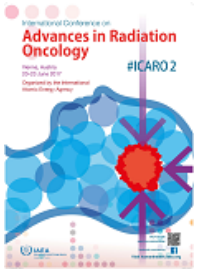

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From ICARO1 to ICARO2: the radiation oncologist perspective

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Advances in the understanding of the etiology of cancer and its treatment continue to happen, but they are gradual and slower than desirable.
Radiotherapy continues to be one of the three main pillars of cancer treatment and is still very relevant in the treatment of some of the most common adult cancers. These include head-and-neck tumours, lung, esophagus, breast, rectum, prostate and gynecological malignancies particularly cervical cancer.
Progress in radiation oncology has been largely due to developments in three fronts: [1] clinical trials, [2] biology and radiobiology and [3] technological advances in computing, imaging and radiotherapy delivery systems.
The current paradigm of evidence-based medicine makes prospective randomized trials and meta-analysis powerful tools to generate knowledge which is then applied in clinical practice. The use of cisplatin as a radiosensitizer in cervical cancer has become standard and has improved outcomes, and is the result of such clinical trials. The use of hypofractionation in certain sites also reflects the impact of clinical research. Dose escalation in localized prostate cancer as well as combination of RT with hormone therapies is the result of a long series of well-planned trials. Radiotherapy in breast conservation as well as post-mastectomy and the irradiation of lymph nodes groups is another of many examples, as is the role of radiotherapy for organ/function preservation in laryngeal, bladder and rectal cancers.
The combination of radiotherapy and targeted therapies seems a promising approach, particularly with the inhibitors of the EGFR pathway and anti-vascular treatments, and require the continuation and intensification of clinical trials.
Advances in computerized treatment planning and in the delivery equipment have had a great positive impact. The development of three-dimensional conformal radiotherapy (3D-CRT) has definitively improved clinical outcomes and should be the standard approach to curative radiotherapy. Subsequent refinements of the 3-D approach such as IMRT, IGRT, SBRT have become established in developed as well as developing countries. These techniques allow not only a more precise deposition of dose in the target volumes, but this is achieved with reduced toxicity levels. Further improvements in the planning and delivery of radiation allowed techniques such as intensity modulated arc therapy; helical tomotherapy and robotic radiotherapy which have become very popular although at present, their high cost limits further deployment in countries with limited resources. The dosimetry of small radiation beams, associated with these modalities is developing fast.
The clinical realization of MRI-guided radiotherapy could represent the ultimate breakthrough in real-time image guidance –offering soft-tissue-based imaging throughout beam delivery. As such, researchers have been working for more than a decade to overcome the substantial technical obstacles required to integrate an MRI scanner with a linear accelerator. These systems are now under clinical testing.
The use of positively charged light ion beams in radiotherapy –mainly the proton beam, but to a more limited extent also carbon ion radiotherapy -has generated enormous interest and development. At this time there are 61 operational proton facilities and 10 carbon ion facilities and a total of 43 facilities are under construction. There are encouraging clinical results of the use of the proton beam and a preferential indication for protons exists in about 14-15% of patients requiring radiotherapy. Laser-accelerated proton beam radiotherapy is under development.
Efforts are underway at CERN to develop a mini-accelerator for particles for medical use. The “mini-RFQ” can produce low-intensity beams, with no significant losses, of just a few microamps that are grouped at a

frequency of 750 MHz. These specifications make the “mini-RFQ”a perfect injector for the new generation of high-frequency, compact linear accelerators used for the treatment of cancer with protons. Clearly, particle radiotherapy will be part of the future of radiation oncology.

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