Radiotherapy

Information for Haematology/Oncology Shared Care Centres

This document contains information and clinical guidelines for management of children attending the Oncology and Haematology department at Sheffield Childrens NHS Foundation Trust or their designated shared care centres or in the community. It is to be used by staff within shared care centres and community services for information whenever they are caring for these children either in hospital or at home.

1. What is Radiotherapy?

Radiotherapy is the use of x-rays (photons) or electron fields to destroy cells. They do this by causing ionisation within the target tissue resulting in electron release in the cells. These electrons interact with cellular molecules, the most important of which is DNA. This causes disruption in the cell function and replication which leads to early cell death in a proportion of cells with each dose.

Radiotherapy doses are measured in Joules of energy given per kilogram mass of tissue and the unit is known as Gray (Gy), after a British Radiobiologist L.H Gray. Unfortunately like many cancer treatments surrounding normal tissue can also be affected by the radiotherapy and this is responsible for the side effects of the treatment. The treatment is carefully calculated to maximise the dose to the tumour cells and minimise it to the surrounding tissue. Treatment designs utilise the differences between tumour and normal tissue so as to maximise the repair capabilities of normal tissue compared to tumour cells.

How a cell is affected by radiotherapy depends on several factors including:

- Inherent radio sensitivity of cell type.
- The cell’s capacity for repair of radiation damage
- The oxygen and nutritional status of the tumour
- The position of cells in cell cycle
- Mitosis (M) and early DNA synthesis phase (S) most sensitive
- The capacity to repopulate
We attempt to protect the normal tissue and make the tumour cells as sensitive as possible in several ways:

- Treatment is given in small doses called ‘fractions’, to allow time for cell repair. These are usually daily Monday to Friday but occasionally they are given twice daily (8 hours apart). It is thought that normal tissue has a greater ability to recover than tumours cells thus more should repair in this time. It also means that a different group of cells should be in the most sensitive phase of replication (Mitosis and S Phase) with each fraction.
- The patient’s Haemoglobin is maintained at greater than 100g/L throughout treatment. This is because oxygen is a radiosensitizer, thus hypoxic tumour cells are relatively radioresistant and anaemia is to be avoided.

2. When is Radiotherapy Used in Children?

Radiotherapy can only be used for those tumours that respond to it i.e. are radiosensitive. It can be used as part of a curative program of treatment or as part of palliative symptom relieving care. Whenever used it has long term consequences for growth and development of the region treated. As such, in children, who have a lot of growing and living still to do, its use is dependent on the risks and benefit for the individual child. In most paediatric patients it is part of multimodal therapy in combination with surgery and chemotherapy, as appropriate to the child and their illness. The list below is an indication of when radiotherapy may be considered. However each patient is an individual who will have an individual treatment plan.

**Brain Tumours**

- Medulloblastoma (all patients – craniospinal for child aged over 3yrs and local to posterior fossa only for those under 3 years)
- High grade gliomas (all patients – cranial)
- Low grade gliomas (some symptomatic patients - generally over 8 years old)
- Ependymomas (all over 3 years)
- Intra cranial germinoma (all patients)
- Craniopharyngioma (some patients)

**Solid Tumours**

- Neuroblastoma (stage 4 disease - to primary site only)
- Wilms tumour (abdominal for stage III, and pulmonary for stage IV if residual unresectable lesions after chemotherapy, also used in relapse)
- Soft tissue sarcomas / rhabdomyosarcoma (to residual mass if not resectable)

**Haematological/Lymphoid Malignancy**

- Leukaemia – local treatment for CNS disease or testicular relapse and pre transplant conditioning including Total Body Irradiation (mainly relapsed or other high risk patients)
- Hodgkin’s Lymphoma - some patients, depends on response to chemotherapy
- Non Hodgkin’s Lymphoma – rarely used, occasionally given for CNS disease
3. What Does Treatment Involve?

All treatment is given at Weston Park Hospital (WPH) Sheffield, Treatment Hall, where the equipment and staff trained to give radiotherapy are based. The treatment process is divided into a planning phase and a period of receiving treatment.

Planning will include scans at WPH to enable the staff to calculate how to give the treatment, and may involve the production of a mould to hold the part of the body to be treated in exactly the same place each day. For cranial radiotherapy this is a clear plastic mould with the face left uncovered. The final session is called a simulation - a dummy run without radiation to check all the calculations are right.

Treatment for the child involves lying very still in a room on their own for several minutes. The position in which they have to lie in depends on what area is being treated. The actual treatment often takes less time than the setting up each day. Being in a room on your own and lying still can be a big challenge for the youngest of our patients and some cannot manage it without an anaesthetic. However, patients as young as three have managed without anaesthesia with the help of our play specialists. Parents cannot be in the room when the radiotherapy is administered because of exposure to radiation but all rooms have a two way intercom so the people outside can see and hear the patient and the patient can hear them.

When an anaesthetic is used a paediatric anaesthetist and ODA from the Children’s Hospital go up to WPH to look after the child. When the child is an inpatient a nurse from M3 also accompanies then. Patients for cranial radiotherapy are admitted to M3 for the first week of treatment because it can result in inflammation leading to raised intracranial pressure. After this if the child is well they can travel daily for treatment. Families who live some distance from the hospital can stay in PACT house for the weeks of treatment. This is best arranged before treatment begins.

4. Personnel Involved

Staff from WPH

Dr Simon Pledge Consultant Clinical Oncologist
Prescribes and plans treatment and discusses this with parents. He reviews treatment and patients through treatment.

Dr Kate Dunn Lead Consultant in Oncology
Prescribes and plans treatment for haematology radiotherapy including Total Body Irradiation (TBI)

Mould room staff making casts and then moulds for treatment. (Ext 65176)

Radiography staff give daily treatment – the people the children see.
Contact via Treatment Hall (Ext 65293)

Lead Radiographers for Paediatric Radiotherapy
Nicola Lee

If there are any queries about treatment or a child is unwell and unable to attend treatment they are contactable via Treatment Hall. (Ext 65293)
Staff from SCH

Play specialists from ward (M3) Cambria Lockwood, Danielle Palmer, Charlotte Cooper
Radiotherapy link nurse (M3) Sister Julie Marples

Paediatric Anaesthetists for those children who need anaesthesia to receive treatment

Dr Lee, Dr Jenkins and Dr Yeomanson see patients weekly for symptom control and FBC through treatment

Preparation is half the battle. The play specialists have a wealth of ideas to explain and encourage children that make treatment easier for all involved whatever their age. But they need time to work with children before the start of planning.

5. General Acute Side Effects & their Treatment

Fatigue
This is due to a combination of the treatment itself and the travelling involved. It usually starts several weeks into the course. Occasionally the patient can be fine throughout the treatment period and suddenly feel tired up to six weeks after treatment. See “somnolence syndrome” under head and neck in next section. Always check that the patient is clinically well and does not have another reason for fatigue such as anaemia, infection or low cortisol. If no other cause is clinically evident, reassurance that this will improve with time and advice to take extra rest in the day is all that is needed. Warn patients that it can occasionally take some months to improve.

Skin reaction
The skin over the treated area will receive a dose of radiation. The changes that can be seen will range from mild skin pigmentation (mottled brown in Caucasian skin and bluish black in pigmented skin), to dry inflammation with erythema and swelling, through to moist desquamation with the appearance of a burn at worst. The areas that often suffer most are skin creases, such as the fold were the ear joins the scalp, groins and axillae. Simple skin care advice can minimise these reactions. Patients can wash the areas daily with water and a simple un-perfumed soap. They should avoid the use of perfumed products such as bubble baths in the area of treatment. The application of aqueous cream twice daily from the beginning to a few weeks after treatment will help reduce dryness and maintain the skin in better condition. Protection of the area from the sun with loose clothing, and adequate sun block for all exposed skin, should be strongly encouraged.

Treatment of skin reactions
Dry erythema - Increase aqueous cream to three times a day and prescribe 1% Hydrocortisone cream once or twice daily dependant on severity of erythema.

Moist desquamation - Swab to exclude infection and apply flamazine (silver sulfadiazine) ointment once or twice daily just to wet areas. Do not use on large areas of skin, as it may be absorbed (see BNF-c). Continue aqueous cream to rest of the treatment area.

Secondary Skin infection - Dry, cracked skin is a broken defence barrier in an often immunocompromised patient. Be alert to the possibility of infection and the need to treat with appropriate antibiotics until the results of swabs are available. The route of the antibiotics will depend on the severity of the reaction and the degree of immunocompetence of the patient and should be discussed with the Sheffield oncology team for each patient.
Dermatological advice should be sought in severe reactions that are not responding to initial treatment.

**Loss of appetite**
This can be because of direct involvement of the mouth (see Local effects) or associated fatigue. Lots of small snacks may be a more efficient way of getting calories in rather than meals. It can be a particular problem for children needing anaesthesia for treatment as there will be daily periods of starvation prior to anaesthetic. This narrows the time when they are able to eat. Dietician advice should be sought.

**Hair loss**
Hair follicles in the area of treatment are affected by radiation. The hair will gradually fall out over the first few weeks of treatment. Whether and to what degree it grows back is dependant on the individual and the dose of radiotherapy they receive. See Head and Neck section for more details.

### 6. Site Specific Acute Side Effects and Their Treatment

**Head and Neck**

**Raised Intracranial pressure (ICP)**
Patients are admitted for the first week of cranial radiotherapy to be monitored for symptoms of raised ICP due to inflammation of treated tissue. It is most likely to occur a couple of days into radiotherapy and needs prompt treatment. Be alert for symptoms of headache and vomiting associated with hypertension and relative bradycardia. The SCH staff will do a full neurological examination and have a low threshold for doing a CT scan. The pressure change is a relatively acute one so there may not be any evidence of papilloedema especially if there is pre-existing optic atrophy from previous raised pressure.

**Nausea and Vomiting**
Not all patients need daily anti-emetics. If they experience nausea they will commence daily ondansetron and/or other anti-emetics as required. Some patients find they can discontinue it at the weekends when they are not having treatment. Continuous use of ondansetron over the length of treatment can lead to constipation particularly as the patients are relatively less active.

**Headache**
Exclude raised ICP. Give simple analgesia e.g. paracetamol first and if insufficient try dihydrocodeine. Continue close monitoring for any other symptoms. If symptoms persist despite analgesia then discuss with a consultant whether further investigation is necessary – they may use dexamethasone for symptom relief but this is a Sheffield Oncology Consultant decision.

**Anaemia**
Spinal radiotherapy irradiates the vertebrae which are an important site of haemopoiesis. Patients must have at least weekly FBCs to monitor for anaemia and thrombocytopenia. Haemoglobin should be maintained above 100g/L with transfused blood if necessary.
Painful Mouth/Throat
The mucosal cells are very radiosensitive. The back of the pharynx can be affected in those having spinal radiotherapy. This can be a practical problem affecting nutrition. Effective symptom control varies between patients. Local analgesia with Difflam spray takes the pain away but may make food taste strange. Gelclair, designed to coat the mucosa, helps but doesn't last very long. Systemic simple analgesia sometimes works. In rare severe cases occasionally opioid analgesia and nutritional support with NGT or TPN is necessary.

Dry mouth
During cranial radiotherapy the salivary glands are also affected. This can lead to a dry mouth which can make chewing and eating uncomfortable. In most patients this will resolve but occasionally it persists as a late effect. There are artificial saliva products that some patients find helpful. These consist of either sprays or lozenges used 2 to 4 times daily depending on preparation.

Tasteless food
This is due to a combination of taste buds being affected by treatment and lack of saliva. Patients may complain of a metallic taste to food. Encourage them to try different foods and find out which are best. Tackle the dry mouth problem (see above) and reassure them that usually the taste buds do recover with time but it may take a couple of months for this to happen.

Hair Loss
Hair is lost in the area of treatment both at beam entry and exit site. It is extremely difficult to predict for a given patient what will happen. It is usually lost more quickly in the areas that get the greatest dose of radiation. How much of it returns is very variable between patients. Some patients only regrow very fine wispy hair all over, while others will have patches that are thin and others that are normal. During treatment it is sometimes more practical, though not essential, to have long hair cut short so that the loss is less dramatic. Patients can choose to have a wig but during treatment when the skin is sore these can be very uncomfortable and they may prefer to protect their head from the sun with a soft hat or bandana. If asked whether the hair will return do not offer false reassurance.

Somnolence syndrome
Patients may become very tired and need day time naps about 4-6 weeks after they have completed treatment. The cause of this is unknown but it can occur even if they were fine throughout treatment. It is advisable to warn them it can occur and that it may take many months to recover. It is particularly important to support the need for adequate schooling to be maintained in such patients.

Thorax
The symptoms experienced will be dependant on what area of the chest is treated and with what dose.

Difficulty swallowing
This may occur during treatment where the oesophagus is included in the treatment field. If it does then simple advice about trying soft moist food and analgesia should be given first. It is worth contacting the dieticians for advice about supplementing calorie intake at an early stage. Exclude evidence of oral or oesophageal candida in these immuno-compromised patients. When prescribing analgesia, remember that liquid forms may be easier for such patients even in the older age groups. Rarely, in severe cases, opioid analgesia and NGT or TPN may be needed.
Nausea and Vomiting
Patients many experience nausea if the treatment field involves the lower portion of the chest. Anti emetics such as ondansetron should be started regularly if this is experienced.

Weight loss
Where the above symptoms occur careful monitoring for weight loss and intervention with dietetic advice and calorie supplementation is important. A malnourished patient tolerates treatment less well.

Breathlessness and cough
Patients may experience a dry cough and breathlessness up to several months after treatment. This can be evidence of a radiation pneumonitis (5-15% of all treated patients) and is more frequent in those who have had higher doses of radiotherapy. Always exclude treatable infective causes. Presence of acute symptoms means they are more like to have long term reduced lung function which must be followed up.

Abdomen and/or pelvis
Symptoms experienced will depend on which areas and organs are included in the treatment site.

Nausea and Vomiting
Anti emetics such as ondansetron should be started regularly at onset of treatment and escalated according to individual patient’s symptoms.

Loss of appetite and weight loss
May be part of non-specific symptoms of treatment or secondary to site specific symptoms below. Seek dietician advice early about calorie supplementation.

Diarrhoea
This may occur where the bowel is in the radiotherapy treatment area. It can be a distressing symptom with serious consequences. When severe it can lead to problems with fluid and electrolyte balance and should always be carefully assessed. Encourage good oral fluid intake if possible. Send a stool sample to virology and microbiology to exclude infective causes. Where there is no history of infective contact there is no need to wait for results before starting treatment for presumed radiotherapy related diarrhoea.

Start treatment with simple anti-diarrhoeal drugs such as loperamide. Serum chemistry for electrolyte disturbance should be checked and deficits of fluid or electrolytes supplemented appropriately. Explain the cause of the diarrhoea to the patient and their family and that it may persist for many weeks following treatment but does resolve with time. In severe cases a referral to the gastroenterology team for advice and guidance is helpful.

Proctitis and tenesmus
In pelvic radiotherapy the rectum can be involved in the treatment field. Proctitis is an inflammatory process leading to pain and discomfort on opening bowels. Tenesmus is when irritation of the area leads to the feeling of an urgent need to defaecate even when the rectum is empty. Systemic and local analgesia can be tried where pain is the primary symptom. Careful monitoring and avoidance of constipation secondary to the pain is important.
Dysuria
In pelvic radiotherapy, cystitis, secondary to bladder irritation can occur. Simple advice to increase fluid intake, avoid coffee, tea and acidic fruit juice (and alcohol when appropriate). Avoid the use of scented bath products such as bubble baths. Some people report drinking cranberry juice or lemon barley water is helpful in relieving symptoms.

7. Late Effects of Radiotherapy
Late damage to growing tissues is a major hazard of radiotherapy. Parents need to be fully informed about these side effects before consenting to treatment. The consent for radiotherapy is taken by the Clinical Oncologist at WPH for this reason. Of particular significance are cardiac, pulmonary, musculoskeletal, endocrine (including hypothyroidism), neuropsychological, dental, intestinal and ocular effects. Acute intestinal problems are usually self-limiting. A small proportion of patients may develop chronic bowel damage eg radiation stricture, fistulae or proctitis. Ocular damage is usually prevented by careful shielding. The lens is highly sensitive to radiation, however, and may be damaged by scattered radiation. Prompt cataract surgery can preserve high-quality vision.

8. Information Sources
Cancer Back Up web site- www.cancerbackup.org.uk, has good general information on radiotherapy.
CCLG web site- www.cclg.org.uk has patient information leaflets for 26 different sites of radiotherapy.

References

9. Glossary of Terms
Fraction An individual dose of radiation. Often used to describe radiotherapy given, e.g. 45Gy in 25 fractions - total of 45Gy given over 25 doses.
Conventional fractionation Usually a daily fraction Monday to Friday only
Hyperfractionation Total dose is increased, Size of dose per fraction is reduced. Twice daily treatment
Accelerated fractionation Overall treatment time is reduced Dose per fraction unchanged (or slightly reduced)
Accelerated hyperfractionation Overall time reduced and total dose increased