

BASIC CURRICULUM AND TEACHER'S SYLLABUS

IN

X-RAY TECHNOLOGY

A TEACHING GUIDE



PUBLISHED BY
THE AMERICAN SOCIETY OF X-RAY TECHNICIANS
1954

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FOREWORD

It has been the constant aim of the American Society of X-Ray Technicians to improve standards of training in approved schools of x-ray technology, and to establish uniformity in teaching material and teaching methods. The way toward this goal was opened in 1952 with the approval of the Basic Curriculum. The ASXT recognized the need for a comprehensive teaching outline and assigned to the Education Committee the responsibility of compiling such a Teacher's Syllabus.

During their months of study the Committee took note of the excellent Instructor's Syllabus published in 1952 by the Canadian Association of Radiologists and the Canadian Society of Radiological Technicians, and saw the advantages of similar didactic training for all technicians in both countries. During the First International Convention in Toronto in the summer of 1953 the CAR and the CSXT granted permission to the ASXT to modify the Canadian Instructor's Syllabus to meet the requirements of the ASXT curriculum.

This outline, the Teacher's Syllabus of the American Society of X-Ray Technicians, is intended as a teaching guide to supplement the Curriculum. We hope that it may prove of assistance to those now engaged, or who may become engaged in the teaching of students in x-ray technology. We feel that standardization of instruction is now possible: we hope that through the medium of the Teacher's Syllabus it may become an accomplished fact.

We are grateful to both the Canadian Association of Radiologists and the Canadian Society of Radiological Technicians for permitting us to borrow freely from their efforts.

Clark R. Warren, R.T.
Chairman, Education Committee ASXT.

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Chapter I

GENERAL CONSIDERATIONS

The curriculum listed below has been approved by the Board of Chancellors of the American College of Radiology, the Board of Trustees of the American Registry of X-Ray Technicians and the Board of Directors of the American Society of X-Ray Technicians.

The primary purpose of this curriculum is to provide a suggested basic guide to radiologists conducting x-ray technology training programs. It is recommended that the same hours listed in the curriculum be applied to two year programs with increased clinical applications of these theoretical principles. Additional hours instruction may be allotted to any or all subjects at the discretion of the radiologist.

In establishing a curriculum for the guidance of teachers and students in radiological technique it is believed that a certain number of hours must be allocated for guidance in the teaching of each subject. The order in which each subject of the curriculum is to be taught must be left to the head of each training institution. It is recommended that during the first six months the technician should receive as much theoretical training as feasible, and that the major portion of the teaching of basic subjects be completed by the end of that time. The remainder of the time should be devoted mainly to practical work. Where a two year program is in effect, refresher courses with question periods in immediate preparation for the Registry examinations are to be encouraged.

In institutions where the entire didactic course is given during the first year, it would be desirable that the students remain a second year for practical training. Otherwise the student would spend his second year either rotating in one or more training institutions, or in some other institution under the supervision of a certified radiologist.

For the guidance of the teachers the following number of hours is suggested as a minimum in the teaching of each subject:

1. Applied Sciences		
Section 1 - Physics	(Chapter II)	20 hours
Section 2 - Anatomy and Physiology	(Chapter III)	20 hours
2. Protection Against Radiation and Electrical Hazards	(Chapter IV)	5 hours
3. Professional Ethics	(Chapter V)	2 hours
4. Nursing Procedures Pertinent to Radiology	(Chapter VI)	10 hours
5. Medical Terminology	(Chapter VII)	2 hours
6. Darkroom Chemistry and Technique	(Chapter VIII)	10 hours

GENERAL CONSIDERATIONS

7. Standard Positions and Clinical Practice	(Chapter IX)	30 hours
8. X-Ray Techniques	(Chapter X)	10 hours
9. Office Procedures	(Chapter XI)	5 hours
10. Departmental Administration	(Chapter XII)	3 hours
11. Special Procedures	(Chapter XIII)	10 hours
12. X-Ray Therapy	(Chapter XIV)	5 hours
13. Film Critique	(Chapter XV)	Weekly
	TOTAL	132 hours
14. Electives	(Chapter XVI)	18 hours
Section 1. History of X-Ray		2 hours
Section 2. Journal Club		2 hours
Section 3. Office Typing		5 hours
Section 4. Equipment Maintenance		2 hours
Section 5. Public Speaking		2 hours
Section 6. Visual Education		2 hours
Section 7. Preparation of Radium Applicators		3 hours

It is understood that insofar as subjects eight, twelve, and thirteen are concerned the teaching should be acceptable whether it is done in the form of practical demonstrations or theoretical lectures. It is strongly recommended that the lectures on X-Ray Therapy be supplemented with a minimum of one month's experience in an x-ray therapy department.

Group lecture series presented by radiologists, registered technicians, or qualified specialists may be applied toward minimum theory hours provided that these lectures are included as an integral part of the training program. (i.e., refresher courses and local, state and national educational programs)

It is suggested that a short series of orientation lectures covering department rules and regulations, hospital and department customs, professional conduct and personal hygiene, should precede the formal didactic program.

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Chapter II

APPLIED SCIENCES: PHYSICS

INTRODUCTION

It is assumed that the student has had basic training in mathematics including the use of algebraic symbols, simple equations, ratio and proportion and graphical representation of data, measurement of angles and geometry of triangles.

It is also assumed that the student has had high school physics to insure understanding of measurements and units, mechanical force, work, energy, heat conduction, convection and radiation.

MAGNETISM AND ELECTRICITY

MAGNETISM

Natural magnets, lodestone
Artificial magnets
Magnetic poles, repulsion and attraction between magnetic poles
Inverse square law
Magnetic fields, field representation by lines of magnetic force
Magnetic properties of iron and steel
Elementary theory of magnetism

ELECTROSTATICS

Electrification by friction
Transfer of electricity by contact
Magnetic versus electric attraction
Properties of conductors and insulators
Types of electricity, positive and negative
Detection of electricity, simple electroscopes

ATOMIC THEORY

Elementary discussion of atomic theory of matter as a basis for:

Electrons, protons, neutrons
Combination of atoms into molecules
Induced charges, charging of electroscopes by induction

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APPLIED SCIENCES - PHYSICS

ELECTRIC CURRENTS AND CIRCUITS

Static electricity and current electricity
Analogy between the flow of electricity and water
Simple cell
Flow of electrons to form a current in a complete electric circuit
The practical unit of current
Measurement of current and potential difference by meters
The practical unit of potential difference, volt, kilovolt, Ohm's law, principle of rheostat
Resistances, series and parallel arrangements
Potential drop in a line
Effects produced by an electric current, magnetic field around a conductor carrying a current, magnetic field around a coil
Electromagnets, air and iron core types
Moving coil galvanometers, ammeter, voltmeter
Heating by electricity
Fuses, circuit breakers
Measurement of electric power, watt, kilowatt
Generators, motors, rotary converter
Electric current; direct and alternating, continuous direct, pulsating direct
Impedance, frequency, cycle, sine wave
Principle of transformers, open and closed core types, choke coil, auto-transformer, induction coil

NATURE OF ELECTROMAGNETIC WAVES

The nature of electromagnetic radiation
Discussion of types of radiation in the complete electromagnetic spectrum
Wave length
Definition of the Angstrom
Photons, recoil electrons, Compton electrons

X-RADIATION

Conditions necessary for production of x-rays
Heterogeneous nature of the x-ray beam
Properties of x-rays
Frequency, energy, the effect of voltage on these properties, absorption of x-rays
The absorption of primary radiation in striking matter
Consideration of secondary, scattered, characteristic radiations
Detection of x-radiation, action on the emulsion of the photographic film, fluorescent effect, physiological action on living tissue, ionizing effects, action of certain chemicals causing a color change to occur
Quantity and quality of radiation
Unit of quantity, the roentgen
Specification of quality, the half-value layer

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APPLIED SCIENCES - PHYSICS

APPARATUS AND ACCESSORY EQUIPMENT

DISTRIBUTION OF ELECTRIC POWER

Source and nature of power supply, main switches, fuses, circuit breakers, grounding

Electrical symbols

Line voltage, voltage drop, voltage compensator, stabilizers

Cable capacity, power supply for mobile unit

TRANSFORMERS

Construction: closed core, function of core; primary and secondary windings

Rating of transformers. Types, step-up and step-down

Ratio of transformers

Control of output:

(1) Resistance control of primary

(2) Autotransformer control of primary, coarse and fine control

CIRCUITS AND DISTRIBUTION

Types of rectification; mechanical, valve tube and self-rectification; half-wave, full wave, three phase

Inverse suppressors

High tension distribution, shock proof and non-shock proof

Electrical protection, safety devices

X-RAY TUBES

History and development

Types of x-ray tubes: diagnostic, therapeutic, stationary anode, rotating anode, gas tubes (ionic), Coolidge tubes (thermionic), line focus, double focus, fractional focus, shock proof and non-shock proof

Electron emission, electron acceleration

Tube rating charts, cooling curves, increment curves, effect of space charge

Methods of cooling the anode, heat units

Measuring size of focal spot, pinhole cameras

INSTRUMENTS AND CONTROLS

Various instruments on control panel and purpose of each

Line voltage indicator and compensator

Kilovolt meters, direct and pre-reading

Filament regulator

Autotransformer control, milliammeters, milliampere-second meter (ballistic)

Focal spot selector, timers, circuit breakers, photo-timing

Timers: synchronous, impulse, electronic, integrating

Methods of testing accuracy of timers, stop watch and spinning top

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EXPERIMENTAL

It is recommended that whenever possible experimental demonstrations be arranged for students in the following:

Plots of magnetic fields (iron filings and small compass)
Magnetic effect of a current explored with small compass
Measurements of current and voltage and application of Ohm's law to resistance measurements
Measurements of current in series and parallel resistance
Voltage drops in long leads of finite resistance
Heat output of low power electric lamp
Shunts for a milliammeter
Voltmeter constructed for milliammeter and high resistance
Induction experiments with coils and magnets
Voltage and output of a small stepdown transformer
KvP measurements with sphere gap
Pinhole pictures of targets

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Chapter III

APPLIED SCIENCES - ANATOMY AND PHYSIOLOGY

GENERAL ANATOMY

INTRODUCTION

Comparison between descriptive anatomy (seen with the human eye) and radiographic anatomy (seen by means of x-ray tube) on the fluoroscopic screen or on the radiograph.

Brief outline of embryology. Origin and development of the structures of the human body.

General summary of human anatomy

Origin and meaning of anatomical terms

Surface anatomy and landmarks for positioning in radiography

Various types of tissues and organs supported on a bony framework

Skin and mucous membrane

OSTEOLOGY

Classification of bones; long, short, flat, irregular

Characteristics of each category

Note: Give a short description of bones and explain how these bones are bound together and form the various articulations, components of joints in general. Also give a general description of the muscular system, voluntary and involuntary, including elementary physiology.

Skull and facial bones

Vertebral column. General and special characteristics of vertebrae; cervical, thoracic, lumbar, sacral coccygeal

Ribs and sternum

Pelvic girdle

Upper extremity; shoulder, arm, forearm, wrist, hand

Lower extremity; thigh, leg, foot

DIGESTIVE SYSTEM

Oral cavity, salivary glands, pharynx, esophagus, stomach, duodenum, jejunum, ileum, cecum, ascending colon, transverse colon, descending colon, sigmoid colon, rectum, anus

Accessory organs; liver, gall bladder, pancreas

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APPLIED SCIENCES - ANATOMY AND PHYSIOLOGY

RESPIRATORY SYSTEM

Nose, paranasal sinuses, larynx, trachea, bronchi, lungs

CIRCULATORY SYSTEM

Blood composition and function, pulmonary and systemic circulation
Heart and its chambers, arteries, veins, capillaries

UROGENITAL SYSTEM

Kidneys, ureters, urinary bladder and urethra
Male and female genital organs

LYMPHATIC SYSTEM

Lymphatic vessels, thoracic duct, lymph nodes
Structures, various drainage areas and elementary physiology

NERVOUS SYSTEM

Composition of nervous tissue, neurons, neurological cells, neural connective tissue

Cerebrospinal fluid	Spinal cord
Meninges	Cranial nerves
Cerebrum	Spinal nerves
Cerebellum	

Autonomic nervous system (sympathetic and parasympathetic)
Special senses (eye and ear)

ENDOCRINE SYSTEM (ductless glands)

Thyroid, parathyroid, adrenal, pituitary, intestinal, pineal, thymus and sex glands

RADIOGRAPHIC ANATOMY

Anatomy well visualized by x-ray examination (Radiopaque Structures)

Skeletal System

IN ADULTS:

Classification of bones; long, short, flat, irregular
Simple classification of joints
Radiological appearance and characteristics of each category

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APPLIED SCIENCES - ANATOMY AND PHYSIOLOGY

IN CHILDREN:

Radiographic appearance at different stages of growth

Appearance and localization of secondary bone nuclei in the development of each bone

Note: The anatomical differences between adult's and children's bones may be outlined at the time of the description of the entire skeletal system or else be the subject of a separate lecture

SPECIFIC REGIONS

- a) Skull, face, paranasal sinuses
- b) Vertebral column, distinguishing characteristics of each section
Cervical, thoracic, lumbar, sacral, coccygeal
- c) Ribs and sternum
- d) Pelvic bones
- e) Upper extremity; shoulder, arm, forearm, hand
- f) Lower extremity; thigh, leg, foot

Anatomy less readily visualized by x-ray examination

Lungs, heart, kidneys, liver, spleen, muscles, soft tissues in general

Anatomy not visualized by ordinary x-ray examination (Contrast media required)

Central nervous system: cerebral ventricular system and subarachnoid spaces
Pneumoencephalography, ventriculography, myelography

Digestive system and accessory organs: esophagus, stomach, duodenum, small and large intestine, gall bladder, salivary glands

Urinary system: calyces, renal pelves, ureters, bladder, urethra

Male and female genital systems
Hystero-salpingography, urethrography

Circulatory system

Contrast media

Basic principles, elements involved, precautions against poisoning

Natural contrast in body, need for contrast media in radiography

Opaque and non-opaque contrast media

Iodized oils, aqueous opaque media, various trade names

Newer preparations for visualization of gall bladder, Telepaque, Teredax

Barium sulphate, Rugar, various trade names

Sodium iodide

Contrast media of lesser density such as oxygen, air, carbon dioxide

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Chapter IV

PROTECTION AGAINST RADIATION AND ELECTRICAL HAZARDS

Principles of protection in radiological departments and international recommendations

Definitions

Permissible dosage for x-ray operators (0.3 r per week)

Protective barriers, materials used

Safety factors used in radiography and fluoroscopy, minimal distance to be used in fluoroscopy, tolerance dose for patient

Importance of distance factor in safety

Electrical hazards, principles of artificial respiration, inflammatory anaesthetic hazards

Safety devices, interlock systems

Monitoring, film badge and ionization methods

Proper working and health conditions for personnel

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Chapter V

PROFESSIONAL ETHICS

Definition of ethics

Ethics from technician's standpoint

Relation to other technicians, patients, radiologists, attending physicians and hospital staff

Technician's Creed

Confidential nature of examinations

Psychological approach to patient as individual and handling of patients

Professional bearing and appearance

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Chapter VI

NURSING PROCEDURES PERTINENT TO RADIOLOGY

HANDLING OF PATIENT: Moving, Lifting and Supporting

Assisting patient into a chair
Technique for lifting helpless patient from stretcher to bed
Technique for turning patient
Technique for undressing ill patient and changing gown
Arranging pillows and comfort devices
Assisting helpless patient in elimination of body wastes, bedpan and urinal

SIMPLE NURSING PROCEDURES

Types of enemas, basic principles of enemas
General instructions to patient
Tray requisites for enemas
Technique of administration of enema to adults and infants
Administration of barium sulphate enema
Object of barium enema
Technique for double contrast enema, air injection apparatus
Care of rubber tubing, enema nozzles, Bardex tube, glass connectors

ASEPTIC TECHNIQUE

Discussion of asepsis, antisepsis, sterilization, disinfection
Handling of sterile articles, solutions, instruments, syringes, needles, dressings
Methods of sterilization
Common types of bandages used in application of dressings

HANDLING OF SURGICAL CASES

Surgical emergencies, shock, hemorrhage, collapse
Effects of anaesthesia
Splints, various types used
Principles of hypodermic, subcutaneous, intramuscular, intravenous injections
Tray setup for each type injection

PREPARATION OF PATIENT FOR RADIOGRAPHIC PROCEDURE

Esophagus, gastrointestinal examinations, barium enema

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NURSING PROCEDURES PERTINENT TO RADIOLOGY

Gall bladder visualization
Intravenous pyelogram
Retrograde pyelogram
Cystoscopy

CARE AND HANDLING OF PATIENTS

Elements of first aid
Care of accident and emergency cases
Importance of awaiting specific instructions from physician before removing dressings or splints

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Chapter VII

MEDICAL TERMINOLOGY

General Remarks:

While detailed knowledge is not expected, the student is required to have some acquaintance with the meaning of the more common terms, normal and pathological, employed in requests furnished by clinicians. It is recommended that mention be made of the more common pathological terms and diseases, and that throughout the didactic program medical terminology be employed.

Origin and meaning of common pathological and medical terms

Origin and meaning of common radiological and positioning terms

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Chapter VIII

DARKROOM CHEMISTRY AND TECHNIQUE

FUNDAMENTALS OF THE PHOTOGRAPHIC PROCESS

Light sensitive salts of silver
Nature of photographic emulsion
Gelatin as a suspending medium and sensitizer
Glass, cellulose and paper as a base
Formation of the latent image on exposure
Need for chemical development

X-RAY FILM AND PAPER

History and development
Types of base, i.e., cellulose nitrate and acetate, clear, translucent, tinted, substratum coating, reason for double coating
Characteristics of screen and non-screen type film
Dental film, miniature film, x-ray negative paper
Storage of unexposed x-ray film
Storage of processed film

INTENSIFYING SCREENS AND CASSETTES

History and development
Fluorescence, applications of fluorescence in radiography
Construction of intensifying screen, fluoroscopic screen
Types of intensifying and fluoroscopic screens
Intensification factor
Cleaning, mounting and general care of screens
Cassettes, testing for screen contact, general care

DEVELOPERS AND DEVELOPMENT

Main constituents of an x-ray developer, i.e., developing agents, alkali or accelerator, preservative and restrainer
Effect of temperature on development rate
Standard development, time and temperature
Exhaustion of a developer
Replenishment or other means of compensating for exhaustion

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DARKROOM CHEMISTRY AND TECHNIC

FIXERS AND FIXATION

Fixing agents, acid and preservative in a fixer
Inclusion of hardening agent
Time of fixation
Exhaustion of a fixer

RINSING, WASHING AND DRYING

Objects and methods of rinsing
Objects and methods of washing
Methods of drying films

PROCESSING APPARATUS

Tray processing
Tank processing
Automatic processing units
Hangers, care of hangers
Control of temperature by heating elements and thermostat, by immersion heater, by water mixer, by refrigeration, and by use of ice

REDUCTION AND INTENSIFICATION

Chemistry and characteristics of Farmer's reducer
Chromium intensifier

PREPARATION OF PHOTOGRAPHIC SOLUTIONS

Suitable water supply
Nature of mixing vessels
Order of mixing special solutions
Filtration
Making stock solutions
Making percentage solutions
Storage of dry chemicals and solutions

THE X-RAY DARKROOM

Size
Light-proof entrance, maze, double doors
Construction of walls for protection against chemicals and radiation
Ceilings
Color schemes
Waterproofing of floors
Loading bench design

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DARKROOM CHEMISTRY AND TECHNIC

Disposition of processing and accessory equipment for efficient working
Arrangement of drying cabinets in darkroom or in adjacent drying room
Darkroom illumination, testing the safety of darkroom illumination
Ventilation
Types of filters for safelight
Importance of cleanliness

FAULTS IN RADIOGRAPHS

Density errors
Light fog
Stains
Airbells
Blistering
Streaks

Contrast errors
X-ray fog
Dichroic fog
Crescent marks
Reticulation
Static marks

Unsharpness
Development fog
Mottle
Abrasion marks
Frilling, stripping

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Chapter IX

STANDARD POSITIONS AND CLINICAL PRACTICE

It is recommended that a discussion of the fundamental principles of positioning precede the demonstrations. Show necessity for different views to maintain correct detail and proportion of parts, and their projection on a plane to avoid magnification, distortion, superimposition of structures, etc.

RADIOGRAPHIC TECHNIQUE FOR INDIVIDUAL SYSTEMS

Technique, where mentioned, refers to the position of the patient, the relative position of the tube to the patient and film, and to all the exposure factors.

OSSEOUS SYSTEM

UPPER EXTREMITY

Technique for hand, thumb, wrist joint, carpus, special views for scaphoid, forearm, elbow joint, radio-ulnar articulations, humerus

SHOULDER GIRDLE

Technique for humerus, shoulder joint, acromio-clavicular articulations, scapula, clavicle, sternoclavicular joint

LOWER EXTREMITY

Technique for toes, foot, tarsus, special views for calcaneus, ankle joint, leg, knee, patella, tibial tubercle, tibio-fibular articulations, meniscus (semilunar cartilages), femur (lower two thirds)

HIP JOINT AND UPPER THIRD OF FEMUR

Technique for hip joint, neck of femur, upper third of femur

PELVIC GIRDLE

Technique for pelvis, ilium, ischium, pubis, sacro-iliac joints.

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STANDARD POSITIONS AND CLINICAL PRACTICE

VERTEBRAL COLUMN

Technique for atlas and axis, cervical vertebrae, cervico-thoracic region; thoracic vertebrae, lumbar vertebrae, lumbosacral articulation, sacrum, coccyx, special views for various regions

BONES OF THE THORAX

Technique for sternum, ribs (upper and lower), cervical ribs

SKULL

Technique for cranium: general, sella turcica, temporal bones, optic foramina, petrous apex

Technique for facial bones: general, zygomatic bones, maxillae, nasal bones

LOWER JAW

Technique for entire mandible and temporo-mandibular joints

AIR SINUSES OF SKULL

PARAMASAL SINUSES

Technique for frontal, maxillary, ethmoidal, sphenoidal sinuses
Demonstration of fluid levels, use of contrast media

MASTOIDS

Technique for mastoids, various positions

THORACIC AND ABDOMINAL VISCERA

General considerations, anatomical outline, subject types, children, variation of position of organs with respiratory movement and change of posture, displacement in pathological conditions, preparation and care of patient, factor variation in relation to thickness, optimum distance and exposure time variation of abnormal and difficult subjects, use of compensating filters, demonstration of fluid levels, differentiation of abnormal shadows, soft tissue technique.

Technique for abdominal aorta, liver, spleen, diaphragms, diaphragmatic hernia, sinuses and cavities, free gas and fluid levels, use of contrast media, types of contrast media

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STANDARD POSITIONS AND CLINICAL PRACTICE

CARDIOVASCULAR SYSTEM

Technique for heart and aorta
Opaque meal for relationship of esophagus

RESPIRATORY SYSTEM

Technique for trachea, lungs, special views for apices, mediastinum, subdiaphragmatic conditions
Erect and supine posture relative to fluid levels
Postures for interlobar effusion

ALIMENTARY SYSTEM (with contrast media)

PHARYNX AND ESOPHAGUS

Movement and shape relative to respiratory and cardiac cycle
Mechanism of swallowing
Correct phasing
Consistency of bolus, contraindications to thick bolus in stenosis
Technique for correct orientation, erect, prone and supine positions, tilting table techniques (Trendelenburg, etc)

STOMACH AND DUODENAL BULB

Opaque meal, proportion and quantity, contraindications to large amount of barium. Average time for filling of duodenal bulb and emptying time of stomach.
Compression technique

SMALL BOWEL

Technique for duodenum, jejunum, ileum
Serial examinations
Small bowel enemas, visualization of terminal ileum and appendix

COLON AND RECTUM

Opaque enemas, proportion, quantity and temperature of media
Methods of administration and fluoroscopic control of enema
Importance of oblique and lateral films, post-evacuation films
Compression techniques
Double contrast enemas
Special techniques for fistulae and colostomy

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STANDARD POSITIONS AND CLINICAL PRACTICE

CHOLECYSTOGRAPHY

Various subject types
Methods of differentiation between biliary, renal, and other shadows
Principles of physiology of the gall bladder
Preparation of patient
Oral and intravenous (historical) contrast media administration
Function of non-fat and fat meal
Normal emptying time after fat meal
Demonstration of ducts
Technique for cholecystography
Combined cholecystography and gastrointestinal examination

LIVER AND SPLEEN

Technique for plain films and contrast media

URINARY TRACT

K.U.B.

Preparation of patient
Technique for KUB, special views for differentiation of prostatic and urinary bladder shadows

FEMALE GENITAL ORGANS

EARLY PREGNANCY

Special care of patient
Technique according to fetal development, position and multiplicity

PELVIMETRY

Snow method, Ball method, Thoms method, Colcher-Sussman method
Technique
Special views of inlet and outlet

DUCTLESS GLANDS

Technique for examination of pineal body, hypophysis (pituitary gland), spleen, thyroid and parathyroid, suprarenal glands

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Chapter X

X-RAY TECHNIQUES

Photographic Effect

The action of x-rays on the photographic emulsion

FOUR PRIME OR BASIC FACTORS (in photographic effect)

1. Milliamperage: Definition, effect on film
2. Time: Definition
3. Kilovoltage (Kv): The penetration factor or main qualitative factor
Effect on film
4. Distance: Focal-film or target-film distance. The inverse square law
illustrated by diagrams and problems

Formula expressing relationship of these four prime factors to the finished roentgenogram

TECHNICAL TERMS USED TO DESCRIBE THE QUALITY OF THE ROENTGENOGRAM

DENSITY

Definition, factors controlling density, i.e., time, milliamperage, KvP, distance; with other miscellaneous factors, temperature of developing solutions, etc., exposure latitude

CONTRAST

Definition, factors controlling contrast, KvP
Long scale and short scale contrast

DETAIL OR SHARPNESS OF DEFINITION

Definition, factors controlling detail, i.e., size of focal spot, target to film distance, approximation of object to film, motion, lack of secondary radiation
Good contact of screens with film, exposure holders, use of fine grain intensifying screens, film emulsion characteristics
Study of shadow formation, diagrams illustrating penumbra and causes

DISTORTION

Two types, true distortion and magnification. Definition and causes of each

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X-RAY TECHNIQUES

CONDITIONS INFLUENCING CHOICE OF PRIME FACTORS

Variations in technique necessitated by:
Bodily habitus, age, muscular condition, nature of part, disease, atrophy
Erect and horizontal positions
Splints, wet and dry plaster
Contrast media

ACCESSORY RADIOGRAPHIC EQUIPMENT

Potter Bucky diaphragm: history and origin, purpose, effect upon exposure, effect upon detail and contrast, essential parts
Grid radius, grid ratio, grid efficiency, reciprocating Bucky, focussed and non-focussed grids, stationary grids
Use of fixed and variable aperture diaphragms, cones and cylinders, angle boards, angle meters, central ray indicators, film holders
Calibration of radiographic equipment using aluminum penetrometer
Spinning top
Sand bags, compression bands, non-opaque pads
Filters, definition and purpose, types of materials used
Viewing films, types of illuminators or viewing boxes

TECHNIQUE CHARTS

Preparation of technique charts
Types of charts
Use of and types of technique conversions to meet individual problems

IDENTIFICATION SYSTEMS

Lead markers
Photographic
Advantages and disadvantages of each

MEDICO-LEGAL ASPECTS OF RADIOLOGY

Confidential nature of records and all information pertaining to patients
Ownership of films
Proper identification of films, importance of accuracy

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Chapter XI

OFFICE PROCEDURES

RECORDS (Practical experience is recommended)

Register of x-ray examinations
Card system. Minimal requirement for identification of patients
Statistical system
Cross reference
Recording of radiological reports
Time schedules
Business correspondence
Medico-legal aspects in handling of films
Identification of films
Ownership of films
Departmental records; x-ray requisitions, charge slips

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Chapter XII

DEPARTMENTAL ADMINISTRATION

Lectures to instruct the student in the internal organization of the x-ray department, handling of requisitions and reports.

Organization to avoid delay

Waiting and rest rooms

Organization of hospitals and radiological departments

Purchasing, ordering and inventorying of supplies

Technical records of apparatus, x-ray and valve tubes and other equipment

Supervision of personnel with preparation of work schedules, etc.

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Chapter XIII

SPECIAL PROCEDURES

STEREOSCOPIC EXAMINATIONS

Physiological principles, binocular and monocular vision, geometric principles, radiographic technique, correct setting up of films for viewing

BODY SECTION RADIOGRAPHY (Tomography, laminography, planigraphy, stratography)

Fundamental principles, application to specialized and adapted apparatus

KYMOGRAPHY

Principles and applications, moving grid (continuous), moving film (step)

PNEUMOARTHROGRAPHY

Surgical procedure, air injection and quantity, restriction of air by compression, soft tissue contrast, use of cones, cassette tunnel
Technique for knee joint, medial and lateral meniscus (semilunar cartilages), with artificial adduction and abduction as required

TEETH

Introduction: anatomical arrangement and development, subject variation
Correct projection, vertical and horizontal positioning, abnormalities, use of general and dental units, dental request formula, identification and handling of films, use of dental film holders
Technique for full mouth, edentulous subjects, children, intra-oral and extra-oral, occlusal views, bite wing

ANGIOGRAPHY

Definitions: angiography (vasography), arteriography, venography (phlebography)
aortography
Indications for angiography
Media used
Contraindications, sensitivity tests
Preparation of patient, preparation of apparatus
Correct phasing for arteriograms and venograms

NOTES

ASPT

SPECIAL PROCEDURES

Serial film technique

Technique for extremities

Site of injection

Technique for cranium (cerebral angiography)

Purpose of examination, media used, site of injection, radiographic procedure

Technique for heart and great vessels (angiocardiography)

Purpose of examination, media used, radiographic procedure

Venous catheterization of heart

Radiographic procedure

Abdominal angiography (aortography)

Purpose of examination, media used, radiographic procedure

BRONCHOGRAPHY

Contrast media, methods of introduction, preparation of instruments, preparation of patient, precautions

Radiographic procedure

ACCESSORY ORGANS OF DIGESTION

Salivary glands and sialography

Demonstration of opaque salivary calculus

Technique for parotid, submandibular, sublingual glands and ducts

Technique following injection of opaque medium

CHOLANGIOGRAPHY

Principles, opaque media, technique of injection

Immediate cholangiography, delayed cholangiography

Techniques for cholangiograms and biliary fistulae

INTRAVENOUS UROGRAPHY

Physiological principles, contrast media (adults, children)

Preparation of patient

Contraindications and precautions, sensitivity tests

Intravenous injection

Signs and symptoms of reaction, systemic and local

Technique for serial roentgenograms, variation of time with interval dependent on suspected lesion

Value of compression, value of upright films

Other methods of administration; oral, subcutaneous, intramuscular

RETROGRADE PYELOGRAPHY

Physiological principles, contrast media

Technique for radiography, tube shift or oblique views in differentiation of ureteral calculus

NOTES

ASPT

SPECIAL PROCEDURES

CYSTOGRAPHY AND URETHROGRAPHY

Preparation of patient, contrast media, method of injection
Instrument tray, special urethral clamp for urethrography
Technique for radiography

CENTRAL NERVOUS SYSTEM

Special care of the neurological patient
Technique for preliminary examination, cranium and neural canal

VENTRICULOGRAPHY AND ENCEPHALOGRAPHY

Principles, contrast media, administration, reaction
Technique for radiography

MYELOGRAPHY

Principles, contrast media, administration, reactions
Technician's role in fluoroscopic examination
Technique for radiography following intraspinal injection of contrast media

PLACENTOGRAPHY

Principles, preparation of patient, contrast media
Method of injection, reaction
Technique for radiography

FOREIGN BODIES

General
Anatomical location
Localization of depth, fluoroscopic and radiographic methods
The orbit
 Confirming presence of foreign body
 Localization of depth and location, charting

BEDSIDE RADIOGRAPHY

Cooperation of nursing staff, adaptation of unit to patient
Technique for acute chest conditions, intestinal obstruction, abdominal perforation, vertebral injuries, skull injuries, fractures immobilized by traction, Balkan frame, Thomas splint, plaster casts, etc.
Radiation protection

OPERATING ROOM RADIOGRAPHY

Asepsis
Electrical hazards, precautions
Anaesthetic dangers, appropriate precautions (See Medical X-Ray Protection up to Two Million Volts, 1949)
Radiation protection

PNEUMOPERITONEUM

Principles, preparation of patient, dangers associated
Technique for radiography

NOTES

ASPT

SPECIAL PROCEDURES

PNEUMORETROPERITONEUM

Principles, preparation of patient
Technique for radiography

PHOTOROENTGENOGRAPHY

General principles, routine procedure
Blue sensitive films, green sensitive films
Identification
Protection of operator
Projection
Filing
Technique for miniature chest radiographs

SOFT TISSUE RADIOGRAPHY

Technique for extremities, face, breast, abdomen, etc.

TELEOROENTGENOGRAMS

Purpose, technique

NOTES

ASPT

Chapter XIV

X-RAY THERAPY

THE PHYSICAL ASPECTS OF X-RAY THERAPY

The aim of x-ray therapy

Quality of an x-ray beam; Grenz rays, contact therapy, low voltage, medium voltage, high voltage, super voltage therapy

X-ray dosage; the roentgen, measurement of x-ray dosage

Filters; definition, object of filters, metals used, effect of filters on x-ray beam, position of filters, importance of checking filters

Secondary radiation, scattered radiation, characteristic radiation, backscatter

MEASUREMENT OF RADIATION

Quantity: definition

Factors influencing quantity of radiation

Measurement of quantity by chemical methods (historical), photographic, biological and ionization methods ("r" meter)

Description of "r" meter, practical demonstration

Principles of integrating dosimeters

Quality: definition

Factors influencing quality of radiation

Measurement of quality by half-value layer, absorption curve, effective wave length

Definition of half-value layer, practical demonstration

CLINICAL DOSAGE MEASUREMENTS

Depth dosage

Percentage depth dose

Isodose curve

Factors affecting depth dose

Distribution of depth dose in tissues

Size of cones

Effect of backscatter

Use of phantoms

Use of isodose charts

DOSAGE DEFINITIONS

Erythema dose, minimal erythema dose, maximum erythema dose

Epilation dose

Air dose

Skin dose, tumor dose, exit dose

Means of determining the abovementioned dosages

NOTES

ASPT

X-RAY THERAPY

BIOLOGICAL EFFECTS OF RADIATION

Normal tissues

Radiosensitivity of different cells and tissues, local tolerance

Radionecrosis

Causes, manifestation, methods of prevention, treatment

Pathological tissues

Malignant tumors, benign tumors

Inflammatory processes

Disorders of function

Radiosensitivity of different tumor cells, factors influencing radiosensitivity

Systemic effects of radiation

Manifestation, methods of prevention and treatment of radiation sickness

PURPOSE OF RADIOTHERAPY

Malignant disease

Cure, palliation, pre-operative and post-operative treatment

Benign tumors

Cosmetic effect, relief of symptoms, pre-cancerous lesions

Inflammatory and other non-malignant lesions

Relief of symptoms, promotion of healing, resoration of normal function

GENERAL PRINCIPLES OF TECHNIQUE

Field planning

Method of localizing tumors originating below the body surface

Beam direction devices, including the making of casts

X-Ray Therapy

Small field, large field, regional and bath therapy, rotating fields, wedge filters

Radium Therapy

Surface application including methods of applicator construction

Teleradium therapy

Implantation and intracavitary methods

Uses of radon

Uses of beta rays

Time factor

Dosage

Radioactive Isotopes

Instrumentation

Diagnostic uses

Therapeutic uses

NOTES

ASPT

X-RAY THERAPY
DUTIES OF THERAPY TECHNICIAN

Approach and attitude

To patient, nursing and medical staff

Clinical

Care of patient
Treatment of local and systemic reactions
Accuracy in treatment

Technical

Care of apparatus and accessories
Checking of output
Care and custody of radium and radioactive isotopes

Records

Clinical
Treatment and follow-up

PROTECTION

Effects of over-exposure to radiation
Maximum permissible dose (tolerance dose)
X-ray and radium protection regulations
Precautions against contamination by radioactive substances
Geiger-Muller counters

NOTES

ASPT

Chapter XV
FILM CRITIQUE

Film analysis

Daily or weekly review of unsatisfactory radiographs, with analysis and explanation of causes of poor quality, and with specific corrective measures indicated to improve each

ASPT

NOTES

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Chapter XVI

ELECTIVES

HISTORY OF X-RAY

Early scientists whose work led to the discovery of x-rays: Gilbert, Torricelli, Guericke, Boyle, Newton, Hauksbee, Gray, DuFay, Watson, Abbe Nollet, Franklin, Galvani, Volta, Oersted, Ampere, Ohm, Faraday, Plucker, Maxwell, Hertz, Crooks, Lenard

Roentgen, the discoverer of x-ray

Becquerel, the discoverer of radioactivity

Marie and Pierre Curie, the discoverers of Polonium and Radium

Later important workers: J.J.Thompson (electrons), Rutherford (proton), Chadwick (neutron), Coolidge, etc.

Development of The American Society of X-Ray Technicians

State Societies

Local Societies

American Registry of X-Ray Technicians

Canadian Society of Radiological Technicians

British Society of Radiographers

JOURNAL CLUB

Display of current periodicals

Demonstration of proper methods of writing for publication

Display of galley cuts, galley proofs and photographs to be sent to publisher

Abstract assigned articles for presentation

OFFICE TYPING

Instructions and practice in typing techniques

EQUIPMENT MAINTENANCE

Causes, corrective and preventive measures of mechanical breakdowns

Analyzing breakdowns in power supply, timer, x-ray tube and valve tube, filament, high tension, control and auxilliary circuits

Testing for electrical failures

Types and use of test equipment available

NOTES

ASPT

ELECTIVES

PUBLIC SPEAKING

Use of library
Preparing a paper or lecture
Use of outline
Pitfalls in speech communication
Methods of classroom instruction

VISUAL EDUCATION

Preparation and use of training aids
Sources of training aid materials

PREPARATION OF RADIUM APPLICATORS

Radioactive emission, properties of alpha, beta, and gamma rays
Principle transformations of radium family
Absorption of gamma rays by matter
Use of radium and radon, preparation of radon
Construction, care and custody of radium and radon needles and tubes
Precautions against loss
Measurement and testing of radium containers
Elementary calculation of dosage from radium and radon sources
Protection problems in the radiotherapy department

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