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Evaluation of oxygen-18 water enriched for the production of fluorine-18 in a medical cyclotron

Background

PET-CT imaging using flourine-18 radiopharmaceuticals more specifically [18F]FDG is an integral part of cancer management. Fluorine-18 is produced by bombarding 18O enriched water with high energy proton beam. The quality of 18O water and its enrichment ratio are very important to ensure higher yields. However, there are a number of other factors that influence the production of 18F ions such as energy of cyclotron beam, beam current, volume of target and irradiation time. In a cyclotron which is routinely used for commercial production, the above factors are varied depending on the production needs. Hence, it is very difficult to do a direct comparison of the quality of different enriched water used. We have done a retrospective analysis of 18O enriched water supplied by two different vendors, the results are presented below.

Methodology

These studies were done in a 11 MeV Siemens Eclipse HP self-shielded medical cyclotron. The cyclotron system has dual beam providing 11 MeV having beam current upto 60 ⍰A in each beam line. Negative hydrogen ion (H-) is accelerated in quasi-spiral orbits and converted to proton beam by using extracting foil and impinged to water targets filled with 18O enriched water to produce 18F - ions by the nuclear reaction, 18O(p, n)18F. The cyclotron has two tantalum water targets having 2.6 ml capacity fitted for each beam line.

Oxygen-18 enriched water supplied by two vendors were, ABX advanced biochemical compounds, Germany and Taiyo Nippon Sanso Corporation, Japan were used in these studies. While the beam current was kept constant at 60 ⍰A irradiations were done for different timings, 120,150, 165 and 180 min. The amount of radioactivity produced was transferred to Capintec CRC-55t PET dose calibrator for measurement.

Results and Discussion

The fluorine-18 activity formed was found to be different with the two different supplies of enriched 18O water and as expected the 98% enriched water gave about 300 mCi higher activity as compared to 97% enriched water when irradiated for 120 min at 60 ⍰A. The results were consistent at 150,165 and 180 minute of irradiation, the average yield enhanced up to 5% in each target. Due to high demand of the 18F radiopharmaceuticals, the higher the quantity of fluoride-18 produced, the economy of production improves with higher enriched water.

Conclusion

It is important to evaluate each and every input used in a commercial site used for the preparation of F-18 radiopharmaceuticals. A judicious selection of enriched water from different vendors will help in achieving higher production yields thereby improving the economy of operation of the machine.

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