

RADIOLOGICAL AND MEDICAL SCIENCES RESEARCH INSTITUTE



GHANA ATOMIC ENERGY COMMISSION

ANNUAL REPORT

2015

ABBREVIATIONS

AEC	Automatic Exposure Control
AIDS	Acquired Immunodeficiency Syndrome
APP	Acute Phase Protein
APR	Acute Phase Response
ARBC	Applied Radiation Biology Centre
CCRC	Cellular and Clinical Research Centre
CRP	C-Reactive Protein
CT	Computerized Tomography
DNA	Deoxyribonucleic Acid
DTM	Dose to Mother
EBF	Exclusive Breastfeeding
FTIR	Fourier Transformed Infrared Spectrophotometer
GAEC	Ghana Atomic Energy Commission
GMIC	Ghana Medical Imaging Centre
GSFP	Ghana Society for Medical Physics
HAB	Harmful Algal Bloom
HIV	Human Immunodeficiency Virus
HPV	Human Papilloma Virus
IAEA	International Atomic Energy Agency
MBC	Minimum Bacterial/Bacteriostatic Concentration
MCNP	Monte Carlo Number Particles Code
MIC	Minimum Inhibitory Concentration

MICS	Multiple Indicator Cluster Survey
MDR-TB	Multi Drug Resistant Tuberculosis
MPECs	Micro nucleated Polychromatic Erythrocytes
MPN	Most Probable Number
MTB	<i>Mycobacterium tuberculosis</i>
MRDR	Modified Relative Dose Response
MRPC	Medical Radiation Physics Centre
MRI	Magnetic Resonance Imaging
NCDs	Non Communicable Diseases
NRC	Nutrition Research Centre
NIRS	National Institute of Radiological Sciences (Chiba, Japan)
OA	Ocean Acidification
PACT	Program of Action for Cancer Therapy
PCR	Polymerase Chain Reaction
PET	Positron Emission Tomography
PSA	Prostrate Stimulating Antigen
QUT	Queensland University of Technology
RAMSRI	Radiological and Medical Sciences Research Institute
RBP	Retinol-binding Protein
RDR	Relative Dose Response
SGMC	Sweden Ghana Medical Centre
SNAS	School of Nuclear and Allied Sciences
SOP	Standard Operating Procedure

SPECT	Single Photon Emission Computed Tomography
TB	Tuberculosis
TLD	Thermo Luminescent Dosimeter
TPS	Treatment Planning System
UG	University of Ghana
VAD	Vitamin A Deficiency
WAHRNET	West Africa Health Network
WHO	World Health Organization

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EXECUTIVE SUMMARY

The Radiological and Medical Sciences Research Institute (RAMSRI) is the fourth Research and Development Institute of the Ghana Atomic Energy Commission (GAEC), undertaking research in human health and nutrition. The major activities undertaken by RAMSRI for the year 2013 include:

- Conducting and supervising the applications of ionizing radiation for the diagnosis and the treatment of cancer in Ghana, with focus on Radiotherapy and Nuclear Medicine Techniques.
- Strengthening capability in medical diagnostic imaging to allow Physicians to obtain rapid and reliable diagnosis and for monitoring the effectiveness of treatment of cancer and other degenerative disorders.
- Development of biodosimetry to help promote emergency response (emergency medicine) methods for biological dose assessment in event of over exposure to ionizing radiation and strengthening capacity in biological dosimetry in Ghana and Africa.
- Application of Molecular Techniques to Interventions against the Major Poverty Related Diseases (HIV, Tuberculosis and Malaria) and the management of communicable diseases (Tuberculosis and Malaria).
- Application of stable isotope techniques to evaluate, monitor and improve nutrition interventions in vulnerable groups such as children, pregnant and lactating mothers.
- Human resource development in the radiological sciences, radiation protection and safety by promoting training of professionals in the medical sciences, health sciences and the nuclear sciences in general. The facilities of the Institute were also made available for the training of students from the universities, other tertiary institutions and hosting of IAEA fellows.
- Research to enhance clinical safety, protection of workers, the public and the environment from the harmful effects of ionizing radiation.

The year has been a success amid challenges with sixteen (16) publications in refereed journals, seven (7) conference proceedings, two (2) chapter in books, one (1) book, fifteen (15) manuscripts in press and fifteen (15) technical reports. It is evident therefore that when these challenges are addressed, work output will increase tremendously.

1. ESTABLISHMENT

The Radiological and Medical Sciences Research Institute was established by Act 588 of 2000 in 2009, as the fourth institute of the Ghana Atomic Energy Commission. It is being nurtured into a complex, composed of research centres and a hospital with a radiation emergency medical facility to serve as a Regional Centre for Research in Cancer and Medical Diagnostic Imaging.

1.1 Vision

To be the leading Medical Research Institution in Ghana, employing Nuclear Techniques to promote Human Health and Nutrition.

1.2 Mission

To contribute to Public Health delivery through Medical Application of Nuclear and Isotopic Techniques and Radiation related devices for the reduction of cancer incidence in Ghana and Africa. To advance research performance in Radiation Medicine, Cancer Treatment, Medical Imaging, Diagnostic Molecular Biology and Nutrition for improved Healthcare delivery.

1.3 Strategic Objectives

RAMSRI is envisaged to be a leading Medical Research Institute in Ghana with the following objectives:

1.3.1 *Cutting-Edge Research*

- To establish radiation treatment and diagnostic protocols customized to cancers peculiar to our environment, using a combination of physical dosimetry and radiobiology to improve diagnoses and treatment outcomes.
- To reduce the national disease burden of poverty-related infectious diseases through research, using molecular biology and related radioisotope techniques.
- To improve the health and nutritional status of Ghanaians particularly the vulnerable, through inter-disciplinary research, using nuclear and related isotopic techniques.
- To enhance the quality of life through nutrition and health-related environmental studies.

1.3.2 *Healthcare Delivery*

- To adopt and accelerate research findings into health solutions.
- To initiate research into niche clinical programmes.

- To invite, involve and respond to the communities we serve.
- To fulfill expectation for efficient biomedical service delivery.
- To engage in the highest quality Biomedical Research which will enhance and support effective medical care.

1.3.3 Training and Human Resource Development

- To recruit, train and retain world-class talent in Biomedical Research and Education and Healthcare.
- To invest effectively in facilities, infrastructure and programmes in order to achieve RAMSR's priority strategies.
- To utilize best practices and multilateral collaboration to achieve effective management and enhance productivity.

2. COLLABORATIONS

2.1 National Institutes

- National Centre for Radiotherapy and Nuclear Medicine, Korle-Bu Teaching Hospital.
- Oncology Directorate, Komfo Anokye Teaching Hospital.
- Noguchi Memorial Institute for Medical Research.
- University of Ghana Medical School.
- Centre for Scientific Research into Plant Medicine.
- Global Medical Imaging Centres (GMIC) & GAEC Nuclear Medical Centre.****

2.2 International Institute

- National Institute for Radiological Sciences (NIRS), Chiba, Japan.

2.3 Purpose of Establishing Collaborations

- Establish a Memorandum of Understanding for Networking in the following areas;
 - ✓ Develop collaborative research activities.
 - ✓ Share resources for Research & Development.
 - ✓ Develop education and training programmes.
- Request Senior Management Staff to serve on the Board and Research & Development Committees of RAMSRI.
- Assist in developing a Strategic and Corporate Plan for the Institute.
- In collaboration, formulate and run Postgraduate programmes (MPhil and PhD) at the Graduate School of Nuclear and Allied Sciences.

3. PERSONNEL AND ORGANISATION

RAMSRI operates under a Directorate and five Scientific and Technical Centres namely:

- a. Applied Radiation Biology Centre.
- b. Cellular and Clinical Research Centre.
- c. Nutrition Research Centre.
- d. Medical Radiation Physics Centre.
- e. Radiopharmacy and Nuclear Medicine Centre.

The structure of the Institute is captured in the organogram below:

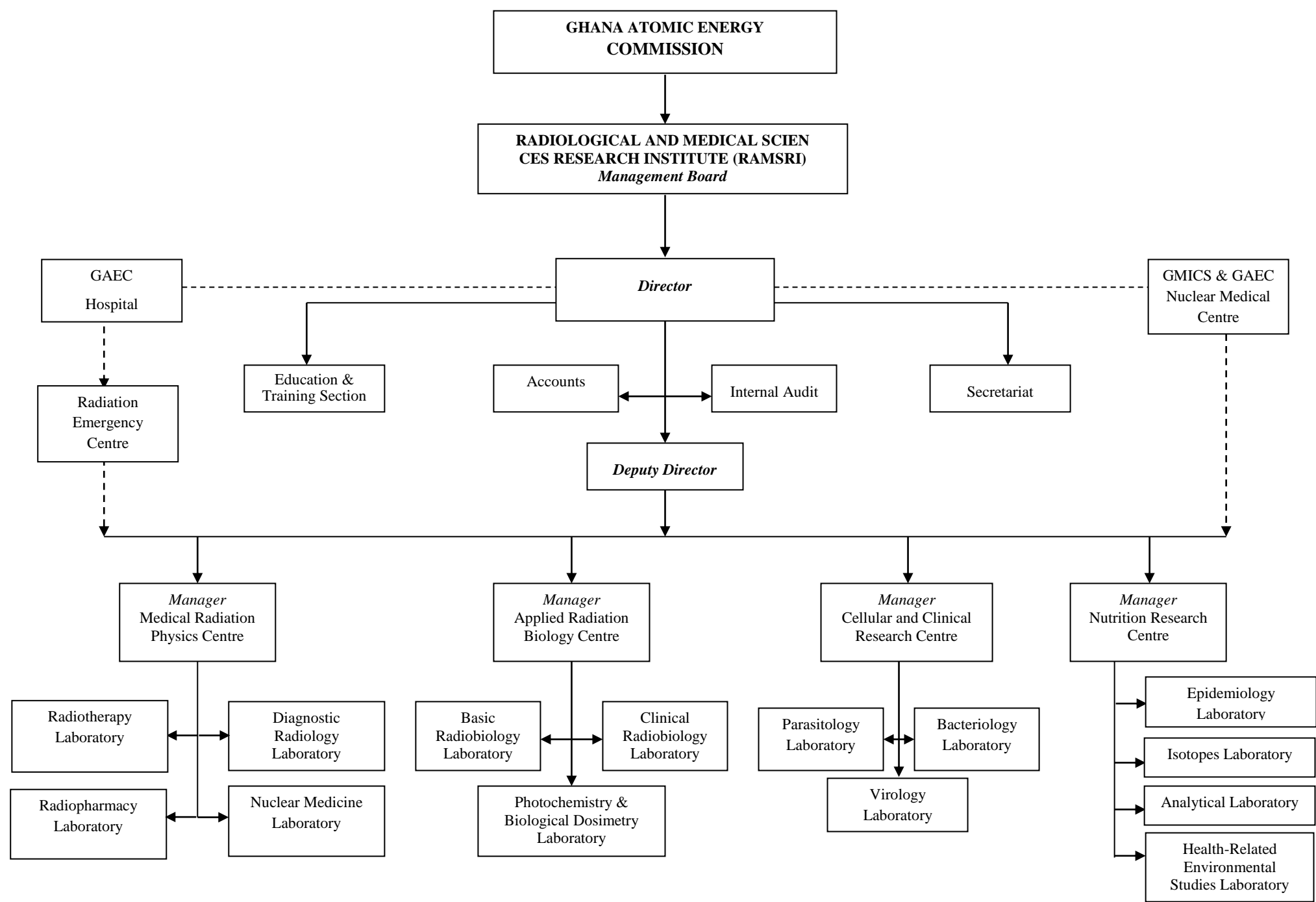


Fig. 1: Organizational Chart of the Radiological and Medical Sciences Research Institute (RAMSRI)

3.1 Staffing

3.1.1 Existing staff, qualification and rank

3.1.2 Research Scientists

Name	Qualification	Position/ Rank
Dr. Mary Boadu	PhD Physics	Director / Principal Research Scientist
Dr Rose Boatin	PhD Biochemistry	Deputy Director/Senior Research Scientist
Dr Daniel Achel	PhD Radiation Biology	Manager / Senior Research Scientist
Ms Theodosia Adom	MPhil Nutrition	Manager / Senior Research Scientist
Mr Oti Gyamfi	MPhil Chemistry	Manager / Research Scientist
Mr Edem Sosu	MPhil Medical Physics	Manager / Research Scientist
Mr Theophilus Sackey	MPhil Medical Physics	Research Scientist
Mr Francis Hasford	MPhil Medical Physics	Research Scientist
Mr Lawrence Akono Sarsah	MPhil Nuclear and Radiochemistry	Research Scientist
Mr Godfred Odame Duodu	MPhil Nuclear and Radiochemistry	Research Scientist
Ms Nana Afua Kobi Adu-Bobi	MPhil Biotechnology	Research Scientist
Mr Shadrak Donkor	MSc Chemical Pathology	Research Scientist
Ms Elom Achoribo	MPhil Nuclear and Radiochemistry	Research Scientist
Mr Adolf Awua	MPhil Biochemistry	Research Scientist
Ms Edna Dzifa Doe	MPhil Chemical Microbiology	Research Scientist
Mr Stephen Odonkor	MPhil Microbiology	Research Scientist
Mr Shirazu Issahaku	MPhil Medical Physics	Assistant Research Scientist
Mr Ernest Eduful	MPhil Medical Physics	Assistant Research Scientist
Mr Mark Pokoo-Aikins	MPhil Medical Physics	Assistant Research Scientist
Ms Theresa Bebaaku Dery	MPhil Medical Physics	Assistant Research Scientist
Mr Akwasi Akomea Agyekum	MPhil Food Science	Assistant Research Scientist
Ms Felicia Akuamoa	MPhil Radiation Processing	Assistant Research Scientist

3.1.3 Technical Staff

Name	Qualification	Position/Rank
Mr Dominic Dombire Datohe	BSc Applied Biology	Principal Technologist
Mr Rudoph Mba	BSc Laboratory Technology	Senior Technologist
Kofi Bedzra	BSc Laboratory Technology	Senior Technologist
Mr Christian Brown-Appiah	BSc Laboratory Technology	Technologist
Ms Akusika Diaba	HND Laboratory Technology	Technologist
Ms Sandra Agbenyegah	BSc Molecular Biology and Biotechnology	Technologist
Mr Kingsley Nsowah	BSc Laboratory Technology	Technologist
Mr Kennedy Amewosina	HND Laboratory Technology	Technologist
Ms Yaa Pokuaa Akomea	MSc Public Health Nutrition	Technologist

3.1.4 Administrative Staff

Name	Qualification	Position/Rank
Mr Charles Frimpong	MPA Public Administration	Administrative Officer
Mr Michael Torkutsah	Royal Society of Arts (Stage 111)	Chief Accounting Assistance
Mrs Leticia Ofosu-Yirenkyi	BA Business Studies	Principal Administrative Assistant
Mr Joachim Dadzie	SSCE	Senior Departmental Assistant

3.2 Staff Promotion

Staff	Rank/Grade: From	Rank/Grade: To	Date
Joachim Dadzie	Departmental Assistant	Senior Departmental Assistant	01-01-2015

3.3 Staff Upgrade

Staff	Rank/Grade: From	Rank/Grade: To	Date
Stephen Tawiah Odonkor	Research Scientist	Research Scientist (with PhD)	12-10-2015

Kennedy Kwame Amewosina	Senior Technician	Technologist	01-10-2015
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3.4 Staff Development

Staff	Institution	Programme	Research Title	Begin	Complete
Francis Hasford	SNAS, Univ. of Ghana, Atomic Campus	PhD Medical Physics	Ultrasound, PET/CT Image Fusion for Prostrate Brachytherapy Image Guidance	2011	2015
Adolf Kofi Awua	School of Public Health, University of Ghana	PhD Epidemiology (Public Health)	Human Papilloma Virus Infection and Cervical Lesions among Women in a High Risk Population; In Two Sub-Districts of the Lower Manya Krobo District, Ghana.	2011	2015
Theophilus Akumea Sackey	University of Ghana	MPhil. Medical Physics	Cancer Risk Assessment of Patients undergoing Computed Tomography (CT) Scan at the Korle-Bu Teaching Hospital	2013	2015
Edem Sosu	University of Cape Coast, Ghana	PhD Physics	Optimization of Radiological Protection of Patients undergoing Diagnostic Radiology Examination in Ghana	2013	2016
Godfred Odame Duodu	Queensland University of Technology, Australia	PhD Analytical and Environmental Chemistry	Characterization of Heavy Metals and Persistent Organic Pollutant Residues in Brisbane River Sediment	2013	2017
Yaa Pokuaa Akomea	Southampton University, United Kingdom	MSc Public Health Nutrition	Risk Factors for Anaemia among Children under Five in Ghana	2013	2014
Oti Kwasi Gyamfi	School of Biological Sciences, University of Cape Coast	PhD Molecular Biology and Biotechnology	Molecular Characterisation of <i>Mycobacterium tuberculosis</i> -complex in Selected Prisons in Health Centres in Ghana	2014	2017

Theodosia Adom	University of the Western Cape, South Africa	PhD Public Health	Individual and Environmental Factors Associated with Obesity among Young Children in Primary Schools in Ghana	2014	2018
Daniel Achel	Stellenbosch University, Cape Town	Post-Doctoral Fellowship	Protein Biomarkers for Radiation Dosimetry	2014	2015
Rudolph Mba	University of Ghana Medical School	MPhil Medical Biochemistry	Cytogenetic Damage in Radiation Workers of Selected Hospitals in Accra	2014	2016
Shirazu Issahaku	University of Cape Coast	PhD	Measurements of Renal Dimensions to Determine the Volumetric Ellipsoid Coefficient of Renal Volume Model for Clinical Applications in Ghana	2014	2017
Elorm Achoribo	IRSS de la Sante, Bobo-Dioulasso, Burkina Faso	Young Scientist Award Fellowship	Evaluation of Antimalarial Activity of <i>Vernonia colorata</i> against <i>Plasmodium berghei</i> , anka, in NMRI Mice	2014	2015
Elom Achoribo	Universiti Sains (USM) Malaysia	PhD	Screening for Anticancer Properties into Ghanaian Medicinal Plants	2015	2018
Dominic Datohe	University of Ghana	MPhil Nutrition		2015	2017
Sandra Agbenyegah	Technische Universitat, Germany	MSc Radiation Biology		2015	2017
Akusika Diaba	Accra Polytechnic	Bachelor of Technology		2015	2016
Mark Pokoo-Aikins	University of Cape Coast	PhD Physics	<i>In-Vivo</i> and <i>Ex-Vivo</i> Transit Dosimetry with Electronic Portal Imaging Devices (EPID) for Prostate External Beam Treatments	2015	2018

Theresa Derry	University of Cape Coast	PhD Physics	Validation of Planned Radiation Absorbed Dose for Breast Cancer Patients Using Thermoluminescent and Radiochromic Film Dosimeters	2015	2018
Ernest Eduful	University of Cape Coast	PhD Physics	Assessment of Doses for Radio Sensitive Organs in Thyroid Cancer Patients by the use of ^{124}I PET and MatLab-3D Internal Dosimetry Algorithm	2015	2018
Joachim Amonoo Dadzie	University of Professional Studies	HND Business Management		2011	2015

4. MAJOR ACTIVITIES

4.1 Major facilities for Research and Technical Services

The following facilities, under the respective Centres are available for research, clinical and technical services.

4.1.1 Nutrition Research Centre:

- 4.1.1.1 Fourier Transformed Infrared Spectrophotometer (FTIR).
- 4.1.1.2 UV Spectrophotometer.
- 4.1.1.3 Eppendorf Centrifuge.
- 4.1.1.4 Bio-electrical Impedance.
- 4.1.1.5 Freeze Drier.
- 4.1.1.6 Skin Fold Callipers.
- 4.1.1.7 Stadiometers.
- 4.1.1.8 -80°C Freezer

4.1.2 Applied Radiation Biology Centre:

- 4.1.2.1 Hybridization Oven.
- 4.1.2.2 Blood Analyser (Coulter A^cT).
- 4.1.2.3 Gamma Well Counter.
- 4.1.2.4 Inverse (3650.0000) Inverted Microscope.
- 4.1.2.5 DC 3-163 Digital Microscope.
- 4.1.2.6 Microbiological Safety Cabinet.
- *4.1.2.7 Multiskan Ascent ELISA System.
- 4.1.2.8 Gel Logic 200 Imaging System.
- 4.1.2.9 CO₂ Incubator HERA Cell[®] 240.
- 4.1.2.10 TC-412 PCR System.

4.1.3 Medical Radiation Physics Centre:

- 4.1.3.1 Computerized Tomography (CT).
- 4.1.3.2 Magnetic Resonance Imaging (MRI) Machine.
- 4.1.3.3 3D Treatment Planning System with Conformal and Intensity Modulated
Radiotherapy capability, electronically linked to MRI and CT.
- 4.1.3.4 Co-60 Teletherapy unit.
- 4.1.3.5 Simulator.

- 4.1.3.6 Cs-137 Brachytherapy machine.
- 4.1.3.7 C-arm X-ray machine.
- 4.1.3.8 Dosimetry equipment e.g. Ionization chambers, dosimeters, water phantom,
(NE 2528 / 3 B), PMMA phantom type 2967
- 4.1.3.9 Automated TLD Reader.
- 4.1.3.10 X-ray generator.
- 4.1.3.11 RTI Piranha QC system with dose probe
- 4.1.3.12 RTI Chamber adapter with CT calibration chamber
- 4.1.3.13 PMMA Mammography breast phantom
- 4.1.3.14 Ocean 2014 Professional software

4.1.4 Radiopharmacy and Nuclear Medicine Centre:

- 4.1.4.1 Dose calibrator.
- 4.1.4.2 Laminar flow hood.
- 4.1.4.3 Survey meters.
- 4.1.4.4 Class II safety cabinet.
- 4.1.4.5 Radioaerosol system.
- 4.1.4.6 Single head SPECT camera.

4.1.5 Cellular and Clinical Research Centre:

- 4.1.5.1 1Biorad Dyad® DNA Engine Thermal Cycler For amplification of Nucleic acids.
- 4.1.5.2 Alpha DigiDoc RT2 Gel Documentation and Analysis System.
- 4.1.5.3 MN 45 Miniblotter Apparatus and associated Dot-blot Apparatus.
- 4.1.5.4 Centrifuges (including one refrigerated) and Autoclaves.
- 4.1.5.5 Hybridisation Chamber/Oven.
- 4.1.5.6 Bio-safety laminar flow workstation and Bio-safety Laminar Flow Hood.
- 4.1.5.7 Two (2) high capacity Microbiological Incubators.

5.0 RESEARCH AND DEVELOPMENT

The following research projects were undertaken during the year under review by the respective centres of the institute.

5.1 NUTRITION RESEARCH CENTRE

5.1.1 Project Title: Applying Nuclear Techniques to Design and Evaluate Interventions to Reduce Obesity and Related Health Risks.

Research Team: T Adom¹, R Boatın¹, K Nyarko², M Steiner-Asiedu³, G Egbi⁴, D Datohe¹, C Brown¹, A Diaba¹, K Amewosina¹, Y P Akomea¹

¹ Nutrition Research Centre, Radiological and Medical Sciences Research Institute, Ghana Atomic Energy Commission

² Disease Control and Prevention Dept, Ghana Health Service P. O. Box KB 493 Korle – Bu, Accra – Ghana

³ Department of Nutrition and Food Science, University of Ghana, Legon

⁴ Noguchi Memorial Institute for Medical Research, University of Ghana

This is an IAEA sponsored project (Code: RAF6042). Project commenced in 2012 and will be completed in 2016.

Executive summary

The main objective this project is to inform the design and improvement of interventions aimed at prevention and control of obesity and related health risks such as hypertension among school children in Africa. WHO has highlighted childhood obesity as one of the most serious health challenges of the 21st century. Obese children are at greater risk of non-communicable diseases (NCDs) such as cardiovascular disease, diabetes and stroke in adulthood. Childhood obesity has increased over the past two decades from less than 1% in 1988 to 5% in 2008; 5% of Ghanaian children under 5 are overweight or obese. Overweight prevalence was high in children in urban areas, among educated mothers, and mothers who live in wealthier households. Current national representative prevalence in school children is limited despite the related health risks associated with these problems.

Stable isotope techniques will add value by increasing the sensitivity of measurements in assessing nutritional status (body fat), total energy expenditure and physical activity. Eleven (11) Member States are participating: Benin, Ghana, Kenya, Mali, Mauritius, Morocco, Namibia, Senegal, Tunisia, Uganda and United Republic of Tanzania.

Three schools were visited for sensitisation, parental informed consent and child assent. Verbal assent was obtained from all pupils whose parents/guardians consented to their participation. Participants were interviewed using study-specific questionnaire to obtain information on age, knowledge and attitudes towards obesity, lifestyle and health and physical activity levels. Information on socio-economic characteristics of the parents/guardians was also be obtained. To assess body composition, anthropometric data (body weight, standing height, mid-upper arm circumference, waist and hip circumference) and deuterated saliva samples were collected. Physical activity was objectively measured in a sub-sample using Actigraph accelerometry. Blood pressure was measured with OMRON, a digital automated blood pressure monitor using appropriate cuff sizes in the right arm. Fasting blood sugar levels were measured with a glucometer and test strips. In each school, the head or their representative completed school environment and audit surveys questionnaires, complemented by trained research assistants who completed the audit forms. The rationale for the school environment survey and audit is to assess the physical, social and policy environment in terms of healthy eating and physical activity in the schools that form the basis of the RAF6042 project in Africa. Questions were asked regarding health promotion, physical activity, sporting facilities, nutrition environment and practices like school feeding scheme, and availability of tuck shops/vendors in and around the schools. A total of one hundred and ninety-five pupils (195) have been sampled in four (4) schools (Adjiringanor AdMA, ICODECS, Sowa Din 1 and Sowa Din 2 Basic Schools).

Deuterated saliva samples were analysed with the FTIR for deuterium enrichment. A Microsoft Excel spreadsheet developed by the Medical Research Council-Human Nutrition Research (MRC-HNR), Cambridge, United Kingdom, was used to estimate the body composition (fat free mass and fat mass) using age- and gender- specific hydration factors. Actigraph data was downloaded and analysed using ActiLife Data Analysis Software version 6.10.4., in Morocco at the Regional Designated Centre for Nutrition (AFRA/IAEA). Data entry was done with the Epidata 3.1. Data compilation and analysis are ongoing.

It is expected that the study will provide more accurate data on the prevalence of overweight and obesity, the health risk factors as well as energy expenditure among school children in Africa thereby contributing to a situation assessment report in countries where obesity is a growing problem and strengthening existing intervention programmes in countries where obesity has already become a major public health problem. Moreover information will be useful by policy makers to develop and design appropriate interventions to address the problem.

5.1.2 Project Title: Using Stable Isotope Techniques to Monitor and Evaluate Vitamin A Status of Children Susceptible to Infection.

Research Team: R. Boatin¹, T. Adom¹, G. Egbi², S. Newton³, D. Datohe¹, C. Brown-Appiah¹, Y. P. Akomea¹, A. Diaba¹ and K. Amewosina¹

¹ Radiological and Medical Sciences Research Institute, Ghana Atomic Energy Commission

² Noguchi Memorial Institute for Medical Research, University of Ghana

³ College of Health Sciences, Kwame Nkrumah University of Science and Technology

This is an on-going project, sponsored by the IAEA (Code: RAF6047). The project commenced in 2014 and due to be completed in 2019.

Executive summary

The overall objectives of this project are; 1)To evaluate the effects of ongoing vitamin A programmes in Member states on the vitamin A status of preschool children and 2)To assess the impact of clinical and subclinical inflammation on vitamin A status of preschool children.

Vitamin A is an essential nutrient needed for the visual system, maintenance of cell function for growth, epithelial integrity, red blood cell production, immunity and reproduction. All infants are born with low stores and depend on vitamin A from breast milk to initially accumulate and maintain adequate stores. Infants of vitamin A-depleted women are at greater risk of becoming vitamin A deficient early in life, especially if they are not breast fed. Vitamin A deficiency is a major nutritional concern in poor societies, affecting 190 million children globally, the leading cause of preventable blindness in children and is associated with a higher mortality risk. Correcting vitamin A deficiency is addressed by some African

countries through vitamin A supplementation of children and food fortification programmes. However, assessing vitamin A status and the effectiveness of government interventions is challenging in settings where infectious diseases are endemic, as in most African countries. Evaluation of vitamin A status is relatively insensitive when based on changes in serum retinol concentrations, which are homeostatically controlled and negatively affected by subclinical infections. Liver stores of vitamin A, the best indicator of vitamin A status, cannot be routinely evaluated. The proposed IAEA project (RAF 6047), an African Regional Project, aims to use stable isotope dilution techniques to monitor and assess the vitamin A status in preschool children susceptible to infection. This is the only indirect assessment method that provides a quantitative estimate of vitamin A across the continuum of deficient to excessive stores. Thus, this technique can be used for assessing vitamin A status in populations at risk of excessive status due to exposure to too much vitamin A through combined supplementation and consumption of fortified foods and/or preformed vitamin A-rich foods. The study is multi-centered with participation from eleven (11) IAEA member states namely, Botswana, Burkina Faso, Cameroon, Ethiopia, Ghana, Morocco, Senegal, South Africa, United Republic of Tanzania, Tunisia and Zambia. To address the primary study objectives, three (3) study designs will be conducted across the study sites. Ghana's team as well as Botswana, Ethiopia and Malawi will be involved in overall objective 1: To evaluate the effects of on-going country level vitamin A programmes on vitamin A status of preschool children. The specific objectives to achieve this are: i) To compare vitamin A assessment using stable isotope and conventional methods (serum retinol concentrations); - ii) To assess individual-level exposure to vitamin A, using dietary intake, history of vitamin A supplementation, intake of fortified foods, etc. to support stable isotope findings; and - iii) To evaluate the possibility of vitamin A excess in settings of multiple exposures of vitamin A interventions.

The other countries will be involved in part of objective 1, and overall objective 2: To assess the impact of clinical and subclinical inflammation on vitamin A status of preschool children. To achieve this, specific objectives will be; - i) To assess the effects of biannual vitamin A supplementation on vitamin A status, before and after supplementation;- ii) To assess the prevalence of clinical infections (e.g., fever, malaria, diarrhoea, respiratory illness, stool helminthic infection, TB, etc); and- iii) To assess the effects of acute phase proteins (e.g., CRP and AGP) on vitamin A indicators both in settings of acute clinical infection, as well as subclinical inflammation.

Ghana developed and submitted its protocol for ethical clearance in December, 2014 and was awarded ethical clearance in November, 2015 by the Radiological and Medical Sciences Research Institute's Ethical Review Committee. Ghana participated in a training workshop on Field Implementation of Assessing Vitamin A Status using Stable Isotope Dilution Technique on 4th-8th May, 2015 in Yaounde, Cameroon. Ethical clearance certificate together with protocol are being used by research team to solicit for funds for the local running of the project.

5.1.3 Project Title: Risk Factors for Anaemia among Children under Five in Ghana.

This is the completed MSc thesis of Yaa Pokua Akomea. The research was sponsored by Ministry of Energy, and carried out at University of Southampton, in the United Kingdom. Her supervisors are Dr Jackie Landman and Dr Penny Nestle.

Executive summary

The overall objective of the research is to investigate the risk factors of anaemia among children under five years old in Ghana. Anaemia is a global public health problem associated with impaired mental and physical development with increased risk of morbidity and mortality in children under five years old. The 2011 Multiple Indicator Cluster Survey (MICS) in Ghana measured the prevalence of anaemia in children under-five year olds as 57% with regional disparities. In Ghana, health officials and policy makers are informed of the prevalence of anaemia from the MICS which reports prevalence and simple associations but not odd ratios of the independent risk factors for anaemia for this age group. The aim of this study therefore, is to investigate the risk factors of anaemia among children under five years old in Ghana.

A secondary analysis was carried out using data from the 2011 MICS Ghana data (a cross-sectional study). A total of 4517 children who were measured for haemoglobin levels were included in the study. A Chi-square statistic test was used to identify for simple associations between anaemia (defined as <11g/dl) and exposure variables (immediate and underlying). A logistic regression with anaemia as the dependent variable as used to measure the independent risk factors of anaemia. All estimates were presented with 95% confidence interval (CI). P values less than 0.05 were considered as statistically significant.

The independent predictive factors were older aged children (36-47months olds) (OR: 0.65, 95% CI: 0.43, 0.99), females (OR: 0.70, 95% CI: 0.60, 0.82), child still breastfed (OR: 0.64,

95% CI: 0.47, 0.86), absence of fever (OR: 0.56, 95% CI: 0.46, 0.69), absence of stunting (OR: 0.73, 95% CI: 0.73, 0.88), children with older maternal age (OR: 0.35, 95% CI: 0.35, 95% CI: 0.16, 0.73), children with mothers' who could read parts of a sentence (OR: 0.73, 95% CI=0.56, 0.96), children with mothers living with 6 children (OR: 1.71, 95% CI: 1.16, 2.51), children from monogamous homes (OR: 0.71, 95% CI: 0.58, 0.89) children of Muslim Religion (OR: 1.53, 95% CI: 1.23, 1.91), children from richest Wealth Index quintile (OR: 0.40, 95% CI: 0.28, 0.56) and children from the Upper West Region (OR: 2.45, 95% CI: 1.37, 4.37).

5.1.4 Project Title: A Secondary Data Analysis for the Development and Evaluation of a Streamlined Dose-to-Mother Technique to Determine Exclusive Breastfeeding.

Research Team: Lisa Houghton¹, Christine Slater², Thomas Preston³, Theodosia Adom⁴ and Participating Collaborators of CRP Number E4.30.26, RAF6039 and RLA6071⁵

¹ Department of Human Nutrition, University of Otago, New Zealand

² Nutritional and Health-Related Environmental Studies Section, Division of Human Health, Department of Nuclear Sciences and Applications, IAEA,

³ University of Glasgow

⁴ Nutrition Research Centre, RAMSRI/GAEC

⁵ Details to be provided when available

This is an on-going project with sponsorship from the Bill and Melinda Gates Foundation and the IAEA. Project commenced in 2015 and due to be completed in 2017.

Executive summary

Project aims to investigate the potential to simplify the deuterium oxide dose-to-mother (DTM) technique using the ratio of the deuterium enrichment in infant to mother at the time of the infant's maximum enrichment. Currently, there is an increased interest in biomarkers of infant feeding practices as a result of the impact of feeding regimes on infant and young child nutrition and health from birth to two years. Although the deuterium oxide DTM technique is a gold standard for evaluating exclusive breastfeeding, there is the need to simplify the technique using the ratio of the deuterium enrichment in infant to mother at the time of the infant's maximum enrichment. To test this hypothesis, a large set of data points to

calculate milk intake from infants of different ages (and therefore different body weights) up to 6 months is required. This will be accomplished through the provision of DTM excel spreadsheet data and the infant feeding questionnaires generated from the International Atomic Energy Agency's Doctoral Coordinated Project "Stable isotope techniques to assess intake of human milk and body composition of infants and young children up to two years of age" and regional technical cooperation projects in Africa and Latin America (RAF6039 and RLA6071) sent by the participating Collaborators.

This is a collaborative initiative among the Department of Human Nutrition of the University of New Zealand (Lead Collaborator), University of Glasgow, the IAEA and other institutions including Nutrition Research Centre of Radiological and Medical Sciences Research Institute of GAEC. Ghana's Team will provide data generated from RAF6039 Project "Applying stable isotope techniques to monitor and improve infant and young child nutrition interventions in AFRA countries". All participating collaborators will review and approve draft manuscripts that will be developed from the secondary data analysis for publication in peer-review journals. It is expected that the findings will provide the opportunity to review the cut-off for water intake associated with different infant feeding practices.

5.1.5 Project Title: Individual and Environmental Factors Associated with Obesity among Young Children in Primary Schools in Ghana.

This is the on-going PhD thesis of Theodosia Adom. Research is sponsored in part by student and in part by the IAEA (Code: RAF6042), at the School of Public Health, University of Western Cape, South Africa. Her supervisors are, Prof. T Puoane, Dr A De Villiers and Prof. AP Kengne.

Executive summary

The overall objective is to identify factors associated with obesity and physical activity of children aged 8-11 years in primary schools within the contexts of the child's family, school and community; and to examine the contributions of the each of these contexts to childhood obesity. The increasing prevalence of obesity and overweight in childhood in developing countries is a major public health concern to many governments, including Ghana. According to the WHO, overweight and obesity is the fifth leading cause of mortality globally and a major risk factor for non-communicable diseases including cardiovascular diseases, diabetes

and some cancers. Childhood obesity is not only a major risk factor for obesity in adulthood, but also increases the risk of developing hypertension, high cholesterol, orthopaedic problems and type 2 diabetes even in young children. Interventions to prevent and control obesity in childhood therefore deserves priority. Schools are effective for implementing behavioural change in children which will have a long-term impact. However for effective intervention, there is the need to assess the magnitude and distribution of overweight and obesity and the risk factors among learners in the local context. This study, which will be guided by a theory, the socio-ecological framework, will be cross-sectional utilising quantitative techniques. Participants will be selected from apparently healthy children aged 8-11 years enrolled in basic schools in the Adenta Municipal District in Accra, Ghana. Sampling will be done using multi-stage sampling techniques. Data will be collected in three phases using questionnaires, direct measurements on the field and laboratory: (1) child level (child behaviours, health outcomes); (2) family level (including family SES, modelling and parental employment) and (3) community level (including school nutrition and physical activity environment, availability and accessibility of recreational facilities). Data collected will be analysed using SPSS version 20.0 software. Descriptive and inferential statistics, hierarchical multiple linear regression and multiple logistic regression will be used to assess variations in main outcome variable explained by the predictor variables.

The study is expected to provide relevant evidence on the magnitude and distribution of overweight and obesity in school-children and the associated risk factors in Ghana thereby supporting the need for appropriate intervention strategies to control the increasing prevalence. It is also expected that the findings will hopefully identify some research gaps for further studies in the area of childhood obesity.

5.1.6 Other Activities

The Centre participated in the 2015 Inter-Laboratory Comparison Study of Deuterium Analysis by FTIR. This exercise is coordinated by the International Atomic Energy Agency. Each participant country was assigned a unique participant reference number and supplied with 4 different deuterium abundance water samples for FTIR analysis. Data has been sent to the Agency awaiting final report.

5.2 APPLIED RADIATION BIOLOGY CENTRE

5.2.1 Project Title: Strengthening of Biological Dosimetry in IAEA Member States:

Improvement of Current Techniques and Intensification of Collaboration and

Networking among the Different Institutes.

Research Team: D.G. Achel¹, Shadrach Donkor¹, Nana Afua Kobi Adu-Bobi¹, Elorm S Achoribo¹, Agyekum Akwasi Akomeah¹, Felicia Akuamoah¹, Rudolph Mba¹, Sandra Agbenyegah¹, Nii Boye Hammond², J Yarney³ and K Adesi³

¹Radiological and Medical Sciences Research Institute, GAEC

²Ghana Atomic Energy Clinic

³National Radiotherapy & Nuclear Medicine Centre, Korle Bu Teaching Hospital

This is an on-going sponsored project by the IAEA (Code: E0.058, Research Contract No. 17126). Project commenced in 2012 and due to be completed in 2016.

Executive summary

The overall objective is to provide a framework to build capacity to be able to effectively respond to a radiological emergency that may affect the Ghanaian public and neighbour countries and also to develop protocols which can be used to acquire accreditation for biological dosimetry.

Radiation induced unstable chromosome aberration frequency in peripheral lymphocytes is a powerful tool for early biological dose assessment in cases of accidental exposures, in occupational medicine and epidemiological studies. Ghana has significant activities in industries like industrial radiology, radiotherapy, medical radiology and military deployments. Furthermore, Ghana aims at including power amongst mix in the near future. In the light of the aforesaid, competence and techniques in biodosimetry for Ghana is necessary. It is necessary to estimate doses absorbed by exposed persons immediately after planned or unplanned radiological incident to plan for their therapy and in longer term assess possible health consequences. Biodosimetry capability will be essential for medical management of those acutely exposed to radiation and is integral to triage and management processes. Biodosimetry will play significant role in evaluating and treatment of victims of mass accidental or deliberate exposure to radiation. Up until now competence in biological dosimetry amongst the sub-Saharan countries remain gray area thus, developing skills in this discipline in Ghana will be a major milestone and a big boost in Africa. The study aims at providing a framework to build capacity to effectively respond to radiological/nuclear emergency that may affect the Ghanaian public and neighbouring countries and also to acquire accreditation for biological dosimetry for individuals suspected to have been

overexposed to radiation. By and large, it will ensure availability of reliable biological dosimeters to evaluate doses in different scenarios, for different radiation qualities for different of dose in the body.

5.2.2 Project Title: Total Antioxidant Activity, Phenolic and Flavonoid Contents of some Ghanaian Fruits and Vegetables.

Research Team: Shadrach Donkor, Daniel Gyingiri Achel, Nana Afua Kobi Adu-Bobi, Agyekum Akwasi Akomeah, Felicia Akuamoa, Sandra Agbenyegah, Elorm Achoribo.

This is an on-going project funded by the research team. Project commenced in 2015 and due to be completed in 2016.

Executive summary

The overall objective is to determine the antioxidant potentials of under utilised fruits and vegetables with the aim of promoting consumption of such fruits and vegetables. Our body is exposed to a large number of foreign chemicals every day. Most of these chemicals are man-made and our inability to properly metabolise them negatively affects our health through the generation of free radicals. Free radicals are generated during normal body metabolism. The oxygen consumption inherent in cells growth leads to the generation of series of oxygen free radicals. Highly active free radicals and their uncontrolled production are responsible for numerous pathological processes such as cardiovascular and degenerative diseases. Antioxidants protect cells from damage caused by free radicals. Antioxidants can thus significantly delay or prevent the oxidation of easily oxidisable substances. Fruits and vegetables contain high concentration of numerous redox-active antioxidants such as polyphenol, carotenoids, ascorbic acids, tocopherol and flavonoids which fight against hazardous oxidative damage of cells. Thus, the consumption of dietary antioxidants from fruits and vegetables is beneficial in preventing aforementioned diseases. Therefore screening of underutilized fruits and vegetables for cheap and affordable antioxidants to combat cardiovascular and degenerative diseases is a step in the right direction.

5.2.3 Project Title: The Safety of Pre-packaged Foods on Accra Markets- A Focus on Labelling Requirements.

Research Team: Akwasi Akomeah Agyekum, Shadrack Donkor, Nana Afua Kobi Adu-Bobi, Felicia Akuamoah, and Sandra Agbenyegah, Daniel Gyingiri Achel. Richard, Aldoph Awua, Edna Dzifa Doe.

Project is on-going and funded by the research team. Project commenced in 2015 and due to be completed in 2016.

Executive summary

The overall objective is carry out checks to find out if packaged foods sold on our markets meet Codex packaging and labelling requirements The food we eat today is a vital part of human lifestyle. What we eat is becoming more important as we move toward healthy, self-improved lifestyles. As consumers become more alert of food ingredients, it is in the interests of manufacturers to highlight product contents and health or nutritional benefits. Labelling includes any written, printed or graphic matter that is present on the label, accompanies the food, or is displayed near the food, including that for the purpose of promoting its sale or disposal. Labeling is just one way of providing consumers with appropriate information. Labelling needs to be accurate, particularly at the point-of-sale. Labelling of food builds and maintains consumer confidence, captures consumer attention, aids decision making at the point of sale, helps differentiate products as well as aiding consumer choice. The issue we have in this country is that there is no national standard regulation as far as food labelling is concerned. The study seeks to investigate the adherence of packaged foods on Accra markets to the labeling requirements established by Codex STAN 1-1985

5.2.4 Project Title: Occurrence of Aflatoxin in Peanut and Processed Peanut Products in Accra.

Research Team: Akwasi Akomeah Agyekum¹, Derry Dontoh², Meinster Kodjo Eduafo², Clifford Frimpong², Araba Incoom², David Amoah², Celestine Osei² and Adolf Kofi Awua¹.

¹Radiological and Medical Sciences Research Institute, GAEC

²Food and Agriculture Department, Ghana Standards Authority, Accra.

This is a completed project with funding from the research team. Project commenced in March 2015 and was completed in October 2015.

Executive summary

The overall objective was to determine the concentration of aflatoxins in peanut and peanut products relative to existing Ghanaian standards, the EU regulations and the Codex alimentarius limits.

Aflatoxin concentrations in peanut and peanut products obtained from local markets in the Accra Metropolis were monitored. The objective of the study was to determine the concentrations of aflatoxins in peanut and peanut products relative to existing Ghanaian standards, the EU regulations and the Codex alimentarius limits to regulate world trade. Locally produced peanuts, peanut butter and other peanut products were purchased from open markets in the metropolis and analysed for aflatoxins by high performance liquid chromatography. In all, extracts obtained from 23 peanut and peanut products were analysed for aflatoxins B₁, B₂, G₁ and G₂. The results showed that the concentration of aflatoxins varied from 0.26 ppb to as high as 538.85 ppb. Six of the samples analyzed (26.1%) had total aflatoxin concentrations (B₁+B₂+G₁+G₂) exceeding the Codex and EU thresholds. The data further revealed that unprocessed peanuts were highly contaminated with aflatoxins compared to processed peanuts and peanut derived products. Therefore, there should be a continuous survey and monitoring programmes for aflatoxins in all food commodities in order to protect the end user from the hazards due to aflatoxin exposure.

5.2.5 Project Title: Protein Biomarkers for Radiation Dosimetry.

Research Team: Prof John Akudugu², Dr Antonio Serafin², Dr Daniel Achel¹, Dr Marguerite Morkel²

¹Radiological and Medical Sciences Research Institute, GAEC

²Division of Radiobiology

This is the completed Post-Doctoral project of Dr Daniel Achel with sponsorship from Stellenbosch University, South Africa. Project commenced in 2014 and was completed in 2015.

Executive summary

The Overall objective is to validate radiation-induced expression of candidate protein biomarkers for low and intermediate doses (up to 5 Gy).

Large-scale radiological events require immediate and accurate estimates of doses received by victims, and possibly the first responders, to assist in treatment decisions. Although there are numerous efforts worldwide to develop biodosimetric tools to adequately handle triage needs during radiological incidents, such endeavours do not seem to actively involve sub-Saharan Africa.

Ex vivo radiation-induced MDM2, HP and γ H2AX expression in peripheral blood lymphocytes from fourteen healthy donors was assessed using flow cytometry. While the γ H2AX technique showed potential for use as a rapid high-throughput biodosimetric tool for radiation absorbed doses up to 5 Gy, significant inter-individual differences in γ H2AX expression emerged. Also, female donors exhibited higher levels of γ H2AX expression than their male counterparts. To address these shortcomings, gender-based in-house dose-response curves for γ H2AX induction in lymphocytes 2, 4 and 6 h after X-ray irradiation are proposed for the South African population. The obtained results show that γ H2AX is a good candidate biomarker for biodosimetry, but might need some refinement and validation through further studies involving a larger cohort of donors. Our results further demonstrated that MDM2, and HP did not appear to be suitable protein biomarkers radiation biodosimetry

5.2.6 Project Title: Applying Nuclear Analytical Techniques to Support Harmful Algal Bloom Management in the Context of Climate and Environmental Change, Phase II” in the Field of Marine, Terrestrial and Coastal Environments.

Research Team: Yaw Serfor-Armah², Daniel Gyingiri Achel¹, Dennis K. Adotey², Harriet Kuranchie², Dzifa Denutsui², Rudolph M. Adaboro¹

¹Radiological and Medical Sciences Research Institute

²School of Nuclear and Allied Sciences, UG

Project is completed with sponsorship from the IAEA (Code: RAF 7012). Project commenced in 2014 and was completed in 2015.

Executive summary

The overall objective of project is to develop and implement harmonized and integrated regional sea food safety monitoring in the Member States, through the application of nuclear techniques for enhanced sustainability of marine resources, food security and socio-economic benefits.

African marine and coastal ecosystems provide a wide array of goods and services, thus supporting the livelihoods and income-generating opportunities for thousands of coastal inhabitants in this region besides significantly contributing to the regional economy. These ecosystems and their services are continuously threatened by a plethora of natural and anthropogenic stressors, i.e pollution, rising sea levels, temperatures and ocean-acidification. The cumulative impacts of these stressors include detrimental effects on exposed organisms; altered key structural and functional attributes of ecosystems; impaired ecosystem health; local declines in biodiversity; high rates of mortality; increased benthic macro-algae, cyanobacteria and harmful algal blooms and reduced productivity (with the associated ability to provide food). Food quality, safety and security are major concerns.

5.2.7 Project Title: Evaluation of Antimalarial Activity of *Vernonia colorata* Against *Plasmodium berghei*, ANKA, in NMRI Mice.

Research Team: Achoribo S. Elom¹, Serge Yerbanga², Ollo Da², Tamboula Souleyman², Aminata Fofana²

¹Radiological and Medical Sciences Research Institute, GAEC

²Institut de Recherche en Science de la Sante, Bobo-Dioulasso, Burkina-Faso

This is the completed project of Elom Achoribo from her Young Scientist Award Fellowship training at Institut de Recherche en Science de la Sante in Bobo-Dioulasso, Burkina Faso. Project commenced in 2014 and was completed in 2015. Funding was by West Africa Health Research Network (WAHRNET).

Executive summary

The overall objective is to evaluate the potential of extracts of the leaves and flowers of *Vernonia colorata* as an antimalarial agent using *in-vivo* assays on NMRI mice infected with *P.berghei*, strain ANKA.

Vernonia spp. has been used throughout West and Central Africa and North America for their anti-inflammatory, analgesic, antibacterial, anticancer, antidiabetic, antifungal, antimalarial

and antioxidant properties. One of most extensively but less scientifically explored member of this family is *V. colorata*. In this regard, we aimed to scientifically explore the antimalarial potential of *V. colorata* to substantiate anecdotal claims. The current research evaluated the potential of the leaf and flower extracts of *V. colorata* as an antimalarial agent in murine malaria using *P. berghei* strain ANKA infected NMRI mice as experimental model.

At 350mg/kg, ethyl acetate extracts of flowers and ethanol extracts of the leaves of *V. colorata* respectively demonstrated 55.5 and 33 percentage inhibition of parasite growth. The ethanol extract of the flowers gave 40% inhibition of parasite growth at 250mg/kg. The flower extract of both extracts elaborated the highest inhibition values.

For the biochemical parameters, no significant differences were observed except for ASAT which may be due to the difference in *organ weights* expressed as a *percentage of body weight*.

From data, it can be said that *V. colorata* has moderate activity and does not show any toxicity below 2000mg/kg (the LD50 >2000mg/kg). Also, the flowers of the plant appears to be more potent compared to the leaves.

5.2.8 Project Title: *In vitro* Cytotoxicity and Radiomodifying Effects of Aqueous Extracts of *Moringa oleifera* (Lam).

Research Team: Daniel G. Achel¹, Antonio M. Serafin², Elom A. Achoribo², Sandra Agbenyegah¹, and John M. Akudugu²

¹Radiological and Medical Sciences Research Institute

²University of Stellenbosch, South Africa

This is the completed Post-Doctoral project of Dr Daniel Achel with sponsorship from Stellenbosch University, South Africa. Project commenced in February 2015 and was completed in August 2015.

Executive summary

Moringa oleifera (*M. oleifera*) is renowned for its range of essential nutrients and bioactive compounds. However, the toxicity and potential radiation modifying effects of extracts from its entities are not well characterized. The cytotoxic and radiomodulatory effects of aqueous

extracts obtained from seeds, leaves and flowers of *M. oleifera* were evaluated. Cytotoxicity and radiation modifying effects of extracts were assessed in apparently normal Chinese hamster lung fibroblasts (V79 cells), using the colony forming assay. The free radical scavenging activity of each extract was also assessed, using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging assay. At relatively low concentrations of 6.25–100 µg/ml, the seed extract showed about 20% cytotoxicity and yielded radiation sensitizing factors ranging from 1.23 ± 0.07 to 2.38 ± 0.76 . The leaf extract was non-toxic at concentrations of up to 50 µg/ml, but produced ~12% cell kill at 100 µg/ml. With little or no cytotoxicity on its own, the leaf extract was radiosensitizing, with radiation modifying factors ranging from 1.30 ± 0.18 to 1.50 ± 0.26 . At all tested concentrations, the flower extract was non-toxic, but significantly enhanced cell growth in unirradiated cultures, showing no effect on cellular radiation response. With the exception of the leaf extract which had a maximum of only 9% free radical scavenging capacity, the other extracts showed no potential as radical scavengers. Aqueous extracts of seeds, leaves and flowers of *M. oleifera* may potentially be clinically useful as cytotoxic agents, radiosensitizers, and wound healing promoters.

5.2.9 Project Title: Flow Cytometry-Assisted Quantification of γ -H2AX Expression has Potential as a Rapid high-Throughput Biodosimetry Tool.

Research Team: Daniel G. Achel¹, Antonio M. Serafin², and John M. Akudugu²

¹Radiological and Medical Sciences Research Institute, GAEC

²Stellenbosch University, South Africa

This is the completed Post-Doctoral project of Dr Daniel Achel with sponsorship from Stellenbosch University, South Africa. Project commenced in February 2015 and was completed in August 2015.

Executive summary

Large-scale radiological events require immediate and accurate estimates of doses received by victims, and possibly the first responders, to assist in treatment decisions. Although there are numerous efforts worldwide to develop biodosimetric tools to adequately handle triage needs during radiological incidents, such endeavours do not seem to actively involve sub-Saharan African. To initiate a similar interest in Africa, *ex vivo* radiation-induced γ H2AX

expression in peripheral blood lymphocytes from fourteen healthy donors was assessed using flow cytometry. While the technique shows potential for use as a rapid high-throughput biodosimetric tool for radiation absorbed doses up to 5 Gy, significant inter-individual differences in γ -H2AX expression emerged. Also, female donors were more radiosensitive than their male counterparts. To address these shortcomings, gender-based in-house dose-response curves for γ H2AX induction in lymphocytes 2, 4 and 6 h after X-ray irradiation are proposed for the South African population. The obtained results show that γ H2AX is a good candidate biomarker for biodosimetry, but might need some refinement and validation through further studies involving a larger cohort of donors.

5.3 MEDICAL RADIATION PHYSICS AND RADIOPHARMACY AND NUCLEAR MEDICINE CENTRES.

5.3.1 *Project Title: Optimization of Radiological Protection of Patients Undergoing Diagnostic Radiology Examination in Ghana.*

This is the on-going PhD thesis of Edem Sosu at the University of Cape Coast. Project commenced in 2013 and due to be completed in 2016. The research is the second phase of work done on “Mammography Examination in Ghana: Preliminary Survey of Patients’ Profiles”. His supervisor is Prof. S. Y. Mensah. Project is capital intensive and funding is being sort for the work.

Executive summary

The primary objective of this work is to assess all mammography installations in the country in order to determine their performance status with respect to optimization of procedures and patient radiation protection. The human female breast is the organ most sensitive to radiation carcinogenesis in post-pubertal women. Risk to cancer is approximately proportional to dose and is relatively independent of ionization density and fractionation of dose. It has been known for several years that high doses of ionizing radiation can cause breast cancer in human females. It has, however, been uncertain whether low doses are carcinogenic, and if so, whether the risk per radiation is as high as that from higher dose exposures. Any risk of inducing breast cancer by mammography must definitely be smaller than the expected benefits if screening is concentrated on women older than 50 years. In Ghana, there has not been any comprehensive study aimed at optimization of the radiological protection of patient

undergoing both screening and diagnostic mammography examinations through effect quality assurance. Quality assurance in mammography is not receiving the needed attention. There has not been any thorough work done in the mammography centre across the nation to ascertain that the quality of the images (mammograms) meet international standards.

5.3.2 Project Title: Ultrasound and PET/CT Image Fusion for Prostate Brachytherapy Image Guidance.

This is the completed PhD thesis of Francis Hasford at University of Witwatersrand (Charlotte Mexeke Johannesburg Academic Hospital), in South Africa. Project commenced in 2011 and was completed in 2015. The research was partly self sponsored and partly sponsored by the IAEA through project GHA6017. His supervisors are Prof. J.H. Amuasi, Prof. A.K. Kyere and Prof. M.D.T. Vangu.

Executive summary

The research employs the fusion of images from three different modalities i.e. Ultrasound, Positron Emission Tomography (PET) and Computed Tomography (CT) of prostate phantom. Outcome of the study would improve prostate diagnosis and also help in the better assessment of doses and tumour volumes for improved dose calculation algorithms in prostate brachytherapy treatment planning.

Two MatLab algorithms were developed and tested. One algorithm was tested and proved to improve the contrast and sharpness of medical images from ultrasound and PET/CT. The second algorithm was successfully tested to be able to fuse images from ultrasound and PET/CT images. Quality Control tests were performed on ultrasound and PET/CT systems used for the study and found it to be performing optimally. The study was successfully completed by fusing ultrasound and PET/CT images for improving image guidance and pre/post-implant dose evaluations for patients undergoing prostate brachytherapy. The thesis has been submitted to the University of Ghana for assessment, awaiting results.

5.3.3 Project Title: Characterization of Heavy Metals and Persistent Organic Pollutant Residues in Brisbane River Sediment.

This is the on-going PhD thesis of Godfred Odame Duodu. Project is sponsored by Queensland University of Technology, Australia through project code, IF49. Project commenced in 2013 and is due to be completed in 2017. His supervisors are Prof. Godwin A. Ayoko and Prof. Ashantha Goonetilleke

Executive summary

The overall objective is to delineate the spatial, impact, sources and contribution of heavy metals, polycyclic aromatic hydrocarbons and organochlorine pesticide residues in the sediment of the Brisbane River. Waterways are among a nation's most precious resources and billions of dollars of national economies rely on their health. They significantly shape our ecosystem and are inextricably linked to the overall health of the environment. Waterways provide many benefits to society, but can easily be impacted by anthropogenic influences. To evaluate the impact of heavy metals, polycyclic aromatic hydrocarbons and organochlorine residue in the Brisbane River, field and laboratory analysis will be conducted on the sediment. Multivariate techniques will be employed to elucidate patterns of contamination, identify sources of contaminants, select and rank sediments according to their quality and priorities remedial actions.

Wet-milling protocol was employed to produce pressed powder tablets with excellent cohesion and homogeneity suitable for laser ablation (LA) analysis of volatile and refractive elements in sediment. The influence of sample preparation on analytical performance was also investigated, including sample homogeneity, accuracy and limit of detection. Milling in volatile solvent for 40 minutes ensured sample is well mixed and could reasonably recover both volatile (Hg) and refractive (Zr) elements. With the exception of Cr (-52 %) and Nb (+26 %) major, minor and trace elements in STSD-1 and MESS-3 could be analysed within ± 20 % of certified values. Applicability of the method compared with total digestion using HF was tested by analysing 10 different sediment samples. The laser method recovers significantly higher amounts of analytes such as Ag, Cd, Sn and Sn than the total digestion method making it a more robust sampling method for elements across the periodic table. LA-ICP-MS also eliminates the time consuming sample preparation steps, interferences from chemical reagents as well as the health and safety risks associated with digestion processes. Therefore, it can be considered as an enhanced method for the analysis of heterogeneous matrices such as river sediments.

On the other hand, conventional methods for the determination of organochlorine (OCPs) residues in river sediments are resource intensive. An innovative approach that is rapid and also reliable for the detection of OCPs is presented. Accelerated Solvent Extraction (ASE) with in-cell silica gel clean-up followed by Triple Quadrupole Gas Chromatograph Mass Spectrometry (GCMS/MS) was used to recover OCPs from sediment samples. Variables such as temperature, solvent ratio, adsorbent mass and extraction cycle were evaluated and optimised for the extraction. With the exception of Aldrin, which was unaffected by any of the variables evaluated, the recovery of OCPs from sediment samples was largely influenced by solvent ratio and adsorbent mass and, to some extent, the number of cycles and temperature. The optimised conditions for OCPs extraction in sediment with good recoveries were determined to be 4 cycles, 4.5 g of silica gel, 105 °C, and 4:3 v/v DCM: hexane mixture. With the exception of two compounds (α -BHC and Aldrin) whose recoveries were low (59.73 and 47.66 % respectively), the recovery of the other pesticides were in the range 85.35 – 117.97%. The method developed significantly reduces sample preparation time, the amount of solvent used, matrix interference, and is highly sensitive and selective.

5.3.4 Project Title: Measurements of Renal Dimensions to Determine Volumetric Ellipsoid Coefficient of Renal Volume Model for Clinical Applications in Ghana

This is the on-going PhD thesis of Isaahaku Shirazu at the University of Cape Coast. The project commenced in 2014 and due to be completed in 2017. Project is being sponsored by student. His supervisors are Dr Yaw B. Mensah, Prof Cyril Schandorf and Prof S. Y. Mensah.

Executive summary

The main objective is to establish and design normal adult renal volume and other related parameters for clinical application using the principle of physics and mathematics.

The desire goal is to construct race-specific mathematical and CAD renal volume models for clinical applications in Ghana. It is also to precisely establish volumetric ellipsoid coefficients of reference renal volume model in computed tomography. The study is based on measurements of renal dimensions to determine volumetric ellipsoid coefficient and reference standard renal volume model. This is to provide reference values of renal dimensions and volumetric ellipsoid coefficient for medical imaging, internal radionuclide dosimetry and radiotherapy applications. In addition, the linear x-ray attenuation coefficients of normal kidney tissues in computed tomography were also estimated. Voxel count method and

rotational ellipsoid equation were the two measuring tools used on an integrated MVL application software platform. The procedure involves physical measurement of renal dimensions using CT images of the abdomen as shown in figure 1. These images were obtained during clinical diagnostic procedures. These were reconstructed at 5 mm, and transferred onto the application software platform. The measurements and calculations were done using the two measuring tools by the snake technique to draw the region of interest (ROI). The approach and procedure were specifically design and documented to assist radiologist, nuclear medicine physicians, oncologist and physicist to accurately measure renal dimensions during diagnostic and therapeutic procedures. The data collections were based on age- and sex-stratified random sample of 500 patients. The parameters measured included; Total number of voxels, renal length, lateral diameter and A-P diameter as shown in figure 2, 3 and 4 respectively. These parameters were then used to determine volumetric ellipsoid coefficient and renal volume using the ellipsoid formula for volume estimation. The reference standard renal volume of real human kidney was also determined using water displacement with the Archimedes' principle. Furthermore, a relationship between the measured renal dimensions and other published renal dimensions in other countries and organizations were done for comparative analytical purposes. The calculated average renal volume was also correlated with BSA and BMI. The average renal shape index and its dispersion (i.e. covariance matrix) were also calculated. Finally, a graphic user interface and CAD models, figure 5 and 6A respectively were designed to adequately reflect the comfortable working process for all the mathematical model equations for clinical application in Ghana

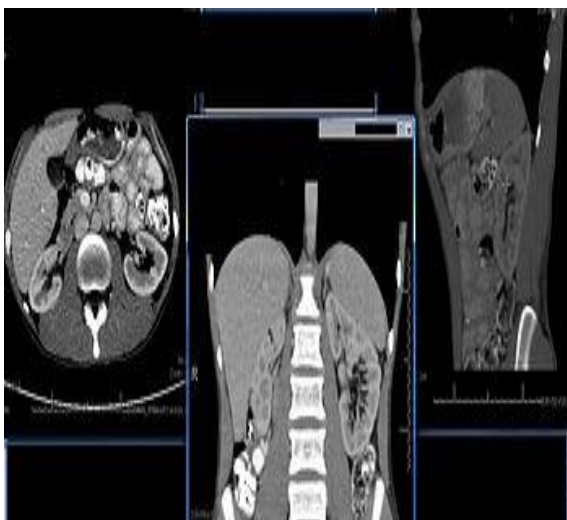


Figure 1. CT Image of the Abdomen

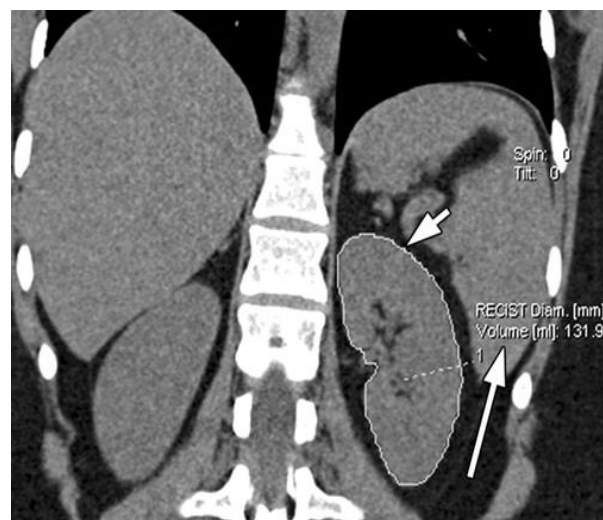


Figure 2. Renal volume measurements

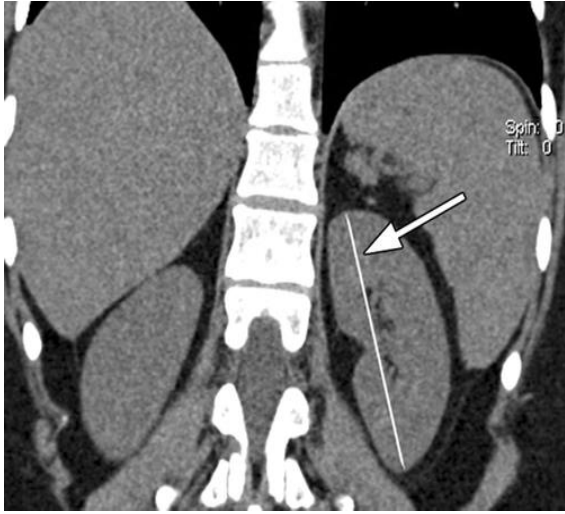


Figure 3: Measurement of renal length.



Figure 4: Lateral and A-P diameter.

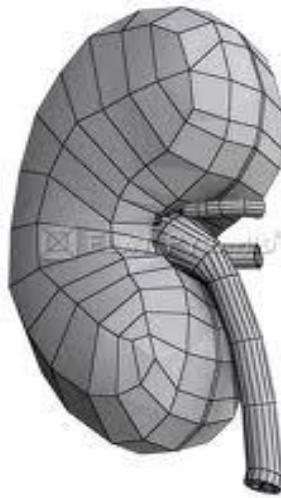


Figure 5 Model Kidney

Figure 6 is the designed interface for clinical application. With known renal length (R_L), A-P diameter (R_w) and lateral diameter (R_T), renal volume can be determined as shown below.

$$RV_a = k * R_L * R_W * R_T$$

Result:

Input:

$R_L * R_W$

Cm²

R_T

Cm

RV

Cm³

Decimal Precision:

2

Figure 6. Graphic user interface

5.3.5 Project Title: The Effect of Administered Activity on Patient Radiation Dose and on SPECT Image Quality at Korle-Bu Teaching Hospital.

Researcher: Issahaku Shirazu

This is an on-going project which commenced in 2014 and due to be completed in 2016. Project is being sponsored by the researcher.

Executive summary

The overall objective of this project is to improve image quality without an increase in patient radiation dose during SPECT imaging. The study is being done at Nuclear Medicine Center at Korle-Bu Teaching Hospital, Accra. It cover's three parameters namely, administered activity, patient radiation dose and image quality. Images have been sorted out according to this parameters and Nuclear Medicine Physician/Specialist were made to interpret the images by the method of "blinded interpretation" to all the images. Analysis of these images and their corresponding reports are completed and the final report writing is currently on-going.

5.3.6 Project Title: Automatic Exposure Control (AEC) system in CT scanners and their effect on image quality.

Researcher: Issahaku Shirazu

This is an on-going project which commenced in 2013 and due to be completed in 2016. Project is being sponsored by the researcher

Executive summary

The aim of this project is to reduce radiation exposure to patients undergoing CT scan.

This study is simultaneously being done with four CT scanners at three different hospitals namely; Department of Radiology, Korle-Bu Teaching Hospital, Cocoa Clinic, Kaneshie and Sweden-Ghana Medical Centre all in Accra. Data collection is completed and analysis is on-going in all cases. The effective use of AEC systems for four (4) CT scanners, from different manufacturers, such as General Electric, Philip, Toshiba and Siemens using the same input parameters to scan the same chest phantom and evaluate the image quality.

5.3.7 Project Title: Validation of Planned Radiation Absorbed Dose for Breast Cancer Patients Using Thermoluminescent and Radiochromic Film Dosimeters.

This is the on-going PhD thesis of Theresa Derry at the University of Cape Coast. The project commenced in 2015 and due to be completed in 2018. The project is being sponsored by student and her supervisors are Prof. Cyril Schandorf and Dr. Joseph Amoako.

Executive summary

The objective of the study is to assess clinically relevant differences between planned and delivered doses to breast cancer patients undergoing external beam radiotherapy using customized phantoms. In Ghana, women are disproportionately afflicted with breast cancer at younger age, and the commonest cause of cancer death in females is malignancies of the breast accounting for 17.24% of all cancer. The World Health Organization reports that 60% of all cancer patients require radiotherapy at one point of their treatment, and 40% of cancer cure results from radiotherapy. Success of planned dose on treatment planning system (TPS) and its outcome are entirely depended on the delivered dose to the respective site of patient with reproducible accuracy of planned dose or within tolerance.

In this study, phantom measurements with thermoluminescent dosimeters (TLD-100 [LiF: Ti, Mg] and radiochromic film will be employed for target organ dose determination for breast cancer treatment using the Co-60 with 1.25MeV. The study would be limited to the use of phantoms for breast cancer treatment at Radiotherapy facilities in Ghana during the time of this study. The beam model will be derived using the Monte Carlo Nuclear Particles Code (MCNP).

5.3.8 Project Title: Assessment of Doses for Radio Sensitive Organs in Thyroid Cancer Patients by the use of ^{124}I PET and MatLab-3D Internal Dosimetry Algorithm.

This is the on-going PhD thesis of Ernest Kojo Eduful at the University of Cape Coast. The project commenced in 2015 and is due to be completed in 2018. Project is being funded by student. His supervisor is Professor J.H Amuasi.

Executive summary

The primary objective is to perform personalized dosimetry for patients undergoing radioiodine therapy for thyroid cancers and determine organ level evaluations to serve as guidance levels in administration of Iodine-131 (I-I31).

Personalized dosimetry of patients undergoing radioiodine therapy has been neglected in majority of nuclear medicine facilities worldwide, raising questions about internal radiation dosimetry audits in nuclear medicine.

This study seeks to assess the levels of absorbed doses to internal organs received as a result of gamma radiation from administered radioiodine. Internal dosimetry software will be used with I-131 SPECT images and compared with an in-house developed MatLab dosimetry algorithm to verify the accuracy of the dosimetry estimates.

Currently a MatLab software is being written (coded) to help with this project.

5.3.9 Project Title: Comparative Assessment of Doses to Patients Undergoing Computed Tomography Scan.

Research Team: Ernest Eduful, Mary Boadu.

This is an on-going project which commenced in 2013 and due to be completed in 2016. Project is funded by the research team.

Executive summary

The overall aim of the project is to reduce doses to patients undergoing computed tomography examination. Appropriate procedures such as scan duration, pitch, use of automatic exposure control (AEC) etc., have been found to be ways to control and reduce doses to patients during CT procedures. This project seeks to improve on these methods and ascertain the correct values that bring about reduced doses. Because of the nature of such a projects, only phantoms can be used to experiment, and a phantom is will still be acquired.

5.3.10 Project Title: Ten (10) Years of the SPECT System Operation at the Korle-Bu Teaching Hospital.

Research Team: Theophilus Sackey, Ernest Kojo Eduful, Issahaku Shirazu

This is a completed project which commenced in 2013 and was completed in 2015. Project was funded by the research team.

Executive summary

The main objective of this project is to find the statistics of patients who have undergone various forms of cancer diagnoses and treatment. A single-photon emission computerized tomography (SPECT) scan is a type of nuclear imaging test, which allowed the uses of radioactive substance and a special camera to create three dimensional (3-D) pictures of various internal organs of the body. It enable analysis of internal organs function. While imaging tests such as conventional X-rays and CT scan can show what the structures inside the body look like, a SPECT scan produces images that show the structure and functions of organs. For instance, a SPECT scan can show how blood flows to the heart or what areas of the brain are more active or less active.

Ghana received its first SPECT machine in 2005 and since then it has been used for management of cancer and non-communicable diseases to diagnose different types of diseases. This study looked at the different types of treatment that has been performed at the Nuclear medicine department of the Korle-Bu Teaching hospital from 4th May, 2005 to 31st December, 2014.

There were 3608 scans in all, with bone scan been the highest with 1,967 scans, which form 54.52%, that is more than half of the study were on bone scan and the least scan being GFR with 5 scan, just about 0.14% of the total study. Together with bone scan thyroid and renal

study shows significant attendance ratio of 24.34% and 15.22% respectively. The three together formed about 94% of all the scans at the centre. It is also important to note that iodine therapy together with brain scan were slightly significant with about 3.41% and 1.64%, with the rest showing just about 1% of the total study.

5.3.11 Project Title: *In-Vivo* and *Ex-Vivo* Transit Dosimetry with Electronic Portal Imaging Devices (EPID).

This is the on-going PhD thesis of Mark Pokoo-Aikins at Cape Coast University. Research is being funded by student. Project commenced in 2015 and is expected to be completed in 2018. His supervisor is Prof. A.W.K Kyere.

Executive summary

The overall objective of project is to improve the accuracy of dose delivery during prostate cancer treatment delivery by using EPID-based *in-vivo* technique.

The success of radiotherapy depends on accurate dose delivery to the specified target volume, accurate target localization, and the tolerance of normal tissues included in the radiation field. *In-vivo* dosimetry provides dosimetric information regarding actual treatment delivery, and is understandably considered an indispensable quality assurance procedure and a safety measure in the treatment process.

While errors in the delivery of radiation therapy cannot be completely ruled out, the real danger is if the error in administration goes undetected. This may result in healthy tissues being exposed to unnecessary levels of radiation or the tumour site not receiving full effect of therapy. Studies have shown that, a severe misadministration may result in radiation necrosis to vital organs or structures and can be fatal. Several cases of dose misadministration have been reported in recent years. These recent sequence of severe accidents in radiotherapy would have been prevented if *in vivo* dosimetry systems were in place.

The study ultimately aims to improve the accuracy of dose delivery during prostate cancer treatment delivery by using EPID-based *in-vivo* technique, whilst using the institute's own treatment protocol. In this way, the patient related influence, and the limitations of the dose calculation algorithms of entrance and exit dose can be identified through the use of EPIDs.

The work will be based on transit dosimetry whiles treatment is ongoing, and is expected to lead to a more precise and accurate treatment delivery, so as to limit the tolerance for errors.

It is also believed that the work will go a long way to provide a generalized *in-vivo* dosimetry procedure for 3D Conformed Radiotherapy Techniques (3D CRT) in Ghana, for Elekta manufactured linear accelerators with open and wedged beam capabilities.

5.3.12 Project Title: Radiolabelling Biomolecules (Proteins, Peptides etc) with Re-188 for Targeted Radionuclide Therapy and Biological Evaluation of the Radiopharmaceuticals.

This is the on-going PhD thesis of Lawrence Sarsah at University of Stellenbosch (Tygerberg Hospital), Cape Town, South Africa. The research is partly funded by student and partly by the IAEA through project GHA6017. His supervisor is Prof. A Africander.

Executive summary

The research employs the Radiolabelling of biomolecules (proteins, peptides etc) with Re-188 for targeted radionuclide therapy: Preparation, radiochemical analysis, biological studies, stability studies, uptake studies, radiotoxicity studies, biological evaluation of the radiopharmaceuticals and the chemistry of Re-188 as compared to the chemistry of Tc-99m. Some literature search has been carried out and laboratory work will commence in February 2016.

5.3.13 Project Title: Assessment of Volumetric Losses during Radiotherapy Treatments for Prostate Cancer Patients (A Case Study at SGMCC).

Research Team: Mark Pokoo-Aikins, Theophilus Sackey

This is an on-going project with funding from the project team. The project commenced in 2014 and due to be completed in 2017.

Executive summary

During cancer treatments, the problem of target localization and verification is a central issue and presents a technical challenge during dose delivery. Changes in the patients volume as a result of dehydration, shrinking of the tumour, and decrease in the size of an organ, present issues of accuracy of dosimetry. This subsequently leads to inaccurate dose delivery to the

tumour, which provides adverse radiobiological effect.

The main objective of this work is to study the dosimetric impacts of volumetric changes on treatment planning systems during prostate cancer treatments. The study also seeks to explore the advantages of gold seed during treatment, and to determine the dosimetric effects of the positioning of the gold seeds during treatment course.

The research is expected to indicate the extent to which volume loss could contribute to clinically considerable changes in the dose delivered to target and organs at risk

5.3.14 Project Title: Cancer Risk Assessment of Patients undergoing Computed Tomography (CT) Scan at the Korle-Bu Teaching Hospital.

This is the completed MPhil thesis of Theophilus Sackey at the School of Nuclear and Allied Sciences, University of Ghana. Project commenced in 2013 and was completed in 2015. Project was partly funded by student and partly by Government of Ghana Bursary. His supervisors are Prof. Cyril Schandorf and Prof. J. J. Fletcher.

Executive summary

The overall objective of study is to estimate the effective dose and assess the risk of patients undergoing computed tomography scan at the Korle-Bu Teaching Hospital. Data on CT Dose index ($CTDI_{vol}$) and Dose length product (DLP) displayed on the scanner control console was recorded after confirmation of the results by performing independent checks on a phantom. The effective doses were estimated using the DLP displayed and the anatomic region specific conversion factors (K). The average effective doses for the head, abdomen, chest, neck, and pelvis were 3.63, 15.37, 12.72, 4.04 and 15.89 mSv respectively. Apart from the values for the head and neck the rest were higher than the typical range of (1 – 10) mSv for CT examination. The average life attributable risk of cancer incidence for each region of examination were determined from the effective dose, sex and age using the *BEIR VII Report*. The average risk for all examinations, head, neck, chest, abdomen and pelvis was low (1 in 10,000 to 1 in 1,000). There was wide variation in the Effective Dose values obtained for the same region under examination. This calls for scanning examination protocol to be established for the centre.

5.3.15 Clinical Services

Scientists of the Centre have also offered clinical services to the National Centre for Radiotherapy and Nuclear Medicine at Korle-Bu Teaching Hospital.

5.4 CELLULAR AND CLINICAL RESEARCH CENTRE

5.4.1 Project Title: RAF/6/040 - ‘Applying Molecular Techniques to Interventions against the Major Poverty Related Diseases (HIV, TB and Malaria) for Improving Disease Control (Tuberculosis Aspect)’

Research Team: Oti Kwasi Gyamfi, Adolf K Awua, Edna Doe, Kofi Bedzra and Kingsley Nsowah.

Project is on-going and is a continuation of some aspects of the completed IAEA project RAF6040. Project commenced in 2015 and due to be completed in 2017. Funding of project is by the research team.

Executive summary

The main objective of the study is to apply molecular techniques to determine the prevalence of MDR-TB and XDR-TB amongst microscopy positive slides in high-risk population groups in Ghana to improve diseases control in the selected countries.

The three major killer diseases in Africa are HIV, TB and malaria. Approximately 70% of adults and 80 % of children living with HIV/AIDS live in Africa. Tuberculosis leads to 3 million deaths every year of which about 90% occur in developing countries, where drug surveillance and rapid detection to anti-TB drugs resistance is uncommon. The annual incidence of TB is 565 per 100 000 in the African population. There are many areas of intersection and similarities between the three diseases, which led to the establishment of the Global Fund for AIDS, TB and Malaria to address common issues. In HIV-infected individuals in Africa, TB is the leading cause of death. The pathogenesis of these two infections is linked in a deadly synergy.

To date, approximately 814 smear positive sputum samples (up from the approximately 750 samples as at 2014) have been elicited from presenting patients and are being worked on. Demographic characteristics of the latest batch of 64 patients providing samples cumulatively in 2015 are as follows: This population batch comprised 38 males (59.4%) and 26 females

(40.6%). The overall population had an age range, a median age and a mean age of 17 – 79 years, 36.5 years and 39.4 years (SD 10.4 years) respectively. For the male group (n=38) these figures were 17 – 79 years, 38 years and 40.3 years (SD 11.5 years) respectively and also for the female group they were 18 – 70 years, 28.1 years and 36.5 years (SD 11.8 years) respectively. The sample population batch could broadly be stratified according to age as follows: 98 patients (67.1%) were below 39 years; 39 patients (26.7%) were between 40 and 60 years and 9 patients (6.2%) were above 60 years.

5.4.2 Project Title: Exploratory Study on the Observance of Lesions on Fish Suggestive of Microbial Infection.

Research Team: Edna Dzifa Doe, Adolf Kofi Awua, Kingsley Kwame Nsowah and Oti Kwasi Gyamfi.

This is an on-going project which is being funded by the research team. Project commenced in 2015 and due to be completed in 2017.

Executive summary

This preliminary study aims to find out if people engaged in the distribution of fish have knowledge of, and observed lesions on fish suggestive of mycobacterial infection.

Mycobacteriosis in fish is a disease caused by some members of the genus *Mycobacterium*. Mycobacteria are quite ubiquitous in the environment and therefore can be a public health hazard. Environmentally, mycobacteria inhabit and proliferate in aquatic bodies and have been found in drinking water, brackish water, coastal waters, riverine bodies, swimming pools, aquaria, and aqua-culture and mari-culture facilities. Some of these species also cause disease in humans. Commonly, Mycobacteria causing disease in fish belong to the group of non-tuberculous mycobacteria (NTM) because they do not cause disease in healthy subjects but can cause serious infections in immuno-compromised subjects. The most common causative agent of Mycobacteriosis in fish is *Mycobacterium marinum*, though other species like *Mycobacterium chelonae* and *Mycobacterium fortuitum* have also been implicated in the pathogenesis of the disease.

In Ghana, there is a paucity of information on the nature of Mycobacteriosis and its causative agents, and the extent of the general knowledge underpinning perceptions and practices amongst people engaged in the fish industry.

A structured questionnaire, with embedded pictures (see below) of fish depicting common classical superficial lesions indicative of mycobacterial disease, has been prepared and distributed to fish mongers in selected suburbs. Elicited responses will provide information on the knowledge, attitude and practices employed in handling fish in the light of any observed superficial lesions.

Preliminary results indicate that some of the respondents recognise and admit observing these superficial lesions on the fish that they deal in. Additionally, some of the respondents allude to also observing the development of skin rashes when handling these diseased fish.



Pictures showing fish with lesions

5.4.3 Project Title: Effect of Storage on the Bactericidal Activity of Seed Extracts of *Polyalthia longifolia* Sonn.

Research team: Adolf Kofi Awua and Edna Dzifa Doe

This is an on-going project which is being funded by the research team. Project commenced in 2014 and due to be completed in 2016.

Executive summary

The main objective of study is to determine changes in the antibacterial activities of oil and ethanol extracts of the seeds of *Polyalthia longifolia* (False Ashoke) by the disc diffusion method. The study screened for potential antibacterial activity and assessed the stability of

the antibacterial activity of oil, 60% ethanol extracts of seeds of *Polyalthia longifolia* during long term of storage under changing temperatures.

Following the promising results of these extracts against four of the six clinical isolates of bacteria used in this study the extracts of the seeds of *Polyalthia longifolia* (False Ashoke) were stored for between 6 and 8 months under varying cycle of temperature changes between 4°C and 25°C and the analysis of their antibacterial activities repeated.

The determination of the minimum inhibitory concentration (MIC) has shown that extracts of *Polyalthia longifolia* (False Ashoke) are showing bactericidal effects. Against *Salmonella typhi* continued storage of the oil for a further month resulted in a greater reduction in the observed zones of inhibition. In respect of the bacteria *Klebsiella* sp, *Staphylococcus* sp. and *Proteus* sp., the bactericidal effects were completely lost after both 7 and 8 months of storage, while the bacteriostatic effect of the stored oil remained. The data generated in this study strongly suggests that the oil extract of the seed of *Polyalthia longifolia* is a potential source of base/initial compounds that are worth further investigations to assess the potential as antibacterials particularly against *Salmonella typhi*.

5.4.4 Project Title: Antibacterial and Antioxidant Properties of the Exocarp, Endocarp and Seeds of *Chrysophyllum albidum* (Alasa).

Research Team: Edna Dzifa Doe, Adolf Kofi Awua, Sandra Afi Agbenyegah

This is an on-going project which is being funded by the research team. Project commenced in 2015 and due to be completed in 2016.

Executive summary

The overall objectives for this study were; 1) To determine the antibacterial properties of *Chrysophyllum albidum* by testing them against some Gram negative and Gram positive clinical isolates, and 2) To determine the Minimum Inhibitory Concentration (MIC), Minimum Bactericidal/ Bacteriostatic Concentration (MBC) of the extracts.

Human beings have depended on both herbal and non-herbal traditional medicines for curative and prophylactic purpose. Fruits are main source of minerals, fibre and vitamins which are inevitable for human health. *Chrysophyllum albidum* is a tropical ever green edible fruit tree which is good for the treatment of fibroids and it is widely used as an application to sprains, bruises and wounds in herbal medicine. It is an important medicinal plant used as a remedy for yellow fever and malaria.

In this study, endocarp, exocarp and seeds were dried and mashed and extraction were carried out. These extracts were impregnated on filter papers and tested against some clinical isolates to observe their susceptibility and resistance patterns. Although there were no bactericidal effects on the growth of the selected clinical isolates, the bacteriostatic effects were indicative of the potential presence of compounds that may be useful as initial compounds in the development of antibacterial.



Picture showing sliced *Chrysophyllum albidum*



Picture showing seeds of *Chrys. albidum*



Picture showing the endocarp of *Chrysophyllum albidum*



Picture showing the susceptibility of antibiotics to *Chrysophyllum albidum* extracts

5.4.5 Project Title: To Determine the Antimicrobial Potential of Aqueous Extracts of *Allium sativum* (Garlic) with that of Conventional Antibiotics of Choice in Treating some Infections Caused by the Test Bacteria.

Research Team: Edna Dzifa Doe, Adolf Kofi Awua, Sandra Afi Agbenyegah,

This is an on-going project which is being funded by the research team. Project commenced in 2015 and due to be completed in 2016.

Executive summary

The main objective of this project is to determine the antimicrobial potential of aqueous extracts of *Allium sativum* (garlic) with that of the conventional antibiotics of choice in treating some infections caused by the test bacteria.

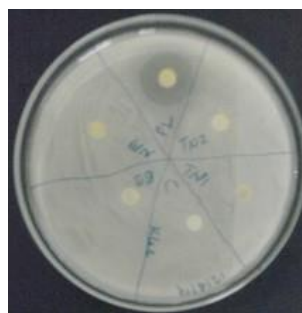
According to the World Health Organization (WHO), as many as 80% of the world's people depend on traditional medicine for their primary health care needs. There are considerable economic benefits in the development of indigenous medicines and in the use of medicinal plants for the treatment of various diseases. *Allium sativum*, which is used widely as a flavouring in cooking, has also been used as a medicine throughout ancient and modern history to prevent and treat a wide range of conditions and diseases.

The garlic were chopped and blended, soaked in 100mls of sterile distilled water for 24hrs in a sterile container. The pulp obtained was shaken vigorously to allow for proper extraction of active ingredients. These extracts were impregnated on filter papers and tested against some clinical isolates to observe their susceptibility and resistance patterns.

Results indicate that garlic has high levels of antioxidant property. Conversely, the bactericidal activity was low with promising extent of bacteriostatic activities against clinical isolates of infectious disease.



A



B

Picture showing peeled garlic *Allium sativum* (A)

Petri dish showing the susceptibility and resistance of standard antibiotics to the *Allium sativum* (Garlic) extracts (B)

5.4.6 Project Title: Assessment of Well Water Quality in the Dangme West District of the Greater Accra Region, Ghana.

Research Team: S.T. Odonkor¹, T. Mahami² and F. C. K. Ocloo²

¹Radiological and Medical Sciences Research Institute, GAEC

²Biotechnology and Nuclear Agriculture Research Institute, GAEC

This is a completed project which was funded by the research team. Project commenced in 2014 and was completed in 2015.

Executive summary

The objective of the study was to assess the microbial and chemical risks associated with open hand-dug wells in the Dangme west district.

Drinking water quality has been linked to several diseases of man including diarrhoea diseases particularly in developing countries where availability of portable water is an issue. This study investigated the quality of well water in the Dangme west district of Ghana. Ten (10) hand-dug wells randomly selected were sampled, and analysed for physical, chemical and bacteriological quality following standard procedures. The results were then compared with World Health Organization (WHO) standards for drinking water. Results obtained showed that the bacteriological quality of well water was particularly unacceptable. Most Probable Number (MPN) of total coliforms in 100mls of water samples, which ranged between 120-1880 was higher than the WHO standard of zero in samples from all wells. Additionally, *E. coli* was isolated from 8 out of 10 wells (80%) and *Streptococcus* from 5 out of 10 wells (50%). Except for turbidity and Nitrates, which were higher than the WHO standards, physicochemical properties of well water were found to be within the WHO standards for drinking water. Due to high turbidity, nitrate content and particularly unacceptable bacteriological quality, well water from the Dangme west district is therefore not suitable for direct consumption.

6.0 ON-GOING IAEA TC AND AFRA PROJECTS

	PROJECT	NATIONAL COUNTERPART
1.	CRP17126 -Strengthening of biological dosimetry in IAEA Member States. Improvement of current techniques and intensification of collaboration and networking among the different institutes.	Dr. Daniel Achel
2.	GHA6017 -Establishing a Nuclear Medicine, Medical Imaging and Radiotherapy Centre for cancer prevention, treatment, research and development.	Dr Mary Boadu
3.	RAF9044 -Strengthening radiological protection of patient and medical exposure.	Dr. Mary Boadu
4.	RAF6048 -Strengthening Medical Physics' capabilities to ensure safety in medical imaging, with an emphasis on paediatric and their care givers and pregnant women jmaging safety.	Mr. Theophilus Sackey
5.	RAF6044 -Medical Physic in support of cancer management.	Mr. Francis Hasford
6.	RAF6042 -Applying nuclear techniques to design and evaluate interventions to reduce obesity and related health risks.	Ms. Theodosia Adom
7.	RAF6047 -Applying stable isotope techniques to monitor and asses the vitamin A status of children susceptible to infection/	Dr Rose Boatin
8.	RAF6049 -Strengthening and improving Radiopharmacy services.	Mr.Lawrence Akono Sarsah

7.0 HUMAN RESOURCE DEVELOPMENT

Scientists from the Institute have proposed and been supervising the projects of Masters and PhD. students. They also lecture students at SNAS and various institutes of higher learning in the country and a neighbouring country as well as being resource persons in international training programmes. Some of the key activities undertaken by staff of RAMSRI to build human resource capacity during the year under review are indicated below.

7.1 Lecturing of Students

Staff of RAMSRI have been providing training to a broad spectrum of medical and health professionals in hospitals (doctors, nurses, technologists etc.), scientists in industry and research institutions, offering practicals and lectures in subject areas such as: Medical Exposure in Radiotherapy, Diagnostic Radiology and Nuclear Medicine; X-rays and Diagnostic Radiology; Radiological Physics and Radiation Oncology; Oral Radiology; Chemistry of Irradiated Foods; Cell and Molecular Biology.

In addition, some members of staff are External Examiners for, Fellowship Examinations of West Africa College of Physicians and Surgeons, Ghana College of Physicians and Surgeons Fellowship examinations, Ghana College of Physicians and Surgeons Primary examination and SNAS students.

Scientists and Technologists also assisted Post graduate students, students on attachment and National Service Personnel in practical laboratory techniques.

7.2 Thesis supervision

7.2.1 Title of thesis: Composting organically amended soft and hard wood saw dust

Programme: M. Phil. Nuclear Agriculture, SNAS, University of Ghana

Student: Rita Takyi-Lartey

Supervisors: Dr.Daniel Asare and **Dr Rose Boatin**

Status: Completed

7.2.2 Title of thesis: Assessment of levels of occupational exposure to UVA and UVC radiation among shielded metal arc welders in Accra, Ghana

Programme: MPhil Radiation Protection, SNAS, University of Ghana

Student: Akilapka Sawyerr

Supervisors: Prof. John Justice, Dr. J.K. Amoako, **Mr. Edem Sosu**

Status: Completed

7.2.3 Title of thesis: Performance evaluation of low dose rate prostate brachytherapy system

Programme: MPhil Medical Physics, SNAS, University of Ghana

Student: Yaa Akomah Asenso

Supervisors: A.K Kyere, **F. Hasford**, S.N. Tagoe

Status: Completed

7.2.4 Title of thesis: Evaluation of absorb dose to critical organs in computed tomography

Programme: MPhil Medical Physics, SNAS, University of Ghana

Student: Kofi Akyea-Larbi

Supervisors: C. Schandorf, **F. Hasford**

Status: Completed

7.2.5 Title of thesis: Development of computed tomography patient dose guidance levels in North-Central Nigeria

Programme: MPhil Medical Physics, SNAS, University of Ghana

Student: Muhammad Kabir Abdulkadir

Supervisors: C. Schandorf, J. J. Fletcher, **F. Hasford**

Status: Completed

7.2.6 Title of thesis: Evaluation of radiation dose to patients during myocardial SPECT imaging (Stress and Rest)

Programme: MPhil Medical Physics, SNAS, University of Ghana

Student: Adamou Soli Idrissa

Supervisors: A.K. Kyere, I.K. Wilson, **F. Hasford**

Status: On-going

7.2.7 Title of thesis: Dose reduction in general radiography while maintaining diagnostic confidence for some selected facilities in Kumasi

Programme: M. Phil. Radiation Protection, SNAS, University of Ghana

Student: Emmanuel Amponsah,

Supervisors: **Dr. Mary Boadu** and Prof. Cyril Schandorf

Status: Completed

7.2.8 Title of thesis: Dose estimation and optimization for paediatric patients undergoing fluoroscopic guided procedures.

Programme: M. Phil. Radiation Protection, SNAS, University of Ghana

Student: Hannah Mantebea

Supervisors: Dr. Mary Boadu and Dr. Joseph Amoako

Status: Awaiting Results

7.2.9 Title of thesis: Assessment of typical radiation doses to patients from orthopaedic examination (spine and extremities) from the Radiology Departments, Korle-Bu Teaching Hospital.

Programme: M. Phil. Radiation Protection, SNAS, University of Ghana

Student: Alberta Ockling

Supervisors: Dr. Mary Boadu and Prof. Cyril Schandorf

Status: On-going

7.2.10 Title of thesis: CT radiation dose in children: a survey to establish regional diagnostic reference levels in Greater Accra-Ghana.

Programme: M. Phil. Radiation Protection, SNAS, University of Ghana

Student: Patience Addo

Supervisors: Dr. Mary Boadu and Prof. Cyril Schandorf

Status: On-going

7.2.11 Title of thesis: Assessment of shielding materials used in mammography facilities in Ghana

Programme: M. Phil. Radiation Protection, SNAS, University of Ghana

Student: Veronica Afriyie Boahene

Supervisors: Dr. Mary Boadu and Prof. J. J. Fletcher

Status: On-going

7.2.12 Title of thesis: Assessment of dose to patients from digital mammography systems in some selected diagnostic centres.

Programme: M. Phil. Medical Physics, SNAS, University of Ghana

Student: Caroline Kachana Pwamang

Supervisors: Dr. Mary Boadu and Mr. Edem Sosu

Status: On-going

7.3 IAEA Post Graduate Education Course (PGEC).

Under the IAEA Post Graduate Education Course in Radiation Protection and Safety of Radiation Sources programme, the following projects have been completed.

Name of Student	Title of Project	Country	Supervisors
Mr. Peter Selato Selato	Protection of the Patient in Dentistry.	Botswana	Dr. J. Yeboah Dr. Mary Boadu
Ms. Mekdes Admassu Melkamu	Protection of Staff in Interventional Radiology	Ethiopia	Dr. Mary Boadu Prof Cyril Schandorf
Mr. Awini Samson Aweligiba	Overview of Digital Radiography	Ghana	Dr. Mary Boadu Prof. Cyril Schandorf
Ms .Seeburrun Vanisha	Radiation Protection in Nuclear Medicine	Mauritius	Prof. J.H. Amuasi Dr. Mary Boadu
Mr. Mujin Kagya Kweyemamu	Overview of Patient Dosimetry in Diagnostic Radiology	Tanzania	Prof.Cyril Schandorf Dr. Mary Boadu
Ms. Nastai Vanessa Tsitsi Mutanga	Use of Dose Constraints in Medical Exposure	Zimbabwe	Prof.Cyril Schandorf Dr. Mary Boadu

7.4 Public Lectures

Date, Organizer	Title	Venue	Speaker
24 th March, 2016 GSMP/RAMSRI	Accuracy of using in-vivo dose verification with diodes at Seeded-Ghana Medical Centre for different treatment sites	School of Nuclear and Allied Sciences,UG.	Mr. Mark Pokoo-Aikins
30 TH April, 2015. RAMSRI	Research Ethics, the responsibility of the Researcher	GAEC	Mr Adolf Awua
13 th October, 2015. RAMSRI	Research Ethics, the responsibility of	School of Nuclear and Allied	Mr Adolf Awua

	Graduate schools	Sciences,UG.	
1-4 November, 2015	Health benefits and health risks of ionizing radiation	Federal University of Technology, Akure, Ondo State, Nigeria	Dr. Mary Boadu

7.5 Participation of Staff in IAEA Training Courses, Meetings and Conferences.

Staff participated in the RAMSRI seminars and the general GAEC seminars held during the period under review. Staff also participated in IAEA Training Courses, Meetings and Conferences as indicated below.

Date, Organizer	Title	Venue	Participant(s)
20th January, 2015 WHO	Comprehensive global guidance on cervical cancer control: New evidence, guidance and fundamentals for country level success	Online seminar (Webinar)	Mr Adolf Awua
12th – 13th February, 2015 Queensland University of Technology	Wet-milling pressed powder tablets for routine analysis of sediments by LA-ICP-MS. Nanotechnology and Molecular Science HDR Symposium 2015	Australia	Mr Godfred Odame Duodu
24th – 26th February, 2015 World Intellectual Property Organisation	2nd Workshop on the effective use of technological and scientific information: Meeting on developing the TISC project	Accra	Mr Adolph Awua
25th-27th February, 2015 RAMSRI	Workshop on Project Planning, Design and Management	GAEC, Accra	RAMSRI Research Scientists and Technologists
9th -11th March, 2015 NMIR	Ethical Review Training Workshop	NMIR, Accra	Mrs Leticia Ofosu-Yirenkyi
9th and 27th April, 2015	Strategy and Planing on working together to to support research in Ghana	GAEC, Accra	Messrs Oti Kwasi Gyamfi and Edem

9th April and 9th June, 2015 Corsofium of Axademic and Research Libraries in Ghana (CARLIGH) and INASP/ UK		CSIR-INSTI, Accra	Sosu Ms Nana Afua Adu- Bobi
4th – 8th May, 2015 IAEA	Training in field implementation on assessing vitamin A status using stable isotope dilution technique and on measurement of inflammatory markers	Yaounde, Cameroon	Dr Rose Boatin
4th – 8th May, 2015 IAEA	Regional workshop on strenthening Member States national systems for safety in medical exposure	Harare, Zimbabwe	Dr Mary Boadu
22nd June, 2015 International Centre for Infectious Diseases	The 9-valent HPV vaccine: What will it bring to HPV prevention in Canada?	Online seminar (Webinar)	Mr Adolf Awua
July-August 2015	17th National congress of the South African Society of Clinical and Radiation Oncology (SASCRO) and the South African Society of Medical Oncology (SASMO)	Cape Town, South Africa	Dr Daniel Achel
10th-14th August, 2015 Regional African Intellectual Property Organisation (ARIPO)	Making better use of Intellectual Property for Business competitiveness and development in Africa	Accra	Mr Adolf Awua

27 th August, 2015 QUT	Training on compressed gas by COREGAS	Australia	Mr Godfred Odame Duodu
2nd – 3rd September, 2015 & 5 th - 9 th October, 2015 OKF/TTMC/G AEC	Leadership and strategic management training	GAEC, Accra	Centre Managers and Focal Persons of RAMSRI
22nd September- 13th October, 2015 Keshe Foundation Technologies and GSSTI	Keshe Foundation Technologies:Nanotechnology		
28th September– 2 nd October 2015 IAEA/RAMS RI	AFRA training course on QUATRO Audits for Medical Physicists	GAEC, Accra	Messrs Francis Hasford and Mark Pokoo-Aikins
5 th – 9 th October, 2015 IAEA	International conference on clinical PET-CT and Molecular imaging (IPET 2015)	Vienna, Austria	Mr Francis Hasford
5th-6th November 2015, University of Ghana	Maiden University of Ghana Doctorial Research Conference	Accra	Mr Francis Hasford

7.6 Fellowship/Post Doctoral Study

1. Francis Hasford was on the third and final six months IAEA PhD Sandwich fellowship programme at the CM Johannesburg Academic Hospital, University of Witwatersrand, South Africa from 16th April to 15th September 2015.
2. Elom Achoribo was on nine months fellowship training in the Institut de Recherche en Science de la Sante in Bobo-Dioulasso, Burkina Faso.
3. Dr Daniel Achel completed a year post doctoral study in the Division of Medical Imaging and Clinical Oncology at Stellenbosch University, Cape Town, South Africa.

8.0 IAEA COORDINATION MEETING HOSTED BY RAMSRI

The Institute hosted the IAEA training course on QUATRO Audits for Medical Physicists from 28th September to 2nd October, 2015

9.0 PUBLICATIONS

9.1 Refereed Journals

1. Alcaraz M, Olivares A, **Achel DG**, García-Cruz E, Fondevilla-Soler A, Canteras-Jordana M (2015) Toxicity of a dental adhesive compared with ionizing radiation and zoledronic acid. *Med Oral Patol Oral Cir Bucal*, 20 (4):e427-34.
2. Darfour B, Asare IK, Ofosu DO, **Achel DG**, **Achoribo S.E** and **Agbenyegah S** (2015). The effect of different drying methods on the phytochemicals and radical scavenging activity of Ceylon cinnamon (*Cinnamomum zeylanicum*) plant parts. *European J Med Plants*. 4(11): 1324-1335, 2014.
3. Doamekpor, L.K., Klake, R.K., Nartey, V.K., Yamato, T., **Gyamfi, O.** and Adotey, D. (2015) Synthesis and Conformational Studies on [3.3.3]Metacyclophane Oligoketone Derivatives, and Their Metal Ion Recognition. *International Journal of Organic Chemistry*, 5, 126-135. [DOI: <http://dx.doi.org/10.4236/ijoc.2015.52014>]
4. **Duodu, G. O.**, Goonetilleke, A., Allen, C., & Ayoko, G. A. (2015). Determination of refractive and volatile elements in sediment using laser ablation inductively coupled plasma mass spectrometry. *Analytica Chimica Acta*, 898, 19-27

5. **F. Hasford**, B. Van Wyk, T. Mabhengu, M.D.T. Vangu, A.K. Kyere, J.H. Amuasi. Determination of dose delivery accuracy in CT examinations. *J Rad Res and App Sci*, (2015);8(1):489-492.
6. **F. Hasford**, Y.H. Yigbedeck, A.K. Kyere, I.K. Wilson, A.O. Ankrah, **E.K. Sosu**. Quantification of radionuclide uptake levels for primary bone tumors, *J Rad Res and App Sci.*, 2015;8(1):182-189.
7. Godfred Egbi, Irene Ayi, Firibu Kwesi Saalia, Francis Zotor, Theodosia Adom, Eric Harrison, Collins K Ahorlu, Matilda Steiner-Asiedu. *Impact of Cowpea-Based Food Containing Fish Served With Vitamin-C-Rich Drink on Iron Stores and Hemoglobin Concentrations in Ghanaian Schoolchildren in a Malaria Endemic Area*. *Food and Nutrition Bulletin* 2015, Vol. 36(3) 264-275. DOI: 10.1177/0379572115596253.
8. Hamunyela R, Serafin A, Hamid M, Maleka S, **Achel D** and Akudugu J(2015). A cocktail of specific inhibitors of HER-2, PI3K, and mTOR radiosensitises human breast cancer cells. *Gratis J Cancer Biol Therap*, 1(1): 46-56.
9. L.T. Bambara, A.K. Kyere, **F. Hasford**, **E.K. Sosu**, I.K. Wilson. Estimation of kidney and bladder radionuclide activity for patients undergoing bone scan. *J Rad Res and App Sci.*, 2015; 8(1):317-322.
10. Maleka S, Serafin A, Hamunyela R Hamid M, **Achel D** and Akudugu J (2015). NVP-BEZ235 Enhances Radiosensitivity of Human Prostate Cancer Cells but Acts as a Radioprotector to Normal Prostate Cells *Gratis J Cancer Biol Therap*, 1(1): 38-45.
11. **Mark Pokoo-Aikins**, George F. Acquah, **Theophilus A. Sackey**, **Mary Boadu**, **Francis Hasford**, **Theresa B. Dery**, Bernhard Schiestl. Accuracy of Using *In-Vivo* Dose Verification with Diodes for Different Sites. *International Journal of Science and Technology*, 5 (1): 6-16, January 2015
12. **Odonkor, S.T.**, and Mahami, T. (2015). *Diagnoses of Emerging but neglected diseases (END's) in Africa: challenges and prospects*. *American International Journal of Contemporary Scientific Research*. AIJCSR-278 ISSN 2349-4425

13. Pardo, M., Alcaraz, M., Bernal, FL., Felices, JM., **Achel, DG** and Canteras, M (2015) Transcutaneous oxygen tension measurements following peripheral transluminal angioplasty procedure has more specificity and sensitivity than ankle brachial index. Br J Radiol **88** 1046-1051 angioplasty. Radiol med (2013) 118: 118:000–000, DOI 10.1007/s11547-012-0000-0
14. **Stephen T. Odonkor, Theophilus Sackey** and Tahiru Mahami. *Evidence of Cross Contamination of Ultrasound Equipment: A call for Infection Prevention Strategy in the Use of Diagnostic Tools*. International Journal of Current Microbiology Applied Science (2015) **4(5): 445-453**.
15. **Stephen T. Odonkor**, Tahiru Mahami and Theophilus Sackey (2015). *Perception, Attitude and Knowledge of Cancer amongst General Populace in Accra, Ghana*. Journal of Bioscience 4(8): 2972-2984
16. V Samlafo, L.H Bobobee, E. Quarshie, **L.A Sarsah** Physicochemical assessment of groundwater samples from Avenorpeme and its environs in the Akatsi District, Ghana. Journal of Radioanalytical and Nuclear chemistry. DOI 10.1007/s10967-012-1750-x

9.2 Conference Proceedings

1. **F. Hasford**, J.H. Amuasi, A.K. Kyere, M.D.T. Vangu. Ultrasound and PET-CT Image Fusion for Prostate Brachytherapy Image Guidance. International Conference on Clinical PET-CT and Molecular Imaging (IPET2015), 5 – 9 October 2015, Vienna – Austria.
2. **F. Hasford**, B. Van Wyk, T. Mabhengu, M.D.T. Vangu, A.K. Kyere, J.H. Amuasi. Quantitative Assessment of PET/CT Image Uniformity. International Conference on Clinical PET-CT and Molecular Imaging (IPET2015), 5 – 9 October 2015, Vienna – Austria.
3. **F. Hasford**, J.H. Amuasi, A.K. Kyere, M.D.T. Vangu. Ultrasound and PET-CT Image Fusion for Prostate Brachytherapy Image Guidance. Maiden University of Ghana PhD Conference, 5 – 6 November 2015, Legon, Accra – Ghana.

4. Hamid MB, Serafin AM, Hamunyela RH, Maleka S, **Achel DG** and Akudugu JM. *Radiosensitisation of low HER-2 expressing human breast cancer cell lines*. 17th National congress of the South African society of Clinical and Radiation Oncology (SASCRO) and the South African Society of Medical Oncology (SASMO), July- August, 2015: book of abstracts.
5. Hamunyela RH, Serafin AM, Hamid MB, Maleka S, **Achel DG** and Akudugu JM. *Radiosensitisation of human breast cancer cell lines with a cocktail of specific inhibitors of HER-2, PI3K and mTOR*. 61st Radiation Research meeting, Florida, USA, September 2015.
6. Hamunyela RH, Serafin AM, Hamid MB, Maleka S, **Achel DG** and Akudugu JM. *Radiosensitisation of human breast cancer cell lines with a cocktail of specific inhibitors of HER-2, PI3K and mTOR*. 17th National congress of the South African society of Clinical and Radiation Oncology (SASCRO) and the South African Society of Medical Oncology (SASMO), July- August, 2015: book of abstracts. p 87.
7. Maleka S, Serafin A, Hamid MB, Hamunyela RH, **Achel DG** and Akudugu JM. *The specific inhibitor of PI3K and mTOR (BEZ-235) has potential radioprotective effect*. 17th National congress of the South African society of Clinical and Radiation Oncology (SASCRO) and the South African Society of Medical Oncology (SASMO), July- August, 2015: book of abstracts. p 50.

9.3 Chapter in Book

1. Dr. Ibewuiké C.U., Dr. Gordon-Harris L., **T.A Sackey**, Dr. Imo A.O.C., Dr. T. Ige and Dr. Sule Ahmed Saidu. MCQ Companion to Radiologic Physics, Vol. 1, ICECANOPY PUBLISHING LTD, Enugu-Nigeria
2. Dr. Ibewuiké C.U., Dr. Gordon-Harris L., **T.A Sackey**, Dr. Imo A.O.C., Dr. T. Ige and Dr. Sule Ahmed Saidu. MCQ Companion to Radiologic Physics, Vol. 2, ICECANOPY PUBLISHING LTD, Enugu-Nigeria

9.4 Book

1. Prof. Nzeh D., Prof. Obajimi M., **T.A. Sackey.**, Fundamentals of Radiological Physics., BOOKBUILDERS PUBLISHING LTD, Ibadan-Nigeria

9.5 Manuscripts in Press

1. Abenaa A. Okyere, Emmanuel K. Gasu, Isaac K. Asare, Dora Duah-Bisiw, Ernestina Ayeh, **Shadrack Donkor.** Pre-treatments effect on proximate and phytochemical components of flour prepared from oyster mushroom
2. **Achel DG**, Serafin AM and Akudugu JM (2015). An evaluation of the *in vitro* cytotoxicity and radiomodifying effects of aqueous extracts of *Moringa oleifera* (Lam) (Accepted)
3. **Achel DG.**, Serafin A. M and Akudugu JM. (2015). Flow cytometry-assisted quantification of γ -H2AX expression has potential as a rapid high-throughput biodosimetry tool.
4. Agyekum Akwasi Akomeah, Achel Daniel Gyingiri, Donkor Shadrack, Adu-Bobi Nana Afua Kobi, Akuamoah Felicia, Agbenyegah Sandra. 2015. Nutritional Properties of *Solanum torvum*
5. Akwasi Akomeah Agyekum, Daniel Gyingiri Achel, Shadrack Donkor, Nana Afua Kobi Adu-Bobi, Felicia Akuamoah, and Sandra Agbenyegah. Nutritional properties of *Solanum torvum*
6. **Akwasi Akomeah Agyekum, Felicia Akuamoah**, Samuel Kofi Frimpong, Achibold Buah-Kwofie, Crentsil Kofi Bempah. Dietary Exposure to Chlorinated Pesticide Residues in Fruit and Vegetables from Ghanaian Markets.
7. **Akwasi Akomeah Agyekum, Felicia Akuamoah**, Isaac Delali Kottoh, Isaac Kwabena Asare, John Opoku Danquah, Daniel Armah. Evaluation of Trace Metal Contents of Three Local Spices on Accra Markets. International Journal of Nutrition and Food Sciences
8. **Akwasi Akomeah Agyekum**, George Soda Ayernor, Firibu Kwasi Saalia, and Betty Bediako-Amoa. Translocation of Pesticide Residues in Tomato, Mango and Pineapple Fruits. Journal of Food Science and Engineering 5 (2015) 86-93.

9. Felicia Akuamoa, Akwasi Akomeah Agyekum, Shadrack Donkor, Nana Afua Kobi Adu-Bobi, Sandra Agbenyegah. Comparative studies on the phytochemical properties of three kola varieties (*Kola nitida*, *Kola acuminata*, *Garcinia kola*).
10. **F. Hasford**, J.H. Amuasi, A.K. Kyere, M.D.T. Vangu, Quantitative Assessment of Radionuclide Uptake and Positron Emission Tomography-Computed Tomography Image Contrast. World Journal of Nuclear Medicine. WJNM_78_15.
11. **F. Hasford**, B. Van Wyk, T. Mabheng, M.D.T. Vangu, A.K. Kyere, J.H. Amuasi. Effect of Radionuclide Activity Concentration on PET-CT Image Uniformity. World Journal of Nuclear Medicine. WJNM_44_15.
12. Frederick Vuvor, Matilda Steiner-Asiedu, Kwesi Firibu Saalia, William Bruce Owusu, **Theodosia Adom**. Predictors of Hypertension, Hypercholesterolaemia and Dyslipidaemia of Men Living in a Peri-urban Community in Ghana, submitted to Journal of Health Research and Review 2015.
13. Quartey EK, Amoatey HM, **Achoribo E**, Owusu-Ansah M, Nunekpeku W, **Donkor S**, Appiah AS, Ofori ESK. Phytochemical Constituents and Antioxidant Activities in Leaves of fourteen (14) Breeding Lines of Cassava (*Manihot esculenta* Crantz).
14. Robert Yankey, **Adolph Awua**, **Edna Dzifa Doe**, **Martin Hayford**, **Elorm Achoribo**, **Sandra Agbenyegah**, **Akomeah Agyekum**, **Felicia Akuamoa**, **Nana Afua Kobi Adu-Bobi**, **Shadrack Donkor**. Evaluation of oxalate content in species and seasonings used in Ghana
15. Serafin A, Fernandez P, **Achel DG.**, Böhm L, Akudugu John (2015). PAI-1 expression in prostate biopsies as a sole predictive marker in prostate cancer.

9.6 Technical Reports

1. **Achoribo S. Elom**; Serge Yerbanga; Ollo Da; Tamboula Souleyman Evaluation of antimalarial activity of *Vernonia colorata* against *Plasmodium berghei*, ANKA, in NMRI mice.
2. Adolf Kofi Awua and Edna Dzifa Doe. Effect of Storage on the Bactericidal Activity of Seed Extracts of *Polyalthia longifolia*.
3. Akilapka Sawyerr, Prof. John Justice, Dr. J.K. Amoako, **Mr. Edem Sosu**. Assessment of levels of occupational exposure to UVA and UVC radiation among shielded metal arc welders in Accra, Ghana”.

4. **Daniel G. Achel**, Antonio M. Serafin, and John M. Akudugu Flow cytometry-assisted quantification of γ -H2AX expression has potential as a rapid high-throughput biodosimetry tool.
5. **Duodu, G. O.**, Goonetilleke, A. & Ayoko, G. A. (2015). Optimisation of In-Cell Accelerated Solvent Extraction Technique for the Determination of Organochlorine Pesticides in River Sediments.
6. **Duodu, G. O.**, Ogogo, K. N., Mummullage, S., Harden, F., Goonetilleke, A. and Ayoko, G. A. (2015). Source and Contribution of PAHs to Brisbane River Sediment.
7. Edna Dzifa Doe, Adolf Kofi Awua, Kingsley Kwame Nsowah and Oti Kwasi Gyamfi. Exploratory study on the observance of lesions on fish suggestive of microbial infection.
8. Frempong Acheampong, Amoako Joseph, Darko Emmanuel Ofori, Appiah Rita and **Dery Theresa**. Induced Electromagnetic Fields Estimation in Spine Examination of MRI Patients.
9. J.H.Amuasi, A.K. Kyere, C. Schandorf, J.J. Fletcher, E.K. Addison, M. Boadu, **F. Hasford, E.K. Sosu, T.A. Sackey**, S.N.A. Tagoe, Y. Serfor-Armah, Medical Physics Practice and Training in Ghana, IUPESM WC2015
10. K.O. Akyea-Larbi, C. Schandorf, **F. Hasford**, S. Inkoom, G.F. Acquah. Effective dose estimation and cancer risk assessment due to some selected CT examinations at Sweden Ghana Medical Centre.
11. **Shadrack Donkor, Daniel Gyingiri Achel, Adu-Bobi Nana Afua Kobi, Agyekum Akwasi Akomeah, Akuamoa Felicia**, Asare Isaac Kwabena. Antioxidant properties of aqueous and ethanolic extracts of *Euphorbia hirta*, (L). 2015.
12. **S.T. Odonkor**, T. Mahami and F. C. K. Ocloo Assessment of Well Water Quality in the Dangme West District of the Greater Accra Region, Ghana.
13. Theophilus Sackey, Ernest Kojo Eduful, Issahaku Shirazu. A ten (10) years of the SPECT system operation at the Korle-Bu Teaching Hospital

14. T.A. Sackey, M. Pookoo Aikins. The IAEA/WHO TLD audit programme. The results of the TLD postal Dosimetry audits in the National Centre for Radiotherapy and Nuclear Medicine Department, Korle-Bu, Accra (1998-2012)

15. **Theodosia Adom**, Thandi Puoane, Anniza De Villiers, André Pascal Kengne. Prevalence of Obesity and Overweight in African Learners – A Protocol for Systematic Review and Meta-analysis. The review protocol is registered in the PROSPERO International Prospective Register of systematic reviews, registration number: CRD42016035248.

10.0 ACHIEVEMENTS

- Rates of projects execution have been very good resulting in a number of publications, despite the numerous challenges. Ethical clearance were awarded for CRP 30.0065 (GHA 17126) and RAF 6047 by the Radiological and Medical Sciences Research Institutes Ethical Review Committee.
- Mr Theophilus Sackey of the Medical Physics Centre was awarded a CRP contract titled “Evaluation and Optimisation of Paediatric Imaging”
- Based on an initial study on the use of Molecular Biology Techniques in Medical Diagnosis by Mr Adolf K. Awua and Ms. Edna D. Doe, a proposal on “Building the Capacity of Biomedical Laboratory Scientist in Molecular Isotopic Techniques for Improved Diagnosis of Infectious Diseases” was developed and won a COTVET/MESTI grant of sixty-two thousand, one hundred and six Ghana cedis and twenty-eight pesewas (GHS 62,106.28), through the Technology Transfer and Marketing Centre of GAEC.
- Mr Francis Hasford facilitated a 3-day workshop on Project Planning, Design and Management for staff of RAMSRI and was a Course Director when RAMSRI’s hosted an IAEA/AFRA Regional Training Course on QUATRO Audits for Medical Physicists from 28th September to 2nd October 2015. Mr Hasford also won Best Poster Presentation Award at the Maiden University of Ghana Doctoral Research Conference in 2015 and also at the International Conference on Clinical PET-CT, at IAEA from 5th-9th October, 2015.

- Mr Adolf K. Awua was appointed an IAEA Expert (Home-based Assignment) for the Compilation of a Regional Database and Data Analysis for (RAF) 6039 from December 2014 to April 2015.
- Mr Francis Hasford and Mr Theophilus Sackey completed a Doctor of Philosophy Degree and a Master of Philosophy Degree respectively in Medical Physics. In addition, four (4) other scientists in the Institute gained admission to various universities to pursue Doctor of Philosophy Degrees and another, a Master of Science Degree. Ms Elom Achoribo was awarded a TWAS sponsorship for her Doctor of Philosophy programme.

11.0 CHALLENGES

- The most crucial challenge facing the Nutrition Research Centre is lack of research scientists to carry out the mandate of the centre. Currently there is only one (1) Research Scientist, there is therefore an urgent need to recruit the needed staff to support the centre based on its manpower needs which has been submitted for consideration. Other challenges include lack of vehicle for field work which greatly affects research output. There is also lack of counterpart funding for IAEA funded and all other projects.
- For the Applied Radiation Biology Centre, as a centre with the mandate to conduct research in radiation biology, the absence a low dose irradiator and good microscope with the requisite software are major obstacles. There is also poor water supply and the practice of buying water from water tanker vendors is not only prohibitive, but also raises questions on the integrity/quality of results generated from experiments conducted.
- The Medical Physics and Radiopharmacy Centres have no dedicated facilities at GAEC to undertake clinical medical physics research and activities. The irregular supply of technetium was a major disincentive that affected the work at the National Centre for Radiotherapy and Nuclear Medicine.
- At the Cellular and Clinical Research Centre, the main challenge for the year under review is lack of adequate cold storage facilities such as refrigerators and deep freezers (both -20°C deep freezers and a -80°C deep freezer). There is also inadequate

staff (both Research and Technical). Lack of proper maintenance culture and frequent servicing of old machines have been challenging.

- What is common to all centres is the inadequate laboratory and office space. Insufficient laboratory space means that, for the specialised nature of work under current projects, there is a real risk of cross-contamination between the limited rooms currently in use. The consequences of cross-contamination will be extremely costly in terms of laboratory reagents, sample loss and experiment re-runs.
- Chronic lack of funds to support basic scientific research work coupled with the silent change of approach or paradigm shift from scientific research to income generation are not helping matters.
- The inadequate supply and absence of some essential consumables, chemicals/reagents especially for routine laboratory experiments such as antioxidant analysis has been a real challenge
- The instability of the broadband internet service at RAMSRI has been a hindrance to the research works.
- There is erratic electricity supply to the laboratories for any meaningful and sustained programme of scientific work. The frequent power cuts slow down work as well as affecting storage of biological samples at the various centres. The unpredictable power supply since the beginning of year, has been a major setback to research activity since working continuously on projects which require constant power as well as storage of very sensitive substances e.g. media for cell culture, enzymes etc. is usually badly compromised. The erratic nature of power supply also poses a risk to the operational life of the major equipment in the centres because of attendant power spikes. This situation, albeit national in character, has stalled most on-going projects and also delayed the initiation of new projects and experiments. The need for the installation of a battery of stand-by fuel-powered generators to supply electricity to the laboratories is most imperative.

12.0 PROJECTIONS FOR THE YEAR 2016

Project teams are soliciting for funds from various organisations for the local running of on-going projects. Even though the teams always make the effort to solicit for funding, they are often not successful but are hopeful next year will be different. It is hoped that the

Commission will intensify its efforts to support the Institute until its Internally Generated Fund activities are in a position to augment or take over from the Commission.

Ethical clearances were awarded to CRP30.0065 (GHA17126) and RAF6047 for field work to commence in 2016. Data collection has been completed on RAF6042 and data analysis is ongoing. Data collection and analysis will continue on “A secondary data analysis for the development and evaluation of a streamlined Dose-to-Mother technique to determine exclusive breastfeeding”.

ARBC will continue with research focused on the construction of dose-response curves for ^{60}Co - γ rays using the Micronucleus and the Dicentric assays. A dose-response curve was constructed using the dicentric assay, however results could not be validated due to the erratic electricity supply, since this phase of work requires at least 72 hours of continuous electricity supply. It is hoped that this issue with erratic electricity supply will be addressed soon for the successful completion of project.

ARBC is a co-applicant of RAF 7012: Applying Nuclear Analytical Techniques to Support Harmful Algal Bloom Management in the Context of Climate and Environmental Change, Phase II” The overall objective is to develop and implement harmonized and integrated regional sea food safety monitoring in the Member States through the application of nuclear techniques for enhanced sustainability of marine resources, food security and socio-economic benefits. The centre has also identified two thematic areas to develop proposals in search for funding as follows:

1. Botanical medicine: towards ameliorating the cancer burden

- Ethnobotanical survey and cytotoxicity testing of anti-cancer plants in some selected districts of Ghana
- Evaluation of some anti-cancer plants used in Ghana for their radiomodulatory activities
- Radical Scavenging and Radiomodulatory Effects of elected anti-cancer plants: Substantiated by in vitro Assays

2. Environmental and occupational cancer risk/Cancer risks in the workplace

- Evaluation of Genotoxicity amongst occupationally exposed workers through in different genotoxicity end points: A human biomonitoring study

3. Personnel development

b. Internally generated funds

This year if all goes well particularly with the electricity stabilizing, the centre is targeting to generate about ten thousand Ghana cedis (GH10, 000.00) as IGF.

With logistical constraints successfully addressed by Management, CCRC will initiate work in the following areas:

- Environmental Mycobacteria Research with specific reference to Mycobacteria in Biofilms formed in Treated Pipe-borne water.
 - Mycobacteria in water used in irrigating vegetables farmed along main streets in Accra.
 - Mycobacteriosis in farmed tilapia and other commonly farmed fish species.
 - Screening of dairy milk obtained from lactating cows.
 - Using microbiological techniques to assess Water Quality and Food Safety.
1. The Centre proposes to increase efforts in identifying problems in order to provide tailor-made and appropriate solutions through biomedical research.
 2. It would STILL be useful to include the HAIN tests on a pilot basis for TB management and control in Ghana.

On-going projects in all the centres will continue as planned.

13.0 RECOMMENDATIONS

It is hoped that:

- Management of GAEC would source for funds to complete the RAMSRI building to increase office and laboratory space in order to enhance work output.
- Management of GAEC would lead efforts in securing funding for research in order that mission and vision of the Institute would be successfully realised.
- A generator would be procured to ensure biological samples are stored effectively.
- The acquisition of an additional vehicle for the institute, mainly for field work, is essential.

- Efforts would be made to increase staff strength to accommodate the expanding work envisaged at the various centres. NRC in particular has only one (1) scientist and it is imperative that a Nutritionist and a Biostatistician/ Epidemiologist are appointed in 2016 as per the Centre's manpower needs. This will help greatly in improving research outputs.
- Appropriate glassware and chemicals and consumables should be provided on a regular basis to enhance work in the laboratories.
- Centres will be well equipped with items including UV spec to facilitate research and commercialization drive.
- It is respectfully proposed that Commission assist the CCRC to win an IAEA Technical Cooperation (TC) project to inject vim into the Centre
- Efforts at establishing the Nuclear and Imaging Centre at GAEC campus ought to be stepped up to aid in clinical and research activities of RAMSRI staff.
- The Institute, on behave of the Commission, should establish MOU with the Imaging Centre's in the four (4) public University Teaching Hospitals in the country. This will enable MRPC staff to have full access to the departments' equipment for research and also provide services to the department that will help raise funds for the institute.
- Staff of MRPC should be permitted to accompany the Radiation Protection Institute personnel who perform the various Quality Control checks at the various hospitals in order to acquire the necessary technical skills.
- There should be increased and effective collaboration between the CCRC and stakeholders such as The National Tuberculosis Control Programme (NTP), The Ghana Prisons Service, Ghana Health Service and selected Metropolitan and District Assemblies.
- Management of GAEC would, as a matter of urgency, offer opportunities to members of staff of the CCRC to pursue training, particularly at the level of PhD, with work already done and garnered. Singular attention is imperative in this regard because the specialised nature of work at the Centre is not matched by the same quantum of PhD-level opportunities observed granted for staff in the Physical Sciences at the Commission.
- The Institute should establish collaborative relationship with similar research institutions and funding organisations in order to attract funding in a formal setting.

- There is the need for the Institute to support the dissemination of research findings by bearing the cost and publication fees and charges.

14.0 CONCLUSION

It is hoped that the financial challenges faced by the Institute since its inception will be a thing of the past. It is also hoped that RAMSRI building will be completed soon for staff to move in. The year has been a success amid challenges with sixteen (16) publications in refereed journals, seven (7) conference proceedings, two (2) Chapter in books, one (1) book, fifteen (15) manuscripts in press and fifteen (15) technical reports. It is evident therefore that when these challenges are addressed, work output will increase tremendously.

16.0 APPENDICES

Appendix 1: Board Members

No.	Name	Address	Position
1.	Prof. A.K. Nyarko	Dean, School of Pharmacy, UG	Chairman
2.	Prof. Isabella Quakyi	School of Public Health, UG	Member
3.	Prof. A. Lassey	Obstetrics and Gynaecology Department, UGMS	Member
4.	Dr. A.A. Sittite	Formerly of Centre for Scientific Research into Plant Medicine, Mampong	Member
5.	Dr. (Mrs.) Verna Vanderpuye	National Centre for Radiotherapy and Nuclear Medicine, KBTH	Member
6.	Dr. Samuel Asiamah	Medical Director, KBTH	Member
7.	Dr. (Mrs.) Mary Boadu	Director, Radiological and Medical Sciences Research Institute	Member
8	Dr. Rose Boatin	Deputy Director, Radiological and Medical Sciences Research Institute	Member
9	Mr. Oti Kwasi Gyamfi	RAMSRI Staff Representative	Member
10	Mr. Charles Frimpong	Administrative Staff, RAMSRI	Secretary

Appendix 2: Research & Technical Committee Members

No.	Name	Address	Position
1.	Prof. Isabella Quakyi	School of Public Health, UG	Chairperson
2.	Prof. A. Lassey	Obstetrics and Gynaecology Department, UGMS	Member
3.	Prof. A.W.K. Kyere	School of Nuclear and Allied Sciences, GAEC/UG	Member
4.	Prof. Kojo Koram	Director, Noguchi Memorial Institute for Medical Research, UG	Member
5.	Dr. A.A. Sittite	Formerly of Centre for Scientific Research into Plant Medicine, Mampong	Member
6.	Dr. Mary Boadu	Director, Radiological and Medical Sciences Research Institute	Member
7.	Dr. Rose Boatin	Deputy Director, Radiological and Medical Sciences Research Institute	Member
8.	Mr. Daniel Achel	RAMSRI Staff Representative	Member
9.	Mr. Charles Frimpong	Administrative Staff, RAMSRI	Secretary