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Errors in manual radiotherapy treatment procedures and their evolution in a low resource setting: Uganda's experience

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ABSTRACT

Purpose: In Uganda, two-dimensional (2D) radiotherapy treatments have been in use since the establishment of radiotherapy in 1995. Preliminary investigations of treatment records in November 2019 showed evidence of gaps requiring urgent attention. The purpose of this study was to improve the safety of the treatments.
Methods: Records of 1164 patients treated in 1387 courses (1412 sites) on Cobalt-60 units were reviewed to determine the frequency and dosimetric implications of events that occurred at different steps of the radiotherapy process. The results were presented and discussed with the different professionals for learning purposes.
Results: Most common d*osimetric events* were omission of block tray, bolus and couch transmission factors in time calculations, incorrect field sizes and depths, wrong beam weighting, independent calculations and prescription doses contributing 28.6 %, 10.1 %, 6.0 %,11.9 %, 10.1 %, 5.4 %, 4.8 % and 8.9 % to the 168 observed errors. Comparison of the calculated treatment doses with the prescribed doses showed that 88 % of the 1412 sites were treated with radiation doses within an accuracy of ± 5 %. However, an analysis of the evolution along the years demonstrated an improvement from 82.8 % in 2018 to 86.1 % in 2019, and 93.2 % in 2020. Most common p*rocedural events* were incomplete setup instructions and missing patient data in the record and verify system of the Co-60 units for 57 % and 60.1 % of the 1164 patients.
Conclusions: Opportunities for improvement of safety in the delivery of radiotherapy treatments were identified. Learning from these past errors should raise awareness in the team leading to a safer treatments.

1. Introduction

The treatment of cancer generally involves the use of radiotherapy, chemotherapy, surgery or a combination of these modalities depending on the site of disease, the patient's general health condition and the stage of the disease [1,2,3,4]. Radiotherapy is highly effective, however the complexity of the treatments [3,5,6] increases the risks of errors occurring during radiotherapy procedures if institutions ignore quality management (QM) [2,7,8,9]. Some effective interventions that can help reduce the risk to patients are the introduction of a thorough Quality assurance (QA) program, the use of safety checklists, failure mode and effects analysis (FMEA), and an incident reporting system to enable reviewing and learning from past errors, enabling the introduction of safety barriers so that they can be avoided in the future [10,11].

The primary objective of radiotherapy is to deliver a uniform dose of radiation to the tumour with minimal dose to the surrounding normal structures or organs [12,13]. However, radiotherapy is recognized as a high-risk procedure because of the numerous steps and staff involved [8,9,14,15]. Although rare, there has been instances of radiation errors with devastating or fatal effects [7,8,9,13] especially when radiation misadministration results into the injury of vital structures [12,13,16,17]. The quality of radiotherapy treatments directly impacts the outcome of the treatments delivered to patients [18,19].

According to literature [15,20], dose delivery to the target should be within ± 5 % of the prescribed dose in order to increase the tumour control probability and reduce the probability of complications.

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Published reports highlight evidence that the challenges associated with delivering safe and good-quality radiotherapy (RT) services in Sub-Saharan Africa are multidimensional. These include lack of planning and integration of RT in national health programs, inadequate facilities, inadequate funding for equipment, reliance on old machines, under-staffing and lack of qualified staff [10,11].

In Uganda, between 1995 and 2021, the only radiotherapy department was delivering two-dimensional radiotherapy (2D RT) relying on two cobalt-60 external beam treatment units [21]. A first advanced linear accelerator (linac) was commissioned in 2021, allowing the introduction of 3-dimensional conformal radiotherapy (3D CRT) and Intensity Modulated Radiotherapy (IMRT). However, many patients still get treated on the Cobalt-60 units. The purpose of our study was to improve the safety of their treatments based on manual calculations, manual input of treatment parameters and manual recording of the treatments by retrospectively and prospectively analyzing patient records. Therefore, the treatment records of patients treated between January 2018 and December 2019 and those undergoing treatment from January to December 2020 on the Cobalt-60 machines were reviewed and approaches to address the observed issues such as the use of an incident reporting and learning system (IRLS) and the requirement for an independent second check of all physics calculations were implemented.

2. Materials and methods

2.1. Radiotherapy equipment

Uganda Cancer Institute's (UCI) Radiotherapy Department is the only center offering radiotherapy services in the country as of December 2023. The center is equipped with two cobalt-60 external beam radiotherapy machines (Terabalt 80, UJP Praha and Bhabhatron II Taw, Panacea Medical Technologies), a high dose rate (HDR) brachytherapy treatment unit with cobalt-60 source (Flexitron, Elekta), a digital conventional simulator (Imagin, Panacea Medical Technologies), a computed tomography (CT) simulator (Brilliance big bore, Phillip), two treatment planning systems (Oncentra and Eclipse v16.1) and a linear accelerator (TrueBeam, Varian Medical Systems). It is important to specify that the two cobalt-60 units are controlled by their own stand-alone record and verify (R&V) computer, where treatment parameters have to be manually entered, and delivered treatment parameters are then automatically recorded.

2.2. Radiotherapy treatment process

Overall, there are five basic steps in the process of radiation therapy: initial consultation, simulation, treatment planning, treatment delivery (generally fractionated in several days), and post-treatment follow-up. Each step involves several tasks and staff (radiation oncologist [ROs], radiation therapist [RTTs], medical physicists [MPs] and Oncology nurses [ONs]) responsible for each task as shown in Fig. 1.

For emergency treatments and simple palliative treatments, mostly delivered in one fraction, a shorter path is sometimes used, without simulation and pre-treatment QA.

2.3. Data collection

Records of 1164 patients out of the 4,690 treated from January 2018 to December 2020 on the two cobalt-60 treatment machines were retrospectively reviewed. Patients who qualify for this study were selected randomly irrespective of age and sex as long as he/she started treatment during that year and have record in hard or soft copy. Efforts were also put to have a fairly equal number of patients selected in each of the 12 months in a year. The yearly distribution of the selected patients was: 350 (20.9 %) of 1,671 patients treated in 2018, 356 (24.4 %) of 1,459 patients treated in 2019 and 458 (29.4 %) of 1,560 patients treated in 2020.

2.4. Treatment time/Dose re-calculation

Required data were extracted from each patient's file to allow re-calculation of irradiation times and compare them with the values used at treatment delivery, as recorded in the treatment charts and in the R&V systems. In case of discrepancy between both, the radiation dose effectively delivered was determined based on the effective treatment time. For each treatment, the deviation (%) between the prescribed radiation dose and the delivered dose were calculated and categorized into four intervals: 0.0 % – 5.0 %, 5.1 % – 10.0 %, 10.1 % – 20.0 % and > 20.0 %.

2.5. Review of patient's treatment records

Alongside the dose re-calculation, a detailed analysis of the treatment parameters was performed, both in the R&V system and in the treatment chart, as well as a comparison between them. The review focused on identifying errors in; (i) prescription of radiation doses (total, fractional/daily and field dose), (ii) treatment planning (field sizes, beam and collimator angles, beam weightings and patient's setup instruction), (iii) data in R&V system in regard with data in the treatment chart.

The most common events (defined here as "unwanted or unexpected change from a normal system behaviour that causes or has the potential to cause an adverse effect to persons or equipment [10]) were then identified, together with the major causes. The waiting periods (time from treatment planning date to treatment start date) for each treatment course were determined and categorized into four intervals: ≤30 days, 31–60 days, 61–99 days, ≥100 days.

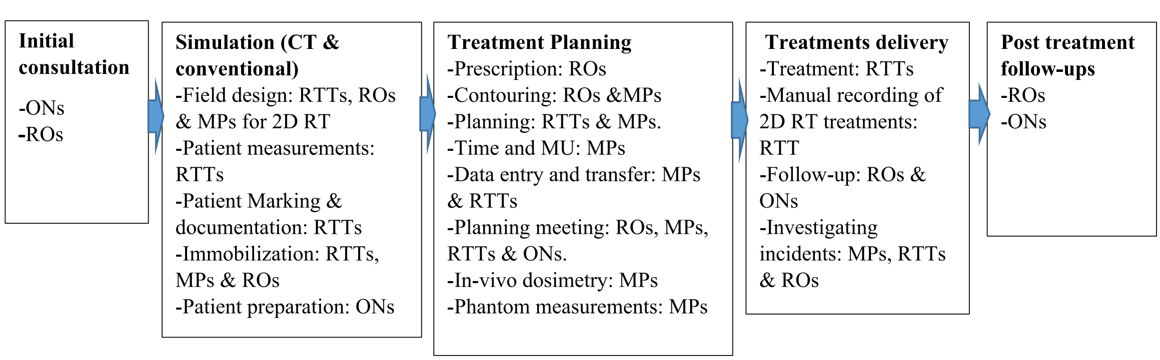

Fig. 1. General work flow for planned patient treatments at Radiation Oncology Division. The figure gives the different radiotherapy staff (RO- Radiation Oncologist, MPs- Medical Physicists, RTTs- Radiation therapists, ONs- Oncology nurses) responsible for each activity at the five major steps in the radiotherapy treatment process. 2D RT: Two-dimensional radiotherapy.

2.6. Compliance with completing selected radiotherapy activities

For each of the 1164 patients considered, the level of compliance of the RTTs, MPs and ROs in completing selected activities was evaluated.

- ROs: provide staging, sign prescriptions and treatment plans.
- RTTs: sign simulated treatment plans and manually enter patients in R&V system.
- MPs: Perform manual calculations of treatment time, sign against calculations they perform and manually enter patient's data in R&V system.

For each activity, the number of patients for which the activity has been completed was determined and expressed as a percentage of the total number of patients in the study.

3. Results

3.1. Key parameters of reviewed treatments

The key parameters of the treatments discussed in this study were summarized and presented in Table 1. These include treatment sites, treatment aim, and the most commonly adopted radiotherapy schemes (fractional dose and number of treatment fractions).

3.2. Dosimetric events

Dosimetric events were classified according to their frequency of occurrence and the results are presented in Table 2.

3.3. Procedure related events

Noted procedure related events included: incomplete or lack of setup instructions, incomplete daily treatment records, long waiting time and frequent machine breakdowns.

Table 2
Most commonly identified dosimetric events.

S/ No.	Event type	Occurrence	Percentage
1	Omission of tray factor	48	28.6
2	Use of incorrect field size (at calculation & treatment)	20	11.9
3	Incorrectly stated prescription depth at planning	17	10.1
4	Omission of bolus effect in treatment time calculation	17	10.1
5	Incorrectly indicated prescription dose at planning	15	8.9
6	Omission of couch transmission factor	10	6.0
7	Incorrectly stated beam weighting at planning	9	5.4
8	Wrong calculation checks	8	4.8
9	Incorrect documentation of daily doses at treatment	8	4.8
10	Only one field indicated as treated	6	3.6
11	Incorrect decay factors	4	2.4
12	Omission of wedge factor	2	1.2
13	Omission of SSD factor	2	1.2
14	Interchange of field data (Tans & S/clav)	2	1.2
	TOTAL	**168**	**100.0**

Note: Tans: - tangential breast fields and S/clav: - supraclavicular field.

3.4. Compliance with completing selected radiotherapy activities

The results are presented in Fig. 2. For most activities, compliance improved with time. ROs are the most compliant. Least compliance is seen in the signing of simulated treatment plans by the planning RTT.

3.5. Treatment time/dose re-calculation

The results show that in 88.0 % of the re-calculated treatment times for the 1412 sites, the doses used to deliver treatments were within ± 5 % of the prescribed doses as seen in Table 3.

An increase in calculation accuracy over the years from 2018 to 2020

Table 1
Key parameters of the 1164 patients reviewed.

Group	Treatment site	Treatment Aim	No. of patients in Group	Dose/fraction (Gy/#)	No of fractions (#)
1	Cervix	Curative	362	1.8, 2.0	28, 25
		Palliative	67	4.0, 8.0, 10	5, 1
		Adjuvant	91	1.8, 2.0	28, 25
2	H&N	Curative	61	1.8, 2.0	25, 28, 33
		Palliative	63	3, 4, 8, 10	10, 5, 1
3	Breast	Curative	3	2.0, 2.7	25, 15
		Palliative	27	3, 4, 8, 10	10, 5, 1
		Adjuvant	89	2.0, 2.7	25, 15
4	Oesophagus	Curative	4	2	23
		Palliative	59	8, 10, 4, 3	10, 5, 1
5	Prostate	Curative	4	3	15
		Palliative	50	10, 8, 4, 3	1, 5, 10
6	Brain	Curative	5	1.8, 2.0	25, 28, 30
		Palliative	21	4.0, 8.0	5, 1
7	Rectum	Curative	12	1.8, 2.0	28, 25
		Palliative	15	10, 8, 4, 3	1, 5, 10
8	Pelvis*	Curative	11	1.8, 2.0	34, 30, 25
		Palliative	25	3.0, 10.0	10, 1
9	Gyne*	Curative	21	1.8, 2.0	28, 25
		Palliative	16	3.0, 4.0, 10	10, 5, 1
10	Lung	Curative	0	0	0
		Palliative	6	4.0, 8.0	5, 1
11	Others	Curative	51	1.8, 2.0, 3.0	25, 28, 30, 33
		Palliative	101	10, 8, 4, 3	1, 5, 10

Note: Highlighted in red are the commonly used fractional doses and number of treatment fractions. Gyne*: - includes vulva, endometrial, vaginal and ovarian cancers. Pelvis*: - excludes prostate, rectum, cervix and Gyne*.

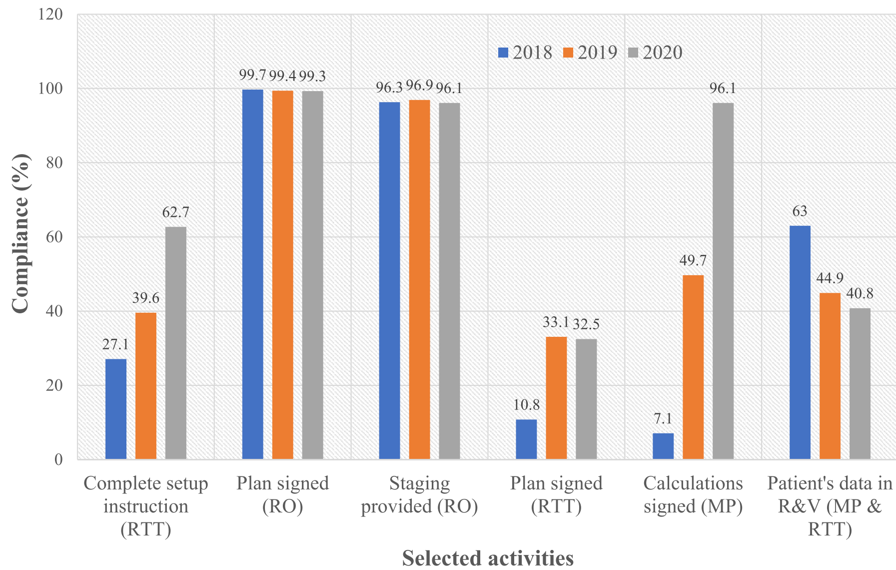

Fig. 2. Bar chart showing compliance by the different staff (RTT- Radiation therapist, RO- Radiation oncologist, MP- Medical Physicist) in completing selected activities in the radiotherapy treatment process for 3 consecutive years. In brackets next to each activity is the responsible staff for that activity. R&V: Record and verify.

Table 3
Categorization of dose calculation accuracy over 3 consecutive years.

Period (year)	Percentage (%) of discrepancy between planned doses and the doses used to deliver actual treatments.					Total sites
	≦ 5.0	5.1–10.0	10.1–20.0	> 20.0	Missing data	
2018	82.8	10.8	3.0	2.3	1.1	435
2019	86.1	7.3	1.9	2.6	2.1	420
2020	93.2	2.9	1.8	0.2	1.9	557
2018–2020	88.0	6.2	1.8	2.0	2.0	1412

Note: Missing data refers to treatment courses for which an independent re-calculation couldn't be carried out due to insufficient treatment planning and prescription information.

Table 4
Categorized patients' waiting periods for 3 consecutive years.

Period	Number of treatment courses per waiting period (days) category					Total Courses
	Average	≧ 100	61–99	31–60	≦ 30	
2018	13.0	0	8	37	349	394
2019	15.8	4	12	78	351	445
2020	15.8	18	22	55	453	548
2018–2020	15.1	22	42	170	1153	1387

was demonstrated. A total of 435, 420 and 557 re-calculations were carried out for patients treated in 2018, 2019 and 2020 respectively. Of these 82.8 % in 2018, 86.1 % in 2019, and 93.2 % in 2020 gave dose deviations within ± 5 % of the intended planned doses. Of the 1412 treated sites, 6.2 % had minor dosimetric events (dose deviation of 5 – 10 %), 1.8 % had moderate dosimetric events (dose deviation of 10.1 – 20 %) and 2.0 % had severe dosimetric events (dose deviations > 20 %).

3.6. Patient waiting period

A comparison of the waiting periods in years 2018, 2019 and 2020 was performed and the results presented in Table 4, showing an increase in the average waiting period from 2018 to 2020. Of the 1387 treatment courses, 1153 (83.1 %) were delivered within a month from the date of planning, which is standard of care, while 22 had waiting periods of more than 100 days.

3.7. Documentation of delivered treatments

Table 5 presents data on the number of delivered courses and fractions as recorded in the chart and in the R&V systems. The highest agreement in the number of delivered fractions as recorded in R&V and in the chart was observed in 2018, i.e.,107 (51.7 %) of the 207 courses recorded in the R&V system had the same number of recorded delivered fractions as in the chart.

Table 5
Number of recorded delivered courses for the selected study patients.

Period (year)	All courses	Courses in R&V	Courses with equal No. of recordedfractions in the chart & R&V
2018	394	207	107
2019	445	200	70
2020	548	186	80
2018–2020	1387	593	257

Note: Table 4 presents the total number of courses delivered in each year, the corresponding number recorded in the R&V system and the number of those courses in R&V with equal recorded treated fractions as in the treatment chart.

Table 6
Checklist for Radiotherapy treatments utilizing manual calculations, manual input of treatment parameters and manual recording of the treatments.

Treating RTT: ____________________________ Treatment unit: __________ Treatment time: ___________

Patient's Name: _______________________________RT No.: __________ Treatment date: ______________

Task requiring the attention of Radiation Therapists and Medical Physicists	**Response: Tick one**		
Part 1: One time check (Medical Physicist or Radiation Therapist)	**YES**	**No**	**N/A**
Does the patient's name and RT No. on treatment chart match the one on case file?			
Has the patient consented to radiotherapy?			
Did the patient provide any pregnancy history and has it been documented?			
Has diagnosis been provided?			
Has the site of the disease been provided and confirmed?			
Has staging been provided on the chart?			
Has all relevant simulation & treatment planning information been documented?			
Is the total prescribed dose provided?			
Is the dose per fraction correctly stated?			
Has the treatment fraction number been stated?			
Was the planned weekly treatment mentioned correctly?			

(*continued on next page*)

Table 6 (*continued*)

Is it possible to reproduce the treatment setup?			
Has the plan been signed by the prescribing Radiation Oncologist (RO)?			
Was the treatment time or monitor unit calculations been independently verified and signed by each physicist?			
Has the simulation Radiation Therapist signed against the simulation report?			
Is the provided setup information complete and sufficient?			
Has treatment technique, gantry and collimator angles been provided?			
Is the planned treatment depth or separation confirmed and correctly used for calculation?			
Has a wedge, tray or couch and/or bolus advised and effect considered during calculation?			
Has the correct beam weighting been used at calculation?			
Part 2: Daily checks by RTTs (Not to be filled but checked)			
Confirm that patient's name and RT No. matches that on the treatment chart			
Does the intended treatment position match the one provided at planning?			
Does the immobilization device (e.g. mask) still fit the patient?			
Does the provided field size in the chart match the one on the patient?			
Are the field arrangement matching disease site mentioned?			
Is shielding block mentioned in the chart & is it implemented at treatment?			

(*continued on next page*)

Table 6 (*continued*)

Has the patient setup been stated (SSD or isocentric)?			
Is the dose per field as stated at planning?			
Is the treatment time or monitor unit entered as per treatment chart?			
Which treatment fraction is to be delivered today?			
Can treatment continue: Patient free from fever, vomiting, diarrhoea or pain?			
Does the patient has any radiation induced skin reaction?			
Was the patient treated and treatment documented?			
Was bolus advised to be used and placed on the patient's skin?			
Has a wedge been advised and the correct one used at treatment?			
Is a new treatment phase due and has dose calculation been re-done?			
Part 3: Additional checks (Radiation Therapist)			
Does the patient require Chemotherapy in addition to radiotherapy?			
Has the patient undergone blood test as required?			
Treatment start: - Is there need for an MP or RO to address issues related setup?			
Treatment start: - Is in-vivo dosimetry required and is the responsible staff available?			
Mid treatment: Is the patient receiving weekly review by RO as required?			
Last treatment: Deliver and send patient to RO for further action			

Please, provide the correct response for every task. Where the response is **NO**, seek help from the Medical Physicist, Radiation Oncologist or Radiation Therapist. If all responses provided are **YES**, treat the patient as planned.

3.8. Checklist for manual radiotherapy treatment procedure

A checklist was developed to cover all aspects of the external beam radiotherapy workflow for manual treatments, aiming to improve their safety (Table 6).

3.9. Staffing and equipment requirements for implementing a safety program

Table 7 shows the evolution of the number of patients, staff and equipment over the years and the additional number of staff required for the implementation of a safety program in Radiotherapy.

4. Discussion

Most events could be attributed to inadequate equipment and training, excessive workload, lack of communication, lack of planning and limited financial resources especially for equipment maintenance and purchase.

A striking example of inadequate training, we shall bring the most frequent dosimetric event, the omission of the block tray factor in treatment time calculation, resulting from a lack of knowledge of the medical physicist who was in charge of the commissioning process.

It is important to emphasize the improvement as of 2020 of the accuracy in dose calculation, probably resulting from the increase in the number of medical physicists from a single one in January 2018 to five in May 2019. This allowed introducing QA methods in January 2020 starting with a compulsory independent calculation check before treatment delivery [22]. The need for a compulsory independent calculation check followed lessons learned at the start of this study in January 2020. However, even in 2020, 4.9 % of the re-calculated plans still showed deviations higher than 5 %, which is of concern.

In-terms of procedures, the high compliance of the ROs could be explained by the relatively adequate size of the team (4 ROs). On the other side, the low number of RTTs (as few as two during some periods) and MPs (only one during some periods) in view of the high workload, might explain the lack of attention to documentation, most of their time being dedicated to the treatment of an overwhelming number of patients per day [2]. This is in agreement with other reported studies by Hendrick [5] and Clark [23].

The analysis of the causes of the increase in waiting time over the years showed multiple causes: first, a reduction in the number of RTTs (manpower shortage) from 8 to 2 during the period January 2018 to April 2019 which led to a reduction in daily working hours from 24 h to about 18.5 h in a day. Secondly, frequent and sometimes prolonged machine breakdowns because of inadequate servicing due to budget constraints [2,18]. As examples: on the Terabalt 80, breakdown of the hand pendant and timer error; on the Bhabhatron II: software malfunction affecting calibrations of mechanical movements between April 2018 and December 2019. Thirdly, the introduction of a fee per treatment fraction affected many patients who could not afford it and needed time to find financial resources to start treatment even after an interruption. Finally, the number of patients seeking radiotherapy services greatly increased over the years yet the investment in equipment in the only center in the country has been relatively slow (Terabalt 80 in 2018, Bhabhatron II in 2019, TrueBeam; 1 in 2021 and 2 in 2023). Similar studies identified the availability and affordability of radiotherapy services as one of the factors affecting cancer care in Africa [2].

An important element in QM of Radiotherapy is the use of a Record &Verify System (R&V). However, the very basic R&V systems controlling the Cobalt-60 machines require manual treatment data entry: out of the 1387 treated courses, only 593 (42.8 %) have been entered in the R&V system, less than half, which is made possible by the option of bypassing the R&V System and treating emergency and palliative cases in manual (service) mode rather than in treatment mode. Besides that, technical problems with one of the cobalt-60 units led to completely stopping the use of the R&V System in 2020 for a while. As of January 2021, with the exception of emergency treatments, MPs have taken the initiative to ensure that all courses are entered in the R&V System as long as the R&V system is operational.

A comparison between R&V and chart records showed an agreement in the number of recorded treated fractions in only 43.3 % of the 593 treated courses. Two main reasons could be responsible for this low number: (i) absence of a conventional simulator between January 2018 and July 2019, requiring determination of parameters like gantry and collimator angles at the treatment machine on the first day of treatment. This led to manual treatments of the first few fractions before entering the patient's data in the R&V system (ii) forgetting to manually record each treated fractions in the treatment chart.

Worth noting was that it was impossible to check the geometric accuracy of dose delivery between January 2018 and July 2019 in the absence of a conventional simulator. The installation of the conventional simulator in July 2019 led to a reduction in the use of incorrect treatment fields as the field parameters determined on this simulator were more accurate compared to clinical mark-ups.

Manual interventions (manual calculations, manual data entry into R&V system, manual recording in treatment charts) were identified as the most vulnerable steps in the treatment process [24]. Measures being implemented to address the above mentioned include: (i) compulsory independent checks of all physics calculations and data entries, (ii) introduction of patient specific QAs (in-vivo dosimetry for 2D and 3D CRT), (iii) weekly departmental planning meetings, (iv) the introduction of IRLS as a tool for quality control, (v) frequent mechanical checks on all treatment/simulator machines and (vi) the use of checklists as provided in section 3.7 above [25].

Table 7
Evolution of the number of staff, patients and equipment at the currently available Radiotherapy Center in Uganda.

Description	Number of available radiotherapy equipment and staff							
	2018	2019	2020	2021	2022	2023	Required	Gap
1. Equipment								
Co-60 EBRT unit	1	2	2	2	2	1	1	0
HDR Brachytherapy	1	1	1	1	3	2	3	1
Conventional simulator		1	1	1	1	1	1	0
CT simulator				1	1	2	2	0
3D TPS (computers)				2	2	6	6	0
Linacs (TrueBeam)				1	1	3	4	1
2. Staffing								
Medical physicist	1	5	8	8	9	8	10	2
Radiation Therapist	2	5	10	12	10	13	21	8
Radiation Oncologist	3	4	4	5	4	4	11	7
Radiation Oncology Nurse	3	3	4	5	5	5	13	8
3. Number of patients								
New referral	1,671	1,459	1,560	1,800	2,200	2,250		
Estimated re-treatments	585	511	546	770	660	675		
Total	2,256	1,970	2,106	2,430	2,970	3,038		

The use of more advanced radiotherapy equipment such as a simulator based on computed tomography, linear accelerators and computerized 3-dimensional treatment planning system is advised as this would lead to a dramatic improvement in quality of the treatments and safety due to the elimination of the manual data entry. However, filling the gaps in staffing presented in Table 7 [26,27] are as well necessary steps for the implementation of a safety program.

Implementation of the Failure Mode and Effects Analysis approach to quality management might allow to optimize the existing resources focusing them on the most risky steps in the radiotherapy treatment process at this facility.

5. Conclusions

Analysis of the events showed that they occurred at different stages of the radiotherapy process, and that the RTTs and MPs were mostly involved. Manual calculations of treatment times and their manual transfer to R&V Systems, as well as delivery of palliative and urgent treatments without simulation, are important elements leading to a lack of safety and quality. Learning from these events led to defining a series of quality management measures, and their implementation already started: weekly planning meetings, compulsory second calculation check, signature of the treating physician on prescription and treatment plan prior to treatment, use of checklists and verification of patient's data in the R&V systems. The recently implemented in-vivo dosimetry measurements using calibrated diodes at first fraction for all radical treatments will continue. A system for reporting and learning from incidents is being developed to continue the process of quality improvement by continuously learning from identified events.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Ethical approval

This study received ethical approval from Uganda Cancer Institute's Research and Ethics Committee (UCIREC) and from Uganda National Council for Science and Technology (UNCST).

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