



# Radiation Therapy

The purpose of *The American Registry of Radiologic Technologists® (ARRT®) Radiation Therapy Examination* is to assess the knowledge and cognitive skills underlying the intelligent performance of the tasks typically required of radiation therapists at entry into the profession. The tasks typically performed were determined by administering a comprehensive practice analysis survey to a nationwide sample of radiation therapists.<sup>1</sup> Using a nationwide survey, the ARRT periodically conducts a practice analysis to develop a task inventory which delineates or lists the job responsibilities typically required of radiation therapists.<sup>1</sup> An advisory committee then determines the knowledge and cognitive skills needed to perform the tasks on the task inventory and these are organized into the content categories within this document. The document is used to develop the examination. The results of the most recent practice analysis have been applied to this document. Every content category can be linked to one or more activities on the task inventory. The complete *Task Inventory* is available for Radiation Therapy may be found on the ARRT's website at ([www.arrt.org](http://www.arrt.org)).

The *Examination Content Specifications for Radiation Therapy* identify the knowledge areas underlying performance of the tasks on the *Task Inventory for Radiation Therapy*. Every content category can be linked to one or more tasks on the task inventory.

The following table below presents the three major content categories and subcategories covered on the examination, and indicates the number of test questions in each category. The remaining pages list the specific topics addressed within each category, with the approximate number of test questions allocated to each topic appearing in parentheses. are listed in bold and number of test questions in each subcategory in parentheses. Specific topics within each category are addressed in the content outline, which makes up the remaining pages of this document.

This document is not intended to serve as a curriculum guide. Although ARRT programs for certification and registration and educational programs may have related purposes, their functions are clearly different. Educational programs are generally broader in scope and address the subject matter that is included in these content specifications, but do not limit themselves to only this content.

Content Category	Number of Scored Questions <sup>2</sup>
Patient Care	4746
<i>Patient Interactions and Management (29 25)</i>	
<i>Patient and Medical Record Management (17 22)</i>	
Safety	4951
<i>Radiation Physics, Equipment, and Quality Assurance and Radiobiology (21 20)</i>	
<i>Radiation Protection<sup>3</sup>, Equipment Operation, and Quality Assurance (30 29)</i>	
Procedures	404103
<i>Treatment Sites and Tumors (26)</i>	
<i>Treatment Volume Localization (18)</i>	
<i>Prescription and Dose Calculation (24)</i>	



*Treatments (35 ~~36~~)*

<b>Total</b>	<b>200</b>
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<sup>1</sup> A special debt of gratitude is due to the hundreds of professionals participating in this project as committee members, survey respondents, and reviewers.

<sup>2</sup> The exam includes an additional ~~20~~-30 unscored (pilot) questions.

<sup>3</sup> SI units are the primary (principal) units of radiation measurement used on the radiation therapy examination.

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## Patient Care

### 1. Patient Interactions and Management

#### A. Ethical and Legal Aspects

1. patients' rights
  - a. consent  
(\*e.g., informed, oral, implied)
  - b. confidentiality (HIPAA)
  - c. American Hospital Association (AHA) Patient Care Partnership (Patients' Bill of Rights)
    1. privacy
    2. extent of care (e.g., DNR)
    3. access to information
    4. living will, health care proxy, advanced directives
    5. research participation
    6. goal of care (e.g., definitive, palliative)
2. legal issues
  - a. verification (e.g., patient identification, treatment site, prescription)
  - b. common terminology (e.g., battery, negligence, malpractice, beneficence)
  - c. legal doctrines (e.g., respondeat superior, res ipsa loquitur)
  - d. restraints versus immobilization (e.g., positioning aids used to prevent motion)
3. ARRT Standards of Ethics

#### B. Interpersonal Communications

1. modes of professional communication
  - a. verbal/written
  - b. nonverbal (e.g., eye contact, touching)
2. challenges in communication
  - a. interactions with others
    1. language barriers
    2. cultural and social factors
    3. physical, ~~or~~ sensory, or cognitive impairments
    4. age
    5. emotional status, acceptance of condition (e.g., stage of grief)
  - b. explanation of medical terms
  - c. strategies to improve understanding
3. patient education
  - a. explanation of treatment or procedure (e.g., purpose, length of time, radiation dose)

- b. pre- and post-treatment or procedure instructions (e.g., preparation, diet, and medications)
  - c. respond to inquiries about other imaging modalities (e.g., dose differences, types of radiation, patient preparation)
  - d. treatment compliance (e.g., positioning, skin marks)
4. support services
    - a. hospice
    - b. other professionals (e.g., dietitian, clergy, social services)

#### C. Physical Assistance Ergonomics and Monitoring

1. body mechanics (e.g., balance, alignment, movement)
  - a. patient transfer techniques (~~e.g., balance, alignment, movement~~)
  - b. ergonomic devices (e.g., transfer board, Hoyer lift, gait belt)
  - ~~c. fall prevention~~
2. assisting patients with medical equipment
  - a. infusion catheters and pumps
  - b. oxygen delivery systems
  - c. other (e.g., nasogastric tubes, urinary catheters, tracheostomy tubes)
3. patient monitoring and documentation
  - a. vital signs
  - b. signs and symptoms (e.g., motor control, cognitive changes)
  - c. fall prevention
  - d. weight

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#### D. Medical Emergencies

1. non-contrast allergic reactions (e.g., latex)
2. cardiac/respiratory arrest (e.g., CPR, AED)
3. physical injury or trauma
4. other medical disorders (e.g., seizures, diabetic reactions)

\*The abbreviation "e.g.," is used to indicate that examples are listed in parentheses, but that it is not a complete list of all possibilities.

(Patient Care continues on the following page.)



## Patient Care (continued)

### E. Infection Control

1. chain of infection (cycle of infection)
  - a. pathogen
  - b. reservoir
  - c. portal of exit
  - d. mode of transmission
    1. direct
      - a. droplet
      - b. direct contact
    2. indirect
      - a. airborne
      - b. vehicle borne (fomite)
      - c. vector borne (mechanical or biological)
  - e. portal of entry
  - f. susceptible host
2. asepsis
  - a. equipment disinfection
  - b. equipment sterilization
  - c. medical aseptic technique
  - d. sterile technique
3. CDC Standard Precautions
  - a. hand hygiene
  - b. use of personal protective equipment (e.g., gloves, gowns, masks)
  - ~~c. safe needle practices~~
  - ~~d. safe handling of contaminated equipment/surfaces~~
  - ~~e. disposal of contaminated materials~~
    1. linens
    2. needles
    3. patient supplies
    4. blood and body fluids
  - e. ~~safe injection~~ **needle practices**
4. transmission-based precautions
  - a. contact
  - b. droplet
  - c. airborne
5. additional precautions
  - a. neutropenic precautions (reverse isolation)
  - b. healthcare associated (nosocomial) infections

### F. Handling and Disposal of Toxic or Hazardous Material

1. types of materials
  - a. chemicals
  - b. chemotherapy
  - c. metals (e.g., block alloy)
2. safety data sheet (e.g., material safety data sheet)

### G. Pharmacology

1. contrast media types and properties (e.g., iodinated, water soluble, barium, ionic versus non-ionic)
2. appropriateness of contrast media to procedure
  - a. patient condition
  - b. patient age and weight
  - c. laboratory values (e.g., BUN, creatinine, eGFR)
3. complications/reactions
  - a. local effects (e.g., extravasation/infiltration, phlebitis)
  - b. systemic effects
    1. mild
    2. moderate
    3. severe
  - c. emergency medications
  - d. radiation therapist's response and documentation

(Patient Care continues on the following page.)



## Patient Care (continued)

### 2. Patient and Medical Record Management

#### A. Evaluation

1. epidemiology and etiology
  - a. cancer risk factors
  - b. prevalence and incidence
2. cancer screening
3. signs and symptoms
4. history and physical examination
5. imaging studies (e.g., CT, MRI, PET/CT)
6. other diagnostic studies
  - a. lab results
  - b. surgical reports
  - c. pathology reports

#### B. Assessment

1. treatment side effects
  - a. signs and symptoms
  - b. causes
  - c. management
2. blood studies
  - a. types of studies (e.g., CBC, BUN, **creatinine**PSA)
  - b. factors affecting blood values
3. dietary counseling
  - a. common problems
  - b. causes
  - c. dietary management

#### C. Documentation

1. information included in treatment record
  - a. prescription
  - b. monitor units
  - c. target dose (daily and accumulated)
  - d. energy and type of radiation
  - e. date
  - f. time of day for b.i.d. treatment
  - g. fraction
  - h. elapsed days
  - i. field number and description
  - j. doses to other regions of interest
  - k. set-up instructions
  - l. **imaging orders**
2. elements of record keeping
  - a. patient identification
  - b. accountability (e.g., signatures)
  - c. accuracy and legibility
  - d. variance from prescription (errors, prescription changes)
  - e. medical events (definition and required documentation)
3. **basic** charge capture terminology <sup>1</sup>
  - a. professional and technical components
  - b. **general CPT®**-principles and purpose (e.g., **billable services, procedures, and devices**)

<sup>1</sup> Specific CPT codes are not covered.



## Safety

### 1. Radiation Physics and Radiobiology

#### A. Sources of Radiation

1. radioactive material
2. machine-produced radiation
  - a. target interactions (i.e., bremsstrahlung, characteristic)
  - b. particles (e.g., protons)

#### B. ~~Basic Properties~~ Principles of Radiation Physics

1. wave characteristics
2. attenuation
3. inverse-square law
4. x-ray beam quality
5. interactions with matter

#### ~~C. Interactions with Matter~~

- ~~1.~~ a. photon interactions (e.g., Compton, photoelectric effect, pair production)
- ~~2.~~ b. electron interactions
- ~~3.~~ c. particle interactions (e.g., proton, neutron)
- d. attenuation by various tissues

#### C. Biological Effects of Radiation

1. Units of measurement (NCRP #160)
  - a. absorbed dose (Gy)
  - b. dose equivalent (Sv, rem)
  - c. exposure (C/kg)
  - d. effective dose (Sv, rem)
  - e. air kerma (Gy)
2. radiosensitivity
  - a. dose-response relationships
  - b. relative tissue radiosensitivities (e.g., LET, RBE)
  - c. oxygen effect
3. somatic effects
  - a. cells
  - b. tissue (e.g., hemopoietic, skin, reproductive organs)
  - c. embryo and fetus
  - d. carcinogenesis

e. early versus late or acute versus chronic

f. deterministic versus stochastic

g. short-term versus long-term exposure

h. acute radiation syndromes

1. hemopoietic

2. gastrointestinal (GI)

3. central nervous system (CNS)

4. genetic effects (e.g., genetically significant dose)

#### D. Radiation Tissue Tolerance

1. tolerance levels (i.e., whole organ TD<sub>5/5</sub>)

2. adverse effects

3. dose to critical structures

4. radiobiological factors (e.g., dose, fractionation schemes, volume)

5. biological factors

(e.g., age, anatomic variation, medical conditions)

6. medical factors

(e.g., prior surgery, pacemakers)

7. other factors (e.g., radiosensitizers, radioprotectors)

8. contribution from other sources

a. chemotherapy

b. brachytherapy<sup>2</sup>

c. other fields (e.g., prior or abutting)

d. radiation effect modifiers

e. daily imaging

f. CT simulation

<sup>2</sup> Only basic concepts related to common uses of brachytherapy are covered, including dose to surrounding tissue and radiation protection issues. Specific procedures and isotope characteristics are not covered.

(Safety continues on the following page.)

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from  
Safety 2



## Safety (continued)

Equip. Operation & QA moved here from Safety 1

### 2. Radiation Protection, Equipment Operation, and Quality Assurance

#### A. Minimizing Patient Exposure

1. exposure factors
  - a. kVp
  - b. mAs
2. shielding
  - a. rationale for use
  - b. types
  - c. placement
3. collimation/beam width
4. patient considerations
  - a. positioning
  - b. communication
  - c. pediatric
  - d. morbid obesity

#### B. Personnel Protection (ALARA)

1. sources of radiation exposure
2. basic methods of protection (i.e., time, distance, shielding)
3. personnel monitoring (NCRP recommendations for personnel monitoring, Report #116)
  - a. occupational exposure
  - b. public exposure
  - c. embryo/fetus exposure
  - d. dose equivalent limits
  - e. evaluation and maintenance of personnel dosimetry records

#### C. Facilities and Area Monitoring

1. NRC regulations (10 CFR, parts 20 and 35)
  - a. classification of areas (restricted, controlled, unrestricted)
  - b. required postings (signs)
  - c. area monitoring devices
2. barrier requirements
  - a. primary
  - b. secondary

#### D. MRI Magnetic Field Screening

1. biomedical implants
2. ferrous foreign bodies
3. medical conditions (e.g., pregnancy)
4. prior diagnostic or surgical procedures
5. topical or externally applied items (e.g., tattoos, medication patches, body piercing jewelry, monitoring devices, clothing)
6. ancillary equipment (e.g., oxygen tank, IV pole)

#### E. Handling and Disposal of Radioactive Materials

#### F. Components and Operation

1. linear accelerator
2. CT simulator

#### G. Instrumentation

1. ionization chamber
2. Geiger-Müller detector
3. TLD/OSL (optically stimulated luminescence)
4. diodes
5. neutron detectors

(Safety continues on the following page.)



#### H. Quality Control Procedures

Moved from Safety 1

1. warm-up and inspection of linear accelerators
  - a. interlock systems
  - b. safety lights
  - c. emergency switches
  - d. laser alignment
  - e. critical machine parameters (e.g., pressure, temperature)
  - f. electrical and mechanical hazards
  - g. imaging systems
  - h. audio/visual systems
2. warm-up and inspection of CT simulators
  - a. safety lights
  - b. emergency switches
  - c. laser alignment
  - d. QC water phantom (e.g., CT number, noise)
  - e. tube warm-up
3. radiation output verification
  - a. methods
  - b. frequency
  - c. effect of environment (e.g., humidity) on measurements
4. light and treatment field checks
  - a. light and radiation field agreement
  - b. collimator indicator agreement
  - c. multileaf collimator performance
  - d. sidelight/laser accuracy check (isocenter)
5. rotation check
  - a. safety procedures
  - b. operation of gantry/console
6. evaluation of quality assurance results
  - a. interpretation
  - b. course of action
  - c. documentation





## Procedures

### 1. Treatment Sites and Tumors

- A. Anatomy, Pathophysiology, Lymphatic Drainage, and Metastatic Patterns
  1. brain and spinal cord
  2. head and neck (including thyroid and salivary glands)
  3. breast
  4. lung
  5. abdomen, pelvis, GI, and GU
    - a. esophagus, stomach, small bowel, large bowel, rectum, and anus
    - b. pancreas, adrenals, liver, and gallbladder
    - c. ureters, kidneys, bladder, and urethra
  6. reproductive
    - a. prostate, testes, penis
    - b. endometrium, cervix, ovaries, uterus, vagina, and vulva
  7. skeletal
  8. miscellaneous
    - a. lymphoma (Hodgkin and non-Hodgkin)
    - b. sarcomas (bone and soft tissue)
    - c. multiple myeloma
    - d. skin
    - e. leukemia
    - f. mycosis fungoides
    - g. bone marrow transplant
    - h. benign (e.g., heterotopic bone, keloid, AVM, meningioma)
    - i. oncologic emergencies (e.g., whole brain, SVC, cord compression)
- B. Tumor Classification
  1. histopathologic types (e.g., benign, sarcomas, carcinomas)
  2. histopathologic grade
    - a. purpose (differentiation and growth rate)
    - b. grading system (e.g., GX, G1-G4)
  3. staging (basic concepts; not specific sites)
    - a. purpose
    - b. systems (e.g., TNM, ~~+~~ Ann Arbor)

### 2. Treatment Volume Localization

- A. Treatment Techniques and Anatomic Relationships
  1. radiation therapy techniques
  2. sectional and topographic anatomy
  3. critical organs
  4. patient positioning and immobilization
  5. types and uses of contrast media
- B. CT Simulation
  1. CT image acquisition (e.g., mA, slice thickness, ~~spacing~~)
  2. CT image processing and display (e.g., reconstruction, window level, field of view, CT number)
  3. contour volume and isocenter determination
  4. image transmission, storage, and retrieval
  5. programmable lasers
- C. Documentation and Verification of Simulation Procedure
  1. implement according to physician order
  - ~~2.~~ anatomic position
  - ~~3.~~ equipment orientation
  - ~~4.~~ accessory equipment
  - ~~5.~~ field parameters
  - ~~6.~~ set-up ~~diagrams~~ ~~instructions~~
  7. set-up photographs
  - ~~8.~~ temporary and/or permanent reference marks

(Procedures continues on the following page.)



## Procedures (continued)

### 3. Prescription and Dose Calculation

- A. Treatment Prescription
  1. total target dose
  2. fractionation schedules
  3. beam energy
  4. types of radiation
  5. treatment volume (e.g., GTV, CTV, PTV)
  6. number of fields
  7. fixed/rotational fields
  8. field weighting
  9. field orientation
  10. treatment unit capabilities and limitations
  11. plan modifications
  12. beam modifiers
- B. Geometric Parameters and Patient Measurements
  1. field size and shape
  2. target depth
  3. patient thickness
  4. SSD (TSD) and SAD (TAD)
  5. collimator setting
  6. abutting fields (e.g., gap calculations)
  7. fusion with outside diagnostic studies
- C. Dose Calculation and Verification
  1. selection of energy
  2. equivalent square (open and blocked field)
  3. scatter factors (e.g., collimator, phantom)
  4. depth of maximum equilibrium ( $d_{max}$ )
  5. percentage depth dose
  6. TAR, TMR
  7. SSD (TSD), SAD (TAD)
  8. inverse square
  9. extended distance factors
  10. wedges (e.g., wedge angle or factor)
  11. off-axis calculation
  12. isodose curve characteristics (e.g., penumbra, DVH)
  13. factors for beam modifiers (e.g., tray factor, bolus, compensator)
  14. inhomogeneity correction factors
  - ~~15. rotational factors~~
  15. machine output data
  16. verification and documentation

### 4. Treatments

- A. Treatment Options (indications, benefits, risks)
  1. chemotherapy
  2. surgery
  3. radiation therapy
    - a. external beam (e.g., photon, electron)
    - b. brachytherapy<sup>2</sup>
  4. multimodality treatment
- B. Verification and Application of the Treatment Plan
  1. patient position
  2. isocenter location and shifts
  3. treatment parameters (e.g., beam orientation, energy)
  4. prescription
  5. techniques
    - a. 2D
    - b. 3D
    - c. non-volumetric arc therapy
    - d. 4D (e.g., respiratory gating)
    - e. IMRT
    - f. volumetric arc therapy
    - g. stereotactic
  6. imaging procedures
    - a. kV imaging
    - b. cone beam CT (CBCT)
    - c. MV imaging

<sup>2</sup> Only basic concepts related to common uses of brachytherapy are covered, including dose to surrounding tissue and radiation protection issues. Specific procedures and isotope characteristics are not covered.

(Procedures continues on the following page.)

## Procedures (continued)

### C. Treatment Machine Set-Up

1. auxiliary set-up devices
  - a. couch indexing
  - b. positioning aids
  - c. alignment lasers
  - d. motion management
    1. surface guided radiation therapy (SGRT)
    2. gating systems
    3. abdominal compression
2. machine operations
  - a. collimator or cone settings
  - b. optical or mechanical distance indicator
  - c. gantry angle
  - d. collimator angle
  - e. field light
  - f. treatment couch
  - g. six degrees of freedom couch
  - h. console controls
  - i. pendant controls
3. parameters
  - a. SSD (TSD), SAD (TAD), depth
  - b. gantry, collimator, and field size settings
  - c. beam energy and type

### D. Treatment Accessories

1. beam modifiers
  - a. compensating filters
  - b. shielding
  - c. blocks (e.g., thickness, half value layer (HVL), half-value thickness (HVT))
  - d. multileaf collimation
  - e. bolus
  - f. wedges (enhanced dynamic wedge, physical wedge)
2. immobilization devices
  - a. custom
  - b. standard

### E. Treatment Administration

1. patient monitoring
  - a. visual (~~mirror, TV monitor~~)
  - b. ~~two-way voice communication system~~ audio
  - c. back-up systems
  - d. monitoring regulations
  - e. emergency situations
2. record and verify systems
3. image acquisition and registration
4. site verification
5. dose verification (e.g., diodes, ~~film~~)
6. equipment malfunctions
  - a. types (e.g., radiation, electrical, mechanical, software)
  - b. troubleshooting and correction
  - c. documentation and reporting