Keywords: Cancer/Side-effects/Radiotherapy/Radiographer/Funding

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In this article...

- The rationale behind the use of radiotherapy to treat cancer
- Recent developments in radiotherapy technology and their implications
- How the new funding from NHS England will be used

Implications of recent advances in radiotherapy techniques and technology

Key points

1. **NHS England is to provide £130m to upgrade radiotherapy equipment**
2. **Radiotherapy is used to treat cancerous tumours with a high dose of radiation while sparing healthy surrounding tissue**
3. **Over the past decade several innovations in radiotherapy technology have improved treatment planning and delivery**
4. **In future, patients will undergo shorter radiotherapy courses, experience fewer long-term side-effects and make fewer visits to hospital**
5. **For professionals, developments imply not only that there is a need for training and to update patient information, but also that there are new research opportunities**

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Abstract In October 2016 NHS England announced it had £130m in funding to upgrade radiotherapy equipment in England – part of an overarching strategy to improve cancer outcomes. Recent advances in radiotherapy techniques have already enhanced the accuracy of treatment and should reduce side-effects. This article outlines the implications of these advances, both for patients and professionals. It explains some of the terminology used by oncologists and therapeutic radiographers, and highlights how a more collaborative approach in radiotherapy should create interesting research opportunities.

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In October 2016, NHS England (2016a) announced the largest investment in radiotherapy equipment in over 15 years. It promised £130m to upgrade equipment to ensure innovative techniques are used in all 50 radiotherapy centres in England.

Radiotherapy is vital in cancer treatment and given to over 40% of patients. However, it is often shrouded in mystery and oncologists' and radiographers' use of technical terminology may prevent patients and other health professionals from understanding how it is delivered. This article explains how radiotherapy works and what the new investment will mean, describes recent developments in the field and considers their implications for patients and professionals.

How radiotherapy works

Patient pathway

The pathway for patients with cancer begins with diagnosis and referral to the oncology team, which comprises nurses, doctors and allied health professionals. Radiotherapy is typically used alongside other treatment modalities such as surgery, chemotherapy, hormone therapy and immunotherapy. For some patients – for example, those with head and neck cancer or prostate cancer – radiotherapy will be the primary treatment. For others, it may be an adjuvant; this is the case with breast cancer, where surgery, hormone therapy and chemotherapy are also used. Short courses of radiotherapy are used to treat disease spread such as bone metastases.

Once it has been agreed that a patient will receive radiotherapy, the oncologist, therapeutic radiographer and physicist undertake specialist imaging, plan the treatment and then deliver it, often over a number of weeks. Patients are supported by radiographers and oncology nurses who help them manage the side-effects of treatment. Therapeutic radiographers

work as part of large multidisciplinary teams to ensure patients receive adequate treatment and support.

Aim and rationale

Radiotherapy aims to treat the tumour with high doses of radiation while sparing any healthy surrounding tissue, so customised radiotherapy plans are created to that effect. Doses are prescribed in Grays (Gy) and delivered over several treatments or fractions (Symonds et al, 2012). This takes into account recovery time to minimise unwanted damage. Daily doses of radiotherapy have a cumulative destructive effect on cells and, while the aim is to destroy cancer cells, healthy tissues are also irradiated, which often results in significant side-effects. The aim when delivering radiotherapy, therefore, has always been to minimise the radiation received by normal tissues.

The whole premise of radiotherapy is that cancer cells are more susceptible to damage than healthy ones and that, if we can target tumour cells more effectively, there will be less damage to healthy cells and patients will experience fewer and less-severe side-effects. This is the aim of the newer techniques and more sophisticated equipment described below; they will also reduce the number of treatments needed.

Research evidence shows that innovative and more targeted treatments can not only improve survival and potential cure rates (Goodman et al, 2010), but also reduce unwanted side-effects for patients (Zefelsky et al, 2012; Den et al, 2010; Wang et al, 2009).

A vision for the future

Three years ago, NHS England and Cancer Research UK published *Vision for Radiotherapy 2014-2024* (Samuel and Boon, 2014), which set out a strategy for improving services through:

- Innovation;
- Consistency in adopting new techniques;
- Provision of clinical and cost-effective radiotherapy for all;
- Personalisation of the treatment planning and delivery;
- Creation of national standards for treatment delivery;
- Collection of high-quality patient data.

Upgrading linear accelerators

Central to the aims of the *Vision for Radiotherapy 2014-2024* was a commitment to upgrade or replace old equipment. The most frequently used form of radiotherapy is external-beam radiotherapy, which is usually delivered by a linear accelerator; other types include brachytherapy, proton therapy, intra-operative radiotherapy and molecular radiotherapy). In 2013, of the 250 linear accelerators in operation in England, more than 30 were older that the recommended 10 years, while many others did not have the capability needed for cutting-edge treatments. The £130m funding is specifically aimed at upgrading or replacing these outdated linear accelerators.

Recent innovations

Over the past decade there has been an unprecedented number of developments in radiotherapy technology. These have greatly improved the planning and delivery of treatment, and include:

- Computerised tomography (CT), magnetic resonance imaging (MRI) and functional imaging such as positron emission tomography (PET) – these provide definitive imaging before treatment, thereby allowing a more accurate assessment of disease spread and more effective treatment planning (Botros et al, 2015);
- Advances in the capability of linear accelerators – these facilitate the aim of delivering high-dose treatment to tumour cells while sparing those tissues that are healthy;
- Real-time imaging – this allows clinicians to correct for patient movement, internal organ movement and change in tumour size, thereby personalising treatment;
- A range of devices designed to keep the patient still during treatment (immobilisation) – this improves treatment accuracy.

Several new techniques have also been developed; some of these are outlined in Box 1. The main consequences of these new developments for patients and professionals are highlighted in Box 2, and described in more detail below.

Implications for patients

The main impact for patients is improved local tumour control (Murray et al, 2016) and survival rates. As treatments become more targeted, there should also be a reduction in the number and severity of side-effects. While the newer techniques sometimes increase short-term side-effects, a considerable reduction in some long-term side-effects is expected – for example, fewer bowel and bladder complications from pelvic radiotherapy treatments, and fewer incidences of permanent damage to critical organs such as the spinal cord, eyes, heart and lungs.

Radiotherapy also has the potential to become more cost effective, as fewer medications will be needed to manage side-effects.

Box 1. New radiotherapy techniques

Intensity-modulated radiotherapy (IMRT)
This is recommended for various curative treatments and is extremely precise. It moulds the shape and dose of radiation closely to the tumour cells and spares healthy tissue. IMRT is delivered using a complex array of radiation beams.

Image-guided radiotherapy (IGRT)
IGRT involves taking X-ray, ultrasound or magnetic resonance images of the patient during treatment to assess any changes that have occurred since previous imaging. The treatment plan should be modified where appropriate.

Four-dimensional adaptive radiotherapy
This is based on the principles of IGRT and works well for tumours that may move during treatment delivery (for example, lung tumours). Equipment tracks movement that occurs through actions such as breathing, and adapts the radiation beam accordingly.

Stereotactic ablative radiotherapy (SABR)
A high-dose, precise therapy delivered in fewer treatments than traditional techniques (Murray et al, 2016). Due to the high doses, specialist immobilisation devices are used, as errors in delivery could have major consequences (such as missing the tumour). Stereotactic body radiotherapy is based on the same principles (Scorsetti et al, 2013).

Stereotactic radiosurgery (SRS)
This is similar to SABR, but treatment is delivered as a single dose of radiation. It is predominantly used to treat brain tumours and, again, requires specialist immobilisation. Clinical trials are under way to assess the effectiveness of SRS (Bujold et al, 2012).

The last five years have seen improvements in cancer outcomes; it is important to continue to collect accurate patient data so the new techniques can be evaluated and their benefits quantified.

Due to the complex nature of treatment planning and delivery, the new techniques may not reduce workload and may actually lengthen appointments – but the huge benefit will be a reduction in number of treatment sessions. One example is stereotactic ablative radiotherapy (SABR): traditionally 20 radiotherapy sessions were needed, but this is reduced to five with SABR. As such, patients will make fewer visits to hospital which, in turn, may change their negative opinions of radiotherapy as a treatment option.

Implications for oncology services

In terms of health budgets, £130m is a relatively modest sum, but the latest government commitment should still be viewed positively as it improves our ability to deliver the best treatments. However, radiotherapy is only one aspect of the cancer pathway and, while the recently announced investment is welcome, more is needed in other areas of cancer care. For example, the need for funding to improve screening and detection was identified to increase prevention (NHS England, 2016b).

Macmillan Cancer Support has produced a strategy for cancer survivors (Snowden and White, 2014) and investment is also needed in that area.

Radiotherapy was raised as a global issue in 2015 (Weng, 2015) and we are beginning to see developments in Asia. If the UK is to remain at the forefront of innovations, investment could not be more timely. Over the next two years, we will see an equipment upgrade taking place. To capitalise on the investment and ensure patient benefit, the wider oncology team needs to be adequately trained as high-precision, high-dose treatments have no margin for errors. Training for oncologists, physicists and therapeutic radiographers is already under way.

A major overhaul of the radiotherapy-related information provided by the wider healthcare team to patients and the public is also required. If nurses and other professionals are well informed about radiotherapy and recent advances, patients will be too.

Implications for nurses

All professionals working in oncology need training on how these developments will affect treatment delivery. Nurses working in specialist oncology roles will be pivotal in the campaign to raise awareness of the changes. Knowledge of the new radiotherapy techniques is part of preparing patients for treatment and managing subsequent side-effects. Training will allow nurses to be better informed and better prepared for patients' questions. Nurses should therefore consider how they can update their existing knowledge.

Nurses working in more generalist settings also need training to ensure consistent, accurate information is conveyed, as outdated information can present a safety risk. This will be a huge undertaking that will require coordination and consistency, but it will also provide an ideal opportunity to revisit how information is designed and shared with patients. Involving nurses in this initiative will improve patient information and support, and strengthen multidisciplinary working.

Box 2. Consequences of new radiotherapy techniques

- Changes to how radiotherapy is delivered will mean shorter courses, which may increase the severity of short-term side-effects but will hopefully reduce some long-term side-effects
- Curative treatment will involve shorter radiotherapy courses, which have been traditionally associated with palliative treatment
- Patients will need fewer hospital visits
- Nurses and other health professionals will need training so they understand the new radiotherapy techniques and can give patients accurate and up-to-date information
- Innovative radiotherapy technologies will create opportunities for multicentre, multidisciplinary research

Conclusion

As patients are empowered to seek out the best treatment, some may be tempted to compare outcomes between the different radiotherapy centres. The NHS prides itself on equal access and, with all 50 radiotherapy centres aiming to consistently deliver new technologies, this is achievable.

The funding boost for updating equipment will facilitate more equitable radiotherapy services. It will also bring about better outcomes for patients and improve their experience. In recent years, cancer outcomes in England have been improving: the investment will help implement the vision that all patients receive advanced, innovative radiotherapy, resulting in higher cure rates and fewer side-effects. The nationwide drive to improve radiotherapy services will also create an opportunity for more rigorous, collaborative and multidisciplinary cancer research that encompasses the wider team involved in detection, treatment and ongoing care. **NT**

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