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Abstracts

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Ahmad Saher Azizi Sultan, J. med phys & appl sci 2018, Volume: 3
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EVOLUTIONARY DVH EVALUATION FOR BEAM ORIENTATIONS IN INTENSITY MODULATED RADIATION THERAPY

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The problem of beam orientations in intensity-modulated radiation therapy (IMRT) is an important, but large-scale non-deterministic polynomial-time (NP) hard optimization problem. A considerable part of this difficulty is due to the essential prerequisite of defining, appropriately, counter-intuitive criteria for a mathematical plan evaluation that coincides with the clinical judgement of the considered plan. Moreover, the quality of beam directions depends heavily on its corresponding beam intensity profiles. Usually a stochastic selector is utilized for optimizing beam orientations, and an inverse treatment planning algorithm is employed to optimize beam intensity profiles for every selection of beam orientations. Thus, intensity profiles are calculated many thousands of times, each time for a different selection of beam directions, resulting in excessive time complexity. Therefore selecting an appropriate set of beam directions in IMRT is still a time consuming manual trial and error search procedure that depends on intuition and empirical knowledge. To overcome these difficulties, this work utilizes the concept of dose volume histogram (DVH), which is one of the main recognized quantitative measurement tools used for plan judgement, to present a DVH evaluation scheme that parallelizes plan evaluation with clinical plan judgement. The DVH evaluation scheme is then combined with an evolutionary algorithm manufactured particularly to solve the problem of beam orientation in IMRT. The results of applying the presented methods to real clinical cases demonstrated that while the evolutionary algorithm converges to appropriate solutions in practical clinical time slot, significant improvement were reported in all clinical cases in comparison to the standard equally spaced beam plans, even when sometimes using a fewer number of beams. A fewer number of beams is always desirable without compromising the quality of the treatment plan. This results in a shorter treatment delivery time which reduces potential errors in terms of patient movements and decreases discomfort, as well as the risk of reoccurring cancers in the future.

Biography

Ahmad Saher Azizi Sultan received his Diploma and PhD in Mathematics from Kaiserslautern University, Fraunhofer Institute, where he gained his training in Industrial Mathematics for several years. He has received his Diploma and PhD; he started his Post-doctoral training in Mathematical Logic at the International Centre for Computational Logic in Dresden. He then moved to Saudi Arabia and started his own research at Taibah University. His interdisciplinary research focuses on Dose Evaluation and Beam Orientations in Multi-criteria Intensity Modulated Radiation Therapy. Especially his knowledge about industrial multi-criteria optimization made him one of the referees for some journals such as *European journal of Operational Research* and *Science Journal of Mathematics and Statistics*. On the other hand, he is currently developing techniques in computational logic to speedup SAT solvers.

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CORRELATION BETWEEN C-FOS AND RADIOIODINE EFFECT IN BREAST CANCER CELL LINES

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When ionizing radiation hits water molecules in the cell, water will be degraded to produce free radicals. Free radicals inhibit the switch from *c-Fos* to Fra1 in chromatin. This inhibition will lead to the failure in cells to express cyclin D1, which then followed by cell cycle arrest. The aim of this study is to investigate the correlation between *c-Fos* with radioiodine effect in breast cancer cell lines. Breast cancer cell lines (MCF7 and SKBR3), and keratinocyte cell line (HaCaT) were used in this study. To induce *c-Fos* expression, cells were treated with 50 ng/ml epidermal growth factor (EGF), 100µM adenosine triphosphate (ATP) and a combination of both. Radioiodine effect was measured by reproductive ability of the cells after which they had been treated with 74.10^4 Becquerel/well of NaI-131. A quantitative real-time reverse transcriptase polymerase chain reaction (qRT-PCR) and immunocytofluorescence were used to assess *c-Fos* expressions. *c-Fos* expressions are found only in MCF-7 cells. A combination of ATP and EGF has a potential to induce 22.74±3.67 fold ($p<0.05$) of *c-Fos* mRNA. Adenosine triphosphate or EGF or combination of both increases *c-Fos* protein expression ($p<0.05$). Induction of EGF or a combination of ATP and EGF reduces the reproductive ability of MCF-7 and SKBR3 cells up to 100% after radioiodine treatment ($p<0.05$). We find an inverse correlation between *c-Fos* mRNA and protein expressions with radioiodine effect are $r=-0.90$ and $r=-0.97$ ($p<0.05$) respectively. Based on the above mentioned results, it appears that radioiodine is able to reduce the reproductive ability of breast cancer cells. Therefore, it opens an opportunity for radioiodine to be used for breast cancer treatment. *c-Fos* plays pivotal role in cell death pathways by radioiodine exposure in MCF7 cells, and other genes may correspond to cell death in SKBR3 cells.

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SPECT CT LYMPHOSCINTIGRAPHY IN LOCALISATION OF SENTINEL NODE IN BREAST CANCER

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Introduction: The introduction of sentinel node biopsy (SNB) in breast cancer management promises to confine a therapeutic axillary procedure to patients who have a positive SNB, those with negative SNB requiring no further treatment to the axilla. To localize a sentinel node is crucial in all terms. So here we use single photon emission computed tomography fused with computed tomography (SPECT-CT) lymphoscintigraphy method along with intraoperative localization of sentinel node for dissection. These were labelled as level I, II or III nodes (axillary) or any other site visualized.

Methods: We have localized the sentinel node using a radioactive isotope injection, which is filtered Tc-99m sulphur colloid (20-40 MBq) is followed by planar and SPECT-CT lymphoscintigraphy and a hand held probe at surgery is used to locate the sentinel node. The sentinel node, once localized, is removed and sent separately for histological examination and this is followed by primary surgery for the breast cancer and an axillary node clearance if required.

Results: We have performed this procedure in 39 patients so far and were able to localize the sentinel node in 33 patients by lymphoscintigraphy method (SPECT-CT) and in 35 patients by gamma probe method intraoperative. 33 times out of 33 patients, we have visualized level I node (100%) on SPECT-CT lymphoscintigraphy. We have also localized level II node in 11 patients (33%), level III node in 2 patients (6%), ipsilateral internal mammary node in 1 patient (3%) and ipsilateral supraclavicular node in one patient (3%). Out of 35 patients, 7 patients had a positive sentinel node and 26 patients had negative sentinel nodes.

Conclusion: We conclude from our early results that the sentinel node in breast cancer can be accurately localized using a combination of methods. SPECT-CT lymphoscintigraphy is very helpful in exact localization of the nodes in axilla as well as in other locations. However this is very initial data with limited number of patients which should be further continued with large number of patients in our population.

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THYROID NODULES THE DARK HORSE OF PARATHYROID IMAGING

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Background: Pre-operative localization of hyperfunctioning parathyroid lesions with dual phase ^{99m}Tc-Sestamibi imaging is a reliable and accurate method, with variable, but high reported sensitivity and specificity for single adenomas. The most common cause of a false positive finding is co-existent nodular thyroid disease. Other causes of false positive findings include the presence of thyroid carcinoma, parathyroid carcinoma, lymphadenopathy, sarcoidosis and other tumours. In order to plan the optimal surgical approach and minimize patient morbidity, it is of vital importance to minimize false positive reports.

Aim: To demonstrate the importance of combined ^{99m}Tc-sestamibi and ^{99m}Tc-pertechnetate thyroid imaging in the pre-operative localization of suspected parathyroid lesions.

Methodology: We present a female patient, aged 38 years, with primary hyperparathyroidism. She was referred to the nuclear medicine department for pre-operative localization of parathyroid adenoma with ^{99m}Tc-sestamibi scan.

Results: On the early images of the dual phase ^{99m}Tc-Sestamibi scan focal tracer accumulation was seen in the superior pole of the left thyroid lobe, which increased in intensity on the delayed images. Single photon emission computed tomography (SPECT) reconstructed images confirmed the location within the left thyroid lobe. Subsequent ^{99m}Tc-pertechnetate thyroid images demonstrated a hot nodule in the superior pole of the left thyroid lobe; in the same location as seen on the ^{99m}Tc-sestamibi scan. The patient was referred for a thyroid ultrasound, which confirmed a benign spongiform nodule in the same location. No suspicious parathyroid lesions were seen on ultrasound. Thyroid function tests revealed subclinical hyperthyroidism.

Conclusion: Coexisting solid thyroid nodules may contribute to false positive localization of parathyroid lesion. Furthermore, the intensity of uptake in these thyroid nodules can potentially result in failure to visualize and locate the suspected hyperfunctioning parathyroid lesion. Dual tracer imaging with ^{99m}Tc-sestamibi and 99mTc-pertechnetate should always be considered in cases with apparent intrathyroidal tracer accumulation on ^{99m}Tc-sestamibi scan to increase the specificity by minimizing false positive findings. The highest sensitivity and specificity for accurate parathyroid lesion localization will be achieved by the combination of dual tracer subtraction and thyroid ultrasound. These instructions give you guidelines for preparing papers.

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NUCLEAR MEDICINE INTERNAL DOSIMETRY: MEASUREMENTS, MODELS, AND METHODS

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Dose estimates for radiopharmaceuticals may be established based on data from preclinical (i.e. animal species) or clinical studies (involving human patients or volunteers). This session will describe current approaches in both areas, and show examples. Traditional mathematical model-based anatomical models have now been replaced with more realistic standardized anatomical models based on patient image data and have been incorporated into the software code OLINDA/EXM 2.0. The code employs these anthropomorphic models, the new International Commission on Radiological Protection (ICRP) human alimentary tract (HAT) model and updated (ICRP 103) tissue weighting factors for calculation of effective dose. Adjustments to traditional dose calculations based on patient specific measurements are routinely needed, especially in therapy calculations, for marrow activity (based on measured blood parameters or image data), organ mass (based on volumes measured by ultrasound or computed tomography (CT), and other variables. Man interesting radiopharmaceutical therapy agents are currently in use, for thyroid disorders, neuroendocrine tumours, and treatment of bone metastases. Clinical experience, success rates, and management of normal tissue toxicity with many nuclear medicine therapy agents will be reviewed. The need for patient individualized approaches to therapy will be emphasized. A discussion of relevant release criteria for therapy patients will be included.

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IODINE-131 REQUIREMENTS FROM A TO Z (AMERICA TO ZAMBIA)

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Radioactive iodine ablations (RAI) with Iodine-131 (^{131}I) have been performed for decades in several countries. This presentation will provide a review of regulatory requirements for management of these patients and compare requirements around the world. Following the presentation, the attendee will have met the following objectives: review thyroid cancer types and treatment options; review regulatory requirements related to ^{131}I treatment: determination, instructions, written directives, release. I will share my experience as a member of a team that provided training in Lusaka, Zambia in Jul' 2017.

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RADIOPHARMACEUTICAL RADIATION EXPOSURE REDUCTION IN NUCLEAR MEDICINE CLINICAL TRIALS

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To maximize the likelihood of a radiopharmaceutical trial's success, designers usually select administered doses yielding the maximum radiation exposure accepted by regulatory agencies and the public. This becomes the accepted dose carried into regulatory labeling and general use. Unless this dose is necessary to meet trial endpoints, the consequences are considerable. Larger than necessary injected doses yield higher than necessary radiation exposures to study subjects, patients and staff. Larger doses yield fewer doses per batch increasing per dose manufacturing costs. Larger doses can cause greater radiolysis, increasing both manufacturing and development costs. These reduce the value of cyclotrons, hot cells and synthesis boxes and the radiopharmaceutical itself. It can even result in the radiopharmaceutical not being commercially viable. Many strategies have been proposed for reducing doses. Most rely on visual or image-based standards rather than quantitative endpoint-based criteria. We have developed methods to identify the lowest dose allowing a nuclear imaging trial objective to be met using a series of images of the same subject and field of increasing duration to model a range of doses. An ROI analysis determines the change in random variations as a function of modeled dose. The tolerable random variation is based on a predetermined threshold in the performance of each image in the study analysis. This method was used in the development of flurpiridaz F-18. The resulting dosing was successful in two efficacy trials while maintaining radiation doses well below accepted limits. We believe methods of this type may be readily extended to other radiopharmaceuticals and adapted to more general models of the relationship between random noise, dose and acquisition time. Applying these methods to existing radiopharmaceuticals as well as to those in development has the potential to make nuclear medicine both less costly in terms of resources and radiation exposure and more widely available.

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RADIOLABELING AND SCINTIGRAPHIC EVALUATION OF TC-99M LABELED 5-FLUOROURACIL AND ZOLEDRONIC ACID FOR TUMOR IMAGING

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In nuclear medicine, the radiation chemistry provides efficient tools for cancer imaging using compounds labeled with radionuclides that emit gamma radiations. In my presentations, I will be explaining the radio labeling methods of two new compounds, (cancer drugs): 5-Flurouracil (5-FU) and zoledronic acid (ZA) for tumor imaging by the scintigraphy (nuclear imaging). 5-fluorouracil is a chemotherapeutic agent and generally used in the targeted therapy for the solid tumors, therefore, I had objective to make this 5-FU a diagnostic compounds for the colon carcinoma, a type of solid tumors, patients. The other drug, zoledronic acid is a bone seeking bisphosphonate and has a strong affinity to bones, so the target was to do osteoscintigraphy. I have radio labeled these two anti-cancer compounds with work horse of nuclear imaging: ^{99m}Tc radioisotope. For radiolabeling, we have adapted standard reduction methods with slight modifications used for general radio labeling of radioisotopes. The different concentrations of reducing agents has been used and also standardized for adequate radiolabeling. The chemical analysis of these compounds also has been done prior to human studies. The previous work regarding the animal and human has been studied. Radiochemistry of the compounds has been studied. We have conducted human studies with these compounds after taking proper safety. These both radio pharmaceutical injected intravenous and nuclear imagings were done with the help of the SPECT system. The other clinical and radiological data also used for the correlations. Radio-pharmacokinetics and bio-distributions have been analysis with the help imaging data and processing software (Syngo, Molecular Imaging). The results of the human studies were very much favorable to make these compounds potential radiopharmaceutical for the Ca Colon and bone cancer respectively. The 5-FU and ZA have provided very satisfactory data and information for to use them as for the nuclear medicine imaging.

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CONSIDERING THE SPATIAL ORGANIZATION OF DNA TO ASSESS PROTON THERAPY RELATIVE BIOLOGICAL EFFECTIVENESS

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Increased use of computer simulations in treatment planning for cancer has highlighted the need for more effective methods in modelling nuclear organisation. Current models aim to predict treatment outcomes by simulating the induction of double strand breaks in the DNA of irradiated cells. In proton therapy, this is achieved via use of Geant-4 software, which tracks electron activity after irradiation with a proton beam. Predictive assays can then be used to assess the value of the relative biological effectiveness (RBE) for protons. Currently, the proton RBE value of 1.1 is taken from results in clinical practice; with proton therapy machinery calibrated using depth dose distribution in water for beams of varying energies. It is thought that a more appropriate value could be computed by analysing to what extent proton beams cause chromosome aberrations, a form of genomic reorganisation that indicates damage to the cell nucleus. For this objective to be realized, the geometric organisation of the nucleus needs to be accurately modelled so that it can be integrated with cellular irradiation simulations. This review describes and evaluates some of the modelling approaches for chromosome territories, and aims to recommend a particular approach that research groups involved in proton therapy can use in their work.

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A RARE CASE OF BUDD-CHIARI SYNDROME ON NUCLEAR MEDICINE LIVER SCINTIGRAPHY

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Introduction: Budd-Chiari syndrome (BCS) is a rare medical condition following obstruction of the hepatic venous outflow by either thrombotic or non-thrombotic occlusions. Performing liver scintigraphy for patients with possible BCS is usually uncommon due to the ability of other diagnostic modalities such as U/S, magnetic resonance angiography (MRA) and CT.

Case presentation: Patient A, a 23 year old female, presented with severe abdominal pain and swelling. The patient is a known HIV patient and is on active ARV treatment as well as oral contraceptives. Initial examinations of the patient confirmed jaundice as well as ascites. Blood tests concluded liver failure and an ultrasound of the abdomen showed decreased liver size, the remaining abdominal organs were normal. The patient then treated with antibiotics and a combination of furosemide and spironolactone. As there was no improvement in patient's condition and no obvious abnormalities were detected by ultrasound scan, the attending physician requested a nuclear medicine liver scan. The scan images demonstrated increased uptake in the caudate lobe of the liver. These findings were suggestive of BCS and a CT scan was advised to confirm the diagnosis. Contrast CT scans performed, which demonstrated a thrombus of the infrahepatic inferior vena cava, confirming a diagnosis of BCS. The patient was then treated with anticoagulation medication.

Discussion: Patient A was on oral contraceptives, which is known to increase the chances of blood clotting. Physicians believed this to be the cause of BCS in patient A. BCS usually presents with hepatomegaly; however patient A had a shrunken liver. The BCS in this patient might have been an unconfirmed diagnosis without the help of NM liver scintigraphy.

Conclusion: This case highlights the significance of liver scintigraphy in a rare case of BCS. In cases like these, liver scintigraphy is commonly overlooked due to other diagnostic imaging modalities.

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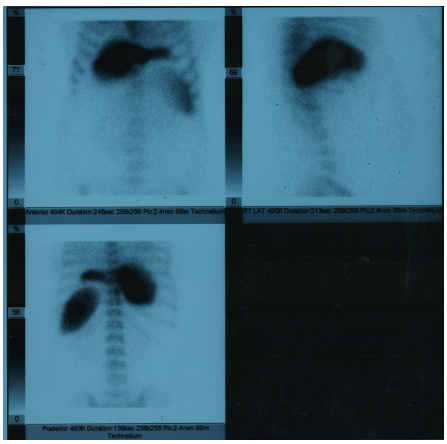

Figure 1: Immediate images

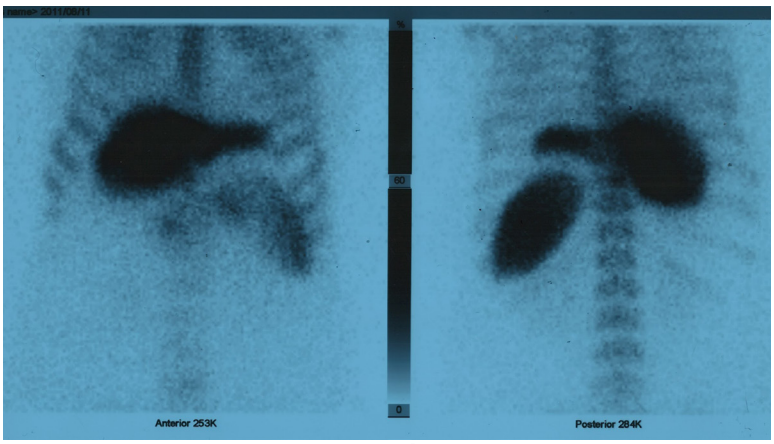

Figure 2: Immediate images

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99MTC LABELLED N-ACETYL NEURAMINIC ACID AS A NEW RADIOTRACER FOR RENAL IMAGING PREPARATION AND PRECLINICAL STUDY

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Many ligands such as diethylenetriaminepentaacetic acid (DTPA), glucoheptonate (GHA), a seven-carbon carboxylic acid sugar, glucuronic acid (GA), a six-carbon carboxylic acid sugar bind with reduced radioactive metal $^{99m}TcO4$- (Pertechnetate). These ligands are assessed as radiotracer for nuclear renal imaging to diagnose the various diseases. But this radiotracer takes prolonged time to accumulate in the kidney which results in waiting for long time for the patients' examination. Hence, development of a new renal radiotracer is urgently required to reduce the time for the examination. On the other hand, N-acetyl neuraminic acid (Neu5Ac) is a nine-carbon carboxylic acid monosaccharide (sialic acid) performs multiple functions in living cells. We developed ^{99m}Tc-radiolabeled Neu5Ac by direct labelling method using SnCl2.2H2O as a reducing agent. Factors such as amount of Neu5Ac, pH, amount of radioactivity, reaction time and various quantities of reducing agent have been systematically studied to optimize the radiochemical yield of complex. Further, we characterized the developed radio-complex by using various techniques that includes ITLC; paper electrophoresis, HPLC, plasma protein binding, lypophilicity and *in vitro* serum stability at physiological conditions. Investigation of coordinated technetium with Neu5Ac was done by cold rhenium using FTIR. Neu5Ac was successfully radiolabelled with ^{99m}Tc as evidenced by high labelling efficiency more than 90%, radiocomplex showed partial negative charge as it shifted toward anodic side. *In vitro* stability was 8 hrs in rat serum. Plasma protein binding is 43±3.4% compared to ^{131}I-OIH, which has protein binding of 44%. Higher accumulation (%ID/g) of radiotracer was observed in kidney, however liver and spleen appears first 15 min and rapidly cleared. Scintigraphic images also reflect the same pattern of radiotracer uptake as observed in bio-distribution studies in rat. Finally this radiocomplex could be converted as new radiopharmaceutical after rigorous quality control in diagnostic role for renal imaging in nuclear medicine field.

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COMPLICATION OF RADIOTHERAPY ON SKIN TISSUES: MELATONIN AS A RADIO PROTECTOR

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Introduction: Radiotherapy is a major treatment modality for cancers using ionization radiation. Despite its enormous successes recorded, the risk of early and late complications to patients after irradiation is a major setback. Hence, there is a need for further studies on radioprotective agents. One of such agents is melatonin. It is a natural hormone inside the body. Using biochemical analysis, we aim to evaluate the radioprotective effect of melatonin on skin tissues.

Methods: 20 male Wistar rats were randomly assigned to four groups (5 rats in each); G1 (control), G2 (melatonin treated), G3 (radiation only) and G4 (radiation + melatonin). Prior to irradiation of their right legs with a single dose of 8 Gy, G3 and G4 rats were anaesthetized via intraperitoneal injection of ketamine (70 mg/kg) and xylazine (10 mg/kg) while 100 mg/kg of melatonin was administered to G2 and G4 rats 30 minutes before commencement. All rats were sacrificed 10 days after irradiation. Their right femoral skin tissues where extracted for biochemical analysis using Sigma kit (USA) according to the manufacturer's instruction. This study was in accordance with the guidelines for the care and use of animals by Ethics Committee of Tehran University of Medical Sciences.

Results: Biochemical results after irradiation of rat's skin showed that malondialdehyde (MDA) levels significantly increased in the radiation group and significantly decreased in the radiation + melatonin group. In addition, catalase (CAT) and superoxide dismutase (SOD) activities decreased in the radiation group and increased in radiation + melatonin group in comparison with the control group ($p<0.05$).

Conclusion: Our results have shown that melatonin can significantly reduce the MDA levels as well as increase the CAT and SOD activities after irradiating the skin. Hence, melatonin can be successfully used to ameliorate complications of radiotherapy to the skin.

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SYNTHESIS, QUALITY CONTROL AND BIODISTRIBUTION OF TECHNEIUM-99M TRIAMCINOLONE ACETONIDE (^{99}MTC-TA) COMPLEX: AN INFLAMMATION TRACER AGENT

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In the present study, synthesis of 99mTc-triamcinolone acetonide (^{99}mTc-TA) complex and its stability using set of quality control parameters such as ligand concentration, reducing agent concentration, pH, temperature and reaction time was assessed. ^{99}mTc-TA complex was characterized in terms of percent (%) yield, stability in saline and serum using chromatographic procedures. Radiochemically, the ^{99}mTc-TA complex was found quite stable in saline and serum. After 30 min of reaction, the complex showed maximum radiochemical yield of 96.32% which decreased to 96.25% after 4 h of incubation period. In serum, the % yield of radiochemical was remained same up to 2 h which decreased to 93.5% at 24 h time point. Normal biodistribution pattern in Sprague Dawley rats revealed liver, stomach and kidneys as areas of high 99mTc-TA complex uptake (8.44±1.32%, 8.75±1.03% and 12.67±1.21%, respectively) at 1 h post injection time point. Scintigraphy of ^{99}mTc-TA in rabbits showed similar eco as observed in biodistribution study. Based on the promising results obtained in context of in vitro and in vivo stability and biodistribution, ^{99}mTc-TA complex could be further studied to identify the inflammation based diseases.

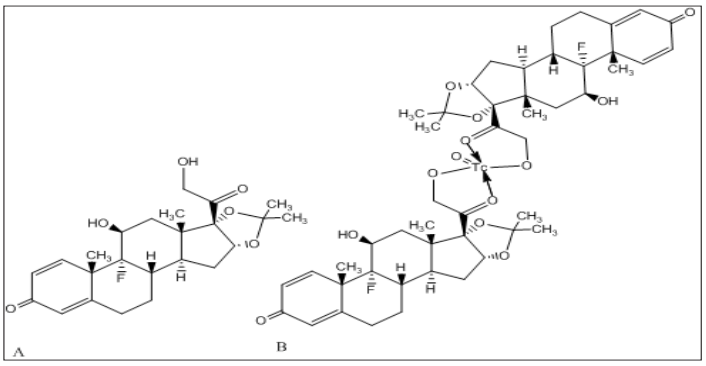

Figure 1: A) Structure of anti-inflammatory agent triamcinolone acetonide, B) the proposed structure of 99mTc-TA complex; the oxygen from hydroxyl and carbonyl carbon from two molecule of TA make coordination bond and present at apex of the complex while oxygen from reduced TcO core present at pyramid of the complex.

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UPDATES ON PSMA TARGETED RADIONUCLIDE THERAPIES FOR PROSTATE CANCER

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Multiple centers around the world are adopting PSMA based radionuclide therapies for treating advanced stage prostate cancer patients. Recent anecdotal reports and clinical trial results have been encouraging and have demonstrated personalized approach and efficacy for PSMA-targeted radionuclide therapies. Both, antibodies and small peptide-based agents as well as beta or alpha emitters are actively being pursued. Identifying the optimal agent with the highest efficacy and least toxicity for individual patients, rather than "one size fits all" approach is the need of the hour. Antibody based agents have longer biologic half-lives and delayed tissue penetration while the peptide-based agents have rapid kinetics that affords only a short time to engage with the target. Similarly, alpha particles have higher energy to deliver while beta emitters have longer range. Significant experience has been gained using ^{177}Lu-PSMA-617 and ^{177}Lu-J591 while reports/results for ^{225}Ac-PSMA-617 and ^{225}Ac-J591 are now getting published. With multiple options of targeted therapies, comes the need to identify the most suitable one for each patient. The goal is to personalize the therapies based on the tumor characteristics that suit the need of individual patients.

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FIRST HUMAN STUDIES EXPERIENCE FOR DOSE AND TIME OPTIMIZATION BY 99MTC-ZOLEDRONIC ACID FOR OSTEOSCINTIGRAPHY

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Aim: To study the optimal dose and optimal time of human skeletal imaging using 99mTc-zoledronic acid (Tc-99m-ZA)

Materials: 30 consecutive patients referred to the nuclear medicine department for bone scan were enrolled for the study after a valid consent.

Methods: The patients were divided into subgroups as described. Tc-99m-ZA was prepared as per the standardized protocol. Patients were divided into 3 groups of 10 each. Group A1 was injected intravenously 5 mCi of tracer, Group A2 was injected 10 mCi of tracer and Group A3 was injected 15 mCi of tracer. The patients were asked to maintain good hydration. In each group, the images were acquired at 1, 2, 2.5 hour(s) after tracer injection in all the patient groups in whole body mode using low energy high resolution (LEHR) collimator. After completion of the study, the images were interpreted independently by two observers for the presence of adequate tracer uptake in the skeleton and also for optimal bone to background ratio. Their findings were then compared and when differences were there the decision was finalized by consensus.

Findings: The skeletal images obtained using Tc-99m-ZA were quite similar to those obtained with ^{99}mTc-methyl diphosphonate (Tc-99m-MDP). The optimal dose for skeletal scintigraphy using Tc-99m-ZA was 15 mCi. The optimal timing post tracer injection was 2 hours.

Conclusion: The images obtained with Tc-99m-ZA are very encouraging. Their revelation of human skeleton matches with that is achieved with established agent Tc-MDP. However, further studies with a large cohort of patients are warranted for clinical use of Tc-99m-ZA and establish its performance *vis-a-vis* Tc-99m-MDP.

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LIMITATIONS AND POSSIBLE SOLUTIONS OF NUCLEAR MEDICINE IN KENYA

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Nuclear medicine is a branch of medicine that utilises the tracer principle. It uses radiopharmaceuticals to evaluate molecular, metabolic, physiological and pathological conditions of the body for diagnosis, treatment and research purpose. Nuclear medicine has clinical applications in almost all body systems, for example, oncologic, gastrointestinal, renal, cardiac, skeletal and endocrine systems. In Kenya, nuclear medicine is mostly practised in the diagnosis and treatment of cancer. Currently, Kenya has a population of about 50.76 million. Every year around 41,000 new cases of cancer are diagnosed, with 28,500 related deaths. 80% of cancer cases are always diagnosed at late stages or at incurable stages. This is largely attributed to the limitations of nuclear medicine in the country. Kenya is currently facing a number challenges in the successful practise and application of nuclear medicine. Kenya has only two nuclear medicine facilities namely; Kenyatta National Hospital and Aga Khan University Hospital with limited nuclear medicine personnel. In addition, nuclear medicine is relatively a new medical field in the country and very few people are aware of it. There is also local unavailability of radioisotope and kits, since Kenya doesn't manufacture radiopharmaceuticals and the kits required instead they are imported from developed nations e.g. USA and South Africa. Kenya also experiences unstable power supply, which has an adverse effect on equipment, leading to frequent machine breakdown and shortened lifespan. Furthermore, there are not more than ten nuclear medicine physicians, medical physicists, nuclear medicine technologists, radiologists, and radio pharmacists in the country. This is caused by lack of local training and research in the field of nuclear medicine. Radiation safety and waste management is another daunting task in the nuclear medicine therapy. Above all, the cost of accessing nuclear medicine services is expensive thus causing patients not to seek for the services.

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QUANTITATIVE PERFUSION IN CARDIAC SPECT IMAGING: FICTION OR FACT?

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Absolute quantification of myocardial blood flow (MBF) by PET is an established method of analysing coronary artery disease, but the limited availability of radiotracers is the main shortcoming. Myocardial perfusion imaging (MPI) by SPECT is the standard method of evaluating myocardial ischemia, but here the diagnosis is made mainly by visual analysis, rather than quantitation. Furthermore, extensive ischemia in patients with multi-vessel disease is often difficult to diagnose in a relative perfusion distribution pattern in SPECT. A new SPECT camera equipped with cadmium zinc telluride crystals not only has been shown improved spacial resolution, but also potential for dynamic perfusion analysis. From this dynamic scan, MBF as well as myocardial flow reserve (MFR) can be calculated. It still remains unclear wether MBF and MFR measured from SPECT can be used in clinical practice to recognise all critical coronary lesions, which need an appropriate coronary intervention.

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SYNTHESIS, LABELLING AND PRELIMINARY BIOEVALUATION OF 99MTC-UREA AS A POTENTIAL KIDNEYS IMAGING AGENT

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We present the development and characterization of a [^{99}mTc] tricarbonyl urea. Labelling with high yield and radiochemical purity was achieved through the formation of a [^{99}mTc] tricarbonyl urea radiotracer. The radiolabeled compound was stable and exhibited plasma protein binding (approximately 40%). The logarithm of the partition coefficient (log p) value of [^{99}mTc] tricarbonyl urea was -2.55±0.17 (hydrophilic). Bio-distribution studies in normal mice confirmed the suitability of [^{99}mTc] tricarbonyl urea as a novel tracer to image kidneys. [^{99}mTc] tricarbonyl urea could be considered a new selective radiotracer for kidneys imaging.

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PERGASCRIPT ORANGE BASED POLYMERIC SOLUTION AS A DOSIMETER FOR RADIOTHERAPY TREATMENT PLANNING

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A radiation colour former of amino fluoran dye, pergascript orange (PGO), in polyvinyl butyral solution containing a colour developer, hexachloroethane (HCE), was prepared and investigated for radiotherapy dosimetry of $^{60}C_o$, 6 MV and 15 MV photons. PGO, a colourless fluoran compound, reacts with acid produced by radiation exposure of HCE, enabling the lactone ring to open and the orange colour of PGO to develop. This was confirmed by detecting a peak at 490 nm with two shoulders at 523 nm and 460 nm upon irradiation of the dosimeter solutions. The ring opening of PGO was also confirmed by appearance of a broad peak of OH- at 3360 cm^{-1}, C=O carboxylic at 1763 cm^{-1}, and Iminium group at 1640 cm^{-1}. Dose response functions of all prepared compositions are linear in the dose range of 1-20 Gy. Increasing HCE in the dosimeter matrixes enhanced significantly the radiation sensitivity. With an increase of HCE from 0.063 M to 0.106 M, the radiation sensitivity increases by 57.76%. The experimental results reveal an energy independent response in the range of 1.33-15 MeV. Based on a theoretical study, this dosimeter is water equivalent in the energy range from 80 keV to 20 MeV. The effective atomic number of the present dosimeter is 7.2 and comparable with water, where the effective atomic number is 7.4. Finally, the uncertainty parameters in absorbed dose were discussed and the overall uncertainty was found to be 4.3% at 95% confidence level.

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LIVER FDG METABOLISM AND LIVER ENZYMES CONNECTIONS

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Introduction: PET/CT with the radioactively labelled glucose analogue [18F]-fluoro-2-deoxy-2-D-glucose (^{18}F-FDG) can be used to quantify the hepatic metabolic function and visualise regional metabolic heterogeneity. We determined the variation in humans with and without liver disease. Standardised uptake value (SUV) of ^{18}F-FDG from static scans can substitute the hepatic systemic clearance of ^{18}F-FDG from dynamic scans as measure of metabolic function.

Patient selection: One year's all oncological patient applicants to PET CT unit were selected. The correlation between ALT, AST and SUV was samples. whole- SUV, average SUV multiplied by total metabolic liver volume) were calculated.

Results: No significant differences were found SUV. SUV had higher with hepatosteotic patients. correlation coefficients metabolic liver enzymes had non-significant variation.

Conclusions: The reproducibility of ^{18}F-FDG PET/CT was good and SUV can of hepatic metabolic function. Total SUV of ^{18}F-FDG is a promising tool for quantification of metabolic liver function in hepatosteoz.

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