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Nigeria Radiotherapy Safety Audit

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Abstract

In June 2011, the new Management at the Nigerian Nuclear Regulatory Authority (NNRA) noted with concern that all radiotherapy centres in Nigeria were not duly licensed for safe operation as required by the Nuclear Safety and Radiation Protection Act 19, of 1995 (Act) [1]. Consequently and by the powers conferred on it by the Act, NNRA conducted a national safety audit of all radiotherapy centres, to benchmark radiation safety in line with regulatory requirements. There were 9 radiotherapy centres, 5 of which were established between 2004 - 2011 under a project between the Federal Government of Nigeria and VAMED Engineering (FGN/VAMED Project). Since 2004, none of the 9 had been fully authorized to operate due to their inability to comply with the authorization requirements, albeit some got provisional authorizations of short durations. Common non-compliance issues included inability to meet the minimum complement of the cadres of personnel; lack of requisite managerial commitment and policy for effective radiation protection and safety; no equipment supplied under the FGN/VAMED Project was licensed for importation; and most of the new centres were sited, designed and constructed without requisite licenses. None of the new centres was consulted in the procurement of equipment. These conditions resulted to a situation of unsustainable and ineffective radiotherapy practice.

Keywords: Radiotherapy; Brachytherapy; Oncologist; Medical Physicist; LINAC; Cobalt-60; CT-Simulator; Personnel Radiation Monitoring; Workplace Monitoring; Regulatory Control; licensing; authorization.

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1. Introduction

Radiotherapy practice in Nigeria came under regulatory control in 2001 with the establishment of NNRA. In 2003, NNRA carried out the first national safety audit of radiotherapy centres, benchmarking radiation safety in line with the **Ni**geria **B**asic **I**onizing **R**adiation **R**egulations (NiBIRR) [2] of 2003 and the Nigerian Radiation Safety in Radiotherapy Regulations, of 2006 [3].

In 2011, NNRA conducted a second national safety audit on the then existent 9 radiotherapy centres in Nigeria:

i Radiotherapy Department, Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto
ii Radiotherapy Department, University of Benin Teaching Hospital (UBTH), Benin
iii Radiotherapy Department, University of Nigeria Teaching Hospital (UNTH), Enugu
iv Radiotherapy Department, Lagos University Teaching Hospital (LUTH), Lagos
v Radiotherapy Department, National Hospital, (NHA), Abuja
vi Radiotherapy Department, University College Hospital (UCH), Ibadan
vii Radiotherapy Department, EkoCorp Plc Hospital (EKO), Lagos
viii Radiotherapy Department, Ahmadu Bello University Teaching Hospital (ABUTH), Zaria
ix Radiotherapy Department, Federal Medical Centre, (FMCG), Gombe.

2. Major Findings

2.1 Authorization Status

Since 2004, none of the 9 centres were fully authorized to operate, due largely to their inability to fully comply with the requirements for authorization. Table 1 shows the statuses of their authorizations.

2.2 Personnel

Most centres did not have the minimum complement of cadres of personnel to practice e.g. Oncologists, Medical Physicists,

Therapy Radiographers, Oncology Nurses etc. Furthermore, where some of these personnel existed, they were often not appropriately trained and certified. Consequently, key functions of the Medical Physicists for example were not properly fulfilled. Some of these functions included commissioning tests of new equipment; treatment planning, treatment delivery, Dosimetry etc. To augment the situation, most centres resorted to the use of visiting experts, especially Oncologists and Medical Physicists. A summary of findings are presented in Table 2.

Table 1: Authorization Status, December 2011

Centre	Authorization Status	Remarks
UDUTH	In 2009, UDUTH was issued: - licence for Design and Construction - Licence to Import LINAC - Commissioning License for LINAC	UDUTH had applied for Operation License, which was yet to be granted because of pending non-compliance issues

UBTH	UBTH had no form of authorization	UBTH submitted Acceptance Test Results but no Commissioning Test Result
UNTH	UNTH had no form of authorizations	UNTH submitted Acceptance Tests Results but no Commissioning Tests Results
LUTH	- LUTH License to Use Radiation Sources expired in 2003 2008, LUTH was issued: – Licence for Design and Construction of a LINAC based facility – Licence to Import LINAC – Commissioning Licence for LINAC – Provisional Operation License All licences expired in December 2008	LUTH applied for renewal of Operation License for Radiotherapy Practice. It was not yet approved
NHA	July 2003, NHA was issued: – Licence for Design and Construction of a LINAC based facility – Licence to Import LINAC – Commissioning Licence for LINAC – Provisional Operation License All licences expired in December 2003	NHA applied for renewal of its Operation License but this had not been renewed due to outstanding non-compliance issues
UCH	January 2004, UCH was issued: – Certificate of Registration of Premises – Licence to Use Ionizing Radiation Sources Both expired in December 2004 2010, UCH was issued: – Decommissioning License for Cobalt-60 Head – Import License for new Cobalt-60 Head	UCH had no valid authorization as at December 2011
EKO	June 2003, EKO was issued: – Licence to Use Radiation Sources – Certificate of Registration of Premises Both expired in December 2003 August 2006, EKO was issued: – Decommissioning License for Cobalt-60 Head – Import License for new Cobalt-60 Head	EKO was yet to renew its authorizations following their expiry in December 2003
ABUTH	2008 ABUTH was issued: – Decommissioning License for Cobalt-60 Head – Import License for new Cobalt-60 Head.	Only an Acceptance Test report was submitted
FMCG	2004 FMCG was issued: – Licence for Design and Construction – Licence to Import Ionizing Radiation Source – Commissioning Licence	FMCG had applied for Operation License, which was yet to be approved due to outstanding non-compliance issues

Table 2: Personnel by Cadres

Centre	Resident Oncologists	Resident Medical Physicists	Therapy Radiographers	Oncology Nurses	Technicians	Remarks
UDUTH	Nil 2 visiting - 2 Senior Registrars	Nil 1 Visiting 7 Trainees	2 Qualified	5 Qualified	1 Qualified	Inadequate staffing in both Oncologists and Medical Physicists
UBTH	1 Resident, 1 Visiting 3 Senior Registrars	Nil 4 Trainees	2 Qualified	3 Qualified	2 Qualified	Inadequate staffing in both Oncologists and Medical Physicists
UNTH	1 Resident 1 Visiting 2 Senior Registrars	Nil 6 Trainees 2 Visiting	5 Qualified	4 Qualified	2 Qualified	Inadequate staffing in both Oncologists and Medical Physicists
LUTH	5 Resident	Nil 5 Trainees	6 Qualified	3 Qualified	1 Qualified	Inadequate staffing in Medical Physicists
NHA	5 Resident	2 Resident 4 Trainees	7 Qualified	3 Qualified	1 Qualified	Adequate staffing
UCH	7 Resident	2 Trainees	6 Qualified	5 Qualified	5	Inadequate staffing in Medical Physicists
EKO	1 Resident 2 Visiting	2 Trainees	3 Qualified	2 Qualified	1	Inadequate staffing - Oncologists and Medical Physicists
ABUTH	4 Resident 6 Registrars	6 Trainees	3 Qualified	9 Qualified	1	Inadequate staffing in Medical Physicists
FMCG	Nil 2 Visiting 2 Registrars	2 Trainees	1 Qualified	3 Qualified	2 Qualified	Inadequate staffing in Oncologists, Medical Physicists and Therapy Radiographers

2.2.1 Personnel Training

i. UDUTH

There were no qualified Resident Oncologists or Medical Physicists. There were visiting Oncologists and Medical Physicists. Most staff in these cadres were newly employed trainees incapable of independent decision making. UDUTH was however conducting training analysis toward the development of a comprehensive training programme to ensure sustainability of practice.

ii.UBTH

There was 1 qualified Oncologist, who was complemented by other visiting Oncologists. All Medical Physicists were newly employed and were undergoing or were due to commence professional training. The situation was compounded by the fact that there was no adequate arrangement for the use of visiting Medical Physicists. There was plan for 1 Oncologist and 1 Medical Physicist to proceed overseas for a 6 month professional training. UBTH had employed nearly all the necessary personnel required to practice, but with little training and

no relevant experience, they could be ineffective for a sustainable practice.

iii. UNTH

UNTH had 1 qualified Oncologist who was complemented by visiting Oncologists. All Medical Physicists were newly employed and were still trainees. There were visiting Medical Physicists who both trained the new recruits and assisted in routine operations. The trainees, with little or no relevant training, experience or certification, could not carry out effective practice. UNTH indicated it was doing a training analysis and had a training programme to fully develop the capacity of its personnel.

iv. LUTH

The team of Oncologists were all well qualified and experienced. However the team of Medical Physicists were all not certified and they did not have the benefit of visiting Medical Physicists. It was indicated that some of their personnel were overseas for various trainings related to the LINAC and ancillary equipment. LUTH further indicated that it was in contact with equipment manufacturers for the retraining of staff on proper use of its Treatment Planning System (TPS). LUTH indicated that it would hire and adequately train new nurses. LUTH had a training programme for staff development.

v. NHA

NHA had a well-developed programme of training and retraining of its staff and had almost all the necessary personnel required for radiotherapy practice. However, most of the equipment were not in operation to fully utilize the available manpower. At the time of the audit, the facility was expected to undergo further structural modification in readiness for the installation of a new unit.

vi. UCH

Except for the Medical Physicists and Technicians, all other personnel showed evidence of adequate training, qualification and professional certification. The Medical Physicists needed clinical training and certification, whilst the Technicians needed to show evidence of training on the Cobalt-60 and ancillary equipment.

vii. EKO

Except for the Oncologist, little evidence of trainings was provided for the other personnel, especially the Medical Physicist. Furthermore, because of the absence of a concrete arrangement for visiting Medical Physicists, the training of at least 2 Medical Physicists was imperative.

viii. ABUTH

The ABUTH team of Oncologists were all well qualified and experienced. However, all the Medical Physicists were not certified and there were no visiting Medical Physicists. ABUTH was aware of the key role of Medical

Physicists and indicated that some of them were due for specialized training overseas.

ix. FMCG

There existed a programme of training and retraining of all staff. FMCG also had an on-going technical cooperation Project with the International Atomic Energy Agency (IAEA), which had a component for staff training through fellowships for Oncologists, Medical Physicists, Biomedical Engineers and Nurses.

2.3 Facility Design

All the facilities were purpose built in accordance with manufacturers' specifications and consistent with the facility designs submitted to the NNRA in support of their applications for authorization. Provisions were made for Examination Rooms; CT-Simulator Rooms; Mould Rooms; Treatment Planning Rooms; Treatment Rooms, and Waiting Areas. For ABUTH and EKO, the facility designs were for Cobalt-60 based radiotherapy, whilst the others were designed for LINAC. Additionally, NHA and FMCG also had purpose-built Brachytherapy Units. Meeting the design specifications was relatively easy as they were done by the equipment manufacturers. All new facilities had CCTV camera and audio communication systems to monitor patients. Door interlocks were provided to prevent unauthorized access. All doors were lead lined and some had maze that provided additional shielding.

2.4 Equipment

2.4.1 Equipment - UDUTH

All the external beam therapy and associated equipment were supplied by the Federal Government under the FGN/VAMED Project. The equipment were new and all the relevant manuals related to them were available. The equipment included imaging equipment - CT Simulator; Computerized TPS; LINAC; Quality Control Equipment; and Radiation Safety Equipment

Table 3: Specifications of the LINAC and CT-Simulator are as listed below:

Equipment Type	Manufacturer/Year	Model	Serial No	Max Output	Max. Output	Exposure/ Day
Linear Accelerator	Elekta Ltd, /2008	Elekta Precise Treatment System	151715	15 MV	15MeV	10 - 15
CT Simulator	GE Hangwei Medical Systems, /2006	2247010	173155HM3	140KV	350 mAs	10 - 15

Equipment were prototype tested subject to IEC and ISO standards. Installation and functional details were provided for the LINAC, CT-Simulator, Mould Room Equipment and TPS. Quality control equipment included a number of Ion Chambers, recently cross calibrated during acceptance/commissioning test. There were also Water and Solid Phantoms, Digital Thermometers and Barometers, and Radiation Check Sources. Radiation safety equipment included Survey Meters and bleeper personnel dosimeters for area survey and personnel radiation monitoring.

2.4.2 Equipment UBTH

Equipment were supplied under the FGN/VAMED Project. They were new and all the relevant manuals related to them were available. These included Imaging equipment - CT Simulator; Computerized TPS; LINAC; Quality Control Equipment; and Radiation Safety Equipment.

Table 4: Specifications of Imaging Equipment and LINAC are listed below:

Equipment Type	Manufacturer/Year	Model	Serial No.	Max output	Max. Output
Linear Accelerator	Elekta Ltd, /2008	Elekta Precise Treatment System	151716	15MV	15MeV
CT Simulator	GE Hangwei Medical Systems, /2007	5143658	175887HM9	140KV	440mAs

Equipment were prototype tested to IEC and ISO standards. Installation and functional details were however not provided. Quality control equipment were available and comprised a number of Ion Chambers and Electrometers, which were last calibrated in November 2007 and were overdue for recalibration by November 2009. Also available were Water and Soild Phantoms, Digital Barometers, Thermometers, Radiation Check Sources, etc. Radiation Safety Equipment included Tandem Survey Meter and personnel dosimeters for area survey/radiation monitoring. Quality Assurance Programme was yet to develop a procedure to ensure a consistent and safe fulfilment of the dose prescription and minimal personnel and public exposure. The main areas for the programme include clinical policies, treatment planning and delivery, a quality control programme for machine and equipment performance, maintenance programmes and investigative procedures for accidental medical exposures.

2.4.3 Equipment - UNTH

Equipment were supplied under the FGN/VAMED Project. They were new and all the relevant manuals related to them were available.

They included CT-Simulator, Computerized TPS, LINAC, Quality Control and Radiation Safety Equipment. They were all prototype tested to IEC and ISO standards and their Installation and functional details were provided.

Table 5: Specifications of the Imaging Equipment and LINAC are as listed below:

Equipment Type	Manufacturer/Year	Model	Serial No.	Max output	Max. output
Linear Accelerator	Elekta Ltd, /2005	Elekta Precise Treatment System	151315	15MV	15MeV
TPS	Elekta Ltd,	Precision Plan	XN0004C	---	--
CT Simulator	GE Hangwei Medical Systems, /2005	2247010	12346HMD	140KV	350mAs

Quality control equipment included Ion Chambers cross calibrated during acceptance/commissioning tests in August 2011. Also available were Water and Soild Phantoms, Digital Barometers and Thermoeters, Check Sources, etc. Radiation monitoring equipment was a Survey Meter with a valid calibration date.

2.4.4 Equipment - LUTH

All equipment were supplied by the Federal Government under the FGN/VAMED Project. They were new but not all the relevant manuals related to them were available. They included CT Simulator, TPS, LINAC, QC and Radiation Safety Equipment.

Table 6: Specifications of the Imaging Equipment and LINAC are listed below:

Type	Manufacture/Year	Model:	Serial No:	Max. Voltage	Status
LINAC	Elekta Limited, /1998	Precise	1310	15MV	Functional
CT Simulator	GE Co. Medical System	HP XW CT	CZC 5480458	N/A	Functional

Some repair was recently carried out on the LINAC by VAMED and beam calibration was done by the Medical Physicist with the assistance of the facility engineer. Result of the recalibration was provided. Quality control equipment included a number of Ion Chambers and Electrometers that were last calibrated in October 2005 and were overdue for recalibration in October 2007. Also available were Water and Soild Phantoms, Digital Barometers, Thermometer, Radiation Check Sources. Radiation Safety Equipment included Survey Meters with calibration due date of July 2011.

2.4.5 Equipment - NHA

The facility existed before the FGN/VAMED Project and the equipment were installed earlier. Amongst others, NHA had the under listed equipment:

Table 7: External Beam Therapy Equipment

Type	Manufacture/Yr	Model No:	**Serial No:**	Max. Output	Status
LINAC	Elekta Linac /1998	SLi	105500	15MV &18MeV	Not Functional
Simulator	Philips		106764	N/A	Not in Operation

Table 8: Brachytherapy Equipment

S/N	Type	Manufacturer/Yr	Serial No	Source No:	Max. activity	Status
1	Brachytherapy Machine	CIS-BIO International, 2001	9825	4154,4161-4160-4150,4159 - 4149, 4158-4148	259GBq	Functional
2	Brachytherapy Machine	CIS-BIO International, 2001	9824	4091, 4088-4087, 4093,4086-4092, 4085-4089,4090	259GBq	Functional

Quality Assurance Equipment included an Electrometer and 2 Ion Chambers, recently cross calibrated. Also available were a digital barometer, thermometer, check sources and dose checker. Radiation safety equipment included functional survey meters with valid calibration certificates.

2.4.6 Equipment - UCH

The equipment were manufactured in 1987 and so they were not amenable to maintenance. Even though the equipment were originally prototype tested to ISO and IEC Standards, both the Cobalt-60 and CT-Simulator were all no longer in use and the Cobalt-60 was due for decommissioning. They included Imaging CT Simulator; Computerized TPS; Cobalt-60 Machine; Quality Control Equipment; and Radiation Safety Equipment.

Table 9: Specifications of the Imaging Equipment and Co-60 machine

Type	Manufacturer/Yr	Mode/Serial No:	Source Serial No	Activity	Status
Theratron Cobalt-60 teletherapy machine	AECL Canada/1987	T78OC/010	S-5353	87.622 TBq 29/08/2011	Not in use
CT Simulator	GE Co. Medical System	Therasim-750			Not in use
TPS	Nucletron, Canada	Theraplan plus			Not in use

Quality control equipment included an Ion Chamber and Electrometer even though they were last calibrated in July 2006. For its radiation safety equipment UCH had 2 Survey Meters for which there were no available technical details or record of calibration.

2.4.7 Equipment - EKO

The equipment and all relevant manuals were available and included Imaging CT Scanner; Computerized TPS; Cobalt-60 Machine; Quality Control Equipment; and Radiation Safety Equipment.

Table 10: Specifications of the Cobalt-60 Machine (old and new):

S/N	Type	Status	Manufacturer/Yr	Model	Serial No		Activity; 24/02/98
1	Teletherapy Machine	Not in Use	Varian-Tem, U.K /Feb, 1998	F100 Mobaltron	M113		83.3TBq
2	New Teletherapy Machine (Phoenix)	Operational	MDS Nordion, , 447 March Road, Ottawa ON K2K IX8, Canada	Phoenix	Teletherapy Source S/No:	Equipment S/No:	Activity as @ 03/08/06
					S-5646	214	131.2 TBq (3535Ci)

Table 11: The specifications of the Imaging Equipment are

Type	Status	Manufacture/Yr	Model No:	Serial No:	Strength	Description
Bright speed CT Scanner	Undergoing repairs	GE Medical/2008	Bright speed Edge select 5191002	TRS0088	150 kVp	Gantry 8 slices

The old Cobalt-60 head was still housed within the premises. EKO was unable to decommission the old Cobalt-60 Head because the company that supplied the source no longer existed. Quality control equipment,

which were last calibrated in 2007 included ion chambers. For its radiation safety equipment, EKO had a portable dose rate meter for which no calibration certificate was provided.

2.4.8 Equipment and Radiation sources - ABUTH

ABUTH had the following equipment and specifications:

Table 12: External beam therapy equipment (Co-60 Machine)

Equipment	Source form/strength	Source S/No	Status	Manufacturer	Model
Teletherapy Co-60 Machine Source	Sealed /215TBq (01-08-08)	028-1445	in Use	Gamma-Service GMBH/Germany	Tk60T03

Table 13: Brachytherapy Equipment (Cs-137)

Equipment	Source form/strength	Source S/No	Status	Manufacturer	Model
Brachytherapy Machine incorporating Cs-137 Source	Sealed/1.5133GBq, 1.5059GBq, .0562GBq, 3.811GBq, 4.588GBq, 5.402GBq & 6.105GBq	51351, 51352,51353, 51354,51355, 51356, 51357	Functional	CIS Bio International, France	CS Curietron Type B

2.4.9 Equipment - FMCG

The equipment at FMCG included Imaging; Treatment planning; Treatment delivery (including after loading equipment, sources, source storage and transportation, and applicators); Quality assurance; and Radiation safety and source handling equipment.

A CT-Machine was available for imaging, although no detailed information on the equipment was provided. Treatment Planning Equipment included a TPS comprised of treatment planning computer, monitor, printer, and digitizer. Detailed information on these equipment were not made available.

Table 14: Specifications of the Treatment delivery Equipment were:

Type	Manufacture/Yr	Model No:	Serial No:	Source	Source Activity	Status
HDR-After Loader Brachytherapy	Varian Medical System/June 2008	Gamma Med plus ix^{TM}	0585	Ir-192	Not available	Not operational

The spent source (Ir-192) had been exported to the source manufacturer via its appointed freight forwarder. FMCG had the following Quality Control/Radiation Safety equipment: Brachytherapy Well Chamber, Phantom, Electrometer, Seuvey Metres with valid calibration certificates.

3. Radiation Protection and Quality Assurance Programmes

The development of Quality Assurance Programme was a weak point of all the facilities. This was due largely to the absence of appointed Radiation Safety Officers (RSO) and Radiation Safety Committees (Committee) in almost all the facilities. By the provisions of the Regulations, these should be appointed in all radiotherapy institutions that handle Categories 1 and 2 sources. They shall coordinate and review the radiation safety and protection programmes as well as quality assurance procedures. Their scope should cover other practices that could lead to exposure to ionizing radiation in the hospital. Thus radiation protection and safety were largely not institutionalized and there was no clearly demonstrable recognition or support for those persons with direct responsibility for radiation safety. Consequently, most hospitals had developed some Treatment Procedures and QC checks for equipment. They however had not developed a comprehensive QA programme that ensured a consistent and safe fulfilment of dose prescription to the target volume with minimal dose to normal tissues and minimal exposure to personnel and the public. The main areas for the programme would include clinical policies, treatment planning and delivery, QC programme for machine and equipment performance, maintenance programmes and investigative procedures for accidental exposures. Very few could provide any records of daily, weekly and monthly QC tests done on the equipment.

4. Personnel and Workplace Monitoring

All facilities had contractual agreements with accredited Dosimetry Service Providers (DSP) for personnel monitoring services. DSP provided all radiation workers with TLD badges, which were periodically recalled and analysed to provide evaluation of personnel dose exposure, reported to the radiation employer. Personnel dose records were part of the requirements for authorization of practice. However, it was noted that personnel dose records were often not current and in some cases, were not even provided.

In some cases, workplace monitoring was done and records kept. Different methods were used to monitor classified areas, including fixed area monitoring. However in general, workplace monitoring was not properly done and even when done records were not kept. In many cases, monitoring equipment were not functional or out of calibration. Furthermore, absence of comprehensive QA programmes meant that responsibility for workplace monitoring was not institutionalized.

5. Emergency Procedure

Most facilities had developed emergency plan covering all foreseeable emergency scenarios including what could be regarded as incident or accident. Emergency drills and rehearsals were however seldom carried out due largely to the lack of responsibility for coordinating emergency response. Most radiation workers did not even know about emergency procedures as facilities simply developed emergency plans as part of paper work for authorization.

Policy on informing patients about incidents was not generally clear and the system of reporting incidents to hospital management was generally absent. Therefore, it was possible for radiological incidents or accidents to pass undetected and unreported.

6. Medical Exposure Control

Medical exposure control was approached differently by facilities. Some used the TPS System and others the Manual Calculations to get their dose calculation results. Some even combined both methods. Few centres ensured that dose calculations for patients were independently checked by 2 independent Medical Physicists. Many did not have this capacity and it was not sure therefore how reliable such calculations would be.

Patient Identification was largely done using names, age, date of birth, gender, referring physician, consultant in charge, hospital ID, Unique Departmental ID, part of body and all treatment procedure. Dose administered were recorded in treatment files. Patient photograph were uploaded in the workstation in the Treatment Room.

Indications and decision to treat should normally be taken by at least 2 Oncologists who had reviewed and discussed patients. This was seldom the case as usually no procedure was in place for such review to establish justification for radiation therapy and avoid unnecessary irradiation and possible human errors. This was due largely to lack of resident Oncologists in many facilities. Despite these, most facilities claimed without evidence that their indication and decision to treat included a multidisciplinary medical approach, practice guidelines and patient information and consent. This included explaining the benefit and risk of radiation exposure to patients before commencement of treatment. Formal consent form to be signed by patients before commencement of treatment was developed and available in some of the facilities.

Usually CT Simulator was used for simulation and this method included automatic transfer from imaging to planning. Once the patient data had been acquired, it was then transferred automatically to the TPS for treatment planning. However, because of the status of most simulators and TPS, it meant that this system was not optimised. The reliability of treatment planning was therefore low.

Patient identification cards were usually kept at the control room by the side of the monitors and the time allocated for the first treatment session and subsequent treatment were clearly indicated on the patient treatment file. The Oncologist physically checked the set-up. Treatment delivery was automated with manual verification. Patients were monitored by video and audio systems. Follow-up was done by the Oncologists and records were usually kept. Follow-up included analysing of complications recorded during the follow-up. All these were recorded in the patient treatment file.

7. Challenges to radiotherapy practice

At the national level, regulation of radiotherapy practice is relatively new and so is compliance with regulatory requirements for radiation safety by radiotherapy centres. Until 2001, there was no legislation on safety of exposure to ionizing radiation. NiBIRR and the radiotherapy regulations proceeded later in 2003 and 2006 respectively. There is also ineffective independence of the regulatory authority leading to inadequate power of enforcing the law and safety regulations, especially on government institutions. This made it possible for regulated equipment to be imported and installed by government institutions without any license from the regulatory authority.At the institutional level, there is usually non-participatory decision making, poor management strategic thinking and planning and poor organizational structure for radiation safety. There are

situations where centres have almost no capacity for maintenance and imaging and therapy machines all break down leading to inability to practice. Systematic analyses of manpower needs and development is generally lacking and so, it is possible for centres to be fully equipped but lack the manpower to carry out any practice. In most centres, quality management/quality assurance programs exist only on paper, but do not ensure effective implementation of activities. These are all symptoms of poor sustainability of practice.

8. Recommendations

Government may wish to:

i address the dearth of oncologists, medical physicists and other professionals in radiotherapy practice as a matter of national priority
ii ensure the passage of the Medical Physics Bill currently before the National Assembly and then also establish a national body for the training and certification of medical physicists
iii ensure that all radiotherapy centres are provided with the appropriate ancillary equipment
iv direct all radiotherapy centres to comply with the Nuclear Safety and Radiation Protection Act of 1995 and extant Safety Regulations on Radiotherapy.

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