Organization and training in radiotherapy for developing countries in Africa

Proceedings of a Regional Seminar jointly organized by the International Atomic Energy Agency and the World Health Organization and held in Cairo, 11–15 December 1989
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FOREWORD

Cancer is now considered as one of the major diseases affecting people in the developing countries. Radiotherapy is one of the major modalities for its treatment. About 50-60% of all types of cancer would require radiotherapy for their effective management. The setting up of a radiotherapy service unfortunately requires a large initial capital outlay which is often beyond the capabilities of many developing countries. In addition, the training of personnel like radiotherapists, medical physicists, technologists and cancer nurses are essential and expensive as most of them have to be trained abroad due to the lack of local training facilities. These and many other considerations are probably responsible for the paucity of radiotherapy facilities in Africa at a time when cancer incidence is on the increase.

Only about 30% of all countries in Africa have radiotherapy facilities which are in many cases inadequately equipped and poorly staffed. This rate is less than the 40% recorded for other developing countries in the world.

This Seminar was held in order to assist in identifying and solving problems that are likely to be encountered by those developing countries, especially in Africa, who are interested in developing radiotherapy facilities.

The Seminar organized by the IAEA in co-operation with WHO and the Government of Egypt, took place in Cairo between December 11-15, 1989.

Eighteen African countries and four others from Europe and Canada participated. Several invited lectures and scientific papers covering various aspects of radiotherapy and cancer management were presented. The Seminar also provided opportunities for interaction between radiotherapists from Africa and other parts of the world. The problems, which are peculiar to Africa with regards to all aspects of radiotherapy, were discussed and solutions preferred. Avenues for future co-operation and collaboration were explored.

For those countries aspiring to develop radiotherapy services, this publication should provide some insight into a suitable line of approach based on the practical experience of others in Africa.

We acknowledge the contributions by all the participants at the seminar and in particular the invited lecturers.

We would also like to thank the Government of Egypt for hosting the Seminar. The roles of Professor M.M. Mahfouz and the staff of the Cairo University, Kasr-El-Einy Centre of Radiation Oncology and Nuclear Medicine (NEMROCK), in ensuring the overall success of the Seminar, are also deeply appreciated.
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INTRODUCTION

Recent evidence has shown that the incidence of cancer is on the increase all over the world especially following the control of many infectious and other communicable diseases. About 3 million new cancer cases are diagnosed per year and over half of these patients are from the developing countries. Between 50-60% of these cases will require radiotherapy either singly or in combination with other forms of treatment such as Surgery and Chemotherapy. Unfortunately, radiotherapy facilities are not available in many developing countries especially in Africa due to many reasons including the lack of the necessary funds and expertise. It is however apparent that many developing countries have now appreciated the need to establish radiotherapy services and have requested technical assistance from the IAEA with emphasis on organization and training.

Only about 30% of all African countries have at least one radiotherapy centre which is usually ill equipped and poorly staffed. Whereas in United States of America, there are about 6 high energy radiotherapy machines per million population, in Africa there is an average of one cobalt teletherapy machine for about 50 million population. There are a total of 50 Cobalt units, 11 Linear Accelerators and 25 Orthovoltage X-ray machines in the region (excluding South Africa). With regard to trained manpower, there are less than 200 Radiotherapists and 60 Medical Physicists in the whole region (excluding South Africa).

This seminar organized by the IAEA in co-operation with WHO was designed to assist in identifying problems that may be encountered by those African countries interested in developing radiotherapy services as well as the possible approach to solve them.

It consisted essentially of invited lectures and papers given by renowned experts in Radiotherapy and Medical Physics drawing especially on the experiences of many pioneer Radiotherapists in the African region. Important areas covered and which are contained in this TECDOC include:

Cancer in Africa
Status of Radiotherapy Services available in Africa
Radiotherapy Techniques
Organization of Radiotherapy Departments and Training and Manpower Development

Also included are two special discussion sessions and recommendations on

Radiotherapy Equipment for Developing Countries and
The Future of Radiotherapy in Africa

The introductory papers discussed the epidemiology of cancer in Africa, aetiological factors and management problems from the African Perspective. Others elucidated the details of the minimum infrastructural and staffing requirements for the organization of a new radiotherapy unit, and recommendations on the choice of suitable items of equipment for such a department. Possible strategies for an effective cancer control programme in a developing country were also highlighted. The various avenues open for obtaining financial support and technical assistance by any developing country that is contemplating the establishment of a radiotherapy service,
were presented with emphasis on the role of International Organizations like the IAEA and WHO. Papers on clinical radiotherapy contained in this TECDOC include the role of brachytherapy in cancer control in Africa, radiotherapy techniques and experimental radiotherapy.

Several other contributors dealt with important aspects of organization such as Cancer Registry Service, Role of a Radiotherapy Unit in relation to other hospital services, Manpower development and the special requirements to be considered when training Radiation Oncologists for Africa. Considerable attention was given to the current status of radiotherapy service in many African countries to enable participants share from the clinical experience of the various African experts present.

The seminar thus provided a largely and hitherto unknown information on the actual situation of radiotherapy services in Africa. It also afforded an opportunity for exchange of ideas between African Radiotherapists and their counterparts from the more industrialized countries including manufacturers of radiotherapy equipment. The need to consider the peculiar requirements of Africa in the design of equipment was emphasised. Factors such as the humid weather, dust, electricity fluctuations and the resultant damage to many of the sophisticated electronic parts on available equipment were discussed. The prolonged down time of faulty equipment due to non-availability of spare parts or funds to procure them and the nonchalant attitude of many equipment manufacturers towards after sales maintenance, coupled with problems previously enumerated, led to the call for the design and manufacture of simple, affordable, and rugged radiotherapy machines for use in Africa and other developing countries. Such a design while preserving its quality may be devoid of costly electronic parts. In other words such a simple cobalt machine should have a good collimator system with optimal radiation safety standards while being more mechanical than electrical. Other problems, recommendations for their solutions and avenues for future co-operation and collaboration were discussed as shown in the panel discussion in this TECDOC.
OPENING SPEECH

M. Nofal
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Vienna

On behalf of the Director General of IAEA, it is my pleasure to welcome all of you to this Seminar for Developing Countries in Africa on "Organization and Training in Radiotherapy". In December, Cairo has this mild warm climate which I hope is conductive to a good meeting and not too tempting to lure away from this meeting room.

Let me take this opportunity to thank the Government of Egypt for kindly hosting this seminar. The Agency also gratefully acknowledges the co-operation and support we have received from Professor Mahfouz and the staff of NEMROCK as the local organizers of this seminar.

The subject of this seminar is an unusual one. It is of utmost importance to all of those concerned with cancer control in the third world, especially in Africa. In 1986, the Agency held an international symposium on radiation therapy in developing countries which reviewed the status of this medical speciality in terms of what is available, what is essential and what is possible in the context of existing situations in the third world. The present seminar is in tandem with the previous one, a sort of continuity, where from the same reference points we would review the present status and the future of organizing radiotherapy services in the African continent.

Before we talk about radiation therapy, it is necessary to remove a simple misconception in the minds of even some responsible authorities, that cancer is not a serious health problem in the third world. The real situation is the other way. Cancer is of increasing concern in the developing world. Presently available means of control of communicable and parasitic diseases have reduced the problems of their treatment to a problem of availability and delivery of proper health care.

Timely vaccination, improvement of sanitation and personal hygiene, maternity and child care as well as the introduction of new curative agents: all these have improved the life expectancy in many developing countries and thus made their population cancer prone.
Subsequently cancer was rendered as an important public health problem for which—unfortunately—health services in developing countries are not yet adequately prepared for.

Young or old, rich or poor, every cancer patient has a right to proper treatment aimed either at eradication of the disease or towards amelioration of its course. In countries where there are no or inadequate radiotherapy facilities, we are denying an effective mode of treatment to a larger group of patients.

When faced with cancer, the physician in the developing world may not have much to offer. Because medical care services are not readily available and because means of early diagnosis are inadequate, cancer patients in the developing world are usually in an advanced stage when first presented for treatment. It is estimated that up to 75% of cancer patients in developing countries are in a non-curable stage when first diagnosed.

Especially in Africa, surgeons are scarce, chemotherapy is too expensive and radiotherapy is so much depending on machines which are costly to purchase and not easy to maintain. Above all, where is the trained manpower behind these machines? How can we provide the machines which are appropriate for the least developed countries? How can we maintain them? What are we doing in this respect and what can we do in the future? Cancer programmes in most African countries are either not existing or inadequate and mostly poorly funded.

IAEA is interested in this problem because a nuclear energy source is being used as a vital instrument for treatment of cancer. Our sister international organization—WHO—is also equally interested because by the year 2000, the problem is going to reach enormous dimensions, especially for developing regions. We should all do something now if we do not want to have regrets after a few decades that we should have thought of doing this much earlier.

Many of the activities of IAEA are done in collaboration with WHO such as this seminar. Another example is the IAEA/WHO project dealing with setting up a network of centres for treatment of cancer of the cervix.
with a simple inexpensive technique, which has been successfully conducted in this country since 1983. However, let me admit that what is being done by international organizations is not enough and more is needed.

WHO data shows that excluding the northern region, Africa has 11 radiotherapy centres serving a population of about 350 millions dispersed throughout a vast territory with limited roads and poor communication systems. By any means, this cannot be accepted.

This seminar is an effort to gather forces and to take a stock of the situation so as to assess the magnitude of the problem of radiotherapy services in the African continent. If nothing else, it has brought together an internationally recognized group of experts from Africa and from industrialized countries and make them focus their thoughts on what needs to be done and how to do it to improve radiotherapy services in Africa. This kind of catalytic exchange between experts will also be a source of guidance to international organizations in planning our future role. There are miles to go before we realize the dream of having adequate radiotherapy facilities for treatment of cancer in each African country.

I should like to express again on behalf of the Director General of IAEA and on my behalf our special appreciation of the host government and its officials and to our counterpart Prof. Mahfouz. Our thanks also goes to the distinguished visitors who are attending this opening session as well as to all the scientists who have agreed to participate in this seminar.
OPENING REMARKS

G.P. Hanson
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Geneva

On behalf of the Director-General of the World Health Organization, it is a pleasure for me to join in welcoming you to this Seminar which is intended to provide a comprehensive review of the current situation in radiotherapy; and to suggest appropriate ways and means for organization and training in radiotherapy in developing countries, especially in Africa. Regarding the planning of facilities, I would like to bring to your attention information that is already available by quoting the following:

"In many parts of the world, particularly in developing countries, cancer control and treatment programmes have had relatively low priority in the past, because of the pressure of other public health problems such as communicable diseases. However, communicable diseases are being brought rapidly under control, and more of the population is reaching the age at which the incidence of malignancy is high. Thus cancer may be expected to become a larger problem and to demand a higher priority in public health planning. The creation of adequate facilities and the training of the necessary personnel to deal with this situation will take time, in many cases 10 to 15 years.

Radiotherapy is at present, and will remain for many years, one of the principal methods of treatment of cancer. It is also used to some extent in the treatment of certain non-malignant conditions, but the indications for such use have tended to diminish with the introduction of other effective methods of therapy. It is for the treatment of cancer that radiotherapy deserves consideration as an essential service in the organization of medical care of any population.

It has been estimated in some developed countries that there are as many as 2000 to 3000 new cases of cancer per million of population arising each year. Similar figures might be expected to be reached in developing countries as the incidence of malignant disease increases. It has also been estimated that radiotherapy has a proper place in the treatment of at least half of all cancer patients at some time in the course of their disease, either as the sole method of treatment or in combination with surgery, chemotherapy or treatment with hormones. In some countries the incidence of cancer may be greater or less than that mentioned above, and there may be great differences in the incidence of various forms of cancer and in the organs affected. However, malignant disease is ubiquitous, and there is a necessity for radiotherapy in all countries whatever their climatic, dietary and economic conditions. In places where medical, social and educational services are less well developed, there will be a higher proportion of cancer cases with advanced disease when first seen medically, and for them radiotherapy may be the only practical method of treatment that will give any chance of alleviation. While for a given country at a particular time it may be that financial and other priorities must go first to the control of other diseases, nevertheless wherever any real attempt is made to improve the treatment of cancer, radiotherapy services must be developed."
Experience has shown that a high standard of achievement in radiotherapy will be maintained only if it is conducted by specialist radiotherapists working in departments devoted solely to radiotherapy. The subject is such a wide one that it is hardly possible for a physician to combine radiotherapy with the practice of another specialty such as radiodiagnosis. If there is to be reasonable economy in the operation of a radiotherapy department, and if efficient treatment is to be given to the maximum number of patients, the conditions of employment of the radiotherapist must be such that he can spend the whole of his working day in the radiotherapy department. He should be thoroughly trained in both the theoretical and technical aspects of radiotherapy, and his clinical competence and status should be comparable with that of other specialists on the medical staff of the hospital.

The treatment of cancer always demands teamwork, and collaboration on the part of the clinicians involved is imperative. The surgeon, the physician practising hormonal treatment or chemotherapy, and the radiotherapist should not work in isolation but should combine their skills and experience in the day-to-day treatment of a majority of cancer patients. The radiotherapy department should therefore be sited in a hospital or oncological institute where medical and surgical care of good quality is also available.

In addition, the radiotherapy department must include appropriately qualified and experienced radiological physicists and trained radiotherapy and physics technicians.

Adequate records of all patients and of their treatment should be maintained, and if progress and improvement are to be achieved, there must be an effective system of follow-up to determine the results of treatment.

Newly developed radiotherapy departments and services may often be fully occupied with routine treatments, but provision of facilities for research work is nevertheless highly desirable and is important in helping to maintain a high standard of treatment.

Proper attention must be paid to the provision of adequate protection against radiological hazards, both in the construction of departments and in the organization of the daily work. The engineering services necessary for the maintenance of apparatus should also be available.

It may surprise some of you to learn that the above was quoted from the report of a joint IAEA-WHO meeting held 25 years ago – in December of 1964.

Many of the recommendations of that report are still valid today, and many of you present here today have been labouring for more than 25 years, often under difficult circumstances, to implement the sensible recommendations contained in that report, and others of its kind, such as the WHO report entitled Optimization of Radiotherapy.


During this Seminar, which is bringing together specialists from developed and developing countries who have experience in providing radiotherapy services, producers of equipment, and representatives of international bodies, we will concentrate our efforts on bringing the knowledge and the technology, that has been tested and proven to be effective, to bear on the particular problems of the developing countries in Africa.

The transfer of technology is a constant challenge. The obstacles to be overcome are steep. Difficulties in communication make the challenge more awesome, and the financial crisis now gripping the developing world is unlikely to pass away in the near future.

Yet with the combined efforts of the scientific and professional community, knowledgeable and resolute policy-makers, and the industrial sector, the benefits of what is already known, and currently available, can be transferred, and absorbed by those countries for whose benefit this Seminar has been organized.

With what promises to be an informative and productive week ahead of us, on behalf of the World Health Organization, I wish you a most interesting and rewarding Seminar in this beautiful city of Cairo.
EPIDEMIOLOGY OF CANCER IN AFRICA:
AETIOLOGICAL FACTORS AND TREATMENT PROBLEMS

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Lagos, Nigeria

Abstract

A general overview of the epidemiology, aetiological factors and management problems with cancer in Africa is described in this invited lecture. Other factors such as geographical, cultural and economic that affect the incidence and prognosis of Cancer in Africa are examined. The common types of cancers seen and their management problems are discussed.

I believe the topic of this lecture is a suitable selection by the International Atomic Energy Agency and the World Health Organisation to act as the opening bat as it were in this training programme. I hope that at the end of it, we will be exposed to the various questions which ought to stimulate our interests. For example, questions like, what is cancer? How common is it in Africa? What pattern exists here? How does Africa present, geographically, ethnically, culturally, or even economically with regards to the incidence, prevalence and prognoses of the tumours we see? Are these comparable with those of the western world? What influence has industrialization played in the changing pattern, or the movement of population from rural environment to urban centres? How has it affected sex distribution and therefore accounted for the changing incidences of cancer? Do these, or any other exposures to the determinant carcinogens or mutagens help to define the aetiology of the commoner tumours among the high risk groups?

What are the facilities available for accurate documentation, for laboratory histopathological or haematological investigations? Are there any good cancer registries? What about radiotherapy centres or oncological units for these must have a bearing on our knowledge of the conditions and offer good service to the victims. How do our treatment problems affect the mortality from cancer?
Or should we rather direct our attention more towards preventive measures than to sophisticated forms of therapy? What do we know about the attitude and beliefs of the African regarding this condition? In other words, what ways are most effective in achieving our objectives or goals when educating the African on the complexity or multiplicity of the diseases generically named cancer, of the confusing amount of statistics, varying results from scientific experimental research laboratories and from clinical trials?

Ladies and Gentlemen, these are some of the topics I shall try to elucidate so that the various speakers in this seminar will appreciate that unless they are fully conversant with the issues and are ready to teach or train those who will grapple with them from a vantage position, we might as well be supplying our fighters in a Nuclear warfare with bows and arrows.

"Malignant disease is common" quote and unquote. This statement was extracted from the memoirs of Sir Albert Cook, perhaps the first European medical doctor who worked among the indigenous peoples of East Africa at the turn of this century. In his writings, he described the prevalence of oesophageal tumours, cervix uteri and skin cancers especially those from old scars and tropical ulcers in the legs. He also commented on peculiar tumours of the jaws in children, later to be known as Burkitt Lymphoma.

From that time, 1901, various workers in this discipline have gone on to establish that the original idea of a rarity of cancer in black Africa ought now to be regarded as untrue. Epidemiology of cancer in Africa today, almost one hundred years later, can still be described as hardly existing south of the Sahara and north of the Zambesi River, when compared with the distribution, incidence and pathology of cancer in the western world during the same period.
Evidence has accumulated in the last forty years to suggest that man's first residence on earth was in East Africa. From here, different ethnic groups spread out to the rest of the world (1). East Africa is also a land of geographical contrasts ranging from the high peaks of Kilimanjaro to the arid desert conditions in north western Kenya and northern Uganda, then stretching down to the humid tropical rain forest coastal belt. This kind of terrain is also seen in Nigeria and parts of the Cameroon where their sub-saharan area of Sokoto and Bornu states change into savanna and down to the tropical rain forest of Bendel thence to the really wet riverine mangrove swampy lands of Cross River and Lagos States.

North Africa can best be regarded as a downward spread of the mediterranean climate, geography and peoples. South Africa on the other hand has emerged largely from migratory infiltration of Europeans and Indians to settle with the indigenous blacks. The continent therefore is a suitably natural area for studying cancer prevalence as well as determining the aetiological factors in a rural and geographical setting. The mass movement of blacks during the period of slave trade into the Americas also afford a unique opportunity for observing changing tumour patterns in the altering climatic and industrial environs.

Having said all these, the vast knowledge we now have comes from comparatively few centres. For instance, in the third volume of Cancer in Five Continents published in 1976, only two African Cancer Registries appear (2). Ibadan in Nigeria which was one of these centres will now be removed in the fourth volume and put under "Cancer Occurrence in Developing Countries". This is because Nigeria could not conduct an accurate population census and UICC will not accept the old 1963 Ibadan population figures of 627,379 persons projected to over 1,000,000 with an annual growth rate of 2.5%, Babalola, (1989) (3).
Twenty five years after Sir Albert's observation, Vint documented 546 properly diagnosed cases of malignant disease in the Kenyan Africans\textsuperscript{(4)}. This was also the first time to compare the types and sites with those common in the European. The paper also observed the similarity in pattern with those of 500 tumour cases published at about the same time in Nigeria by Smith and Elmes\textsuperscript{(5)}. These two were the first hospital based cancer registries on record. The first real population based cancer registry in tropical Africa was started by Professor J.N.P. Davies, a pathologist at Makerere University Medical School, Kampala, Uganda in 1952. The first published work from this came out seven years later\textsuperscript{(6)}. The awakening had begun and in 1962, Pedersen, an epidemiologist from Norway wrote that the apparent lower incidence of cancer in Africa compared with Europe was a reflection of under-recording rather than a true difference\textsuperscript{(7)}.

**PATTERN OF CANCER**

Tribute should be paid to those who documented their observations at the beginning and to Davies, Elmes and Hutt et. al. who in 1964 collected the in-patients notes at Mengo Hospital in Kampala from 1897 to 1956\textsuperscript{(8)}. Through this analysis it became clear that the pattern of cancer was the same not only in sites but also in the percentage of admissions, (Tables I & II).

It is difficult to establish an accurate pattern of cancer in Africa for many reasons. Many patients are suspicious of modern available medical facilities. Others are sold to traditional methods. In addition to these, many african hospitals are usually in such a rush with the management of other more pressing acute disorders that cancer patients when they do present tend to lead to under-registration. Presentation is often late anyway and the competent staff to deal adequately with them are sadly few. The distance that these patients have to travel is sometimes very long and when they are older and unwell this could be a serious ordeal. There is a paucity of facilities for histological
TABLE I
MENGO HOSPITAL KAMPALA

<table>
<thead>
<tr>
<th>Cancer Sites</th>
<th>Proportional</th>
<th>Rates %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1907 - 16</td>
<td>1927 - 36</td>
</tr>
<tr>
<td>Stomach</td>
<td>2.4</td>
<td>5.4</td>
</tr>
<tr>
<td>Liver</td>
<td>7.1</td>
<td>3.9</td>
</tr>
<tr>
<td>Lung</td>
<td>0.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Breast</td>
<td>4.7</td>
<td>2.3</td>
</tr>
<tr>
<td>Penis</td>
<td>10.2</td>
<td>8.5</td>
</tr>
<tr>
<td>Cervix</td>
<td>10.2</td>
<td>6.2</td>
</tr>
</tbody>
</table>

From: Davies, Elmes, Hutt, Et al., 1964

TABLE II
MENGO HOSPITAL KAMPALA

<table>
<thead>
<tr>
<th>Total Admissions and Cancer</th>
<th>1907-16</th>
<th>1927-36</th>
<th>1947-56</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admissions</td>
<td>14,229</td>
<td>16,293</td>
<td>31,164</td>
</tr>
<tr>
<td>Cancer</td>
<td>127</td>
<td>130</td>
<td>279</td>
</tr>
<tr>
<td>Percentage</td>
<td>0.89</td>
<td>0.79</td>
<td>0.89</td>
</tr>
</tbody>
</table>

From: Davies, Elmes, Hutt, Et al., 1964

classification and histochemical studies. There are only very few good radio-
therapy and oncological units and those that there are have limited staff.

These factors and many more such as inadequate maintenance, shortage of funds
for the purchase of expensive chemotherapy, lead to under-registration.

AETIOLOGICAL FACTORS

Certain cancers occur very commonly in well defined areas and the proportional
frequency distribution throw light on to their aetiological factors. Well
planned population based epidemiological studies are highly essential in defining
these factors both in the rural and urban settings. Majority of the factors responsible for the common cancers result from people's behaviour and their environment. Exposure to pollutants, simple hygiene, lack of control in sexual behaviours, promiscuity; excessive use of tobacco and alcohol both of varying quality, standard and contamination; ingestion of indigenous medication and their plant based chemicals are all largely preventable if education is intensified. I shall now proceed to discuss some of these aetiological factors by mentioning briefly some of the commoner cancers, using them as examples.

BURKITT LYMPHOMA: The round cell sarcoma of face and abdomen described by Dr. Dennis Burkitt is by far the most common tumour in children in certain areas where malarial fever prevails. It was originally reported by Berry in 1964 as rare in the savanna region of Nigeria, but after there was a later establishment of histopathological facility in this region in Zaria, that impression changed because cases began to be diagnosed. However Edington noted that the proportional frequency merely rose but never was as high as it occurred in the rain forest belt of the south. Loubiere had also described a similar high incidence in Ivory Coast. Williams and others noted seasonal variation with rainfall in the west bank of the Nile river in Sudan. In these endemic areas, younger aged children are more commonly affected and the sex ratio of male to female is 2:1, a ratio which is lost in the older kids.

Of the aetiological factors responsible in Burkitt lymphoma, the Epstein-Barr virus (EBV), an intracellular Herpes type virus, stable falciparum malaria in endemic areas, a genetic predisposition which perhaps disappears in the older children — probably an X linked recessive and finally malnutrition and marasmus in early infancy have all been mentioned.

LEUKAEMIAS & LYMPHORETICULAR DISORDERS

Chronic lymphatic leukaemia which is rarely seen under the age of 45 outside Africa has a high incidence in African women under this age particularly in rural areas. Essien reported this finding and Edington suggested that
this may be due to intense antigenic barrage \(^{(26)}\), but Fleming \(^{(27)}\) and Finn \(^{(28)}\) blamed the occurrence on a depression of cell mediated immunity during pregnancy rendering the women more susceptible to leukaemogenic agents.

**PRIMARY LIVER CANCER**

There is a high incidence of this disease in wide areas of east and west Africa. It is reported to be the highest form of cancer occurring in the world, IACR \(^{(29)}\). From the Ibadan cancer registry, it is the commonest in males in Nigeria besides the lymphoreticular diseases \(^{(30)}\). The proportional rates as well as the estimated incidence rates show high levels in Mozambique and within short distances in east Africa \(^{(31)}\). The originally advanced role of hepatitis-B virus has now largely been superseded by the more exciting influence of mycotoxins such as the aflatoxins \(^{(32)}\). However, recent studies by Bababunmi and others \(^{(33)}\) on four plant species which form part of the herbal tea and some others used in cooking and in folk medicine in Nigeria, show distinct carcinogens. The aetiological factor in PLC may yet prove to be due to multiple chemicals and further research is in progress \(^{(34)}\). The common occurrence of primary liver carcinoma appears to be diminishing and giving way to oesophageal and other gastro-intestinal tumours in east Africa. This is blamed on the mass mobilisation of young males to urban centres and the intake of strong alcohol and tobacco \(^{(35)}\). A similar reduction in the incidence of PLC in the gold-miners of Johannesburg who migrated from endemic areas, over a 14 year period was noted by Bradshaw and Harington \(^{(36)}\). Furthermore, a migration from Mozambique which has the highest world incidence of PLC to a neighbouring territory began to show significant reduction in incidence. All these support the hypothesis that there are some obligatory yet preventable environmental exposures which when removed reduces the occurrence.
OESOPHAGUS

Carcinoma of the oesophagus is highly common in the rural areas of Transkei and in the gold mines of the urban Johannesburg. This bears a direct relationship to the habit of smoking pipe tobacco either in pipes or hand rolled as cigarettes. Bradshaw and Schonland (37) showed that this tobacco was a far more powerful insult to the oesophageal mucosa than the ordinary cigarette or the consumption of alcohol.

SKIN

Ultraviolet light and the part played in skin cancer is very well known. Basal cell carcinoma, seen in the emigrated caucaseans of eastern and southern Africa is unknown in the black who utilise the ultraviolet light through the medium of melanophores to manufacture vitamin D. Squamous cell lesions are never-the-less seen commonly in tropical leg ulcers even when they have healed for many years. In Nigeria, they are seen more commonly in the north. Also the legs are more commonly affected by tropical ulcers. Squamous cell tumours have been reported in other sites and on the scalp. Areas of high background radioactivity exist in parts of Northern Nigeria. Sanni found Thorium-232 and Radium -226 isotopes in Monazite Ore in the savanna region. The thyroid glands of cattle grazing here also had sources of high alpha particles (38). Although thorium and radium deposit in the bones, it will be of interest to know if these or any other radiation has a part to play in the pathogenesis of these ulcer cancers or in the melanomata which are also frequent.

CERVIX UTERI

This is a tumour of low socio-economic status rather than a racial factor. Christopherson and Parker established this in a comparative study of blacks and whites in Louisville, Kentucky, in 1960 (39). They, as well as many other workers showed a significant decrease in the incidence, irrespective of the race, of up to 60% after starting a mass cervical cytology screening. In
my view, this is about the best of the common tumours in Africa where a significant reduction in incidence can be achieved with a properly directed cancer screening and cancer education. The screening procedure is cost effective because it is simple, it can be directed to the high risk group, the tumour is locally spreading for a long time before it becomes widespread, symptoms present early and the effective treatment itself is clearly defined and can be made available at a low cost if carried out early. Above all, the precancerous stage, cervical intraepithelial neoplasia or carcinoma in situ, as has been observed by many, becomes manifest, often many years before any frank invasive carcinoma. Adeleye advocates that any good gynaecological centre which engages in family planning must have a good screening centre.

The pathogenesis of cancer of the cervix emphasises the role of Herpes Simplex Virus type II and the Human papiloma virus. It is also thought that arginine-rich histones contained in the sperm cell head which have been found to be highly traumatic to the sensitive cervical mucosa of the very young adult may be responsible. The hypothesis of early cervical trauma is modified by Singer's observation that this may have a genetic predisposition. Women with the tumour had a deficiency of Alpha-1-antitrypsin common in normal cervical mucosal epithelium and believed to be protective against trauma.

**TREATMENT PROBLEMS**

The following true story adequately sets the scene for this topic. A very amiable female patient once had to travel from Uyo in Akwa Ibom state, a distance of about 150 kilometres to Calabar, Cross River State, then on to Ibadan in Oyo State, another distance of nearly 800 kilometres for radiotherapy. Being an intelligent person, she felt rather sad to realise that she and many others like her needed to do this kind of journey for a confirmation of diagnosis and definitive therapy.
Her history started with a lump in the left breast in September of 1988. She saw her institutional doctor who after examining her sent her to the local hospital in Uyo. There, she met a gynaecologist who told her the lump was merely a 'breast tissue'. Meanwhile, in spite of her intelligence, she sought no further consultation until two months later when she visited her father who was hospitalised at the University of Calabar Teaching Hospital, UCTH. There she came across a surgeon friend to whom she related the story of her lump. She was examined and it was arranged for her to have a biopsy three weeks later. A diagnosis of cancer was made and naturally she became emotionally distressed.

In January 1989, six weeks later, she came into UCTH for a mastectomy. At operation, it was confirmed that the disease was localised and no clinical involvement of the axillary lymph nodes was noted. She was at this point greatly and justifiably reassured. Having been on nolvadex post-operatively for six months, she was referred to the University College Hospital, Ibadan, for radiotherapy. Without any preparation as to what to expect in terms of hospital accommodation, financial needs, etc., for a period of six weeks, the duration of the treatment, she left for Ibadan. It took one week in Ibadan before she got information that the only machine in the Country was broken down. She was given another appointment for August when hopefully the machine would have been repaired. At this point she returned to Uyo.

In August, she left Uyo once more for Ibadan. On arrival there the second time she learnt that there were no facilities for such ambulant patients to stay in the hospital during the period of treatment. They were to provide their own accommodation outside. She was however informed that the Roman Catholic Church ran relief centres where very many cancer patients lived whilst receiving their radiotherapy. At these centres, patients' diseases were of varying degrees which meant that there were no good hospital accommodations for the advanced cases either. Too many patients for too few beds. Patients like her, in the early stages found this set up most depressing and were robbed of
the reassurances they previously embraced from their doctors. The accommoda-
tion fee was N5.00 (£0.30) daily, no meals and food was secured from outside
at another N5.00 for the basic.

Since radiotherapy could only be received at this hospital alone, there were
obviously many patients on the waiting list. The machine itself often breaks
down for weeks at a time and the other elder Cobalt-60 in Lagos, a gift to the
Country from Canada, has finally packed up. Meanwhile the number of waiting
patients continues to rise thus providing a suitable pabulum for those employed
in the lower cadre to engage in sideline trade for readjusting the queue for
a small fee. The daily fare for transport was N5.00 and there is worse to
come. The cost of treatment per day is N40.00, about N720.00 for a course.
Naturally she did not expect nor did she have that sort of money on her. She
had to send an S.O.S. message home to her parents, who very quickly provided
it. She completed her radiotherapy some eleven months after mastectomy.

This is of course not the whole truth. I once had an eighteen year old female
student referred to me for radiotherapy after a large abdominal mass was
removed by the urologist. It was the size of a large grape fruit and it
could only be partially removed. The histology was a nephroblastoma. It
realised that the facilities were not adequate at the time for a curative
treatment and the parents were capable of providing funds. She was in London
seeing Miss Margret Snelling within one week. She had electron therapy and
started on effective chemotherapy which we continued in Lagos. Being a
student at the University of Ife at the time, I got her transferred to Lagos
University where she completed her studies. She is well today, has got married
and has three children.

In tackling the problem of cancer management or any other problem for that
matter, its magnitude ought to be defined. I have already laid stress on
certain aspects of these in my talk. The people tend to be ignorant about the importance or consequence of their ailment hence the delay in reporting to the appropriate centres. The facilities, both for diagnoses and for treatment whether these be material or in human resources are lacking. Pollutants and carcinogens must be recognised and the people must be properly educated about these and their habits.

It strikes me therefore that the pivot of our cancer management in Africa is on funds. For instance, in a symposium organised in Nigeria to define priorities in National Health Planning in 1973, it was published that the health bill of the nation per head of population per annum in 1969, (population about $80 \times 10^5$) was $1.00$ or $0.13$. In the USA, it was $90 — 110$ ($\$675 — \$825$). How can any meaningful health management be embarked upon let alone cancer, where palliation is the best in about half of the presenting cases?

I suggest that the days of individual management where each doctor arms himself with his own protocol and carries on to the exclusion of others, is long past. A team of health professionals is far more desirable. This should consist of a specialist in each of the appropriate disciplines in addition to a physiotherapist and perhaps a school teacher needed to teach any of the children afflicted with lymphoma. Institutions should learn to cooperate. The Nigerian Cancer Society is now embarking on a joint meeting between institutions to decide on various protocols for the treatment of specific types of tumours. Once these are set up, each specialist should then be matured and disciplined enough to adhere to these protocols agreed on by the consensus.

The faith-healer or the traditional medicineman has played a great and important role in the management of cancer in Africa. He is here to stay because many believe in him and will continue to do so. He may not have a definite scientific proof for whatever he may lay claim to in cancer success, but he certainly raises the hopes and boosts the morale of the afflicted. We are all
aware of the unquantifiable host tissue resistance. The patient who is always hopeful and looks on the brighter side of the disability often has a longer symptom free period and generally a better prognosis. Through prayers, mysticism psyche or even magic, the faith healer somehow succeeds in getting the patient's mind to play over the body. We all ought to come together and find avenues for the mutual good of the cancer victim.

Communication between the medical team on the one hand and the patients and their relatives on the other hand is very important. There is a lot of grey area about whether the patient should be informed of the disease and if so, how much. Frankly, this depends on the intelligence of all concerned. Above all, whatever is said or done, must be towards raising their state of well-being.

In this talk, I have tried to present a complex problem lightly, simply and briefly. All the aetiological factors and treatment problems are well known to us. Many of them will be discussed later by the participants in this seminar in some greater detail. The overall aim is to train those personnel who will be faced with the cancer education, prevention and treatment in their respective countries.

Their education must therefore be directed first towards the authorities in government and the rulers in their states. The government through the Ministries of Health, Education and Finance must be informed and somehow made to accept that the need for providing adequately for cancer is fast becoming a priority. Diagnostic centres geared specifically for cancer screening and production of appropriate treatment methods for eradicating early disease or precancerous disorders should be provided in all centres of higher learning. National Cancer Institutes must be set up and the government must encourage cancer aid foundations and cancer societies.

Unfortunately, those that constitute the elitist group or the upper echelon in the society in developing countries, all too frequently, find their way to
America or Europe at the slightest suspicion that all is not well with their health. The wealthy of the land are also to be educated about the need to give generously to cancer aid foundations. The money collected must be carefully supervised by a Board of Trustees who will invest it and the proceeds directed towards training of personnel. These consist of post-graduate doctors in radiotherapy, oncology, nuclear medicine, epidemiologists, geographical pathologists, histochemists etc. Physicists, technologists, radiographers and allied disciplines ought to be trained pari passu. Their return must be made to synchronize with the provision of facilities such as machines, reagents, laboratory equipment, drugs and most especially good living accommodation and transport so that they can work in a congenial atmosphere and not tempted to migrate to better lands. Once our students go abroad to train, they immediately get exposed to good working facilities and can compare these with the paucity of equipment in their homes. Often this is not so difficult to overcome. It is the lack of good remuneration and living conditions with lack of schools for their children and generally no incentive that make them wish to emigrate.

The second aim of this education must be directed towards eradicating the carcinogens from the populace or preventing the populace from coming into contact with the carcinogens. The logistics for achieving this seemingly simple exercise can raise quite serious political issues. How do we stop the national from drinking the local brew, such as palm wine or local gin? The former has been found to contain N-nitrosamines which are versatile potent carcinogens. It is also difficult trying to stop the elderly from snuffing all too frequently practiced by younger persons in these African communities. Cigarette smoking also embraces a governmental policy constraint. Lots of revenue come from the sale of tobacco. The lower socio-economic will smoke poorer quality with higher tar content cigarette often to the last centimetre.

Luckily, many countries in Africa are now suffering from considerable economic recession and at the moment, many are facing structural adjustment and reappraisal
of their priorities. Therefore, smoking, drinking, prodigious baby making and generally a high cancer risk life style are all on the decline. Changes for the better may yet come through natural process and selection.

Finally, I like to end this talk by leaving with you the views and suggestions of a good friend and colleague to which I absolutely contribute and share. Most of us are looking at cancer from the wrong perspectives. We are standing too close to it and therefore cannot see the forest for the trees. Each specialist sees his own tree and not the forest. Consequently, when asked to describe the problem, his description does not suit that of the other. The real question is, how do we all proceed to see the forest? There is a lot of information in cancer research as can be testified to by those of us who attend cancer conferences. These informations do not appear to hang together but stand out on their own. Our problem therefore is that we cannot see the forest for the trees. A complicated problem, looked at in a complicated manner, will never be solved. We therefore have to learn to look at complicated problems as simple problems. Cancer is a disease that arises, like other diseases, in accordance with biological processes. We are already conversant with these. We have to look at cancer from the point of view that it is a result of the reaction of a biological reaction of the body to a carcinogen. If we know how carcinogens affect the cell, then we would have a better understanding of cancer. A carcinogen is an agent which inflicts injury in the body, especially upon the young elements of the tissue. In repeated efforts to repair this injury, cancer arises. In other words, cancer is the product of the body's attempt to repair the damaging effect of a carcinogen. This is a problem of biology, just as in the process of wound healing, only forming a different product. Something must have gone wrong with the healing process. Cancer is therefore an abnormal scar tissue, produced in an abnormal attempt to repair a curious injury, out of the best intention of the body. There is need for us to look at the problem of cancer from a newer and simpler angle. (47).
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DELAY IN SEEKING MEDICAL ADVICE BY BREAST CANCER PATIENTS PRESENTING WITH A BREAST LUMP

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Abstract

Among the most commonly cited causes of delay in seeking medical advice by breast cancer females patients are ignorance, fear and fatalistic attitude. In a previous study we found that psychologic factors played the major role in this delay. It was a surprise to us to see that in a developing country like Egypt most of the delayer patients realized the significance of the presence of a breast lump. This initiated us to do this deeper study of another 80 breast cancer female patients. We applied our method that indicate the necessity of doing at least four interviews with each patient within six months by the treating oncologist. The lag time between the discovery of the lump and seeking medical consultation varied between few hours and five years with a mean of eight months after four interviews while it was one month after the first interview. Fifty five patients (68.7%) sought medical advice after more than three months of the self-discovery of the lump. Patients who were above 50 years of age delayed more than younger patients. The presence of husband and the work of patients had no effect on the delay. It seems that high education did not prevent the procrastination. Most of the patients (90%) realized the significance of presence of breast lump. Variations of fear — and not ignorance — were the main causes of delay. The fear of the socio-economic consequences of diagnosis of cancer, the incurability of the disease, the pain and death were more prominent than the fear of disfigurement and mastectomy. The elderly patients had more fatalistic outlook. We suggest that the radiation oncologists should be involved in the studies of different aspects of this complicated problem.

1. INTRODUCTION

Ignorance, fear and fatalistic attitude are the most commonly cited causes of delay in seeking medical advice by breast cancer females patients [1]. In a previous study conducted in the region of Suez Canal and Sinai, Egypt, we found that psychologic factors played the major role in delay of seeking medical advice by breast cancer patients in whom the first manifestation was the presence
of breast lump discovered by them. It was a surprise to us to see that in a developing country like Egypt most of the delayers patients realized the significance of the presence of breast lump [2].

The results of our previous study initiated us to do this deeper study of more cases.

2. MATERIALS AND METHODS

80 female breast cancer patients presenting with breast lump discovered by themselves were included in the present study that was conducted in the region of Suez Canal and Sinai between December, 1986 and May, 1989. Their ages varied between 28 and 75 years with a mean of 44 years. Among them 33 patients were above 50 years and 47 patients were below 50 years.

As regards the marital status, only 5 patients were never married while among the other 75 patients there were 60 patients living with their husbands, 10 widows and 5 divorced patients.

Among the 80 patients, 52 were illiterate, 20 patients educated to less than finishing studies of secondary schools and only 8 patients had certificates of secondary school or higher grades.

26 patients were working ladies, while the remaining 54 patients were housewives.

We interviewed each patient at least four times within six months after the diagnosis. During these interviews we identified the lagtime and the delay in seeking medical advice. The lagtime is defined as the time from discovery of breast lump as stated by the patient to the time of seeking medical care [3]. The delay in seeking a physician is defined as a lapse of more than three months between the self—palpation of breast lump and medical consultation [4,5]. Then we studied how the age, education, living with husbands and the work of the patients bore on the delay.

We discussed and analyzed progressively with each patient — whatever their education level — the most commonly cited causes of delay; ignorance, fear and fatalistic attitude according to the patient's points of view. All patients were encouraged to tell and to discuss their ideas and even to change the information given by them when they like. Also, they were assured every time by the oncologist that they were not blamed for any delay and the secrecy will be respected.
3. RESULTS

The lagtime ranging between few hours (the same day) and five years with a mean of 8 months. It is worthwhile to note that after the first interview the lagtime varied between few hours and 3 years with a mean of one month.

Only 25 patients (31.3%) asked for medical advice within the first three months while there were 55 delayers (68.7%).

Among the 33 patients who were above 50 years of age there were 28 delayers (84.8%), while among the 47 patients who had less than 50 years there were 27 delayers (57.4%). This is significant (p<0.05 according to Fisher's exact test).

Among the 50 patients who were living with their husbands there were 41 delayers (68.3%), while among the remaining 20 patients there were 14 delayers (70%). This is not significant (p>0.05).

Among the 54 housewives there were 36 delayers (66.7%) while among the 26 working ladies there were 19 delayers (73%). This is not significant (p>0.05).

The number of highly educated patients was limited to get a definite conclusion. But we can't ignore the fact that 5 of the 8 highly educated patients delayed more than 3 months and one of them delayed more than 3 years. It seems that high education did not prevent the delay.

72 patients (90%) realized the significance of presence of breast lump. According to these patients any breast lump should be seen by a physician and even they admitted the possibility of having cancer (they used the term the bad disease) when they palpated the mass.

The delayers had marked tendency to deny and to repress the idea of having breast disease as they didn't like to increase their problems. Deeper discussions with the patients revealed that they didn't like to disturb the life of their children and families. Most of them (80%) were scared of the financial cost of the malignant disease and its consequences while they thought that there were more urgent financial needs for their families and for themselves. Therefore they simply repress or postponed the idea of having cancer.

Among the 55 delayers there were 51 patients (92.7%) who revealed that their fears of the incurability of cancer, pain and
death are more prominent than the fear of disfigurement and mastectomy.

As regards fatalism, among the 33 patients who were above 50 years of age there were 15 patients (54.4%) who cited fatalism as the most important factor that bore on the delay. Among the 47 patients who had less than 50 years there were only 5 patients only (10.6%) who cited the fatalistic attitude as the most important factor that lie behind the delay, while in the case of the remaining 42 patients, their variable grades of belief in fatalism did not present their understanding that something should be done to try to overcome a health problem.

4. DISCUSSION

The mean lagtime varied between one month after the first interview and eight months after four interviews within six months. This indicates that the Egyptian patients, in the present study, have the tendency to deny the exact course of events and they need time to have enough courage and confidence to reveal the depth of their thoughts and secrets to their physician. We assume that this denial is one of the defensive mechanisms to lessen the problem, trying to convince the physicians and themselves that they are not so late and to avoid blaming by doctors. Thus, in any further study it will be not reliable to depend on the results of one questionnaire or interview.

As far as we know, we didn't find in the literature this method of interviewing used in the present study. Humphrey [6] drew the attention to the remarkable indifference of all authors he had consulted to the matter of reliability of reporting the lagtime or the delay as stated by the patients in the first instance and he concluded that the published figures must be regarded conservatively. In fact even in this study, we have the impression that what we presented were just approximate figures. It was hard for some patients to pinpoint the onset of a symptom unless it could be linked to unforgettable event of some kind.

The figures of delay in seeking medical advice more than three months in the present work (68.7% of 80 patients) was slightly less than delay in our previous study (76% of 50 patients) [2]. However it is still higher than the delay in some western studies as it was 33% of 166 patients in the study of Greer [1] and 45% of 100 cases in the study of Lyon [7].
In the present study it was observed that only the age of the patient played a significant role in the delay of consulting a physician. While it seems that the high education level, the work of the patient and their living with husbands had no significant effect on the delay. Maguire [6] suggested that the husband might be the person to concentrate if we want to shorten the delay as he found that 21% of women stated that their husbands encouraged them to seek help. However, in the present study we found that even the absence of husband (single, divorced, widow) did not influence the delay in a significant way. We assume that the patients who were encouraged by their husbands to consult a physician in the study of Maguire had a tendency to seek medical advice even without the encouragement of their husbands. This means that we have doubts about the value of campaigns concentrating on the husband.

According to the results of the present study, the main causes of delay were variations on the theme of fear and not ignorance. This confirm the results of our previous study [2] and the results of Western studies [8,9]. However, we admit the difference in education, culture and values between the patients in the present work and the patients in Western studies [10].

The exact nature of fear differs from one case to another but fear of the diagnosis of cancer is still the most common because the notion of the incurability persists while there is no strong evidence that the fear of disfigurement is the major cause of fear [6]. This is in accordance with our results.

Henderson et al., [8] reported that many of the attitudes held by the public that cancer means inevitable death are often a reflection of their physician’s feelings. This lead us to suggest that studies of cancer education programs should not only be directed to public but also to the physicians including the oncologists.

We found in the present study other variation of fear in our society. The patient is scared of the economic and social impact of cancer diagnosis — and the eventual treatment — on their families and children. It is a real tragic situation.

Ignorance has long ceased to be an important factor in delay [6]. In an early but frequently quoted article, Shands et al., [12] pointed to the ambiguity of statements about 'knowing', since awareness can occur at many different levels. It may be partly happening by chance how soon a woman become aware of a lump but the more crucial question is how awareness comes to be translated into action.
Turning to fatalism as a cause of delay, this may be common deterrent to early consultation in elderly patients as shown in the present work and in the study of Humphery [6] who raised the question about how much pressure should be exerted by friends or neighbours if they happen to get aware of a breast lump in patients who are over 70 years of age. However, we suggest that each patient should be studied as an individual case and the advantages and inconveniences of exerting much pressure should be assessed.

There are strong doubts about the value of breast cancer education campaigns — as they are done until now — in reducing the delay [6,7,12]. In fact, the subject is rather complicated than the case in cancer cervix. Underlying the emphasis on immediate consultation is the assumption on the hope that this will improve the prognosis. However, Bloom [13] pointed out that there is no simple relationship between speed of action by the patient and response to treatment. A crucial factor in treatment is the histology of the tumour and Bloom found that the more rapidly growing and lethal tumours predominated among women consulting early whereas the less malignant lesions appeared more often in women with long history. Thus the distribution of histological gradings tend to counterbalance the influence of delay on survival rate. This paradox is not fully explained but could be due to the capacity of highly malignant tumours to produce more alarming symptoms.

Miller [12] reported that there is no evidence on the effectiveness of breast self examination in reducing mortality from breast cancer. Studies are ongoing but it may be several years before results become available.

In general, there is now ample evidence that people are more readily influenced by mild — and not strong — propaganda when it comes to safeguarding their health or avoiding unnecessary hazards [14].

Finally, actually we exposed more the problem of delay in seeking medical advice than our previous study, but we did not solve this dilemma. This indicates that further deeper studies are needed. Cancer education programs should be preceded and followed by such researches. The methods used in the present work may be of value in doing further studies.

We do not mean — at all — that the oncologist should replace completely the psychiatrist but the treating oncologist can get valuable data that may help him in treating his patients and detect the serious psychiatric problems that should be referred to
specialists. It is not exaggeration to conclude that tackling such problems is not less important than radiation physics for the daily work of radiation oncologist of today.

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SOCIAL AND OTHER FACTORS ASSOCIATED WITH THE LATE DIAGNOSIS AND TREATMENT OF CANCER IN AFRICA

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Abstract

The late presentation of cancer patients for diagnosis and treatment is one of the major problems confronting effective management of cancer in almost all the developing countries, particularly in Africa.

It is recognized that the cancer patient presenting early as we commonly see in the developed countries usually conveys a totally different clinical picture from his counterpart in the developing countries. A typical patient in Africa with a tumour in the head and neck region, for example, usually presents with a huge tumour mass originating from the primary site, with secondary unilateral or bilateral neck nodes. These nodes are often very large and sometimes fungate with infected and malodorous ulcers. He is usually very ill-looking, anaemic, and malnourished. This picture of advanced disease is also true for other sites such as the cervix or breast. Patients with advanced breast cancer have been seen with the anterior chest wall on both sides destroyed by tumour, often with necrotic, infected and foul-smelling ulcers and sometimes with maggots. Soft-tissue tumours, bone tumours and tumours in other sites are usually seen towards the end of their natural course. They present as huge masses often outgrowing their blood supplies.

This picture as portrayed above is hardly ever encountered in the developed countries where the majority of the patients present early for diagnosis and treatment. The occasional late case when seen may be regarded as being too advanced and not suitable for treatment.

This study which attempts to quantify the severity of the problem in an African country showed that 92% of the cancer patients presented with late stages 3 and 4 disease. The various factors responsible for the late presentation of cancer patients for diagnosis and treatment are assessed with reference to the experience from Nigeria, which is one of the largest countries in Africa with a population of 120 million people.

Suggestions are offered towards improving this unacceptable situation and to ensure earlier diagnosis and treatment of cancer in Africa.

1. INTRODUCTION

One of the major problems associated with the management of cancer in Africa is the late presentation of the patients, usually at a stage near the end of the natural course of the disease when only palliative treatment is possible. Many cancer patients in Africa, and indeed other developing countries, present with features which can be regarded as "typical" and totally unlike what obtains in the more developed society where early presentation is the norm. A patient with a tumour in the head and neck region in Africa would more likely present with a mass, which invariably is ulcerated
and necrotic in parts with an added infection often with malodorous discharge. There will be large unilateral or bilateral neck nodes. He is ill-looking, anaemic, and malnourished. He constitutes a nuisance to himself and family, particularly from his malodorous ulcers, which probably forced him to visit a hospital at all. The picture is equally pathetic amongst patients presenting late with breast cancer. Large fungating tumour masses involving one or both breasts are common. Cases of automastectomy from breast cancer are common with large raw and necrotic areas on the chest wall. These are also severely infected, producing malodorous discharge. The author has indeed managed some patients discharging maggots from their tumours. Similarly a visit to a gynae-oncological ward usually with many patients with carcinoma of the cervix would reveal a peculiar but typical malodour due to the infected discharge from the tumours on the cervix. Patients with tumours from other sites essentially follow the same pattern as those described above. This pattern is hardly ever seen in the developed countries where such late cases may be regarded as being too advanced and unsuitable for treatment. A familiar annotation on the patient's case notes is the acronym NMTBD which means NOTHING MORE TO BE DONE. For many developing countries in Africa such an approach is unrealistic and impracticable due to the large number of patients presenting late.

This study was an attempt to establish the magnitude of the problem and to identify the various social and other factors that are responsible for the delay before diagnosis and treatment of cancer in Africa. The study was done at the Lagos University Teaching Hospital, Lagos, Nigeria, which for a long time had the only radiotherapy department in the whole of Anglophone West Africa. The department served the whole of Nigeria with a population of 120 million people and some neighbouring West African states like Cameroun, Ghana, Liberia and Sierra-Leone from where patients were referred. About 500 new cancer cases are seen annually.

2. MATERIALS AND METHODS

Five hundred and ten cancer patients who were referred to the unit and who actually had radiotherapy as part of their management were interviewed with the aid of a questionnaire. The questionnaires were designed to obtain information about the history of their disease from the earliest symptoms, various measures taken by the patient, until referral to the radiotherapy department. Only five hundred questionnaires were evaluable. The ten exclusions from analysis were due to incomplete or incorrect filling in of the forms by the respondents.

3. RESULTS

There were 122 and 378 female respondents (ratio M:F = 1:3) The mean age of the respondents was 45 years (range 2 - 78 years). The types of tumours seen are shown in Table I. Most of the tumours had been staged before referral; however, for the purpose of this analysis, they were reclassified into two main groups as shown.

Stages I and II tumours were classified as Early whilst stages III and IV tumours were classified as Late (Table II). The analysis showed that 8% of the cases presented with early disease while 92% presented late. The mean interval between the patients' first symptom and visit to a medical practitioner was nine months (range two weeks to five years).

Analysis of the various reasons given for the delay showed that 42% went to native doctors or prayer houses, whilst another 20% had self-medication. 30% did not think their symptoms were serious and did nothing about it; 5%
TABLE I TUMOUR TYPES AND FREQUENCY

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<tr>
<th>Tumour type</th>
<th>No.</th>
<th>%</th>
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<td>Cervix carcinoma</td>
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<td>34.0</td>
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<td>Head and neck tumours</td>
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<td>17.2</td>
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<td>Childhood tumours</td>
<td>24</td>
<td>4.8</td>
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<tr>
<td>Others</td>
<td>35</td>
<td>7.0</td>
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<tr>
<td><strong>Total</strong></td>
<td>500</td>
<td>100.0</td>
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</table>

TABLE II RECLASSIFICATION OF CLINICAL STAGING INTO TWO BROAD GROUPS

<table>
<thead>
<tr>
<th>Reclassification</th>
<th>Stages of disease</th>
<th>No.</th>
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<tr>
<td>Early</td>
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<td></td>
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<td>28</td>
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<tr>
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<td>133</td>
<td>26.6</td>
<td></td>
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<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>500</td>
<td>100</td>
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</table>

were afraid of hospitals and doctors, whilst 3% gave other reasons, including poverty, advice by friends and relations that their disease was best treated outside the hospital walls.

The mean interval between referral by the general practitioner and the patient receiving specialist treatment at a Teaching Hospital was eight weeks (range one week to six months), whilst there was an average of four weeks before referral by the specialist to the radiotherapist. Reasons for the delay included time spent in arranging for investigations like biopsies, X-rays, etc. Some patients with breast cancer also had surgery during this period.
4. RADIOTHERAPY

There was an average of four weeks (range one day to six weeks) between referral and actual commencement of radiotherapy. The delay was due to a long waiting list in 64% of cases while 25% were delayed because of faulty equipment. Industrial action by various cadres of hospital staff was responsible in 5% of cases. Other reasons include unhealed surgical wounds 2%; water shortage 1% (the orthovoltage machine is water-cooled) and patient default in 3% of the cases.

5. DISCUSSION

This study has shown that 92% of cancer patients in Nigeria present with late and metastatic disease, and the situation is similar with other African countries. There is a mean interval of nine months from onset of illness to presentation to a medical practitioner. A similar study in the United Kingdom [1] showed that over 50% of their sample delayed seeking advice for three months or more and 21% delayed for a year or more after their first symptoms. This study has also revealed that 62% of the patients spent the early stages of their disease with native doctors, prayer homes or trying self-medication.

Aitken-Swan in a similar study [2] showed fear and ignorance as the leading causes for delay, while Henderson, et al. [3] from Canada enumerated fear of the disease, lack of confidence in the usefulness of treatment, and ignorance as the root causes of delay. A survey among nurses in the Public Health Service in the United Kingdom [4] showed that 95% of the respondents gave fear as the leading cause of delay. This fear, according to Wakefield [5] is not the normal and healthy defence reaction that leads to a prompt visit to a doctor, but an intolerable anxiety that inhibits all actions. Such fear was detailed in the study by Davidson [4] and may be expressed in various ways such as reluctance to leave the home unattended, or a family uncared for, anxiety over a job, or simply fear of hospital and doctors. It is interesting that only 5% of our African respondents gave fear as the reason for their delay.

Measures that may be taken to encourage earlier presentation, diagnosis and treatment of cancer in Africa must include special cancer education campaigns, directed at the native doctors, spiritual healing homes, and the public at large. The potential benefits from early diagnosis and treatment must be clearly and simply demonstrated.

At the tertiary health-care level, joint oncology groups must be established at the teaching hospitals. It will include various specialists in different disciplines with interest in cancer management. Once a provisional diagnosis of cancer is made, prompt referral to the oncology group or a tumour board at the University Teaching Hospital will ensure a speedy work up, confirmation of diagnosis, and the institution of prompt treatment. Such a multi-disciplinary co-ordination would go a long way in reducing the long delay.

It has been shown that over 30% of cancer patients will require radiotherapy at one stage or another during the management of their disease [6,7]. Radiotherapy facilities are unfortunately rare in Africa where there is approximately one cobalt machine per 30 million population. Available data have shown that whereas Europe (excluding the USSR) in 1989 has 1300 high energy radiotherapy machines, Africa (excluding South Africa) has only 20
machines [8]. This unacceptable situation must be addressed and attempts made to establish more radiotherapy centres in addition to training the required manpower particularly radiotherapists, medical physicists, radiation technologists, oncology nurses, etc.

Periodic screening examinations should be encouraged for early detection of carcinoma of the breast and cervix among the susceptible groups. These two tumours account for over 70% of all the cancer cases in this study.

ACKNOWLEDGEMENTS

This study was sponsored by the Cancer Aid Foundation in Nigeria.

REFERENCES


THE ROLE OF BRACHYTHERAPY IN CANCER CONTROL IN AFRICA

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Abstract

The availability of radiotherapy is an essential for the adequate cure or palliation of cancer in developing as it is in Industrialized Countries. The use of sealed sources in surface, interstitial and intracavitary techniques makes possible the administration of a very high dose in a matter of hours or even minutes, and owing to the inverse square law, this dose falls off rapidly both between the sources in the tumour and in the surrounding normal tissues. A curative treatment may be given in this way to small accessible cancers such as Stage 1 cancer of the cervix or tongue, and complementary treatment by external irradiation from a Cobalt Unit or a Linear accelerator for a more extensive disease such as a Stage 3 carcinoma of the cervix, turns a palliation into a cure in a significant number of patients.

The paper amongst other things, discusses the advantages and disadvantages of manual and remote after loading techniques with high and low dose-rate techniques. It also examines the problems raised by requests for an increase in the size of the sources at present in use in manual and remote systems. The potential advantages from such an increase are discussed.

The availability of Brachytherapy is as essential for the adequate cure or palliation of cancer in Developing as it is in Industrialised countries. The use of sealed sources in surface, interstitial and intracavitary techniques makes possible the administration of a very high dose in a matter of hours- or even minutes- and because of the Inverse square law this dose falls off rapidly both between the sources in the tumour where necrosis is rare and in the surrounding normal tissues. A curative treatment may be given in this way to small accessible cancers such as Stage 1 cancer of the cervix or tongue or it may be used for complementary treatment to external irradiation by external irradiation with Telecobalt or Linear Accelerator for advanced disease such as Stage 3 carcinoma cervix-treatment which may prove curative in a significant number of patients.
Modern brachytherapy, based on the experience acquired over the first half of the century with the use of Radium 226 and the replacement of Radium and Radon by Cobalt 60, Caesium 137, Iridium 192 and Gold has resulted in great advances in the protection from irradiation of medical, physics and nursing staff during the preparation, insertion, removal and storage of the sources as well as that of the nursing staff and patients in the wards and of radiologists, technicians, porters and visitors in X-ray department, corridors and lifts and elsewhere in the hospital.

The use of Caesium 137 and Iridium 192 with the lower energy gamma rays made possible the introduction of smaller and less cumbersome shields that were easier to use and less expensive and again protection was improved in theatre and wards. The change to these safer alternatives without any production of Radon gas also avoided many of the hazards associated with leaking and lost tubes while their higher energy and the absence of alpha particle emission made possible the use of smaller but more radioactive sources. The production of miniature sources stimulated a rapid development of the afterloading techniques now regarded as mandatory in the handling of sealed sources today. With their introduction theatre procedures by the radiotherapist became safer and dosimetry improved as the need for speed was diminished by the absence of active sources until the last stage of the procedure.

The first changes from Radium involved the use of permanently loaded alternatives of the same dimensions and energies and these were followed by manually afterloaded techniques with the same 'conventional', (low) dose-rate as the Radium sources to which we were accustomed. Remote loading was introduced with low dose-rate techniques and the later production of large powerful sources of Cobalt 60 and Iridium 192 led to the introduction of high-dose-rate therapy.
INTRODUCTION OF BRACHYTHERAPY IN A NEW DEVELOPING CENTRE

In the IAEA/WHO Egypt Project, described in this seminar by its Director Professor Mahfouz, work in the diagnosis and treatment of carcinoma cervix is shared in a network of Regional and District hospitals covering the country, led by a University Hospital in Cairo. External Teletherapy and brachytherapy are carried out in Regional fully equipped radiotherapy departments. Brachytherapy is also carried out close to the patients' homes in new departments close to the patients' homes. Here the work is carried out by teams of radiotherapist, physicist, and gynaecologist who are trained together for this technique only at an annual course in Cairo.

NECESSITIES IN INTRODUCTION OF MANUAL AFTERLOADING TO A CENTRE

BRACHYTHERAPY SHOULD COMMENCE WITH THE INTRODUCTION OF LOW DOSE RATE MANUAL OR MANUAL-REMOTE AFTERLOADING.

The SYSTEM chose must have been used and fully reported in a centre of expertise which should be visited by the new team. An agreed PROTOCOL is essential describing patients, disease, sources and treatments, follow-up work of the RECORDS OFFICER. Measures for the RADIOPROTECTION of staff and patients must be defined. A responsible PROTECTION OFFICER must be appointed. The same well-trained TEAM should be available for all treatments. (Radiotherapist, gynaecologist, physicist, technician, nursing officer.) One member should be the responsible DIRECTOR of the project. A responsible PROTECTION OFFICER should be designated.

ADVANTAGES OF MANUAL LOW DOSE RATE AFTERLOADING

There is an immediate REDUCTION in the IRRADIATION received by all the STAFF in the THEATRE and elsewhere in the hospital as sources are
inserted only when the patient is in her chosen place in the ward nursed by trained staff. DOSIMETRY is improved from the use of inactive dummy sources during the insertion.

Using CAESIUM 137 and IRIDIUM 198 the previously used RADIUM techniques can be reproduced.

The sources are comparatively inexpensive: CAESIUM sources are replaced at intervals of approximately 14 years, but IRIDIUM replaced every 3 months or so requires careful book-keeping.

COBALT 60 is inexpensive where there is a pile but the energy is higher than necessary and demands careful and expensive protection. The half life is inconveniently short. COBALT 60 is importantly used in high dose-rate therapy: IRIDIUM 192 can also be used for H.D.R therapy but changes of source and re-estimation of doserate are required more often.

The introduction of modern after-loading Brachytherapy into a Developing Country makes possible the cure of early stages and the palliation of later stages of many common cancers and is as essential there as in any industrialised country. Brachytherapy should be available to all Cancer patients when a Cancer Control system is set up in a National health service. For reasons of expense Teletherapy is provided in large well-staffed and well-equipped Regional/University hospitals but Brachytherapy is inexpensive and can be set up in District hospitals with teams trained and directed by the Regional Hospitals. In this way more early cases will be diagnosed and treated while still curable.

FUTURE OF BRACHYTHERAPY IN DEVELOPING AREAS

EXPECTED FUTURE INCREASE IN CANCER

It is expected that the incidence of cancer will increase greatly in future years since the expectancy of death in younger ages has reduced owing to modern treatment of acute and chronic infections and the improved medical
services. The provision of diagnostic and treatment facilities is also increasing and these will be more more used following improved education of public and professions in the causes, symptoms and treatment of common cancers.

As the financial state of a developing country improves Cancer control programmes become feasible and a lead from government departments and large University hospitals can eventually result in the spreading of Cancer Care and Control throughout even the vast extent and population found in these Countries: here the many small private and Mission hospitals and Primary Health Care Units already working in many isolated rural situations can be included in the District network of hospitals while improved communications and collaboration results in the Registration of cancer (first hospital and later country based) which again facilitates the comprehensive planning and financing of the system.

The assessment and treatment of cancer is increased by transfer of technology: it is not difficult for those who understand the disease and the relevant anatomy but it requires constant conscientiousness, patience and commitment by all involved.

A small well trained Brachytherapy unit in a District Hospital which is backed by a Regional department with teletherapy, not only benefits the local population but may also with the support of the community later develop into a well-staffed and well-equipped Radiotherapy and Oncology Department. Developing countries have great financial problems and while their trained Medical and Physics graduates and their trained technicians and nurses can be equal to any elsewhere in the world there are often problems due to shortage of trained staff and the necessary backing by technicians and assistants when new equipment is introduced.

The help of the Agencies in the supplying of equipment and training of staff which includes the provision of scholarships and the introduction of new technology is of great importance as is any additional assistance provided by Oncology centres and colleagues in industrialised Centres.
FURTHER DEVELOPMENTS IN RADIOTHERAPY:

INCREASED SOURCES, REMOTE LOADING AND HIGH DOSE RATE THERAPY

After experience and expertise have been achieved in the use of low dose-rate manual afterloading with reduced hazard to staff and good clinical results, many new centres wish to increase the number of patients that can be treated with each set of sources by decreasing the treatment time necessary for each patient without increasing exposure to staff in theatre, ward or elsewhere.

POSSIBLE METHODS INCLUDE

1. INCREASING (DOUBLING OR TREBLING) THE STRENGTH OF THE SOURCE) and so decreasing the treatment time - and increasing the number of patients

This would be acceptable for its effect on tumour and tumour bed providing the total dose were suitably reduced by 10-20%. The integral dose of the patient would not be important.

INEXPENSIVE BUT IMPORTANT DISADVANTAGE TO INCREASING SOURCE.

--Unless ALL STAFF at the centre are very expert there may be too high a dose for staff at insertion, removal, transport, and during nursing in the ward.

THEREFORE- NOT SUITABLE IN MOST SMALL DEVELOPING CENTRES.

2. USE OF MANUALLY OPERATED REMOTE LOADER (CERVIFIX, GYNATRON)

In low or medium dose-rate treatment for carcinoma cervix/oesophagus this provides acceptable effects on tumour and tumour bed and also the safety of staff at insertion and removal. It can be (remotely) removed for nursing.

IT IS RELATIVELY INEXPENSIVE AND USEFUL IN DEVELOPING CENTRES WITH TRAINED CLINICIANS /PHYSICIST/TECHNICIANS.
CARE IS NECESSARY IN PLANNING PROTECTION AND IN THE TRAINING OF NURSING STAFF. BECAUSE OF NURSING STAFF IT IS DOUBTFUL WHETHER SEVERAL PATIENTS SHOULD BE TREATED IN ONE WARD AND ANY INCREASE IN SIZE OF SOURCE NEEDS GREAT CONSIDERATION.

3. USE OF SOPHISTICATED REMOTE LOADERS
----------------------------------------
A LOW doserate
B MEDIUM
SUITABLE for Developing Centre already trained with manual afterloaders

GOOD TREATMENT AND SAFETY
Adequate staff necessary
INCREASED PATIENT LOAD POSSIBLE

EXPENSIVE AND NEEDS PLANNED TREATMENT/PATIENT ROOM.

C HIGH DOSE_RATE REMOTE LOADERS
----------------------------------------
AN IDEAL ARRANGEMENT FOR A VERY BUSY DEVELOPING CENTRE

10-20 treatments + possible per day

Patient comfort increased: Accurate treatment; Administrative advantages;
No In-patient beds necessary

RADIATION ONLY IN PROTECTED TREATMENT ROOM.

BUT-

H.D.R.THERAPY REQUIRES VERY HIGH EXPERTISE IN ALL STAFF
----------------------------------------
AND--- NO MISTAKE IS PERMISSIBLE
----------------------------------------

IT IS EXPENSIVE AND A HIGHLY PROTECTED TREATMENT ROOM IS ESSENTIAL
----------------------------------------
CONCLUSION

BRACHYTHERAPY like TELEThERAPY should be readily available for curative or palliative treatment of cancer patients throughout Africa.

The choice of equipment and technique in any centre depends upon the patient load and the available financial support.

Centres must have trained graduate and technical staff adequate for the proposed work and hospitals without a fully staffed and equipped radiotherapy department should be supported by a neighbouring larger institution. The construction of necessary treatment rooms and the provision of adequate protection of staff and patients is essential.
EXPECTED RELATIONSHIP BETWEEN A RADIOTHERAPY UNIT AND OTHER HOSPITAL SERVICES IN CANCER MANAGEMENT

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Abstract

Radiotherapy is a relatively new speciality in medical practice. It is however an important and rapidly growing modality of cancer treatment which should be developed in all countries regardless of their economic conditions. Differences in the size and functions of a radiotherapy unit may however change from one country to the other. Nevertheless, in all situations radiotherapy should be considered an independent speciality in its own right with its special building, staff, equipment, budget and administration. On the other hand, it should be fully integrated functionally with other national and hospital services in the field of cancer. As such it should have close association with national and regional planning authorities specially those related to cancer central programmes, central cancer registries, the national atomic energy authorities and medical teaching, training and research programmes. A strong relationship should be developed with University and Teaching Hospitals especially with diagnostic departments i.e. pathology radiology and nuclear medicine and therapeutic departments such as surgery and medicine. Joint clinics and team work should be the guide lines of service. Also a close association should be built between the radiotherapy unit and district hospitals and primary health-care units for the purposes of early detection, patients' follow-up and rehabilitation. These relations may vary from one country to the other depending on various factors such as the size of the radiotherapy unit, the volume and nature of work and its status of autonomy. These factors will be fully presented and discussed in the present communication.

1. INTRODUCTION

The potential therapeutic applications of ionizing radiation were apparent soon after the spectacular discoveries in physics towards the end of the last century. However, it was several decades before technological advances in equipment and a rational understanding and quantification of the biological effects of ionizing radiations that radiotherapy has become an accepted independent medical speciality (Table I). It has now developed into one of the most important modalities for cancer treatment either as a single discipline or in combination with the traditional disciplines of surgery and medicine. It has been estimated that at least 50 to 75% of all cancer cases are treatable by radiotherapy at some stage of their disease [1]. As cancer is a ubiquitous disease involving all countries radiotherapy services for cancer treatment are required in all countries regardless of their stage of development [2]. However, considerable differences might arise in relation to the requirements and specifications of radiotherapy facilities from one country to the other and special constraints may be countered in developing countries [3].
### TABLE I: RADIOTHERAPY MILESTONES

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</table>

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#### 2. RADIOTHERAPY UNITS

Several factors may interact to determine the possible size and type of a radiotherapy unit in any locality. Nevertheless, depending on size and status of autonomy three basic types of radiotherapy units are currently in existence. These may vary from a unit being a small section of a radiology or other department in a general hospital, to a separate department in a major hospital and finally to a major comprehensive radiotherapy department in a major teaching hospital or a cancer institute. The first option in this list is only mentioned to be condemned. It is now realised that the two specialities of diagnostic and therapeutic radiology are two different functions, and that they have grown so much that excellence in both of them by the same individuals is too hard to obtain [4]. In view of the recent technological and clinical advances it is now realised that for the good functioning of a radiotherapy unit in any setting certain requirements are deemed necessary (table II). It is important that a radiotherapy unit should have a reasonable size to accommodate an adequate number of therapy equipment with possibilities of modification or expansion. It should be staffed by qualified radiotherapists, physicists and other paramedical trained staff. Most important of all it should be an autonomous body with its own administration, budget and premises [5]. However, it should have a close relationship with other hospital departments and other bodies associated with cancer management (Table III). Radiotherapy is a highly specialized discipline that requires highly trained staff specially radiotherapists and physicists. It is imperative that those staff should be attached to the job from the best graduates, should have adequate training in the speciality and should have professional and academic status equal to the best in other specialities. This staff in addition to running the technical work should have the responsibility of running and administering their centre with minimum interference from other hospital departments. On the other hand, close functional association should be built between the unit and other departments specially those related to cancer.
TABLE II: REQUIREMENTS OF A RADIOTHERAPY UNIT

1. AUTONOMY IN ADMINISTRATION, BUDGET, PREMISES
2. QUALIFIED STAFF: RADIOTHERAPIST, PHYSICIST, TECHNICIANS, OTHERS.
3. CENTRAL LOCATION
4. ASSOCIATION WITH MAJOR HOSPITAL SERVICE AND TEACHING AND RESEARCH INSTITUTE.
5. ADEQUATE THERAPY AND OTHER RELATED EQUIPMENT.
6. ASSOCIATION WITH OTHER CENTRES.
7. PROVISION OF SPECIAL FACILITIES.

TABLE III: SUPPORTIVE SERVICES FOR A RADIOTHERAPY CENTRE

1. CENTRAL CANCER CONTROL UNIT NATIONAL CANCER REGISTRY
2. NATIONAL ATOMIC ENERGY AUTHORITY
3. DIAGNOSTIC HOSPITAL FACILITIES PATHOLOGY - RADIOLOGY
4. CLINICAL HOSPITAL DEPARTMENTS SURGERY - OBST & GYN. - MED. - PAEDIATRICS - PHARMACY - THEATRE, SERVICES
5. PERIPHERAL HOSPITALS
6. NON-HOSPITAL: CANCER SOCIETY, SOCIAL WELFARE

Cancer is a complex group of more than a hundred pathologically and epidemiologically distinct diseases [6]. Its causation, diagnosis, work up and therapy is related to various diagnostic and clinical departments depending on the site and type of the neoplasms. The radiotherapy unit should be associated with all stages of cancer diagnosis and treatment.

3. DIAGNOSTIC SERVICES
3.1. PATHOLOGY

Pathology plays a central role in the histological diagnosis, classification, typing and staging of cancer. The radiotherapist should be in close contact with the pathologist so that they can understand each other's diagnosis and staging.

The haematologist has the same standing as the pathologist especially in relation to leukaemias and lymphomas. He may have the added role of acting as a medical oncologist.
Radiological procedures are essential to good radiotherapy for diagnosis, staging, planning and follow-up. All radiological examinations by plain X-rays, contrast media, computerized tomography, nuclear medicine and ultrasound are required for radiotherapy. Some of these procedures can be done at the radiotherapy unit and others are done in the radiology department or elsewhere. It is however necessary to have in the radiotherapy unit radiological facilities for at least plain X-rays and treatment planning. A part time radiologist in the unit may be a useful addition. More elaborate examinations may have to be done at the radiological department or elsewhere. A close relation should be built with these departments to determine the nature and types of tests to be done for specific tumours or organs.

In many countries Nuclear Medicine has grown up with radiotherapy in the same premises. If this relationship exists it would be appropriate to separate the two specialities or to run them as separate autonomous functions.

4. THERAPEUTIC DEPARTMENTS

4.1. SURGERY

Surgery plays a major role in the diagnosis and treatment of cancer. In almost all cases a surgical biopsy: aspiration, needle, incisional or excisional, has to be performed to establish the histological diagnosis of cancer. A number of surgical procedures such as endoscopies have to be performed by the surgeon to achieve this goal. Surgery remains the primary modality of treatment for cancer, especially early cancer. It also plays an important role in palliation and reconstruction. The type and extent of surgery for specific tumours differs depending on tumour parameters, patients status and experience of the radiotherapists. In many large centres surgical oncologists may carry out much of the surgical work. However, in developing countries much of the surgery is performed by the various surgical departments in teaching hospitals or peripheral hospitals. It is most important to have a close association between the various surgical specialities and the radiotherapy unit. The best arrangement is to form combined clinics for the different sites and to agree on the initial treatment as a team. The best available radiotherapists and surgical care should be provided to the patient. These patients may enter protocols which can assess the value of the different modalities of treatment. The relation of surgery and radiotherapy is complex and can only come to fruitful results by close collaboration of the two specialities in all steps of patient's management.

4.2. MEDICINE

An important role is played by internists in the management of malignant disease. Many cancer patients specially those of old age are suffering from concomitant diseases such as hypertension, diabetes and cardiovascular disease. Others may be suffering from medical complications of the neoplastic process. All of these need medical care that can only be given by physicians. In addition, physicians are involved in the treatment of cancer by cytotoxic drugs. Cancer chemotherapy is now extensively used as a major primary treatment in leukaemia and lymphomas and as adjuvant or palliative treatment in many solid tumours. Particular among those are childhood neoplasms. All these activities necessitate close association between radiotherapists and physicians especially paediatricians. In big centres medical
oncologists may be responsible for this work. However, in most developing countries collaboration between the radiotherapists, physicians and paediatricians would be the best option to carry out the job. In all cases, team work is essential. The best combination of surgery, radiotherapy and chemotherapy should be tailored to the neoplasm under consideration to give the best therapeutic results. Joint clinic, therapeutic trials, follow-up and evaluation should be the rule rather than the exception.

5. OTHER DEPARTMENTS

For the better functioning of a radiotherapy unit, it has to be associated with certain hospital and non-hospital departments that can render it valuable service. These may include university training and research centres, physics and maintenance services, central planning bodies and local representative of WHO and IAEA. All of these are much more important for radiotherapy units in developing countries than in developed ones. The needs for technical assistance are more acute and difficult to come by in the setting of developing countries and the role played by United Nations' agencies is crucial to the good functioning of these centres.

6. CONCLUSION

Radiotherapy is a relatively new and expanding speciality. It is mainly applied in the treatment of cancer. Before it can be started in any developing country certain minimum requirements of staff, equipment and buildings have to be met. The running of radiotherapy department should best be done on an autonomous basis. However, association with a laboratory, radiological, clinical and other hospital departments related to cancer diagnosis and therapy is mandatory.

REFERENCES


EXPERIMENTAL RADIOTHERAPY: ITS ROLE IN PROMOTING CANCER TREATMENT IN DEVELOPING COUNTRIES

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Abstract

Experimental radiotherapy is within the means of most developing countries. In addition to promoting the scientific innovating thinking, it may have an impact on the economics and the efficacy of the cancer control programme by: (a) limiting the application of radiotherapy to the domain where it is most effective, (b) shortening the treatment time while maintaining the efficacy and the level of toxicity, thus permitting the treatment of a larger number of patients with existing treatment facilities, (c) combining radiotherapy with modified radical surgical procedures in order to improve the functional results of treatment which is particularly important in the young age groups. The potential gain from experimental radiotherapy is exemplified by studies involving brachytherapy, unconventional fractionation (hypofractionation and accelerated fractionation), predictive assay of tumour response and radiation modifying agents.

1. INTRODUCTION

Radiotherapy in developing countries faces three major problems: (a) the prevalence of advanced cancer, (b) the limited radiation facilities, and (c) the relatively young age of the cancer patient (reflecting a relatively young population) which calls for a special attention to the functional aspects of treatment. The problems pertaining to precision of delivery of the tumour dose, quality assurance, training of physicists and radiographers are not included in the present discussion. Experimental radiotherapy aims at optimizing the use of radiotherapy by: (a) the study of the factors involved in the tumour response such as the intrinsic radiosensitivity, growth characteristics, hypoxia, fractionation and radiation modifiers, and (b) understanding of the factors involved in normal tissue tolerance particularly as regards the proliferation kinetics and fractionation.

In developing countries research in the above mentioned areas is possible and needed in order to optimize the use of the existing radiation treatment facilities and reduce the cost of cancer treatment without sacrificing the quality of treatment. Most developing countries have a sufficient number of young investigators that have been trained in advanced learning institutions abroad. They represent an important resource of skilled manpower which, with proper planning and scientific leadership, can achieve very rewarding results. This paper gives some examples of the potential application of experimental radiotherapy research which are particularly useful in developing countries.

2. BRACHYTHERAPY

Brachytherapy involves the use of low dose-rate continuous irradiation in the treatment of tumours of limited extent and of a moderate degree of radio-sensitivity. It is estimated that 15-20% of cancer patients would need
brachytherapy at one stage of their treatment either as the only modality or combined with other treatment procedures. Brachytherapy has the physical advantage of a localized zone of a high radiation intensity encompassing the tumour plus a safety margin, with a steep fall of dose outside this volume. The low dose-rate would also result in sparing late reacting tissues which are often dose-limiting for tumours treatable with brachytherapy [1]. Tissues having a high repair capacity are spared to a greater extent than tissues having a low repair potential, when treated with low dose-rate irradiation.

The capital expenses involved in establishing a brachytherapy service is much less than that of modern external beam radiation treatment facilities. Applied research can optimize the use of brachytherapy in cancer treatment. This may pursue two main directions:

a. The possibility of extending the domain of applicability of brachytherapy to newer domains may be explored particularly with 192-Iridium wires. In view of the prevalence of bulky tumours in developing countries large radiation doses are often required. It is often feasible to extend the main treatment as external beam therapy and to deliver a booster dose to the residual tumour masses using brachytherapy. Fig.1 illustrates the application of interstitial 192-Iridium wire therapy to residual neck nodes failing to regress completely after external beam therapy. Owing to the limited extent of the high dose zone after interstitial therapy and the better tolerance of the soft tissues in the neck (late reacting) to low dose irradiation, the booster dose is expected to be well tolerated. The interstitial wire technique can be adapted to relatively bulky tumours commonly met with in advanced neglected tumours of the lip and the oral cavity which are particularly prevalent in developing countries. Fig.2 gives an example of interstitial iridium wire implant in a bulky tumour of the lower lip. Carcinoma of the nasopharynx is prevalent in many Eastern countries. Success in the local control of this tumour depends to a large extent on the possibility of delivery of a relatively high dose to the nasopharynx. A part of this dose may be delivered via an intracavitary radiotherapy using a radioactive mould. Residual bladder tumours after external therapy may be also implanted using appropriately tested techniques.

b. The intrinsic radiosensitivity of human tumour cell lines may be also tested by irradiating them while in short-term culture [2]. The response to both low and high dose-rate irradiation may be determined. Tumour cells showing a broad shoulder on the dose-survival curve of the high dose-rate irradiation would show a greater degree of damage sparing after low dose-rate irradiation and can be then considered unsuitable for brachytherapy as illustrated in Fig.3. Such a predictive assay would help to choose tumours eligible for brachytherapy and this may reduce the risk of treatment failure.

3. SOME PREDICTORS OF THE RADIATION RESPONSE

Tumours belonging to the same histological type may show a wide range of sensitivity to radiation. A non-clonogenic predictive assay has been recently developed for the determination of the intrinsic radiosensitivity of human tumour cells grown for 14 days on an adhesive matrix in an enriched medium. The surviving fraction after 2 Gy proved to be a strong predictor of radiation response of human tumours [3]. The application of this simple procedure would help in choosing tumours suitable for the application of radiotherapy and avoiding such a treatment in the case of radioresistant tumours. This is particularly useful if more than one treatment modality are applicable, e.g. surgery and radiotherapy; the latter would be then limited to radiosensitive tumours.
Fig. 1: Interstitial implant of Iridium-192 wires in a residual cervical nodal mass left after external irradiation. The plastic tube technique of implantation was used.

Fig. 2: Interstitial implant of 192-Iridium wires in a bulky tumour of the lower lip.
The magnitude of tumour volume reduction also proved to be a strong predictor of the response to radiation in bladder [4] and cervical cancer [5]. A study of this simple predictor in other tumour types is worthwhile since this may provide a basis for discontinuing radiotherapy in case that the long-term treatment results prove to have a strong correlation with the magnitude of tumour volume reduction during treatment. Table I illustrates the dependence of long-term results of carcinoma of the cervix on the degree of tumour volume reduction after 40 Gy of whole pelvic irradiation. Based on this result a new protocol was applied whereby patients who fail to show more than 50% volume reduction after 40 Gy are subjected to surgery (if feasible) instead of continuation of radiotherapy. As seen in Table 2, the results of surgery in this category is significantly better than when radiotherapy is completed.

**TABLE 1.** Correlation between tumour volume reduction after 40 Gy whole pelvic irradiation and the 5-year survival of patients in stages IIB and III carcinoma of the cervix uteri

<table>
<thead>
<tr>
<th>TUMOUR VOLUME REDUCTION</th>
<th>&lt; 50%</th>
<th>&gt; 50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>IIB</td>
<td>3/17 (18%)</td>
<td>50/67 (75%)</td>
</tr>
<tr>
<td>III</td>
<td>9/52 (17%)</td>
<td>35/67 (52%)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>12/69 (17%)</td>
<td>85/134 (63%)</td>
</tr>
</tbody>
</table>
TABLE 2. The 5-year disease-free survival results of a protocol based on the estimation of tumour volume reduction after 40 Gy whole pelvic irradiation. Patients showing >50% reduction are subjected to intracavitary treatment and a booster dose to pelvic nodes. Patients showing <50% shrinkage are considered for hysterectomy.

<table>
<thead>
<tr>
<th>Stage</th>
<th>&lt;50% SHRINKAGE</th>
<th>&gt;50% SHRINKAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Surgery Radiotherapy</td>
<td>Radiotherapy</td>
</tr>
<tr>
<td>I</td>
<td>2/3 (67%)</td>
<td>-</td>
</tr>
<tr>
<td>II</td>
<td>13/23 (57%)</td>
<td>0/8 (0.0%)</td>
</tr>
<tr>
<td>III</td>
<td>3/5 (60%)</td>
<td>6/36 (16%)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>18/31 (58%)</td>
<td>6/44 (14%)</td>
</tr>
</tbody>
</table>

1 Patients refused hysterectomy and hence radiotherapy had to be completed.

4. HYPOFRACTIONATION. RADIATION-MODIFYING AGENTS

Hypofractionation refers to the use of a few but large radiation fractions. It has two main disadvantages: (a) It does not exploit the spontaneous reoxygenation occurring during conventional multifraction regimens to the full extent. (b) The tolerance of late reacting normal tissues diminishes with increasing fraction size to a greater extent than early reacting tissues. Nevertheless hypofractionation is useful for palliation as they constitute simple short schedules convenient for both the patient and the radiotherapy department. It has been shown, for example, that a regimen of 3 fractions of 7 Gy given over 5 days could induce a complete remission in 25 and a partial remission in more than 50% of patients with locally advanced bladder cancer. Such a schedule does not exhaust the local tissue tolerance to the full extent. It is also feasible to attempt at improving the utility of such regimens by the use of some radiation-modifying agents. Two classes of such agents are worth investigating:

1. Solid tumours may contain a fraction of their cell population deprived of oxygen. Hypoxic cells are known to be about three times as radioresistant as well oxygenated cells. A number of chemical hypoxic cell sensitizers are currently tested in the clinic[6]. If they prove to be effective in clinically achievable doses, they may be then used in association with hypofractionation in order to make up for the lack in spontaneous reoxygenation during a limited number of interfraction intervals. Relatively large drug doses can be used before each fraction of radiation and hence a relatively high radiosensitization level may be achieved. Thus a higher level of response may be attained for the same radiation dose.

2. Radioprotectors constitute another class of radiation modifying agents the most important of which are the aminothiols e.g. WR-2721[7]. Ideally, a radioprotector should selectively protect the limiting normal tissue more than tumours. The possibility of achieving this goal is greater when large radiation doses are used. Hypofractionation, therefore may be hence an appropriate system for testing these radioprotectors since (a) relatively large drug doses may be used, and (b) the relatively large radiation doses reduces protection to tumours. The skin, intestine, bone marrow and testes.
are among the well protected normal tissues and these constitute dose-limiting factors in many anatomical sites. Protection of these organs may therefore permit the delivery of higher doses in hypofractionation and thus increasing the response rate of this practical fractionation system.

It can be seen that the use of radiation modifying agents in association with suboptimal fractionation regimes may improve the efficacy of such simple systems. This would optimize the use of the limited radiation treatment facilities in developing countries.

In a radical radiotherapy setting it is also possible to reduce the number of fractions in order to economize on the machine time and the number of visits paid by the patient. This, however, strictly requires dose-time adjustment using a normalization system based on sound radiobiological principles. The St. Thomas' Hospital clinical trial dealing with postoperative irradiation of breast cancer [8] demonstrated the possibility of devising a 3-fraction per week schedule that is equivalent to the conventional 5-fraction per week one. In a later study, the number of fractions could be further reduced to two while maintaining the same level of normal tissue reactions and tumour control.

Another example of the practical utility of hypofractionation is provided by the use of preoperative irradiation in bilharzial bladder cancer [9]. A pre-operative irradiation schedule of 40 Gy given over 5 weeks was shown to increase the survival of patients with T3-tumours from 26 to 58% without any increase in morbidity. However, a 5-week schedule is too long to use on a wide scale considering the prevalence of bladder cancer in Egypt. A concentrated pre-operative schedule of 5 fractions of 4 Gy was shown to give equivalent results. However, the use of the chemical hypoxic cell radiosensitizer misonidazole in association with such a concentrated schedule did not seem to improve the clinical results. The potential usefulness of the use of more efficient radiosensitizers, such as etanidazole, is currently under testing [10].

5. ACCELERATED FRACTIONATION

Accelerated fractionation refers to regimens where the overall time is reduced in order to reduce the influence of any accelerated repopulation that may occur during the more protracted conventional fractionation systems. Repopulation is expected to play a greater role when treating an actively proliferating tumour. A knowledge of the pre-treatment tumour doubling time may be, therefore, useful in selecting tumours for accelerated fractionation.

One common version of accelerated fractionation involves the use of multiple fractions per day. In this case the overall time is reduced to 10-12 days. This represents an advantage to the patient particularly in the relatively young age group who often has to resume work at the earliest possible date after treatment. Again, the application of accelerated fractionation requires dose-time adjustment using a normalization system based on sound radiobiological principles. In a recent study dealing with postoperative irradiation of locally advanced head and neck cancer, it could be shown that accelerated fractionation was better than conventional fractionation in patients having tumours with a doubling time of 4.5 days or less. In case of less proliferating tumours the two fractionation schedules were equivalent. The potential doubling time can be determined by the relatively simple technique of in vitro determination of the labelling index or by the application of more sophisticated procedures such as DNA analysis by cytometry [11].

6. HYPERThERMIA

Heat, by itself, induces cell killing having a pattern which is complementary to that of radiation. Cells in the S-phase are sensitive to heat but are relatively resistant to radiation. The hypoxic cells are radioresistant but are at least as sensitive to heat as well oxygenated cells. In addition heat
interacts with radiation and enhances the radiation-induced cell killing but this enhancement may involve both normal tissues and tumours. The enhancement tends to fade as the interval between heat and irradiation is increased. When heat is given 3-4 hours after irradiation the effect of heat would be simply added to that of irradiation with heat destroying those tumour cells which are resistant to irradiation [12].

Relatively simple and home-made heating equipment can be used in heating superficial tumours such as primary and metastatic skin cancer. Skin cancer is relatively common and, in developing countries, patients often present with bulky advanced disease. A combination of heat and hyperthermia may provide a more effective treatment than radiation alone.

7. IMPROVEMENT OF THE QUALITY OF LIFE AFTER CANCER SURGERY

A better quality of life is a general objective in cancer treatment which assumes a special importance in the young age groups which prevail in the developing countries. Attempts can be made to reduce the functional loss after surgery by modifying the extent of surgical excision. Radical cystectomy for cancer bladder involves the removal of the prostate, seminal vesicles and the internal sphincter. This leads to incontinence, impotence and loss of the ejaculation power. A modified approach may be applied when there is sufficient clearance between the lower margin of the tumour and the internal sphincter at the bladder neck. In such cases the prostate, the seminal vesicles and the internal sphincter may be preserved. In such cases we have to apply postoperative irradiation in order to deal with any residual microscopic foci in the pelvis. Such an approach is at present investigated in the National Cancer Institute. In this respect, accelerated postoperative irradiation may offer special practical advantages, in addition to a better counteraction of the possibility of a more active cell proliferation in residual pelvic disease. Preservation of the sternomatoïd muscle during block dissection of metastatic cervical nodes is another example of reduction of the extent of surgery in order to improve functional results. Again postoperative irradiation is recommended with this modified approach.

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6. Awwad, H.K., El Badawy S., Ghonein, M., Barsoum, M., Zaghoul, M.S. optimization of the use of radiosensitizers and radioprotectors in clinical radiotherapy. In: Improvement of cancer therapy by the combination of conventional radiation and chemical or physical means. IAEA-TECDOC-493, Vienna, 1989 pp. 7-17

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EVALUATION OF A LOW DOSE RATE MECHANICAL AFTERLOADING DEVICE (CERVIFIX) FOR CARCINOMA OF THE CERVIX UTERI

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Cairo University,
Cairo, Egypt

Abstract

Cervifix is a prototype of mechanical remote afterloading machine (MRAL) for low dose rate brachytherapy developed by Galo Italy. The machine was installed at 1986 for evaluation. It can be manually loaded by five caesium 137 source trains of Amersham. At NEMROCK, it was loaded with one long intrauterine, two medium vaginal, one medium and one long vaginal tandem source trains. The machine was routinely used at NEMROCK for the last two years. The main advantages of Cervifix are its simple operation, independence on electric power supply and high level of radiation protection. However, the apparatus has certain mechanical and technical limitations.

1- Introduction

The wide use of remote afterloading machines was faced in many developing countries with problems of high purchase price, sophisticated operation, frequent power cut-off and the need of high level of technical skills for operation, maintenance and repair. The costly service contracts and availability of spare parts add to these problems. Therefore, it came evident that there is a need for a simple afterloading device which is electric power-independent, durable and at the same time maintains a high degree of radiation safety. Galo Industry of Italy has produced such MRAL for brachytherapy for carcinoma cervix uteri (Cervifix). The aim of this work is to present the experience of NEMROCK in using Cervifix for the treatment of carcinoma cervix and to report on its mechanical, technical and radiation safety standards.

2- Material & Methods

Cervifix (figure I) was brought into operation in NEMROCK since 1986. It has a store for five Amersham Cesium-137 source trains. In NEMROCK, it was loaded with one long intrauterine, two vaginal, one medium and one long vaginal tandem source trains. The total nominal activity of the five sources was 492.0 mci (18.21 GBq).

1 Supplied through IAEA project Egy/6/004 for brachytherapy of carcinoma cervix uteri.
The selected source for use can be moved out from the safe to the applicator inside the patient by moving the corresponding handle of this channel at the back of the machine to the “out” position. For additional safety, the movement of these handles can be locked by a key at “in” and “out” positions. The exposure dose rate in air was measured at six reference points around cervifix while the five sources were in the safe. Measurements were carried out by calibrated surveymeter.

3- Results & Discussion

3.1 Loading Cervifix with active sources. This procedure was carried out manually once by removing the identification handle of the source train and anchoring its distal end to the carrier rod of one channel of the cervifix. This procedure was carried out in less than two minutes and entailed very little radiation exposure as it was completed while the active part of the source train was inside its safe pot.

3.2 Radiation safety standard of Cervifix: when the five source trains were in the store, the exposure dose rate in air at the six reference points of measurements (fig. 2) are
shown in table I. The maximum reading of 100 μSv/h was obtained at point 2 immediately in front of the exit opening for the sources. It dropped to 30.0 μSv/h when cables were

Fig. 2: Points of measurements of radiation in relation to Cervifix.
TABLE I. EXPOSURE DOSE RATE (μSv/h) AT REFERENCE POINTS AROUND CERVIFIX

<table>
<thead>
<tr>
<th>Position of measurements *</th>
<th>Dose rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10.00</td>
</tr>
<tr>
<td>2</td>
<td>100.00</td>
</tr>
<tr>
<td>3</td>
<td>1.5</td>
</tr>
<tr>
<td>4</td>
<td>1.00</td>
</tr>
<tr>
<td>5</td>
<td>4.00</td>
</tr>
<tr>
<td>6</td>
<td>0.00</td>
</tr>
<tr>
<td>7 (position 2 with cable connected)</td>
<td>30.00</td>
</tr>
</tbody>
</table>

* See figure 2 for identification of positions of measurement

connected. At all other points of measurements, the level was nearly background. Therefore, cervifix can be considered to comply with the acceptable radiation safety standards when loaded with these 5 Amersham Caesium 137 source trains. However, when higher activity sources are stored, a complete re-check survey has to be carried out.

3.4 Mechanical limitations: the top front part of cervifix is protruding forward beyond the base. This design makes the connecting cables at risk of damage when cervifix is pushed by untrained person against a wall (figure 3). This situation has happened once in NEMROCK and required replacement of three cables. Similar accidents can be prevented if the base of cervifix is prolonged forward or supplied with a strong bumper. Furthermore, a modification of Cervifix roller system is recommended to make maneuvering of the machine easier in small spaces.

4.5 Technical limitations: cervifix is not provided with any time recording system. Serious errors can happen in exact time of application. This situation is specially possible when the active sources are frequently withdrawn from the patient when attended by medical staff or visitors. A spring-operated timer can be integrated into Cervifix. Each timer will operate whenever the corresponding source is at "out" position and stops when it retracts to "in" position.
Fig. 3: Simulation of mechanical accident when Cervifix is pushed against a wall

4- Conclusion

Cervifix was used routinely at NEMROCK during the last three years. It was found a very simple, safe remote after-loading machine. Cervifix has virtually no breaks, its independence on electric power is considered a great advantage. If the mechanical and technical limitations described can be amended, cervifix will be strongly recommended for use in any developing country requiring low dose rate remote afterloading brachytherapy system.
EXPERIENCE WITH AN ORTHOVOLTAGE X-RAY THERAPY MACHINE BEING USED AS THE ONLY RADIOTHERAPY EQUIPMENT AT MULAGO HOSPITAL, KAMPALA, UGANDA

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Abstract

In October 1988 a Radiotherapy Unit became fully operational utilising a deep x-ray Therapy machine operating at a maximum kilovoltage of 300 kv at Mulago Hospital. This is the national referral hospital of Uganda and it is the teaching hospital of Makerere University Medical School which is Uganda's only Medical School. A review of the first one hundred and sixty one cancer patients (161) treated with this machine is presented showing the commonly treated tumours, common problems encountered during the treatment as well as the complications seen and their frequency during this period. A review of the common tumours (histologically proven) as recorded in the Uganda cancer register from 1975-1978 (which were the latest records available in the register at the time of writing of the Paper) is also presented. These figures are used in combination with our experiences to point out the inadequacy of having only orthovoltage facilities in a centre like ours. The dire need for Megavoltage Radiotherapy facilities as well as facilities for intracavitary treatment are pointed out as being basic in a unit which can effectively treat most of the tumours as seen at Mulago Hospital, Uganda and probably in most centres of the developing world.

1. INTRODUCTION

Plans for having radiotherapy facilities at Mulago Hospital were first drawn up in 1962 at the time of Uganda's independence when the then New Mulago Hospital was opened but it was not until January 1987 that eventually a small unit was fully renovated and an orthovoltage x-ray therapy machine first installed.

However, due to a series of technical problems during installation and testing this unit only started working on 4th October 1988. From 4th October 1988 to 3rd October, 1989 a period of one year which is our period of interest, one hundred and sixty one cancer patients had been treated using this machine and it is these patients that are analysed in a retrospective study and a review of the common tumours as recorded in the Uganda Cancer Register from 1975 - 1978 is done and presented in this study.
2. OBJECTIVES OF THE STUDY

1. To show the commonly treated tumours at Mulago Hospital and the patients’ characteristics e.g. age and sex.

2. To demonstrate the stage of the tumours at presentation and the application of palliative radiotherapy compared with radical treatment in our patients.

3. To show the immediate results and short term follow-up results as well as side-effects of radiotherapy as seen in our patients.

4. To make recommendations in view of the above regarding the facilities which best suit a unit like the one at Mulago Hospital.

3. MATERIALS AND METHODS

A retrospective study of the cancer patients treated in the first year utilising the available orthovoltage x-ray therapy machine with maximum kilovoltage of 300kv was done.

This machine was manufactured by Siemens and its make is stabilipan. The patients totalled one hundred and sixty one and the available medical records in the radiotherapy unit namely:- Patients register, treatment charts, clinical notes as well as x-ray films, ultrasound and laboratory results e.g. Histology, Haemogram etc. were analysed. A study of the tumour pattern as recorded in the Uganda Cancer Register from 1975-1978 was also done for comparison with the data from the radiotherapy unit (This period was the most current available at the time of the study!)

4. RESULTS

The results are shown in a series of tables namely:-

Table I: Age distribution of patients.

II: Sex distribution

III: Type of cancers as seen in the Radiotherapy Unit.

IV: The 15 most commonly diagnosed tumours between 1975-1978 as shown in the Uganda Cancer Register.

V: Stage of tumours at Presentation.


VII: Side-effects of Radiotherapy.

VIII: Results of Radiotherapy on Follow-up.
### Table I: AGE DISTRIBUTION OF PATIENTS

<table>
<thead>
<tr>
<th>AGE GROUP</th>
<th>NO OF PATIENTS</th>
<th>PERCENTAGE OF TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 9</td>
<td>7</td>
<td>4.3</td>
</tr>
<tr>
<td>10 - 19</td>
<td>4</td>
<td>2.5</td>
</tr>
<tr>
<td>20 - 29</td>
<td>10</td>
<td>6.2</td>
</tr>
<tr>
<td>30 - 39</td>
<td>30</td>
<td>18.6</td>
</tr>
<tr>
<td>40 - 49</td>
<td>36</td>
<td>22.4</td>
</tr>
<tr>
<td>50 - 59</td>
<td>28</td>
<td>17.4</td>
</tr>
<tr>
<td>60 - 69</td>
<td>30</td>
<td>18.6</td>
</tr>
<tr>
<td>70 and above</td>
<td>16</td>
<td>9.9</td>
</tr>
<tr>
<td>TOTAL</td>
<td>161</td>
<td>100</td>
</tr>
</tbody>
</table>

### Table II: SEX DISTRIBUTION

<table>
<thead>
<tr>
<th>SEX</th>
<th>No. of Patients</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>MALE</td>
<td>47</td>
<td>29.2</td>
</tr>
<tr>
<td>FEMALE</td>
<td>114</td>
<td>70.8</td>
</tr>
<tr>
<td>TOTAL</td>
<td>161</td>
<td>100</td>
</tr>
</tbody>
</table>

Male : Female = 1 : 2.4
### Table III: TYPE OF CANCERS

<table>
<thead>
<tr>
<th>TUMOUR</th>
<th>No. of Case</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ca cervix</td>
<td>68</td>
<td>42.2</td>
</tr>
<tr>
<td>2. Ca breast</td>
<td>24</td>
<td>14.9</td>
</tr>
<tr>
<td>3. Ca oral cavity</td>
<td>14</td>
<td>8.7</td>
</tr>
<tr>
<td>4. Retinoblastoma</td>
<td>7</td>
<td>4.3</td>
</tr>
<tr>
<td>5. Nasopharyngeal ca.</td>
<td>7</td>
<td>4.3</td>
</tr>
<tr>
<td>6. Squamous Cell ca. skin</td>
<td>7</td>
<td>4.3</td>
</tr>
<tr>
<td>7. Ca Larynx</td>
<td>5</td>
<td>3.1</td>
</tr>
<tr>
<td>8. Ca Maxillary antrum</td>
<td>5</td>
<td>3.1</td>
</tr>
<tr>
<td>9. Kaposi's Sarcoma</td>
<td>4</td>
<td>2.5</td>
</tr>
<tr>
<td>10. Salivary gland tumour</td>
<td>4</td>
<td>2.5</td>
</tr>
<tr>
<td>11. Rhabdomyosarcoma</td>
<td>2</td>
<td>1.2</td>
</tr>
<tr>
<td>12. Nostril</td>
<td>2</td>
<td>1.2</td>
</tr>
<tr>
<td>13. Secondaries (to head, sternum, spine)</td>
<td>5</td>
<td>3.1</td>
</tr>
<tr>
<td>14. Others*</td>
<td>7</td>
<td>4.3</td>
</tr>
</tbody>
</table>

**TOTAL** 161 100

[Others* include one case each of retropharyngeal tumour, Basal cell ca, ca Tonsil, ca rectum, ca Penis, Liposarcoma (back) and sweat gland tumour (leg)]

### Table IV: The 15 most commonly diagnosed tumours between 1975-1978 as shown in the Uganda Cancer Register

<table>
<thead>
<tr>
<th>Tumour</th>
<th>% of Total</th>
<th>Tumour</th>
<th>% of Total</th>
<th>Tumour</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cervix</td>
<td>12.9</td>
<td>Penis</td>
<td>11.3</td>
<td>Cervix</td>
<td>24.3</td>
</tr>
<tr>
<td>2. Skin</td>
<td>9.2</td>
<td>Liver</td>
<td>11.0</td>
<td>Breast</td>
<td>9.6</td>
</tr>
<tr>
<td>3. Malignant Lymphoma</td>
<td>7.3</td>
<td>Skin</td>
<td>10.9</td>
<td>Skin</td>
<td>7.6</td>
</tr>
<tr>
<td>4. Liver</td>
<td>6.9</td>
<td>Malignant Lymphoma</td>
<td>9.3</td>
<td>Ovary</td>
<td>5.5</td>
</tr>
<tr>
<td>5. Breast</td>
<td>5.8</td>
<td>Kaposi's Sarcoma</td>
<td>9.0</td>
<td>Malignant Lymphoma</td>
<td>4.7</td>
</tr>
<tr>
<td>6. Penis</td>
<td>5.3</td>
<td>Malignant Melanoma</td>
<td>4.4</td>
<td>Liver</td>
<td>3.2</td>
</tr>
<tr>
<td>7. Kaposi's Sarcoma</td>
<td>5.3</td>
<td>Burkitt's Lymphoma</td>
<td>4.4</td>
<td>Uterus</td>
<td>2.8</td>
</tr>
<tr>
<td>8. Malignant Melanoma</td>
<td>3.3</td>
<td>Prostate</td>
<td>3.9</td>
<td>Malignant Melanoma</td>
<td>2.4</td>
</tr>
<tr>
<td>9. Ovary</td>
<td>2.9</td>
<td>Stomach</td>
<td>2.5</td>
<td>Burkitt's Lymphoma</td>
<td>2.3</td>
</tr>
<tr>
<td>10. Burkitt's Lymphoma</td>
<td>2.6</td>
<td>Rectum</td>
<td>2.3</td>
<td>Vulva</td>
<td>2.0</td>
</tr>
<tr>
<td>11. Rectum</td>
<td>1.9</td>
<td>Fibrosarcoma</td>
<td>2.1</td>
<td>Rectum</td>
<td>1.6</td>
</tr>
<tr>
<td>12. Prostate</td>
<td>1.8</td>
<td>Oesophagus</td>
<td>1.7</td>
<td>Salivary gland</td>
<td>1.3</td>
</tr>
<tr>
<td>13. Stomach</td>
<td>1.6</td>
<td>Breast</td>
<td>1.5</td>
<td>Kaposi's Sarcoma</td>
<td>1.2</td>
</tr>
<tr>
<td>14. Fibrosarcoma</td>
<td>1.6</td>
<td>Eye</td>
<td>1.0</td>
<td>Fibrosarcoma</td>
<td>1.2</td>
</tr>
<tr>
<td>15. Uterus</td>
<td>1.5</td>
<td>Salivary gland</td>
<td>1.0</td>
<td>Eye</td>
<td>1.1</td>
</tr>
<tr>
<td>16. Others (rare)</td>
<td>30.1</td>
<td>Others (rare)</td>
<td>23.7</td>
<td>Others (rare)</td>
<td>29.2</td>
</tr>
</tbody>
</table>

17. TOTAL (4307) 100  TOTAL (2337) 100  TOTAL (1970) 100
Table V: STAGE OF TUMOURS AT PRESENTATION

<table>
<thead>
<tr>
<th>TUMOUR</th>
<th>STAGE</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of Cases</td>
<td>% of total</td>
<td>No of cases</td>
<td>% of total</td>
<td>No. of cases</td>
<td>% of total</td>
</tr>
<tr>
<td>Ca Cervix</td>
<td>4*</td>
<td>5.9</td>
<td>11</td>
<td>16.2</td>
<td>43</td>
<td>63.2</td>
</tr>
<tr>
<td>Ca Breast</td>
<td>0</td>
<td>0</td>
<td>2*</td>
<td>9.1</td>
<td>17</td>
<td>70.8</td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>4.3</td>
<td>13</td>
<td>14.1</td>
<td>60</td>
<td>65.2</td>
</tr>
<tr>
<td>Others (when stage I-IV was not used)</td>
<td>EARLY</td>
<td>X</td>
<td>ADVANCED</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>17.4</td>
<td>57</td>
<td>82.6</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>Grand Total</td>
<td>29</td>
<td>18.0</td>
<td>132</td>
<td>82.0</td>
<td>161</td>
<td></td>
</tr>
</tbody>
</table>

The asterisk * refers to Post-operative Patients.

Table VI: INTENTIONS OF TREATMENT

<table>
<thead>
<tr>
<th>FACILITIES</th>
<th>NO OF PATIENTS WHEN USING ONLY ORTHOVOLTAGE FACILITIES (MULAGO - 1989)</th>
<th>PROBABLE NO OF PATIENTS WHEN USING MEGAVOLTAGE TELEThERAPY + BRACHYTHERAPY FACILITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTENTION</td>
<td>Post-operative early tumours plus superficial tumours (e.g. 4 + 6 + 2 + 4 + 8 + 2) = 26 (16.1%)</td>
<td>Up to stage III Ca Cervix and Breast plus the early and some advanced cases of the other (e.g. 77 + 12 + 6) = 95 (59%)</td>
</tr>
<tr>
<td>RADICAL</td>
<td>The rest</td>
<td>The rest</td>
</tr>
<tr>
<td>(Percentage)</td>
<td>= 135</td>
<td>(Percentage) = 66</td>
</tr>
<tr>
<td>PALLIATIVE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Percentage)</td>
<td>= (83.9%)</td>
<td>(Percentage) = (41%)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>161</td>
<td>161</td>
</tr>
<tr>
<td>(Percentage)</td>
<td>= (100%)</td>
<td>(Percentage) = (100%)</td>
</tr>
</tbody>
</table>
## Table VII: Side-effects of Radiotherapy

<table>
<thead>
<tr>
<th>Side-effects</th>
<th>No. of Cases</th>
<th>Percentage of the total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin Reaction</td>
<td>104</td>
<td>64.6</td>
</tr>
<tr>
<td>Diarrhoea</td>
<td>37</td>
<td>23.0</td>
</tr>
<tr>
<td>Vomiting</td>
<td>20</td>
<td>12.4</td>
</tr>
<tr>
<td>Oral Mucosal reactions</td>
<td>20</td>
<td>12.4</td>
</tr>
<tr>
<td>Dysphagia</td>
<td>15</td>
<td>9.3</td>
</tr>
<tr>
<td>Radiation sickness</td>
<td>9</td>
<td>5.6</td>
</tr>
<tr>
<td>Severe Pains</td>
<td>5</td>
<td>3.1</td>
</tr>
<tr>
<td>Dysuria</td>
<td>4</td>
<td>2.5</td>
</tr>
<tr>
<td>Bleeding (per rectum)</td>
<td>1</td>
<td>0.6</td>
</tr>
</tbody>
</table>

## Table VIII: Results of Radiotherapy on Follow Up

<table>
<thead>
<tr>
<th>Period</th>
<th>Good Response</th>
<th>No Change in Tumour Size</th>
<th>Progressive Disease</th>
<th>Died within the Period</th>
<th>Total Who Survived in the Period</th>
<th>Difference Between Those Seen at The End and Those Lost on Follow Up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Percentage)</td>
<td>0 (11.2%)</td>
<td>30 (18.6%)</td>
<td>50 (31.1%)</td>
<td>30 (18.6%)</td>
<td>7 (4.3%)</td>
<td>1 (0.6%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Three Months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Percentage)</td>
<td>0 (3.8%)</td>
<td>19 (14.4%)</td>
<td>23 (17.4%)</td>
<td>16 (12.1%)</td>
<td>5 (3.8%)</td>
<td>2 (1.5%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Six Months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Percentage)</td>
<td>0 (3.2%)</td>
<td>11 (11.6%)</td>
<td>6 (6.3%)</td>
<td>7 (17.4%)</td>
<td>11 (11.5%)</td>
<td>7 (7.4%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Percentage)</td>
<td>0 (4.3%)</td>
<td>4 (8.9%)</td>
<td>1 (2.2%)</td>
<td>0 (11.1%)</td>
<td>5 (6.7%)</td>
<td>3 (40.6%)</td>
</tr>
</tbody>
</table>

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5. DISCUSSION

Most of the patients seen were between 30 and 69 years of age (see Table I). These were 124 patients giving 77.0% of the total compared with only 21 patients below 30 years (13.0%). The younger patients (below 30) were so few probably because most of the childhood tumours may have been referred for chemotherapy in the medical oncology unit as they tend to respond well to chemotherapy.

Table II showing the sex distribution indicates that most patients in our series were female (114) making up 70.8% of the total while males were only 47 making up 29.2%. This high figure is contributed to mainly by the high incidence of cancer of the cervix (68 patients), followed by cancer of the breast (25 patients) which were the leading two common tumours making up 57.8% of the tumours seen (see Table III). Cancer of the cervix stood out by itself contributing 42.2% of all the tumours.

This high frequency is supported by the data as shown in Table IV which lists the 15 most commonly diagnosed tumours in the Uganda Cancer Register (1975-1978). This confirms that cancer of the cervix is the most frequently seen cancer contributing 12.9% of all the tumours, followed by skin (9.2%), cancer of the breast is in the fifth position contributing 5.8% of all the tumours. All the tumours in the 1975-1978 period in the Uganda Cancer Register were however histologically proven. A.C. Templeton [1] in his book "Tumours in a tropical country" analysing tumours in Uganda over the period of 1964-1968 also showed that cancer of the cervix (10.2%) was the most frequent cancer in that period. His results add weight to our findings since the Uganda Cancer Register at that time was a true population based register.

Cancer of the cervix is however a deeply seated tumour and since our patients present late (see Table V) showing that 77.9% of all the ca cervix patients presented with tumours at stage III and IV which tumours were inoperable, it is imperative that provision of appropriate radiotherapy facilities for the treatment of this radiosensitive tumour should be priority. Indeed Table V shows clearly that in general 82.0% of all our patients present with advanced, inoperable tumours.

In our series with only orthovoltage therapy facilities available, only 16.1% of the patients underwent radical treatment for curative purposes. In the rest of the patients (83.9%) only palliative effects of radiotherapy could be expected as shown in Table VI.

Even with the late presentation of our patients, this percentage of patients where a "cure" could be expected would significantly rise to 59% if Megavoltage teletherapy facilities and Brachytherapy facilities were available. In a significant percentage of patients (41%) only palliative effects would still be expected which necessitates other measures of management like public health-education as well as efforts for early diagnosis and treatment.
It is not surprising that in 104 patients (64.6%) severe skin reactions developed (see Table VII) because we attempted to give radical treatment to many of our patients using the available orthovoltage unit which would naturally deliver 100% of the dose to the skin. These reactions would often be used as an indicator either to rest the patient or sometimes even to stop him completely from further treatment. If megavoltage treatment facilities were available (e.g. a Cobalt 60 teletherapy unit) these skin reactions would be significantly reduced due to the "skin-sparing effect" at these higher energy levels. The other reactions were not so frequent and often required only re-assurance with some symptomatic treatment.

Table VIII shows that none of our patients showed complete tumour regression basically because most of the tumours were deep tumours and the superficial ones were too advanced at presentation.

There were however two post-operative patients on one year follow-up one with cancer of the cervix and another cancer of the breast who showed no sign of disease at the end of the one year and who were deemed to have responded well to a combination of surgery and radiotherapy.

In a large percentage of patients (18.6%) however there was good palliation to radiotherapy whereby all the presenting symptoms e.g. bleeding, discharge, pain etc. disappeared on treatment (see Table VII). Fair palliation was shown in an even greater percentage (31.1%) where either some of the symptoms disappeared or they were reduced by the treatment. 49.7% of all the patients had some palliation within the first month of the treatment. A large number of patients where no palliation was shown was in patients who did not complete the prescribed treatment although indeed some completed treatment without any palliation and others even became worse in the immediate period (4.3%) and one actually died in the same period.

Thirteen patients are known to have died during the year although this figure may be higher as information about patients who have died is scanty.

Thirteen patients were seen in the follow up clinic at the end of the year period. This percentage of 40.6% (13 out of a possible 32 patients who qualified) was thought to be fair since it is likely that the rest are not all lost on follow-up. Others are expected to continue coming as the period of observation at the end of the cut-off of one year was only six weeks while many were on three months appointments. This turn up can still be improved by more counselling of all the patients at the start of treatment concerning the importance of follow up in cancer management. This would hopefully reduce on the drop-out rate during or soon after treatment of those who get discouraged by the treatment or its complications and want to try other methods (usually with traditional medicinemen!)
6. CONCLUSIONS AND RECOMMENDATIONS

1. The orthovoltage x-ray therapy machine achieved good palliation in a large percentage of patients and it should be used for that purpose as well as in the treatment of superficial tumours.

2. To decrease the high incidence of skin reactions and to increase the number of patients in whom successful radical treatment can be undertaken, Megavoltage teletherapy facilities and Brachytherapy treatment especially for cancer of the cervix are essential for Mulago Hospital.

These recommendations could be applicable in most centres of the developing world.

REFERENCE

SEQUENTIAL HALF BODY IRRADIATION (HBI)
AS SYSTEMIC TREATMENT OF METASTATIC
BREAST CANCER — AN INEXPENSIVE ALTERNATIVE
TO CHEMOTHERAPY

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Abstract

This study includes 40 patients 38 females and
2 males with wide spread bone metastases from breast
cancer. All patients were previously treated by local
radiation therapy in addition to other systemic therapy
(chemotherapy, hormonal therapy) and had either failed
to respond or developed recurrence of their symptoms
and were no longer suitable for such therapy.

Out of 38 female patients, 16 were pre-menopausal,
14 post-menopausal and eight had bilateral oopherectomy.
The half of the body showing most symptoms was irradiated
first. The dose to the upper half was limited to 8 Gy
corrected for lung in order to reduce the risk of radiation
pneumonitis and lung complications. A dose of 10 Gy
was given to the lower half. A four to six weeks interval
was needed if both halves were to be treated to allow
for bone marrow recovery. The radiation field for the
U.H. extended from the inferior margin of the orbit to
the iliac crest. The corresponding for the L.H. extended
from the iliac crests to just below both knees. Five
patients received U.H.B.I., 16 L.H.B.I. and 19 to both
upper and lower halves. The treatment was given by
telecobalt machine.

All patient received antiemetics, I.V. glucose
and steroid to reduce the incidence of nausea and vomiting.
Pain relief was achieved in 80 % of patients. Dramatic
pain relief occurred within 24 h. in 65 % of all responders.
The duration of pain relief ranged from 3-24 months.
INTRODUCTION

Osseous metastases are common in breast cancer and constitute the first manifestation of recurrence in one third of patients (5). At autopsy skeletal metastases were found in 70% of a series of 647 patients with breast cancer (7). Pain is the main symptom of skeletal metastases and is usually treated by repeated courses of radiotherapy. Radiotherapy can induce pain relief in approximately 70% of patients. The use of daily fractionation may be tedious to patient and radiotherapist and this led to the policy of the use of large single doses to be repeated according to needs (4). However, bone metastases can be diffuse and widespread and for such lesions halfbody irradiation (HBI) was introduced in the Princess Margaret Hospital (2).

This paper reports the experience with 59 HBI treatment applied in 40 patients with metastatic breast cancer who failed to respond to endocrine or chemotherapy or where the disease was too diffuse to be treated by localised irradiation.

MATERIALS AND METHODS

Forty patients with widespread bone metastases from breast cancer were treated during the period April 1981 and March 1983 in the Radiotherapy Department of the National Cancer Institute. All patients had been previously treated by a combination of local radiotherapy and systemic therapy (endocrine or chemotherapy) and either failed to respond or relapsed and were no longer eligible to these therapeutic measures. Intractable pain was the main symptom.
In case that symptoms were limited to one half of the body, the corresponding half was treated. When symptoms involved both halves the half with more symptoms was treated first.

All patients were treated with cobalt machines through large parallel opposing fields for each half of the body. An interval of 4-6 weeks was allowed in case that the other half had to be treated.

**Upper Half Body Irradiation (UHBI)**

The treated volume extended from the inferior margins of both orbits to the highest points of the iliac crests which corresponded in most patients to the lower border of the fourth lumbar vertebra or the level of the umbilicus. Both arms were included but the skull was included only when having metastases (Fig. 1).

![Field arrangements for HBI](image)

**Fig. (1) Field arrangements for HBI**

**Lower Half Body Irradiation (LHBI)**

The treatment volume extended from the highest points of the iliac crests to just below the knees (Fig. 1). But the volume was extended beyond the knees if metastases were present.
A HBI irradiation dose of 600 cGy was used in case of the upper half (uncorrected for lung transmission) while the dose for LHBI amounted to 1000 cGy.

**Patients Characteristics**

The series of 40 patients included two males. Out of the 38 women 16 were premenopausal, 14 postmenopausal while 8 patients had been previously subjected to ovariectomy. The age ranged between 27 and 68 years.

Nineteen patients received both UHBI and LHBI, while 16 received treatment to the LH and 5 patients to the UH.

All patients had normal blood counts before treatment. Previous treatment included ovariectomy: 8, anti-oestrogen: 6, chemotherapy: 10 and localised radiotherapy: 13.

All patients had normal kidney and liver functions as indicated by standard tests.

**Premedications**

Anti-emetics (Primperan/Plasil) was given intramuscularly half an hour before treatment together with an injection of 8 mg Decadron.

**RESULTS**

The results were assessed in terms of both subjective and objective responses. Response of pain was evaluated by its severity, frequency, duration and the need for administration of analgesics. A complete response was judged in case of complete absence of pain when analgesics were withdrawn for a period of two months at least. A partial response indicates significant reduction of the severity of pain and the reduction of the need for analgesics by 50%.
Subjective Response

Some relief of pain was obtained in 32/40 (80%) of patients and this amounted to a complete response in 18 (45%) and partial response in 14 patients (35%) while 8 patients did not show an appreciable pain relief. Amelioration of pain was noted within 24-48 hours. The response duration varied between 3-24 months with a median of 6.2 month.

Objective Response

One patient had bilateral breast cancer at the time of HBI and the breast masses showed marked volume reduction which lasted for 24 month.

Radiological evidence of consolidation of the bone metastases was found in 45% of patients and this is illustrated in comparing figures 2 and 3.

Toxicity

All patients experienced nausea and vomiting immediately after irradiation while diarrhea was an occasional symptom. These GIT manifestations were more marked with UHBI than LHBI. Nausea can persist for several days. These symptoms could be markedly reduced by the use of anti-emetics.

All patients showed some evidence of myelosuppression which was more severe when the second half had to be irradiated. The reduction in formed blood elements involved the erythrocytes, leucocytes and platelets. No life-threatening myelosuppression was noted and only four patients needed blood transfusion before irradiating the other half. Recovery was complete within 4-6 weeks and when needed the opposite half body could be irradiated after this period.

No evidence of hepatic, renal toxicity or pneumonitis could be detected within the observation period.
Fig. (2) Lytic metastases from breast cancer

Fig. (3) Lytic metastases from breast cancer have healed following 1000 cGy LHBI., 2 years after treatment.
DISCUSSION

The present study demonstrates the therapeutic benefit of HBI in a group of patients with disseminated bone metastases in whom all other modalities of treatment were exhausted. The therapeutic responses obtained were comparable to that reported by the Toronto group who used the same criteria for scoring of bone pain relief. The 48% complete relief and the 46% partial relief rates reported by the Toronto group are very close to the 45% and 35% rates obtained in the present study. The onset and duration of responses were also comparable in both studies. However all our patients having LHBI received a dose of 1000 cGy while the Toronto study included patients who received a LHBI dose of 800 cGy only. There is, however no clear advantage of such a dose increase.

The UHBI dose, in the present study, was limited to 600 cGy which corresponds to 800 cGy when lung correction is allowed for. This dose selection was based on the reports of the Toronto group which showed a rapid increase of the risk of pneumonitis when the UHBI dose increased beyond this dose. Such a policy is justified by the fact that in the present study there was a virtual absence of pneumonitis.

The mechanism of action of HBI in pain relief is not exactly known. Effect on cell proliferation can be a factor but dose not account for the rapid pain relief obtained within 1-2 days. It has been suggested that metabolic or biochemical changes (for example release of prostaglandins or encephalins) may be the factors involved in rapid relief rather than tumour control\(^1\).

In the present study HBI was used as a second line therapy after exhaustion of other modalities. The 80% response rate obtained may motivate the consideration of the use of HBI as the first line of treatment in special groups of patients with symptomatic bone metastases.
This could be either used alone or in conjunction with endocrine therapy which does not add to the myelosuppression induced by HBI. Such an approach may provide an alternative modality to the more expensive and, at best, equally effective modalities.

REFERENCES


CONVENTIONAL VERSUS MULTIPLE DAILY FRACTIONATION (MDF) IN POST-OPERATIVE RADIOTHERAPY OF CARCINOMA IN BILHARZIAL BLADDER

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Abstract

Carcinoma in bilharzial urinary bladder is the commonest malignant tumour among males in Egypt. In spite of the great efforts performed, radical cystectomy could not improve the survival rates above a certain level. The addition of post operative radiotherapy to radical surgery could improve the 5-year survival rate. In a controlled randomized clinical trial, 236 patients were randomized to either cystectomy alone, post operative radiotherapy using multiple daily fractionation or the conventional post operative radiotherapy using one fraction per day. The 5-year disease-free survival rates for these groups were 25, 52 and 44 respectively. On comparing the 2 regimens of post operative radiotherapy, it was proved that there was no significant difference between the clinical outcome of each regimen including the 5-year disease free survival rate and the incidence of local recurrence. The early reactions of the small bowel and rectum to both regimens were nearly equal. The recovery rate from such reactions was faster in the conventional fractionation group. On the other hand, chronic or late complications of the skin, small intestine and rectum were much lower in the multiple daily fractionation regimen to the extent that it can be considered as one way of protection against the late (chronic) complications of radiotherapy.

Introduction

Radical cystectomy is generally considered the treatment of choice for carcinoma in the bilharzial bladder[1]. Local recurrence accounts for approximately 75% of the causes of failure of this treatment[2]. The most frequent sites of local
recurrence are within the volume of tissue that can be adequately covered by total pelvic irradiation. This was the rationale for applying post operative irradiation after radical cystectomy for carcinoma in bilharzial bladder. The rapid detection of the local recurrence within the first few months after surgery gives an indication that it originates either from a large tumour-cell burden or rapid proliferation clonogens. Both possibilities could be eliminated or markedly reduced by adequate dose of irradiation. This hypothesis proved to be valid as a marked reduction of the incidence of local recurrence was experienced by those patients who received post-operative radiotherapy\textsuperscript{[8]}. Such reduction in the incidence of local recurrence was reflected on disease-free survival of such patients. Multiple daily fractionation (MDF) radiotherapy schedule could raise the 2-year disease free survival rate from 33 ± 6\% for those treated by cystectomy alone to 65 ± 6\% for patients received radiotherapy after cystectomy. The MDF regimen adopted had 2 main features: a small dose per fraction (125 cGy) and a short overall time (12 days). The rational using small dose per fraction aimed at reduction of late damage of slowly proliferation normal tissues. The short overall period is meant to cope with the possible rapid proliferating clonogens that may lead to the rapid local recurrence. It is worth noting that intestinal radiation reaction is a dose limiting factor and using the adequate tolerable time-dose schedule is an important way to reach favourable results.

In this study we used 2 types of fractionation schedules with 2 different sets of dose per fraction, total radiotherapeutic dose and overall time. A thorough comparison had been attempted between these 2 different time-dose schedules and also between them and those who did not receive radiotherapy after cystectomy.

**Patients and Methods**

This randomized clinical trial started on Jan. 1981, in National Cancer Institute, Cairo, including 236 patients suffering from carcinoma in the urinary bladder on top of bilharziasis. All patients underwent radical cystectomy with urinary diversion. Randomization were undergone 3–6 weeks after surgery, a time
enough for recovery from surgery. Eligibility for randomization was as follows: The patients had to recover completely from surgery with normal wound healing, normal kidney and liver functions. No residue has to be left during radical cystectomy. The bladder tumour had to belong to the categories P3a, P3b or P4a i.e., the excised tumour had to be extended to the deep muscle layer but not extended beyond the usual surgically removable pelvic organs (uterus, prostate or seminal vesicles....) During the period 1981-1984 randomization was restricted to cystectomy alone and cystectomy followed by multiple daily fractionation (MDF). Those randomized to MDF were rerandomized to either receiving radiosensitizer or not. On the second period 1984-1987, patients were randomized into 3 groups cystectomy alone, postoperative radiotherapy using MDF and conventional postoperative radiotherapy in a ratio 1 : 1 : 4 in order to substitute for the lacking third group in the first period.

Total pelvic irradiation using telecobalt machine at a source skin distance (SSD) of 80cm were given to both second and third group. The target volume extended inferiorly to the lower margin of the obturator foramen, laterally to a distance 1 cm outside the bony pelvic brim, and superiorly to the level of the first sacral vertebra. Half of the treatment dose was given via anteroposterior parallel opposing fields to include the whole rectal circumference and pararectal gutter. The other half treatment dose was given with a three-field arrangement, in order to spare the posterior wall of the rectum. The three-field technique included a direct anterior open field and two lateral 45° wedge fields with $\pm 15°$ forward angulation.

The radiotherapy dose in the second group (MDF) was 3750 c Gy divided into 30 fractions over 12 days. The dose per fraction was 125 cGy given thrice a day five days a week with allowance of 3 hours interval in between each fractions. On the third (conventional) group the radiotherapy dose was 5000 c Gy/25 fractions/5 weeks. The daily single dose was 200 c Gy given five days a week.
All patients were subjected to clinical and laboratory investigations weekly during treatment and at least monthly thereafter for 2 years. They were followed up each 3-4 months thereafter. Special attention was paid to the possible reactions, adverse effects complications as well as the evidence of local recurrence and distant metastases.

The statistical evaluation was performed in November 1989, using the ordinary statistical methods, Kaplan-Meier survival rates and log rank test for comparison between survival rates. Ridit test was used on comparing the scores of reactions.[4]

Results

The 236 patients randomized were 193 males and 43 females with a ratio of 4.5 : 1. Their ages ranged from 24-66 years with a mean of 48 ± 9 years. Table I shows that the patients' characteristics were evenly distributed among the 3 randomized groups expect that there was a higher predominance of tumour grade I in patients treated with cystectomy alone (37%) and a lower percentage of the same grade I in conventional PORT group.

The 5-year disease-free actuarial survival rates for the 3 groups were 25, 52 and 44% for cystectomy alone, MDF and conventional fractionation respectively. Using the log rank test, a statistical significant difference between cystectomy alone group and the 2 groups received postoperative radiotherapy could be shown (P < 0.0001). On the other hand the difference between the 5 year disease-free survival rates for MDF and conventional fractions (52% vs 44%) could not be ranked to the level of statistical significance.

Acute reactions were scored in all patients at the end of radiotherapeutic treatment and 2-4 weeks after, including small intestinal and rectal reactions. There was no difference of statistical significance between both, small intestinal and rectal reactions in MDF and conventional groups at the end of treatment. After the lapse
of 2-4 weeks post treatment the rate of recovery of the small intestinal as well as
the rectal reaction were noticed to be more rapid in the conventional groups than
that in the MDF group, (table II and III).

The incidence of chronic complications of postoperative radiotherapy were
reported in those patients who survived and were followed up with no evidence of disease
more than 18 months post radiotherapy (table IV). Small bowel chronic reactions
were more intensified in the conventional group than MDF group. Faecal fistulae
were experienced by one patient in MDF compared to 3 patients in the conventional
group. Faecal fistulae were fatal in 3 out of the 4 patients. One patient received
conventional radiotherapy could be salvaged by exploration and resection
anastomosis of the small intestine. Rectal reactions were nearly the same like that of
small intestine. No subcutaneous fibrosis was experienced by those who received MDF
compared to an incidence of 36% in the conventional group.
Table (II): Acute small bowel reactions in PORT at end and 2-4 weeks after treatment

<table>
<thead>
<tr>
<th>Grade</th>
<th>At end of treatment</th>
<th>After 2-4 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MDF (75 Pts)</td>
<td>conventional (78 Pts)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>27 (36%)</td>
<td>25 (32%)</td>
</tr>
<tr>
<td>I</td>
<td>25 (33%)</td>
<td>19 (24%)</td>
</tr>
<tr>
<td>II</td>
<td>9 (12%)</td>
<td>19 (24%)</td>
</tr>
<tr>
<td>III</td>
<td>14 (19%)</td>
<td>15 (19%)</td>
</tr>
<tr>
<td>IV</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Z (ridit test) P = 0.06 = 0.0001

Table (III): Acute rectal reactions in PORT at end and 2-4 weeks after treatment

<table>
<thead>
<tr>
<th>Grade</th>
<th>At end of treatment</th>
<th>After 2-4 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MDF (75 Pts)</td>
<td>conventional (78 Pts)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>36 (48%)</td>
<td>34 (44%)</td>
</tr>
<tr>
<td>I</td>
<td>37 (49%)</td>
<td>43 (55%)</td>
</tr>
<tr>
<td>II</td>
<td>2 (03%)</td>
<td>1 (01%)</td>
</tr>
<tr>
<td>III</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>IV</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Z (ridit test) P = 0.74 = 0.0001

The causes of treatment failure were nearly the same in both radiotherapy groups with slightly higher incidence of distant metastases in the conventional group. Both postoperative radiotherapy group experienced a much lower incidence of local recurrence (11% and 5% in MDF and conventional groups compared to 38% in the cystectomy group. The other causes of death and treatment failure were nearly the same in the two therapeutic groups, (table V).
Table (IV): Chronic complication for PORT

<table>
<thead>
<tr>
<th>Complications</th>
<th>MFD (51 patients)</th>
<th>Conventional (39 patients)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subcut. fibrosis</td>
<td>0</td>
<td>14 (36%)*</td>
</tr>
<tr>
<td>Chronic enteritis</td>
<td>4 (8%)</td>
<td>11 (28%)*</td>
</tr>
<tr>
<td>Faecal fistula</td>
<td>1 (2%)</td>
<td>03 (08%)</td>
</tr>
<tr>
<td>Chronic proctitis</td>
<td>3 (5%)</td>
<td>07 (16%)</td>
</tr>
<tr>
<td>Rectal stenosis</td>
<td>0</td>
<td>02 (05%)</td>
</tr>
</tbody>
</table>

* Statistically significant

Table (V): Causes of failure in bilharzial bladder cancer

<table>
<thead>
<tr>
<th>Cause</th>
<th>Cystectomy (83 Pts)</th>
<th>MDF (75 Pts)</th>
<th>Conventional (78 Pts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local recurrence</td>
<td>38* (46%)</td>
<td>8* (11%)</td>
<td>4 (05%)</td>
</tr>
<tr>
<td>Distant metastasis</td>
<td>7* (8%)</td>
<td>5* (07%)</td>
<td>21 (27%)</td>
</tr>
<tr>
<td>Uraemia</td>
<td>6 (7%)</td>
<td>8 (11%)</td>
<td>2 (03%)</td>
</tr>
<tr>
<td>Iatrogenic</td>
<td>2 (03%)</td>
<td>2 (03%)</td>
<td>2 (03%)</td>
</tr>
<tr>
<td>Liver failure</td>
<td>2 (2%)</td>
<td>1 (01%)</td>
<td>1 (01%)</td>
</tr>
<tr>
<td>Intercurrent infections</td>
<td></td>
<td>2 (03%)</td>
<td>1 (01%)</td>
</tr>
<tr>
<td>Unknown</td>
<td>8 (10%)</td>
<td>9 (12%)</td>
<td></td>
</tr>
</tbody>
</table>

Total                   | 60* (72%)           | 34* (45%)    | 31 (50%)               |

* One patient developed both local recurrence and distant metastasis

Discussions

Radical cystectomy, though still the treatment usually performed for carcinoma in bilharzial bladder, yet it failed to achieve a considerably high 5-year survival rate. The risk of local recurrence was high (46%) in cystectomy alone group
due to penetration of tumour deep into the bladder wall, perivesical extension or infiltration of the prostate, lower parts of ureters, uterus or the peritoneal covering of the bladder. The application of postoperative radiotherapy was associated with a reduction of the local recurrence rate to 8% (12/153). Distant metastases appeared to be rising in incidence with such adoption of adjuvant therapy. The other causes of failure had similar frequency in the 3 treatment groups.

No much differences were noticed between the 2 radiotherapy schedules as regards disease-free survival rates (52 and 44%) and the incidence of local recurrence (11 and 5%). On the other hand, there were also no much differences in acute bowel and rectal reactions noticed at the end of treatment. The rate of recovery from such reactions was faster in the conventional fractionation than MDF reflecting the influence of shortening of the overall time on the regeneration response of the bowel epithelium\(^6\). The more protracted conventional daily fractionation allowed more complete regeneration of the bowel (small and large). Such regeneration was manifested by a greater percentage of patients suffering no symptoms or improvement of the degree of the manifested symptoms in the conventional fractionation group than MDF patients.

The main purpose of using MDF regimen with a short overall time and a small dose per fraction was the reduction of the late damage of the slowly proliferating normal tissue\(^6,7\). Such regimen succeeded in complete elimination of the chronic skin complications (subcutaneous fibrosis). Chronic enteritis and its severe form, faecal fistula was reduced much with MDF. The same reduction of chronic complications of the rectal mucosa namely chronic proctitis and rectal stenosis were also noticed. The pathogenesis of chronic enteritis and colitis seems to be related to the effects of radiation on submucosal fine vasculature and connective tissue\(^8\). Many authors failed to demonstrate a clear relationship between the delivered dose, fractionation and dose per fraction and the intestinal complication risk level\(^8,9\). The explanation of such failure was probably as a result of treating patients in these studies in relatively homogeneous manners both for dose and
fractionation. However, Gallez-Marchal et al.\textsuperscript{10} had reported an increase in intestinal risk of complications when patients were treated with a hypofractionation schedule using 3 large fractions a week instead of the conventional 5 fractions per week. This results favour a positive relationship between the dose per fraction and the risk of late intestinal sequelae. Hyperfractionated multiple daily fractionation regimen using small dose per fraction is expected to reduce the late complication rate. An expectation that could be proved, to a great extent, in our study.

Another important purpose of using MDF regimen was to decrease the hospital stay to 12 days instead of the usual 5 weeks needed to complete the conventional postoperative regimen. The reduction of the cost of the hospital stay add much to the clinical and radiobiological advantages expected from adoption of MDF regimen.

REFERENCES


BASIC INFRASTRUCTURAL REQUIREMENTS, EQUIPMENT, BUILDING LAYOUT AND TECHNICAL STAFF FOR A NEW RADIOTHERAPY UNIT

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Vienna

Abstract

This invited lecture dealt with the basic requirements essential for the establishment of a radiotherapy unit. Equipment needs, Infrastructure, Technical Staff are described. The suggestions offered are in line with recommendations produced by various other international expert groups sponsored by bodies such as the EORTC, WHO, IAEA, ICRU, IARC.

1. Introduction

The lifetime risk of developing cancer is quite high. In many developed countries it was of the order of 15 % - 20 % during the 1970's (1). The incidence rate increases rapidly with age for instance for the Scandinavian countries the number of cases per 100 000 people at risk increases from 100 for 40 year-olds to 1 000 for 70 year-olds (2). A small increase in the proportion of old people in a population would therefore increase the crude incidence rate considerably.

The age adjusted cancer incidence (i.e. the cancer rate for a population of a given age distribution) seems to have increased during the 1970's (3) and somewhat less rapidly in the 1980's. Fortunately the upward trend in the age standardized mortality rate, in a few developed countries, seems to have been halted during the last few years (4). Improved therapy appears to be the main reason.

Africa, with a much younger population has of course a much smaller crude cancer incidence rate than most developed countries. There is, however, no evidence that Africa's age standardized cancer rate should be much different from that in the developed countries even if the spectrum of the types of tumours may differ.
Facilities for cancer therapy are not sufficient or are not available in most parts of Africa. The situation will certainly be much worse in the future when the proportion of old people increases.

Surgery and radiotherapy are still the major treatment methods for local control of tumours. Chemotherapy has been much less successful than expected some years ago (5,6). The trend today, at least in some advanced countries, is to treat an increasing number of newly diagnosed cancer cases with radiation, up to about 50% in some parts of the Scandinavian countries (7). It has been estimated in other studies that between 50 to 60% of all cancer patients need radiation treatment during some point of their illness (8).

The situation is quite different in Africa. Only a few percent of the cancer patients today are treated with radiotherapy due to lack of or inadequate resources. In this situation, it is very important that when new resources become available they are invested in a cost effective way. The present paper deals with different technical requirements of a new radiotherapy department.

2. Equipment

**External beam treatment units**

Conventional x-ray was the major modality of external therapy till about 1960, but soon lost importance, in advanced centres, after the introduction of 60Co-units. It has been estimated that about 180 60Co-units were sold worldwide per year in the mid 1960's as compared to about 10 linear accelerators. However, during the 1980's most of the installed units were linear accelerators; 250 units per year compared with about 60 60Co-units per year (figures estimated by the Siemens company). It might therefore be argued that a new centre in a developing country should have a linear accelerator. However, this is generally not a correct conclusion.
It is a trend in modern therapy to reduce the treated volume as much as possible and to contain the high dose region to the tumour or target region. The idea is that the tumour dose can be increased without severe complications when a small region is irradiated, resulting in higher probability of local control of the tumour (compare below, Fig 4). A small linear accelerator (4 MV - 6 MV) could for this purpose give somewhat better radiation fields than a $^{60}$Co-unit. One reason is that the half-shadow due to the geometrical size of the source is fairly large with a $^{60}$Co-unit, see Fig 1; for most types of units about 2 cm at the depth of dose maximum (9). This is about 2 to 3 times larger than with a linear accelerator. There are however ways to reduce this problem. Special penumbra-trimmers may be used i.e. the beam is collimated closer to the patient. Furthermore, it might not always be an advantage to have very "sharp" beams as there are always some uncertainties in outlining the tumour (or target) region and in the positioning of the patient in each treatment. Such uncertainties are surely larger in a new department.

Another reason is that beams from a 4 - 6 MV linear accelerator are more penetrating than those from a $^{60}$Co-unit. This is certainly an advantage when deep seated tumours are treated, Fig 2. However, adequate dose plans could generally be obtained using "cross-fire" techniques. The disadvantage may thus be compensated with one or more extra fields towards the tumour when $^{60}$Co-units are used. A careful dose planning procedure is therefore often more important using $^{60}$Co-radiation than accelerator beams. Further arguments for using linear accelerators are their higher output and often possibilities for larger beams.

The disadvantages are the need for service, maintenance, and dose checks. A new department can generally not be staffed adequately with physicists and engineers for an accelerator. Furthermore, there must be a good infrastructure as spare parts should reach the centre within 24 hours. The local representative for the accelerator company generally can not store all the parts that might be needed. There are numerous examples of centres in the developing countries, where expensive accelerators have been of little use due to technical difficulties.
Figure 1. The half shadow due to the size of the $^{60}$Co-source is shown. The size of the source is often 2 cm in diameter. A reduction of the source diameter would reduce the dose rate. The penumbra at the depth of dose maximum is often about 2 cm for a $^{60}$Co-unit. (The penumbra is generally defined as the distance between the 80% and 20% isodoses in a plane perpendicular to the beam axis). A collimator using a large distance, $c$, might be used to reduce the penumbra. However, there are practical restrictions in increasing $c$ as the collimator will be clumsy. Furthermore, electrons created due to photon interaction in the collimator might reach the patient. This will increase the skin dose.

- The geometrical penumbra is much smaller with a linear accelerator as the effective source size is only a few millimetres.
In weighing advantages and disadvantages it is quite clear that $^{60}$Co-units should be recommended at least as the first machine for external therapy to all new centres. This recommendation follows closely the guidelines by the WHO from 1980 (11).

A coordinated research meeting took place at the IAEA 1989 (12). At this meeting it was agreed that the WHO report (11) is still relevant. Some conclusions from the IAEA meeting are cited here:

"Megavoltage units are strongly recommended for curative radiotherapy. When setting up a new facility it is strongly recommended that the first therapy unit be a Cobalt unit, isocentric with an SAD of 80 cm. The unit should include a movable collimator, mechanical scales for all the motions, a mechanical distance indicator, an automatic timer and the necessary safety devices."
As additional equipment, the minimum requirement is
- a set of wedge filters
- a tray with standard shielding blocks
- a convenient couch

Sources:

The outputs stated below are dose-rates to water in air for a 10 cm x 10 cm field at the usual treatment distance.

Patients should never be treated with an output lower than 0.25 Gy min\(^{-1}\) and it is strongly recommended that the source be changed when the output is equal to or lower than 0.5 Gy min\(^{-1}\).

One should not buy a source with an output lower than 1 Gy min\(^{-1}\).

If a centre has a linear accelerator then it is necessary that a phantom and a dosimeter with a calibration traceable to an SSDL be available (in addition a calibrated barometer and thermometer) to routinely check the monitor response and the beam characteristics.

**Brachytherapy**

A full radiotherapy department also needs a technique for intracavitary therapy in gynaecology. This is of special importance in some African countries as the incidence of cervix tumours is generally high. Intracavitary brachytherapy is still very much based on the knowledge gained using radium. A large number of centres, in developed countries, still base most of their cervix treatments on radium applicators. Some centres even consider that the old radium techniques give better treatment results, in particular less complications, than methods based on remote
afterloading techniques using high dose rates. Remote afterloading techniques have sometimes been introduced in advanced centres, just to reduce the exposure to the staff. A new centre should, however, not use radium due to radiation protection problems. Cs-137 or Co-60 sources are the choice today.

In conventional brachytherapy with radium tubes, the dose rate at the point of the surface where the dose is prescribed lies between 0.4 and 2 gray per hour. It is common practice to refer to this type of treatment as low dose-rate brachytherapy. Between 2 and 12 gray per hour is generally referred to as medium dose rate, and a dose rate over 12 gray per hour as high dose rate (13).

The high-dose rate therapy requires high accuracy in the geometrical positioning of the sources and also in the dosimetry. The irradiations must be carried out in a special bunker. The maintenance and service problems must be considered for a remote afterloading system. Some of the new systems are rather complicated. Manual or half-manual systems based on a medium-dose rate technique, are therefore often preferable in new centres in developing countries. Radiation protection problems for the staff need to be studied carefully when planning for and choosing a special unit.

It is often stressed that clinical experience accumulated with radium techniques cannot be applied to new irradiation conditions without careful consideration (13). The best way for a new department is to try as much as possible to copy the procedures at a centre with long experience in a certain technique.

**Simulator and film developing facilities**

A simulator is needed for dose planning. The unit should have an isocentric mounting and possibilities for the same source-skin distances (SSD) and field sizes as the treatment unit. The film developer should be in the therapy department.
Films are also needed for the quality assurance programme of the treatments e.g. for the test of the coincidence of light field and radiation field, and for checking the irradiated volume (portal film).

**Treatment planning unit**

In 1980 the WHO (11) recommended the use of either a simplified dose plan (calculation of percentage depth doses at a limited number of points) or the use of a set of precalculated dose distributions. Since then a rapid development of computers has occurred. PCs (personal computers) available today have more complete treatment planning programs than expensive large dose planning systems did 10 years ago. Some of the dose planning systems are based on PC's that are commonly used in offices, so local service may be available. Commercial systems including complete programs for external- and brachytherapy may be bought for about 25 000 USD. The computer company can often supply isodose distributions for the treatment unit in use at the clinic. It is, however, the responsibility of the local physicist to investigate if the dose distributions entered into the unit agree with the radiation fields from the machines.

Ideally, it should be possible to enter CT pictures into the unit. This is often a problem as manufacturers of CT-machines often try to sell their own dose-planning system and do not supply information to make an interface possible. It is of great importance that the centre has a guarantee that a transfer of CT pictures is possible when purchasing a dose planning computer.

**Moulding**

$^{60}$Co-units and accelerators deliver rectangular fields of different shapes. Metal blocks are therefore needed in order to produce irregular fields. It should also be possible to make patient fixation devices, wedges and different boluses.
3. Staff

In 1985, the staff and equipment in relation to the workload was compared in 17 centres in 7 countries in Europe (14). Table 1 gives the minimum, maximum and average values together with the standard deviation (σ). For instance, in these centres an average of 501 patients were treated per megavoltage unit (i.e. 60Co-unit or accelerator), min. was 325 and max. was 833 patients. The average values give a rough idea what could be expected by a new centre in "output" after a few years in operation.

| Table 1 |
| Data collected by the EORTC cooperative group (14) at 17 centres in 7 European countries. |

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>Max</th>
<th>Average</th>
<th>σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patient treatments per megavoltage unit</td>
<td>325</td>
<td>833</td>
<td>501</td>
<td>126</td>
</tr>
<tr>
<td>Number of patients per simulator per year</td>
<td>500</td>
<td>2500</td>
<td>1185</td>
<td>537</td>
</tr>
<tr>
<td>Number of patients treated per full-time</td>
<td>130</td>
<td>770</td>
<td>328</td>
<td>147</td>
</tr>
<tr>
<td>radiotherapist per year</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of patients treated per full-time</td>
<td>186</td>
<td>1250</td>
<td>482</td>
<td>285</td>
</tr>
<tr>
<td>member of physics team per year</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of patients treated per full-time</td>
<td>58</td>
<td>250</td>
<td>117</td>
<td>60</td>
</tr>
<tr>
<td>technician per year</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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The staff problem in the developing countries was discussed in the CRP (12) at the IAEA in 1989. It was then stated:

- "A medical doctor qualified in radiation therapy has to be responsible for the treatment.

- The service of a qualified radiation physicist is recommended for Cobalt units and essential for linacs.

- To operate the unit a minimum of one trained technician is required for a Cobalt unit and a minimum of two for an accelerator."

A centre with a small accelerator (4 MV - 6 MV) must in addition have at least one well qualified engineer.

4. General procedures

The CRP at the IAEA in 1989 (12) made a few general recommendations that should be followed when a new centre is set up or when a new megavoltage unit is put into operation.

"- The national or international protection recommendations (i.e. ICRP) for patient, staff and public safety should be carefully followed.

- A calibration of the beam must be performed before the first treatment. This calibration should be verified independently and if this procedure cannot be followed, a check by mailed dosimeters is strongly recommended.

- An output check should be performed at the very minimum once a year for Cobalt 60 and once a week for linacs."
- Commissioning of the treatment and verification of the appropriate safety and performance of the treatment unit should be performed by qualified personnel each time new equipment is installed or following a major repair or source change.

- A minimum Quality Assurance programme should be applied to verify mechanical and dosimetric characteristics of the treatment unit.

5. Building layout

The radiotherapy clinic must be situated close to other medical departments in order to facilitate different types of diagnostic investigations, other types of therapy (surgery and chemotherapy) and special care. Special cancer hospitals are established in some countries including all these specialities. This organization may be chosen if the centre has the responsibility of several thousand new cancer patients in a year and if the country has a good medical infrastructure so that suspected or diagnosed cancer cases can be transferred to the centre.

In other countries, radiotherapy centres are always integrated in, or close to, a general hospital. This is often the only possible organization in developing countries.

An example of a proposed layout for a radiotherapy department in Addis Ababa is shown in Fig 3. The radiotherapy department will be situated at the major hospital in the country. The layout has been done by an IAEA consultant who visited the country for three weeks. The layout contains one treatment floor (shown in the figure) and also a second floor containing rooms for patient beds and care.

The layout must always be adjusted to the local conditions. There are, however, some general features in the example (Fig 3) that should be stressed.
Figure 3. Example of building layout of a small radiotherapy department. The drawings were made by an IAEA consultant (Mr L Jonsson) for a centre in Addis Ababa. The department will be a part of a general hospital. A possible future expansion is already considered.

The bunkers ought to be in the basement floor as that simplifies the shielding. A future possible expansion of the centre must always be considered. An increase of the number of treatment units may otherwise be impossible or very expensive.

The $^{60}$Co-room must be easily accessible for the installation of the unit and future change of sources or other parts.
The rooms for the simulator, film developing, treatment unit, treatment planning computer, and moulding should be situated in one area (see Fig 3). It must be possible to transport patients in beds inside the radiotherapy department and to other parts of the hospitals.

6. Dosimetry and quality assurance

The situation today is that the majority part of the radiotherapy patients in developed countries are given curative treatments, while most patients in developing countries are palliative cases.

The radiotherapist community in the advanced countries has been working hard to identify cancer cases for early treatment, stressing that a large percentage of these patients can be cured. Careful treatments of early cases have resulted in good local tumour control in a high percentage of patients. Radiotherapy has therefore improved its reputation. Corresponding work is also needed in the developing countries. Quality assurance procedures must be a part of the routine patient work, as they are today at the advanced centres. The treatment regime (i.e. fractionation, total dose, treatment volume) must be optimized and the uncertainty in the dose minimized.

The dose-response curves for local control of different types of tumours and also for different complications are fairly well known today. Some of these curves are rather steep. The steepness is often given as a "normalized dose response gradient (γ)" (15), see Fig 4. For instance, a gamma-value of 2 means that an increase of the dose to the tumour of 1 % would increase the probability of local control by 2 %. The dose gradient is often measured at the steepest part of the dose-response curves. Typical values are between 2 and 6. This means that a fairly small increase of the dose might increase considerably the number of patients having local cancer control.
Figure 4. The radiation response of tumours and normal tissues as a function of the absorbed dose can generally be represented by sigmoidal curves. The steepnesses of such curves are fairly well known today. A normalized dose gradient, $\gamma = D \frac{dP}{dD}$ is often used as a measure of the steepness (15). A literature compilation based on about 30 different clinical materials for 14 different tumour sites has been made (15). This shows that the gamma-value is typically between 2 and 6. These values thus give the percentage increased probability of local control for each percentage increase in the dose level (at the steepest part of the curve). The complication rate increases with similar steepness but at a different absolute level. It is indicated that the complication rate generally is decreased with a decrease in the tissue volume irradiated. It might then be possible to increase the dose and thus have a larger probability of local control of the tumour.
These facts mean that small changes in the dose level might be of great importance for the outcome of the treatment. The EORTC recommends that the dose calibration at the reference point in a water phantom should be made within \( \pm 3\% \) and that the dose to the target volume should be determined within \( \pm 5\% \) (16). The idea is that in the future all centres that are planning to take part in an interdepartmental trial, first must prove that they are within these limits.

The IAEA, together with the WHO, organized a worldwide dosimetry service. There is a network of 63 secondary standard dosimetry laboratories (SSDLs) in the world. The therapy centre should have an ionization chamber with a calibration certificate from one of these laboratories. Furthermore, IAEA/WHO has a postal dosimetry service directly to hospitals. The IAEA is preparing TL-dosimeters which are sent out through the WHO to the hospitals. Such service can be requested from the regional WHO offices. About 700 hospitals have been included in this service.

<table>
<thead>
<tr>
<th>DeViation [%]</th>
<th>No. of Centers</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;5</td>
<td>50.2%</td>
</tr>
<tr>
<td>&gt;10</td>
<td>26.2%</td>
</tr>
<tr>
<td>&gt;20</td>
<td>11.2%</td>
</tr>
<tr>
<td>&gt;30</td>
<td>5.25%</td>
</tr>
</tbody>
</table>

Figure 5. Number of participating radiotherapy centres having deviated at least once with more than 5, 10, 20 and 30% respectively from the IAEA reference. The total number of centres was 686 (17).
The results show that as many as 50% of the hospitals on at least one occasion, have been off in their calibration from the IAEA reference by more than 5%, and 26% of the hospitals have been off by more than 10%. The worldwide situation is thus not very good.

The investigation shows that centres participating several times have improved considerably. It is therefore recommended that as many centres as possible participate. The situation regarding dosimetry according to the IAEA/WHO study is no worse in Africa than in many so called developed countries.

Conclusions

* It has been shown that the resources for radiotherapy in Africa need to be increased considerably as only a few percent of the patients needing treatment can now be covered and the crude cancer incidence will increase considerably in the future.

* The equipment needed for a new centre has been discussed. It is still recommended that the major part of radiotherapy should be based on 60Co-units, even if there is a different trend in the developed countries. Accelerators are generally not recommended due to maintenance problems.

* A simple afterloading system is needed as cervix cancer is fairly frequent in many African countries. Radium techniques should not be accepted for new departments due to radiation protection problems.

* A new radiotherapy department should also have a simulator, a simple dose-planning system based on a PC, and moulding facilities.
A typical layout for a new therapy department has been presented. It is stressed that the planning should be made so that a future expansion is possible.

A good quality assurance programme is needed in all radiotherapy centres. It has been shown that it is possible to improve the treatment results considerably using accurate dosimetry.

References


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CHOICE OF RADIOThERAPY EQUIPMENT IN DEVELOPING COUNTRIES

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Kasr El-Einy Centre of Radiation Oncology and Nuclear Medicine (NEMROCK), Cairo University, Cairo, Egypt

Abstract

Although the choice of equipment for radiotherapy in developed countries became more or less a standard procedure governed by well known rules and quality assurance criteria, such choice is not so clear in developing or underdeveloped countries. The choice in many cases is made by non-technical staff. The choice of proper equipment for a particular center should pass through a well defined plan starting from definition of needs, identification of types of cancers to be treated, the load of work, passing through clear identification of spaces available, infrastructure, water and power supply ending with the budget allocated. Setting of technical specifications of suitable equipment needs very high standard of experience that is lacking in many developing countries. Similar situation is usually faced when a decision has to be taken. The creation of a non profitable international technical advisory body will be extremely useful in helping developing countries to make proper choice of equipment. This body should have well defined procedures that must be adaptable to specific situations for particular countries. The experience of NEMROCK as a center in a developing country is reviewed.

1. Introduction

Radiotherapy service plays an important role in any cancer control program. In developed countries 30-50% of new cancer patients need radiation treatment at one time of their illness. However, in developing countries this proportion may increase to 70% or more as many patients will present in advanced inoperable stages. Therefore, the choice of quality and quantity of radiotherapy equipment in developing countries should receive the due attention of health administrators and radiotherapists.

2. Factors influencing choice of equipment

Many factors will influence the proper choice of equipment among which are the epidemiologic pattern of cancer prevailing in the region, the expected number of patients going to receive radiotherapy per year, the available health resources in form of money and personnel, the state of infrastructure services and space allocated for the radiotherapy activity. In developed countries such data are usually available to health administrators, therefore the choice of equipment becomes more or less a standard procedure governed by known rules and quality assurance criteria.
3. Problems of choice of equipment in developing countries

In developing countries the needed data for proper choice are not always available and may be faced by many problems some of which are listed in Table I. The identification of needs should be based on solid facts rather than speculations. Similarly, setting of technical data for equipment needed should be laid by group of experts supplied with all information needed and guided by international and national quality assurance criteria. In many instances such conditions cannot be fulfilled. Furthermore, some manufacturers give their offers in general terms without precise specification of parts depending on lack of experience among health administrators in such countries. The condition becomes more complicated when a decision maker does not have enough technical experience or administrative background. This situation usually leads to inappropriate selection of equipment and conflicts with manufacturers at time of delivery or operation of machines. Inadequate or conditioned financial resources may also lead to wrong choice of equipment.

4. Criteria for choice of radiotherapy equipment

Therefore it may be useful to set general criteria for choice of equipment in developing countries that can help decision makers. The selected machine should have a reputation of high durability. It can be the only radiotherapy equipment in the region, or even in the whole country. Patient's loading may be large and it can work over three shifts per day as it happened many times in NEMROCK. This situation always needs very durable machine. Most manufacturers today are moving very fast towards more sophistication of their equipment. This usually means better technology that is well appreciated in developed countries. It means higher prices of equipment and it needs a higher level of technical staff for operation and service as well as better working environment. As these requirements are not always fulfilled, these sophisticated equipment will usually suffer from repeated breaks that end ultimately in permanent stoppage. At the same time such equipment should be supplied with extra mechanical and radiation safety interlocks to guard against accidents due to lack of adequate training of technical staff. The presence of satisfactory maintenance service and spare parts stock is very important in developing countries to prevent long break-down time of these equipment.

4.1. Choice of teletherapy equipment

Apart from the general criteria for selection of equipment, there are more questions regarding items in selection of tele- and brachytherapy equipment. Tables II and III outline these issues respectively. Many of these factors are dependent on each other. The choice of energy of teletherapy machine for example will depend on whether it will be the only equipment available or there are other teletherapy machines in use. The choice between cobalt-60 and linear accelerator is becoming a difficult issue for many developing countries. Telecobalt machines are generally more suitable for those who are starting the practice of radiotherapy by being more simple, cheap and with very little breakdown time. On the other hand, most manufacturers have already stopped cobalt production lines and very few remaining are increasing in prices very close to small linear accelerators (LA). When the decision goes for LA's then it becomes necessary to decide on photon energy requirements and if electrons are needed, which electron energy should be selected. The choice of photon energies will depend on many factors, among which are the presence or absence of telecobalt machines, type of patients and the region to be treated. In general, if a telecobalt machine is present, one LA machine
### Table I. Problems of choice of radiotherapy equipments in developing countries

1. Identification of needs and setting of technical specifications of equipment required.

2. Type of budget allocated either limited or unknown to personnel ordering equipment.

3. Offers submitted by manufacturers are not always clear and specific.

4. Decision makers are health administrators with limited administrative experience.

5. Local contractors cannot meet manufacturers' requirements as regards dates or specifications.

### Table II. Specific issues in the choice of teletherapy equipment

1. Energy selection
   - Orthovoltage
   - Megavoltage
     - Cobalt-60
     - Linear Accelerator
       - Photon (? energy)
       - Photon + electron (? energy)

2. Accessories required

3. One or more teletherapy machines

4. New or refurbished equipment

5. Other equipment needed
   - Dosimetry
   - Simulator
   - Mould room
   - Computerized planning system

### Table III. Specific issues in the choice of brachytherapy equipment

1. Dose rate specification

2. Types and number of sources needed

3. Method of operation
   - Manual
   - Manual afterloading
   - Mechanical remote afterloading
   - Automatic remote afterloading

4. National regulation for radiation safety

5. Medical Physics service availability
10-12 MeV photon energy will be enough to cover most of the clinical requirements, but if a LA will be the only teletherapy machine present, then two energies will be required, e.g. one low (4-6 MeV) and another medium (10-12 MeV). For electron energy selection, 4 or 5 steps covering low and medium ranges will be enough. In developing countries, the choice of 18 or 20 MeV energy range may not be the best choice as such high energies have their engineering, dosimetric and radiation protection problems, and also have very few clinical applications that does not worth selecting this type of equipment. It is always a good policy for busy radiotherapy departments to have at least two teletherapy machines to back-up each other. These two machines should be of different energy levels to widen the scope of application. If the budget only allows for one, there must be a plan to have a second machine in the near future.

In many developing countries, the budget allocated for teletherapy machine cannot allow for a new machine and many centres are forced to look for a second hand or refurbished equipment. This issue is becoming a worldwide problem and co-operation of many parties is highly needed. Although second hand or refurbished equipment are cheaper than new equipment, they suffer major defects such as lack of spare parts and frequent breaks and in many instances cannot fulfil the present day quality assurance standards.

When selecting a teletherapy machine, one should not forget to order other equipment which are essential for proper use of this machine e.g. wedges, beam direction devices, dosimetric equipment and simulator if possible. For new beginners, it is not advisable to start with a computerized planning system even if money is available. Development of manual planning by medical physicists and or radiotherapists is important for proper safe use of computerized planning systems.

4.2. Choice of brachytherapy equipment

In the selection of brachytherapy equipment the choice will depend very much on the expected number of cases to be treated every week and on the common types of cancers which will need brachytherapy. It will depend also on previous experience of the radiotherapists with brachytherapy systems and availability of medical physics service. For a small number of cases, manual or mechanical remote low dose rate devices are quite satisfactory but for a very busy unit expecting a large number of patients weekly, a remote medium or high dose rate machine will be more appropriate provided there are adequate radiation protection facilities and high standard of the medical physics service.

5. NEMROCK experience

NEMROCK is a big radiation therapy service in the faculty of medicine Cairo University which first started more than 50 years ago. Our experience in upgrading of radiotherapy service may be a good model for many developing countries. Our policy in NEMROCK was based on two positive attitudes, the first was that man power development for radiation therapists, physicists and technologists should precede transfer of new technology. This attitude resulted in maximum utilization of new technology with very few losses. The development of binstitutional links and co-operation with international organizations helped NEMROCK along the years to build up its own man power. The second positive attitude was a consequence of the first, because it became easy now to set correctly our priorities for equipment and identify our needs for development.
Furthermore, attachment to a university gave us a continuous supply of best personnel for manpower developments. Our major difficulty was raising adequate budget for equipment. This difficulty was mainly due to low rank priority of radiotherapy equipment in the university and health administrators plans. This difficulty resulted on many occasions when we bought equipment that were not corresponding to our priority plan in NEMROCK. However, one should point to the fact that personal efforts, perseverance and good public relations have played a major role in raising money for development of NEMROCK. The second important difficulty we faced was to set technical details for equipment. This was mainly due to lack of sufficient experience in medical engineering of radiotherapy equipment. Experience of NEMROCK with the three common sources of financial support for equipment is summarized in Table IV. It seems that in many developing countries, the foreign aids will remain the main source for financing the purchase of radiotherapy equipment for sometime. Therefore, it is important that international efforts should be organized and increased to help these countries to get the optimum benefit from the available aids.

6. Developing countries and international aids

Developing countries can be categorized into three types as regards the type of aid they need. Type I are those countries with high financial resources but with limited manpower development. These countries will need mainly technical assistance in developing their manpower and in selecting their needs from equipment.

Type II: are those countries with adequate manpower development but suffer from inadequate financial resources. This type will need financial support for purchase of essential radiotherapy equipment.

Table IV. NEMROCK experience with different financial sources

<table>
<thead>
<tr>
<th></th>
<th>Government budget</th>
<th>Government to Government loan</th>
<th>International aids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive aspects</td>
<td>Free hand to choose best offer</td>
<td>Adequate in amount</td>
<td>No restriction on country of origin of equipment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Payment in hard currency</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Payment in hard currency</td>
</tr>
<tr>
<td>Negative aspects</td>
<td>Often limited and inadequate to cover cost of equipment</td>
<td>- Difficult to obtain due to low priority accorded radiotherapy</td>
<td>Long administrative procedures.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Long complicated administrative procedures</td>
<td>The international organization has final say on choice of equipment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Equipment often tied to production by donor country</td>
<td></td>
</tr>
</tbody>
</table>
Type III: are those with inadequate financial resources and limited man-power development. They will need both technical and financial aids.

The best technical aid usually comes from the same region since those experts will have no language barrier and are familiar with local conditions of the region and, hence can offer the optimum aid possible. This suggestion is best achieved if regional training centres are set in different regions of the third world by co-operation of type I and II countries with the support of International bodies such as WHO and IAEA (Fig. 1).

The creation of a non-profitable advisory body that receives all financial aids and donations of second hand or refurbished equipment will help very much in organizing these aids and its proper direction. This body will redistribute these aids and machines according to set priorities of urgent needs.

FIG. 1. Regional training centers in developing countries.

FIG. 2. International advisory body for the organization of aid and checking equipment for developing countries.
Radiotherapy departments are one of the most expensive health facilities to equip, maintain and run efficiently. In Zimbabwe, there are two radiotherapy centres - one at Parirenyatwa Central Hospital in Harare and the other at Mpilo Central Hospital in Bulawayo. Both these centres have nuclear imaging facilities. The radiotherapy services also cater for patients from neighbouring states. A referral system for consultation and prescription by the radiotherapist is in use. Administration of most cytotoxics is done in the radiotherapy department. Zimbabwe's population is over 8 million. Of this, a yearly average of 400 to 500 new patients and over 700 are seen at the Bulawayo and Harare centres respectively. So far 159 new cervical cancer patients have been seen this year at the Bulawayo centre. To cater for this and other malignancies, facilities ranging from the supervoltage therapy to a linear accelerator are available as well as limited brachytherapy facilities. The funding of these has been from the government, charity organisations and international aid agreements. Servicing and maintenance of the units is done by the private sector. Treatment planning is done mostly by radiographers but the more complex techniques are not done due to lack of qualified medical physicists. This shortage also affects the calibration of and other routine checks of the equipment. Progress in these services has been hampered by the lack of local radiotherapists. Improvements are expected with the WHO radiotherapist training programme due to start in 1990. If the cancer awareness programme is stepped up, then the demands on the radiotherapy services will increase necessitating review and updating of the present facilities and staffing levels.

1. INTRODUCTION

1961 saw the establishment of the radiotherapy centres in Zimbabwe. They are located in the country's two largest cities - the Parirenyatwa Central Hospital Radiotherapy Centre in Harare and the Mpilo Central Hospital Radiotherapy Centre in Bulawayo (Fig 1). Both these central hospitals are the country's main health teaching centres for most of the health cadres.

In the first five years, (1961-1965), a total of 2747 new patients were seen at the Bulawayo centre with a total of 12 797 follow up clinic attendances.

Treatment units most of which have since been replaced ranged from the cobalt-60 unit to a superficial X-ray unit. Also in use and still in stock were the radium-226 needles and tubes. The total number of treatments given and the number of patients treated during that time is as in Table 1a and 1b.
Fig. 1. Map of Zimbabwe.

Table Ia

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Co-60</th>
<th>DXT</th>
<th>Radium</th>
<th>Others</th>
<th>Total</th>
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<tr>
<td>1961</td>
<td>1,045</td>
<td>1,405</td>
<td>34</td>
<td>1,335</td>
<td>3,819</td>
</tr>
<tr>
<td>1962</td>
<td>4,679</td>
<td>1,475</td>
<td>79</td>
<td>631</td>
<td>6,864</td>
</tr>
<tr>
<td>1963</td>
<td>5,210</td>
<td>506</td>
<td>767</td>
<td>879</td>
<td>6,671</td>
</tr>
<tr>
<td>1964</td>
<td>3,629</td>
<td>1,657</td>
<td>78</td>
<td>927</td>
<td>6,291</td>
</tr>
<tr>
<td>1965</td>
<td>4,782</td>
<td>1,889</td>
<td>65</td>
<td>976</td>
<td>7,712</td>
</tr>
<tr>
<td></td>
<td>19,345</td>
<td>6,932</td>
<td>332</td>
<td>4,784</td>
<td>31,357</td>
</tr>
</tbody>
</table>
Table Ib

TOTAL PATIENTS TREATED BY RADIATION 1962-1965 (MPIO)

<table>
<thead>
<tr>
<th>YEAR</th>
<th>PATIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961</td>
<td>numbers not available</td>
</tr>
<tr>
<td>1962</td>
<td>453</td>
</tr>
<tr>
<td>1963</td>
<td>474</td>
</tr>
<tr>
<td>1964</td>
<td>538</td>
</tr>
<tr>
<td>1965</td>
<td>835</td>
</tr>
<tr>
<td></td>
<td>2300</td>
</tr>
</tbody>
</table>

The staffing level then was one (1) radiotherapist, three (3) radiographers and in 1965, a full time physicist joined the department. The staffing level in Harare was almost the same.

The numbers of patients with cancer are on the increase resulting in an increase on the demands on the radiotherapy services. This is due to factors such as - attainment of independence (1980) resulting in freer movement in the rural areas, improvement in the literacy level of the population as well as the accessibility of the health services to the rural population. The increase in the demands makes it necessary to look at the present radiotherapy services in the country and see if they do meet the needs of the population per se.

2. PREMISES

The premises both at the Harare and the Bulawayo centres have the same building plan with a department of nuclear imaging on the same complex.

Basically, these are two therapy rooms, a simulator room, consultancy rooms and sufficient waiting space. The Parirenyatwa centre had an extension made in 1987 for the housing of the linear accelerator. All the rooms are built to the ionising radiation specifications.

Radiotherapy departments are sited such that the public and hospital inmates are not exposed to the scattered radiation from the treatment rooms. Warning signs are displayed appropriately.

The potential for expanding these premises is there as there is need to acquire more treatment units to meet the increasing number of patients without having to put them on a waiting list. The waiting list has the disadvantage that a patient is more anxious and can actually resort to the traditional healing, can fail to turn up or only comes back when the disease is too advanced for anything to be done.
3. EQUIPMENT

3.1. LINEAR ACCELERATOR

There is only one in the country which is in use at the Parirenyatwa Hospital. It is a DYNARAY-CH 6 model which was purchased as a mixed credit agreement between the Zimbabwe Government and the Swiss Government.

Since it came into use, a total of 4503 were given in 1988. This lessened the workload on the cobalt-60 unit from 10 784 treatments in 1987 to 8 713 treatments in 1988 (Table II).

Two radiographers from the user department attended a six week course on the use of the linear accelerator in Cardiff, U.K.

Accessories such as wedges and patient monitoring/observation television units and intercom system are available.

The Mpilo linear accelerator acquisition has not yet been finalised due mainly to the argument that there is not much advantage in having a linac in the energy range of 4-6mv without electron facilities.

3.2. COBALT-60 UNITS

There are two such teletherapy units in Zimbabwe but these are different models.

The SIEMENS GAMMATRON S-180 was purchased as a replacement for the Mpilo unit in 1984. It took six months to install and came into full clinical use in March 1975.

The gammatron accommodates an average of forty patients a day and the radiographers find it simple to operate especially as the functions are similar to those of the simulator.

The Parirenyatwa unit is a THERATRON 180 which was purchased three years after the Mpilo unit. It is interesting to note that the initial choice of cobalt unit for Mpilo was a Theratron 780. The operations of this unit are different from those of the gammatron. This unit accomodates an average of 70 (seventy) patients per day.

Source exchanges are carried out on these units every four years. The last source exchange for the Mpilo was in July 1988 - a delay of over three months. This is always carried out by the Siemens engineer from West Germany.

The Parirenyatwa unit just had its source exchange on the first of December. The peak dose rate in air before the exchange was 106.22 cGy/min for a 10X10 cm field at 80cm SSD. The Mpilo dose rate at present is 106.38 cGy/min with the same factors.

The Mpilo centre might appear to be not busy as the Parirenyatwa one. This is due to a number of factors which will become self-explanatory later, the main one being the lack of full time radiotherapist at Mpilo from 1985 to June 1989 (Table IIIa, b, c).

Both units are in good working conditions thanks to the back up service from the engineers of the respective companies.
3.3. DEEP X-RAY THERAPY UNIT

Both centres had Phillips 250KV/15MA orthovoltage units purchased almost thirty years ago. These units were utilised to their maximum because of the prevalence of skin cancers in this country as advanced stages of disease on presentation.

Both units are now not operational and await urgent replacement.

3.4. SUPERFICIAL X-RAY UNIT

Mpilo has one DERMOPAN unit which is still functional though some of the cones require replacement. Very few treatments are being carried out on it mainly because the type of tumours suitable for this 50KV/25MA are not seen in the African population.

Parirenyatwa has a Phillips unit which is barely functional.
### Table IIIa

**PATIENTS TREATED BY RADIATION THERAPY 1984 - 1988**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Co-60</th>
<th>DXT</th>
<th>SXT</th>
<th>CXT</th>
<th>Ra-226</th>
<th>I-131</th>
<th>Sr-90</th>
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<tbody>
<tr>
<td>1988</td>
<td>627</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>12</td>
<td>-</td>
<td>641</td>
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<tr>
<td>1987</td>
<td>969</td>
<td>38</td>
<td>4</td>
<td>5</td>
<td>-</td>
<td>16</td>
<td>-</td>
<td>1 032</td>
</tr>
<tr>
<td>1986</td>
<td>438</td>
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<td>14</td>
<td>20</td>
<td>-</td>
<td>7</td>
<td>-</td>
<td>571</td>
</tr>
<tr>
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<td>29</td>
<td>-</td>
<td>18</td>
<td>-</td>
<td>665</td>
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<tr>
<td>1984</td>
<td>767</td>
<td>110</td>
<td>40</td>
<td>78</td>
<td>33</td>
<td>10</td>
<td>3</td>
<td>1 041</td>
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<td></td>
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<td>74</td>
<td>133</td>
<td>34</td>
<td>63</td>
<td>3</td>
<td>3 950</td>
</tr>
</tbody>
</table>

### Table IIIb

**RADIATION TREATMENTS GIVEN 1984 - 1988**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Co-60</th>
<th>DXT</th>
<th>SXT</th>
<th>CXT</th>
<th>Ra-226</th>
<th>I-131</th>
<th>Sr-90</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>5 318</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>-</td>
<td>12</td>
<td>-</td>
<td>5 336</td>
</tr>
<tr>
<td>1987</td>
<td>6 269</td>
<td>346</td>
<td>6</td>
<td>16</td>
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<td>16</td>
<td>-</td>
<td>6 652</td>
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<tr>
<td>1986</td>
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<td>59</td>
<td>19</td>
<td>-</td>
<td>-*</td>
<td>-</td>
<td>5 829</td>
</tr>
<tr>
<td>1985</td>
<td>5 662</td>
<td>809</td>
<td>48</td>
<td>152</td>
<td>-</td>
<td>18</td>
<td>-</td>
<td>6 689</td>
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<tr>
<td>1984</td>
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<td>297</td>
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<td>10</td>
<td>9 055</td>
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<td></td>
<td>29 634</td>
<td>2 918</td>
<td>409</td>
<td>490</td>
<td>44</td>
<td>56</td>
<td>10</td>
<td>33 569</td>
</tr>
</tbody>
</table>

### Table IIIc

**CLINIC ATTENDANCES 1984 - 1988**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>NEW PATIENTS</th>
<th>FOLLOW UPS</th>
<th>TOTAL ATTENDANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>413</td>
<td>2 893</td>
<td>3 306</td>
</tr>
<tr>
<td>1987</td>
<td>527</td>
<td>2 756</td>
<td>3 283</td>
</tr>
<tr>
<td>1986</td>
<td>491</td>
<td>3 839</td>
<td>4 330</td>
</tr>
<tr>
<td>1985</td>
<td>512</td>
<td>4 329</td>
<td>4 841</td>
</tr>
<tr>
<td>1984</td>
<td>652</td>
<td>4 062</td>
<td>4 814</td>
</tr>
<tr>
<td></td>
<td>2 595</td>
<td>17 879</td>
<td>20 574</td>
</tr>
</tbody>
</table>

New patients seen from outside Zimbabwe:

1989 31
1988 12
1987 14
1986 6
1985 3

Total 66*

More than 90% of these patients are from Botswana & same % are cervical cancer.
3.5. THERAPY SIMULATOR

Each department has one Siemens simulator. The Mpilo one was a donation from the Bulawayo branch of the Cancer Association, in 1974. It came into use in October 1975. The Parirenyatwa unit was purchased later by the government. The simulator has proved to be of immense benefit in providing the means for precise tumour localisation as well as easy and accurate treatment planning.

Both units have image intensifiers and televisions for fluoroscopy. They are all in full operation and have not given any major problems.

3.6. FAULT REPORTING

Each unit or equipment in the department has a log book. This is always kept at the control desk. All faults and subsequent repairs are recorded.

The most senior person on the unit is responsible for the reporting usually to the principal radiographer or where available to the physicist. Evaluation of the fault will then be taken and the respective engineers called in.

3.7. MAINTENANCE

As much effort as is possible is made to try and follow the manufacturer's specifications on the frequency and routine maintenance service to be done on the units. The shortage of capable engineers or equipment technicians has hampered this. Back up service is however available from the private sector, mainly Protea Medical Services, G.E.C., Phillips and Brown Boveri Zimbabwe.

Prior to independence, there was a team of X-ray engineers attached to the hospital. They used to provide an efficient service to all radiological equipment. It is thus desirable that such arrangement be made whereby the hospital equipment technicians receive in-service training from the above mentioned companies so that they specialise in the servicing and maintenance of the ionising radiation apparatus. These are very expensive to purchase and every possible step should be made to ensure that they are being used properly and maintained accordingly. At the end of the day, the government will benefit by not having to pay the private sector.

4. SEALED SOURCES

Excluding the teletherapy source, Radium-226 constitutes the bulk of the sealed sources currently in stock in the radiotherapy centres in Zimbabwe. About 516mgm radium are in stock at each centre.

Efforts to have this radium disposed of have not been successful. The country had a visit from the WAMAP team and this problem was again raised. Both stocks are well locked away in the appropriate safes.

The use of radium for intracavitary treatment of cervical cancer has been replaced by the caesium-137 afterloading system. This is only available at Parirenyatwa Hospital. The same is desirable at the Mpilo Centre. The Manchester spacer system is used. The afterloading system has been used for pre-external beam or post external beam irradiation as a booster dose. It has also been used in the further treatment of early recurrences.
An iridium-192 encapsulator with its necessary accessories was purchased by the Cancer Association in 1977 for use at Mpilo Hospital. This is still available for use if desired.

A set of strontium-90 opthalmic applicators is available at both centres. Also available are facilities for gold-198 grain implantation.

It is a pity that most of this useful equipment has not been put to its maximum use because of the lack of key staff - Qualified hospital physicist to calibrate and calculate the dosages for these treatments as well as construct the necessary moulds etc, a full time radiotherapist to carry out the implantation, insertions and prescribe the doses to be given.

5. UNSEALED SOURCES

The following unsealed sources are used for therapy purposes - Iodine-131, and phosphorus-32. The nuclear imaging department uses technetium-99 for all the scans that are carried out. Iodine-131 is used where indicated - uptake tests and in whole body scans following malignancy of the thyroid.

Instruments in the nuclear imaging department include a Pho/GammaIV camera (not working), Picker clinical analyzer, Picker Spectroscaler 4R and Scintimat 2 scanner. There is need for replacement of the isotope calibrator as well as the scanner.

6. MONITORING AND CALIBRATION OF UNITS

There is an efficient film badge service for the whole country. This is based at Parirenyatwa Radiotherapy Centre.

Instruments for radiation detection include a battery operated mini-monitor series 900R with scale reading of 10 - 5 000uSv per hour at one meter as well as a minialarm monitor type 7 - 10R with mains supply and scale reading 0,5 - 2 000uGy/hr.

There are no alpha monitors in stock.

Calibration of machines is done using the BALDWIN FARMER dosemeter with a 0,6cc thimble ionisation chamber and a radiological reference Source Strontium-90 designed to check the long term stability of the thimble ionisation chamber. The dosemeter is used for high accuracy exposure and dose measurement of X-rays from 10kV to 35MV, gamma and electrons from 5Kev to 35 MEV.

7. MOULD ROOM FACILITIES

These are available but are not being utilised.

8. TRAINING

8.1. RADIOThERAPISTS

No local training is available for these specialists. A doctor, however, wishing to become a radiotherapist would be attached to the department as a senior house officer or registrar under radiotherapist. The doctor would then go overseas for training. The first black Zimbabwe doctor to undergo training is now in the U.K. and is expected back in 1990-91.
With effect from January 1990, there is going to be a local training programme for radiotherapist at the University of Zimbabwe. This is being organised by the WHO in collaboration with the Ministry of Health.

8.2. PHYSICISTS

No formal training available in the country as yet.

Trainee physicists join the department with a BSc degree in physics. He will be trained by a qualified medical physicist. The trainee physicist then goes overseas for further training. One of the physicists left in September this year for the U.K. for further training. He was based at Parirenyatwa. The centre now has no physicist.

A trainee physicist recently joined the Mpilo Hospital but there is no medical physicist to train him.

We are awaiting the return of our senior physicist who is in Canada doing his doctorate studies.

8.3. TECHNOLOGISTS

These are referred to in Zimbabwe as therapy radiographers.

The training is local with an external examination body. This body - London College of Radiographers' provides regulations and syllabus for the schools of radiography to follow.

Entry qualifications are two A levels one of which has to be a science subject. The course lasts a period of three years. Part I examinations in the following subjects are written after the first eighteen months: Care of patient and Hospital Practice; Physics, Anatomy and physiology. Part II examination is on: Radiotherapy technique, Principles of Radiotherapy and Oncology as well as Radiotherapy Physics and Equipment. A Viva-Voce is also included in Part II examination. Once successful, the student is awarded a diploma with the College of Radiographers. The theory and practical training is done by the school in conjunction with the departmental staff.

There are two schools of radiography in Zimbabwe. One is at Parirenyatwa Central Hospital and the other one at Mpilo Central Hospital. The first therapy radiographer training was in 1965.

9. RELATIONSHIP WITH OTHER SUPPORTING SERVICES

There is a definite need for improvement in these relationships. The lack of a full time radiotherapist especially at Mpilo has contributed to these poor relationships.

No combined consultants clinics or ward rounds are held. The only combined clinic is conducted at Mpilo Hospital. It is referred to as the 'Combined Cancer Clinic' or CCC. This is done jointly by the radiotherapist, the gynaecologist and house officer every Tuesday afternoon.

The relationship with the Ear Nose and Throat department at Mpilo Hospital is also good. The department of pathology also has a fair relationship, though improvements are necessary for the doctors to discuss the results of histology especially where there is doubt.
10. CANCER REGISTRY

Mpilo has a cancer registry which now falls under the country's cancer registry in Harare. The registration is based on histological findings. The I C D-0 (International Classification of Disease for Oncology) 1976 is used.

This registry is based at the radiotherapy centre. A total of 3 066 registrations were done from 1985 to end of November 1989.

11. WELFARE ORGANISATIONS

Welfare organisations which have done and are still doing a tremendous job to help the radiotherapy services are: The Cancer Association of Zimbabwe, The Lions and Lioness' Clubs, The Rotary Clubs, The State Lotteries as well as the Island Hospice.

The Zororo Hostel at Harare Hospital and the Insagogwane Hostel at Mpilo were both set up by the cancer association. They also finance the running and maintenance of the two hostels. These hostels are for out-patients receiving radiotherapy but do not stay in homes near the department.

12. FOLLOW UP CLINICS

There has been an improvement in attendances of these clinics. An appointment system for the date is used. Where feasible patients who will have defaulted are traced using their departments notes through their housing offices or the police (Table IIIc).

13. PRESENT STAFFING LEVEL (see Table V)

14. SUMMARY

The radiotherapy services in Zimbabwe at present do meet the number of patients who attend for treatment (Table IV). The main area lacking is that of specialists, physicists as well as brachytherapy facilities. As already indicated in 3.3., there is need to replace the orthovoltage units as well as a cobalt-60 unit to cater for any increase in workload.

Radiography staffing can also be improved so that there are at least three qualified radiographers on each treatment unit.

Again the disused radium in stock needs to be disposed of and I hope this meeting will come up with some solution to this problem.

In the meantime we continue to look ahead and hope that with advent of the equipment situation and services in general will improve.
Table IVa

MPILO RADIOTHERAPY CENTRE COMMON MALIGNANT CONDITIONS

IN FEMALES 1984 - 1988

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>Cervical Ca.</td>
<td>132</td>
<td>113</td>
<td>122</td>
<td>158</td>
<td>132</td>
<td>657</td>
<td>25.32</td>
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<tr>
<td>Endometrial Ca.</td>
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<td>8</td>
<td>3</td>
<td>8</td>
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<td>Ovarian Ca.</td>
<td>14</td>
<td>5</td>
<td>10</td>
<td>11</td>
<td>7</td>
<td>47</td>
<td>1.8</td>
</tr>
<tr>
<td>Vaginal Ca.</td>
<td>-</td>
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<td>2</td>
<td>1</td>
<td>-</td>
<td>4</td>
<td>0.15</td>
</tr>
<tr>
<td>Vulva Ca.</td>
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<td>2</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>10</td>
<td>0.39</td>
</tr>
<tr>
<td>Breast</td>
<td>43</td>
<td>41</td>
<td>31</td>
<td>41</td>
<td>42</td>
<td>198</td>
<td>7.63</td>
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<tr>
<td>Ca-in-situ</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>8</td>
<td>0.31</td>
</tr>
<tr>
<td>Thyroid</td>
<td>2</td>
<td>4</td>
<td>10</td>
<td>5</td>
<td>3</td>
<td>24</td>
<td>0.92</td>
</tr>
<tr>
<td>Choriocarcinoma</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>6</td>
<td>6</td>
<td>18</td>
<td>0.69</td>
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<tr>
<td>Oesophagus</td>
<td>1</td>
<td>3</td>
<td>7</td>
<td>-</td>
<td>4</td>
<td>15</td>
<td>0.58</td>
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<tr>
<td>Bladder</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>7</td>
<td>9</td>
<td>21</td>
<td>0.81</td>
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<tr>
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<td>4</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>9</td>
<td>0.35</td>
</tr>
</tbody>
</table>

*The percentages are of the total new patients seen from 1984-1988 i.e. 2595.*

Table IVb.

IN MALES 1984 - 1988

<table>
<thead>
<tr>
<th></th>
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<tr>
<td>Breast</td>
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<td>0.27</td>
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<tr>
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<td>1</td>
<td>9</td>
<td>3</td>
<td>7</td>
<td>31</td>
<td>1.19</td>
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<td>22</td>
<td>21</td>
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<td>116</td>
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<td>35</td>
<td>36</td>
<td>49</td>
<td>188</td>
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<td>9</td>
<td>5</td>
<td>7</td>
<td>8</td>
<td>38</td>
<td>1.46</td>
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*The percentages are of the total new patients seen from 1984-1988 i.e. 2595.*
TABLE V. STAFFING LEVELS 1989

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<th></th>
<th>Mpilo</th>
<th>Parirenyatwa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultant radiotherapist</td>
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<td>1</td>
</tr>
<tr>
<td>Radiotherapist</td>
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<td>1</td>
</tr>
<tr>
<td>Registrar</td>
<td>-</td>
<td>1 (studying for DMRT)</td>
</tr>
<tr>
<td>Senior house Officer</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Junior house officer</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Principal radiographer</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Senior physicist</td>
<td>1 (on studies)</td>
<td>-</td>
</tr>
<tr>
<td>Physicist</td>
<td>-</td>
<td>1 (on studies)</td>
</tr>
<tr>
<td>Trainee Physicist</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Senior radiographer</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Radiographers</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Student radiographers posts</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

ACKNOWLEDGEMENTS

My special thanks to the Ministry of Health for allowing me to attend this seminar.

My colleagues at Mpilo Hospital Radiotherapy Centre for the support they gave me, as well as the Parirenyatwa Radiotherapy staff, and the IAEA for sponsoring me.
LA RADIOTHERAPIE AU MAROC

B. EL GUEDDARI
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Centre hospitalier Ibn Sina,
Rabat, Maroc

Abstract-Résumé

RADIOTHERAPY IN MOROCCO

This is an approach to the status of radiotherapy in Morocco. We describe our equipment and human facilities.

The main details of our department of radiotherapy in the Institut National d'Oncologie Sidi Mohamed Ben Abdellah are reviewed, with an epidemiological approach and our activity for the last two years.

We also discuss the problems that developing countries confront with maintenance, dosimetry and radiation physics.

LA RADIOTHERAPIE AU MAROC

Nous nous proposons de rendre compte de l'état actuel de la radiothérapie au Maroc, en décrivant nos moyens matériels et humains.

Un compte rendu détaillé sur le Service de radiothérapie de l'Institut National d'Oncologie Sidi Mohamed Ben Abdellah est donné avec un survol sur nos données épidémiologiques et le détail sur le bilan de notre activité au cours des deux premières années de notre fonctionnement.

Nous soulevons aussi les problèmes qui se posent à nos services dans des pays en développement, concernant la maintenance, le service après vente et surtout le problème de la radiophysique.

INTRODUCTION HISTORIQUE

Le Royaume du Maroc se trouve à la partie la plus au nord et à l'ouest du Continent Africain, il est à 13 Km de l'Europe (détroit à Gibraltar), sa superficie est de 710.850 Km² et sa population est de 25 Millions d'habitants.

La radiothérapie a vu le jour dans notre pays dès 1929 avec la création du Centre Bergonié à Casablanca, dans l'enceinte du Centre Hospitalier IBN ROCHD. Ce Centre a été crée à l'instar des centres anticancéreux Français et travaillait en liaison étroite avec le Centre Bergonié de Bordeaux. Le fonctionnement
de ce centre a connu des hauts et des bas, il disposait d'un équipement de radiothérapie conventionnelle et d'un service de médecine nucléaire, un télécésium a été installé au début des années 50 et un télécobalt de conception russe en 1965.

Ce centre a été entièrement rénové à partir de 1980 à l'occasion de notre retour de France (Dr KHALAIN et moi même) grâce aux efforts et l'aide de l'Association Marocaine de Lutte Contre le Cancer (Réaménagement des locaux, acquisition d'un Alcyon, d'un simulateur TOSHIBA et d'un service de curiethérapie de 6 lits avec 3 curiethrons).

Le statut de ce centre est universitaire, il est dirigé par le Professeur KHALAIN et 5 Radiothérapeutes sont en fonction.

En 1975, le Ministère de la Santé Publique a décidé de créer un Centre National de Lutte Contre le Cancer à Rabat, la conception et la réalisation de ce centre a été faite grâce à la collaboration et à l'assistance de la coopération Française dans le domaine de la conception et de la formation de l'équipe médicale et paramédicale.

Nous tenons à rendre hommage au Professeur CHARDOT C., Directeur du Centre Alexis Vautrin de Nancy qui a accueilli toute l'équipe médicale et suivi toutes les étapes de construction et d'équipement.

Le Gouvernement Marocain a supporté toutes les charges de construction et de l'équipement.

Dès 1975, la première promotion de radiothérapeutes et de radiodiagnosticiens sont partis en formation.

L'Institut National d'Oncologie Sidi Mohamed Ben Abdellah n'a démarré qu'en Janvier 1985, il est dité d'un service d'Accueil et d'Epidémiologie, d'un service de Radiodiagnostic d'un service d'Anatomie pathologique, d'un Laboratoire de Biochimie et d'hématologie, de Réanimation Anesthésie, d'un Service de Chirurgie Carcinologique et d'un service de Radiothérapie et Curithérapie.

Il n'y a pas d'unité de Chimiothérapie, celle-ci est faite dans les services de chirurgie et de radiothérapie.
Cet Hôpital est destiné uniquement aux soins, à la prévention et à l'enseignement en matière de cancer, il dispose de 276 lits (90 lits en chirurgie, 120 en radiothérapie + 26 en curiethérapie, 30 lits de médecine et 10 lits de réanimation). Il a un statut hospitalo-universitaire et fait partie de l'ensemble du Centre Hospitalier IBN SINA.

**LE SERVICE DE RADIOTHERAPIE**

Le service est fait de 3 unités :
- Hospitalisation 90 lits
- Plateforme technique
- Curiethérapie

Il travaille en étroite collaboration dans l'esprit multidisciplinaire avec les autres services du centre et en étroite collaboration avec les différents services des 10 Formations constituant le Centre Hospitalier IBN SINA.

Par ailleurs, il reçoit des patients de toutes les provinces du Royaume ce qui lui donne une importance nationale.

**A/ EQUIPEMENT**

1- Radiothérapie externe

- 2 Appareils de télécobalt de type Alcyon CGR MeV fonctionnels dès 1983
- 1 Appareil de radiothérapie de contact Philips RT 50
- 1 Simulateur de type VERASIM
- 1 Tomographe axial transverse
- 1 Salle de centrage avec colonne pour contrôle des applications curiethérapiques
- 1 Conformateur mural
- 1 Appareil de découpage de caches type MECASERTO
1 Système de dosimétrie RT. Plan Général Électric très preformant avec traitement dosimétrique à partir de coupes tomodensitométriques.

Dosimètres : 2 P. T. W. + 1 Scanditronix + 1 PDP. 11

1 Accélérateur linéaire en cours d'acquisition qui sera installé en Aout 1990 : 25 MV. GE-CGR MeV dont le local est déjà prêt depuis l'inauguration du centre.

2- Curiethérapie (Unité de 26 lits)

2 Salles d'application (1 pour la gynécologie et l'autre pour l'ORL avec fauteuil dentaire)

1 Amplificateur de luminance mobile

1 Local de dosimétrie

Une Gammathèque

- avec 5 stockeurs de sources comportant 50 sources de Césium 137 (vaginales et utérines)
- Une paillassechaude pour le découpage des fils d'Iridium
- 1 Dosimètre, 1 chambre à puits et 1 ultracentrifugeuse à ultrason
- Ensemble pour réalisation de moulages
- 13 Curiethrons.

B/ PERSONNEL

- Médical
  1 Professeur Chef de service
  1 Maître Assistant en Radiothérapie
  2 Médecins de Santé Publique Spécialisés en radiothérapie
  1 Assistant
  1 Interne
- Physicien

4 physiciens Marocains ont été formés et n'ont pu regagner le pays pour des problèmes de salaire. Nous n'avons actuellement qu'un physicien travaillant à mi-temps, ce problème est en cours de résolution.

- Paramédical

. 1 Technicien Major en Radiothérapie externe
. 7 Techniciens manipulateurs en Radiothérapie
. 1 Technicien Major en curiethérapie
. 1 Technicien manipulateur en curiethérapie
. 7 Infirmières en curiethérapie
. 2 Infirmières en radiothérapie externe

* Les unités d'hospitalisation de radiothérapie sont fournies en personnel selon les normes établis par le Ministère de la Santé Publique.

C/ BILAN D'ACTIVITE /

L'Institut National d'Oncologie reçoit plus de 2600 nouveaux cas de cancer par an.

1986 : 2644 Cas
1987 : 2665 Cas
1988 : 2686 Cas

plus de 80% des malades reçoivent des soins radiothérapeutiques. Avant d'envisager le bilan d'activité proprement dite de nos services, voici le profil épidémiologique de nos malades en considérant les 5 premières localisations que nous rencontrons.
<table>
<thead>
<tr>
<th>ANNE</th>
<th>1986</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Col Utérin</td>
<td>349</td>
<td>18,3</td>
</tr>
<tr>
<td>Sein</td>
<td>227</td>
<td>11,9</td>
</tr>
<tr>
<td>Nasopharynx</td>
<td>160</td>
<td>8,4</td>
</tr>
<tr>
<td>Lymphomes malins</td>
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<td>6,3</td>
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<tr>
<td>Larynx</td>
<td>73</td>
<td>3,8</td>
</tr>
<tr>
<td>Autres</td>
<td>978</td>
<td>51,3</td>
</tr>
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* Cinq premières localisations

Seuls sont compris ici les cas à malignité certaine histologiquement, radiologiquement ou cliniquement.

Avec une répartition selon le sexe

<table>
<thead>
<tr>
<th>TABLEAU 2</th>
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<tr>
<td></td>
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</tr>
<tr>
<td>Nasopharynx</td>
<td>107</td>
</tr>
<tr>
<td>Larynx</td>
<td>67</td>
</tr>
<tr>
<td>Poumon</td>
<td>54</td>
</tr>
<tr>
<td>SHRH(LMNH)</td>
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<td>Peau(ESC)</td>
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<td></td>
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<tr>
<td>Sein</td>
<td>218</td>
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<tr>
<td>Ovaire</td>
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</tr>
<tr>
<td>SHRH</td>
<td>29</td>
</tr>
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</table>
Les traitements réalisés

Nous pensons utile de présenter le nombre de traitements réalisés avec le nombre de champs établis ce qui reflète au mieux l'activité.

**TABLEAU 4**

**TRAITEMENTS REALISES EN RADIOTHERAPIE**

<table>
<thead>
<tr>
<th>ANNÉE</th>
<th>N. TRAITEMENT</th>
<th>N. CHAMPS</th>
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<td>23.985</td>
<td>59.068</td>
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<td>1987</td>
<td>25.384</td>
<td>59.517</td>
</tr>
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<td>1988</td>
<td>30.810</td>
<td>73.840</td>
</tr>
</tbody>
</table>

Nous faisons travailler les appareils par deux équipes de manipulateurs, les traitements commencent à 7h du matin et se terminent à 8h du soir.

**En Curiethérapie**

Une moyenne de 391 applications par an est réalisée avec le détail suivant :

**TABLEAU 5**

<table>
<thead>
<tr>
<th>ANNÉE</th>
<th>CURIE. ENDO CAVITAIRE</th>
<th>CURIE. INTERSTITIELLE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986</td>
<td>237</td>
<td>112</td>
<td>349</td>
</tr>
<tr>
<td>1987</td>
<td>244</td>
<td>111</td>
<td>355</td>
</tr>
<tr>
<td>1988</td>
<td>354</td>
<td>115</td>
<td>469</td>
</tr>
</tbody>
</table>

Remarquer la progression importante des applications gynécologiques qui va de paire avec la fréquence accrue des cancers du col utérin.

La curiethérapie interstitielle est non moins importante dans notre activité, elle représente environ le 1/3 des applications et principalement elle interesse les EOA cutanés, ORL, mammaires et autres.
Sur le plan de l'équipement, l'unicité des appareillages et leur provenance d'un même fabriquant font que le problème de maintenance et du service après vente est facilité par l'existence d'un seul interlocuteur, avec lequel un contrat de maintenance annuel est établi mais devient très cher car ampute une bonne partie de notre budget de fonctionnement.

Le nombre de pannes noté durant les 3 dernières années est de 28 en 1986, 42 en 1987 et 42 en 1988. Ces pannes du cobalt ont presque toujours été en rapport avec des problèmes de table de traitement (circuits électriques, moteur électrique ....) le délai d'intervention est en moyenne de 4 heures. La durée de la panne n'exède pas la demi-journée dans la plupart des cas.

Un solution sur place rendrait mieux fonctionnel notre service.

Quant au problème des curiethrons, nous avons souffert la première année à cause de l'existence d'un vice de fabrication à la sortie des gaines. Ce problème résolu, l'entretien de ces appareils n'est pas lourd.

Sur le plan du personnel, si le problème des radiothérapeutes ne se pose pas avec la formation en continue de jeunes radiothérapeutes, c'est au niveau du physicien que la défaillance est grande, surtout avec l'acquisition d'un accélérateur où l'on ne peut plus se suffir d'un demi-physicien. Des efforts sont en cours pour sensibiliser nos responsables afin d'améliorer leurs salaires.
CONCLUSIONS

Après avoir brossé un tableau assez exhaustif sur notre Institut et particulièrement notre service, nous insistons sur les efforts consentis par notre pays qui est un pays en développement et qui n'a ménagé aucun effort dans le domaine de la construction de l'équipement et de la formation du personnel, par ses propres moyens, pour nous fournir un outil de travail performant.

Il n'en demeure par moins que les problèmes de maintenance de service après vente et d'entretien de nos appareils doivent trouver leur solution dans la simplicité des appareils et dans la constitution d'équipes de maintenance propre à notre Institut. Les instances internationales telles que : l'A.I.E.A., l'O.M.S. peuvent nous assister dans ce domaine.

Nous ne cesserons pas d'insister sur le rôle du radiophysicien qui est partie intégrante de l'équipe médicale et dont la responsabilité est de premier ordre dans le traitement du cancéreux, sa reconnaissance et son reclassement dans l'échelle administrative est indispensable.

Par ailleurs, nous ne pouvons conclure sans mettre en exergue le développement futur de la radiothérapie dans notre pays qui a gagné le secteur libéral et dont la première installation est déjà fonctionnelle à Casablanca avec 2 radiothérapeutes outillés d'un Alcyon et de 2 curiethrons.

Nous restons ouvert à toute sorte de collaboration aussi bien dans le domaine de l'assistanat technique que dans le domaine de la formation de jeunes radiothérapeutes des pays Africains frères.
STATUS OF RADIOTHERAPY IN EGYPT

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* Kasr El-Einy Centre of Radiation Oncology and Nuclear Medicine (NEMROCK), Cairo University
** Curative Health Services, Ministry of Health Cairo, Egypt

Abstract

This paper traced the history of the development of medical services including radiotherapy in Egypt. Radiological medicine was introduced in Egypt in 1923 first and brachytherapy with radium was introduced as early as 1927. An overview of the current status including the roles in research, teaching and clinical services to cancer patients are described.

INTRODUCTION

Radiation therapy and Nuclear Medicine are two disciplines of radiological sciences which started concomitant with the development of the era of modern medicine in Egypt.

Modern medicine started in Egypt at the fall of the 18th century after the French invasion of the country at the fall of the 17th century.

Dr. Clott a French Medical Officer founded the first school for physicians and nurses at Abo-Zabal 28 kms. north of Cairo. The Abo-Zabal school has been the first medical school in the Eastern Mediterranean region.

Later in 1820 Mohamed Aly, the Ruler of Egypt and the founder of the last monarchy, moved the hospital to Cairo to a place (Kasr) owned by one of the Memliouks was named El-Einy after which the school got its name "Kasr El-Einy Medical School" (KEEMS).

Dr. Clott who stayed in Egypt after the withdrawal of the French forces, was appointed the school's Director and was strongly supported by the Egyptian Monarch.

Egyptian scholars were sent to Montpelier school of medicine in the South of France. Those scholars were the founders of the Modern Egyptian Medical School.

Ever since the Kasr El-Einy Medical School (KEEMS), has been the cradle of Medical Education in the Eastern Mediterranean region. Many physicians from the Mid-East and African countries were graduated from that medical school.

The history of Radiological Medicine in the Egypt dates back to 1923 when the first diagnostic radiological equipment was installed in KEEMS.
In 1927, Radium Brachytherapy was introduced followed by Radioisotopes in 1954, Cobalt-60 Teletherapy in 1962, Low Dose Rate After Loading Brachytherapy and Axial Tomography in 1978, Linear Accelerator in 1985 and at least MRI in 1989.

**TABLE 1: HISTORICAL REVIEW OF THE MOST IMPORTANT EVENTS IN HEALTH SERVICES EVOLUTION IN EGYPT**

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1798</td>
<td>Establishment of the 1st Medical School at Abo-Zabal by Dr. Clott</td>
</tr>
<tr>
<td>1820</td>
<td>Mohamed Aly moved the school of medicine to Cairo and was named Kasr El-Einy School of Medicine.</td>
</tr>
<tr>
<td>1923</td>
<td>Radiological Equipment</td>
</tr>
<tr>
<td>1927</td>
<td>Radium Brachytherapy</td>
</tr>
<tr>
<td>1928</td>
<td>Establishment of Fouad 1st University latter on, Cairo University</td>
</tr>
<tr>
<td>1936</td>
<td>Diploma of Medical Radiology &amp; Electrology Cairo Univ. (DMRE)</td>
</tr>
<tr>
<td>1954</td>
<td>Establishment of the Ministry of Health</td>
</tr>
<tr>
<td>1954</td>
<td>Radioisotope medical applications</td>
</tr>
<tr>
<td>1962</td>
<td>Cobalt-60 Teletherapy</td>
</tr>
<tr>
<td>1978</td>
<td>Automatic Low Dose Rate Brachytherapy</td>
</tr>
<tr>
<td>1985</td>
<td>Computerized Axial Tomography CAT</td>
</tr>
<tr>
<td>1989</td>
<td>Linear Accelerator</td>
</tr>
<tr>
<td>1989</td>
<td>Magnetic Resonance Imaging</td>
</tr>
</tbody>
</table>

Since Radiotherapy and Nuclear Medicine are parts of the National Health Care System, the survey of the available radiotherapy equipments in the country has to include some of the demographic data and a short description of the Health Care Delivery System.

**Table 2: SOME OF THE DEMOGRAPHIC DATA OF EGYPT**

<table>
<thead>
<tr>
<th>Description</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>51 Millions</td>
</tr>
<tr>
<td>Sex Ratio</td>
<td>51%: 49%; F.M.</td>
</tr>
<tr>
<td>Age &lt; 20 years</td>
<td>40% of the population</td>
</tr>
<tr>
<td>Governorates</td>
<td>26</td>
</tr>
<tr>
<td>Cairo Metropolitan area</td>
<td>10 million population</td>
</tr>
<tr>
<td>Airid zones surface area KM²</td>
<td>96% of the country</td>
</tr>
</tbody>
</table>

**THE HEALTH CARE SYSTEM IN EGYPT**

On the other hand, the Health-care System is composed of a public and a private sector.

The public sector includes the Ministry of Health Services and its services; the National Health Insurance Facilities (covers about 4 million individuals) and the Universities Medical School Hospitals.

The private sector includes private clinics and hospitals and represents approximately 10% of the health services in the country.
There are three levels of Health-care in Egypt, Primary, Secondary and Tertiary levels.

Table 3:  THE HEALTH CARE LEVELS IN EGYPT

<table>
<thead>
<tr>
<th>Primary H.C.L.</th>
<th>3020 Rural Health Centers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary H.C.L.</td>
<td>157 District Hospitals (80-120 b.)</td>
</tr>
<tr>
<td>Tertiary H.C.L.</td>
<td>29 General Hospital (300-450 b.)</td>
</tr>
<tr>
<td></td>
<td>11 University Hospitals (1000-2000 b.)</td>
</tr>
<tr>
<td></td>
<td>6 Medical Insurance Hospitals</td>
</tr>
</tbody>
</table>

The Radiation Oncology facilities in Egypt are found in 37 centers of which 29 are public sector facilities and 8 are privately owned facilities. However, Brachytherapy is available in 24 hospitals, 17 of which are included in the Egyptian Brachytherapy project for CCU. in the LDCs.

Table 4:  THE RADIATION ONCOLOGY FACILITIES IN EGYPT

<table>
<thead>
<tr>
<th>TYPE</th>
<th>TOTAL</th>
<th>L.A.</th>
<th>Co\textsuperscript{60}</th>
<th>Cs\textsuperscript{137}</th>
<th>BRTH</th>
<th>ORTH</th>
<th>SIM</th>
<th>D.PR.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government</td>
<td>H.29.</td>
<td>37</td>
<td>4+4*</td>
<td>16</td>
<td>4</td>
<td>20</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>Private</td>
<td>Cl. 8</td>
<td>8</td>
<td>1</td>
<td>2+1*</td>
<td>2</td>
<td>4</td>
<td>7</td>
<td>1*</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>44</td>
<td>24</td>
<td>22</td>
<td>5+1*</td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = 14 Gov. Hospitals have BRTH. only.
= Under installment
L.A. = Linear Accelerator
Co\textsuperscript{60} = Cobalt Teletherapy
Cs\textsuperscript{137} = Caesium Teletherapy
BRTH. = Brachytherapy
ORTH. = Orthovoltage
SIM. = Simulator
D.Pr. = Data Processing.

The human resources development programme in the field of Radiation Oncology and Nuclear Medicine in Egypt includes 4 main disciplines:
Table 5: SCIENTIFIC DISCIPLINES FOR HUMAN RESOURCES DEVELOPMENT IN RADIATION ONCOLOGY AND NUCLEAR MEDICINE

<table>
<thead>
<tr>
<th>Category</th>
<th>Disciplines</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Medical</td>
<td>Radiation &amp; Nuclear Oncology as well as Nuclear Medicine</td>
</tr>
<tr>
<td>2. Physics</td>
<td>Hospital, Medical and Nuclear Physics Bioengineering</td>
</tr>
<tr>
<td>3. Engineering</td>
<td>Nurses</td>
</tr>
<tr>
<td>4. Paramedical</td>
<td>Radiation Technicians Data processing and statistics</td>
</tr>
</tbody>
</table>

Opportunities for training are available in NEMROCK Cairo University and the other Universities in the country.

*In the field of Radiation and Medical Oncology as well as Nuclear Medicine, a Master (3 yrs) and a Doctorate (M.D.); degrees are obtained from Cairo and other 5 universities in the country.

*In the field of physics the following degrees are obtained:

- Diploma of Hospital Physics, 2 years, Cairo University
- Master in Medical Physics, 2 years, Cairo University
- Basic 4 years, Master (2 years) and Ph.D. in Biophysics, Cairo University,

*In the field of Engineering, Cairo University, Faculty of Engineering offers a B.Sc. (4 years), a Master MS (2 years) and Ph.D. degrees in Bioengineering.

*In the paramedical fields of education the following degrees are offered by different Egyptian Universities:

- Nursing:
  The Certificate of Secondary Technical Nursing School-3 years, Ministry of Education.
  B.Sc. (4 years), Master (3 years) and Doctorate (minimum 2 years) of Nursing from the High Institute of Nursing from 5 Universities.
- Data Processing and Statistics, Master and Doctorate degrees from the Institute of Data Processing and Statistics Cairo University.
- Radiation Technicians (2 years) Diploma from the Institute of Paramedical Technicians, Ministry of Health.

The status of Human Resources in the field of Radiology shows that these are 660 Radiologists including Radiotherapy and Radiodiagnosis. Some of them working ahead.

Table 6: HUMAN RESOURCES IN RADIOLOGICAL SERVICES IN EGYPT

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>NUMBER IN SERVICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiologists</td>
<td>660</td>
</tr>
<tr>
<td>(Diag. &amp; Thr.)</td>
<td></td>
</tr>
<tr>
<td>Post. Grad. Students</td>
<td>361</td>
</tr>
<tr>
<td>Physicists</td>
<td>14</td>
</tr>
<tr>
<td>Rad. Technicians</td>
<td>3104</td>
</tr>
<tr>
<td>Bioengineers</td>
<td>48</td>
</tr>
</tbody>
</table>

1987 figures
The cancer incidence in Egypt is still a scientific problem because of absence of national incidence figures. A guarded estimation of the annual new cancer cases in Egypt is about 115/110,000, this estimate was based on the fact that about 16,000 cases of the radiotherapy are treated by radiotherapy in public and private sector facilities which represents 40% of all new cancer patients i.e. about 50,000 new patients per year.

Another estimate of WHO ranged between 70-140/100,000; lately the Cairo Metropolitan Cancer Registry presented a figure of 120-180/100,000.

It is obvious that due to the inadequacy of cancer registry facilities that such an approximate presentation of data is arrived at.

**Radiation Protection Legislation Law 60/1959 and the Radiation Protection Service in Egypt**

In 1959, Egypt introduced a legislation for radiation protection. An Executive Radiation Protection Bureau has been formed in the Ministry of Public Health.

The duties performed by this radiation protection service is the provision of radiation protection measurements, surveillance of equipment and providing advise on the implementation of radiation protection measures.

**NEMROCK** is a Comprehensive Cancer Center of Faculty of Medicine of Cairo University. It is situated in the Faculty's Campus. It is connected to the University Hospital, however, it is independent financially and administratively. Its Board of Directors is Chaired by the Dean of the Cairo University, Faculty of Medicine, the Professors of Surgery, Medicine and Pathology are members of the Board.

The objectives of **NEMROCK** are:

- Cancer Control and Management of Cancer cases.
- Oncological Education and Training for Medical and Paramedicals.
- Research and Development

**NEMROCK** has a surface area of 2400 m² and includes the following services:

- Outpatient service
- Tumor Clinics: (Breast, Orthopaedics, Gynaecology, Opthalmology, Urology, Endocrinology, Neurology, E.N.T., Plastic Surgery, Dermatology, Hematology and Lymphoreticular).
- Hospital Service, 80 beds.
- Radiation and Medical Oncology Service.
- Radiodiagnostic service.
- Clinical and Chemical Pathology Service.
- Nuclear Medicine Service
- Radiation Physics Unit
- Molecular Biology Unit
- Radiobiology Unit
- Electron Microscopy Center
- Bone Marrow transfusion Unit
- Cancer Registry (Data Processing)
- Social and Almoner Service
- Electrical and mechanical workshop
NEMROCK depends on the University Hospital on various hardware services and various infrastructural services.

Table 7: THE HUMAN RESOURCES OF NEMROCK

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical and Scientific staff</td>
<td>(42)</td>
</tr>
<tr>
<td>Nursing staff</td>
<td>(28)</td>
</tr>
<tr>
<td>Administrative and others</td>
<td>(152)</td>
</tr>
</tbody>
</table>

Since 1927, radiotherapy was a joint discipline with its sister speciality radiodiagnosis. Growing steadily, Radiotherapy became autonomous administratively but it was under the umbrella of the Radiology Department.

In 1962, the Diploma and Doctorate in Radiotherapy separated from radiodiagnosis, followed in 1989 by complete Administrative and Academic separation.

It is now called the Kasr El-Einy Oncology and Nuclear Medicine Center of Faculty of Medicine of Cairo University.
INTRODUCTION OF RADIOTHERAPY SERVICES IN A DEVELOPING COUNTRY: THE EXPERIENCE OF CAMEROON

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J. YOMI
Department of Radiotherapy, General Hospital, Yaounde

Cameroun

Abstract

On the 30th of December 1987 the President of the Cameroon Republic signed a decree creating and organizing 2 General Hospitals of 310 beds each, with major services of radiotherapy.

This project initiated in 1983 by Cameroon in collaboration with the French and Belgian Governments is at its realization phase. The authors present an epidemiological survey of treated cancers since April 1989 and analyse the situation and future trends.

INTRODUCTION

Until 1987 Cameroon used to transfer patients whose treatment could be only well assured in Developed Countries (FRANCE, GB, CANADA). The cost was quite high (in 1985, more than US $1.5 million for only patients transferred to France). When the President of Cameroon signed a decree in December 1987 creating and organizing the functions of 2 General Hospitals, one in YAOUNDE and the other in DOUALA, the construction of buildings had nearly ended and the equipment was being installed.

Every Hospital would be able to:

- deliver highly improved treatments in multidisciplinary forms;
- support the training of specialized medical and paramedical staff;
- promote medical research.
The financial support was studied within the cooperation programmes. Each Hospital will be built and equipped with immediate possession by a consortium of companies.

The cost of the premises was approximately estimated US $ 34 million and that equipment US $ 20 million.

In each Hospital there will be a department of radiotherapy costing approximately US $ 2.5 million. On this basis France agreed to give a loan of US $ 45 million for the Douala General Hospital and Belgium did the same for the Yaounde General Hospital.

EPIDEMIOLOGICAL DATA

Cameroon is a triangular land of 475 000 sq.km (183 410 sq.miles) facing the Atlantic ocean on the equatorial depression of Africa. Its population in 1988 is estimated 11.047 millions. 60 % live in rural areas (2). 43 % of the population is less than 15 years and 4 % is more than 64 YEARS. Life expectancy is 52. Birthrate is approximately 44 per 1000 while Deathrate is 17 per 1000, this including an infant mortality of 117 per 1000.

There is only one medical doctor for 7400 and a ward bed for 3000 inhabitants.

There is no national cancer registry but the estimations of new cases calculated from cancer mortality give between 3000 to 5000 new cases a year.

The structure of Health Services define 5 levels of infrastructure which are comparative with administrative subdivisions (Fig. 1).

<table>
<thead>
<tr>
<th>N°</th>
<th>DENOMINATION</th>
<th>N° BEDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>UNIVERSITY TEACHING HOSPITALS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 1 University Hospital</td>
<td>350</td>
</tr>
<tr>
<td></td>
<td>- 2 General Hospitals</td>
<td>310</td>
</tr>
<tr>
<td>10</td>
<td>PROVINCIAL HOSPITALS</td>
<td></td>
</tr>
<tr>
<td>52</td>
<td>DEPARTMENTAL HOSPITALS</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>DISTRICT HOSPITALS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>COMMUNITY HEALTH CENTRES</td>
<td></td>
</tr>
</tbody>
</table>

FIG. 1. Health service infrastructure.
The UCHS (University Centre for Health Sciences) was created in 1969 and since 1975, 40 Medical Doctors graduate every year. This number has doubled in 1987, owing to the needs of the population. 2 years ago a training course of specialized practitioners in Gynecology and Obstetrics, Pediatrics, Surgery Parasitology and Radiology started.

BUILDING AND EQUIPMENT

The creation of these 2 General Hospitals has brought a new dimension in the field of training specialized medical and paramedical staff. Started in 1983, the operation was ready for 1988.

The Radiotherapy Department at the Douala General Hospital has 330 sq.m. It has:
- a treatment room with a Cobalt 60 unit (Alcyon II);
- a simulation room with a simulator (Verasim) connected to a fluoroscope (Imex);
- a mold room with a Polystirene cutter and Cerroben blocking material;
- a dark room;
- an examination room;
- 2 medical offices;
- 1 physicist office;
- 2 waiting rooms.

The cost of the building is estimated US $ 750000. The annual maintenance agreement of the equipment (10% of its cost) is almost US $ 150 000.

The Radiotherapy Department at the Yaounde General Hospital has approximately the same structures:
- an area of 260 sq. m;
- a treatment room with a Cobalt 60 unit (Alcyon II);
- a superficial X-Ray therapy room with a 100 Kv machine (NEODERMO);
- 1 medical office;
- 1 waiting room.

The simulation room is not yet equipped with a simulator.
SPECIALIZED STAFF

In provision of the staff, 3 national medical Doctors went to France in 1984 for specialization in radiotherapy. One of them has been working in the Department of Radiation Oncology in Douala for a year and the 2 others have started working in the Department of Radiotherapy in Yaounde since February, 1989.

2 other radiotherapists are graduating in France and will be awaited to Cameroon in 1990 together with a french Consultant Radiotherapist.

The 2 Physicists working in both departments had advanced training courses of one year in Toulouse for one and 6 months in Bruxelles for the other.

4 local radiotechnologists had their training course in France for conversion into radiotherapy technologists and were dispatched to the 2 Hospitals.

Besides these 2 Hospitals, there is a private radiotherapy unit functioning in Douala since 1985 with a Cobalt 60 machine (ELDORADO 6).

EVOLUTION OF THE DEPARTMENTS

The Department of Radiotherapy in Yaounde has not yet started treatments because of the lack of a simulator. Data from the private radiotherapy unit in Douala are not available. The Department of Radiation Oncology in Douala has received a few patients since April 1989; often referred by Medical Practitioners. After simulation of the fields of treatment they are informed of the fees of treatment fixed according to the Cameroonian nomenclature. The result is one abandon out of 3, for financial reasons.

The number of cases received from April to August 1989 (5 months) is summarized in table 1.
### TABLE 1

**NO. OF CASES RECEIVED AT THE DOUALA GENERAL HOSPITAL FOR RADIOTHERAPY FROM APRIL TO AUGUST 1989**

(PRIMARY SITES OR METASTASES)

<table>
<thead>
<tr>
<th>SITES</th>
<th>NO. TREATED</th>
<th>NO. UNTREATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>CERVIX UTERI</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>BREAST</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>ORAL CAVITY</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>SARCOMA</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>LYMPHOMA</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>KAPOSI</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CONNECTIVE TISSUE</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>SKIN</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>LIVER</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>BLADDER</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>NASOPHARYNX</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>MYELOMA</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>PROSTATE</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>VULVA</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>VAGINA</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>THYROID</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>SINUSES</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>ADAMANTINOMA</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>RECTUM</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>BOWEL (Carcinoid T.)</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>34</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>

### DISCUSSION

All the 3 Departments of Radiotherapy work with private conditions in a Country where just a few patients can have their medical fees paid or reimbursed by Social Welfare Funds. That limits tremendously the number of treated cases. Cancer patients are obviously received with very advanced stages or recurrent disease after surgery. This leads to non optimization of Radiotherapy. In order to introduce adequate curative results of the discipline multidisciplinary therapeutic protocols should be defined by a local cancer team.

Moreover, in order to have a correct machine output Information, it is necessary to have a full calibration of the Cobalt 60 source after installation by means of a dosimetric device (e.g. ionization chamber). The measurements might be done by a commission of quality control of ionizing radiation approved by the Ministry of Health.
CONCLUSION

Constraints linked to a good introduction of radiotherapy and control of cancer incidences in a developing country are multiple. Our small experience of a few months gives the opportunity to list some of them:

- 1) Cancer patients should be offered almost free treatment; hence, Radiotherapy Departments should receive subventions to be able to carry out their activities.

- 2) Legislation must be well set out for control of every unit of radiotherapy.

- 3) There is crucial need of cervical brachytherapy facilities when external radiotherapy is available.

- 4) Establishment of radiotherapy should be followed or preceded by a national cancer programme.

- 5) It is essential to get at least one dosimetric device (e.g. ionization chamber) in any country with radiotherapy facilities.

REFERENCES


PRESENT AND FUTURE STATUS OF RADIOTHERAPY SERVICES IN THE LIByan Arab Jamahiriya

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Tripoli

I. ABDEL RAHMAN
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Libyan Arab Jamahiriya

Abstract

Treatment of cancer patients in Libya commenced in 1968 using a 250 KV X-ray machine. Additional units: Co-60, localizer/simulator and computer planning system were procured in latter years. An average of 300 new patients were treated per year. The incidence of cancer in the Libyan population is not known because of lack of a Cancer Registry. However, the most important cancers prevalent are discussed for both males and females. Future developments are centered around Radiotherapy Department at New Tripoli Central Hospital. The Department is equipped with treatment units that include 20 MV Mevatron Linear Accelerator, 6 MV Linear Accelerator, Co-60 Unit, Intracavitary and Interstitial units. The commissioning of these units require additional man-power which is not available at present, but it is hoped to overcome these difficulties through IAEA and WHO Technical Co-operation Programmes.

The Present Status:

The Radiotherapy Department at Tripoli Central Hospital, the only cancer treatment centre in Libya, at present, was established in 1968. A 250 KV X-ray unit and superficial unit were the sole treatment units. In 1973 modifications were made in the treatment rooms to accommodate a 222 TBq (6000 Ci) Co-60 Theratron 80 Unit which was the only unit available for treating patients until 1982, when a Siemens 250 KV X-ray machine and a CGR localizer/simulator were installed. In 1985 a computer planning (Evadose system) from Siemens was installed.

The number of new patients treated by radiotherapy during the years 1968-1983 is shown in Table (1).

The record files before 1973 were incomplete.

The above figures do not represent all cancer cases in Libya because unfortunately up to now, there is no cancer registry. However, during these years of treating cancer cases, some conclusions could be reached as to the status of
<table>
<thead>
<tr>
<th>Malignancy site</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Lung</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>2) Lymphomas</td>
<td>11.7</td>
<td>11.7</td>
</tr>
<tr>
<td>3) Larynx</td>
<td>9.3</td>
<td>9.3</td>
</tr>
<tr>
<td>4) Skin, excluding malignant melanoma</td>
<td>8.6</td>
<td>8.6</td>
</tr>
<tr>
<td>5) Lip, oral cavity &amp; Oropharynx</td>
<td>7.3</td>
<td>7.3</td>
</tr>
<tr>
<td>6) Urinary bladder</td>
<td>6.7</td>
<td>6.7</td>
</tr>
<tr>
<td>7) Nasopharynx</td>
<td>4.9</td>
<td>4.9</td>
</tr>
<tr>
<td>8) Bones</td>
<td>3.7</td>
<td>3.7</td>
</tr>
<tr>
<td>9) Leukamias</td>
<td>3.2</td>
<td>3.2</td>
</tr>
<tr>
<td>10) Central nervous system</td>
<td>2.5</td>
<td>2.5</td>
</tr>
</tbody>
</table>

We note from the above data for male patients the following:

1. The commonest tumor between the ages 20-40 years is testicular tumors.
2. Leukamias and CNS tumors are the commonest in children.
3. Cancer of the lung predominates above 40 years of age.
(4) Unexpectedly there is a much higher incidence of lymphomas in Libya compared with Europe and U.S.A.

(5) Cancer of Prostate predominates in late years as expected.

(6) Nasopharyngeal Carcinoma is fairly common for both males and females.

Furthermore we note for female patients the following:

(1) Breast cancer is the most frequent, ranking No. 1.

(2) Uterine cervix is following in second place.

(3) Lymphomas have high incidence in females similar to males.

(4) The incidence of lung cancer is very low in females, while it ranks No. 1 in males.

Figure (1) shows the age distributions of all cancer cases treated from 1973-1983, which in fact is not much different from other populations.

FIG. 1. Age distribution of cancer cases treated from 1973 to 1983.
The future developments:

As to the future development of radiotherapy services in Libya, a new Radiotherapy Department was planned for Tripoli New Central Hospital, which is a 1450 beds teaching hospital adjoining the Faculty of Medicine, Al'Fateh University, taking into consideration the future needs of the Libyan population for radiotherapy services as well as the modern trends in cancer treatment. The major treatment units and equipment ordered for the Department are listed in Table (4); in addition to this equipment, there is available CAT, NMR and Radioisotope Scanning in Radiology and Nuclear Medicine Departments.

### Table (4)

List of Major Units & Equipments ordered for the Radiotherapy Department, New Tripoli Central Hospital

<table>
<thead>
<tr>
<th>S1.No.</th>
<th>Unit</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20 MV Mevatron Linear Accelerator</td>
<td>Siemens</td>
</tr>
<tr>
<td>2</td>
<td>6 MV Mevatron Linear Accelerator</td>
<td>Siemens</td>
</tr>
<tr>
<td>3</td>
<td>Co-60 Unit 222 TBq (6000 Ci)</td>
<td>Theratron</td>
</tr>
<tr>
<td>4</td>
<td>250/300 KV X-ray Unit</td>
<td>Siemens</td>
</tr>
<tr>
<td>5</td>
<td>Afterloading 6 channels</td>
<td>Selectron</td>
</tr>
<tr>
<td>6</td>
<td>Intersitial Microselectron</td>
<td>Selectron</td>
</tr>
<tr>
<td>7</td>
<td>Localizer/Simulator</td>
<td>Siemens</td>
</tr>
<tr>
<td>8</td>
<td>Dose Planning Simulator</td>
<td>Siemens</td>
</tr>
<tr>
<td>9</td>
<td>Mechanical and Electronic Workshop</td>
<td>Miscellaneous suppliers</td>
</tr>
<tr>
<td>10</td>
<td>Dosimetry Equipment - N.P.L.</td>
<td>Miscellaneous suppliers</td>
</tr>
<tr>
<td></td>
<td>Calibrated Dosimeter, Farmer, Phantoms, T.L.D. etc.</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Mould room equipment</td>
<td>Miscellaneous suppliers</td>
</tr>
</tbody>
</table>

Other supporting dosimetry services are made available to the Department from the Secondary Standard Dosimetry Laboratory S.S.D.L. which is affiliated to the WHO/IAEA S.S.D.L. Network. This laboratory is located at Tajoura Nuclear Research Center. There is very close co-operation between the S.S.D.L. and the Radiotherapy Department at present.

The major constraint to development of radiotherapy in Libya, similar to other developing countries (1) is the limited number of trained personnel working presently in the department (Table 5) and who shall certainly be required to run the new department adequately. As a solution to this problem, in immediate future, and specially during the commissioning of the unit, an IAEA Technical Co-operation Project is submitted for 1990, for the expert services, of Radiotherapist, Medical Physicist, Mould room Technician and Maintenance Engineer. A Medical Physicist and Electronics Engineer were awarded IAEA fellowships, others are pending consideration by host countries.
Table (5)

Number of Present Staff in Radiotherapy Department

<table>
<thead>
<tr>
<th></th>
<th>National Trained</th>
<th>Expatriate Under-training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiotherapist</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Medical Physicist</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Electronic Engineer</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Radiographer</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Careful planning is definitely needed to develop manpower capabilities in all fields of specializations related to radiotherapy now and in the future, if the department has to function satisfactorily and make use of all the facilities that are going to be available. Here international assistance from both IAEA and WHO is urgently needed, perhaps by initiating an Advisory Mission for this purpose.

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Constraints and Possible Solutions
LA RADIOTHERAPIE EN TUNISIE

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Abstract-Résumé

RADIOTHERAPY IN TUNISIA

More than 85% of cancer patients at the Salah Azaiz Institute are treated using radiotherapy. The number of patients treated by means of telecobalt and curietherapy has increased threefold from 1969 to 1988. Cancers of the ear, nose and throat are the most numerous (29.6%), followed by breast cancer (19.8%), cancer of the uterus (12.4%), of the lymphoma (9%) and of the bronchi (8.3%).

In order to deal with this situation in which radiotherapy is the main method of fighting cancer at the ISA, we have 40 hospital beds and equipment which includes two telecobalt units with a simulator, a radiophysics unit and curietherapy equipment.

This infrastructure has remained virtually unchanged since 1969. The age of the equipment, the shortage of technical staff and the lack of hospital beds and dosimetry equipment have contributed to the deterioration in the quality of care and have reduced the scope of radiotherapy.

This situation could be improved by projects for the provision of equipment and restructuring of the administration.

A National Carcinology Institute (Salah Azaiz Institute) was set up in Tunisia in 1969.

Following the first few years of work, this Institute was used by WHO as a regional reference centre for breast cancer and cervical cancer. So far, the objective has been to provide care to cancer patients, and it is reasonable that, after two decades of experience, the health policy of our country should include all aspects of cancer treatment from prevention to rehabilitation.

At each stage of this programme, radiotherapy will, as in the past, continue to occupy an important position.

This paper describes the radiotherapy situation (equipment, premises, personnel), the results of the radiotherapy service's activities, together with the problems encountered and solutions proposed.

LA RADIOTHERAPIE EN TUNISIE

Les cancers ORL sont les plus nombreux (29,6 %) suivis du sein (19,8 %) de l'utérus (12,4 %) des lymphomes (9 %) et des bronches (8,3 %).

Pour faire face à cette situation qui fait de la radiothérapie la principale arme anticancéreuse de l'ISA, nous disposons d'un service d'hospitalisation de 40 lits, d'un plateau technique comprenant 2 appareils de télécobalt avec simulateur, une unité de radiophysique et du matériel de curiethérapie.

Cette infrastructure est restée pratiquement inchangée depuis 1969. Le vétusté du matériel, le manque du personnel technique, l'insuffisance des lits d'hospitalisation et du matériel de dosimétrie ont contribué à la détérioration de la qualité des soins et ont réduit le champ d'action de la radiothérapie.

Cette situation pourra être améliorée par des projets d'équipement et de restructuration de l'administration.

La Tunisie a été dotée en 1969, d'un Institut National de Carcinologie (Institut Salah Azaiz : ISA).

Le travail des premières années a fait de cet Institut pour l'O.M.S. un centre de référence régional pour le cancer du sein et le cancer du col de l'utérus. Jusqu'à maintenant, l'objectif était d'assurer des soins aux cancéreux, et il est normal qu'après une expérience de deux décades, la politique de santé de notre pays doit inclure tous les aspects du cancer de la prévention à la réhabilitation du cancéreux.

A chaque étape de ce programme, la radiothérapie continuera comme dans le passé à occuper une place importante.

Dans ce travail nous allons présenter la situation de la radiothérapie (équipement, locaux, personnel ...) le bilan d'activité du service de radiothérapie, ainsi que les problèmes rencontrés et des solutions préconisées.

1. SITUATION A L'OUVERTURE DE L'ISA

1.1. Equipement

Le département de radiothérapie est composé de 3 unités :
- radiothérapie externe
- curiethérapie
- radiophysique
a) L'unité de radiothérapie externe est équipée de :
- 2 appareils de télécobalt (thératron 80)
- 1 appareil de radiothérapie conventionnelle (200 KV)
- un simulateur (thérasim)
- un système de repérage avec table de radiologie et 2 tubes de Rayons X montés sur une suspension plafonnière.

b) L'unité de curiethérapie se composait de :
- une salle d'application
- un stock de 200 mg de Radium en tubes et aiguilles.

Dès 1971, le Radium a été abandonné, au profit de l'Iridium 192 et du Césium 137.

c) L'unité de radiophysique comportait le matériel indispensable pour l'étalonnage des appareils et le contrôle de qualité des faisceaux.

1.2. Locaux d'hospitalisation
Il comportent 31 lits d'hospitalisation qui sont réservés aux malades irradiés par télécobalt, et 9 lits pour la curiethérapie repartis en 3 chambres blindées.

1.3. Personnel
Le personnel médical était composé de 3 radiothérapeutes formés dans des centres anticancéreux français.

Le personnel paramédical (manipulateurs de radiologie) a été également formé dans des centres français.

Chaque salle de traitement était doté de 2 techniciens.

Les salles de repérage et de simulation travaillent avec un seul technicien par salle.

La curiethérapie ne dispose pas de techniciens spécialisés et du personnel infirmier a été formé sur place pour accomplir les travaux nécessaires.

En radiophysique, un ingénieur a été formé et a bénéficié de quelques stages à l'étranger. Il était aidé de 2 techniciens de radiologie.

Ce personnel effectuait des dosimétries manuelles pour tous les malades, et s'occupait du contrôle de qualité des rayonnements utilisés.

Cette infrastructure s'est avérée suffisante pendant les premières années pour prendre en charge la totalité des malades qu'il fallait irradier.
2. PROBLEMES

Après la première période (1969 - 1974) qui a suivi l'ouverture de l'ISA et que l'on pourrait qualifier à postériori d'idéale, les problèmes se sont posés et la situation s'est dégradée. L'accroissement considérable des actes de radiothérapie s'est fait sans que l'infrastructure nécessaire à la prise en charge de ces malades évolue en conséquence. Cette situation a engendré :
+ une altération de la qualité du traitement
+ la limitation des actes de radiothérapie

2.1. Equipement

1) Radiothérapie externe

a) L'appareil de contactthérapie est en panne depuis plusieurs années et plusieurs malades relevant de cette technique ont été adressés à l'étranger. L'appareil de radiothérapie conventionnelle en panne depuis 1985 a été réformé.

b) Les appareils de Co\textsuperscript{60} et le simulateur ont entre 18 et 20 ans d'âge. Les pannes sont de ce fait de plus en plus fréquentes, et de plus en plus difficiles à réparer. Les accessoires nécessaires à l'irradiation (caches, lasers, ...) sont devenus soit très insuffisants soit en panne. Le vétusté du matériel a entraîné une détérioration de la précision de l'irradiation et l'adoption des techniques simples souvent mal adaptées au volume cible.

c) Un accélérateur linéaire acheté en 1986, est arrivé en Tunisie en Juin 88. Son installation a été continuellement reportée à cause du retard de la construction de ses bâtiments. Les conséquences sont néfastes :
- le délai de garantie est dépassé
- les programmes établis comme la greffe de moelle et la radiothérapie per opératoire sont tout simplement retardés ...

2) Curiethérapie

Un manque flagrant de matériel est noté :
- activimetre linéique
- compteur Geiger Muller pour détecter les débruits de fils radioactifs ou les fils perdus.
- insuffisance de mesures de protection
3) Unité de Radiophysique

2.2. Locaux
Le nombre de lits d'hospitalisation en radiothérapie est devenu très insuffisant car le nombre de malades habitant loin de Tunis et ne pouvant subir leur traitement à titre externe est en augmentation progressive. Il s'en est suivi un allongement des délais d'hospitalisation qui sont actuellement de l'ordre de 2 à 4 mois. Et il n'est pas rare que, la visée thérapeutique curative se transforme en palliative.

2.3. Personnel
Le personnel est devenu insuffisant du fait de la constitution de 2 équipes de travail.
La curiethérapie et l'unité de radiophysique ne comportent pas de techniciens spécialisés.

2.4. Fonctionnement
La gestion adoptée par l'administration centrale et les hôpitaux n'est pas adaptée aux besoins d'un service de pointe.
exemples =
+ Pénurie de matériel de première nécessité par défaut de commande ou compléxité des procédures administratives ...
+ Retard de construction des bâtiments de l'accélérateur alors que l'accélérateur est livré.
+ Local pour l'hospitalisation construit mais non fonctionnel ...
+ absence de maintenance préventive et de service de maintenance compétant ...
+ les 2/3 du budget commun à l'électroradiologie de 1989 (radio-diagnostic, Radiothérapie, médecine nucléaire) sont utilisés par le service de médecine nucléaire.
3. BILAN D'ACTIVITÉ ET RESULTATS THÉRAPEUTIQUES

3.1. La part de la radiothérapie dans le traitement du cancer à l'ISA a toujours été très importante puisque 85 % des malades traités sont justiciables d'une radiothérapie exclusive ou associée à d'autres thérapeutiques, radicale ou palliative. (Courbe 1)
De 1969 à 1985, 17 082 malades ont bénéficié d'une irradiation :
- 13 662 ont été traités par Cobalt 60
- 2 643 par radiothérapie conventionnelle
- 2 699 par curiethérapie
- 1 922 ont eu une association de 2 ou 3 méthodes d'irradiation.

**MALADES IRRADIES PAR RAPPORT AU NOMBRE DE CANCERS ENREGISTRES À L'ISA**

![Courbe 1]

Pendant ce temps, le nombre de malades traités par télécobalt est en voie d'augmentation continue allant de 400 en 1970 à 1 200 en 1985. Le nombre de malades traités par la curiethérapie a augmenté progressivement de 120 en 1970 à 233 en 1985. (Courbe 2)

3.2. Par localisation néoplasique, les cancers ORL sont les plus nombreux, et constituent près de 29,6 % des malades traités par télécobalt (1/3 de cancer du cavum, 1/3 de cancer du larynx...
et 1/3 de cancers divers). Les cancers ORL sont suivis du sein (19,8 %), l'utérus (essentiellement le col = 12,4 %), les lymphomes et les leucémies (9 %) et les bronches (8,3 %) (Courbe 3)

La curiethérapie s'adresse pour la moitié des cas aux cancers utérins et pour l'autre moitié aux carcinomes cutanés et de la cavité buccale. Plus intéressante est l'évolution de la fréquence de ces localisations puisque pendant cette période, nous avons observé (Courbe 4):

. Une légère régression des lymphomes liée au développement de la chimiothérapie exclusive.
. Une stabilisation depuis une dizaine d'année des cancers du col de l'utérus.
. Une augmentation régulière des cancers ORL et du sein.
. Un accroissement considérable des cancers bronchiques.

Actuellement, ils occupent la première place (plus de 200 cancers traités par Radiothérapie en 1988 sur un total de 509 diagnostiqués dans tous le pays).
REPARTITION DES MALADES TRAITÉS PAR Co60
EN FONCTION DES LOCALISATIONS

Courbe 3

EVOLUTION DU NOMBRE DES MALADES TRAITÉS
PAR LOCALISATION

Courbe 4
3.3. Résultats thérapeutiques
Malgré les difficultés rencontrées, les résultats thérapeutiques des cancers que nous traitons se rapprochent de ceux de la litté-
rature. Mais ceci ne doit pas cacher quelques réalités.(1 – 2)
1) Les résultats enregistrés concernent des malades bénéficiant d'un traitement complet et curatif.
2) 50 % de nos malades consultent à un stade tardif.
3) 25 % des irradiations ont une visée palliative (stades avancés, rendez vous d'hospitalisation long).
4) 30 % à 40 % des malades sont perdus de vue soit par refus de traitement soit avant le démarage du traitement, soit enfin au cours du traitement. Ce pourcentage est constant et interresse aussi bien les stades de début que les stades évolués.
5) 10 à 20 % des malades correctement traités sont perdus de vue après le traitement.
Cette situation est inhérente au fait =
   a) Absence d'une stratégie de lutte contre le cancer
      - défaut de médiatisation
      - absence de recyclage du personnel médical
      - pas d'enseignement modulaire de carcinologie aux écoles de santé.
      - aucun programme de prévention et de dépistage n'est adopté.
   b) Problème d'accueil et de prise en charge des patients cancéreux.
   c) Surbooking des services hospitaliers de l'ISA par les malades porteurs de maladies bénignes au détriment de la pathologie maligne.
   d) Conditions socio-économiques précaires de la majorité de nos malades et problème de prise en charge d'une catégorie de malades démunis.

4. SOLUTIONS PRÉCONISEES
La situation décrite requiert des solutions radicales.

4.1. A l'échelle de l'Institut
1) Satisfaire les besoins urgents du service de radiothérapie =
   - renouvellement des appareils
   - mise en marche de l'accélérateur linéaire
2) Créer une unité de maintenance formée d'un ou 2 personnels compétents pour les interventions rapides et appropriées.

4.2. A l'échelle du Ministère

1) Rénover le système de gestion du centre anticancéreux dans le sens de l'autonomie budgétaire des différents services.

2) Prise en charge par les différentes caisses de prévoyance sociale, les actes de radiothérapie à l'instar des examens de tomodensitométrie.

3) Nécessité d'établissement d'un programme de lutte contre le cancer (prévention, formation, sensibilisation ...).(3)

4) Nécessité de prise de mesures sociales en faveur des cancéreux (gratuité du transport ...).(3)

4.3. A l'échelle Internationale

- Nécessité d'établir une collaboration étroite entre le service de Radiothérapie et les organismes internationaux (OMS et AIEA).

- Profit de technologie avancée.

- Formation du personnel médical et technique.

- Participation aux manifestations internationales organisées par l'OMS et l'AIEA.

- Assistance de l'AIEA et de l'OMS pour la création et l'installation d'un SSLD à Tunis.

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CANCER CONTROL IN LESS DEVELOPED COUNTRIES

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Abstract

This invited lecture covers the wide and varied problems with cancer control in the less developed countries. The incidence of cancer and the causative factors in these regions are examined.

The author described various ways of overcoming these problems.

At last the words of wisdom have prevailed and human Rights are gaining grounds against the arms-race. We should be hopeful and supportive of these human-trends.

It is hoped that more resources would be directed from mass destruction arsenals to the well-fare of the human race.

A new world economic order is highly needed and we should work hard to achieve it. The North South dialogue has to continue.

Recent demographic U.N. reports quoted by Hanson in Nairobi Sept. 89 [table 1] indicates that 78-82% of the world population years 1990-2020 respectively occur in the LDCs.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>WORLD POP./MIL</th>
<th>MORE DEV.</th>
<th>LESS DEV.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NO.</td>
<td>%</td>
</tr>
<tr>
<td>1970</td>
<td>3,683</td>
<td>1,047</td>
<td>2,636</td>
</tr>
<tr>
<td>1980</td>
<td>4,453</td>
<td>1,136</td>
<td>3,317</td>
</tr>
<tr>
<td>1990</td>
<td>5,248</td>
<td>1,209</td>
<td>4,040</td>
</tr>
<tr>
<td>2000</td>
<td>6,127</td>
<td>1,276</td>
<td>4,851</td>
</tr>
<tr>
<td>2010</td>
<td>6,995</td>
<td>1,331</td>
<td>5,664</td>
</tr>
<tr>
<td>2020</td>
<td>7,806</td>
<td>1,377</td>
<td>6,429</td>
</tr>
</tbody>
</table>

Furthermore, 3.6 million new cancer patients are expected annually in those countries, Table (2).
# Cancer is of a low Health priority.
# Low Socio-economic standard:
- High rate of illiteracy and low state of awareness of the cancer problem.
- Inadequate health resources and absence of a cancer control policy.
- Unsecure and high cost of maintenance of Medical and Radiation Oncology equipments.
- Inadequate numbers of trained man-power.
- Poor patient-referral, follow up & Health Registration Systems

In the absence of adequate health resources to deal with such a health challenge, the human sufferings can not be estimated, imagined or overlooked. The problem is imposing and difficult but not impossible to solve.

Thus, a call for mobilization of health resources and cooperation between International, Regional, Governmental, Non-governmental, Scientific Forae and International Organization for Cancer Control in the less Developed Countries is imperative.

The International Working Party for CCU in the less Developed Countries (IWP) has been the first Non-governmental Organization to draw the attention to the problems of Cancer Control of the LDCs.

The IWP sponsored by IAEA and WHO, convened biannually for 9 times in less developed countries has addressed itself to many problems of cancer control in the LDCs.

During its meeting in Cairo in 1978 the basic concept of Early Diagnosis and treatment of CCU which formulated the basic philosophy of the Egypt/IAEA/WHO, Pilot project of Brachytherapy for Early Management of Cancer Cervix Uteri in the Less Developed Countries was developed.

Since the LDCs share common features of under-development, eventually they will almost have the same problems of cancer control.

In an attempt to introduce a slogan for the problems of cancer control in the LDCs, the four Us. (4, Us) slogan is suggested.

<table>
<thead>
<tr>
<th>TABLE (3): CANCER PROBLEM IN THE LDCs (THE FOUR Us. SLOGAN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Unawareness of the Cancer problem.</td>
</tr>
<tr>
<td>- Unpreparedness (No Health Policies).</td>
</tr>
<tr>
<td>- Unknown information about cancer.</td>
</tr>
<tr>
<td>- Unavailable Health Resources.</td>
</tr>
</tbody>
</table>
Various reports from WHO and UICC indicates that the cancer incidence in the 3rd world is increasing without concomitant appropriate development of management facilities as, cancer is not yet among the high health priorities in the LDCs.

In a recent study of cancer incidence in Africa and the Mideast, an estimate of 250,000 new cases are expected annually in each region respectively. An incidence of 70/100,000 (Table 4). Racoveanu, WHO, 1984.

**TABLE (4)**

CANCER INCIDENCE IN THE 3rd WORLD COUNTRIES
(Extrapolated figures)

<table>
<thead>
<tr>
<th>AREA</th>
<th>AV/INC#</th>
<th>POP.MIL.</th>
<th>EXPECTED NO. CASES/Y.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>70</td>
<td>360</td>
<td>250,000</td>
</tr>
<tr>
<td>Mid-East</td>
<td>100</td>
<td>250</td>
<td>250,000</td>
</tr>
<tr>
<td>Latin Am.</td>
<td>150</td>
<td>350</td>
<td>500,000</td>
</tr>
<tr>
<td>Asia</td>
<td>120</td>
<td>2,000</td>
<td>2,400,000</td>
</tr>
<tr>
<td>Pacific</td>
<td>100</td>
<td>200</td>
<td>200,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>115</strong></td>
<td><strong>2,160</strong></td>
<td><strong>3,600,000</strong></td>
</tr>
</tbody>
</table>

# : incidence/100,000.

In a recent study of cancer incidence in Egypt, it was found that the incidence is about 180-125/100,000 Sherif, 1989. Other lower figures were also given.

There are reasons for this discrepancy in the incidence figures:
- **First**: The inefficient Health Registration system
- **Second**: Many cases are registered in more than one center.
- **Third**: Mortality information has been deficient.

Although epidemiological data of cancer incidence in the LDCs are lacking yet, there are strong evidence to support that cancer incidence is on the increase.

**TABLE (5):**

CAUSES OF INCREASE IN CANCER INCIDENCE IN LDCs

- More control of Communicable Diseases has been achieved in the 3rd World countries in the last 2 decades.
- Increased risks of environmental pollution.
- Slow but perpetual development of Health Services (improved detection capability).
- Improvement of methods of diagnosis of cancer.
At the fall of this century, the developing countries shall meet two major health challenges:
- Environmental pollution and the consequent perpetual increase in cancer incidence.
- The population explosion.

Therefore, Cancer Control Health Policies have to be immediately thought of and formulated.

Needless to mention that International, Bilateral and Multilateral as well as, Regional cooperation and technical assistance from the UN Organizations and other sources are available and are to be requested.

The greatest challenge in most of the LDCs is how to formulate a health policy in the absence of adequate health information data.

Obviously, since adequate health information is the only means of providing data about cancer incidence, Health Registration system has to be given immediate and a high priority for implementation in the LDCs.

There are two approaches to the development of Health Registration Systems: The first approach is to establish a National Health Registry. The second approach is to start departmental registries which grows-up into a Hospital Registry (HR) and then such Hospital Registries grows later into a National Health Registry i.e. (build the system from the periphery to the center). The Medical Educational System ought to take Health Information into its syllabus formulation.

Starting small and growing big seems to be the appropriate approach as it allows building up the human resources and the necessary infrastructure.

In the Egyptian BRTH/IAEA/WHO project cancer Registry is based upon the establishment of a Departmental Registry (DR) in the 17 affiliated hospitals of the project; connected with a central registry in the Reference Center (NEMROCK).

Such a small sized registry will act as a nucleus for health information and would act as a good example to be followed in other hospitals.

Furthermore, the provision of the Secondary Health Care level (district hospital) with Cytodiagnosis and Brachytherapy facilities are in fact, advancing and providing the diagnosis and treatment as near as possible to the patient.

In Africa and the Third world countries an estimate of 3.8 million new cases of cancer every year is challenging the limited capabilities of their Health Care Systems and resources which should build up and tailor a system of cancer control.
Cancer control is achievable through various health and social activities.

**TABLE (6): DIFFERENT CANCER CONTROL SERVICES**

| # Radiotherapy service or department (RTH). | # Cancer Unit (CU) in a General Hospital. |
| # Comprehensive cancer center (CCC) in a University or a Teaching hospital. | # Cancer hospital (CH). |
| # Cancer research unit (CRU) | # Cancer research institute (CRI). |

The various types and components of cancer control services are given in table (7).

**TABLE (7) THE DIFFERENT STRUCTURAL COMPONENTS OF CANCER CONTROL SERVICES**

<table>
<thead>
<tr>
<th>TYPE OF SERVICE</th>
<th>Rth Ser</th>
<th>C/Uni</th>
<th>CCC</th>
<th>CH</th>
<th>CRU</th>
<th>CRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hos. Outpatient</td>
<td>--</td>
<td>DOH</td>
<td>X</td>
<td>X</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Dept. O/P</td>
<td>X</td>
<td>--</td>
<td>X</td>
<td>X</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Tu. Clinic.</td>
<td>--</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Cancer Reg.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Hosp Beds</td>
<td>&amp;DOH</td>
<td>DOH</td>
<td>X</td>
<td>X</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Surg. &amp; Med.Serv.</td>
<td>DOH</td>
<td>DOH</td>
<td>X</td>
<td>X</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Rth Dept.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Med. Oncology</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Diag. Services</td>
<td>DOH</td>
<td>DOH</td>
<td>DOH</td>
<td>X</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Rehabilitation</td>
<td>DOH</td>
<td>DOH</td>
<td>DOH</td>
<td>X</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Education</td>
<td>--</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Training.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Pain Clinic.</td>
<td>DOH</td>
<td>DOH</td>
<td>X</td>
<td>X</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Hospices</td>
<td>--</td>
<td>--</td>
<td>X</td>
<td>X</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>R. &amp; D.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>--</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

-- : not available.  
X : available.  
C/Unit: Cancer Unit.  
CCC: Comprehensive Cancer Unit.  
CH: Cancer Hospital.  
DOH: Dependent on the hospital  
CRU: Cancer Research Unit.  
CRI: Cancer Research Institute.
The relationship between the low socio-economic status of these countries and the present appalling situation of the management capabilities of cancer, is quite evident and alarming. Subsequently, two factors are identifiable; a low level of awareness of the cancer problem as well as, the lack of health resources.

The problem of initiating, stimulating and increasing the awareness about the cancer problem in the LDCs is axial in nature. However, awareness of the public in the LDCs does not play an effective role and on the contrary may stirr-up a state of cancer Phobia among the people.

On the other hand, awareness of Health Teams and the Academia may be effective in establishing a type of scientific pressure on Health Administration of the country which eventually may succeed in initiating the formulation
of a cancer policy and/or avail Health Resources for cancer control.

There are different ways of stimulating the awareness of the Health Team:

**TABLE (10): METHODS OF STIMULATION OF AWARENESS AGAINST CANCER AMONG HEALTH TEAM**

- Establish a Combined Tumor Clinic and a Departmental Cancer Registry in every hospital.
- Assure the continuous flow of cancer health information to all levels of the health team.
- Encourage, assist, finance local symposia on cancer.
- Establish continuous education and training in cancer.
- Assist and ensure the attendance of physicians and nurses conferences on cancer.
- Establish national and regional Anticancer Campaign and start linkage with International activities.

The formulation of a Tumor Clinic is an axial step in the promotion of awareness about cancer control in any small or large hospital and among health teams.

**TABLE (11) FORMULATION OF A TUMOR CLINIC IN A HOSPITAL**

- Identify increased Medical personnel.
- Fix a regular time table.
- New and follow up patients are seen.
- Start a departmental cancer registry.
- Release and circulate regular reports about the activity of the Tu. Cl. to the staff of the hospital.

A Surgeon, an Internist, a Pathologist, a Radiotherapist (when available and a medical record officer are the minimum staff required to establish a Tu. Clinic. Other Medical Specialists are called according to necessity.

Inspite that the establishment of the Tumor Clinic and the Cancer Dept. Registry are the mile-stones of cancer control yet, the provision of management facilities is imperative, especially those of Radiation Oncology, Medical Oncology and Pain Control services.

The present status of Radiotherapy in Africa (51 countries) table (12) is appalling. Five countries have fully equipped facilities of Radiation Oncology Centers with capabilities of training and education. Six countries have equipped facilities and 5 countries have radiation facilities which need up-grading. Unfortunately no information exists about the status of Rad. Oncology in the remaining 35 countries.
TABLE (12)
PRESENT STATUS OF RADIATION ONCOLOGY

<table>
<thead>
<tr>
<th>STATUS</th>
<th>COUNTRY</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fully Equipped + Training</td>
<td>Egypt, Tunisia</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Algeria, Morocco</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S. Africa.</td>
<td>5</td>
</tr>
<tr>
<td>Equipped</td>
<td>Libya, Sudan</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quinia, Nigeria</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tanzania, Cameroon</td>
<td>6</td>
</tr>
<tr>
<td>Up-grading req.</td>
<td>Ethiopia, Senegal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zimbabwe, Mozambique</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Madagascar</td>
<td></td>
</tr>
<tr>
<td>Data unavailable</td>
<td></td>
<td>35</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>51</td>
</tr>
</tbody>
</table>

The challenge posed by the lack of health resources and the perpetual increase of new cancer cases of (mostly clinically advanced) invites for a non-orthodox solution.

Consideration has to be given to the cost estimate of establishing a radiotherapy service which is capable of dealing with 2000 new cases/year which ranges between 3.205-1.940 Millions $, table (13).

TABLE (13)
COST ESTIMATE OF A RADIOTHERAPY SERVICE (2000 CASES/YEAR) 1988 PRICES

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>NO</th>
<th>PRICE/K$ Standard</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co60 Teleth.</td>
<td>1</td>
<td>400-</td>
<td>250</td>
</tr>
<tr>
<td>Source exchange/Y</td>
<td></td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Simulator</td>
<td>1</td>
<td>400-</td>
<td>200</td>
</tr>
<tr>
<td>Mould Room</td>
<td>1</td>
<td></td>
<td>35</td>
</tr>
<tr>
<td>Automatic Planing syst.#</td>
<td></td>
<td>450</td>
<td>---</td>
</tr>
<tr>
<td>Brachytherapy:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M LD AL</td>
<td>1</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>A HD AL</td>
<td>1</td>
<td>500</td>
<td>---</td>
</tr>
<tr>
<td>Radiation physics Lab.</td>
<td></td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Dept. Registry</td>
<td></td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Building Cost 480 m²*</td>
<td></td>
<td>1,300</td>
<td>1,300</td>
</tr>
<tr>
<td>(Land price not inclusive)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>3,205-</td>
<td>1,940 K$.</td>
</tr>
</tbody>
</table>

# : Include fixed cost estimates of a standard and a low cost estimate, no including running costs.
K$: 1000 $.
* : Air conditioning included.
M L DR AL: Low Dose Rate Afterloading.
A H DR AL: Automatic High Dose Rate Afterloading.
A comparative cost study of the treatment of cancer cervix uteri shows that the cheapest palliative treatment is Radiotherapy (44–125 $) Table (14).

**TABLE (14)**
COMPARATIVE COST STUDY OF TREATMENT OF CARCINOMA CERVIX UTERI

<table>
<thead>
<tr>
<th>MODALITY</th>
<th>RELATIVE COST/PA.T**</th>
</tr>
</thead>
<tbody>
<tr>
<td>CL. Stage.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CIS and Ia. Ia, II,</td>
</tr>
<tr>
<td></td>
<td>Radial</td>
</tr>
<tr>
<td>BRTH</td>
<td>44.0</td>
</tr>
<tr>
<td>ORTHO</td>
<td>133.0</td>
</tr>
<tr>
<td>Co60</td>
<td>197.0</td>
</tr>
<tr>
<td>L.A. &gt; 10 MEV</td>
<td>470.0</td>
</tr>
<tr>
<td>L.A. &lt; 10 MEV</td>
<td>864.5</td>
</tr>
<tr>
<td>CHT. 6 Courses</td>
<td>-----</td>
</tr>
</tbody>
</table>

* : Adapted from N.T. Recoveanu. IEAE-SM-290/79.

** : Includes fixed and running costs except for CHT. fixed costs only. 1983 prices in US $.

Moreover, a rough estimate for the needed health resources to cope with the present level of cancer incidence in the LDCs (3.8 millions/Y) is a total of 1800 RTH Depts., the approximate total cost of which shall be: 1800 units X 3.2 mill. $= 5.7–3.2 Millions of $. (The price of one Ballistic Missile). This estimate does not include the cost of development of necessary human resources as well as the running expenses.

**TABLE (15):**
HUMAN RESOURCES NEEDS FOR RADIOTHERAPY IN LDCs

<table>
<thead>
<tr>
<th>TYPE</th>
<th>NO/UNIT</th>
<th>TOTAL/1800</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiotherapists</td>
<td>5</td>
<td>9000</td>
</tr>
<tr>
<td>Physicists</td>
<td>2</td>
<td>3600</td>
</tr>
<tr>
<td>Engineers</td>
<td>2</td>
<td>3600</td>
</tr>
<tr>
<td>Cancer Registry</td>
<td>2</td>
<td>3600</td>
</tr>
<tr>
<td>Radiotherapy technicians</td>
<td>7</td>
<td>12600</td>
</tr>
</tbody>
</table>
### TABLE (16):
**DECISION VARIABLES OF CANCER CONTROL POLICY FORMULATION**

- The social & political impact of the unmanaged cancer cases
- Cost equipment and spare parts as well as Technology sophistication and maintenance problems (cost and manpower)
- Paucity of Health resources and poor developmental infrastructure and absence of Cancer Control Policy.

The suggested solution should be based on the following philosophy:

### TABLE (17):
**PHILOSOPHY FOR CANCER CONTROL IN THE LDCs**

- Maximization of the use of the available health resources at the national, regional and international levels.
- Early detection and diagnosis of cases.
- Involvement of the Primary Health Care level teams in cancer registration.

The strategies evolving:

### TABLE (18)
**A PROPOSED CANCER CONTROL STRATEGY FOR THE LDCs**

- Detect as much as possible of early cases and precancerous conditions. Treatment of which is very highly cost effective.
- Provide palliative measures for the late cases at the primary H.C.L. (Pain relieving measures, referral to Radiotherapy when available and or apply BRTH).

- Provide palliation by radiotherapy cheaper than chemotherapy and more cost effective (Table 14).

- Start Departmental Cancer Registries and Tumor Clinics in secondary and tertiary H.C.L.

- Start Human Resources Training and Education in Radiotherapy, Radn. Physics and Chemotherapy.

- Utilize available International and Interregional cooperation opportunities are highly recommended.
ROLE OF INTERNATIONAL ORGANIZATIONS IN MANPOWER DEVELOPMENT IN RADIOTHERAPY

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Geneva

M. NOFAL
International Atomic Energy Agency,
Vienna

Abstract

The authors described the roles of the IAEA and WHO in supporting radiotherapy in the developing countries through various research and fellowship programmes, organization of training courses, seminars, symposia and publication of the proceedings of such meetings are described.

Introduction

The IAEA was established in 1957 as an autonomous member of the United Nations family, with one of its mandates being to "seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world". Since its establishment in 1948, the World Health Organization, an autonomous "specialized agency" within the United Nations, as set forth in its Constitution has been fulfilling its mandate as "the directing and coordinating authority on international health work".

Both of these roles are being met, in part, by the growing involvement of the IAEA in collaboration with WHO in the field of radiotherapy for patients with cancer. These activities of IAEA and WHO are tailored to the needs and wishes of individual countries. Through these activities the indigenous capabilities of their Member States in radiotherapy are being strengthened, with the aim of an overall improvement in the management of cancer patients, both for curative and palliative treatment.

The development of the national manpower and expertise is one of the key elements for transferring the radiotherapeutic technology that has been mastered in numerous parts of the world during the past eighty years. For this manpower
development the following mechanisms are used by IAEA and WHO: Technical cooperation projects, Coordinated research programmes, Fellowships, Training programmes and short courses, Symposia, Seminars and Publications.

**Technical cooperation projects**

Through technical cooperation projects, IAEA and WHO have helped to establish or upgrade radiotherapy facilities in many developing countries through the provision of experts such as radiotherapists and medical physicists and in some cases the provision of modern equipment for teletherapy and brachytherapy. The experts visit institutions that are carrying out the technical cooperation projects in order to train, advise and/or assist national scientists or professionals to conduct the work in a specific area in radiotherapy. IAEA radiotherapy projects often include significant resources for the purchase of equipment such as a treatment unit, brachytherapy equipment, radiation sources, and dosimeters. Although on occasion WHO has provided equipment and radiation sources, due to the emphasis on primary health care, its technical cooperation activity in radiotherapy tends to be limited to the provision of consultants.

**Coordinated research programmes**

Research activities are encouraged by the IAEA under its coordinated research programmes. Specific scientific topics for research are suggested by the Agency and different research institutes are invited to work together on integrated research to achieve the aims of this programme. The research programmes are mainly oriented towards areas of relevance to developing countries, either by developing a new application or more commonly by adapting available techniques to local problems. Participating institutions from the developing countries are provided with grants administered through the award of research contracts. They provide modest financial support for a project on a cost-sharing basis which is usually used for the purchase of small items of equipment and supplies. Coordinated research programmes usually run for a period of three to five years.
Fellowships

IAEA fellowships are awarded to enable the developing countries to train qualified indigenous personnel from a few months to a few years in the relevant areas of radiotherapy, medical physics, and equipment maintenance engineering, thereby strengthening the indigenous capabilities in these areas.

Additionally, IAEA supports scientific visits over a short period to enable senior radiotherapists and medical physicists from developing countries to visit other institutions for learning special techniques or updating their knowledge on recent developments in their area of specialization.

WHO, which has a decentralized organizational structure, also provides fellowships, and a limited amount of support for upgrading of facilities and equipment, through its established channels, with the priorities being established at the local level through consultation between the Ministry of Health and the WHO representative in the country. Because the priorities for primary health care, communicable disease control and environmental sanitation are very high, careful scrutiny and lower priority is usually given to requests for fellowships for medical care, including radiotherapy.

Training courses and training programmes

Short training courses are organized in various developed and developing countries based on national or regional needs. Usually about twenty participants attend, depending on the available facilities at the host institution. These courses are usually held jointly with WHO. On a wider scale, training is provided through arrangements with the more developed countries, whereby IAEA fellows are trained in a speciality based on their needs. Since 1983, IAEA/WHO have supported a project in Egypt on brachytherapy of cancer of the cervix using manual after-loading techniques, in which an annual training is offered. Trainees from other African countries have attended some of the courses.
WHO in recent years has concentrated on establishing training programmes for radiotherapists in the developing countries themselves. In 1986, a course was started in Colombo, Sri Lanka, for radiotherapists, and another course is scheduled to start in Harare, Zimbabwe in 1990. IAEA is joining forces with WHO in the Harare course in order to provide training for medical radiation physics supporting staff and dosimetrists. The objectives of these courses are to make the host countries self-sufficient plus to serve as a centre of excellence for the future training of doctors and scientific supporting staff from neighbouring countries. In addition, IAEA and WHO plan to collaborate with the Ministry of Health and the Ministry of Cooperation of France to establish a similar training programme to serve the French-speaking countries of Africa.

**Symposia, seminars, and workshops**

The IAEA in cooperation with WHO regularly organizes symposia, seminars and workshops on various aspects of radiotherapy. These have proved very useful to participants from the developing countries. A decision on what areas or topics for symposia or seminars is sometimes based on the suggestions from consultants and specialists selected from various institutions in Member States, or from ideas obtained from different scientific conferences in the field. In addition, each year, both organizations convene several smaller meetings to examine particular topics and to plan future programmes or review results achieved in a particular area.

**Publications**

Another major area of activity is in publications. Research findings, proceedings of symposia, seminars, training courses, and other various educational activities are published in order to disseminate the information.
Discussion

A considerable international effort has been made to prepare the scientific, and technical staff that is so urgently needed in the developing world. Yet, the unmet need is enormous. Despite considerable achievements in the transfer of technology, there are pitfalls and obstacles to be overcome.

Manpower development through training in advanced countries is relatively expensive and the level of training provided may not always be entirely suitable for trainees from the developing countries where the problems and equipment are usually different from those encountered during their training. Communications and other difficulties sometimes make it hard for the trainee to adapt to the conditions in the developed country. Those who adapt are in danger of not returning home after their training. These drawbacks may be overcome by the establishment of regional centres of excellence where local specialists can be trained in order to cope with their specific problems. The concept of regional training programmes organized by the IAEA/WHO is therefore a promising step in the right direction.
INTERREGIONAL TRAINING OF RADIOTHERAPISTS IN ZIMBABWE AS PART OF THE PRIORITIES AND STRATEGIES FOR CANCER CONTROL IN AFRICA

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Geneva

Abstract

More than half of the world's seven million cancer patients are in the developing countries. Most are incurable at time of diagnosis. Therapy efforts in those countries should be linked with the search for earlier referral and effective palliative care. There is a lack of about 4,000 radiotherapists, twice as many radiation technicians and over 1500 teletherapy machines in the developing countries. WHO has therefore initiated in close collaboration with national governments, post-graduate schools, and some external donors, the establishment of national and regional training courses in radiotherapy and oncology in Sri Lanka and Zimbabwe. While it is stressed that the Syllabus should be relevant to the countries' cancer control situation, there should be no compromise on the quality.

The paper describes the organization and logistics for the support of two such training programmes in Sri Lanka and Zimbabwe for the training of radiotherapists who are likely to remain in the countries or region. It also stressed the need to determine the right priorities and strategies through well conceived national cancer control programmes.

Introduction

Nothing would have a greater impact on cancer throughout the world today than being able to put into effect the enormous knowledge we have gained in cancer control. This is the fundamental basis for WHO's Cancer Control Programme: as one-third of all cancers are preventable at least one-third of cancer patients can be cured provided the diagnosis is made early enough and provided adequate routine state-of-the-art therapies can be offered (1). For the great majority of incurable cancer patients relatively inexpensive but efficient methods exist for relieving their pain, controlling symptoms and improving their quality of life (2, 3).

The great majority of the world's cancer patients do not benefit from all this knowledge gained in cancer control. Contrary to what most people think cancer is a problem in Africa too. More than half of the world's cancer patients are in developing countries and most of these patients are incurable at time of diagnosis.
The size of the problem

There are about 7 million new cancer patients every year, and 5 million of them die of cancer. Half of these new patients are in developing countries. Two out of three cancer patients in developed countries die of their disease. In the developing countries the figure is much higher. Once an individual has survived the first five years, cancer is one of the three major killers in both developed and developing countries. In spite of all the resources spent on therapy in the industrialized countries, between 1960 and 1980 age-adjusted mortality for cancer increased (4, 5). The mortality pattern of developing countries is approaching that of industrialized countries. If existing trends continue, cancer mortality is expected to rise in the future in nearly all regions of the world. The major reasons are the increasing ageing of populations and the increasing use of tobacco. In other words, the problem of cancer is already today also a major one in developing countries. It will be even worse in the near future if we do not act now.

Priorities and strategies

Unless the right priorities and strategies are developed in a systematic way to gain maximum benefit from available resources (5), preferably through well conceived national cancer control programmes (6), there is unlikely to be much impact on cancer, especially in the less developed countries. Table 1 shows the priorities and strategies for the eight most common cancers worldwide. As can be seen, primary prevention should have much more emphasis than at present. So should also early diagnosis and palliative care.

<table>
<thead>
<tr>
<th>Tumour (1)</th>
<th>Primary Prevention</th>
<th>Early Diagnosis</th>
<th>Curative(3) Therapy</th>
<th>Pain Relief &amp; Palliative Care</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stomach</td>
<td>+(2)</td>
<td>-</td>
<td>-</td>
<td>++</td>
</tr>
<tr>
<td>Lung</td>
<td>++</td>
<td>-</td>
<td>-</td>
<td>++</td>
</tr>
<tr>
<td>Breast</td>
<td>-</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Colon/Rectum</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Cervix</td>
<td>+</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Mouth/pharynx</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Oesophagus</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>++</td>
</tr>
<tr>
<td>Liver</td>
<td>++</td>
<td>-</td>
<td>-</td>
<td>++</td>
</tr>
</tbody>
</table>

(1) Listed in order of the eight most common tumours globally;
(2) ++ = effective; + = partly effective; - = not effective;
(3) Curative for majority of cases with a realistic opportunity of finding them early.

Therapy has no major curative effect in four of the most common cancers globally. However, three of the eight most common cancers, breast, cervix and mouth cancer are eligible for curative therapy. In developing countries this does not occur, because most of these three common cancers are first seen when incurable and less than ten percent are seen at
specialized centres, if at all. Thus in Black Africa there are fewer than 75 full-time cancer specialists of any kind to serve over 285 million people. In Sri Lanka, there are 2 radiotherapists for 15 million people. In Indonesia, only about 33,000 cancer patients out of an estimated 170,000 new cancer patients every year are seen by a cancer doctor. Eighty six percent of breast cancer patients seen at a leading hospital in Djakarta are inoperable at time of diagnosis. Three-quarters of the world cervical cancer patients are in developing countries. Not in a single developing country has early detection through screening decreased mortality in cervical cancer, as demonstrated in many developed countries (7). All too often the limited resources of developing countries are spent on therapies only, which have a marginal effect when applied to an ocean of incurable patients. However, cancers of the breast, cervix and mouth can be cured if found early, using basic standard therapies.

Therefore it is vital that therapy efforts in developing countries are linked with the active search for earlier referral and diagnosis. For the three common cancers above, an early diagnosis leads to a much higher survival than any therapy applied in a late stage of disease, as is commonly done at present. The importance of earlier diagnosis and referral is pointed out in Table 2. The promotion of earlier referral and diagnosis should be the responsibility of every radiation oncologist and surgeon in developing countries.

TABLE 2. THE WHO CONCEPT OF DOWN-STAGING

Earlier referral, diagnosis and therapy of cancer of the breast, cervix and mouth has greater prognostic importance than any therapy effort, however sophisticated, applied at a late stage of disease.

<table>
<thead>
<tr>
<th>Stage of disease at diagnosis</th>
<th>In developed countries</th>
<th>In developing countries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent of 5 years survival patients</td>
<td>Percent patient</td>
</tr>
<tr>
<td>I-II</td>
<td>~80% → 80%</td>
<td>&lt;20%</td>
</tr>
<tr>
<td>III-IV</td>
<td>~20% → 20%</td>
<td>&gt;80%</td>
</tr>
</tbody>
</table>

Early diagnosis of oral cancer by primary health-care workers was shown to work in Sri Lanka (8, 9). However, the implementation of a nationwide early detection programme had to be delayed due to lack of radiotherapists to take care of found cases. Thus, before early detection programmes are activated there must be adequate therapy facilities to absorb found cases; and if established therapy facilities in developing countries should have any impact on mortality, they must be linked with the search for earlier referral and diagnosis of cancer patients.
TABLE 3. THE MOST COMMON CANCERS IN ZIMBABWE: PREVENTION AND MANAGEMENT

<table>
<thead>
<tr>
<th>SITE</th>
<th>PRIMARY PREVENTION</th>
<th>EARLY DETECTION</th>
<th>THERAPY</th>
<th>PAIN RELIEF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancer of Cervix</td>
<td>+</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Bladder</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Oesophagus</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>++</td>
</tr>
<tr>
<td>Breast</td>
<td>-</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Liver</td>
<td>++</td>
<td>-</td>
<td>-</td>
<td>++</td>
</tr>
<tr>
<td>Nasal Cavity &amp; Ear</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Skin</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Stomach</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>++</td>
</tr>
<tr>
<td>Small Intestine and Anus</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Trachea, Bronchus and Lung</td>
<td>++</td>
<td>-</td>
<td>-</td>
<td>++</td>
</tr>
</tbody>
</table>

++ = effective  
+ = partially effective  
- = not effective

Comments: Many cancer are preventable  
- early presentations/diagnosis important for successful therapy in several cancers  
- curative therapy in only three of the common cancers at present  
- nearly all cancer patients will need pain relief

Training of cancer specialists in the countries. WHO's efforts in Sri Lanka and Zimbabwe

It is estimated that there is a lack of about 3000 - 4000 radiotherapists, 5000 - 10000 radiotherapy technicians, 2000 - 3000 medical physicists and about 1400 - 1800 teletherapy machines in the developing countries (10, 11).

There is thus a need to establish facilities for the training of cancer specialists in the developing countries themselves. The reasons for establishing regional or national syllabuses and degrees are many. The "brain drain" is one. Many trained specialists are either not returning home or are leaving soon after their return. Such a situation is common.
It contributes to the continuous shortage of radiotherapists in many countries in Africa and South-East Asia. Another factor is that the common types of tumours and stages of disease the trainee sees during this training abroad are different from those he will have to treat upon his return home. A third factor is the equipment - as well as the whole environment of the hospital - which in industrialized countries has practically no or few limitations, compared to the situation our colleagues will have to face after returning home. Furthermore, patient characteristics and cultural attitudes are important considerations in promoting early diagnosis and referral, and ensuring patient compliance. The above factors justify that radiotherapists should be trained as closely as possible under the conditions in which they will work. From the purely clinical therapy aspects three points are important to consider conceptually when developing cancer facilities in developing countries.

1. It is mandatory that the giving of therapy is linked with the search for earlier referral and diagnosis.

2. Palliative therapy and care, including symptom control and pain relief, will for years to come be important, before points 1 and 3 will have taken effect.

3. Existing numbers of nurses and doctors are totally inadequate for dealing with the existing number of cancer patients, and the training of future cancer specialists at national or regional levels is a priority.

Many developing countries have nationals qualified in radiotherapy but only a few remain serving their own people. The majority remain abroad after training (e.g. this is the situation in Sri Lanka and Sudan). Zimbabwe is a country of 8 million people, with an adequate number of radiotherapy machines but not a single African radiotherapist to deal with the estimated 4,000 new cancer patients diagnosed each year.

At present all African doctors aspiring to become cancer specialists must leave their countries for training abroad. This training is often not relevant to the cancer situation in their own countries. WHO has therefore initiated, in close collaboration with the National Governments and external donors, national and regional training courses in radiotherapy and oncology in Sri Lanka and Zimbabwe (12, 13). While it was stressed that the syllabus should be relevant to the countries' cancer therapy and control situation, there would be no compromise on quality. The aim is to produce specialists who have excellent knowledge and technical competence, but who are aware of the local cancer problems and the limited resources available to combat them. The doctors would be expected to set the right priorities which, for the foreseeable future, must include the peripheral extension of adequate palliative care and pain control programmes towards the provincial and district hospitals, since the majority of patients live in the rural areas.

In 1984, the Government of Sri Lanka decided to develop postgraduate training in radiotherapy and oncology. In this way it was hoped to build up a cadre of specialists likely to remain in the country. WHO supported this training with WHO consultants in radiotherapy and oncology. A three-year training programme was developed, leading to the degree of M.D. (Radiotherapy and Oncology) of the postgraduate Institute of Medicine (PGIM), University of Colombo and to Board Certification for the status of Consultant in Radiotherapy and Oncology.
The first stage of the course consists of 12 months in-service training at the Cancer Hospital with lectures, followed by written and oral examinations. The second stage is 24 months of in-service training leading to an M.D. degree. This is followed by 12 months of study abroad, and then 12 months as assistant in Radiotherapy and Oncology in Sri Lanka. After dissertation, Board Certification for the status of Consultant in Radiotherapy and Oncology can be achieved. On the first batch of five students starting in 1986, 3 passed the first examination and 2 failed. At present 7 doctors are undergoing training and one has qualified as M.D. (Radiotherapy and Oncology). Three new students per year are expected and Government has earmarked at least nine future positions as Consultants in Radiotherapy and Oncology.

The course in Zimbabwe, financed by funds from the Swiss Government, will be run by three WHO consultants over four years in consultation with the Ministry of Health and the University's Postgraduate Medical School. Four Zimbabwean doctors and six doctors from other English-speaking African countries will be trained on the first course. Besides radiotherapy and chemotherapy of solid tumours, primary prevention, early referral and diagnosis, cancer pain relief and symptom management will be covered in the course.

The first part of the in-service course will last 15 months and consist of instructions in the basic sciences relevant to the practice of radiation oncology (medical physics, radiobiology, pathology and medical statistics), at the end of which candidates will sit the Part I examinations. A further 33 months will cover radiotherapeutics and clinical oncology. Candidates will then sit for the Part II examination leading to the M. Med (Rad.Onc.) postgraduate degree of the University of Zimbabwe. Continuous assessment and a final dissertation are included in the programme.

Adequate therapy facilities are available in Zimbabwe in the form of one linear accelerator (6MeV), two Co-60 and two 250Kv machines, strontium, Caesium brachytherapy applicators and two simulators. A teacher in radiation physics to train the radiation physicists as well as the doctors is promised from the International Atomic Energy Agency, Vienna. The programme will aim to interest and involve a wide section of the University academic and hospital staff and students, and promote joint clinics and multidisciplinary seminars. Twinning the programme with, and the support of teaching faculties and resources from developed countries, is encouraged and any assistance will be most welcome.

A sufficient number of doctors will be trained in the above two courses so that Sri Lanka and Zimbabwe should be self-sufficient in the numbers of radiotherapists during the 1990's. The ultimate goal will be to build up a critical mass of excellence and knowledge, locally, for the future training of cancer health workers who will be in the frontline of cancer health education, and assist in the establishment of national cancer control programmes. Zimbabwe could serve as a future centre for the training of African doctors, by African doctors, within the African environment, without the need for extensive and expensive training abroad. These home-bred specialists should collaborate with WHO, and other international agencies, in research and evaluation of the impact of current strategies on cancer statistics in developing countries, and assist in determining future directions.
Conclusion

The development of therapy facilities should not be done in isolation to other cancer control activities. The right priorities and strategies must be determined in a systematic way, preferably through well conceived national cancer control programmes. If this is not done, there is unlikely to be any impact on cancer, especially in the developing countries. However, even limited resources may have an effect on controlling cancer provided the right priorities and strategies are followed. National and regional training facilities with a suitably adapted syllabus in radiotherapy and oncology is a part of this.

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SPECIAL REQUIREMENTS IN THE TRAINING OF RADIATION ONCOLOGISTS FOR AFRICA

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Abstract

Cancer has gradually emerged as one of the leading causes of death in many developing countries, following the reduction through prevention in the incidence of several other communicable diseases. This worldwide increase in the incidence of cancer as reported by the WHO is more pronounced in the developing countries which sadly are those least equipped to deal with the management, due to several factors, among which are lack of the necessary manpower, equipment and funds. Clinical data have also shown that cancer patients in the developing countries usually present with late and advanced disease where only palliative treatment is all that can be offered.

There are in addition a myriad of other socio-cultural problems which are peculiar to cancer management in the developing countries and Africa in particular. It is thus obvious that a radiation oncologist who is expected to practice in Africa requires additional training to the formal training programme as currently provided in the developed countries.

This paper critically examines the various problem areas associated with cancer care with which a trainee radiation oncologist in Africa must be familiar. Suggestions are provided towards meeting these additional but essential requirements in the training of radiation oncologists for Africa.

1. INTRODUCTION

The continent of Africa probably constitutes the majority within the community of the so-called developing countries, where the incidence of cancer is on the increase and where available facilities and resources are inadequate to cope with its management. There are social, religious and many other factors which affect the management and overall prognosis of cancer in Africa. The clinical presentation of cancer as seen in Africa is different from what is seen in the developed countries.

Training of radiation oncologists should, however, follow the same basic approach and syllabus as in the developed countries with instructions in radiation physics, radiobiology, pathology of neoplastic disorders, statistics, treatment planning techniques, oncology, etc. The additional requirements are based on the peculiar problems in those regions. Therefore, in order to determine the additional training needs, we need to identify the special problems and offer solutions which should be included in the training of radiotherapists in the developing countries. I propose to enumerate the more common problems and peculiarities and suggest solutions that may be considered in the training programme.

2.1 Late Presentation of Patients

The majority of cancer patients seen present with late and advanced disease. A study of 3259 cancer patients in Nigeria showed that 92% present with late stage 3 or 4 disease (stage 1 = 2%, stage 2 = 6%, stage 3 = 62%, etc.)
stage 4 = 30%). In Europe and other developed countries, these cases are regarded as being too advanced and for which nothing more can be done. In Africa some attempts at adequate palliation are made, with good results in many cases, particularly for tumours in the head and neck region.

A trainee in radiation oncology must be mentally prepared to cope with the problem of late presentation, and take effective steps to encourage early presentation through public education campaigns and other means. The various causes of the delay before presentation are many and have been analysed in a separate publication [1]. All the same, it is worthy of note that part of the blame lies with our professional colleagues, particularly the general practitioners who will only refer the patients for specialist treatment when they have had their fill—both financially and professionally.

2.2 General Condition of the Cancer Patient

In close association with the problem of late presentation is the poor general condition of the patient. Anaemia, severe infections, malnutrition, and other medical conditions tend to mitigate against effective palliation. In Nigeria, many of the cancer patients present with large, fungating and severely infected tumours, particularly in the breast and head and neck regions. They constitute a nuisance to themselves, relations and neighbours from the malodour from their ulcerated lesions. It may not always be possible or affordable to obtain laboratory cultures or suitable antibiotics. In co-operation with colleagues from our microbiology and pharmacy departments, we developed a metronidazole-based paste which we used in a clinical trial for the management of these malodorous ulcers. The results, which are published, showed the benefit of this preparation [2, 3] which is now used routinely. We also preferred to debulk the tumour where possible by chemotherapy before radiation in suitable cases. The results have been good, although not necessarily prolonging survival [4]. Thus, the trainee radio-oncologist must be able to adapt his knowledge to cope with the general condition of his patient.

2.3 Pattern of Tumour Types Seen

Table 1 shows the frequency and the types of tumour seen in Nigeria. Carcinoma of the cervix and breast account for over 50% of all tumours seen. Others include primary liver cell carcinoma, Kaposi sarcoma and skin cancer (SCC) amongst the albinos. This pattern is obviously different from what obtains in other parts of the world like Europe, for example, where lung cancer is commonest. In my over ten years' practice of radiotherapy in Nigeria I have not treated up to ten cases of lung cancer whereas in England I treated an average of four patients a week. Conversely, I have treated more cases of Kaposi sarcoma which are more common in Africa than in Europe. Observations later supported by findings of a clinical study [5] have showed us that it is better to treat the nodular type of Kaposi initially by chemotherapy while reserving irradiation for the more resistant localized residual lesions. It is therefore important that the trainee radio-oncologist from Africa recognises this and other geographical variations in the incidence of cancer and pays more attention to the management of those cancers prevalent in his country. An effective means of achieving this is by the establishment of regional centres of excellence where radio-oncologists can be trained locally within the environment where they will practice and with which they are more familiar. This will also have the added advantages of providing cheaper training for more candidates, discourage the tendency towards "brain-drain" and avoid the series of socio-cultural and language barriers often associated with training in a foreign country.
<table>
<thead>
<tr>
<th>Tumour site</th>
<th>No. Male</th>
<th>No. Female</th>
<th>Total</th>
<th>% Male</th>
<th>% Female</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cervix carcinoma</td>
<td></td>
<td>857</td>
<td>857</td>
<td>0.5</td>
<td>23.7</td>
<td>26.3</td>
</tr>
<tr>
<td>Breast cancer</td>
<td>16</td>
<td>773</td>
<td>789</td>
<td></td>
<td></td>
<td>24.2</td>
</tr>
<tr>
<td>Head and neck cancer</td>
<td>196</td>
<td>326</td>
<td>522</td>
<td>6</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>Childhood malignancies</td>
<td>130</td>
<td>229</td>
<td>359</td>
<td>4</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Soft tissue sarcomas</td>
<td>65</td>
<td>98</td>
<td>163</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Malignant sarcomas</td>
<td>66</td>
<td>42</td>
<td>108</td>
<td>2</td>
<td>1.3</td>
<td>3.3</td>
</tr>
<tr>
<td>Colo-rectal cancer</td>
<td>65</td>
<td>42</td>
<td>107</td>
<td>2</td>
<td>1.3</td>
<td>3.3</td>
</tr>
<tr>
<td>Skin incl. melanomas</td>
<td>49</td>
<td>42</td>
<td>91</td>
<td>1.5</td>
<td>1.3</td>
<td>2.8</td>
</tr>
<tr>
<td>Leukaemia</td>
<td>23</td>
<td>16</td>
<td>39</td>
<td>0.7</td>
<td>0.5</td>
<td>1.2</td>
</tr>
<tr>
<td>Bone tumours</td>
<td>26</td>
<td>13</td>
<td>39</td>
<td>0.8</td>
<td>0.4</td>
<td>1.2</td>
</tr>
<tr>
<td>Undetermined origin</td>
<td>3</td>
<td>13</td>
<td>16</td>
<td>0.1</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Others</td>
<td>68</td>
<td>101</td>
<td>169</td>
<td>2.1</td>
<td>3.1</td>
<td>5.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>707</td>
<td>2552</td>
<td>3259</td>
<td>21.7</td>
<td>78.3</td>
<td>100</td>
</tr>
</tbody>
</table>

2.4 Adequate Diagnostic Facilities

Cancer management is more successful when done through a multi-disciplinary approach. However, in many parts of the developing countries, the radio-oncologist finds he may not get the required support from his medical colleagues and hospital administration, either because they are not available, or the required services could not be provided quickly enough. The oncologist usually finds he has to be able to take biopsies, interpret slides, and X-ray films, etc. It is essential during his training that these skills are well taught and emphasized. General pathology, including pathology of neoplastic disorders must be given prominence in his training. Basic surgical skills must be taught and where possible candidates with previous surgical training and experience should be given preference during selection for training as radio-oncologists.

2.5 Radiotherapy Equipment

The cobalt-60 machine is the most common teletherapy equipment in the developing countries. This is justifiably so.[6] Some superficial and orthovoltage X-ray machines are also still in use in some centres and are desirable. The basic engineering principles in the design, function,
installation, calibration requirements, dosimetry protection measures, and operation of these machines must be emphasized in the training programme. The radio-oncologist, as the head of the treatment team, must be fully conversant with all the aspects enumerated above for effective leadership, though he must learn to moderate his role, particularly where he is fortunate enough to have qualified staff (physicists, technologists) around him. His training should, however, endow him with the ability to fill in, wherever a gap exists which would otherwise disrupt the services.

The trainee should also where possible be aware of the existence and indications for use of the more sophisticated machines such as linear accelerators, cyclotrons, and other high-LET sources of radiation, and he should only be trained on them if there is the likelihood of his ever using them. Brachytherapy particularly for carcinoma of the cervix, breast, head and neck and other suitable areas must be taught and encouraged. The trainee must be conversant with all the various techniques currently available, but must choose and be proficient in at least one technique himself. The introduction of after-loading techniques has made brachytherapy less hazardous and the techniques must be taught to every trainee radio-oncologist in the developing countries.

The use of computers in treatment planning both for tele- and brachytherapy must also be included in the training programme. This would not only make planning easier, but ensures accurate dosimetry in the treatment plan. The cheaper cost of personal computers, and the availability of different suitable software programmes now make the introduction and use of computers in radiotherapy planning essential.[6]

2.6 Chemotherapy

I have previously mentioned the benefits of combining chemotherapy and radiotherapy as part of our management strategy in some cases. These drugs are toxic and also very expensive when available. The trainee radio-oncologist must be fully trained in all aspects of chemotherapy to enable him to effectively utilise these drugs and be able to assess the cost-benefit effectiveness. His training would enable him to know which drugs to use singly or in combination, and what reactions to expect. The training must include both theory and extensive clinical experience with the administration of the drugs, including the necessary precautions to be taken.

2.7 Patient Records and Statistics

Many developing countries do not have a properly organized national cancer registry. Most information and statistics obtained from them are from hospital-based records which in many cases are unreliable or incomplete. The trainee radio-oncologist must be aware of the need for establishing a cancer registry and his training must equip him for such a task preferably using modern technology including computers. Post-treatment follow-up of patients is sometimes impossible. Some patients live far away from the radiotherapy centre and cannot afford the cost of travelling back for a follow-up. Others just do not appreciate the need for a follow-up as long as they remain disease-free. Local solutions have to be adapted to deal with this problem wherever it arises and the trainee should be encouraged to suggest his own solutions to this problem.

2.8 Management of Complications and Recurrence

The training programme must emphasize ways and means of limiting or reducing the rate of complications or recurrence without necessarily compromising the quality of treatment. A good radio-oncologist gets the
confidence of his patient by warning him beforehand of the likely reactions, or complications from the treatment being given, and also by reassurance on the successful management of these complications if and when they do occur. This calls for tolerance and a good ability to communicate with the patient. A sound knowledge of the fundamental principles of radiotherapy will ensure the rate of complications and recurrence are within the acceptable limits.

2.9 Terminal Care

This is an important social problem in Africa and other developing countries. Relations, friends, and even the doctors looking after the cancer patients tend to abandon them when the end is near. This is probably out of frustration, or just being tired from looking after the patient for a long time. He is therefore abandoned at a time when he needed help most. In the developed countries, these patients are looked after in hospices or similar nursing homes. Such facilities do not exist in many developing countries. The trainee radio-oncologist must be made to appreciate the need to stand by his patient to the end. He should understudy the requirements for running a good hospice and explore the possibility of establishing one in his area of practice. He should be able to motivate people to come together and form societies or voluntary organizations that could help cancer patients particularly the poor and terminal cases.

2.10 Public Education Campaign Against Cancer

The trainee radio-oncologist must also receive adequate instructions in the preventive measures against cancer, and be aware of the ways and means of organizing effective public education campaigns against cancer. The voluntary organizations and societies can be very useful here but the oncologist must be in a position to motivate and give useful direction in such campaign programmes. He will in the long run appreciate that prevention is not only better, but also cheaper than a cure.

3. Conclusion

It is clear so far that with the peculiar situation in Africa and other developing countries, the radio-oncologist must be a Jack of all trades, and a master of all. His training must ensure he fully understands the basis and rudiments of radiotherapy. As the head of the cancer treatment team, he should be equipped by his training to perform most of the duties of the other members of the team where and when necessary. He should be able to do minor and sometimes major operations, fix and interpret slides, operate radiotherapy machines, set patients up for treatment, calculate doses manually or through use of computers, play the role of a nurse, social worker, etc. He must be trained to be a confident and responsible leader, a competent administrator, and social mixer able to deal with various types of people - like his professional colleagues, other paramedical staff, relations, and the Government. Finally, he must be a good teacher, able to impart his knowledge and experience to others, while he must remain a student willing to learn and improve himself and his skill always, in the ever-increasing frontiers of radiation oncology.

REFERENCES


PANEL 1
RADIOTherAPY EQUIPMENT FOR DEVELOPING COUNTRIES

The panel consisted of H. Svensson (IAEA) (Chairman); A.M. Mabrouk (Libya) (Co-chairman); M.M. Mahfouz (Egypt); H. Skeete (Zimbabwe); J. Luande (Tanzania); F. Durosimil-Etti (IAEA). Active participation from the other participants was encouraged, among whom were representatives of various equipment manufacturing companies including Theratronics (formerly AECL), Canada; Gallo, Italy; Philips, United Kingdom; Nucletron, Holland.

The issues listed for discussion were:

A. Type of equipment
   - Cobalt-60
   - Linear accelerator
   - Simulator
   - Dose planning system
   - Mould room facilities
   - Computer tomography
   - Brachytherapy

B. Maintenance
   - Personnel
   - Training facilities
   - Service contracts

C. Quality assurance programme

D. Conclusions

The cobalt is the most common teletherapy machine in the developing countries including Africa and therefore these aspects received more emphasis. The Chairman invited discussion on the cobalt, including servicing, maintenance and source replacement problems. He noted that the high cost of a cobalt machine is mostly due to cost of the radioactive source and its transportation. It may be possible to reduce this considerably by obtaining cobalt source from countries like the USSR. Standardization of such sources would assist in reducing the overall cost.

H.K. Awwad (Egypt) added that we should usually seek the opportunity of source replacement to do the overhauling of the machine. In cases where the supplier of the source is different from the manufacturer this may create a problem. However, we should be aware of this problem.

H. Svensson (IAEA) added that it is very important that when you are purchasing equipment you get the company to give a commitment about the repairs. It is always possible to get a lot of concessions from the companies during the negotiation for purchase.

K.A. Chamravi (Egypt) raised three problems as regards the cobalt machines. Firstly, the initial high price of the machine, and there are two proposals for that. Either we should in Africa depend on second-hand machines, or encourage the international manufacturers to start the industry in one of the countries where labour is cheaper, such as Egypt or India, thus producing cheaper machines. The second point is that we ask the manufacturers to standardize the technical specification of the sources, so that we can replace, say a cobalt source from Canada with one from France or Italy. The third point is on spare parts; he claimed that international law guarantees a
ten-year supply of spare parts, but cobalt machines usually work longer than ten years and often we can no longer get the spares. One example is in Cairo where the cobalt machine in the department at NEMROCK was taken off refurbished, and installed in another place after fifteen years and is still working. Thus he advised an extension of the guarantee of over ten years for spare parts supply.

M. Nofal (IAEA) observed that in M.M. Mahfouz's earlier paper on cancer control services, he cited different departments of cancer control including radiotherapy service, cancer unit in a general hospital, comprehensive cancer centre in a university or a teaching hospital, cancer hospital, cancer research unit, and cancer research institute. He wondered if the requirements for the machines will be different or whether we may use the same equipment for each of these.

In replying, M.M. Mahfouz said that the cobalt unit should be the same but when you discuss the need for a cobalt unit according to the workload, then the source size and type of machine would come into perspective in a sense that it is not economic to use an isocentric type of equipment with laborious electronic and electric devices in order to palliate a patient who needs one direct field or a pair of parallel opposing fields. It would be cheaper to use a simple machine. One should also define the workload and the percentage of types of patients to be treated before choosing the machine. In such cancer control services, there may be more than one cobalt machine. A linear accelerator may be added if the number of patients would allow. In some countries there are machines not being used to full capacity whereas there are others without any machines whatsoever. In others, you find machines either working or not but with workload higher than their capacity.

H. Skeete (Zimbabwe) drew attention to the fact that one cannot discuss radiotherapy in isolation. He runs a centre in Zimbabwe with a very expensive linear accelerator; however, the housing is inadequate. It was not built to specification, the roof is leaking and when it is raining he has to cover this expensive machine with a plastic sheet. He does not consider this situation good enough and wished some more concrete planning was done at the initial stages to prevent such a situation.

F. Durosinmi-Etti (IAEA) recalled that we have had a series of discussions on the problems with the cobalt machine. The question we should actively discuss is, whether there is a need indeed for the developing countries, particularly in Africa, to continue to rely on the equipment as we have them to-day; in other words, the sophisticated electronic parts which in eighty percent of cases cannot withstand the weather, humidity, fluctuations in electric power supply, lack of spare parts, and proper maintenance programmes? Alternatively, should we look elsewhere, such as requesting manufacturers to produce equipment specially suited to our needs - rugged, cheap, independent of fluctuating electric power supply, more mechanical and manual rather than remote-controlled? This may be a small price for us to pay in order to ensure continuity of treatment to our patients. However, we must be careful. Are we suggesting we want to take the developing countries in Africa out of the mainstream of technological advancement? Is this simple but more reliable equipment our best choice now? Is it worthwhile getting the expensive machines which often break down within a short period after purchase and where it takes another year or longer to get it repaired? These issues he suggested should be considered here.

J.A. Rawlinson (Canada) responded to the last comment which was a plea for very simple equipment because of the shortage of manpower to maintain the more sophisticated equipment, and said that there is a limit to how far one can go with regard to simplicity of equipment. Inevitably, any twentieth century equipment is going to fail routinely and often. There is no alternative here or in any other part of the world to the need to develop ones own expertise in maintaining such equipment. One cannot expect perfect equipment which will
operate all the time. One must, while planning, envisage that any equipment will fail and there must therefore be a system in place to take care of the equipment. In general terms it is safe to assume that the operating cost of radiotherapy equipment is something like five to ten percent of the new capital cost of the equipment per year, so over a fifteen-year life of the machine one has to expect to pay, in effect, an amount equal to the initial cost. This is inevitable and is important to plan for it when one is planning to purchase the equipment. There are possibilities to try and get engineers in house. They may not be sophisticated enough in their abilities to solve all problems on the equipment, but they should be available to at least diagnose simple problems and make sure that the manufacturer is ready and willing to look after the more complex problems. His message was that one must consider in one's planning the need to develop in-house maintenance of these machines. It is foolhardy to rely on a manufacturer who is in another part of the world to come at once to fix a minor problem.

J. Luande (Tanzania) reminded the panel that we do not intend to settle for double standards of care for cancer patients in our part of the world just because we are disadvantaged for one reason or another. We ought to strive for the same level of care as is available elsewhere. Having said that, it is important we realise that if we are dealing with over ninety percent of our tumours requiring palliative care and with only ten percent curative, we need to define minimal requirements for a new department. His feeling was that in a new department you require one simple work horse, a simple machine for routine work for simple AP/PA parallel-opposed palliative treatment which will offload your volume of work by ninety percent and leave the more sophisticated machine for your ten percent curative cases that require elaborate treatment planning and dosimetry. He understood that the world bodies concerned with this have discouraged radium and it is not being imported into the third world for use. He never heard it said anywhere that caesium has been discarded. If you need two machines for treatment anywhere in Africa, and you need two sources of cobalt changed every five years at US$ 80-100 000 per source, this is about US$ 200 000 every five years. He did not think that a small African country setting up a new radiotherapy centre can afford such costs. He had also never heard anyone discourage the use of caesium because caesium, when installed, lasts for fifteen years as against a cobalt source lasting five years.

H. Svensson (IAEA) added that in fact you can have cobalt-60 sources lasting up to ten years if you had a high enough source activity from the beginning.

Mr. Chenkshok (Philips) reacting to a comment from B.K. El Gueddari (Morocco) reaffirmed that they no longer make cobalt machines but manufacture linear accelerators. He further remarked on a previous comment made by J. A. Rawlinson (Canada) about the reliability of equipment, that at Philips they are trying to set up regional centres of competence for their machines in Africa. In other words, where they have machines in Egypt or Sudan, they are trying to use these areas to train highly-skilled technicians who do not have to be flown out from England. They will have their spares already located in Africa so that spares and service personnel are immediately available should there be equipment breakdown.

G.P. Hanson (WHO) commented and supported the remarks made by Prof. Mahfouz and Dr. Luande. He suggested the need to go to the fundamentals on what kind of machines we really want. He gave two examples. In India some simple machine was made but the radiotherapists there do not like the machine. It was tried in Argentina and the machine was thought to be sophisticated. We talk about simplicity but when it comes to the user, the user wants certain specifications which may not be necessary. He recalled the Janus unit designed by Henschke twenty five years or so ago. A very simple unit, yet many radiotherapists will not use the unit. He advised that we get to the fundamentals, work on equipment design, and map out the maintenance policies.
A.M. Hidayatalla (Sudan) in his own contribution, dwelt further on what Dr. El Gueddari and a few others have said. He thought we should all aim at having a medium-sized radiotherapy department. He did not personally think one machine was enough for any department. If patients are insufficient they should be sent to another place because it is not only a machine and a radiotherapist that make up a department. There is a lot of back-up required for any radiotherapy department. You need physicists, engineers, technologists, etc., so there is no point having a small machine somewhere. Also, any radiotherapy unit must have a minimum standard of personnel, equipment and other things. Otherwise, we should not start a department. He advised that one must have good machines not the simplified versions as suggested earlier, and also they must all preferably be from one company. There is no point having your source from one company, and the machine from another. This often causes problems as he had experienced. We should also discourage competitiveness between linear accelerators and cobalt machines; they are complimentary in his opinion. In order to start a radiotherapy unit we must have at least two cobalt-60 machines, one with a higher source activity. This enables you to transfer the higher-activity source every ten years or so. In this way, you save time, services, cost of a source, and you are dealing with one company at a time.

M.M. Mahfouz (Egypt) further associated himself with the idea that a standard radiotherapy service should depend on the workload and unless the workload justifies at least the capacity of one cobalt unit, we should move the patients to another centre rather than have a centre without patients. Secondly, the simple machine ought not to be a replacement for a standard machine. A simple machine is being suggested to deal with the workload of the present situation of eighty five percent late cases, so the simple machine does not push out the necessity for a more sturdy machine. He also associated himself with the idea that the cobalt and linear accelerators are not competitive but complementary. Thirdly, on the question of control of humidity and temperature in areas where this meteorological situation causes a lot of damage and a lot of inefficiency in utilizing linear accelerators, he recalled that in Cairo they estimated the cost of the air conditioners necessary to run the linear accelerators properly and this was twelve percent of the total cost of the treatment room. Furthermore, where the type of water available is not suitable for the cooling system, you need extra devices in order to prepare the water which is used by the coolers. These are points and details which add to the problems of choice of the proper equipment for the proper place.

H. Svensson (IAEA) summarized the discussion on external radiotherapy, particularly on cobalt-60 and the linear accelerators. Regarding the source he advised that it is very important that we do not pay too much for it and that when we make the initial negotiation with the company, we have some written documentation that it is possible to go over to another manufacturer if necessary. The manufacturer or producer of the cobalt-60 unit itself, should if possible also be responsible for the replacement of the source, and guarantee access to cheap standardized ones. He then invited other comments.

M. Schindler (Theratronics, Canada) said that most of the ideas that have been presented so far to industry are good. Manufacturers also suffer from the same problems as you do. He commented further: the question with standardizing cobalt sources is a good idea but the problem is that the two major suppliers of cobalt units to-day approach this idea from radically different directions. He believes in just replacing the cobalt source itself, which is a capsule several centimeters long; other manufacturers believe in replacing the whole head, partly because of the design of their unit which they feel has certain advantages. He feels however that it has disadvantages and he prefers his way. Thus, part of the problem is the fundamental difference in the design of the units and this will be a very thorny problem to deal with.
H. Svensson (IAEA) remarked that an AECL (Theratronics) source is inside CGR equipment in some countries, and that it is possible to use Theratronics sources in CGR and CGR sources in Theratronics equipment if there is real co-operation.

M. Schindler (Theratronics, Canada) replied that as far as the source capsule is concerned, he understood that it was possible. However, he was talking about the broader issue of what happens at the time the source is changed and that is when some of the complications arise.

Commenting on the subject, Mr. Chenkshok (Philips) said regrettably his company no longer manufactures cobalt machines. However, their cobalt machines that are currently in the field are being supported and serviced. His company will also support any manufacturer that can replace the cobalt source. They work closely with Theratronics because they believe in the quality that they use.

The Chairman asked for more comments on this issue and the following dialogue ensued.

J.M.A. Ahmad (Sudan) said he understood that CGR changes the whole head during source change, which means this could only be done with the company.

H. Svensson (IAEA) answered that this is not necessary. In India it is done by the Indians themselves. What is needed is a place where you can handle this in an automatic way and could be done outside France.

G.P. Hanson (WHO) wanted to know how the Indian engineers got into the CGR head? Was it on their own initiative or do the CGR people help them?

H. Svensson replied that you have to push the company. You could tell them that they should be prepared to take sources from other manufacturers and that they will be responsible for the operation to put in the source. This can be done anywhere in the world where they will send a technician provided the right handling equipment are locally available.

M.M. Mahfouz (Egypt) in his contribution, informed that a major component of the price of the source is the transportation cost. He understood very recently that a recommendation from the International Aviation Transport Union, had been adding extra regulations and precautionary measures for transportation of sources, which had added a lot to the price.

M. Nofal (IAEA) observed that this last point was very important and required more detailed discussion. He suggested there should be a dialogue between the suppliers and the users regarding this matter.

H. Svensson (IAEA) supported the idea and suggested that it would be very nice to have a meeting in Vienna about this subject which is important from many points of view, such as radiation protection, transportation and so on. He commented further on other issues, for instance about the local representation of companies. He felt that Philips' point of view was very good provided the implementation is as good as they claimed and that there would be a representative in Africa very close to the users if possible.

G.L.O. Gordon-Harris (Sierra-Leone) in his contribution mentioned that in diagnostic radiology it has been possible to have the BRS (basic radiological system) recommended by WHO. Such simplification will be useful in doing the bulk of the work and recommended a similar type of equipment for radiotherapy.

M.M. Mahfouz replied that there is a need for both sophisticated and simple machines. However, sophisticated machines are less suitable for the
developing countries in Africa. The simple machines will be used for advanced palliative cases only, while the other is for more curative treatments.

A.R. Ibrahim (Libya) contributing agreed with Dr. Hanson on the minimum specification requirements for equipment for developing countries. Such specifications for a workable unit could be worked out. He advised that we should obtain records of the most common breakdown problems that are encountered and try to avoid them, when we develop a prototype for the cobalt machine.

H. Svensson suggested that while it is difficult to set up a panel to define what an item of equipment should look like, the International Organizations like IAEA, WHO, UNIDO can bring the users and manufacturers together to examine the possibility of designing simple equipment.

M.M. Mahfouz (Egypt) suggested that UNIDO in Vienna should bring equipment manufacturers while the IAEA bring the potential users together to find out the possibility of designing simplified equipment.

G.P. Hanson (WHO) also suggested that the IAEA should convene a meeting soon to update the 1966 report on planning a radiotherapy unit. He assured the WHO will co-operate with such a project.

The discussion then moved on to equipment maintenance and was moderated by A.M. Mabrouk (Libya). He started by requesting some manufacturers present to discuss their policy for servicing and maintaining their equipment.

E. Van Hooft (Selectron) said it is their practice to offer customer service at a reasonable price. In India, for example, they were so pleased with their service that the company sold more machines. He assured they will do exactly the same in Africa if they sell Selectron by providing service facilities in the different countries. They would also offer training of local engineers in those countries where the Selectron is in use.

M. Schindler (Theratronics) summarized his reactions to all the remarks made. He felt the ideas and messages conveyed at this Seminar were fairly consistent. He noted however that whenever he made visits to Seminars and individual clinics in various countries, he does not always hear the same message. Whenever he visited administrators, they gave him an entirely different message. Theratronics had tried to come up with a family of products, for instance, like the Phoenix machine which is manual in almost all of its motions. The administrators, however, thought they were trying to peddle cheap junk in the developing countries. Theratronics cannot afford to open up a subsidiary of Theratronics at every place they have equipment, although it can be considered where they have a sufficient volume of equipment. In India for example, they are in the process of doing it in Europe and Singapore. They will certainly do it in Africa when market conditions warrant that. Meanwhile, the company has picked selected agents in various parts of Africa. Egypt is one of those locations, and they try to provide as much training to the local agents as they could so they can maintain the equipment in Egypt and surrounding areas.

J.A. Chenkshok (Philips) in his contribution informed that out of fifty one countries in Africa, Philips medical systems are used in about thirty five of them. They already had a large service network in Africa. However, in areas of competence they have taken places like Egypt, Sudan, possibly Kenya, Nigeria and Zimbabwe as places where they will hold spares and highly-trained technicians so that equipment will not need to be serviced from England.

The Co-chairman, after a brief summary of the proceedings, brought the session to a close.
The panel discussion took place on 15 December 1990. The Chairman was Prof. M. Nofal, IAEA, and the Co-Chairman was Dr. G. Hanson, WHO. In order to ensure maximum contribution from all participants the meeting was conducted as a round-table discussion.

In his introductory remark, the Chairman, observed that most African countries are ill-prepared and clearly unable to cope with the cancer problem. The reasons are multiple and complex. Some are due to the lack of recognition of cancer as a major health problem by the authorities as a result of non-availability of supporting statistical data. Another reason may be due to the non-existence of a well-conceived and easily-acceptable model for comprehensive cancer control, as seen in the industrialized countries. There are the problems of heavy capital investment for equipment and training which are beyond the financial capabilities of many developing countries at a period when there may also be other more urgent health problems which attract a large percentage of the financial resources available for health care. Prof. Nofal opined that there is a need for a drastic action to be taken to improve the sad situation in Africa. Guidance from the health sector in the developed countries with support from International Organizations, donor agencies, and other non-governmental organizations are needed. In order to approach the discussion in a more logical way, he suggested the following plan: radiotherapy being one of the major multidisciplinary approaches to cancer treatment, it is important that the service is properly organized. Basic needs, such as infrastructure, personnel, equipment, training, etc. must be discussed. More important is the awareness of the cancer problem by the appropriate health administrators, who invariably are responsible for adequate financial support for the programmes. The discussion must also consider the potential role of external support by International Organizations, non-governmental organizations, both international and local, and other bilateral government agreements. He suggested covering these areas and others if any, during the discussions at the end of which recommendations would be welcomed. It was hoped that at the end of the discussions, participants would be in a better position to be able to formulate guidelines which would enable them to discuss the establishment of a radiotherapy service on return to their various countries, if so desired.

Prof. Mahfouz (Egypt), in his contribution, noted that while cancer is a common health problem in Africa, a majority of the African states have no radiotherapy facilities and these should be established. While most cases present with late disease, it is usually possible to pick up a few early cases through public education and screening campaigns, and where possible for example in carcinoma of the cervix, treat by brachytherapy which could be immediately started in some of these countries as a nidus around which a larger radiotherapy service may eventually develop. Brachytherapy will cure some early cases and palliate others, while at the same time bringing the cancer problem to the notice of health administrators.

Supporting the previous speakers, Dr. El Gueddari, Morocco, suggested that the recommendations from the discussions be sent to the appropriate governmental officials in various African countries, though he is aware that many African countries have no means of supporting the establishment of radiotherapy services, and that the problems are likely to remain. Dr. Sanqui, Burundi, an observer, disclosed that young doctors in Burundi are not interested in cancer management and will not usually specialize in radiotherapy because they lack the facilities to work with on completion of their training.
In her contribution, Ms. Tham, Mali, claimed that her country in West Africa has no radiotherapy facilities and they have always depended on Senegal and Cote d'Ivoire for services. They are, however, interested in developing a radiotherapy service as soon as possible. There is already a cancer registry service, and rudiments of nuclear medicine where they carry out radio-immunoassay studies and scanning for thyroid. She called for assistance from the IAEA in establishing a radiotherapy service in Mali.

Dr. Musinguzi, Uganda, suggested that the Seminar should devise ways of helping both large and small radiotherapy centres in addition to supporting those aspiring to establish radiotherapy services. Uganda, for instance, requires assistance in upgrading the small radiotherapy unit there, where the major equipment is an old orthovoltage machine. The country would like to own a cobalt machine and he wanted some guidance on how to get a suitable donor since his country cannot afford to purchase one. The training of personnel is also foreseen.

Prof. Nofal further stressed the importance of well-trained personnel to run radiotherapy services. The IAEA, under its technical co-operation programme, has provision for assisting Member States in this regard.

Dr. Luande, Tanzania, questioned the desirability of having a brachytherapy unit where infrastructure and other facilities for external radiotherapy are non-existent. Installing a brachytherapy unit without provision for proper facilities for external therapy may be counter-productive and should be discouraged.

Dr. Rawlinson, Canada, was also against the idea of setting up brachytherapy services in preference to teletherapy units, and made reference to the WHO recommendation in the report on Optimization of Radiotherapy 1980, where it suggested that it was inappropriate to establish facilities for intracavitary radiotherapy where external beam irradiation facilities are non-existent. Dr. M. Snelling, United Kingdom, pointed out that a possible advantage in such a set up is that it may in fact act as an impetus for the development of a fully-fledged radiotherapy service with facilities for teletherapy and brachytherapy.

On the requirements for setting up a radiotherapy service, Dr. Onyango, Kenya, suggested that it might in fact be better to start the centre in an already-established hospital where other supporting services are existent. This will also allow for easy interaction between different specialists. However, suitable buildings must be available together with at least a simple cobalt-60 teletherapy machine. Such a machine need not be sophisticated and may be devoid of sensitive electronic parts. It should, however, be functional. Training of local radiotherapists, physicists, and technologists takes a long time; it may be worthwhile to rely on neighbouring African countries, with existing services, for such staff as an interim measure. It is also possible to have inter-regional co-operation and the establishment of a regional centre of excellence supported by several countries requiring the service and by International Organizations. Dr. Hanson, WHO, referred to a WHO/IAEA 1966 publication on Planning of Radiotherapy Facilities (WHO Technical Report Series No. 328), which may still be relevant to-day, and many participants agreed this report needs to be updated and made available to interested Member States. Suggestions on how to obtain funding for such projects from International Organizations, and others, would be a useful addition.

Dr. Hamad, Sudan, also raised the question of the role of second-hand equipment in establishment of radiotherapy services in Africa. According to him, Sudan had a bad experience which he would not want repeated elsewhere.
He called for avenues to good technical advice and assessment of second-hand equipment before being accepted, even as a donation. Dr. Rawlinson, Canada, also supported this, and reminded participants that in many cases second-hand equipment being donated is obviously no longer useful for the donor institute, either due to old age or some fault, or to other reasons; otherwise they are unlikely to be donated at all. He therefore urged that proper caution be taken in assessing such equipment before being accepted, otherwise it may become a liability to the recipient. Prof. Nofal, IAEA, while agreeing, also informed participants that the IAEA in fact has a procedure for obtaining technical expert advice on the status of such equipment whenever requested to do so by a potential recipient from a Member State. This has been a good safeguard against "dumping" of unserviceable equipment through donation. Dr. Haddad, Egypt, further added that such equipment can be refurbished and such an exercise has already been done in Egypt where an old and outdated cobalt machine was completely refurbished and installed at another hospital where it is still in operation several years later. Dr. Diab, Egypt, the engineer responsible for the restoration of the machine, confirmed this and offered a similar service to interested participants though problems with the logistics are apparent. Several other speakers endorsed the view and Dr. Hanson advised that anyone offered used equipment should get in touch either with the WHO or the IAEA for assistance with the evaluation and other assessment of the equipment. The IAEA had in the past solicited donation of equipment, particularly old cobalt units, but the response had been poor. This, according to Dr. Hanson, WHO, was probably because there is a good market for second-hand cobalt units, particularly in the USA. On the question of second-hand linear accelerators, the participants did not appear interested because most centres in the developing countries do not have the necessary wherewithal, viz. infrastructure, maintenance staff, etc., for operating a linear accelerator. In addition, the usual erratic power supply is a major problem. On the other hand, it is easier according to Dr. Diab, Egypt, to design a simple cobalt unit devoid of complicated electronic parts with minimum electric power supply, with or without a battery-operated back-up. Such a machine will be cheap and the harsh environmental conditions, such as temperature, humidity, dust, etc., will all be taken care of.

The discussions also dealt with training and personnel requirements and, at the instance of the Chairman, the discussions were brought to a close with the formulation of the following recommendations.

Recommendations

A. Personnel/training

The discussants recognized the need to develop human resources in all aspects of radiotherapy in Africa, and recommended that training of all cadre of staff should be encouraged and started as soon as possible. Where possible, regional training centres utilizing available infrastructure from developed and developing areas within the region should be started. For example, in Egypt and Morocco for North Africa, Nigeria for West Africa, Kenya for East Africa and Zimbabwe for South African regions. Such training centres must encompass both English- and French-speaking countries in Africa. The training of technologists, engineers and other paramedical staff must be considered in addition to the training of radiotherapists, physicists and radiation technologists.

B. Equipment

1. The discussants recognized that African countries are in dire need of radiotherapy equipment. While most of the available equipment is sophisticated and expensive, they recommended that as much as possible the design of simple, sturdy, safe and reliable cobalt machines for radiotherapy
should be encouraged. Such equipment should be cheap and affordable, while at the same time it will not compromise safety, reliability and efficiency. It is believed that this is feasible if such a machine is devoid of costly and sophisticated electronic and mechanical parts.

2. Second-hand or refurbished radiotherapy machines could be a good source for equipment for developing countries, provided such equipment undergoes stringent safety standards on evaluation and is so guaranteed as having a useful life left. It is recommended that such evaluation, where possible, should be requested through the International Organizations like IAEA and WHO.

3. Purchase of equipment for radiotherapy should preferably be tied with a maintenance contract and a guarantee of availability of spare parts to minimize the down time of such machines. Companies with local service agents within the country are therefore to be favoured during purchase and sufficient guarantees obtained.

4. Adequate care must be taken in Africa to ensure optimal suitable power and air conditioning wherever any major radiotherapy equipment is to be installed in order to reduce the risk of damage from the harsh atmospheric conditions, like temperature, humidity, dust, etc.

C. Public awareness

The panel appreciated the role of high governmental officials and other health administrators, and the public, in ensuring the success of any health programme within the community. It recommended that adequate measures must be taken to ensure the awareness of the degree of the cancer problems by health administrators and other top governmental officials for the necessary support. Cancer control programmes should be encouraged in various countries by non-governmental organizations and anti-cancer societies.

D. Financial resources

As much as possible local sources of revenue must be available to ensure continuing operation of all radiotherapy equipment in the department through regular maintenance and availability of spare parts. Such revenue drive should be supported by the local community and other non-governmental organizations and anti-cancer societies within the country concerned.

E. External support

The panel having realized that most African countries desirous of having a radiotherapy service cannot afford one due to lack of sufficient funds, recommends that in addition to local country effort, the International Organizations and non-governmental organizations in developed countries with programmes for assistance for developing countries, should be contacted. Also, bilateral governmental aid programmes should be explored as a potential source of funding in addition to regional projects such as IAEA, AFRA.
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