2.5 Recommended and Acceptable Radiotherapy Delay Time</td>
<td>28</td>
</tr>
<tr>
<td>2.6 Quality Improvement and Quality Improvement Models</td>
<td>30</td>
</tr>
<tr>
<td>2.7 Quality Improvement with the PDSA Model</td>
<td>33</td>
</tr>
<tr>
<td>2.8 The Breakthrough Series (BTS)</td>
<td>38</td>
</tr>
<tr>
<td>2.9 Measuring Effectiveness of Change with the PDSA Model</td>
<td>40</td>
</tr>
<tr>
<td>2.10 Using the PDSA Model for Improvement in Healthcare</td>
<td>42</td>
</tr>
<tr>
<td>2.11 Conclusion</td>
<td>45</td>
</tr>
<tr>
<td><strong>3 CHAPTER 3 METHODOLOGY</strong></td>
<td>46</td>
</tr>
<tr>
<td>3.1 Introduction</td>
<td>46</td>
</tr>
<tr>
<td>3.2 Research Design</td>
<td>46</td>
</tr>
<tr>
<td>3.3 Methods and Materials</td>
<td>48</td>
</tr>
<tr>
<td>3.3.1 Retrospective Phase</td>
<td>48</td>
</tr>
<tr>
<td>3.3.2 Process Management Tools</td>
<td>49</td>
</tr>
<tr>
<td>3.3.3 Prospective Phase</td>
<td>52</td>
</tr>
<tr>
<td>3.4 Data Processing and Analysis</td>
<td>53</td>
</tr>
<tr>
<td>3.5 Reliability and Validity of the Research Process</td>
<td>54</td>
</tr>
<tr>
<td>3.6 Ethical Considerations</td>
<td>55</td>
</tr>
<tr>
<td>3.7 Conclusion</td>
<td>56</td>
</tr>
<tr>
<td><strong>CHAPTER 4 RESULTS AND DISCUSSION</strong></td>
<td>57</td>
</tr>
<tr>
<td>4.1 Introduction</td>
<td>57</td>
</tr>
<tr>
<td>4.2 Retrospective Phase</td>
<td>57</td>
</tr>
<tr>
<td>4.2.1 Head and Neck Cancers Results</td>
<td>57</td>
</tr>
<tr>
<td>4.2.3 Cervix Cancer Results</td>
<td>59</td>
</tr>
<tr>
<td>4.3 Process Management Tools Results</td>
<td>60</td>
</tr>
</tbody>
</table>
LIST OF FIGURES

Figure 1.1. The PDSA model for improvement (Langley et al. 1996:10). ......................... 4
Figure 1.2. PDSA cycle (Langley et al. 1996: 7)............................................................... 5
Figure 1.3. Repeated PDSA Cycles (Langley et al. 1996:9)............................................. 6
Figure 1.4. The number of new cancer patients seen between the years 2000 and 2007 at Gaborone Private Hospital (Gaborone Private Hospital statistics 2008). ................. 7
Figure 1.5. The number of radiotherapy treated cancers at Gaborone Private Hospital Radiotherapy Department in the year 2006 (Gaborone Private Hospital statistics 2008). ........................................................................................................ 8
Figure 2.1. A change concept (Langley et al.1996: 88-91). ........................................... 35
Figure 2.2. Performance Improvement Process (Langley et al.1996). .......................... 36
Figure 2.3. Sequential PDSA cycles (Langley et al.1996:66). ....................................... 37
Figure 2.4. Multiple PDSA cycles (Langley et al.1996:66). ............................................ 38
Figure 2.5. BTS ( IHI BTS series innovations 2003:5). .................................................. 39
Figure 2.6. Changes using the PDSA model for improvement (The Institute of Health improvement IHI, 2003).............................................................................................. 41
Figure 3.1. Cause and effect Diagram............................................................................. 51
Figure 4.1. Retrospective survey for head and neck cancer patients treated between January and December 2007 at Gaborone Oncology.................................................. 58
Figure 4.2. Retrospective survey for breast cancer patients treated between January and December 2007 at Gaborone Oncology.............................................................. 59
Figure 4.3. Retrospective survey for cervix cancer patients treated between January and December 2007 at Gaborone Oncology.............................................................. 60
Figure 4.4. Treatment Process Chart For Gaborone Oncology Centre ......................... 61
Figure 4.5. Treatment Process Chart for Gaborone Oncology Centre…cont. ............... 62
Figure 4.6. Cause and effect Diagram at Gaborone Oncology........................................ 65
Figure 4.7. Pareto diagram Gaborone Oncology.............................................................. 66
Figure 4.8. Average monthly delay in days after PDSA implementation at Gaborone Oncology ......................................................................................................................... 74
Figure 4.9. Head and Neck cancer run chart for radiotherapy delays at Gaborone Oncology Centre. .......................................................................................................................... 75
Figure 4.10. Breast cancer run chart for radiotherapy delays at Gaborone Oncology Centre. .......................................................................................................................... 77
Figure 4.11. Cervix cancer run chart for radiotherapy delays at Gaborone Oncology Centre. .......................................................................................................................... 78

LIST OF TABLES

Table 2-1. Standards for waiting times for cancer treatment set by JCCO (1993) ........ 30
Table 4-1. PDSA Cycles Made In Appointment Booking Process................................. 68
Table 4-2. PDSA Cycles Made To CT/Contour Planning Process ................................. 69
Table 4-3. PDSA Cycles Made To Improve Medical Aid Response .............................. 70
CHAPTER 1 INTRODUCTION

1.1 Introduction

Radiotherapy is the use of high energy beams of radiation (x-rays and similar 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: 25-31). In the treatment of cancers, radical radiotherapy is intended to destroy the cancer in the treated area consequently curing the cancer (Rubin 1993: 71). 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: 25-31).

In recent years reports of increased demand of radiotherapy services in radiotherapy departments have surfaced (Robinson et al. 2005: 1201-1208). According to Dodwell and Crellin (2006:107-109), in healthcare services that deliver vital treatments such as radiotherapy, increased demand over supply causes delays between referrals and start of treatment. The prevailing increase in the demand for radiotherapy services have resulted into significant delays in the commencement of radical radiotherapy in many radiotherapy departments (Mackillop et al. 1999: 355-365).

Studies of the effects of ionising radiation on cancer tissue (radiobiology) indicate that a delay in starting radiotherapy can be detrimental to the cancer patient’s treatment outcome (Mackillop 2007: 1). Dodwell and Crellin (2006: 107-109) highlight that delays in starting radiotherapy may have a clinically significant negative impact on tumour control. 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: 283-289).

The growing demand for radiotherapy services has resulted in many radiotherapy departments finding it difficult to manage and maintain treatment delays within acceptable limits (Jensen et al. 2007: 5-10). Pioneers of quality improvement in healthcare services recommend the use of modern quality improvement models to
assist with providing better healthcare (Berwick 1996: 619-622). Therefore, in order to cope with the demand for radiotherapy, modern quality improvement models need to be accepted and adapted in radiotherapy departments. The Plan–Do-Study-Act (PDSA) model for improvement is an example of such models that make use of experiments to reveal potential for improvement (Langley et al. 1996: 6-9).

The PDSA model works by temporarily implementing and trailing a change. The impact of the change can be assessed in the trial and continuously changed for the better. The model encourages use of small scale changes before they are finally applied to the whole system (Langley et al. 1996:6-9). 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: 619-622). Most importantly the model provides team effort in testing and developing ideas; as a result, there is often less resistance to the change process (Langley et al. 1996: 26-27).

1.2 Description of Radiotherapy Delay and PDSA Model for Improvement

1.2.1 Radiotherapy Delay

Radiotherapy delay is defined as any wait from diagnosis of cancer to the initial delivery of radiotherapy. The Joint Council of Clinical Oncology JCCO (1993:1-9) 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 Gaborone Oncology to the start of the radiotherapy treatment.

Mackillop (2007:1) 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 tumour. Mackillop (2007:1), in fact, states that "the probability of controlling a tumour is inversely related to the number of clonogenic cells it contains such that a relatively small increase in tumour cell number may have a relatively large effect on probability of
tumour control.” In order to increase the chances of controlling tumours, radiotherapy management therefore requires that the treatment be started as soon as possible.

1.2.2 The Plan Do Study Act (PDSA) Model for Improvement

The PDSA cycle, also known as the Shewhart cycle or Deming cycle as stated by Cass et al. (2003: 270-273) was originally developed by Walter A Shewhart in the late 1920’s and in 1950 Edward Deming simplified the PDSA cycle to illustrate the continuous improvement process. Langley et al. (1996: 6-9), have since devised a widely utilised version called the PDSA model for achieving changes that ultimately lead to improvements.

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. The PDSA model for improvement consists of two parts:

The first part: the thinking part. As shown in Figure 1.1 the model for improvement, consist of three fundamental questions to guide improvement to work.

The second part: the doing part, as shown in Figure 1.2 by Langley et al. (1996: 6-9) 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.
Model for Improvement

1. What are we trying to accomplish?
2. How will we know that a change is an improvement?
3. What changes can we test that will result in an improvement?

Figure 1.1. The PDSA model for improvement (Langley et al. 1996:10).
1.2.3 The PDSA Cycle and How It Works

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: 619-622) 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 1.3, the process progresses from hunches, theories and ideas to actual changes that result in improvement.

Figure 1.2. PDSA cycle (Langley et al. 1996: 7).
1.3 Background to study

The year 2000 saw the introduction of the only radiotherapy centre in Botswana, namely the Gaborone Oncology Centre. The centre provides for both radiotherapy and chemotherapy facilities. The staff includes 2 radiation oncologists, 1 medical physicist, 6 radiation therapists, 2 nurses and support staff (2 nurse aids, 2 receptionists and 1 helper). The radiotherapy facility includes a Philips simulator, a CT scanner linked with radiology department, a Plato treatment planning unit and an Elekta Precise linear accelerator. The Gaborone Oncology radiotherapy department depends on an outsourced laboratory mainly for customised blocks. Since the establishment of the Gaborone Oncology Centre the number of new cancer patients seen has increased as indicated in Figure 1.4, with the commonly treated tumours being head and neck, breast and cervix cancers as illustrated in a pie chart Figure 1.5.
Figure 1.4. The number of new cancer patients seen between the years 2000 and 2007 at Gaborone Private Hospital (Gaborone Private Hospital statistics 2008).
In light of the yearly increase in the number of cancer patients seen at Gaborone Oncology, the need to review radiotherapy delays was recognised. It has been reported that radiotherapy delays can adversely affect treatment outcome of cancer patients (Mackillop 2007: 1). Due to its guaranteed ability of providing low risk of normal work disruption, less time consuming and low cost (Berwick 1996: 619-622), the researcher opted to utilise the PDSA model for improvement to address unacceptable radiotherapy delay.
1.4 Radiotherapy Management Process at Gaborone Oncology

Gaborone Oncology is the only centre that provides radiotherapy services in Botswana, and therefore caters for both private and government (public) patients in the country. The private patients at Gaborone Oncology are those who would usually have medical aid cover or personal funding and are sent to the department after diagnosis of cancer or suspected diagnosis of cancer. Private patients with medical aid cover will usually require approval from the medical aid company for funding their radiotherapy treatment. Government patients seen at Gaborone Oncology are citizens of Botswana who are funded by the Botswana government for their medical expenses. Government patients are sent to the department mainly for radiotherapy treatment after diagnosis of cancer from the public hospitals.

The radiotherapy process from referral to the oncologist at Gaborone Oncology Centre to the start of treatment is similar for both private and government patients. The patients are initially sent for consultation to the oncologist at the Oncology Centre. After consultation, the oncologist decides on the required radiotherapy management of the disease and the patient is sent for treatment simulation and, or CT scanning where appropriate. The department uses a shared CT scanner with the Gaborone Private Hospital radiology department for CT radiotherapy planning and the CT scanner is linked to the radiotherapy planning system. 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 computerised treatment planning system. In the case of three dimensional CT plans, treatment tumour 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 customised lead blocks and bolus are ordered for the patient. At the moment the department does not have a lead block cutter for customised treatment planning lead.
blocks 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 Gaborone Oncology Centre, 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.

1.5 Research Problem

Studies have documented that radiotherapy delays are common the world over (Mackillop et al. 1999: 355-365) and Botswana is no exception. Mackillop (2007:1) and Lehman et al. (2004 283-289) have shown that radiotherapy delay can have a negative radiobiological and psychological effect on the patient. According to Berwick (1996: 619-622), 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. 2008:7). This research attempts to reduce radiotherapy delays from the patients' first visit to Gaborone Oncology to the start of initial treatment within good practice standards according to the JCCO (1993: 1-9).
1.6 Research Aims and Objectives

1.6.1 Aim

The aim of the study was to develop and implement improvements for reducing radiotherapy delays between the patient’s referral to a radiotherapy department to the start of radical radiotherapy by using the PDSA model for improvement.

1.6.2 Objectives

The main objectives of the study were:

- 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 Gaborone Oncology to 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.

1.7 Definition of Key Concepts

- Radiotherapy
  A branch of oncology which uses radioactive substances or radiant energy to treat cancers.

- 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
A method for systemic change to achieve improvement.

• A Process
A series of events to produce a result.

• Process Management Tools
The ensemble of activities of planning and monitoring the performance of a process (Evan and Lindsay 1999: 340).

• Hawthorn Effect
A term referring to the tendency of some people to perform better when they are participating in an experiment or being observed.
• Gaborone Oncology
Life Healthcare Oncology centre in Botswana.

1.8 Abbreviations

• ASARA
As Soon As Reasonably Achievable

• BCS
Breast Conservation Surgery

• BTS
Breakthrough Series

• BPR
Business Process Re-engineering

• CT
Computed Tomography

• CHART
Continuous Hyper fractionated Accelerated Radiation Therapy

• Gy
Gray (Radiation dose absorbed per unit mass)

• CED
Cause and Effect Diagram

• IHI
Institute of Health Improvement
Radiotherapy delays have a profound negative effect on tumour control. Therefore reducing radiotherapy delays is vital so as to increase survival of cancer patients as well as to alleviate psychological stress in the cancer patients and staff providing care for these patients. In recent years, healthcare services have become more complex 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.
CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

Radiotherapy delay was identified as cause for concern about 20 years ago (Mackillop 2007:1). The main reason for this concern is that sufficient evidence showing that radiotherapy delay can cause cancer progression and render it incurable has emerged (Barret et al. 2004: 387-394). 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: 3-16) have suggested that the negative effects of the prevailing radiotherapy delays may be sufficient to cancel out the positive effects of many advancements 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 practices worldwide. A survey conducted by Mackillop et al. (1996: 243-250), showed that there is ample evidence that radiotherapy departments are active in trying to manage radiotherapy delays. Kerr et al. (2002:164-166) 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 organisation (Koeck 1998: 1267-1268). Therefore a quality improvement model will initially look at the service delivered and how it can be improved (Bloomfield and Logan 2003: 439-443). Quality improvement models are now widely being applied in several healthcare organisations. 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: 666-673). This makes the improvement process more effective. Kerr et al. (2002:164-166) 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 \textit{et al.} (2002:164-166) 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: 619-622), 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.

2.2 Effects of Radiotherapy Delay in Cancers

Mackillop (2007:1-4) and Mackillop \textit{et al.} (1996:243-250) have suggested that a delay in starting radiotherapy may cause tumour cell proliferation or permit tumour spread beyond the intended treatment area. Evidently uncontrolled delays in radiation treatment of cancers will affect the probability to control the disease (Leon \textit{et al.} 2003:277-281). In a study by Mackillop \textit{et al.} (1996:243-250) it has been highlighted that the consequences of delayed radiotherapy are related to the tumour volume doubling time and the growth rate of the tumour. Therefore, for a fast growing tumour, even a short delay time in starting treatment can result in adverse effects (Mackillop 2007: 1-4; Wyatt \textit{et al.} 2003:139-155).

Malignant head and neck, breast and cervix cancers are regarded as fast growing tumours when compared to other tumours like prostate cancers. By comparing tumour volume doubling times in these fast growing cancers Wyatt \textit{et al.} (2003: 139-155) have reported that a delay of 1 to 2 months may have a significant unfavourable effect on treatment outcome. Furthermore, depending on tumour volume doubling time, radiotherapy delays of up to 4 weeks may result in loss of local tumour control of between 8 and 20 percent (Jensen \textit{et al.} 2007: 5-10; Mackillop \textit{et al.} 1996:243-250). The risk of local tumour recurrences also increases with extended radiotherapy delay time (Chen \textit{et al.} 2008:3-16). For this reason, it is recommended that radiotherapy delay should be kept as short as clinically possible in these tumours.
2.2.1 Effects of Radiotherapy Delay in Head and Neck Cancers

In head and neck cancers radiotherapy is highly effective in controlling microscopic subclinical disease and can be given preoperatively or postoperatively for large primary tumours (Rubin 1993: 319-355). The evidence that radiotherapy delay increases the risk of local failure appears unquestionable, with so much high quality information about tumour progression in these cancers (Mackillop 2007: 1-4). However, it still remains uncertain if treatment outcome is worsened due to radiotherapy delay especially in patients with advanced disease (Marshak and Popovtzer 2006: 82-84). Marshak and Popovtzer (2006: 82-84) highlights that the adverse effects of radiotherapy delay could probably be minimised due to use of current advanced techniques such as altered treatment fractionation, reduction in overall treatment time and combined post operative radiotherapy and chemotherapy.

Studies comparing diagnostic and radiotherapy Computer Tomography (CT) scans in patients with head and neck cancers have shown tumour growth during radiotherapy delay time. Waaijer et al. (2003: 271-276) compared diagnostic and treatment planning CT scans for 13 patients with advanced oropharyngeal cancers and found tumour growth to be substantial. In this study the mean delay time between the two CT scans was 34 days, in which time three patients had progressed to an advanced stage due to lymph node metastases. Though the sample size was small, Waaijer et al. (2003:271-276) have reported that this was a realistic reflection of the treated population in their clinic. To consolidate the findings by Waaijer et al. (2003: 271-276), Jensen et al. (2007: 5-10) also compared tumour progression between diagnostic and radiation therapy treatment planning CT Scans. In this study a larger sample size of 61 patients with squamous cell carcinoma of head and neck tumours were analysed. Jensen et al. (2007: 5-10) showed that within a mean delay time of one month the majority of the patients developed tumour progression of measurable parameters. In some cases, interval time of less than 14 days showed measurable progression. As a result Jensen et al. (2007:5-10) were unable to define a threshold for acceptable time intervals of avoiding volume changes or a subgroup that did not show a negative impact of the
delay. This could probably have been due to the majority of the patients analysed having quite advanced disease at presentation.

Nevertheless, Fortin et al. (2002: 929-936) analysed 623 patients with early stage T2 N0 head and neck cancers. In this study it was found that delays of less than 30 days resulted in poor patient survival and beyond 40 days, an increased risk of local failure and neck failure. Due to their findings, Fortin et al. (2002: 929-936) have suggested that it is preferable for patients to start radiotherapy within 20 to 30 days after evaluation of a radiation oncologist. To support this, Chen et al. (2008: 3-16) also found that a one month delay increases the risk of local recurrences in head and neck cancer patients. However, the study by Chen et al. (2008: 3-16) had insufficient evidence that was able to show an association between the radiotherapy delays and distance metastasis in head and neck cancer patients.

In head and neck patients that receive post operative radiotherapy, Huang et al. (2003: 555-563) and Schiff et al. (1990: 203-208) have reported of the local recurrence rate being higher beyond a 6 weeks delay mark. Schiff et al. (1990: 203-208) have further noted that local recurrence rates are higher only when total radiation doses of less than 60 Gy are used. According to Schiff et al. (1990: 203-208), as long as appropriate total tumour doses of above 60 Gy are used, a negative impact due to radiotherapy delay should not be expected. As mentioned above, Marshak and Popovtzer (2006: 82-84) further suggest that shortening the overall treatment period, hyperfractionation and concomitant chemotherapy and post operative radiotherapy could also minimise negative effects of treatment outcome due to radiotherapy delay. However for radiotherapy departments to cope with altered fractionation regimes, additional equipment and human resources may be required (Burnet et al. 2000: 198-199). Conversely, Hansen et al. (2005: 789-794), used higher radiation doses of 50 to 71 Gy and have reported that a delay of one month can still result in a decreased recurrence-free survival. In this retrospective study, early stage 1 to 3 glottis cancer patients were analysed in which a one month radiotherapy delay from onset of symptoms showed a 4.5 percent decrease in recurrence-free survival. However in this study, radiotherapy was given as primary treatment.
In contrast Leon et al. (2003: 277-281), Marshak et al. (2003: 489-493) and Brouha et al. (2000: 215-218) have reported no significant effects on disease treatment outcome due to radiotherapy delays. Leon et al. (2003: 489-493) conducted a retrospective study of various stage oral cavity, pharynx and larynx cancer patients with a mean delay time of 44 days and follow up of 3 years. However in this study, a bias was shown because the delay for more advanced disease patients was 5 days shorter than for those with early stage disease. Marshak et al. (2003: 498-493) reviewed 44 late stage laryngeal cancer patients with a median delay time of 50 days. Though there were no reports of significant effects on local control, lymphatic spread which could have a significant effect on treatment outcome within the delay time was noted. Moreover, though the delay time was longer compared to other studies, a smaller sample size was used. In a retrospective study for early glottis cancer, Brouha et al. (2000: 215-218) showed no effects in up to 43 days of radiotherapy delay on outcome of disease. However, local recurrences were found in 58 out of 362 patients included in the study.

Similarly Lee et al. (1994: 1111-1117), found no adverse effects due to delayed radiotherapy in T1 nasopharyngeal cancers treated within 6 weeks of diagnosis. Barton et al. (1997: 137-141) also reported that radiotherapy delay of median 24 days was not significantly associated with local recurrence in patients with laryngeal tumors. However most of the patients in these studies were treated within 6 weeks compared to the study by Fortin et al. (2002: 929-936) who reported of adverse treatment outcome when patients are treated beyond 6 weeks. The study by lee et al. (1994: 1111-1117) also corresponded to Marshak et al. (2003: 82-84), by finding a small trend towards distant metastatic rates that could not be clinically ignored.

However, the case upon which all the authors agree is that it is logical for any kind of oncology treatment to begin early so as to minimise patient distress and maximise possibilities for tumour control. In view of the research mentioned, it is self evident that reducing radiotherapy delay time in head and neck cancers is important and should be seriously considered in radiotherapy departments.
2.2.2 Effects of Radiotherapy Delay in Breast Cancers

The treatment of breast cancer will usually involve either breast conservation surgery (BCS) or mastectomy, followed by chemotherapy or radiotherapy or both (Whelan et al. 2003: 1-14). Advances in the management of early breast cancers have placed a huge demand on radiotherapy services as BCS is always followed by radiotherapy. Poortmans (2007: 84-101) highlights that the timing and sequencing of adjuvant radiotherapy and chemotherapy given after surgery in early breast cancer is controversial. A study by Recht et al. (1995: 1356-1361) has reported of a 5 year local recurrence rate of breast cancer when chemotherapy follows radiotherapy in BCS patients. Recht (2003: 104-113) have also reported that early breast cancer patients treated with BCS who have positive, closed, or unknown microscopic margins tend to benefit from early initiation of radiotherapy, whereas those with wider tumour free margins width do not. Bell and Wein (2002: 279-286) and Recht (2003: 104-113) have suggested that for breast cancer patients at high risk of developing distance recurrences, administering chemotherapy prior to radiotherapy is favourable.

To eradicate all clonogenic cancers cells theoretically the ideal would be to administer adjuvant radiotherapy and chemotherapy concurrently (Poortmans 2007: 84-101). However due to the toxic effects that can occur, administering radiotherapy and chemotherapy concurrently may not be the best option (Marenghi et al. 2005: 126-130; Whelan et al. 2003: 1-14). Furthermore there is little evidence that administering chemotherapy and radiotherapy concurrently leads to better results (Whelan et al. 2003:1-14) According to Poortmans (2007: 84-101) different countries and even different oncology centres within each country have differing policies in regard to the sequencing of radiotherapy and chemotherapy in breast cancers. However most oncology centres favour administering chemotherapy before radiotherapy (Whelan et al. 2003:1-14) and this is the sequencing used at Gaborone Oncology Centre.

The optimal interval on when to start radiotherapy after surgery is also yet to be defined (Marenghi et al. 2005: 126-130; Mikljevic et al. 2004: 1343-1348; Whelan et al. 2003: 1-14; Redda et al. 2002: 5-10). In a systemic study Huang et al. (2003: 555-563) have
shown that radiotherapy delayed beyond the 8th week mark after surgery in early breast cancer patients leads to an increase in 5 year local recurrence rates. In a population based study Mikljevic et al. (2004:1343-1438) report that delaying the initiation of radiotherapy for 20 to 26 weeks is also associated with a decrease in patient survival. A report by Poortmans (2007: 84-101) has also recommended that for breast cancer patients who do not need systemic treatment the interval between surgery and radiotherapy should not exceed 8 weeks. Furthermore, Whelan et al. (2003: 1-14) advises to initiate radiotherapy within 12 weeks after surgery except in patients in whom radiotherapy precedes chemotherapy.

In node positive and high recurrence risk patients receiving BCS, Redda et al. (2002: 5-10) suggest that adjuvant chemotherapy should be administered before radiotherapy but the delay from surgery to radiotherapy should not exceed 20 to 24 weeks. On the other hand, Yock et al. (2004: 161-171) reported that a 7 month radiotherapy delay from surgery has no adverse effect on local tumor control. Though Yock et al. (2004: 161-171) found no adverse effect in delaying radiotherapy by up to 7 months, patients with positive margins in this study showed a higher rate of local failure. Hartsell et al. (1995: 2497-2503) also analysed lymph node positive intact breast cancer patients with median radiotherapy delays of 120 days from surgery and found an increased risk of breast cancer relapse.

In node negative BCS patients Vujovic et al. (2006: 760-764) have reported that a radiotherapy delay of 16 weeks from surgery showed no detrimental effects on local recurrence or disease free survival. Contrary to this, Buchholz et al. (1993: 23-35) found that initiating radiotherapy after a period of over 6 months caused higher local failure irrespective of nodal status, stage of primary, estrogen receptor status, age or type of surgery performed. Though the patient sample reviewed in the study by Vujovic et al. (2006: 760-764) was higher, 568 patients, the time interval was short compared to Buchholz et al., (1993: 23-35). On the other hand Vujovic et al. (2006: 760-764) omitted chemotherapy in their patients in which other authors suggest can be associated with risk of local recurrences and increased mortality (Benk et al. 2004: 6-11; Vinh-Hung et al. 2003:147-158).
The sequencing of administering radiotherapy and how long a delay is acceptable remains controversial in the management of breast cancers. However, for the most part, the authors agree to early initiation of breast cancer radiotherapy and thus reducing radiotherapy delays.

### 2.2.3 Effects of Radiotherapy Delay in Cervix Cancers

Very little has been reported on effects of radiotherapy delay in cervix cancers. Cervix cancers are the most common cancers in women worldwide and the disease proportionately affects the poorest regions (Petignant and Roy 2007: 765-768). This cancer is also the second most common cause of death in women and radiotherapy has shown to be very effective in treatment of all stages of the cancer (Rubin 1993: 363-373). Because of this at Gaborone Oncology cervix cancers are considered to have a relatively high priority in terms of urgency.

Due to the fast growing nature of these tumours, it has been reported that a delay of 1 to 2 months can have significant adverse effect on treatment outcome (Wyatt et al. 2003:139-155). Other studies have reported that the adverse impact of radiotherapy delay is greater in patients with more aggressive disease (Choan et al. 2005: 1071-1077; Coles 2003: 47-54). In a retrospective study, Choan et al. (2005: 1071-1077) have reported that longer radiotherapy delay in itself was not significantly associated with increased risk of recurrences. In this study a total delay time of 42 days from biopsy to radiotherapy and 21 days from first radiation oncologist consultation to radiotherapy found no adverse effects.

In contrast, Coles (2003: 47-54) used radiobiological modeling and showed that due to increased waiting time of up to 35 days, tumour control probability is lost. To support their study Coles (2003: 47-54) had limited interruptions during the course of radiotherapy in an attempt at increasing the probability of tumour control. Overall, this study agreed that adverse affects are more significant in cervix cancer patients with shorter volume doubling times or medium chance of tumour control at the onset of treatment.
Kodaira et al. (2002: 255-261) performed a retrospective analysis on cervix cancer patients and reported that radiotherapy delay time ranging from 12 to 68 days from surgery, may have adverse effect on treatment outcome. In this study other factors such as tumour size and adenocarcinoma histology could also have led to an adverse effect on the patient's treatment outcome.

Choan et al. (2005: 1071-1077), Coles (2003:47-54) and Kodaira et al. (2002:255-261) agree that radiotherapy delay will affect patient survival. It can therefore be safe to say that radiotherapy delays should be kept within acceptable standards in cervix cancer patients.

2.2.4 Effects of Radiotherapy Delay in Other Malignant Cancers

Negative effects of radiotherapy delays have also been reported in other tumours. Vieta et al. (2000: 131-136) 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: 339-343) 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: 141-144) 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: 141-144) reported of median increase of 19 percent and mean increase 56 percent in tumour volumes during these waiting times.

2.2.5 Other 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: 1-9) 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 tumour control probability of 1.6 percent per day of treatment prolongation (Hendrey et al. 1996: 297-307). Dubray et al. (1992: 267-272) has 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: 198-199). 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: 229-230) 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 Psychological Effects of Radiotherapy Delay

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: 283-289). Souza et al. (2001:3) 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, Palda et al. (1997:192-200) 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: 22-26) 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: 243-250; JCCO 1993: 1-9). Leon et al. (2003: 277-281) and Mackillop et al. (1996: 243-250) 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.

2.4 The Possible Causes of Radiotherapy Delay

The main cause of radiotherapy delay worldwide has been an imbalance between supply and demand for radiotherapy services (Mackillop 2007: 1-4). Dodwell and Crellin (2006: 107-109), 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 tumours and in many situations radiotherapy offers local control and survival rates similar to surgery (Burnet et al. 2000: 198-199).

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: 1-4; Souza et al. 2001: 1-3). It has also been estimated that 60 percent of all cancer patients will require radiotherapy at one point or another in the course of their disease (Durosinmi-Etti et al. 1991: 24-28). Cancer awareness campaigns and screening programs are becoming prominent in many countries and Dodwell and Crellin (2006: 107-109) 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 (Mbulaitseye et al. 2003: 673-696). To make matters worse in the African situation, according to an International Atomic Energy Agency IAEA report (2003:6), 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 pretreatment planning procedures that have developed over the years (Radiotherapie Onze Zorge 2000: 1-88). 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: 1-4) points out that the sequential short delays in pretreatment 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: 113-121) 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: 1-3) have reported that poor remuneration of staff leads to other centres employing radiotherapy staff to supplement for their own shortages. In the United Kingdom, Dodwell and Crellin (2006: 107-109) have reported that, irrespective of funding available for the purchase of new radiotherapy equipment, many radiotherapy centres are still unable to meet the demands due to staff shortages. Durosini-Etti et al. (1991: 24-28) 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: 506) 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 than 25 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 complimentary staff such as dietitians, 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) and Stereotactic Radiosurgery and Radiotherapy 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: 1-17).
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: 1105). Whether patients have public or private medical insurance, most patients will be expected to top up costs when treated in private healthcare (Gubb 2008: 1104). Therefore in a situation where a patient may need to prepare personal finance or obtain medical insurance treatment approval, delay in 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: 1-3) 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: 1-4; Souza et al. 2001: 1-3).

2.5 Recommended and Acceptable Radiotherapy Delay Time

Recommended targets have been set by the JCCO on what is considered as acceptable radiotherapy delay time. The JCCO (1993:1-9) cautions that the targets should not be achieved at the expense of time for explanation and counseling of patients and patients’ relatives. Similarly the education of radiotherapy staff and time for effective clinical audit and research must be maintained while adhering to the recommended targets. The recommended waiting times as outlined by the JCCO (Table 2.1) suggest that for radical radiotherapy, even that which involves complex treatment planning, a two week wait is considered good practice (JCCO 1993:6). 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: 222-228). In analysing head and neck tumors, Fortin et al. (2002: 929-936) have suggested that patients should start radiotherapy treatment within 20 to 30 days after evaluation by a
radiation oncologist. Chen et al. (2008: 3-16) also points out that local tumour control can be achieved in head and neck cancers by maintaining waiting times of up to 6 weeks. Wyatt et al. (2003:139-155) has analysed cervix, breast and head and neck cancer showing that a radiotherapy delay of 1 to 2 months has an unfavourable effect on treatment outcome. As there is no threshold on which delay may be considered safe, Mackillop (2007: 1-4) 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: 1-4). 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 practically 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: 24-28). By implementing cancer control policies, international radiotherapy treatment standards and recommended targets set by international organisations such as the JCCO could be easily achieved.
Table 2-1. Standards for waiting times for cancer treatment set by JCCO (1993)

<table>
<thead>
<tr>
<th>Standards for waiting times for cancer treatment set by JCCO (1993)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. For urgent radiotherapy or chemotherapy</td>
</tr>
<tr>
<td>Good practice</td>
</tr>
<tr>
<td>Maximum Acceptable</td>
</tr>
<tr>
<td>2. For palliative radiotherapy (According to severity of symptoms)</td>
</tr>
<tr>
<td>Good Practice</td>
</tr>
<tr>
<td>Maximum Acceptable</td>
</tr>
<tr>
<td>3. For radical radiotherapy involving complex treatment planning</td>
</tr>
<tr>
<td>Good practice</td>
</tr>
<tr>
<td>Maximum Acceptable</td>
</tr>
<tr>
<td>*Where additional specialised staging process are necessary</td>
</tr>
</tbody>
</table>

2.6 Quality Improvement and Quality Improvement Models

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: 209-220).

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: 1-7). 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 organisation is trying to achieve and the manager’s preference. According to Roland (2001:66-67), strategies that combine an audit with feedback and computerised prompts or academic detail tend to be more effective. In healthcare the main aims of improvement are to provide safety, effectiveness, be patient centred, efficient and timely in providing services and ensuring equitability of all patients receiving the services (Schille 2007:1). Therefore, improvement models in healthcare should use strategies that strive to achieve these six aims of improvement. Powell et al. (2008:7) identifies five key models for improvement; Total Quality Management (TQM), Business Process Reengineering (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: 209-220). TQM have been adopted in healthcare, however, Powell et al. (2008:7) has suggested that it provides little impact on the work of medical staff due to problems with embedding its core approach in healthcare organisations. However, TQM has contributed greatly in redesign initiatives such as redesigning patient care pathways (Powell et al. 2008:7). BPR which emerged in the United States of America in the 1990’s emphasises on a radical “clean break” approach to organisational change and like TQM has also contributed to redesign initiatives (Powell et al. 2008:7).

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: 1-5). 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. (2008:7) the Six Sigma has been applied to a limited extent in healthcare although it has potential for wider application. Sehwail and DeYong (2003: 1-5) recommends 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. 2008:7).
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. 2008:7). 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. 2008:7).

The PDSA model for improvement involves the use of Plan Do Study and Act cycles to achieve improvements (Langley et al. 1996:6-9). PDSA cycles have been widely used in initiatives promotion by the institute of health improvement and in quality collaborative (Powell et al. 2008:7). According to Berwick (1996: 619-622) the PDSA cycles enables low risk changes based on proposal by the staff involved in improvement and therefore encourage staff participation in the improvement process. Powell et al. (2008:7) reports that there is limited evidence in terms of changes in improvement outcome from the PDSA approach. However, Powell et al. (2008:7), points out that ongoing work at various healthcare sites is beginning to address this gap.

The founders of the PDSA model, Langley et al. (1996: 6-9), have recommended its use because it is simple, cost effective, and it restructures and accelerates improvements in areas of healthcare. According to Berwick (1996: 619-622) simplicity of a system is very important, as trying to achieve improvement breakthrough can be difficult for leaders if a complex approach is used. Though using PDSA cycles to improve processes may appear simple, problems may arise if attention to balancing all the four activities in the cycle is not followed. According to the international organisational standards (ISO) 9000:2000 quality management system manual (2005:9), too much planning without pausing to study what has been learnt can be overwhelming and may mislead the team. Powell et al. (2008:7) have suggested that in certain instances teams may be unwilling to carryout the full cycle of Plan Do Study and Act and therefore risk jumping to premature solutions or fail to benefit from the full potential of this approach. Furthermore, perpetual meetings without enough doing, studying and acting can cause difficulties in the improvement process. Due to the imbalances that can occur, it is debatable if PDSA cycles should be applied to major organisational improvements. In
addition, conflict between changes that the local individuals or team and the organisational strategic objectives may arise (Powell et al. 2008:1-64). Schouten et al. (2008: 1491-1494) also argues that, due to flaws and heterogeneity in many quality improvement collaborations, there is no certainty that the quality improvement intervention itself creates improvements. However, it is certain that the PDSA cycles can be applied to any organisational quality improvement system (ISO 9000:2000 Quality Management Systems manual 2005: 1-54).

Developed countries involved in restructuring of their healthcare systems have realised that clinical practice improvement often centres on a particular aspect of clinical care or disease (Bloomfield and Logan 2003: 439-443). Because of this, they have become aware that redesign principles when applied across whole delivery systems can have a huge positive effect in healthcare (Bell et al. 2006:1286-1287). With this in mind the PDSA model for improvement has become widely accepted as a method to use for sustainable healthcare improvements.

2.7 Quality Improvement with the PDSA Model

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 (Koeck1998:1267-1268). As a result of these changes, high cost in managing a healthcare organisation is inevitable. In order for a healthcare system to provide high quality of care while maintaining costs, better organisational structures and process are required (Bloomfield and Logan 2003: 439-443). Bell et al. (2006:1286-1287) 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. (1996:6-10) have created the PDSA model that can assist healthcare organisations 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: 1286-1287; Bloomfield and Logan 2003:439-443).

In using the PDSA model for improvement, healthcare organisations 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: 85-97). 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: 6-10). Berwick (1996: 619-622) 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 1996:106-121).

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: 203-214). 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: 619-622). As illustrated in Figure 2.2 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 2.3. Multiple changes can also be conducted to achieve maximised improvement as indicated in Figure 2.4.
Figure 2.1. A change concept (Langley et al. 1996: 88-91).
Figure 2.2: Performance Improvement Process (Langley et al. 1996).
Figure 2.3. Sequential PDSA cycles (Langley et al. 1996:66).
2.8 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 organisations 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: 1-15). The BTS aims to assist organisations 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 organisations. As indicated by the IHI BTS innovations (2003: 1-15) and shown in Figure 2.5 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 organisations (Plesk 1999: 203-214).

Figure 2.5. BTS (IHI BTS series innovations 2003:5).
2.9 Measuring Effectiveness of Change with the PDSA Model

Berwick (1996: 619-622) 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: 619-622) 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: 203-214) 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 1999:203-214). 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: 619-622). 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: 203-214).

The final question should then identify what changes will result in an improvement. The PDSA cycles are then systematically implemented to test the changes. Progress for
improvement should be monitored on a regular basis. Plesk (1999: 203-214) 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 2.6. Changes using the PDSA model for improvement (The Institute of Health improvement IHI, 2003).
2.10. 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 area of healthcare. In radiotherapy departments, Kerr et al. (2002: 164-166) have suggested that there has been slow progress in showing improvement using the PDSA model probably due to staffing problems. However the PDSA model has been used in some radiotherapy departments as well as other healthcare improvement projects with successful results (Berwick 1996: 619-622).

In an effort to reduce radiotherapy delays after surgery for breast cancer, five departments in the French Ministry of Health acted by redesigning their organisation while implementing the PDSA model for improvement (Woynar et al. 2007: 17011). The background to the intervention was based on Huang et al. (2003: 555-563), 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: 17011) undertook an organisational 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 standardised 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: 1309-1313) 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: 164-166) 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 randomised 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: 164-166) mapped cancer paths for each tumour 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: 286-292) 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 standardised and implemented in the clinic. Van Teil et al. (2003: 64-70), 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: 491-494) 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: 388) introduced the PDSA model in 44
random 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. (2004:1004) 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. (2004:1004) included audit and feedback, quality improvement training and follow up support which changed the behaviour 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 utilise the PDSA model and BTS with successful results because they focus to produce and sustain improvement in a short period (IHI BTS innovation 2003:1-15).

The Institute of Health improvement (IHI BTS innovation 2003:1-15) 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, involving 1000 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: 463-470) 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.
2.11. Conclusion

Several studies have highlighted the negative effects of radiotherapy delay in cancers of the breast, head and neck, and cervix. Further studies have also shown the psychological effects on both the cancer patients and staff providing radiotherapy services. The JCCO has already established what are considered as safe and acceptable delay times in fast growing tumors. Because of the stress of radiotherapy delay in both cancer patients and radiotherapy staff, it has become evident that most radiotherapy departments aim to address waiting lists that cause unnecessary treatment delays. However, they are often unsure how to go about making the necessary changes.

Quality improvement models such as PDSA model for improvement are available and can assist in achieving treatment delay standard as outlined by JCCO. To save on cost and reduce departmental interruptions the PDSA model is becoming widely used in healthcare. Collaborative teams internationally have also used PDSA models showing remarkable improvements. Although evidence suggests that quality improvement initiatives have been positive in many instances, the effects of improvement can still not be predicted with certainty due to the heterogeneity of these initiatives. However accelerated improvements with regards to reduction in radiotherapy delays have been shown in some studies.

In this study interventions in line with PDSA model were utilised in an attempt to reduce radiotherapy delays from first visit to the radiation oncologist at Gaborone Oncology to first definitive treatment of radiotherapy.
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 Gaborone Oncology 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 analysed as they constitute the most commonly treated cancers at Gaborone Oncology (Gaborone Oncology statistics from 2006 to 2008).

The objectives of this research involved measuring the baseline delay time of previously treated head and neck, breast and cervix cancer patients. The objectives further included exploring possible causes of the radiotherapy delay, developing, implementing and validating the effectiveness of using the PDSA model in reducing radiotherapy delay. Process management tools using a flow chart, a cause and effect diagram and a Pareto analysis graph were used to explore possible causes of treatment delays. To show the effectiveness of the PDSA model for improvement, monthly improved delayed time in days was monitored and plotted on a run chart.

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. Dick (2002: 157-170) defines action research as a flexible spiral process which allows action (change, improvement) and research (understanding, knowledge) to be achieved at the same time. A collaborative inquiry refers to action research undertaken by teams of colleagues. The defining characteristics of action research according to Denscombe (2003: 73-74) is that:

1. It is practical and therefore aimed at dealing with real world problems and issues at work and in organisational settings.
2. It regards change as an integral part of the research.

3. It is a cyclical process involving feedback where changes can be made and evaluated for further investigation.

4. It involves participation of the researcher in all stages of the research. According to Dick (2002:157-170) the people affected by the change are involved in the action and feedback.

This makes action research suitable for identifying problems in clinical practice and also helps to develop potential solutions to improve practice (Meyer 2000: 178-181). In order to develop solutions to reduce radiotherapy delays, an action research approach was necessary. Furthermore, collaboration is highlighted as the desirable feature in an action research design. Carr and Kemmis (1986: 165-166) emphasise that action research studies should involve those responsible for the practice in each of the stages of the activity, widening participation of the project gradually to include others affected by the practice, and maintaining collaboration in the process. Implementing the PDSA model to improve radiotherapy delays at Gaborone Oncology 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 was 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 delays time was achieved.

In order to understand the problem of radiotherapy delays and create intervention strategies, it was necessary to employ process management tools to assist in exploring the causes of radiotherapy delay at Gaborone Oncology. Domingo (2000:np) 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 utilised 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 was collected and analysed only for the selected sample group as they represented a true reflection of radical patients treated with radiotherapy at the centre.

Based on action research studies definition by Carr and Kemmis (1986: 165-166), 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.

3.3 Methods and Materials

3.3.1 Retrospective Phase

At the beginning of this research a retrospective survey of all head and neck, breast and cervix cancer patients who were treated radically at Gaborone Oncology from January to December 2007 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. In the retrospective survey, radiotherapy delay time in a total of 145 patients comprising 68 cervix patients, 37 breast patients and 40 head and neck patients who were treated radically was analysed. The mean delay time and possible causes of radiotherapy delay was documented for each of the above tumour 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: 203-214) it is important to set a target for improvement. Thus a target was set based on the JCCO (1993: 1-9) 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 analysing each patient's treatment chart with the aid of process management tools.

3.3.2 Process Management Tools

Evan and Lindsay (1999: 340) 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.

As Is Flow Chart

A flow chart is a pictorial presentation describing a process being studied (Plesk 1999: 203). 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: 11). Therefore to understand the current process at Gaborone Oncology, a patients’ “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.

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 2006:1-4). 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: 1-9). In order to reduce radiotherapy delays, the causes of the delays needed to be recognised and understood. Therefore root cause analysis was performed. Doggett (2004: 1-9) 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: 1-9) has suggested that the cause and effect diagram works by breaking down potential causes into more detailed categories so that they can be organised 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.
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: 1-7). In order to target the causes that affect most radiotherapy delays, a Pareto analysis was performed. According to Hackman and Wagema (1995: 309-342) 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: 1-7).

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.

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: 340). 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.

3.3.3 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 2008 to December 2008. 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 Gaborone Oncology. 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:

1. What are we trying to accomplish? This was the overall aim: to reduce radiotherapy delays.

2. 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.
3. 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.* (1996:66), to maximise achieving improved results multiple cycles running parallel to each other were used. Based on the data collected from the Pareto analysis diagram at Gaborone Oncology, changes were targeted to the vital few categories that caused most of the delay using PDSA cycles.

### 3.4 Data Processing and Analysis

Quantitative data collection was used in the research. The advantage of quantitative research is that data interpretation and findings are based on measured quantities (Denscombe 2000: 236). According to Greenhalgh and Taylor (1997: 740-743) quantitative research provides solid and objective research due to its use of various forms of statistical techniques. Tables and charts are used in data collection, thus ensuring effective ways of organising and communicating data. With the availability of computer software that aids in the design of tables and charts statistical analysis is also made easier (Denscombe 2000: 236). For this research, quantitative data was 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 tumour type was used as the baseline for improvement (Appendix 1).

In the prospective phase, after implementing changes with the PDSA model for improvement, data was 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 2008 to December 2008. 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 (1993:1-9) was also set on the run chart.

3.5 Reliability and Validity of the Research Process

Research reliability implies that the tools used to measure data are consistent and validity refers to support that the data collected during the research reflects the truth, reality and covers the crucial points of the research (Denscombe 2003:300-301). By using quantitative methods the data collected was consistent in both the retrospective and prospective phase of the research. In this study, using two standard points of collecting data (from first visit to Gaborone Oncology to start of radiation treatment) created a constant period to measure for the sample group thus adding to the reliability of the data. Furthermore through identifying the “vital few” factors from the Pareto analysis to target for improvement and concentrating improvements in these categories increased consistency of the data collected. Monthly monitoring of improvement using
run charts also added to the reliability and validity of research process as progress was noted throughout the PDSA model implementation. To avoid bias towards the studied sample group the PDSA model was implemented on all other patients receiving radiotherapy.

In spite of the above, validity of the observed change in improvement due to implementing the PDSA model could be questioned. Due to the participative nature of the researcher in action research studies, it could be argued that the research may have been influenced by the tendency of people to perform better when being observed, also known as the “Hawthorn Effect” (Leonard and Masutu 2006: 1-4). The danger of the Hawthorn Effect is that results are temporary and once the study is completed people tend to return to normal behaviour. This could defeat the purpose of the quality improvement process as it requires improvements to be sustainable. In this research, the strategic plans observed to show improvement were accepted and standardised for routine departmental practice. This could reduce the Hawthorn Effect. However continuous data collection will have to be done to accurately support this fact and due to the time frame of the research the influence of the Hawthorn Effect on this research may not be analysed adequately.

3.6 Ethical Considerations

Ethical considerations refer to ensuring that all research participants are aware and agree to participation in the research (Denscombe 2003: 53) thus providing their consent to the research. Ethics will also consider that permission has been granted by an ethics committee and that participants confidentiality and data privacy is take into account (Denscombe 2003:134). 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 University of Johannesburg, faculty of health sciences ethics committee and the head of department at Gaborone Oncology Centre (Appendix 3) 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 2002:85-97). Reducing radiotherapy delays increases the patients’ tumour control, reduces patients’ psychological effects and therefore enhances radiotherapy treatment outcome (Mackillop 2007: 1-4). This research could therefore benefit the patients.

3.7 Conclusion

An action research design to answer the question of whether the PDSA model could improve radiotherapy delays was deemed the most suitable design for the study. An action research design allows change and improvement to be implemented while understanding and gaining knowledge in the process. Identifying a baseline delay time in the retrospective survey assisted in obtaining a measure of improvement for the prospective phase. Process management tools were used to identify the areas of delay at Gaborone Oncology. The used process management tools further assisted in identifying the major causes of delay and monitoring the improvement process. Quantitative data collection added to the reliability and validity of the research process.
CHAPTER 4 RESULTS AND DISCUSSION

4.1 Introduction

The research results presented in this chapter contain the data collected from the retrospective and the prospective phases of the study. The results obtained from the flow chart show the areas and causes of radiotherapy delays. The cause and effect diagram indicates the major causes and root causes of radiotherapy delays. The Pareto analysis identifies the major causes of radiotherapy delays that were targeted for improvement. Furthermore, the results for each PDSA cycles are documented. Finally the results of the run charts used to monitor improvements in breast, head and neck, and cervix cancer patients after implementing the PDSA cycles are presented.

4.2 Retrospective Phase

4.2.1 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 2007. The graph in Figure 4.1 below indicate the results of the total number of patients treated during this period with the maximum radiotherapy delay time at 92 days and the minimum radiotherapy delay time at 4 days. The mean radiotherapy delay time (baseline delay) was 17.5 days with 47.5 percent 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 customised 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 financing by the medical aid, delayed government financial assistance 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 dental assessment). Other radiotherapy delay causes included treatment machine service or break downs.
Figure 4.1. Retrospective survey for head and neck cancer patients treated between January and December 2007 at Gaborone Oncology.

4.2.2 Breast Cancers Results

The retrospective survey for breast cancer was conducted on a total of 37 patients treated in between January and December 2007. 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 financing by the medical aid or government assistance. 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.
4.2.3 Cervix Cancer Results

The retrospective survey for cervix cancer was conducted on a total of 68 patients treated in 2007. The mean radiotherapy delay time (baseline delay) was 7.4 days with 10.3 percent of these patients starting their treatment 14 days and beyond. The graph in Figure 4.3 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 4.2. Retrospective survey for breast cancer patients treated between January and December 2007 at Gaborone Oncology.
Figure 4.3. Retrospective survey for cervix cancer patients treated between January and December 2007 at Gaborone Oncology.

4.3 Process Management Tools Results

As explained earlier the process management tool was implemented to identify opportunities or areas for improvement (Evan and Lindsay 1999: 340).

4.3.1 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 Gaborone Oncology 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 4.4. Treatment Process Chart for Gaborone Oncology Centre.
Radiotherapy Planning Process

Book Pre Treatment simulation

CT scan required?

No

Yes CT scan with Radiology

Personal Block required?

No

Yes

Order personal blocks from South Africa

Treatment data calculations and treatment plan checks and approvals

Patient to commence treatment

Book patient at treatment Unit (LINAC)

Phone patient on appointment date

Start Radiotherapy

Figure 4.5. Treatment Process Chart for Gaborone Oncology Centre…cont.
From the flow chart, the following causes of radiotherapy delays were identified:

1. Delays due to patients seeking finances for their treatment either from their medical aid, the Botswana government medical aid assistance or personal finances.

2. The delays taken by the oncologist to decide on a course of treatment in instances where multidisciplinary consultation was required.

3. Delays due to patients’ waiting for customised blocks to be made, mounted and to be ready for the patients’ treatment.

4. 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.

5. Delays in communications of radiotherapy appointment dates for patients to start treatment after completion of the treatment planning process. Equipment service and staff leave days also contributed to radiotherapy delays of appointment bookings.

4.3.2 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 Gaborone Oncology. The six major causes of radiotherapy delays were identified as: Decision Making, Treatment Finance, CT/Contour Plans, Customised Block Making, Patient Booking, Equipment and Staffing.

1. 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 resimulation of the treatment plan.

2. 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 Botswana government medical aid cover, delay by government to authorise approval for treatment also added to radiotherapy delay. Patients without medical aid or not under government medical aid cover needed to look for personal financing, thus also adding to the radiotherapy delay time.

3. The root causes in pre-treatment CT and contour plans contributed to 15.6 percent 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.

4. 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 Botswana) and delays in arrangement of blocks according to planned treatment after delivery to the department.

5. 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.

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

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

![Cause and effect Diagram at Gaborone Oncology.](image)

Figure 4.6. Cause and effect Diagram at Gaborone Oncology.
4.3.3 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 Gaborone Oncology. 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 tumour types.

Figure 4.7. Pareto diagram Gaborone Oncology.
As indicated in Figure 4.7, the frequency in causes of delay were found to be 42.1 percent due to departmental bookings, 15.6 percent due to CT and contour plans, 14.1 percent for finance and oncologist decision making, 7.8 percent due to customised 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 and treatment financing. The PDSA model for improvement was planned to target these radiotherapy delay causes.

4.4 The Prospective Phase

In the prospective phase, PDSA cycles were implemented to a total of 109 radically treated patients between May and December 2008 (22 Head and Neck, 24 Breast and 63 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. The PDSA cycles implemented are indicated below.

4.4.1 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 4.1.
Table 4-1: PDSA Cycles Made In Appointment Booking Process

<table>
<thead>
<tr>
<th>CYCLE 1 June to August 2008</th>
<th>Give radiotherapy start date at day of pre-treatment simulation. Ensure given start date is adhered to.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREDICTED/UNPREDICTED</td>
<td>As predicted patients started treatment on the appointed date. An unpredicted outcome arose when customised shielding blocks were required. It was difficult to give and maintain the appointed start date as shielding blocks were imported from outside Botswana.</td>
</tr>
<tr>
<td>OUTCOME</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CYCLE 2 September to October 2008. Block cutter installed at Gaborone Oncology in September</th>
<th>Repeat cycle 1 with block cutter at Gaborone Oncology center premises. The cycle was repeated to show the changes in radiotherapy delays if there are no delays of making and couriering customised blocks from outside the country.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREDICTED/UNPREDICTED</td>
<td>An unpredicted outcome was that the customised blocks were still not delivered to the radiotherapy department in time for the treatment start date, thus affecting the appointed bookings.</td>
</tr>
<tr>
<td>OUTCOME</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CYCLE 3 October to December 2008</th>
<th>Document start date for block cutter laboratory.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREDICTED/UNPREDICTED</td>
<td>As predicted appointment dates were maintained.</td>
</tr>
<tr>
<td>OUTCOME</td>
<td></td>
</tr>
</tbody>
</table>

4.4.2 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>
<thead>
<tr>
<th>CYCLE 1 May to June 2008</th>
<th>Oncologists to draw tumor volumes on same day as pre-treatment simulations.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREDICTED/UNPREDICTED OUTCOME</td>
<td>The number of days for complex treatment planning was reduced. An unpredicted outcome occurred when pre-treatment CT simulations and CT scans were not booked to take place on the same day, thus increasing the delay time.</td>
</tr>
<tr>
<td>CYCLE 2 June to July 2008</td>
<td>To book all Pre-treatment simulations and CT scans on the same day for all CT plans.</td>
</tr>
<tr>
<td>PREDICTED/UNPREDICTED OUTCOME</td>
<td>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.</td>
</tr>
<tr>
<td>CYCLE 3 July 2008</td>
<td>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.</td>
</tr>
<tr>
<td>PREDICTED/UNPREDICTED OUTCOME</td>
<td>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.</td>
</tr>
<tr>
<td>CYCLE 4 July to August</td>
<td>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.</td>
</tr>
<tr>
<td>PREDICTED/UNPREDICTED OUTCOME</td>
<td>As predicted, the number of days taken for tumor volume delineation and treatment planning of complex plans reduced.</td>
</tr>
</tbody>
</table>
4.4.3 Change 3: PDSA Cycles Made to Improve Medical Aid Response

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 4-3: PDSA Cycles Made To Improve Medical Aid Response

<table>
<thead>
<tr>
<th>CYCLE 1 July to September</th>
<th>Send patient treatment motivation letter to medical aid. A copy given to the patient so that they contact medical aid directly (to show urgency).</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREDICTED/UNPREDICTED OUTCOME</td>
<td>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 aid funds are exhausted patients are forced to look for personal means to finance treatment thus delay is inevitable. In certain instances medical aid motivations were not sent on time from the Gaborone oncology department.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CYCLE 2 September to December</th>
<th>Ensure that all medical aid motivation letters are sent to the appropriate office on time.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREDICTED/UNPREDICTED OUTCOME</td>
<td>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.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CYCLE 3 December 2008</th>
<th>Relevant staff to undergo in house training on medical aid motivations and treatment quotations.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREDICTED/UNPREDICTED OUTCOME</td>
<td>Reducing the time patients’ medical aid motivation letter spends within the department assisted in reducing delays.</td>
</tr>
</tbody>
</table>
Monthly Results for Improvement in Each Cycle Change:

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

May to June 2008

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 tumour 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 2008

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 tumour 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 15.8 days.

July to August 2008

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 tumour 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 tumour type were as follows: breast cancer patients, 9 days, head and patients cancer 23.7 days and cervix cancer patients 7.3 days. The total average delay being 13.3 days.

August to September 2008

In this period sending medical aid motivations continued to be monitored. A block cutter was also installed at the Gaborone Oncology Centre premises. Sending of patient’s customised 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 tumour 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 customised 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 2008

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 tumour 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 2008

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 tumour 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 2008

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 tumour 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 4.8 below shows the changes in delays in days after implementing the PDSA changes.
4.5 Run Charts Results

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

4.5.1 Head and Neck Cancer Patients’ Run Chart

The results of the head and neck run chart are indicated in the graph in Figure 4.9 below. As mentioned earlier, the PDSA cycles were implemented on 22 head and neck cancer patients seen between May and December 2008. In these patients twelve (54.5 percent) 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 customised block making which were still imported from Johannesburg. Between August and December 2008 after a block cutter was installed at Gaborone Oncology and PDSA cycles change to the CT and contour plans process, no head and neck patients were delayed beyond 14 days.

Figure 4.9. Head and Neck cancer run chart for radiotherapy delays at Gaborone Oncology Centre.
4.5.2 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 2008 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 81 days 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 2008 when the radiotherapy treatment planning digitizer at Gaborone Oncology 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 Gaborone Oncology. 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.
4.5.3 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 (84.1 percent) patients started their treatment below the 14 day target. However, ten (15.9 percent) 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 2008. Similar to breast cancer patients most cervix patients are also planned with a contour and treatment planning digitizer at Gaborone Oncology. 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 4.11. Cervix cancer run chart for radiotherapy delays at Gaborone Oncology Centre.
4.6 Results Discussion

The results from the study indicate that implementing PDSA cycles reduced radiotherapy delays at Gaborone Oncology Centre 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 Gaborone Oncology 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 delays in medical aid cover or financial assistance especially for patients who were not automatically covered under Botswana government medical aid. The results are in line with comments by Bloor (2008: 1105) and Gubb (2008: 1104) 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: 1-4) and Souza et al. (2001: 1-3) 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 customised block preparation and deliveries. These results are in line with suggestions by Mackillop (2007: 1-4) who points out that the sequential short delays in pretreatment imaging may also add to the total delay time. In this study, installing a block cutter laboratory within the Gaborone Oncology premises lead 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: 1-4) and Souza et al. (2001: 1-3).
Overall implementation of the PDSA cycles showed significant reduction in radiotherapy delays at Gaborone Oncology. In head and neck cancer patients 54.5 percent 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 compared to 25 percent who received treatment above 14 days. In cervix cancer patients 83.6 percent received their treatment below 14 days compared to 16.1 percent who received treatment above 14 days.

4.7 Limitation of Study

The research at Gaborone Oncology had certain limitations. Although the results indicated that implementing the PDSA model improved radiotherapy delays at Gaborone Oncology, it was impossible to rule out the Hawthorne Effect on the result of the study. According to Leonard and Masutu (2006: 1-4) the danger of the Hawthorne Effect is that results are temporary and once the study is completed people tend to return to normal behaviour. In spite of this, since the Hawthorne Effect is always on the side of better performance (Leonard and Masutu 2006: 1-4) 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 Gaborone Oncology sustainability of these results requires continuous data collection. As stated in the introduction and shown with Gaborone Oncology statistics the number of new patients seen at Gaborone Oncology is continuing to increase and expected to increase even more in the coming years. Souza et al. (2001: 1-3) 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 one linear accelerator and same number of staff from inception in the year 2000. Due to the seen increase in number of cancer patients at the centre and future expected increase, one linear accelerator and same number of staff may not
be sufficient to provide services. Therefore although the results at Gaborone Oncology showed that staffing was in the least causes of delay, the near future may indicate contrary results. According to Khan (1994: 506), staffing recommendations and looking at the staffing levels and the number of patient increase from 2000 to 2008 at Gaborone Oncology, this is one area the centre will have to look at.

4.8 Conclusion

The results in this study indicated that using the PDSA model of improvement reduced radiotherapy delays in head and neck, breast and cervix cancers. The retrospective results indicted the base line delays in each tumour type and the prospective phase identified areas of improvement using process management tools. Furthermore in the prospective phase the results of the PDSA cycles implemented showed improvement in radiotherapy delays. Run charts results also showed improvement in radiotherapy delays after using the PDSA cycles. Despite the above mentioned limitations of the study, the results definitely showed a significant improvement in radiotherapy delays after implementing the PDSA improvement model.
CHAPTER 5 RECOMMENDATION AND CONCLUSION

5.1 Introduction

Radiotherapy is the most effective curative treatment for cancer after surgery (Burnet et al. 2000: 198-199). Most patients with cancer will have radiotherapy as a form of treatment therefore improving effectiveness of radiotherapy will have a substantial impact on cancer cure (Levin et al. 2001: 25-31). Research has shown that reducing radiotherapy delays is one effective way of increasing effectiveness of radiotherapy (Jensen et al. 2007). Furthermore reducing radiotherapy delays reduces psychological morbidity for the cancer patients waiting to start treatment (Lehman et al. 2004: 283-289). Quality improvement models such as the PDSA model are available that can assist radiotherapy department to reduce unnecessary radiotherapy delays. In the study at Gaborone Oncology, using the PDSA model for improvement to reduce radiotherapy delays in head and neck, breast and cervix cancer patients was achieved. The PDSA model was able to reduce these delays with minimum disruption to normal departmental routine. Through restructuring of the patients booking process, treatment planning process and medical aid process a reduction in radiotherapy delays of these cancers was observed within six months after implementing the PDSA model.

5.2 Recommendations

In this study it was not possible to significantly reduce radiotherapy delays in medical aid cover using the PDSA model. Other quality improvement models or strategies could therefore be recommended in improving radiotherapy delays in this area. It would further be recommended that more education on importance of starting radiotherapy delay be introduced to medical aid organisations.

Due to the increased awareness of cancer and availability of treatment at Gaborone Oncology Centre, 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 Gaborone Oncology. The department will in future need to look
at increasing equipment capacity such as installing a second linear accelerator and more staff to manage this linear accelerator.

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: 198-199; Horiot et al. (1992: 229-230). At present at Gaborone Oncology Centre patients are already treated twice a day or treated over the weekend to 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.

5.3 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: 5). The JCCO recommends that for radical radiotherapy, even that which involves
complex treatment planning; a two week delay is considered good practice (JCCO 1993:6). 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: 222-228). Mackillop (2007: 1-4) 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: 619-622) 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: 17011; Kerr et al. 2002: 164-166). 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: 26-27) 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: 619-622), the PDSA model was the ideal model chosen for this research. The research at Gaborone Oncology showed that implementing the PDSA model reduced radiotherapy delays from the patients’ first visit to Gaborone Oncology 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 2008) after implementing the PDSA model. As head and neck, breast and cervix cancer patients are the most treated cancer at Gaborone Oncology 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. At the beginning of the study, customised blocks were imported from outside the Botswana, but halfway through the study a block cutter was installed within the hospital premises. Installing a block cutter laboratory within the Gaborone Oncology premises led 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. (2008:10-24) highlights that no quality improvement model is superior over the other. The choice of the quality improvement model 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 Gaborone Oncology Centre. 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: 198 -199) 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 Gaborone Oncology Centre 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: 1-5) also highlights that it is logical to start to start any kind of oncology treatment as soon as possible so as to minimise psychological distress for cancer patients and maximise possible tumour control. Through implementing the PDSA model this study was able to reduce and maintain radiotherapy delays to within the standards set by the JCCO.
6. References


Gaborone Oncology Centre., Statistics up date 2008.


### 1.1 Breast Cancer Retrospective Data Collection Sheet

<table>
<thead>
<tr>
<th>RESEARCH NUMBER</th>
<th>DATE OF REFERAL</th>
<th>FIRST TREATMENT DATE</th>
<th>DELAY IN DAYS</th>
<th>REASONS FOR DELAY</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR 07/ 01</td>
<td>17-Jan-07</td>
<td>24-Jan-07</td>
<td>7</td>
<td>Routine Plan</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 02</td>
<td>25-Jan-07</td>
<td>5-Feb-07</td>
<td>10</td>
<td>Bookings</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 03</td>
<td>9-Feb-07</td>
<td>5-Feb-07</td>
<td>10</td>
<td>Bookings</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 04</td>
<td>28-Feb-07</td>
<td>7-Mar-07</td>
<td>7</td>
<td>Routine Plan</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 05</td>
<td>28-Feb-07</td>
<td>15-Mar-07</td>
<td>15</td>
<td>Bookings</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 06</td>
<td>6-Mar-07</td>
<td>25-Mar-07</td>
<td>19</td>
<td>Waiting histology + Staging</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 07</td>
<td>9-Jul-07</td>
<td>31-Jul-07</td>
<td>22</td>
<td>Medical Aid</td>
<td>Private Patient</td>
</tr>
<tr>
<td>BR 07/ 08</td>
<td>13-Mar-07</td>
<td>19-Mar-07</td>
<td>6</td>
<td>Routine Plan</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 10</td>
<td>11-Apr-07</td>
<td>18-Apr-07</td>
<td>7</td>
<td>Routine Plan</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 11</td>
<td>11-Apr-07</td>
<td>19-Apr-07</td>
<td>8</td>
<td>Routine Plan</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 12</td>
<td>11-Apr-07</td>
<td>18-Apr-07</td>
<td>7</td>
<td>Routine Plan</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 13</td>
<td>12-Apr-07</td>
<td>2-May-07</td>
<td>20</td>
<td>Re simulation + Re Plan</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 14</td>
<td>26-Apr-07</td>
<td>15-May-07</td>
<td>19</td>
<td>Bookings</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 15</td>
<td>9-May-07</td>
<td>6-Jun-07</td>
<td>27</td>
<td>Re simulation + Re Plan</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 16</td>
<td>15-May-07</td>
<td>28-May-07</td>
<td>13</td>
<td>Bookings</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 17</td>
<td>9-Nov-07</td>
<td>22-Jan-08</td>
<td>73</td>
<td>Bookings + Communication</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 18</td>
<td>4-Jun-07</td>
<td>12-Jun-07</td>
<td>8</td>
<td>Routine Plan</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 19</td>
<td>25-Jun-07</td>
<td>9-Jul-07</td>
<td>14</td>
<td>Bookings</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 20</td>
<td>3-Jul-07</td>
<td>10-Jul-07</td>
<td>7</td>
<td>Routine Plan</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 21</td>
<td>9-Jul-07</td>
<td>24-Jul-07</td>
<td>15</td>
<td>Machine Service</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 22</td>
<td>10-Jul-07</td>
<td>26-Jul-07</td>
<td>16</td>
<td>Machine Service</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 23</td>
<td>10-Jul-07</td>
<td>30-Jul-07</td>
<td>20</td>
<td>Machine Service</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 24</td>
<td>18-Dec-07</td>
<td>4-Feb-08</td>
<td>46</td>
<td>Medical Aid</td>
<td>Private Patient</td>
</tr>
<tr>
<td>BR 07/ 25</td>
<td>11-Jul-07</td>
<td>25-Jul-07</td>
<td>14</td>
<td>Bookings</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 26</td>
<td>2-Aug-07</td>
<td>14-Aug-07</td>
<td>12</td>
<td>Bookings</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 27</td>
<td>7-Aug-07</td>
<td>15-Aug-07</td>
<td>6</td>
<td>Routine Plan</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 29</td>
<td>29-Oct-07</td>
<td>9-Nov-07</td>
<td>10</td>
<td>Bookings</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 30</td>
<td>1-Nov-07</td>
<td>12-Nov-07</td>
<td>11</td>
<td>Bookings</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 31</td>
<td>1-Nov-07</td>
<td>20-Nov-07</td>
<td>19</td>
<td>Bookings</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 32</td>
<td>5-Nov-07</td>
<td>9-Jan-08</td>
<td>64</td>
<td>Medical Aid + Communication</td>
<td>Private Patient</td>
</tr>
<tr>
<td>BR 07/ 33</td>
<td>14-Nov-07</td>
<td>27-Nov-07</td>
<td>13</td>
<td>Bookings</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 34</td>
<td>27-Dec-07</td>
<td>31-Jan-08</td>
<td>34</td>
<td>Medical Aid</td>
<td>Private Patient</td>
</tr>
<tr>
<td>BR 07/ 35</td>
<td>12-Nov-07</td>
<td>4-Dec-07</td>
<td>22</td>
<td>Bookings</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 36</td>
<td>26-Nov-07</td>
<td>29-Nov-07</td>
<td>3</td>
<td>Routine Plan</td>
<td>Government patient</td>
</tr>
<tr>
<td>BR 07/ 37</td>
<td>12-Dec-07</td>
<td>16-Jan-08</td>
<td>34</td>
<td>Doctor consultations</td>
<td>Government patient</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td></td>
<td></td>
<td><strong>17.64864865</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 1.2 Cervix Cancer Retrospective Data Collection Sheet

<table>
<thead>
<tr>
<th>RESEARCH NUMBER</th>
<th>DATE OF REFERRAL</th>
<th>FIRST TREATMENT DATE</th>
<th>DELAY IN DAYS</th>
<th>REASONS FOR DELAY</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CX 07/ 01</td>
<td>4-Jan-07</td>
<td>9-Jan-07</td>
<td>5</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 02</td>
<td>8-Jan-07</td>
<td>10-Jan-07</td>
<td>2</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 03</td>
<td>16-Jan-07</td>
<td>30-Jan-07</td>
<td>14</td>
<td>Dr consults + Low HB</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 04</td>
<td>17-Jan-07</td>
<td>23-Jan-07</td>
<td>6</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 05</td>
<td>25-Jan-07</td>
<td>7-Feb-07</td>
<td>12</td>
<td>Bookings</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 06</td>
<td>5-Feb-07</td>
<td>12-Feb-07</td>
<td>7</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 07</td>
<td>6-Feb-07</td>
<td>14-Feb-07</td>
<td>8</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 08</td>
<td>7-Feb-07</td>
<td>14-Feb-07</td>
<td>7</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 09</td>
<td>12-Feb-07</td>
<td>19-Feb-07</td>
<td>7</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 10</td>
<td>13-Feb-07</td>
<td>27-Feb-07</td>
<td>14</td>
<td>Bookings</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 11</td>
<td>16-Feb-07</td>
<td>5-Mar-07</td>
<td>19</td>
<td>Waiting Histology</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 12</td>
<td>19-Feb-07</td>
<td>1-Mar-07</td>
<td>12</td>
<td>Bookings</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 13</td>
<td>19-Feb-07</td>
<td>28-Feb-07</td>
<td>9</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 15</td>
<td>19-Mar-07</td>
<td>20-Mar-07</td>
<td>1</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 16</td>
<td>26-Mar-07</td>
<td>28-Mar-07</td>
<td>2</td>
<td>Routine Plan &amp; Palliative</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 17</td>
<td>16-Apr-07</td>
<td>23-Apr-07</td>
<td>7</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 18</td>
<td>18-Apr-07</td>
<td>19-Apr-07</td>
<td>3</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 19</td>
<td>24-Apr-07</td>
<td>7-May-07</td>
<td>13</td>
<td>Bookings</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 20</td>
<td>8-May-07</td>
<td>14-May-07</td>
<td>6</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 21</td>
<td>14-May-07</td>
<td>22-May-07</td>
<td>8</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 22</td>
<td>15-May-07</td>
<td>28-May-07</td>
<td>13</td>
<td>Bookings</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 23</td>
<td>29-May-07</td>
<td>7-Jun-07</td>
<td>8</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 24</td>
<td>29-May-07</td>
<td>5-Jun-07</td>
<td>6</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 30</td>
<td>29-Jun-07</td>
<td>5-Jul-07</td>
<td>6</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 31</td>
<td>9-Jul-07</td>
<td>23-Jul-07</td>
<td>14</td>
<td>Bookings</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 32</td>
<td>13-Jul-07</td>
<td>26-Jul-07</td>
<td>13</td>
<td>Bookings</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 33</td>
<td>23-Jul-07</td>
<td>14-Aug-07</td>
<td>21</td>
<td>Dr consults sent for U/S</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 34</td>
<td>23-Jul-07</td>
<td>1-Aug-07</td>
<td>8</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 35</td>
<td>23-Jul-07</td>
<td>1-Aug-07</td>
<td>8</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 36</td>
<td>23-Jul-07</td>
<td>31-Jul-07</td>
<td>8</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 37</td>
<td>23-Jul-07</td>
<td>1-Aug-07</td>
<td>8</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 38</td>
<td>23-Jul-07</td>
<td>2-Aug-07</td>
<td>9</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 40</td>
<td>23-Jul-07</td>
<td>1-Aug-07</td>
<td>8</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 41</td>
<td>23-Jul-07</td>
<td>1-Aug-07</td>
<td>8</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 42</td>
<td>7-Aug-07</td>
<td>15-Aug-07</td>
<td>8</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 43</td>
<td>13-Aug-07</td>
<td>20-Aug-07</td>
<td>7</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 44</td>
<td>20-Aug-07</td>
<td>22-Aug-07</td>
<td>2</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 45</td>
<td>20-Aug-07</td>
<td>22-Aug-07</td>
<td>2</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 46</td>
<td>21-Aug-07</td>
<td>27-Aug-07</td>
<td>6</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 47</td>
<td>31-Aug-07</td>
<td>11-Sep-07</td>
<td>11</td>
<td>Delayed Finance Grant</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 48</td>
<td>13-Sep-07</td>
<td>20-Sep-07</td>
<td>7</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 49</td>
<td>17-Sep-07</td>
<td>27-Sep-07</td>
<td>10</td>
<td>Bookings</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 50</td>
<td>18-Sep-07</td>
<td>24-Sep-07</td>
<td>6</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 51</td>
<td>19-Sep-07</td>
<td>24-Sep-07</td>
<td>5</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 52</td>
<td>21-Sep-07</td>
<td>30-Sep-07</td>
<td>9</td>
<td>Routine Plan</td>
<td>Private patient</td>
</tr>
<tr>
<td>CX 07/ 53</td>
<td>13-Sep-07</td>
<td>3-Oct-07</td>
<td>20</td>
<td>Dr consults + Low HB</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 57</td>
<td>31-Oct-07</td>
<td>8-Nov-07</td>
<td>8</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>CX 07/ 58</td>
<td>9-Nov-07</td>
<td>14-Nov-07</td>
<td>5</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
</tbody>
</table>
## 1.3 Head and Neck Cancer Retrospective Data Collection Sheet

<table>
<thead>
<tr>
<th>RESEARCH NUMBER</th>
<th>DATE OF REFERAL</th>
<th>FIRST TREATMENT DATE</th>
<th>DELAY IN DAYS</th>
<th>REASONS FOR DELAY</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>H/N 07/01</td>
<td>3-Jan-07</td>
<td>24-Jan-07</td>
<td>21</td>
<td>Blocks</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/02</td>
<td>4-Jan-07</td>
<td>8-Jan-07</td>
<td>4</td>
<td>Routine plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/03</td>
<td>9-Jan-07</td>
<td>30-Jan-07</td>
<td>7</td>
<td>Routine plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/04</td>
<td>22-Jan-07</td>
<td>31-Jan-07</td>
<td>9</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/05</td>
<td>23-Jan-07</td>
<td>30-Jan-07</td>
<td>7</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/06</td>
<td>24-Jan-07</td>
<td>20-Feb-07</td>
<td>27</td>
<td>Bookings</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/07</td>
<td>25-Jan-07</td>
<td>21-Feb-07</td>
<td>27</td>
<td>CT Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/08</td>
<td>8-Feb-07</td>
<td>28-Feb-07</td>
<td>20</td>
<td>CT Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/09</td>
<td>14-Feb-07</td>
<td>21-Feb-07</td>
<td>7</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/10</td>
<td>7-Mar-07</td>
<td>21-Mar-07</td>
<td>14</td>
<td>Bookings</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/11</td>
<td>26-Mar-07</td>
<td>26-Jun-07</td>
<td>92</td>
<td>Bookings Dr re- assessment</td>
<td>Government Patient, Dental assessment</td>
</tr>
<tr>
<td>H/N 07/12</td>
<td>2-Apr-07</td>
<td>2-May-07</td>
<td>30</td>
<td>Medical Aid, Blocks,</td>
<td>Government Patient, Started with manual Blocks</td>
</tr>
<tr>
<td>H/N 07/13</td>
<td>10-Apr-07</td>
<td>23-Apr-07</td>
<td>14</td>
<td>Blocks</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/14</td>
<td>13-Apr-07</td>
<td>23-Apr-07</td>
<td>10</td>
<td>Bookings</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/15</td>
<td>2-May-07</td>
<td>8-May-07</td>
<td>6</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/16</td>
<td>3-May-07</td>
<td>30-May-07</td>
<td>27</td>
<td>Blocks</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/17</td>
<td>3-May-07</td>
<td>14-May-07</td>
<td>11</td>
<td>Bookings</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/18</td>
<td>8-May-07</td>
<td>30-May-07</td>
<td>22</td>
<td>CT Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/19</td>
<td>14-May-07</td>
<td>24-May-07</td>
<td>10</td>
<td>Bookings</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/20</td>
<td>4-Jun-07</td>
<td>28-Jun-07</td>
<td>35</td>
<td>Bookings</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/21</td>
<td>4-Jun-07</td>
<td>27-Jun-07</td>
<td>23</td>
<td>Bookings</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/22</td>
<td>5-Jun-07</td>
<td>13-Jun-07</td>
<td>7</td>
<td>Routine plan</td>
<td>Government Patient, treatment incomplete</td>
</tr>
<tr>
<td>H/N 07/23</td>
<td>26-Jun-07</td>
<td>23-Jul-07</td>
<td>27</td>
<td>Bookings</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/24</td>
<td>26-Jun-07</td>
<td>3-Jul-07</td>
<td>8</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/25</td>
<td>3-Jul-07</td>
<td>10-Jul-07</td>
<td>7</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/26</td>
<td>20-Jul-07</td>
<td>25-Jul-07</td>
<td>5</td>
<td>Routine Plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/27</td>
<td>25-Jul-07</td>
<td>28-Aug-07</td>
<td>34</td>
<td>Bookings</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/28</td>
<td>6-Aug-07</td>
<td>16-Aug-07</td>
<td>10</td>
<td>Bookings</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/29</td>
<td>13-Aug-07</td>
<td>20-Aug-07</td>
<td>7</td>
<td>Routine plan</td>
<td>Government Patient</td>
</tr>
<tr>
<td>H/N 07/31</td>
<td>22-Oct-07</td>
<td>8-Nov-07</td>
<td>16</td>
<td>CT Plan</td>
<td>Government Patient</td>
</tr>
</tbody>
</table>
### 8. APPENDIX 2 PROSPECTIVE DATA COLLECTION SHEET (AFTER PDSA IMPLEMENTATION)

#### 2.1 Cervix Cancer Prospective Data Collection Sheet

<table>
<thead>
<tr>
<th>RESEARCH NUMBER</th>
<th>DATE OF REFERAL</th>
<th>DATE OF FIRST TREATMENT</th>
<th>TIME INTERVAL IN DAYS</th>
<th>REASON FOR DELAYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPH CACX 01</td>
<td>6-May-08</td>
<td>23-Jun-08</td>
<td>47</td>
<td>medical aid</td>
</tr>
<tr>
<td>GPH CACX 02</td>
<td>27-May-08</td>
<td>11-Jun-08</td>
<td>14</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 03</td>
<td>11-Jun-08</td>
<td>19-Jun-08</td>
<td>8</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 04</td>
<td>3-Jun-08</td>
<td>16-Jun-08</td>
<td>13</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 05</td>
<td>12-May-08</td>
<td>22-May-08</td>
<td>10</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 06</td>
<td>28-May-08</td>
<td>3-Jun-08</td>
<td>7</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 07</td>
<td>13-Jun-08</td>
<td>23-Jun-08</td>
<td>10</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 08</td>
<td>16-Jun-08</td>
<td>24-Jun-08</td>
<td>8</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 09</td>
<td>2-Jun-08</td>
<td>13-Jun-08</td>
<td>11</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 10</td>
<td>27-May-08</td>
<td>18-Jun-08</td>
<td>21</td>
<td>Bookings</td>
</tr>
<tr>
<td>GPH CACX 11</td>
<td>9-Jun-08</td>
<td>17-Jun-08</td>
<td>8</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 12</td>
<td>5-May-08</td>
<td>11-Jun-08</td>
<td>36</td>
<td>medical aid</td>
</tr>
<tr>
<td>GPH CACX 13</td>
<td>27-May-08</td>
<td>11-Jun-08</td>
<td>14</td>
<td>Acceptable</td>
</tr>
<tr>
<td>MEAN</td>
<td></td>
<td></td>
<td>15.92307692</td>
<td></td>
</tr>
</tbody>
</table>
## CERVIX
### DATA COLLECTION MONTHLY CHART  JUNE –JULY 2008

<table>
<thead>
<tr>
<th>RESEARCH NUMBER</th>
<th>DATE OF REFERAL</th>
<th>DATE OF FIRST TREATMENT</th>
<th>TIME INTERVAL IN DAYS</th>
<th>REASONS FOR DELAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPH CACX 14</td>
<td>23-Jun-08</td>
<td>9-Jul-08</td>
<td>16</td>
<td>Booking</td>
</tr>
<tr>
<td>GPH CACX 15</td>
<td>16-Jun-08</td>
<td>2-Jul-08</td>
<td>16</td>
<td>Booking</td>
</tr>
<tr>
<td>GPH CACX 16</td>
<td>26-Jun-08</td>
<td>7-Jul-08</td>
<td>11</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 17</td>
<td>26-Jun-08</td>
<td>7-Jul-08</td>
<td>11</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 18</td>
<td>20-Jun-08</td>
<td>3-Jul-08</td>
<td>13</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 19</td>
<td>3-Jul-08</td>
<td>14-Jul-08</td>
<td>11</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 20</td>
<td>26-Jun-08</td>
<td>8-Jul-08</td>
<td>12</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 21</td>
<td>23-Jun-08</td>
<td>8-Jul-08</td>
<td>15</td>
<td>Booking</td>
</tr>
<tr>
<td>GPH CACX 22</td>
<td>2-Jul-08</td>
<td>9-Jul-08</td>
<td>7</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 23</td>
<td>30-Jun-08</td>
<td>9-Jul-08</td>
<td>9</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 24</td>
<td>23-Jun-08</td>
<td>8-Jul-08</td>
<td>15</td>
<td>Booking</td>
</tr>
<tr>
<td>GPH CACX 25</td>
<td>2-Jul-08</td>
<td>9-Jul-08</td>
<td>7</td>
<td>Acceptable</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td></td>
<td></td>
<td><strong>11.91666667</strong></td>
<td></td>
</tr>
</tbody>
</table>

## CERVIX
### DATA COLLECTION MONTHLY CHART  JULY-AUGUST 2008

<table>
<thead>
<tr>
<th>RESEARCH NUMBER</th>
<th>DATE OF REFERAL</th>
<th>DATE OF FIRST TREATMENT</th>
<th>TIME INTERVAL IN DAYS</th>
<th>REASONS FOR DELAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPH CACX 26</td>
<td>19-Aug-08</td>
<td>27-Aug-08</td>
<td>8</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 27</td>
<td>28-Jul-08</td>
<td>6-Aug-08</td>
<td>8</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 28</td>
<td>21-Aug-08</td>
<td>27-Aug-08</td>
<td>6</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 29</td>
<td>21-Aug-08</td>
<td>28-Aug-08</td>
<td>7</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 30</td>
<td>6-Aug-08</td>
<td>13-Aug-08</td>
<td>7</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 31</td>
<td>5-Aug-08</td>
<td>13-Aug-08</td>
<td>8</td>
<td>Acceptable</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td></td>
<td></td>
<td><strong>7.333333333</strong></td>
<td></td>
</tr>
</tbody>
</table>

## CERVIX
### DATA COLLECTION MONTHLY CHART  AUGUST –SEPTEMBER 2008

<table>
<thead>
<tr>
<th>RESEARCH NUMBER</th>
<th>DATE OF REFERAL</th>
<th>DATE OF FIRST TREATMENT</th>
<th>TIME INTERVAL IN DAYS</th>
<th>REASONS FOR DELAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPH CACX 32</td>
<td>3-Sep-08</td>
<td>15-Sep-08</td>
<td>12</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 33</td>
<td>4-Sep-08</td>
<td>17-Sep-08</td>
<td>13</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 34</td>
<td>5-Aug-08</td>
<td>15-Sep-08</td>
<td>40</td>
<td>Medical Aid denied-sent to Government</td>
</tr>
<tr>
<td>GPH CACX 35</td>
<td>19-Sep-08</td>
<td>24-Sep-08</td>
<td>5</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 36</td>
<td>5-Sep-08</td>
<td>22-Sep-08</td>
<td>17</td>
<td>Medical Aid</td>
</tr>
<tr>
<td>GPH CACX 37</td>
<td>18-Sep-08</td>
<td>23-Sep-08</td>
<td>5</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 38</td>
<td>23-Sep-08</td>
<td>23-Sep-08</td>
<td>0</td>
<td>Acceptable Urgent</td>
</tr>
<tr>
<td>GPH CACX 39</td>
<td>3-Sep-08</td>
<td>15-Sep-08</td>
<td>12</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 40</td>
<td>15-Jul-08</td>
<td>9-Sep-08</td>
<td>54</td>
<td>Medical aid + Planning digitizer down</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td></td>
<td></td>
<td><strong>17.55555556</strong></td>
<td></td>
</tr>
</tbody>
</table>
### DATA COLLECTION MONTHLY CHART SEPTEMBER – OCTOBER 2008

<table>
<thead>
<tr>
<th>RESEARCH NUMBER</th>
<th>DATE OF REFERAL</th>
<th>DATE OF FIRST TREATMENT</th>
<th>TIME INTERVAL IN DAYS</th>
<th>REASONS FOR DELAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPH CACX 41</td>
<td>23-Sep-08</td>
<td>7-Oct-08</td>
<td>14</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 42</td>
<td>2-Oct-08</td>
<td>2-Oct-08</td>
<td>0</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 43</td>
<td>2-Oct-08</td>
<td>7-Oct-08</td>
<td>5</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 44</td>
<td>2-Oct-08</td>
<td>8-Oct-08</td>
<td>6</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 45</td>
<td>9-Oct-08</td>
<td>14-Oct-08</td>
<td>5</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 46</td>
<td>16-Oct-08</td>
<td>22-Oct-08</td>
<td>6</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 47</td>
<td>2-Oct-08</td>
<td>13-Oct-08</td>
<td>11</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 48</td>
<td>2-Oct-08</td>
<td>14-Oct-08</td>
<td>12</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 49</td>
<td>16-Oct-08</td>
<td>22-Oct-08</td>
<td>6</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 50</td>
<td>2-Oct-08</td>
<td>13-Oct-08</td>
<td>11</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 51</td>
<td>25-Sep-08</td>
<td>8-Oct-08</td>
<td>13</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 52</td>
<td>2-Oct-08</td>
<td>15-Oct-08</td>
<td>13</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 53</td>
<td>21-Oct-08</td>
<td>29-Oct-08</td>
<td>8</td>
<td>Acceptable</td>
</tr>
</tbody>
</table>

**MEAN**: 8.461538462

### DATA COLLECTION MONTHLY CHART OCTOBER – NOVEMBER 2008

<table>
<thead>
<tr>
<th>RESEARCH NUMBER</th>
<th>DATE OF REFERAL</th>
<th>DATE OF FIRST TREATMENT</th>
<th>TIME INTERVAL IN DAYS</th>
<th>REASONS FOR DELAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPH CACX 54</td>
<td>5-Nov-08</td>
<td>17-Nov-08</td>
<td>12</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 55</td>
<td>24-Nov-08</td>
<td>1-Dec-08</td>
<td>7</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 56</td>
<td>17-Nov-08</td>
<td>20-Nov-08</td>
<td>3</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 57</td>
<td>12-Nov-08</td>
<td>17-Nov-08</td>
<td>5</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 58</td>
<td>26-Nov-08</td>
<td>1-Dec-08</td>
<td>5</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 59</td>
<td>17-Nov-08</td>
<td>20-Nov-08</td>
<td>3</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 60</td>
<td>3-Oct-08</td>
<td>19-Nov-08</td>
<td>46</td>
<td>Medical Aid</td>
</tr>
</tbody>
</table>

**MEAN**: 11.57142857

### DATA COLLECTION MONTHLY CHART NOVEMBER- DECEMBER

<table>
<thead>
<tr>
<th>RESEARCH NUMBER</th>
<th>DATE OF REFERAL</th>
<th>DATE OF FIRST TREATMENT</th>
<th>TIME INTERVAL IN DAYS</th>
<th>REASONS FOR DELAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPH CACX 61</td>
<td>1-Dec-08</td>
<td>8-Dec-08</td>
<td>7</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 62</td>
<td>15-Dec-08</td>
<td>23-Dec-08</td>
<td>8</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH CACX 63</td>
<td>9-Dec-08</td>
<td>16-Dec-08</td>
<td>7</td>
<td>Acceptable</td>
</tr>
</tbody>
</table>

**MEAN**: 7.333333333

105
### 2.2 Breast Cancer Prospective Data Collection Sheet

#### DATA COLLECTION MONTHLY CHART MAY-JUNE 2008

<table>
<thead>
<tr>
<th>RESEARCH NUMBER</th>
<th>DATE OF REFERAL</th>
<th>DATE OF FIRST TREATMENT</th>
<th>TIME INTERVAL IN DAYS</th>
<th>REASONS FOR DELAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPH BREAST 01</td>
<td>16-Jun-08</td>
<td>19-Jun-08</td>
<td>3</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH BREAST 02</td>
<td>19-May-08</td>
<td>2-Jun-08</td>
<td>13</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH BREAST 03</td>
<td>12-May-08</td>
<td>22-May-08</td>
<td>10</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH BREAST 04</td>
<td>20-Mar-08</td>
<td>11-Jun-08</td>
<td>81</td>
<td>Medical aid + patient preference</td>
</tr>
<tr>
<td>GPH BREAST 05</td>
<td>16-Jun-08</td>
<td>24-Jun-08</td>
<td>8</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH BREAST 06</td>
<td>27-May-08</td>
<td>18-Jun-08</td>
<td>21</td>
<td>Bookings</td>
</tr>
<tr>
<td>GPH BREAST 07</td>
<td>27-May-08</td>
<td>23-Jun-08</td>
<td>26</td>
<td>Bookings</td>
</tr>
<tr>
<td>GPH BREAST 08</td>
<td>26-May-08</td>
<td>9-Jun-08</td>
<td>13</td>
<td>Acceptable</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td></td>
<td></td>
<td><strong>21.875</strong></td>
<td></td>
</tr>
</tbody>
</table>

#### DATA COLLECTION MONTHLY CHART JUNE – JULY 2008

<table>
<thead>
<tr>
<th>RESEARCH NUMBER</th>
<th>DATE OF REFERAL</th>
<th>DATE OF FIRST TREATMENT</th>
<th>TIME INTERVAL IN DAYS</th>
<th>REASONS FOR DELAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPH BREAST 09</td>
<td>23-Jun-08</td>
<td>7-Jul-08</td>
<td>14</td>
<td>Acceptable</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td></td>
<td></td>
<td><strong>14</strong></td>
<td></td>
</tr>
</tbody>
</table>

#### DATA COLLECTION MONTHLY CHART JULY – AUGUST 2008

<table>
<thead>
<tr>
<th>RESEARCH NUMBER</th>
<th>DATE OF REFERAL</th>
<th>DATE OF FIRST TREATMENT</th>
<th>TIME INTERVAL IN DAYS</th>
<th>REASONS FOR DELAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPH BREAST 10</td>
<td>19-Aug-08</td>
<td>27-Aug-08</td>
<td>8</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH BREAST 11</td>
<td>6-Aug-08</td>
<td>13-Aug-08</td>
<td>7</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH BREAST 12</td>
<td>11-Aug-08</td>
<td>20-Aug-08</td>
<td>9</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH BREAST 13</td>
<td>30-Jul-08</td>
<td>13-Aug-08</td>
<td>13</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH BREAST 14</td>
<td>19-Aug-08</td>
<td>27-Aug-08</td>
<td>8</td>
<td>Acceptable</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td></td>
<td></td>
<td><strong>9</strong></td>
<td></td>
</tr>
</tbody>
</table>

#### DATA COLLECTION MONTHLY CHART AUGUST- SEPTEMBER 2008

<table>
<thead>
<tr>
<th>RESEARCH NUMBER</th>
<th>DATE OF REFERAL</th>
<th>DATE OF FIRST TREATMENT</th>
<th>TIME INTERVAL IN DAYS</th>
<th>REASONS FOR DELAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPH BREAST 15</td>
<td>25-Aug-08</td>
<td>8-Sep-08</td>
<td>13</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH BREAST 16</td>
<td>15-Aug-08</td>
<td>8-Sep-08</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>GPH BREAST 17</td>
<td>3-Sep-08</td>
<td>8-Sep-08</td>
<td>5</td>
<td>Acceptable</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td></td>
<td></td>
<td><strong>13.66666667</strong></td>
<td></td>
</tr>
</tbody>
</table>
### Breast Data Collection Monthly Chart September - October 2008

<table>
<thead>
<tr>
<th>Research Number</th>
<th>Date of Referal</th>
<th>Date of First Treatment</th>
<th>Time Interval in Days</th>
<th>Reasons for Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPH BREAST 18</td>
<td>22-Sep-08</td>
<td>8-Oct-08</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>GPH BREAST 19</td>
<td>8-Oct-08</td>
<td>20-Oct-08</td>
<td>12</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH BREAST 20</td>
<td>29-Sep-08</td>
<td>8-Oct-08</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>GPH BREAST 21</td>
<td>16-Sep-08</td>
<td>22-Oct-08</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td></td>
<td></td>
<td><strong>18.25</strong></td>
<td></td>
</tr>
</tbody>
</table>

### Breast Data Collection Monthly Chart October – November 2008

<table>
<thead>
<tr>
<th>Research Number</th>
<th>Date of Referal</th>
<th>Date of First Treatment</th>
<th>Time Interval in Days</th>
<th>Reasons for Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPH BREAST 22</td>
<td>12-Nov-08</td>
<td>19-Nov-08</td>
<td>7</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH BREAST 23</td>
<td>3-Nov-08</td>
<td>4-Nov-08</td>
<td>1</td>
<td>Acceptable</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td></td>
<td></td>
<td><strong>4</strong></td>
<td></td>
</tr>
</tbody>
</table>

### Breast Data Collection Monthly Chart November – December 2008

<table>
<thead>
<tr>
<th>Research Number</th>
<th>Date of Referal</th>
<th>Date of First Treatment</th>
<th>Time Interval in Days</th>
<th>Reasons for Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPH BREAST 24</td>
<td>12-Dec-08</td>
<td>22-Dec-08</td>
<td>10</td>
<td>Acceptable</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td></td>
<td></td>
<td><strong>10</strong></td>
<td></td>
</tr>
</tbody>
</table>

#### 2.3 Head and Neck Cancer Prospective Data Collection Sheet

### Head/Neck Data Collection Monthly Chart May – June 2008

<table>
<thead>
<tr>
<th>Research Number</th>
<th>Date of Referal</th>
<th>Date of First Treatment</th>
<th>Time Interval in Days</th>
<th>Reasons for Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPH H/N 01</td>
<td>3-Jun-08</td>
<td>20-Jun-08</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>GPH H/N 02</td>
<td>7-May-08</td>
<td>14-May-08</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>GPH H/N 03</td>
<td>6-May-08</td>
<td>14-May-08</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>GPH H/N 04</td>
<td>9-Jun-08</td>
<td>19-Jun-08</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>GPH H/N 05</td>
<td>26-May-08</td>
<td>23-Jun-08</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>GPH H/N 06</td>
<td>20-May-08</td>
<td>23-Jun-08</td>
<td>33</td>
<td>Blocks delay</td>
</tr>
<tr>
<td>GPH H/N 07</td>
<td>3-Jun-08</td>
<td>23-Jun-08</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>GPH H/N 08</td>
<td>6-May-08</td>
<td>19-May-08</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>GPH H/N 09</td>
<td>27-May-08</td>
<td>23-Jun-08</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td></td>
<td></td>
<td><strong>17.88888889</strong></td>
<td></td>
</tr>
</tbody>
</table>
### HEAD/NECK DATA

#### DATA COLLECTION MONTHLY CHART  JUNE – JULY  2008

<table>
<thead>
<tr>
<th>RESEARCH NUMBER</th>
<th>DATE OF REFERAL</th>
<th>DATE OF FIRST TREATMENT</th>
<th>TIME INTERVAL IN DAYS</th>
<th>REASONS FOR DELAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPH H/N 10</td>
<td>24-Jun-08</td>
<td>28-Jul-08</td>
<td>34</td>
<td>Booking</td>
</tr>
<tr>
<td>GPH H/N 11</td>
<td>7-Jul-08</td>
<td>16-Jul-08</td>
<td>9</td>
<td>Acceptable</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td></td>
<td></td>
<td><strong>21.5</strong></td>
<td></td>
</tr>
</tbody>
</table>

### HEAD/NECK DATA

#### DATA COLLECTION MONTHLY CHART  JULY – AUGUST 2008

<table>
<thead>
<tr>
<th>RESEARCH NUMBER</th>
<th>DATE OF REFERAL</th>
<th>DATE OF FIRST TREATMENT</th>
<th>TIME INTERVAL IN DAYS</th>
<th>REASONS FOR DELAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPH H/N 12</td>
<td>15-Aug-08</td>
<td>27-Aug-08</td>
<td>12</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH H/N 13</td>
<td>21-Aug-08</td>
<td>28-Aug-08</td>
<td>7</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH H/N 14</td>
<td>16-Jul-08</td>
<td>5-Aug-08</td>
<td>19</td>
<td>Booking</td>
</tr>
<tr>
<td>GPH H/N 15</td>
<td>4-Aug-08</td>
<td>27-Aug-08</td>
<td>23</td>
<td>Booking</td>
</tr>
<tr>
<td>GPH H/N 16</td>
<td>8-Jul-08</td>
<td>5-Aug-08</td>
<td>27</td>
<td>Booking</td>
</tr>
<tr>
<td>GPH H/N 17</td>
<td>8-Jul-08</td>
<td>26-Aug-08</td>
<td>48</td>
<td>Dental assessment</td>
</tr>
<tr>
<td>GPH H/N 18</td>
<td>30-Jul-08</td>
<td>30-Aug-08</td>
<td>30</td>
<td>booking</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td></td>
<td></td>
<td><strong>23.71428571</strong></td>
<td></td>
</tr>
</tbody>
</table>

### HEAD/NECK DATA

#### DATA COLLECTION MONTHLY CHART  AUGUST - SEPTEMBER 2008

<table>
<thead>
<tr>
<th>RESEARCH NUMBER</th>
<th>DATE OF REFERAL</th>
<th>DATE OF FIRST TREATMENT</th>
<th>TIME INTERVAL IN DAYS</th>
<th>REASONS FOR DELAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPH H/N 19</td>
<td>3-Sep-08</td>
<td>16-Sep-08</td>
<td>13</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH H/N 20</td>
<td>9-Sep-08</td>
<td>18-Sep-08</td>
<td>9</td>
<td>Acceptable</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td></td>
<td></td>
<td><strong>11</strong></td>
<td></td>
</tr>
</tbody>
</table>

### HEAD/NECK DATA

#### DATA COLLECTION MONTHLY CHART  OCTOBER- NOVEMBER 2008

<table>
<thead>
<tr>
<th>RESEARCH NUMBER</th>
<th>DATE OF REFERAL</th>
<th>DATE OF FIRST TREATMENT</th>
<th>TIME INTERVAL IN DAYS</th>
<th>REASONS FOR DELAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPH H/N 21</td>
<td>5-Nov-08</td>
<td>18-Nov-08</td>
<td>13</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GPH H/N 22</td>
<td>3-Nov-08</td>
<td>11-Nov-08</td>
<td>8</td>
<td>Acceptable</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td></td>
<td></td>
<td><strong>10.5</strong></td>
<td></td>
</tr>
</tbody>
</table>
Date 12 February 2008

To Whom It May Concern
University Of Johannesburg
Faculty of Health Sciences

Dear Sir/Madam,

RE: PERMISSION TO CONDUCT RESEARCH AT GABORONE ONCOLOGY CENTRE.

This serves to confirm that Catherine C Chilanga Student Number 200830370 has been granted permission to conduct a research at Gaborone Oncology Center for the fulfillment of a Master s Degree (M-Tech Radiography - Therapy) with the University Of Johannesburg, titled: A Quality Improvement Model to Assess Improvement in Delay of Commencement of Radiotherapy.

The research will not alter any patient’s radiation treatment or change any patient’s treatment department protocol. The data will be collected from previously treated patients and the improvement model implemented in areas that might need improvement to reduce delay time in starting radiotherapy. Therefore no patient consent will be needed for this study.

The main aims and objectives of the study are to identify causes radiotherapy delays, plan and implement a quality improvement model to address the causes and to monitor the effectiveness of the plan. The research outcome will reveal possible quality improvement initiatives and solutions, which are intended to improve radiotherapy delay in our department. Reducing delay time has shown to increase tumor local control and will reduce patient’s psychological morbidity. The research will thus benefit both the patients and the department.

Yours Faithfully,

Dr Magda Heunis (Head of Department)
Clinical Oncologist- MB,ChB (UOFS), MMED.Radt. (UOFS)

Dr Joe Kasese
Clinical Oncologist- MD (U SANTIAGO), MMED RadT. (U.ZIMBABWE), M.Sc
Nuclear Medicine (U LONDON)