Long-Term Effects of Cancer and its Treatment  
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Executive Summary

Late Effects of Radiation Therapy  
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A. Background Information about Radiation
   o There are two types of radiation:
     a) Internal—implants placed directly in an organ or tumor to deliver radiation dose directly
     b) External—linear accelerator used to deliver radiation beam to patient lying on a treatment table
     c) External radiation treatment is usually given daily over the course of several weeks.
   o Humans are very sensitive to radiation and doses must be carefully calculated.
   o Normal tissue and organs are avoided as much as possible, but cannot be completely avoided.
   o Some organs are more sensitive (testes, ovaries, kidney, lung, salivary glands) than others (muscles, bone, nerves).
   o Normal tissues are protected using customized treatments for each patient.
   o New technologies to improve how radiation is given are evolving rapidly (major focus of VCU’s radiation oncology department).

B. Types of Side Effects of Radiation
   o Acute (early): develop during treatment, usually resolve within three months or so after treatment ends.
   o Late: Develop more than three months after treatment has ended; may or may not go away.
   o Consequential: Late effects that develop as a consequence of early effects; may or may not go away.
C. Late Effects
   - Occur in organs that were exposed to radiation.
   - Loss of normal function in the exposed area due to build up of scar tissue and/or death of stem cells.
   - Usually do not affect unexposed areas.
   - Once felt to be permanent, now researchers are finding ways to reverse the effects of radiation.
   - Most severe late effects are rare (major exception is dry mouth with head and neck cancers due to salivary gland damage).
   - More people will show physical effects in scans, etc. than will actually experience symptoms or problems.
   - Any other health issues that affect the body’s ability to heal will increase a patient’s risk for late effects from radiation (diabetes, high blood pressure, obesity, rare genetic diseases, etc.).

D. Late Effects Without Symptoms
   - Most patients who show late effects will not have symptoms—are they then still a problem?
   - They teach researchers about the biology of the problem and the underlying cause that makes the body develop the injury, which can lead to more treatments and preventions.
   - Since late effects are rare, they are really orphan diseases and are treated separately.
   - Focus of research remains on prevention of late effects, especially as a result of increase perceived threat of nuclear terrorism.
   - Few studies have been done to treat established late injury.

E. Current Treatment of Late Effects
   - Hyperbaric Oxygen—oxygen delivered under high pressure promotes wound healing and improves circulation to wounded areas; used in skin, head and neck areas.
   - Pentoxifylline and Vitamin E—helps reduce the viscosity or thickness of the blood and allows the blood to deliver oxygen better to tissues; has shown to be effective in scar tissue that develops in treatment of breast cancer or other soft tissue areas.
   - Steroids—not consistently effective; used for some rectal bleeding issues—often used due to low risk as they are given topically.
   - Angiotensin-converting Enzyme (ACE) Inhibitors—blood pressure medications; in trials now for reducing kidney toxicity that can develop after bone marrow transplantation.
   - Risk Reduction—healthy lifestyle is important.

F. The Future
   - Radiation delivery continues to improve.
Drug therapies for prevention
  a) Can be targeted to specific processes or specific molecules that are implicated in the radiation area.
  b) Can also be more general.
Drug therapies for Reversal
  a) Can be targeted to specific molecules that are involved.
  b) New area of research—Stem Cell replacement therapy or stem cell protective radiation therapy in areas where stem cells reside in a particular organ will be identified and doses of radiation to those sites will be reduced.