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POSITION STATEMENT

The British Institute of Radiology supports the use of proton radiotherapy, but only as a treatment for certain types of cancers

The British Institute of Radiology (BIR) supports the use of proton radiotherapy, a type of radiation treatment that uses protons rather than X-rays to treat cancer. It is effective because it can treat certain cancers with a lower level of radiation dose to healthy tissue, thereby causing less damage to those healthy tissues. The BIR does not support proton beam therapy for all cancers, but supports carefully designed clinical trials and other research studies with the aims of

a) determining which patients benefit from this treatment and the magnitude of that benefit
b) improving technology to allow proton radiotherapy to be delivered with improved accuracy

The BIR is also supportive of research to evaluate alternative approaches to radiotherapy using beams of light ions.

Determining which patients will benefit from proton radiotherapy

There are widely accepted indications for proton radiotherapy, some of which were developed in the historically very small number of centres with proton beam radiotherapy, utilising this capability to overcome limitations of the available X-ray technology of the time. Consequently, there is a need to keep these indications under continuous review as the capabilities of both technologies are improved. It is important to appreciate that with currently available proton systems, the high dose region around the tumour, and therefore the doses to critical structures close to this region, are generally more or less unchanged from best quality IMRT delivered with X-rays. Notwithstanding this, there may still be selected cases where proton radiotherapy can offer significant dose advantages. Importantly, with only a little over 100,000 patients treated, proton radiotherapy is still a developing field with considerable scope for technological improvement.

The reduced overall dose to the body is particularly important for the treatment of children with cancer. In such cases, the damage associated with successful treatment must be minimised to avoid unwelcome consequences for the child later in life. By inference these advantages also apply to teenage and young adult patients, and indeed could extend to other cancer types where the probability of cure is high and life expectancy beyond treatment is long. Well designed clinical trials are required focusing on endpoints to reflect the low dose exposure advantage. Such studies will help to define the role of proton radiotherapy.

Some technical aspects of proton radiotherapy that need careful monitoring

There is considerable research into the dependence of proton radiotherapy dose distributions on changes in patient anatomy that may occur during a treatment course. Proton treatments are more vulnerable to these changes than treatments delivered with X-ray radiotherapy. Hence there is a need for the highest quality daily imaging and readiness to adapt treatment during the treatment course. This creates a demand for a very high level of technical quality to ensure that proton treatments are delivered as intended, thereby ensuring that the potential advantages of this form of radiotherapy are actually delivered. Such techniques are not routinely available in all proton units. The most advanced and becoming dominant form of proton radiotherapy involves narrow "pencil" beams of protons which are scanned to cover the desired target volume. The speed at which beams are scanned over the target volume can have a time structure which is relatively similar to the frequency at which patients breathe. This creates technical issues when treating tumours in regions of the body that move with breathing, and such cases need very careful consideration and efforts to mitigate the effects of motion.

How proton beam therapy is currently used in the UK

Proton beam therapy has been offered to clinically appropriate patients in England since 2008 through the NHS Proton Overseas Programme. To date over 750 patients have been accepted for proton treatment in one of the widest overseas access programmes in the world. Of these patients nearly 600 are children. Adult patients include those with rare tumours of the base of skull and sarcomas near the spine. Patients are sent to Switzerland and to the USA. Patients from Scotland, Wales and Northern Ireland also have access through aligned pathways to the NHS England Programme.

The government has committed £250m to build two high energy proton centres at The Christie NHS Foundation Trust, Manchester, and University College London Hospitals NHS Foundation Trust (UCLH) as a national resource of six treatment rooms. They will have the most up to date equipment available, working within an academic setting and the integrated hospital-based model of multidisciplinary cancer treatment that is required for the safe and effective delivery of treatment for complex patients, including children. The first patients will be treated in mid 2018 and expand on the current Overseas Programme, allowing patients to be treated in England as well as abroad. Manchester and London will deliver treatment for the well established and evidence based, routinely commissioned uses of proton therapy for cancer treatment to NHS patients. All outcomes will be evaluated. The NHS centres will also link with the Oxford Precision Cancer Medicine Institute to generate clinical trial and evaluative commissioning proposals as well as technical developments in physics and underpinning translational research. All of these new activities will add to the existing low energy National Eye Proton service at Clatterbridge Cancer Centre which has produced excellent clinical outcomes. This strategy can allow the future role of protons to be developed in the UK, based on sound clinical evidence, in a safe, sustainable and affordable way.

In addition there are planned developments of proton therapy in the private sector which could add between three and ten treatment rooms to the six that will be delivered by the NHS.

Other forms of advanced radiotherapy with light ions

There are currently (September 2016) ten centres in the world treating patients with beams of light ions, specifically beams of carbon ions (three in Europe, five in Japan and two in China). A number of these centres are actively engaged in clinical trials of this therapy. Such ion beams have potential for both biological and physical dose advantages compared to proton radiotherapy. These biological advantages serve to improve the chance of cure through greater damage to cancer cells. Research is encouraged to understand

- Which subset of patients can benefit most from therapy using beams of light ions, and the magnitude of this benefit
- How such facilities can be delivered at a price which is affordable to most health systems around the world

How proton radiotherapy works

A machine called a particle accelerator (usually a synchrotron or cyclotron) accelerates (ie speeds-up) the protons. The speed of the protons reflects their energy, and protons travel to a specific depth in the body determined by their energy.

After the protons reach the required place in the body, they deposit the specified radiation dose in the tumour. With a proton radiotherapy beam, there is no radiation dose beyond the tumour unlike an X-ray beam which continues to deposit diminishing radiation doses as it exits the patient's body. Most cancers suitable for radiotherapy can be treated with modern photon therapy, however, multiple beams are often required to ensure adequate coverage. This reduces the impact of any one exit beam, but also results in more healthy tissue being exposed to a low dose of radiation. Proton radiotherapy can be administered with a much lower radiation dose to the body tissues overall. Modelling suggests that this lower overall dose will be accompanied by a reduced incidence of cancers caused by the consequences of treatment, and clinical data may be emerging to support this. There may also be additional benefits from this reduction in lower dose exposure.

Staff training

While proton radiotherapy has some differences, there are many areas of common ground with modern advanced X-ray radiotherapy. Indeed the demands from clinical staff for capability which is now becoming standard in X-ray radiotherapy – such as on-treatment image guidance and the ability to adapt treatment during the course provide a helpful drive for development in proton therapy. The particular staffing issue for the UK is that the need for staff for multi-room NHS and multiple single-room private proton facilities, comes on-top of well recognised shortages of all key staff groups in radiotherapy in the UK. Clinical oncology, radiotherapy physics and therapy radiography posts around the country have high vacancy rates and recruitment from overseas trained staff is common to maintain a functioning service, but with Brexit, easy access to such overseas trained staff becomes a less secure option.

In order to generate the skilled workforce required by proton centres in two to three years from now, it is only practical to make minor adjustments to underpinning training for all professions and then rely on top-up or higher level training for those staff that are directly involved or highly motivated. The BIR would support the development of higher level specialist modules from appropriate academic and clinical providers. These would usefully be combined with an organised programme of clinical experience placements at treating centres. It is important that all training programmes are underpinned by the need to evaluate practice and outcomes.