Predicting Radiotherapy-Related Clinical Toxicities in Cancer: A Literature Review

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Assessment of patients receiving radiotherapy for cancer is essential, with the ability to identify those who may be more likely to experience radiotherapy-related side effects noted as an important issue for nurses. Body mass, age, and radiation dose may be predictive factors for the development of such side effects. This review considers these factors and how nurses can use this evidence to inform their care, with results indicating that the dose of radiation, the site treated, and body mass index are predictive of toxicities that may develop. Increased awareness of these predictive factors will aid nurses in identifying patients at greater risk of developing radiation-related side effects. This will assist in guiding nursing interventions, as well as enabling the individualization of patient education, by placing greater emphasis on preventive measures for patients who are more vulnerable to the development of radiation-related toxicities.

The use of ionizing radiation to treat numerous forms of cancer is now widely accepted as standard practice (Ryan, 2012). However, despite many technological advances in this area, the development of toxicities and side effects remains a significant problem that affects the delivery of optimum treatment doses and poses a challenge for nursing care (Ryan, 2012). Documented side effects of radiotherapy include fatigue, dermatologic effects, and site-specific issues such as genitourinary dysfunction, gastrointestinal issues, and pain (O’Gorman, Denieffe, & Gooney, 2013).

The literature indicates the provision of information about side effects is an important unmet requirement of patients receiving radiotherapy, and a need exists to strengthen health education for those more prone to developing symptoms (Knapp et al., 2012; Tang, Wang, Hung, & Lin, 2011). Nurses care for patients before, during, and after radiotherapy and, therefore, are in an ideal position to perform a thorough assessment of a patient’s risk for developing radiation-related symptoms, particularly because it has been demonstrated that nurse-led care is widely acceptable to patients and leads to positive outcomes (Dunberger & Bergmark, 2012; Moore et al., 2002).

The extent of side effects experienced by patients is determined partly by their level of radiosensitivity. This inherent individual response leads to increased effects of radiotherapy on the body and the development of toxicities and side effects (Twardella & Chang-Claude, 2002). Highlighting factors that may increase patients’ radiosensitivity would enable nurses to perform a more comprehensive assessment, tailor patient information requirements, and implement necessary interventions in a timely and efficient manner. For patients receiving radiotherapy for cancer, studies have shown that predictive factors of clinical radiosensitivity may include body mass index (BMI), age, and radiation dose. This review will examine these studies and critically appraise the evidence to consider how knowledge of these factors can guide clinical practice.

Methods

A literature search was conducted using CINAHL®, PubMed, Science Direct, the Cochrane Library, and Wiley Online Library. Search terms employed were radiotherapy, cancer, radiosensitivity, side effects, toxicities, body mass index, age,
and radiation dose. Inclusion and exclusion criteria are outlined in Figure 1. Studies were selected based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 27-item checklist and flow chart (Moher, Liberati, Tetzlaff, Altman, & PRISMA Group, 2009) (see Figure 2).

A total of 21 publications met the selection criteria and were included in the review for critical analysis. Of these, eight were discussed in relation to BMI, five in relation to age, and nine in relation to radiotherapy dose. Sample sizes ranged from 40–1,688. The majority of studies discussed implemented either the Radiation Therapy Oncology Group (RTOG) Scoring System or the Common Terminology Criteria for Adverse Events (CTCAE) to grade severity of toxicities (National Cancer Institute 2006, RTOG 2011). Both systems use a Likert-type scale with the RTOG score ranging from 0–4 and the CTCAE scoring effects from 1–5. A summary of all studies is shown in Table 1.

Discussion

Body Mass Index

BMI may influence the development of clinical toxicities because the presence of extra tissue may affect the absorption of radiation. BMI provides an index of weight-for-height by dividing an individual's weight in kilograms by their square height in centimeters, with the result categorized as underweight (less than 18.5 kg/m²), normal weight (18.5 kg/m²–24.9 kg/m²), overweight (25 kg/m²–29.99 kg/m²), or obese (greater than 30 kg/m²) (World Health Organization, 2004). BMI may influence the development of acute skin reactions, which include faint erythema, dry desquamation, decreased sweating, bright erythema, moist desquamation, ulceration, and necrosis (National Cancer Institute, 2006; RTOG, 2011).

Twardella et al. (2003) examined the influence of personal characteristics, including BMI, on the risk of developing acute skin reactions in 478 patients with breast cancer receiving radiotherapy, and identified a significant association between skin reaction and a BMI of greater than 25.1. However, no association between BMI and acute skin reaction was observed by Kraus-Tiefenbacher et al. (2012) in a study of patients with breast cancer that included a smaller sample (N = 211). However, a statistically significant correlation between larger breast volume and the development of skin toxicity was documented in this study. Both studies used the same endpoints to measure toxicity, but population characteristics differed slightly in that the average BMI was 25 and 23.9, respectively, which may account for the differing results, as the BMI cutoff point for developing this toxicity was 25.1 (overweight) (Kraus-Tiefenbacher et al., 2012; Twardella et al., 2003). Findings in Ambrosone et al. (2006) support this. In that study, 446 patients with breast cancer were investigated, with findings indicating a positive association between increased BMI and radiation-induced skin toxicity, where incidence was 10% in normal or underweight, 24% in overweight, and 28% in obese patients.

With external beam radiotherapy for cervical cancer, grade 1–2 skin toxicity also was more prevalent in obese patients (Legge et al., 2013), although the tool used to measure adverse effects differed from that of the three previous studies. The Legge et al. (2013) study implemented the Chassagne Classification tool to report complications specifically related to the treatment of gynaecologic cancers and was similar to the RTOG and CTCAE tools; a Likert-type scale was adopted that includes five degrees of increasing severity, ranging from 0–4 (Chassagne et al., 1993). However, no significant difference was observed in gastrointestinal, genitourinary, and vascular toxicities in normal weight, overweight, or obese patients in the study (Legge et al., 2013). No association was noted between the development of late small bowel toxicity and BMI in a study of 806 patients with gynaecologic cancer treated with postoperative radiotherapy (Huscher et al., 2009).

Conversely, the occurrence of gastrointestinal toxicity in patients receiving radiotherapy for rectal cancer was significantly worse in underweight patients, with grade 3–4 diarrhea occurring in 27% of this group versus 18% in normal weight patients (Meyerhardt et al., 2004). This large-scale trial included a sample of 1,688 patients, and results are supported by a smaller scale study (Wolff et al., 2011) that also investigated patients with rectal cancer and used the same tool to measure toxicity. In Wolff et al. (2011), almost 4% of the total sample surveyed developed severe grade 4 acute toxicities, which included gastrointestinal, urologic, and dermatologic effects. All affected had a BMI of less than 22, whereas the average BMI for the total sample was 26.4 (Wolff et al., 2011). However, results of a study by Tho et al. (2006) indicated no significant correlation between BMI and acute effects of radiotherapy in rectal cancer, although this difference may be attributed to the smaller sample size (41 patients) and, also, the lower dose of radiotherapy received by the sample (45 Gy versus 50.4–54 Gy). As a result, it could be concluded that an association exists between a lower BMI and the development of acute toxicities in patients with rectal cancer receiving radiotherapy.

In contrast, the development of acute toxicities from radiotherapy treatment for head and neck cancer has been associated with a BMI of greater than 25, although weight loss was established as a predictor of the development of late effects (Meyer, Fortin, Wang, Liu, & Bairati, 2012). These results are confirmed in a smaller study that examined predictors of severe late radiotherapy effects in the same cohort and also identified weight loss as an influencing factor (Ghadjar et al., 2012).

In relation to the side effects of radiotherapy, the literature examined here has identified that a higher BMI is associated with the development of acute toxicities in breast, cervical, and head and neck cancers; weight loss is an influencing factor.

Inclusion Criteria

- Articles must address the topics of clinical toxicity associated with cellular radiosensitivity, body mass index, age, and radiation dose in patients with cancer treated with radiotherapy.
- Articles must be of good quality as determined by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses criteria.
- Publications must be a research study, peer reviewed, and in the English language.
- The date of authorship must be from 2000–2013.

Exclusion Criteria

- Articles that did not meet the inclusion criteria
- Commentaries and editorials

FIGURE 1. Inclusion and Exclusion Criteria
in the development of late effects in those treated for head and neck cancer, and lower BMI is predictive of acute toxicities in patients with rectal cancer (Ambrosone et al., 2006; Ghadjar et al., 2012; Legge et al., 2013; Meyer et al., 2012; Meyerhardt et al., 2004; Twardella et al., 2003; Wolff et al., 2011).

Age

In clinical practice, it has been demonstrated that older patients (older than age 70 years) are more likely to receive radiotherapy alone, rather than combined chemoradiotherapy, thereby warranting additional discussion in relation to the influence of age on toxicities associated with radiotherapy treatment (Firat, Pleister, Byhardt, & Gore, 2006).

An investigation involving 178 patients with prostate cancer receiving radiotherapy treatment reported that lower grade 1–2 levels of acute toxicity were more prevalent in patients older than age 66 years (Longobardi et al., 2011). In a similar investigation of patients with prostate cancer receiving radiotherapy, which used the same toxicity measurement tool, results were contradictory in that no association between age and the development of either acute (as much as three months post-treatment) or late (after three months post-treatment) toxicity was evident (Jani, Parikh, Vijayakumar, & Gratzel, 2005). After further examination, the samples in both studies received similar doses of radiation (median = 69.9 Gy versus 68.1 Gy, respectively), were of similar ages (median = 71 years versus 70 Gy, respectively), and both studies measured gastrointestinal toxicity (diarrhea, constipation, nausea and vomiting) as an end point (Jani et al., 2005; Longobardi et al., 2011). An interesting point of note is the cutoff age associated with the development of toxicity, outlined by Longobardi et al. (2011), was 66 years, and the average age of the sample studied by Jani et al. (2005) was 67.9 years. An explanation for the contradictory results may be from the sample size, as Longobardi et al. (2011) included just 178 patients whereas Jani et al. (2005) included 527 patients, thus making their findings more robust.

The negative correlation between age and the development of gastrointestinal toxicity is further confirmed in patients with rectal cancer, although the tool to measure toxicity in Jani et al. (2005) differed from that of the two other investigations (Longobardi et al., 2011; Tho et al., 2006). However, acceleration of treatment in older patients treated for head and neck cancer, which involved a concomitant boost of radiation at weeks 5 and 6 of treatment, was associated with increased rates of mucositis, pain, weight loss, and dermatitis, indicating that the dose of radiation administered has a significant impact on toxicity (Palazzi et al., 2008). Literature published in relation to this requires further discussion.

Radiation Dose

In quantifying the relationship between the volume of small bowel irradiated and the degree of acute small bowel toxicity in patients receiving chemoradiotherapy for rectal cancer, a significant positive correlation was observed, particularly with increasing doses of radiotherapy and the occurrence of grade 3 diarrhea (Baglan et al., 2002). The volume of small bowel receiving at least 15 Gy of radiation was associated with the degree of toxicity (Baglan et al., 2002). The findings are further supported by results of a similar study investigating patients with rectal cancer, although small bowel toxicity was observed in Tho et al. (2006) at radiation doses of 5–45 Gy, and the risk of developing grade 2 toxicity was less than 20% at doses of 15 Gy (Tho et al., 2006). Robertson, Lockman, Yan, and Wallace (2008) also reported a significant association with increasing small bowel dose volume of radiotherapy and the occurrence of gastrointestinal toxicity in patients receiving radiotherapy for rectal cancer, with this symptom occurring at doses of 5–40 Gy.

All three studies used the same tool to assess toxicity and each sample received similar total doses of radiation (45–50.4 Gy), with combined results confirming that increasing doses of radiotherapy in the treatment of rectal cancer is associated with the development of gastrointestinal toxicity (Baglan et al., 2002; Robertson et al., 2008; Tho et al., 2006).

Similarly, for radiotherapy administered in the treatment of prostate cancer, findings in the literature have indicated the occurrence of acute small bowel toxicity is dose and volume related in this instance (Karlsdóttir, Johannessen, Muren, Wentzel-Larsen, & Dahl, 2004; Longobardi et al., 2011; Nuyttens, Milito, Rust, & Turrisi, 2002; Peeters et al., 2005). Four studies used the same tool to assess radiosensitivity and each sample received a mean total radiation dose 76 Gy, 70 Gy, 73 Gy, and 70 Gy, respectively (Karlsdóttir et al., 2004; Longobardi et al., 2011; Nuyttens et al., 2002; Peeters et al., 2005).

Nuyttens et al. (2002) observed that grade 2 rectal toxicity occurred at a mean radiation dose of 38 Gy and, similarly, Karlsdóttir et al. (2004) noted the same finding at doses of 37–40 Gy. This
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<tr>
<td>Baglan et al., 2002</td>
<td>To quantify the dose volume relationship between the volume of small bowel irradiated and the degree of acute small bowel toxicity during chemoradiotherapy</td>
<td>40 patients with rectal cancer toxicity measured using CTCAE Patients received total dose of 50.4 Gy of irradiation.</td>
<td>Grade 3 or higher small bowel toxicity was observed in 25% of patients. Statistically significant correlation between grade 3 or higher small bowel toxicity and the volume of bowel irradiated. The volume of small bowel receiving at least 15 Gy was associated with the degree of toxicity.</td>
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<td>Nuyttens et al., 2002</td>
<td>To determine acute and late complications for bladder and rectum and to determine dose-volume correlations</td>
<td>64 patients with prostate cancer acute and late side effects assessed using RTOG criteria Patients received a dose of 72–80 Gy of irradiation.</td>
<td>Grade 2 rectal toxicity was observed at a mean dose of 38 Gy. Grade 2 urinary symptoms were observed at a mean dose of 43 Gy. Acute rectal symptoms were observed to be dose-volume related.</td>
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<td>Belgium</td>
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<td>Twardella et al., 2003</td>
<td>To evaluate the influence of therapy modalities, personal characteristics, and individual DNA repair capacity on the risk of acute skin toxicity in patients with breast cancer receiving radiotherapy</td>
<td>478 patients with breast cancer CTCAE to assess skin toxicity Alkaline comet assay to assess DNA repair capacity using stimulated lymphocytes exposed to 5 Gy of irradiation Patients received a dose of 60–66 Gy of irradiation.</td>
<td>84 patients had acute reactions (greater than grade 2), BMI greater than 25.1 was associated with increased risk for skin toxicity. No association between DNA repair capacity and acute skin reactions. Addition radiotherapy, hormone therapy, skin sensitivity to sun, skin diseases, and smoking were not associated with skin reactions. The development of skin reactions increased with dose and was first documented at 35.5 Gy and last documented at 62 Gy.</td>
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<td>Germany</td>
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<td>Karlsdóttir et al., 2004</td>
<td>To investigate the relationship between acute toxicity and irradiated volume in organs at risk during radiotherapy for prostate cancer</td>
<td>132 patients with prostate cancer Acute toxicity measured using the RTOG scoring system Patients received a dose of 70 Gy of irradiation.</td>
<td>Dose-volume parameters of 37–40 Gy and higher than 70 Gy demonstrated a statistically significant correlation with grade 2 rectal toxicity. Bladder volume receiving doses of more than 14–27 Gy showed a statistically significant correlation with acute urinary toxicity.</td>
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<td>Norway</td>
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<td>Meyerhardt et al., 2004</td>
<td>To investigate the relationship between BMI and rates of survival, surgery, cancer recurrence, and toxicity in patients with rectal cancer</td>
<td>1,688 patients with rectal cancer CTCAE to assess skin toxicity Patients received a dose of 50.4 Gy of irradiation.</td>
<td>Obese patients are more likely to undergo APR than normal patients. Obesity was not predictive of cancer recurrence in women. Underweight patients had an increased risk of death. Obese patients had a significantly lower rate of grade 3–4 leukopenia, neutropenia, and stomatitis. Obese patients had a significantly lower rate of grade 3 or worse toxicity than normal patients. Actual body weight dosing of fluorouracil is justified.</td>
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<td>United States</td>
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<td>Jani et al., 2005</td>
<td>To analyze the influence of age on acute and late toxicity after radiotherapy for prostate cancer</td>
<td>527 patients with prostate cancer Acute toxicity measured using the RTOG criteria Patients were categorized based on age (younger than 60; 60–69; 70–74; older than 75).</td>
<td>The toxicity rates were not significantly different as a function of age for either acute or late GI and GU toxicity.</td>
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<td>United States</td>
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<td>Peeters et al., 2005</td>
<td>To identify dosimetric variables predictive of acute GI and GU toxicity</td>
<td>336 patients with prostate cancer Acute toxicity measured using RTOG criteria Patients received a dose of 68–78 Gy of irradiation.</td>
<td>GI toxicity greater than 2 was observed in 46% of patients. GU toxicity greater than 2 was observed in 56% of patients. Positive volume effect for GI toxicity</td>
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<td>Netherlands</td>
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<td>Ambrosone et al., 2006</td>
<td>To investigate genetic predictors of acute toxicities related to radiation therapy for breast cancer</td>
<td>446 patients with breast cancer CTCAE to assess skin toxicity Patients received a dose of 50–56 Gy of irradiation.</td>
<td>BMI was significantly associated with the development of acute skin toxicity Normal/underweight, 10%; overweight, 24%; and obese, 28%</td>
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<td>Germany</td>
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<td>Firt et al., 2006</td>
<td>To determine the influence of age and comorbidity influencing patient selection for radiotherapy and/or chemotherapy for lung cancer</td>
<td>102 patients with stage III non–small cell lung cancer All patients received radiotherapy; 57 also received chemotherapy.</td>
<td>Patients selected for combined therapy were younger and had less comorbidities than patients receiving radiotherapy alone</td>
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<td>United States</td>
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APR—abdominoperineal resection; BMI—body mass index; CTCAE—Common Terminology Criteria for Adverse Events; CTVN—nodal clinical target volume; EORTC—European Organisation for the Research and Treatment of Cancer; GI—gastrointestinal; GU—genitourinary; RTOG—Radiation Therapy Oncology Group

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### TABLE 1. Article Review: Correlation of BMI, Age, and Radiotherapy Dose With Clinical Radiosensitivity (Continued)

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<th>Study/Country</th>
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<tr>
<td>Takeda et al., 2006 Japan</td>
<td>To evaluate the clinical and dosimetric factors associated with oesophageal toxicity in patients with intrathoracic malignancies</td>
<td>61 patients with intrathoracic malignancies Toxicity measured using RTOG criteria Patients received a dose of 40–67 Gy of irradiation.</td>
<td>70% developed grade 1–2 toxicity Doses greater than 35 Gy were associated with development of toxicity. No significant association between oesophageal toxicity, age, and gender Nonhomogenous sample used: 44 male, 17 female, age 26–88</td>
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<td>Tho et al., 2006 United Kingdom</td>
<td>To quantify the relationship between the volume of irradiated small bowel and acute toxicity in rectal cancer</td>
<td>41 patients with rectal cancer Acute toxicity measured using CTCAE Patients received a total dose of 45 Gy of irradiation.</td>
<td>Correlation between volume of irradiated small bowel and severity of diarrhea at every dose level, with the strongest correlation at the lowest dose level Doses of 5–45 Gy correlated with toxicity. Risk of developing grade 2 toxicity was less than 20% at 15 Gy. No correlation between toxicity and age, gender, and BMI.</td>
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<td>Palazzi et al., 2008 Italy</td>
<td>To evaluate the effects of treatment intensification on acute toxicity during radiotherapy for head and neck cancer</td>
<td>149 patients with head and neck cancer Toxicity measured using CTCAE 48 patients had radiotherapy, 82 patients had chemoradiotherapy, and 20 had accelerated fractionation radiotherapy and chemotherapy.</td>
<td>Radiotherapy acceleration in older patients and female gender predicted for worse outcome of mucositis, weight loss, pain, and dermatitis.</td>
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<td>Robertson et al., 2008 United States</td>
<td>To establish the relationship between irradiated small bowel volume and the development of grade 3 small bowel toxicity</td>
<td>96 patients with rectal cancer Toxicity measured using CTCAE Patients received a total dose of 45 Gy of irradiation.</td>
<td>Significant association with small bowel dose volume and grade 3 diarrhea 5–40 Gy correlated with toxicity</td>
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<tr>
<td>Huscher et al., 2009 Italy</td>
<td>To assess the rate of late small bowel toxicity in patients treated with postoperative radiotherapy for gynaecologic toxicity</td>
<td>806 patients with gynaecologic cancer Retrospective analysis of data from patient notes Toxicity measurement tool not determined Patients received a dose of 40–55 Gy of irradiation.</td>
<td>Late severe small bowel toxicity (fistula or obstruction) occurred in 4% of patients. Age (older than 60) at time of irradiation was associated with the development of late toxicity. BMI and smoking did not affect rate of toxicity. The total pelvic dose had no effect on the endpoint. A daily dose fraction of less than 1.8 Gy of irradiation showed a clearly reduced risk of developing late complications. Patients requiring discontinuation of therapy for acute severe effects had increased risk for developing late toxicity.</td>
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<td>Longobardi et al., 2011 Italy</td>
<td>To assess predictors of acute bowel toxicity in whole pelvis irradiation with tomotherapy</td>
<td>178 patients with prostate cancer EORTC criteria used to assess toxicity Patients received a dose of 56.5–74.2 Gy of irradiation.</td>
<td>Grade 1–2 toxicity occurred in 32% and 8% of patients, respectively. Acute bowel toxicity after radiotherapy was associated with therapy duration (less than 40 days), age, and larger CTVN.</td>
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<td>Wolff et al., 2011 Germany</td>
<td>To identify subgroups of patients with rectal cancer at risk for high-grade toxicity</td>
<td>196 patients with rectal cancer Toxicity measured using CTCAE Patients received a dose of 50.4 Gy of irradiation.</td>
<td>Women with lower BMI were at greater risk of developing acute toxicity. Gender and BMI correlated significantly with acute toxicity. Seven patients experienced grade 4 toxicities and were all women who had lower BMI (lower than 22); however, those patients also had intensified chemotherapy.</td>
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<tr>
<td>Ghadjar et al., 2012 Switzerland</td>
<td>To identify predictive factors for severe late radiotherapy-related toxicity</td>
<td>213 patients with head and neck cancer Retrospective analysis of data from a previous trial Late toxicity assessed using RTOG criteria Patients received a dose of 72–76.8 Gy of irradiation.</td>
<td>39% experienced severe late radiotherapy-related toxicity. Severe late effects were associated with advanced nodal classification, technically unresectable disease, weight loss ratio, and acute dysphagia.</td>
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APR—abdominoperineal resection; BMI—body mass index; CTCAE—Common Terminology Criteria for Adverse Events; CTNV—nodal clinical target volume; EORTC—European Organisation for the Research and Treatment of Cancer; GI—gastrointestinal; GU—genitourinary; RTOG—Radiation Therapy Oncology Group
positive dose and volume effect in relation to the development of gastrointestinal toxicity also has been reported in two separate investigations of patients with prostate cancer (Longobardi et al., 2011; Peeters et al., 2005).

Interestingly, gastrointestinal toxicity in patients receiving radiotherapy for rectal cancer began to occur at a much lower dose of 5 Gy of irradiation, whereas in relation to prostate cancer, toxicity was documented at a mean dose of 38 Gy, further confirming that radiotherapy-related toxicity is dependent on the dose administered to the volume of the organ targeted (Nuyttens et al., 2002; Robertson et al., 2008).

Postoperative pelvic radiotherapy was administered to 806 patients with gynaecologic cancer, and the sample was retrospectively assessed for the occurrence of radiation-related late small bowel toxicity (Huscher et al., 2009). Interestingly, the total pelvic dose had no effect on the endpoint, but a daily dose fraction of 1.8 Gy or less was associated with a reduced risk of developing late complications, further confirming the dose and volume effect of radiotherapy on the development of toxicities (Huscher et al., 2009).

The results also are confirmed by findings of an investigation of 478 patients with breast cancer that evaluated the influence of radiotherapy on the development of skin toxicity (Twardella et al., 2003). The development of skin reactions increased with dose and was first documented at 35.5 Gy of radiation (Twardella et al., 2003). Similar findings were reported in a study that used a nonhomogeneous sample of 61 patients with intrathoracic malignancies and included 44 male and 17 female patients, with the development of toxicities associated with radiotherapy doses of greater than 35 Gy (Takeda et al., 2006). Therefore, findings in the literature strongly indicate that increasing doses of radiation result in the development of toxicities; however, these occur at varying doses, depending on the type of cancer and the treatment site.

**Future Research**

BMI and radiation dose are predictive factors of radiotherapy-related side effects. The development of a test to predict adverse reactions of healthy tissue to radiation at a cellular level may identify those patients more at risk of being radiosensitive and developing more severe side effects; this would be very useful to nurses and other health professionals and is one of the long-term objectives of radiobiology (Rzeszowska-Wolny, Palyvoda, Polanska, Wygoda, & Hancock, 2008).

Initially, differences in individual radiosensitivity were observed in those with hereditary chromosomal instability syndromes such as Nijmegen breakage syndrome and ataxia telangiectasia, where not only enhanced clinical but also in vitro cellular radiosensitivity was exhibited by patients (De Ruyck et al., 2005). This awareness of cellular radiosensitivity has led to the development of a growing body of evidence that has investigated individuals who do not possess these rare genetic syndromes, but nonetheless exhibit increased intrinsic cellular radiosensitivity (De Ruyck et al., 2005). In accordance with this, a number of blood tests have been developed to quantify the level of radiation-induced DNA damage or DNA repair capacity, which include micronucleus and G2-phase assays, comet assays,
Implications for Practice

- Identify patients who are at greater risk of developing radiation-related side effects through awareness of factors that predict radiosensitivity.
- Guide nursing interventions with early detection of side effects related to radiotherapy through increased knowledge of their occurrence in high-risk groups.
- Individualize patient education by placing more emphasis on preventive measures for those at greater risk of developing radiation-related toxicities.

and genome expression analysis (Greve et al., 2009; Pietrowska et al., 2011; Vral, Thierens, Baeyensa, & De Riddera, 2002). However, studies vary widely in the use of sample size and type, radiation doses, and methodologies applied, particularly in relation to the type of blood test implemented (Barber et al., 2000; Borgmann et al., 2008; De Ruyck et al., 2005; Hoeller et al., 2003). Therefore, research to develop a definitive test that can predict radiotherapy-related side effects is ongoing. As nurses are in an ideal position to assess and measure radiation-induced side effects, their involvement in such studies would make a significant contribution to future research in this area.

Conclusion

Findings of the literature examined have indicated that a higher BMI is associated with the development of acute toxicities in breast, cervical, and head and neck cancers; weight loss during treatment for head and neck cancer is an influencing factor in the development of late effects; and a lower BMI is predictive of acute toxicities in patients with rectal cancer.

Age is less predictive of the occurrence of toxicities, as it was only successfully correlated with milder levels of fatigue in older patients treated for lung cancer, and no definitive association was made with the development of gastrointestinal toxicity in the treatment of either rectal or prostate cancer in older patients. Nonetheless, acceleration of radiotherapy did lead to greater incidence of mucositis, pain, weight loss, and dermatitis in older patients treated for head and neck cancer. Increasing doses of radiotherapy have been associated with greater levels of toxicity in various types of cancer, including rectal, prostate, gynaecologic, breast, intrathoracic malignancies, and head and neck cancer.

Therefore, the dose of radiation and the site treated, as well as the BMI of each patient, are predictive of toxicities they may develop during radiotherapy. Awareness of these predictive factors will enable nurses to identify patients at greater risk of developing radiation-related side effects, enable individualization of patient education, and guide nursing interventions. However, further research is required to develop a definitive cellular assay that can predict radiotherapy-related side effects. Nurses are ideally positioned to collaborate with such studies as they care for patients before and during radiotherapy and, also, possess knowledge pertaining to the assessment and treatment of radiotherapy-related side effects.

References


