100

Is there an interest to use deuteron beams to produce non-conventional radionuclides?

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Purpose: With the recent interest on the theranostic approach, there has been a renewed interest for alternative radionuclides in nuclear medicine. They can be produced using common production routes using protons accelerated by biomedical cyclotrons or neutrons produced in research reactors. However, in some cases, it can be more valuable to use deuterons as projectiles.

The aim of this study is to illustrate the interest of using deuterons as projectiles to produce alternative radionuclides for medical applications. For that purpose, three examples have been chosen according to the fact that these radionuclides are produced using deuterons: production of Cu-64, Sc-44m and Re-186.

Materials/methods: For each radionuclide of interest, production yields have been calculated using experimental data from the literature when they exist or calculated value obtained using the TALYS 1.6 code [1] when no experimental data is available or for stable element. In some cases, new experimental production cross section have been measured [2, 3] at our facility [4].

Results: New set of cross sections have been obtained for $^{nat}W(d,x)^{186}Re$ and for $^{44}Ca(d,n)^{44}Sc$ using the stacked foil technique. Thick target yield for deuteron induced and proton induced reaction have been calculated and compared with yield obtained real production run.

In the case of Cu-64, smaller quantities of the expensive target material, Ni-64, are used with deuterons as compared with protons for the same produced activity. For the Sc-44m/Sc-44g generator, deuterons afford a higher Sc-44m production yield than with protons. Finally, in the case of Re-186g, deuterons lead to a production yield three times higher than protons.

Conclusions: These three examples show that it is of interest to consider not only protons or neutrons but also deuterons to produce alternative radionuclides. At the Arronax facility where deuteron beams are available with energy ranging from 15 MeV to 34 MeV, Cu-64 and Sc-44 are produced using 16 MeV deuterons. In the future Re-186 will also be considered for production using deuteron beams.

Keywords: deuteron induced production

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101

Disruption of telomere equilibrium sensitises human cancer cells to DNA repair inhibition and radiation

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Telomerase reactivation is essential for telomere maintenance in human cancer cells ensuring indefinite proliferation. Targeting telomere homeostasis has become one of the promising strategies in the therapeutic management of tumours. One major potential drawback, however, is the time lag between telomerase inhibition and critically shortened telomeres triggering cell death, allowing cancer cells to acquire drug resistance. Dysfunctional telomeres, resulting from the loss of telomeric DNA repeats or the loss of function of telomere-associated proteins trigger DNA damage responses similar to that observed for double strand breaks. We have recently shown that inhibition of DNA repair protein and telomerase renders cells more sensitive to DNA damaging agent. In addition to the disruption of telomere length maintenance, telomerase inhibition decreased tumour cell viability, induced cell cycle arrest and DNA damage. Repair of telomerase inhibitor-induced DNA damage involved activation of DNA-PKcs protein with inhibition of DNA-PKcs activity causing delay in the repair of induced DNA damage. Additionally, telomere dysfunctional foci were more detectable in DNA-PKcs deficient cancer cells as compared to DNA-PKcs proficient cells. The observed therapeutic potential in the cancer tumour cells improved when they were combined with the inhibition of certain selective DNA repair factors (such as PARP-1 and DNA-PKcs). We have also observed the radio-sensitisation potential of these telomerase inhibitors in selected human tumour cells. Taken together, our in vitro studies in cancer cells demonstrate that inhibition of DNA repair pathways and that of telomerase could be an alternative strategy to enhance anti-tumour effects and circumvent the possibility of drug resistance.

Keywords: Biology, Telomerase Inhibition, DNA repair inhibition, Experimental cancer therapeutics.

102

Pelvic tumor irradiation: new tools to reduce toxicity: from technology to drugs.

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Radiotherapy plays an important role in the treatment of pelvic tumors. The advances in patients' prognosis come at the expense of radiation-induced toxicity. Progressive cell depletion and inflammation are the leading mechanisms of acute toxicity which is observed during or shortly after treatment. The pathogenetic pathways of late toxicity, developing 90 days after the onset of radiotherapy, are more complex and involve processes such as vascular sclerosis and fibrosis. Since many patients have become long-term survivors, awareness and recognition of treatment-related toxicity has gained in importance and increased efforts are made for its prevention and management.

Technical innovations contribute to a reduction in radiotherapy-associated toxicity. The steep dose gradients of highly-conformal radiotherapy techniques allow for an accurate dose delivery with optimal sparing of the normal tissues. Several studies have demonstrated the dosimetrical benefit of intensity-modulated radiotherapy (IMRT) and volumetric modulated radiotherapy (VMAT) compared to