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

Upon completion of this lecture, participants will be able to explain the role of radiation therapy and breast cancer treatment for women who undergo breast conserving therapy and for women who undergo mastectomy; describe how radiation therapy works; and list the steps that are taken to initiate breast cancer radiation treatment.

Radiation therapy is an important component of multimodality cancer treatment for many women with breast cancer as a component of definitive cancer treatment and its palliative treatment for symptomatic metastases.

For patients receiving definitive cancer treatment radiation therapy is usually administered after surgical resection either breast conserving surgery or mastectomy and any cytotoxic chemotherapy.

Breast conserving surgery refers to the surgical removal of the tumor and a small amount of surrounding breast tissue. It is also called lumpectomy or partial mastectomy. Breast conserving surgery is almost always followed by radiation therapy administered to the remaining breast tissue. This treatment was originally investigated as an alternative to mastectomy because it permits preservation of the breast.

Breast conserving therapy provides outcomes equivalent to mastectomy. Randomized trials demonstrate the equivalence of breast conserving surgery plus radiation, also called breast conserving therapy, and mastectomy.

In patients with negative resection margins who receive systemic therapy and undergo breast conserving surgery, there're extremely low in breast tumor recurrence rates.

Radiation therapy is an important component of breast conserving therapy for invasive cancer. Radiation therapy administered after breast conserving surgery improves local control and survival. In a meta-analysis of over 7,000 patients, 5-year isolated local recurrence improved from 26% to 7%. This resulted in a 15-year improvement in breast cancer mortality from 36% to 31%.

Radiation therapy is also an important component of breast conserving therapy for ductal carcinoma in situ. Radiation therapy administered after breast conserving surgery improves local control. In a meta-analysis of 3,729 women, administration of radiation therapy improved ipsilateral breast cancer recurrence at five years from 18% to 8% and at 10 years from 28% to 13%. It is important to prevent recurrences because approximately half of all recurrences are invasive cancers. While radiation therapy has been shown to improve local control after breast conserving surgery for ductal carcinoma in situ, it has not been shown to improve overall survival.
Ongoing investigations seek to identify women with small volume favorable disease who may not require radiation therapy after breast conserving surgery, such as older women with small volume estrogen receptor-positive invasive disease willing to take anti-estrogen therapy and women with small-volume low-to-intermediate grade ductal carcinoma in situ. Omission of radiation therapy is considered for select women after an informed discussion that considers patient and cancer characteristics.

Women with clinically significant risk of locoregional recurrence after mastectomy benefit from radiation therapy. For women with lymph node-positive breast cancer, post-mastectomy radiation therapy improves both locoregional control and breast cancer survival. In a meta-meta-analysis, administration of post-mastectomy radiation therapy to women with lymph node-positive breast cancer improved five year isolated local recurrence from 23% to 6% and improved breast cancer mortality from 60% to 55%.

Post-mastectomy radiation therapy is generally administered to women with tumors larger than 5 cm in size at diagnosis or four or more involved lymph nodes. It is also considered for women with tumors less than 5 cm in size at diagnosis who have one to three involved lymph nodes. It is usually not administered to women with tumors less than 5 cm in size and no lymph node involvement.

Radiation therapy is therapy that uses high energy radiation to kill cancer cells including x-rays, gamma rays, and charged particles. There are two major categories of radiation therapy: external beam radiation therapy which is radiation delivered by a machine outside the body and brachytherapy which is radiation delivered by radioactive material placed in the body near the cancer cells.

Most women who receive external beam radiation therapy that is delivered by linear accelerators which generate ionizing radiation. This picture is a woman who is receiving external beam radiation therapy. You can see that the patient is lying on the treatment table and the radiation is delivered from the head of the machine towards the patient as indicated by the arrow. While undergoing radiation therapy, it does not hurt during the actual treatment, but side effects can develop.

The goal of radiation treatment is to destroy cancer cells while preserving the integrity of normal tissues within the radiation treatment field. The radiation kills cancer cells by damaging their DNA. Radiation can damage DNA directly or create charged particles in the cells called free radicals that then damage the DNA. DNA chromosomal strand breaks are the most important damage cause of radiation therapy that causes cell death.

Since cancer cells do not repair DNA damage well, they are more likely to stop dividing or die than normal cells in the radiation treatment field. When the cancer cells die, they are broken down and eliminated by the body. Radiation can also damage normal cells.
However, normal cells do a better job repairing DNA damage. The imperfect DNA damage repair by normal cells results in the side effects of treatment.

Radiation treatment planning and delivery is a complex technical process. The radiation treatment team includes a board certified physician specializing in radiation oncology, dosimetrists who help design radiation treatment plans, certified physicists who perform important quality assurance checks, and therapists who operate the treatment machines.

This diagram shows the overview of radiation treatment. Initially, the patient meets in consultation with a radiation oncologist. They then undergo radiation simulation which is a CT imaging in the treatment position. The clinical treatment plan is created. Daily radiation treatments are administered. And then the patient returns for follow-up visits to evaluate disease response and side effects.

The patient is seen in consultation by a radiation oncologist who reviews the patient’s medical history and cancer characteristics and determines if radiation therapy is recommended.

Before starting treatment, patients undergo a “simulation” which is a treatment planning session. A customized mold, or “cradle” shaped to the patient’s body is made in the treatment position and is used during each treatment to ensure consistent positioning. CT images are obtained through the treatment region which will be used to create a radiation treatment plan.

Marks are made on the skin with semi-permanent ink to help with daily alignment for radiation treatments. This picture is a patient in a custom cradle in the treatment position with skin marks for daily alignment.

An individualized radiation treatment plan is created using three-dimensional CT imaging. The plan is designed to deliver radiation dose to the target regions which can include the breast tissue, the chest wall, and the undissected lymph node basins, such as the supraclavicular, medial infraclavicular, and internal mammary chains. The plan is designed to limit dose to adjacent normal structures including the heart, the lung, and brach --- brachial plexus.

This is a picture of a radiation treatment plan for a woman receiving whole breast radiation treatment. As you can see in the picture on the right, the radiation is limited primarily to the breast. And the different colored lines represent a different radiation dose.

This is a picture of a post-mastectomy radiation treatment plan with radiation directed at the chest wall and undissected lymphatics, including the supraclavicular and internal mammary chain.
Typical treatment course is five to seven weeks with daily treatments scheduled every weekday, Monday through Friday. The treatments last a few minutes and patients are in the treatment room for less than 30 minutes. Patients are seen weekly by their radiation oncologist to monitor treatment response and side effects.

Shorter radiation regimens for women undergoing breast conserving therapy are currently under investigation because they can decrease the total number of radiation treatments for women who had breast conserving surgery for early invasive cancer and, thereby, improve the convenience of treatment and lower treatment costs. These regimens use larger daily doses to deliver treatment over a shorter period of time. A completed randomized trials support hypofractionated radiation which is daily whole breast radiation treatments delivered over three to four weeks. There is an ongoing randomized trial investigating partial breast radiation which delivers dose to part of the breast twice daily over one week.

Partial breast irradiation can be delivered with external beam radiation or brachytherapy. For brachytherapy, catheters or a balloon are placed in the breast. And for each treatment, the catheters or balloon are connected to a machine that contains a radiation source that travels from the machine into the catheters or balloon and delivers radiation to the tissue near the resection bed.

After completion of radiation treatment, a report is created summarizing the radiation treatment, including radiation treatment target and treatment dose. The treatment summary report is sent to the other involved providers, including the surgeon, medical oncologist, and primary care physician. After completion of treatment, patients return for regular follow-up visits to assess for resolution of acute side effects and development of any late side effects and to monitor for disease recurrence.

In summary, radiation treatment is an important component of multimodality cancer treatment for many women with breast cancer. Radiation is delivered to the whole breast after breast conserving surgery and is delivered to select women after mastectomy who have clinically significant risk of recurrence. Radiation therapy can improve both local cancer control and breast cancer survival.

Radiation kills cancer cells by damaging their DNA. Radiation treatment for breast cancer typically lasts five to seven weeks with daily treatments scheduled every weekday Monday through Friday. Shorter radiation treatment regimens including partial breast radiation are available for women with early invasive breast cancer who undergo breast conserving surgery. Patients are followed after completion of treatment to monitor disease status and for treatment-related side effects. Thank you for your attention. I would welcome any feedback.