SKIN REACTIONS FROM RADIOTHERAPY

Clare Warnock and Nicola Lee describe the ways skin reacts to radiotherapy and explain how well-informed nurses can support patients undergoing treatment.

Abstract

Radiotherapy is a widely used cancer treatment that can be used for curative and palliative intent. While it is effective, it can also result in side effects, including skin reactions. The type and severity of skin reaction experienced are influenced by intrinsic and extrinsic factors, and include erythema, dry desquamation and moist desquamation. These can make a significant impact on patients’ wellbeing as they have physical, psychological and social consequences. Accurate and structured skin assessment throughout treatment is needed to monitor reactions, evaluate interventions and plan care. Many patients have fears about the use of radiation as a treatment along with concerns about its potential side effects, including skin reactions. The provision of accurate patient information can help allay anxiety and improve their ability to cope with the challenges of treatment.

Keywords

Anxiety, erythema, fear, neoplasms, radiotherapy, skin reactions

RADIOTHERAPY IS the second most effective treatment for cancer, next to surgery. It is cost effective and clinically effective and is used widely in curative treatment, long-term palliation and symptom control (Department of Health (DH) 2012). Radiotherapy is delivered in specialist centres, but a diverse range of nurses are involved in patient care before, during and after treatment. This includes those providing surgical, chemotherapy, rehabilitation and palliative services for patients, along with community and specialist nurses.

All nurses caring for patients with cancer need to have an understanding of the different treatments patients may receive along the disease pathway, as it may influence the care they deliver. It will also enable them to provide accurate information at times when it is needed by patients. Many patients have fears about the use of radiation as a treatment along with concerns about its potential side effects, including skin reactions (Brennan 2004). The provision of accurate and appropriately timed information to patients receiving radiotherapy has been shown to reduce anxiety and help them cope with the demands it places on them (Knobf 2013).

This article aims to provide nurses with knowledge that will help them support patients before, during and after radiotherapy. It explores:

- How and why skin reactions occur.
- Risk factors that influence their severity.
- Consequences.
- Assessment.
- Topics to include, and words to avoid, when delivering patient information.

This article does not cover interventions to prevent or manage skin reactions, as a systematic review of radiotherapy skin care interventions is taking place in the UK and new national guidelines are anticipated this year (Trueman 2014).

Why radiotherapy damages the skin

Radiotherapy is the use of ionising radiation to kill cancer cells by causing irreparable damage
to their deoxyribonucleic acid (DNA). Ionising radiation is radiation that is able to affect the material it passes through by disrupting its atomic and molecular structure, causing instability. As ionising radiation passes through the cell, it damages the DNA by direct and indirect action (Adamson 2003).

Direct action describes the damage caused by the effects of ionising radiation on the atoms and molecules contained in the DNA.

Indirect action occurs when the radiation interacts with water and oxygen molecules in the cell to create chemical changes that then cause DNA damage.

As a result of the combination of direct and indirect action, most cells do not die immediately after radiotherapy damage but continue to divide a few times before doing so (Camporeale 2008). This explains why some side effects are delayed and the full effect of radiotherapy on the cancer - the effectiveness of treatment - can take some time to be revealed.

The intent of radiotherapy is to create damage to cancer cells, but some radiation will reach normal tissues when the radiation passes through them to reach the cancer (Mitchell 2013).

Skin reactions arising from radiotherapy occur after damage to the epidermis as the radiation passes through the skin (Butcher and Williamson 2012). The skin is composed of three layers: the epidermis, dermis and hypodermis (Figure 1).

The epidermis sits above the dermis and is made up of five sub-layers that start with the basal layer and finish at the outer layer of the skin surface. Skin cells are constantly being shed from the outer layer of the epidermis as part of the normal physiological process called desquamation. These cells are replaced by new cells that are produced in the basal layer and migrate up through the sub-layers of the epidermis over approximately 35 days (Montague et al 2005). The dermis sits below the epidermis and provides the supportive structure required for the skin cells in the epidermis to be renewed. The dermis also contains blood vessels, glands, nerves and hair follicles (Montague et al 2005).

Radiotherapy is most effective when cells are actively dividing, particularly in the mitosis phase of the cell cycle. This means that while radiotherapy can potentially affect all the cells in the treatment area, it has a greater effect on cells that are dividing more often, including cancer cells, as they replicate more often and are more likely to be in phases of the cell cycle when they are prone to its effects (Mitchell 2013). This feature of radiotherapy also helps to explain why skin reactions are a common side effect of treatment, as the basal layer of the epidermis is particularly sensitive to the effects of radiotherapy due to its high rate of cellular division and replication (Tadman and Roberts 2007).

Classifying skin reactions
The type of skin reactions that can occur as a result of radiotherapy range in severity. The terms used to describe them are erythema, dry desquamation, moist desquamation and necrosis. A description of each of these reactions and why they occur is detailed in Box 1. However, due to advances in treatment delivery necrosis is rarely seen (Wells and MacBride 2003) and is not discussed in this article.

Healing post-radiotherapy
Treatment reactions reach their peak approximately ten to 14 days after treatment completion (Knobf and Sun 2005, Glover and Harmer 2014). After this time the skin reaction will gradually reduce as the basal cell layer recovers and normal equilibrium between cell death and cell reproduction returns to the epidermis (NHS Quality Improvement Scotland (NHS QIS) 2010).

While most skin reactions heal over time, some patients may experience long-term skin changes that appear months or years after treatment (Harris 2011). These include (NHS QIS 2010, Feight et al 2011):

- Changes in pigmentation due to the effect of radiation on melanocytes.
- Decreased tissue flexibility affecting range of motion and tissue strength caused by
the effect of radiation on the supporting structures in the dermis.

- The appearance of spidery red lines, called telangiectasia, caused by damage and stretching of the capillary blood vessels during treatment.
- Impaired wound healing in the treated area.

Factors influencing the severity of skin reactions

While skin reactions are one of the most common side effects of external beam radiotherapy, the severity varies between patients due to a wide range of factors. This means that it is not always possible to predict in advance the severity of skin reactions that an individual may experience (Harris et al 2011). However, knowledge of the risk factors can help staff develop appropriate individualised evidence-based care.

Influences on radiotherapy skin reactions can be divided into extrinsic and intrinsic factors. Extrinsic factors are those related to the treatment process, while intrinsic factors are those related to the patient (D’haese et al 2005).

**Extrinsic factors**

*Treatment dose and volume* Severity of skin reactions is affected by the cumulative treatment dose. Skin reactions tend to appear in the second and third week of treatment and their incidence increases as treatment continues (Hickok et al 2005).

**Intrinsic factors**

*Individual patient factors* Factors that influence the severity of skin reactions include:

1. **Age**
2. **Gender**
3. **Dose and volume**
4. **Prior skin conditions**
5. **Skin reaction history**
6. **Post-mastectomy radiotherapy**
7. **Seabourn-Coulter index**

**Box 1 How and why radiotherapy skin reactions occur**

**Erythema**

Damage to the basal layer of the epidermis triggers the body’s inflammatory response as part of the normal physiological process of wound healing (Gosselin et al 2010). This involves the release of histamine-like substances, capillary dilation and increased vascular permeability that result in skin redness and warmth (Trueman 2013) (Figure 2). Patients may also experience sensations such as itching, discomfort and tightness. The words used to describe the severity of erythema range from faint and dull to bright and tender (Hollinworth and Mann 2010). In patients with darker/black skin the treatment field will appear a darker colour (Trueman 2013). Erythema may appear at doses of 2000cGy (Feight et al 2011).

**Dry desquamation**

As the skin is further damaged by exposure to radiation, the basal layer compensates by increasing the rate at which it produces new skin cells, termed mitotic activity (NHS Quality Improvement Scotland (NHS QIS) 2010). Many of these cells are immature and vulnerable to trauma from normal wear and tear once they reach the skin surface (NHS QIS 2010). If the new skin cells are produced faster than the old skin cells are being shed, this leads to dry desquamation which results in the skin appearing dry, flaky and scaly (Glover and Harmer 2014) (Figure 3). The dryness of the skin can be worsened by the reduction in skin lubrication brought about by damage to the sweat and sebaceous glands in the dermis (Heggie et al 2002). Dry desquamation appears at doses above 3000cGy (Feight et al 2011).

**Moist desquamation**

As radiotherapy continues, the stem cells in the basal layer are affected, impairing their ability to produce enough new cells to replace those that have been damaged (Hollinworth and Mann 2010). This results in sloughing of the epidermis and leakage of serous fluid and a skin reaction that appears blistered, moist and oedematous (Figure 4). The area affected can be partial or widespread (confluent) and can feel painful, tender and sensitive (Wells and MacBride 2003). Trueman (2013) describes how the exudate produced in moist desquamation can have beneficial properties as it helps towards a moist wound-healing environment and bathes nerve endings in the area affected, decreasing discomfort. As a consequence, Trueman (2013) proposes that routine cleansing of the skin reaction to remove exudate is not advised unless excessive and there is risk of maceration of the surrounding skin. Moist desquamation can appear at doses above 4000cGy (Feight et al 2011).

Note: The measurement of radiotherapy is gray (Gy) or centigray (cGy), which describes how much energy has been absorbed in the tissue. One gray equals 100 centigray (Camporeale 2008).
Gosselin et al 2010). Patients having palliative radiotherapy at doses less than a total of 2000cGy are at reduced risk of skin reactions (Bolderston et al 2006).

Size and location of the treatment field Reactions are greater in larger and/or irregular shaped treatment areas where it is more difficult to achieve an even dose across the field. This can be seen in radiotherapy to the breast, where women with larger cup sizes of D or above tend to have more severe skin reactions than women with smaller breasts (Heggie et al 2002, Feight et al 2011).

Skin folds and treatment sites with increased potential for friction and/or moistness are also associated with more severe skin reactions (D’haese et al 2005). This includes the axilla, under the breast, head and neck, perineum and groin (NHS QIS 2010).

Fractionation Radiotherapy is often delivered in small doses each day over a period of time; this is called fractionation. Delivering treatment this way increases the chances of killing cancer cells when they are more sensitive to the effects of radiotherapy in the mitosis phase. These smaller daily doses also allow normal cells to recover and repair from sub-lethal damage, therefore reducing toxicity (Mitchell 2013). Different fractionation schedules influence the incidence, timing and severity of skin reactions (NHS QIS 2010).

Treatment technique Different techniques are used to plan and deliver radiotherapy and the technology used is continually evolving to improve treatment accuracy. The use of intensity-modulated radiotherapy (IMRT) has been shown to reduce the incidence of long-term effects and plans are in place for its use to be increased in the UK (DH 2012).

Combined cancer treatments There is increasing use of chemo-radiotherapy, where the two treatments are given together to improve the overall response. However, this can increase the severity of radiotherapy skin reactions (NHS QIS 2010).

Intrinsic factors Intrinsic factors affecting skin reactions include nutritional status, smoking, co-existing diseases and higher body mass index (Feight et al 2011, Glover and Harmer 2014). Patients should be made aware of the increased potential of skin reactions associated with smoking and be encouraged to stop, while being referred to smoking cessation services before treatment (NHS QIS 2010).

Age is associated with incidence and severity of skin reactions. There is some evidence to suggest that younger women may have an increased incidence of dry desquamation compared with older women, possibly due to their slower skin cell turnover rate (Porock et al 2004). However, this may be influenced by other factors such as the less frequent use of adjuvant chemotherapy in older patients (Heggie et al 2002). In much of the literature, older patients are identified as having a higher incidence of reactions due to the influence of ageing on wound healing times and the potential for other risk factors to be present, such as co-existing diseases (D’haese et al 2005, NHS QIS 2010).

Consequences Skin reactions have physical, psychological and social consequences. Physical changes include discomfort, pain and changes in sensation, including increased itchiness, sensitivity, tightness and heat (MacBride et al 2008, Gosselin et al 2010). These problems can affect activities of daily living, interfere with body image, be a source of stress and anxiety and limit participation in work and social activities (Bieck and Phillips 2010, Glover and Harmer 2014).

Severe skin reactions can also necessitate temporary interruption of treatment to allow the skin time to heal. This has the potential to reduce the effectiveness of treatment and influence survival by allowing malignant cells time to repair damage and grow (Bieck and Phillips 2010, Oddie et al 2014).

There has been little research focusing primarily on patients’ own reports of their experiences of skin reactions (MacBride et al 2008). One exception is an interview study with breast cancer patients in which participants described how the distress caused by their skin reactions affected multiple dimensions of their life (Schnur et al 2011). They told how the pain and discomfort from skin reactions had emotional consequences as it made them irritable and impatient. It also impaired sleep as they found it difficult to find a comfortable position. Skin changes were also a public and visible sign of their illness that altered their body image and might need explaining to others. The study found that skin reactions can have a negative effect on physical, functional and emotional wellbeing. It provides valuable insights into the experiences of women receiving radiotherapy for breast cancer. Further research
is needed to explore the consequences of skin reactions in other treatment sites.

**Assessment**

Assessment tools are recommended as they provide a consistent, structured approach to evaluating skin reactions before, during and after treatment (Trueman 2013). The Radiation Therapy Oncology Group (RTOG) assessment tool (Harris *et al* 2011) is used most often in UK radiotherapy treatment centres (Box 2). While it is widely used and relatively easy to complete, the RTOG does not include an assessment of skin reaction from the patient’s perspective or other measures of its consequences (Trueman 2013).

The Radiation-induced Skin Reaction Assessment Scale (RISRAS) includes an evaluation of skin reactions and has an additional patient self-report section to evaluate pain, sensation changes and effect of skin reactions on day-to-day activities (Noble-Adams 1999). While the RISRAS provides opportunities for patients to report on their symptoms, it is still relatively limited. Researchers into interventions to manage skin reactions using RISRAS have also included other measures such as numeric pain ratings, sleep disturbance and analgesia use to evaluate the level of distress experienced (MacBride *et al* 2008, Scott 2013). Other possible outcome measures for assessing interventions used to prevent or manage skin reactions include their ease of use by patients and their effect on symptom relief (Feight *et al* 2011).

**Patient information**

Radiotherapy is predominantly given as an outpatient treatment, so great reliance is placed on the patient’s ability to carry out self-care and cope with treatment effects (Trueman 2013). Effective patient education is a vital component in providing patients with the tools to enable them to achieve this.

The benefits of providing radiotherapy patients with information that is concrete, objective, sensory – for example, what it will feel like, and temporal – for example, when it will begin, how long it will last – are well established (Knobf 2013). Inaccurate or misleading information can also result in increased stress and uncertainty for patients. This has been illustrated in previous research where patients reported that healthcare staff’s description of skin reactions being like ‘sunburn’ did not match their own experiences nor capture the severity and duration of their symptoms (Schnur *et al* 2012). In other research, patients also expressed fears of being burnt, suggesting this may not be a helpful term to use (Halkett *et al* 2008).

Trueman (2013) describes how ‘burn’ is an inappropriate word to use when describing radiotherapy skin reactions as they differ in their causes, extent, duration and consequences. In giving information it would be more helpful to describe what patients are likely to see and feel, where the skin reaction will occur, when skin changes can happen and how the skin will recover after treatment has ended (Harris 2011). Other useful information includes why skin reactions happen, how they will be treated and measures the patient can take for self-care (Trueman 2013).

To date it has been difficult for healthcare staff to be confident in the advice they provide to patients on a range of self-care measures, such as the use of creams and dressings, due to the lack of a firm evidence base for appropriate interventions (Feight *et al* 2011). However, there is some agreement on skin care and hygiene practices, and gentle skin washing, and hair washing for patients receiving cranial and head and neck radiotherapy, should be unrestricted (D’haese *et al* 2005, Bolderston *et al* 2006). Current advice suggests deodorants can be used unless they are found to irritate the skin (Harris *et al* 2011).

Reviews carried out in the UK, Europe and the US have uncovered variations in practice between and within radiotherapy treatment centres (D’haese *et al* 2005, Harris *et al* 2011, Oddie *et al* 2014). The absence of consistent practice is a potential source of confusion for patients and practitioners and can lead to patients receiving conflicting or incorrect information (Glover and Harmer 2014). An expert working group in the UK is undertaking a review of evidence to develop national guidelines to support practitioners in providing evidence-based care (Trueman 2014). Their publication is anticipated.

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**Box 2 Radiation Therapy Oncology Group skin reaction grading**

- **RTOG 0**: No visible change to the skin.
- **RTOG 1**: Faint or dull erythema.
- **RTOG 2a**: Tender or bright erythema/dry desquamation.
- **RTOG 2b**: Patchy moist desquamation; moderate oedema.
- **RTOG 3**: Confluent moist desquamation.
- **RTOG 4**: Ulceration, bleeding, necrosis.

(Harris 2011, Trueman 2013)
Conclusion
The incidence and severity of radiotherapy skin reactions are influenced by treatment and patient-related factors. They present patients with physical, psychological and social challenges before, during and after treatment (Brennan 2004). By being well informed, nurses are more able to prepare patients for potential skin reactions, help them understand the changes that can occur and provide support that meets their needs. This article has given an overview of radiotherapy skin reactions that will support staff in their efforts to provide effective, evidence-based care for patients receiving this treatment.

References