I'm Karen Hoffman, Assistant Professor, Department of Radiation Oncology at The University of Texas MD Anderson Cancer Center. I will be discussing the Late Effects of Radiation Therapy.

Upon completion of this lecture, participants will be able to identify common side effects of breast radiation therapy; describe factors that can contribute to the development of more severe radiation side effects; and explain skin care during and after radiation therapy.

The extent and severity of side effects from radiation therapy vary depending on patient factors and radiation treatment design. The majority of radiation side effects occur within the radiation treatment field. Early radiation side effects develop during radiation treatment and most improve within a few weeks after completion of radiation treatment. However, late effects can develop months or years after completion of radiation treatment.

Radiation therapy is usually well tolerated with few side effects. Fatigue is common during radiation treatment and skin changes are expected. Skin changes improve after radiation therapy. However, some skin changes including dryness persist after completion of treatment. Women who receive radiation therapy to the lymph node basins are at increased risks of developing arm edema especially if they had an axillary lymph node dissection. Brachial plexus injury, symptomatic radiation pneumonitis, and cardiac injury are rare side effects of radiation therapy and can be prevented by limiting radiation dose to these critical structures. Thankfully, cancers caused by radiation therapy such as chest wall angiosarcomas are extremely rare.

Patients can develop fatigue while receiving radiation therapy, with more pronounced fatigue occurring in the last week or two of treatment. The mechanisms that produce fatigue are not well understood. However, there are several theories including that fatigue occurs because energy is needed for normal tissue cellular repair after radiation and that coming in for radiation treatments five times per week, in and of itself, is tiring.

Several factors can contribute to the development of fatigue during radiation treatment including: recent surgery or chemotherapy, emotional or psychological stress, disturbed sleep patterns, hormonal changes, anemia and nutrition, medications, and pain.

Patients undergoing radiation treatment are educated on radiation treatment-induced fatigue. They are advised that fatigue is common and are encouraged to exercise daily as regular exercise may reduce symptoms of fatigue. They are also counseled to maintain adequate fluid intake and eat well during treatment.

Skin changes are expected during radiation treatment and accumulate gradually over the course of treatment. They include: hyperpigmentation, erythema, dryness, and
pruritis. Erythema may progress to dry and then moist desquamation. And skin changes usually develop three to six weeks into radiation treatment.

This and the next slide contain pictures of radiation treatment skin changes. The patient on the left has mild erythema within the radiation treatment field. And the patient on the right has more pronounced erythema within the radiation treatment field.

The patient on the left in this slide has dry desquamation. And the patient on the right has more significant dry desquamation, particularly in the intramammary field.

Multiple factors impact the severity of skin reactions that develop during radiation treatment. Total radiation dose and radiation treatment technique impact the severity of skin reactions with increased dose causing more pronounced skin reactions. Patients receiving radiation therapy after breast conservation tend to have less severe skin reactions than those women who receive post-mastectomy radiation therapy. Women with large pendulous breasts tend to have more significant skin reactions especially in the inframammary folds. And obese women also have more significant skin reactions particularly in the excess skin and tissue folds. Chemotherapy immediately prior or during radiation treatment can increase the severity of skin reactions. And uncontrolled diabetes and tobacco use during radiation treatment are also associated with increased skin reaction during radiation treatment.

Patients are advised to apply a lotion or ointment recommended by the treating physician to the treated skin during radiation treatment and are advised to avoid scratching the skin during treatment although patting the irradiated skin is okay. They are instructed to not shave the underarm on the treated side and to avoid tight-fitting clothes and bras with wires which can increase skin friction. They also are counseled to avoid extreme temperatures and skin exposure.

The treatment of the skin reaction depends on the severity of the skin reaction. It is common to moisturize the dry skin with a lotion or ointment approved by the treating physician. Occasionally, hydrocortisone cream is used in small areas for irritated skin. Dressings are available that can help prevent skin rubbing and irritation. And dressings are available that have soothing or cooling properties that can make the skin areas feel better.

Patients are instructed on skin care after radiation therapy. They are advised to apply moisturizer to the treated skin daily but to avoid lotions that contain perfume because it can cause a drying effect or irritation. They are advised to avoid exposure to extreme changes in temperature, such as an ice pack or hot water bottle, because the treated skin may be more sensitive to injury. And [they] are also advised to avoid sun exposure in the treated area because the treated skin will be more sensitive to sunburn.

Most patients have good resolution of acute skin changes but some patients experience long-term skin and tissue changes including: dark --- dry skin, skin darkening or tanning, telangiectasias, breast contracture, implant contracture, and chest wall tightening.
This and the next slide contain pictures of radiation skin and tissue changes. The patient on the left has slight breast asymmetry with good long term cosmesis. And the patient on the right has skin darkening in the treated breast.

On this slide, in the patient on the left has red telangiectasias that actually could be treated with laser therapy if they were bothersome to the patient. And the patient on the right has a contracture of a breast implant.

Arm lymphedema can develop at any time after axillary surgery or radiation. It is caused by accumulation of fluid in the subcutaneous tissue caused by the disruption of the lymphatic system. It can result in: functional disability, pain, cosmetic disfigurement, and reduced quality of life. The pathophysiology is multifactorial. Both axillary node dissection and radiation to the axillary lymph nodes increase the risk of lymphedema. Patient factors also impact the risk of lymphedema as higher --- as women with higher body mass index are also more likely to develop lymphedema.

In order to prevent lymphedema, patients are advised to practice good skin hygiene and nail care to prevent infection that could trigger lymphedema, including wearing gloves while gardening and treating cuts immediately. They are advised to avoid invasive procedures, including blood draws and vaccinations. And to avoid arm constriction that could obstruct lymph flow, including avoiding wearing tight clothing and blood pressure measurements on the side that was treated. Early detection and intervention may prevent more severe lymphedema.

There also are some rare late effects from radiation treatment, but the risk of energy injury to critical normal tissues can be minimized by limiting radiation dose to the area. Brachial plexus injury can cause paresthesias and weakness. However, recurrent cancer can also compress the brachial plexus causing similar symptoms. So if these symptoms were to develop, it would be important to assess the patient for both cancer recurrence and potential injury from treatment. Radiation can cause lung inflammation or pneumonitis that is usually manifest as asymptomatic radiographic changes. However, if too much radiation dose is delivered to the lungs, symptomatic radiation pneumonitis can develop resulting in shortness of breath.

Cardiac injury from radiation treatment can develop 15 or more years after treatment. And excess cardiac disease was seen among women treated for left-sided breast cancers prior to 1980. However, it is no longer seen because of CT-based planning and improved radiation techniques that spare the heart.

These pictures are axial CT slices of scans used for radiation treatment planning for a woman with left-sided breast cancer. The heart is visible on both scans and the green line is the deep edge of the radiation treatment field. The left is a woman breathing normally. And as you can see, the tip of the heart has crossed past the green line so it actually is inside of the radiation field. And the woman on the right, she has taken a
deep breath. This has expanded her lungs and elongated her heart and, therefore, increased the distance between the treatment target, the breast tissue and the heart. So in the patient on right, the heart is now outside of the radiation treatment field. This decreases the dose to the heart and, therefore, decreases the risk of long-term side effects.

In summary, radiation treatment for breast cancer is usually well tolerated with few side effects. Fatigue is common during radiation treatment. Skin changes are expected during radiation treatment and can range from mild erythema to skin desquamation. Arm lymphedema can develop at any time after radiation treatment. And the risk of lymphedema is higher in women who undergo axillary dissection and receive nodal radiation.

The risk of late effects involving critical normal tissues including brachial plex --- plexus injury, radiation pneumonitis, and cardiac injury can be minimized by careful radiation planning that limits radiation dose to the tissues. Thank you for your attention. We would appreciate any feedback.