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Towards a Kenyan National Quality Assurance program

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AIM

To report phase 1 results of a multi-institutional international collaborative quality assurance project assessing linear accelerator output accuracy and treatment planning system agreement.

INTRODUCTION

Kenyan Physicists Forum (KPF) was initiated in 2018 to establish a mechanism for peer support for Kenyan medical physics. By 2021, members of KPF included 24 Kenyan medical physicists (MPs) from 12 cancer centres, one MP from Princess Margaret (PM) Cancer Centre in Canada, and one MP from Atrium Health Wake Forest Baptist High Point Medical Center (HP) in the United States. Over the next 4 years, KPF conducted a seminar series based on topics chosen by Kenyan medical physicists.[1,2]

With the rapid expansion of cancer centres in Kenya, KPF shifted its focus in 2023 to developing a national quality assurance (QA) initiative. The aim was to evaluate agreement between treatment planning systems (TPS) and linear accelerator (linac) output across institutions.[3]

In 2024, the project received funding for an expansion of this work from a PM Global Cancer Program[4] Seed Grant. The project was designed in two phases: Phase 1 assesses basic commissioning accuracy using open fields, while Phase 2 evaluates shaped and modulated treatments. Seed grant funding was sufficient to support travel costs and honoraria for Kenyan medical physicists to conduct tests at up to 10 cancer centres. Additional support was received from the National Cancer Institute – Kenya, which enhanced the project's credibility among participating institutions and allowed for project expansion to any additional centres willing to participate.

We are pleased to report results of Phase 1 of the project.

FUNDING

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METHODS AND MATERIALS

Two 2-person Kenyan teams, based in either Nairobi or Eldoret, were assigned 5 cancer centres as determined by geographic location, and the North American (NA) team consisted of the NA members of KPF (Table 1). Testing occurred on weekends in collaboration with local cancer centre physicists (Table 2 and Figure 1). MU for delivery of 300 cGy at central axis points with a 6 MV photon beam was calculated with each institution's TPS for three rectangular field sizes and two depths. Measurements in a water tank using calibrated ion chambers and electrometers was completed with the same MU's, energy, field sizes and depths as the calculations. Electrometer readings were corrected for temperature and pressure, polarity, and ionization recombination. Ion chamber and electrometer calibration factors were used to calculate measured dose to water from the corrected readings. Measured dose was then compared to the 300 cGy expected dose. Instructions and a spreadsheet for documenting results were distributed to the two teams. Feedback was provided during bi-weekly meetings. Results were collated and evaluated.

Table 2: Participating Kenyan Centres and Physicists

Hospital	Location	Physicist
Cancer Care Kenya	Nairobi	Peter Loreh
Kenyatta University Teaching Referral & Research Hospital	Nairobi	Ian Chanzu
Moi Teaching and Referral Hospital	Eldoret	Evans Okwaro
Nakuru Referral and Teaching Hospital	Nakuru	James Ngure
Garissa County Referral Hospital	Garissa	Wilson Egadwa
Coast General Hospital	Mombasa	Bob Omondi
Ruai Family Hospital	Nairobi	Maxwel Songa
Eldoret Hospital	Eldoret	Lennox Koromicha
Kenyatta National Hospital	Nairobi	Aggrey Wakhule
Aga Khan	Nairobi	Saukat Ali

Gray font: measurements pending

RESULTS

To date, calculations and measurements were completed at 7 Kenyan and 2 NA institutions. TPS/accelerator combinations are RayStation/Elekta Infinity, Eclipse AAA/Varian VitalBeam or Clinac IX, Monaco/Elekta Harmony or Versa HD. Percent differences between calculated and measured doses ranged from -0.67 to +2.36% (Table 3) with an average and standard deviation of 0.44% +/-0.80% for all measurements. At one centre, the test was performed in PMMA due to a broken water tank. The higher results are being further investigated.

Table 1: KPF QA Teams

Team	Members	
Nairobi	Peter Loreh	Ian Chanzu
Eldoret	Evans Okwaro	Benjamin Mwangi
North America	Stephanie Parker	Monique van Prooijen

Figure 1: Kenyan Cancer Centres

Nairobi – only city with cancer centres prior to 2017
Eldoret – 1 private, 1 public
Others marked with green: opened between 2020 – 2023
Orange: up and coming centres after 2023

DISCUSSION

Results indicate that agreements between TPS prediction and accelerator output are largely (~88%, Kenya) within 2%. The higher results are being further investigated. The project shows that treatment systems in Kenya were commissioned accurately at multiple cancer centres, which indicates good potential for treatment quality comparable to high income countries.

The seed grant was essential for covering travel costs and provided additional incentive for participation. Coordination of fund transfers and travel bookings was challenging but was eventually resolved. There are still challenges with linac malfunctions and occasionally also equipment breakdown as evidenced by needing to use a PMMA phantom instead of a water tank at one centre. Flexibility is necessary when conducting international collaborations.

SUMMARY & CONCLUSIONS

A seed grant funded, two-phase international collaborative quality assurance project was designed and initiated by medical physicists in Kenya and North America. The aim of the project is to assess treatment planning system and linear accelerator output accuracy and agreement. Phase 1 measurements have been completed at 7 Kenyan and 2 NA cancer centres and showed reasonable (≦ 2.36%) agreement between TPS calculation and linear accelerator output for simple rectangular fields. Phase 2 will assess shaped and modulated fields. The results of Phase 1 indicate TPS and linear accelerator output in Kenya achieve agreement similar to those in HICs and that international peer collaborations can be successful, innovative, and impactful.

REFERENCES

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Table 3: Percent Difference Between TPS Calculation and Linac Measurement

Test point			Centre										
Field size, cm^2	SSD, cm	Depth, cm	1	2	3	4	5	6	7	8	9	average	st dev.
10 x 10	100	d_{max}	-0.41	0.22	2.24	0.40	0.38	-0.67	na	0.67	0.36	0.40	0.81
10 x 10	90	8	0.04	-0.56	1.28	0.24	0.55	0.63	2.36	-0.25	-0.18	0.46	0.85
8 x 8	90	8	0.21	-0.55	1.23	na	0.58	0.94	1.86	-0.25	-0.12	0.49	0.77
15 x 15	90	8	-0.06	-0.62	1.00	-0.21	0.69	0.79	2.00	0.29	-0.05	0.43	0.74
		average	-0.06	-0.38	1.44	0.14	0.55	0.42	2.07	0.12	0.00		
		st dev	0.23	0.35	0.48	0.26	0.11	0.64	0.21	0.39	0.21		

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