Treating cancer patients with the cyberknife

Health & Medicine, Cancer

Introduction

To evaluate the use of CyberKnife therapy in local cancer centres, an overview of the evidence needs to be obtained for the clinical and cost-effectiveness of such therapy in different types of cancer. Cancer is a broad group of diseases, where cells grow and reproduce uncontrollably. There are over 200 different types of cancers and the survival rate varies greatly by type and location of the cancer and extent of the disease at the beginning of treatment (1).

The mechanisms causing cancer are complex and there are many different management options. The primary options are: chemotherapy, radiotherapy and surgery. The choice of therapy varies depending on the type, location and grade of cancer as well as the patient’shealth. Surgery, the primary method of treatment of most cancers, is often combined with chemotherapy and or radiation therapy. Chemotherapy is the treatment of cancer with drugs that target all rapidly dividing cells. A large number of these drugs are available and are mainly administered in cycles, with the frequency and duration of treatments limited by toxicity to the patient (2).

Radiation therapy uses ionizing radiation to kill cancer cells and can be administered externally via external beam radiation therapy or internally via brachytherapy. A specialised type of external beam radiation therapy is stereotactic therapy, which uses focused radiation beams to target a tumour using detailed imaging scans. A newly developed stereotactic treatmenttechnologysystem is the CyberKnife (Accuray Incorporated, Sunnyvale, CA). This robotic system became available on the NHS in 2010

and several systems have been installed in NHS hospitals and private clinics in the UK. However, some health authority commissioning groups have banned NHS patients in certain regions within the UK from being treated with the CyberKnife system as stated in the Telegraph article “ Cancer patients denied ‘ last hope’ robotic surgery (3)”. This review aims to critically review the use of CyberKnife therapy in cancer centres.

CyberKnife technology

The CyberKnife technology system has a number of advantages over other treatments. It delivers multiple precise beams of radiation generated within its linear particle accelerator element using a robotic arm at any part of the body from any direction. These radiation beams converge at the tumour, allowing high doses to be aimed at the tumour, while minimizing toxicity to the surrounding healthy tissues. These properties were presented in a study treating locally advanced pancreatic cancer (4). This allows patients to be treated, whom are not able to tolerate further conventional radiation therapy or chemotherapy as they have already exceeded their dose limits or are not capable of undergoing further treatment of this type. However, CyberKnife treatment is only a local treatment and does not prevent cancer from spreading.

The CyberKnife is able to follow tumours that are in motion such as lung tumours with its beam of radiation, because of its synchrony-tracking feature (5). This enables treatment of patients with inoperable tumours as it decreases the risk of damaging vital organs. Several trials have shown that it

is an effective treatment for high-risk surgical patients with lung metastases (6, 7).

Unlike some other radiotherapy systems, CyberKnife is frameless allowing radiation treatment to occur in regions other than the brain, head and neck. For example, the Gamma Knife is only able to treat cranial lesions, while the Cyberknife can treat a number of cancers such as prostate, lung, brain, spine, liver, pancreas and kidney.

Although CyberKnife treatment sessions last longer than in conventional radiotherapy (30 min instead of 15 min), fewer sessions are needed and treatment can often be completed within 1-5 days. Chemotherapy and conventional radiotherapy has often to be given daily over several weeks.

CyberKnife is able to deliver an accurate radiation field size of 5 mm (8) making it one of the most precise treatments.

The high cost of CyberKnife treatment (? 22 000) has been a major disadvantage. There are a large number of clinical studies underway to compare the clinical and cost-effectiveness between radiotherapy and conventional radiotherapies. However, such comparisons are difficult as they require very careful consideration in their design to capture properly all of the cost components of each treatment option.

Current policy on CyberKnife treatment

Currently, the National Institute for Health and Clinical Excellence (NICE) guidelines for radiation therapy are in preparation. Until these guidelines are

published, individual NHS trusts use the process of clinical decision-making to determine whether to fund CyberKnife therapy. This process has led NHS trusts across the UK to reach opposing decisions on funding CyberKnife therapy for cancer treatment. For example, the NHS trust in London funds the use of Cyberknife treatment in its cancer centre, while the NHS trust in the East of England strategic health authority refuses to fund the treatment with CyberKnife citing the lack of evidence for clinical and cost-effectiveness. This raises a number of ethical issues.

Key ethical issues

The following ethical matrix has been constructed to summarize the key issues for the use of the CyberKnife in cancer centres (Table 1).

Table 1: The ethical matrix applied to the use of CyberKnife in local cancer centres

Stake holderWellbeing (Health/Welfare)Autonomy –(Freedom/Choice)Justice (Fairness)
Patient·Patients may benefit from this treatment

·The treatment has been shown to be effective in certain cancers

·Freedom to decide on treatment

·Entitlement to care wherever they live

·Restrictions due to cost are not fair and lead to inequality

Medical profession·Duty of careto provide treatment·Managerial freedom of care·Restrictions on prescriptions

NHS·Financial viability of the service

·Managerial freedom of funds·NICE guidance

·Providing a service to everyone

The matrix was assigned the following interest groups: the patients, NHS and technology providers. Each stakeholder/ interest group is awarded consideration to three ethical principles: Wellbeing, Fairness and Autonomy.

The Patient

Fairness, Wellbeing and Autonomy

In the UK, the refusal of CyberKnife treatment by NHS trusts in certain regions has sparked a debate in relation to fairness and inequality for the patient within the NHS. Patients in need of CyberKnife therapy feel they should be entitled to access to specific treatments wherever they live. However, currently according to section 3 of the " Rights in relation to NHS treatment" factsheet (9), patients do not have the right to a specific type of treatment and can therefore be refused specific treatment by their local NHS Trust. This is specifically the case for treatments that have not been recommended by NICE. It also states that local NHS trusts are able to take into consideration its resources when deciding what services should be paid for in a particular area. Many patients agree that the NHS has limited resources, but believe it is not fair, when services are provided in one region

but not another. Therefore, there is a lack of fairness and justice in the application of CyberKnife therapy in cancer centres in the UK.

The refusal of NHS trusts to fund the treatment of patients with cancer with CyberKnife therapy can have a negative impact on the wellbeing of the patient. For example, some patients have tumours inaccessible to surgery (i. e. in the brain, spine or pancreas) and do not respond to chemotherapy. It has been argued that in these cases, patients should gain access to CyberKnife therapy. However, there is heterogeneity across clinical studies. Some studies have shown that CyberKnife treatment is not clinically effective or showed statistically significant differences compared with standard treatment (10), while others have shown benefits (11, 12). The author of one study (11) concludes that CyberKnife treatment is better than conventional treatment due to its accuracy, which prevents damage to surrounding areas of tissue. It is important to note that the effectiveness varies according to cancer type. Therefore, there is insufficient evidence that can be used to reliably estimate the clinical effectiveness (benefit and harm) and cost-effectiveness of CyberKnife therapy. Results from the large number of clinical trials currently underway to assess the long-term efficacy and toxicity of CyberKnife treatment and other stereotactic therapies will provide much needed guidance.

The variation in access to CyberKnife treatment across the country also affects the patient’s autonomy. Currently, a NHS patient is unable to exercise a full right of choice in their cancer treatments as the NHS is under

no obligation to provide specialised treatments that have not been recommended by NICE (9).

The NHS

Fairness, Autonomy and Wellbeing

The primary purpose and concern of the NHS is to deliver a good healthcare service to the general public. The rapid developments of robotic technology have created cost and capacity pressures for the NHS. For example, it was estimated that NHS expenditure in 2008/2009 on cancer treatments reached over 5. 1 billion, making it the third largest section of expenditure (13). In order to be able to provide a service to everyone, managerial freedom of the limited resources is crucial. NICE was created to help health care decision-makers make well-informed decisions and set standards for high quality healthcare. Currently, guidelines for radiation therapy are in preparation. By imposing conditions on the NHS to provide treatments that have not been proven to be clinically effective and cost-effective, the empowerment of local NHS trusts and professionals to deliver care of the highest quality for all patients might be restricted.

Medical profession

Wellbeing, Autonomy and Fairness

The major concern to the medical profession is their duty of care to provide their patient with appropriate care. It is clear that clinicians do not have the managerial freedom to prescribe the treatment that they feel could benefit their patients, as the treatment is not currently funded in their region. This

creates frustration among clinicians as well as their patients. It is estimated that 52 % of cancer patients should receive radiotherapy as part of their treatment (14), however only 37% of cancer patients assessed this treatment in 2007. Changes are clearly needed to tackle health inequalities and access in the UK in order to improve outcomes and achieving cancer survival rates.

Conclusions

In conclusion, CyberKnife treatment has important advantages over other stereotactic radiation methods and can benefit patients with certain types of cancers. A number of studies have shown Cyberknife therapy can be clinically and cost-effective. Therefore, CyberKnife therapy should be made available across the UK to patients in need of this treatment and not only in certain regions. As more clinical trial data become available, guidelines should be updated.

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