Radiation Therapy

The purpose of the examination requirement is to assess whether individuals have obtained the knowledge and cognitive skills underlying the intelligent performance of the tasks typically required in radiation therapy for practice at entry level.

ARRT determined the tasks that entry-level radiation therapists typically perform by administering a comprehensive practice analysis survey to a nationwide sample of radiation therapists.[1] The *Task Inventory for Radiation Therapy* is on ARRT's website (www.arrt.org**)**.

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

ARRT avoids content when there are multiple resources with conflicting perspectives. Educational programs accredited by a mechanism acceptable to ARRT offer education and experience beyond the minimum requirements specified in the content specifications and clinical requirements documents.

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 the content outline, but do not limit themselves to only this content. ARRT administers this examination on a computer at a standardized testing center.

The table below presents the major content categories and subcategories that the examination covers. The table lists the number of test questions in each category in bold and the number of test questions in each subcategory in parentheses. The content outline, which makes up the remaining pages of this document, addresses specific topics within each category.

Content Category	**Number of Scored Questions[2]**
Patient Care	**47**
Patient Interactions and Management (28)	
Patient and Medical Record Management (19)	
Safety	**51**
Radiation Physics and Radiobiology (23)	
Radiation Protection[3], Equipment Operation, and Quality Assurance (28)	
Procedures	**102**
Treatment Sites and Tumors (23)	
Treatment Volume Localization (20)	
Prescription and Dose Calculation (21)	
Treatments (38)	
Total	**200**

[1] A special debt of gratitude is due to the hundreds of professionals participating in this project as committee members, survey respondents, and reviewers.
[2] The exam includes an additional 30 unscored (pilot) questions.
[3] SI units are the primary (principal) units of radiation measurement used on the radiation therapy examination.

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
         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 Communication
   1. modes of 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, sensory, or cognitive impairments
         4. age
         5. emotional status, acceptance of condition (e.g., grief cycle, suicidal ideation, aggressive behavior)
      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. review pertinent medical history
      d. respond to inquiries about other imaging modalities (e.g., dose differences, types of radiation, patient preparation)
      e. communication with patient during procedure
      f. CT simulation compliance (e.g., biomedical implant, dental bridge, hearing aids, cardiac device)
      g. treatment compliance (e.g., positioning, skin marks / tattoos)
   4. support services
      a. hospice
      b. other professionals (e.g., dietitian, clergy, social services)

C. Physical Assistance and Monitoring
   1. body ergonomics (e.g., balance, alignment, movement)
      a. patient transfer techniques
      b. safe patient handling devices (e.g., transfer board, Hoyer lift, gait belt)
   2. assisting patients with medical equipment and monitor function
      a. infusion catheters and pumps
      b. oxygen delivery systems
      c. other (e.g., nasogastric tubes, urinary catheters, tracheostomy tubes)

*"e.g." indicates examples of the topics covered, but is not a complete list.

Patient Care (continued)

3. routine monitoring and documentation
   a. vital signs
   b. physical signs and symptoms (e.g., motor control, cognitive changes, bleeding, breathing difficulties)
   c. fall prevention
   d. weight changes
   e. patient comfort and modesty

D. Medical Emergencies
1. 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)
5. communication of critical findings to health care team

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 (PPE) (e.g., gloves, gowns, masks)
   c. safe handling of contaminated equipment and surfaces
   d. disposal of contaminated materials
      1. linens
      2. needles
      3. patient supplies
      4. blood and body fluids
   e. safe 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, Cerrobend)
2. 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. response and documentation

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, 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. dose 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 (e.g., errors, prescription changes, d/c bolus)
      e. medical events (definition and required documentation)
   3. basic charge capture terminology[1]
      a. professional and technical components
      b. general principles and purpose (e.g., billable services, procedures, and devices)

[1] 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 (e.g., bremsstrahlung, characteristic)
      b. particles (e.g., protons)

B. Principles of Radiation Physics
   1. wave characteristics
   2. attenuation
   3. inverse-square law
   4. X-ray beam quality
   5. interactions with matter
      a. photon interactions (e.g., Compton, photoelectric effect, pair production)
      b. electron interactions
      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 (e.g., whole organ $TD_{5/5}$)
   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, electronic medical device)
   7. other factors (e.g., radiosensitizers, radioprotectors)
   8. contribution from other sources
      a. chemotherapy
      b. brachytherapy[2]
      c. other fields (e.g., prior or abutting)
      d. radiation effect modifiers
      e. daily imaging
      f. CT simulation

[2] 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 (continued)

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 (e.g., testicular, eye)
      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 (e.g., 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 (continued)

H. Quality Control Procedures
   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., gas pressure, temperature, water level)
      f. electrical and mechanical hazards
      g. imaging systems (e.g., MV, kV, CBCT)
      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 (MLC) performance
      d. sidelight/laser accuracy check (isocenter)
   5. mechanical safety check
      a. safety procedures
      b. operation of gantry, collimator, console, and imaging systems
   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
      a. sarcomas (bone and soft tissue)
      b. bone metastasis
      c. multiple myeloma
   8. lymphoma (e.g., Hodgkin and non-Hodgkin, mycosis fungoides)
   9. leukemia
   10. skin
   11. benign (e.g., heterotopic bone, arthritis, keloid, AVM)
   12. oncologic emergencies (e.g., whole brain, SVC, cord compression, bleeding)

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)
   2. 3D and 4D CT simulations
   3. CT image processing and display (e.g., reconstruction, window level, field of view, CT number)
   4. contour volume and isocenter determination
   5. image transmission, storage, and retrieval
   6. 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 instructions (e.g., immobilization device)
   7. set-up photographs
   8. temporary and/or permanent reference marks
   9. electronic medical device (e.g., pacemaker, insulin pump)

Procedures (continued)

3. Prescription and Dose Calculation

A. Treatment Prescription
   1. total target dose
   2. fractionation schedule
   3. beam energy
   4. type of radiation
   5. treatment volume (e.g., GTV, CTV, ITV, 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)

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. machine output data (e.g., dose rate, monitor units)
   16. verification and documentation

4. Treatments

A. Treatment Options (indications, benefits, risks)
   1. systemic therapy (e.g., chemotherapy, immunotherapy, targeted therapy)
   2. surgery
   3. radiation therapy
      a. external beam (e.g., photon, electron)
      b. brachytherapy[2]
      c. TBI (total body irradiation) (e.g., pre-bone marrow transplant)
      d. TSE/TBE (total skin/body electrons)
   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

[2] 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 (continued)

C. Treatment Machine Set-Up
   1. auxiliary set-up devices
      a. couch indexing
      b. alignment lasers
      c. motion management
         1. surface-guided radiation therapy (SGRT) (e.g., AlignRT®, OSMS)
         2. gating systems
         3. abdominal compression
   2. machine operations
      a. collimator jaws
      b. electron applicator
      c. optical or mechanical distance indicator
      d. gantry angle
      e. collimator rotation
      f. field light
      g. treatment couch
      h. six-degrees-of-freedom couch
      i. console controls
      j. 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 (e.g., enhanced dynamic wedge, physical wedge)
   2. immobilization devices
      a. simple (e.g., breast board)
      b. complex (e.g., Vac-Lok, mask)
   3. positioning aids
      (e.g., knee sponge, table pad)

E. Treatment Administration
   1. patient monitoring
      a. monitoring regulations (e.g., visual, audio)
      b. urgent situation responses (e.g., patient movement, vomiting)
   2. record and verify systems
   3. image acquisition and registration
   4. site verification
   5. dose verification (e.g., diodes)
   6. equipment malfunctions
      a. types (e.g., radiation, electrical, mechanical, software)
      b. troubleshooting and correction (e.g., back-up MU counter)
      c. documentation and reporting