

Requirements for Roentgenological Services in the Field of Combat¹

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THE SPIRIT of co-operation and the patriotic interests which have repeatedly been manifested by the American College of Radiology and representative societies of our specialty are deeply appreciated by the Office of the Surgeon General of the Army. I sincerely respect the privilege of expressing this appreciation. In the present paper it is my intention to present generalities relative to the responsibilities of the roentgenologist in assisting the combatant forces, and at the same time to solicit ideas as to qualification requirements and the most practical means of providing emergency or additional instruction.

Our Army has need for more roentgenologists, a need which appears to be in excess of the number now recognized as qualified and available. This situation may be explained, no doubt, by the fact that, when medical and surgical services must be accomplished under such conditions of stress as characterize activities in the combat zone, the roentgenologist must assume, in addition to strictly roentgenological duties, a large measure of the diagnostic responsibilities which are ordinarily handled by the general practitioner, the internist, and other specialists. It can be expected that, during combat, casualties will be received in large numbers and diagnoses must be made within a minimum of time. This can be accomplished most expeditiously by exercising judgment with the assistance of the most trustworthy of our special senses—the visual sense. That which cannot be seen by external viewing will be sought by roentgen study. This would seem to be true to an extent even greater than during the first World War, for today, in addition to general fluoroscopic procedures for study

of the skeleton, x-ray examinations are accepted as the most reliable means of diagnosing abnormalities in the abdomen, the chest, and the skull. True enough, localization of foreign bodies may not be required as frequently as during the last World War. The science of ballistics has so changed that today missiles have greater penetrating characteristics and many cases, we understand, will be handled immediately by surgical débridement, chemotherapy, and closure without roentgenologic assistance. Nevertheless, a considerable demand for fluoroscopy is to be expected, and there can be no doubt but that there will be some foreign body localization. A single case of this sort, such as is familiar to all of you in your practice, will emphasize the fallacies of a policy whereby surgery would be initiated without roentgenologic assistance. This case, with pertinent details, is shown in Figure 1.

It appears that our specialty will be utilized to an extent proportionately greater than is required for general civilian care. For this reason it would seem that for the present emergency there has been a disproportion in the development of radiologists as compared with other specialties. We face a shortage, therefore, which must be met by special training. For certain assignments, it would seem that this training need not be as complete as that which is considered essential for a well rounded roentgenologist; not sufficiently complete, for instance, to meet the qualifications required by the American Board of Radiology. Still, certain fundamentals must be understood. What may these be?

The answer to this question must be based upon a consideration of the activities to be expected of a roentgenologist in one or another medical installation. Because of the character of present-day warfare,

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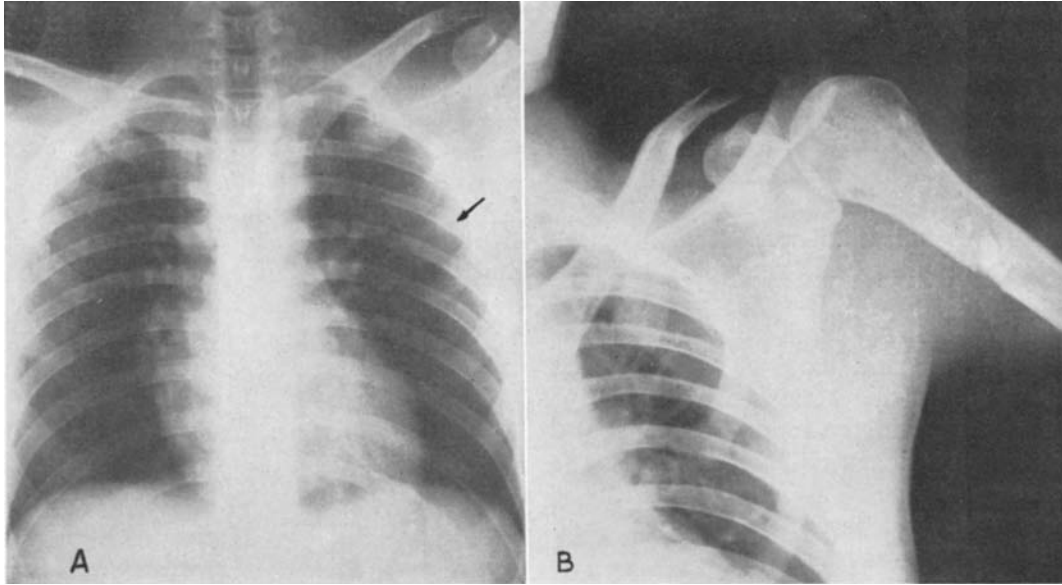


Fig. 1. This patient was shot in the chest. A wound of entrance was noted in the left upper thorax. This site was identified roentgenologically because of the powder markings (see arrow in A). The clinician was interested in the location of the bullet and when it was reported that none was demonstrable within the thorax, he was greatly surprised. No wound of exit could be found and therefore further roentgenographic studies were requested. It was then found that the bullet had been deflected from a rib surface into the left axilla, finally to become embedded in the left humerus (B).

Analysis of this case required a considerable period of time—more time than would have been required had the roentgenoscopist been recognized as the diagnostician.

however—the rapidity of movement and the frequent change in the battle front with alternations of offensive and defensive tactics—medical installations can be considered merely in a relative manner. We cannot think of well identified and established situations. The surgical hospital of today may serve as an evacuation hospital tomorrow, and within a few days may become a general hospital—or *vice versa*. For purposes of orientation, nevertheless, we may speak of a type arrangement.

It may be recalled that in the U. S. Army it has not been found practical to provide for roentgenologic assistance with the attached medical troops of the front-line forces nor to assign such services directly with the medical battalion (*i.e.*, medical regiment of the first World War). Roentgenologic units are not constituents of the division. It is believed that the furthest forward medical installation at which roentgenologic assistance can be utilized effectively is the surgical hospital. This is an Army unit which moves forward

to the vicinity of the clearing station (of the medical battalion) as casualties accumulate there. Its purpose is to provide the first real surgical care for those of the wounded who, because of their condition, cannot be evacuated further to the rear—to the evacuation hospital. Prior to this care, treatment will have consisted merely of first-aid dressings or perhaps the application of a tourniquet. At the surgical hospital, any type of emergency surgery may be performed, though all procedures must be accomplished quickly. Usually, the casualties reach this station within four to fifteen hours and should be transported further to the rear as soon as possible—probably within one to three or four days.

The surgical hospital consists of a “hospitalization unit” and a “mobile surgical unit.” The hospitalization unit includes two to four tents, each accommodating 100 cots, thus providing a total accommodation for as many as 400 patients. The mobile surgical unit consists of a “corridor tent” and equipment for two sur-

gical teams, a splint team, a shock team, a plastic maxillo-facial team, and a roentgenologist (having rank of a lieutenant). These groups are expected to handle as many as eighty major surgical procedures each twenty-four hours. A second roentgenologist (perhaps a captain) is assigned to the hospitalization unit. Thus, according to present plans, there will be two roentgenologists at the surgical hospital, to be assisted by three x-ray technicians (a staff sergeant and two fourth-class privates). During periods of considerable activity, both of the roentgenologists will doubtless be engaged in fluoroscopy. Some of this work may be accomplished within a closed truck but certainly some of it, and in many of the installations all of it, will be accomplished in fluoroscopic tents.²

The operating section of the surgical hospital is especially mobile and self-contained. After meeting the needs in one location where casualties have accumulated, it can move on to another location where others have collected or it may function with an evacuation hospital or any other medical aggregation. One of the two roentgenologists moves on with the operating unit (the lieutenant), while the other (the captain) remains with the hospitalization unit, which is left behind. The latter is equipped with a fluoroscopic tent, an x-ray machine unit, and a field table unit. No doubt some further fluoroscopy may be required, or possibly roentgen therapy for the treatment of infections. The roentgenologist accompanying the operating unit will for the most part confine his activities to general fluoroscopy and foreign body localizations. These activities must be taken into consideration when we discuss the training requirements for these assignments.

The evacuation hospital will ordinarily accommodate more patients than the mobile surgical hospital. Usually, it will be located close to transportation facilities—perhaps in a schoolhouse, theatre, or

church, though it may consist of tents. To it, equipment has been allotted for handling as many as 750 patients. In most instances, it will be 30 to 70 miles to the rear of the front line, but even so, expeditious handling of the casualties is essential. Two roentgenologists (a captain and a lieutenant) have been allotted for this installation, with as many as ten x-ray technicians (three staff sergeants and seven privates). The services here will be mostly fluoroscopic—just as at the mobile surgical hospital. Occasionally, perhaps in 10 per cent of the studies, roentgenography may be practical. In addition, therefore, to the equipment provided for the mobile surgical hospital, there will be at the evacuation hospital some films, a film processing unit, and a film dryer unit. The dark room tent such as is used for fluoroscopic purposes at the surgical hospital can be adapted for film processing, and several of these will be supplied. Thus, the roentgenologists at the evacuation hospital must be competent to handle general fluoroscopic procedures, foreign body localizations, diagnostic roentgenology, and superficial roentgen therapy.

It is realized that in both the surgical hospital and in the evacuation hospital, quick judgments must be rendered. The roentgenologists must possess self-reliance and resourcefulness.

A convalescent hospital may be set up near an evacuation hospital. This may have accommodation for as many as 3,000 patients. Active studies here, however, should not be as numerous as in the surgical hospital or the evacuation hospital and therefore only one roentgenologist and five technicians have been allotted to this installation. The roentgenologist may have the rank of captain. Since this hospital will serve to accommodate overflow from the evacuation hospital and since it will be located close to that installation, the assistance of the senior roentgenologist of the latter hospital may be utilized for serious problems.

The next echelon concerned with the handling of battle casualties will ordinarily be the general hospital. While treatment

² For a description of the fluoroscopic tent and illustrations see the author's paper in *Radiology* 36: 391-403, April 1941.

range at the mobile surgical hospital may be one or two days, and at the evacuation hospital three or four days or a week, more definitive handling can ordinarily be expected at the general hospital. The general hospital is therefore more completely equipped. As far as x-ray apparatus is concerned, there will be four to eight portable and mobile units and one or two high-milliamperage-capacity machine units (1 2-

to me that for an isolated general hospital, both should be able to meet the requirements of the American Board of Radiology. In case of an aggregation of general hospitals, with a bed census in excess of one thousand, there would be developed a hospital center. Additional radiologists would then be available. It would seem that some of these might be assigned limited activities, much as in the case of fellows in

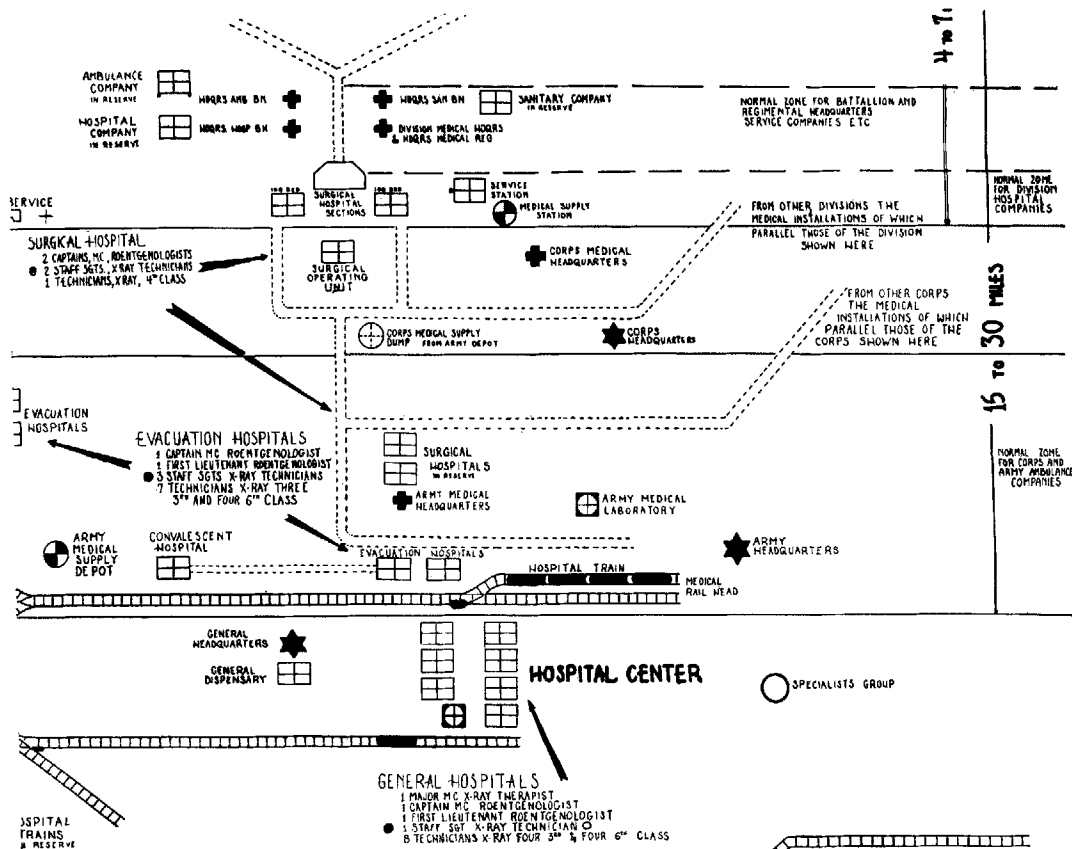


Fig. 2. Relative positions of the three important installations in the theatre of operations requiring roentgenologic services.

tube/200 ma. unit and 1 1-tube/200 ma. unit) complete with tables. Various auxiliary items will be provided. One thousand patients can be accommodated and for each one thousand patients, three roentgenologists and nine x-ray technicians have been allotted. Their services may be of a versatile character—practically any service required in a well recognized hospital. At least two of these roentgenologists must be well qualified; it would seem

radiology in teaching institutions, so that not all of them need possess the range of qualifications required by the Board.

Station hospitals should be mentioned. These serve “combatant forces not actually engaged.” To those having a bed capacity in excess of 250, a roentgenologist may be assigned. His activities would be of a diverse character. For a medium-sized (500 beds) or larger installation, a well qualified

roentgenologist having a rank of captain or major would be provided.

The next question might be: What is the approximate number of each of these types of hospital installation? Perhaps some of you are acquainted with percentage considerations. You may have heard that accommodations of "fixed beds" (at general hospitals and station hospitals, but not including mobile surgical hospitals or evacuation hospitals) are estimated on the basis of 10 to 15 per cent of the strength in the combat zone. You probably know that in the theatre of operations allotment of Medical Department troops is calculated as 10 per cent of the numerical strength of the field force, and perhaps you realize that ordinarily 13 or 14 of each thousand of these would be x-ray technicians. In a similar manner, estimates as to the need of roentgenologists might be figured. However, because of the fact that for this *worldwide* war our forces must be so greatly distributed, it has not been believed practical to follow these percentage calculations. Instead, estimates of professional needs have been based upon "sampling"—indications as to needs for isolated stations, closely communicating stations, and installations of varied sorts such as armored units, coast artillery units, air corps, etc. On the basis of this study, it is estimated that for an active Army of 3,600,000, there will be needed approximately 6,000 x-ray technicians.

I have not been able to learn the actual number of qualified x-ray technicians now in the Service. I am told, however, by the Office of the Surgeon General, that considering technicians now available and our training facilities within the Army, our needs can be met. Today, two- and three-month courses in roentgenography are being given at six locations, the Army Medical Center (having a quota of 40 per month); Fort Sam Houston (having a quota of 15 per month); Fitzsimons General Hospital (having a quota of 15 per month); William Beaumont General Hospital (having a quota of 15 per month); The Army and Navy General Hospital

(having a quota of 10 per month), and the Letterman General Hospital (having a quota of 6 per month). Provision is thus made for the production of x-ray technicians at the rate of 101 per month. Accommodations are being increased and it is estimated that our Army courses together with enlistments and draftings of qualified technicians will account for increments of approximately 1,500 x-ray technicians annually.

Formerly our course at the Army Medical School was recognized by the National Registry of X-ray Technicians. Very recently, this recognition has been withdrawn. We have no criticism of this decision. We realize that today our training must be hurried and of a didactic character; it is not possible to develop fully competent technicians having a range of practical experience and for this reason the roentgenologist must possess fundamental knowledge. He may have to utilize the services of stranger technicians. He may develop a good one only to lose him, either because of his own transfer or transfer of the technician. Thus, he must conduct close supervision and actual training in order to provide himself with suitable assistance.

The following is an estimate as to needs of roentgenologists for our Army of 3,600,000, based upon sampling such as described above:

| Hospital Installation | Estimate of Number | Roentgenologists Required | Estimate as to Need of Well Qualified Roentgenologists |
|------------------------|------------------------------|---------------------------|--|
| General hospitals | 225 (numbered) 22 (named) | 675 66 | 350 22 |
| Evacuation hospitals | 45 | 90 | 45 |
| Surgical hospitals | 15 | 30 | 15 |
| Station hospitals | 129 | 129 | 65 |
| Convalescent hospitals | 3 | 3 | 3 |

According to these estimates for a numerical strength of 3,600,000, it would seem that the Army has need for approxi-

mately 1,000 roentgenologists. Of these, we believe that approximately 500 should be comprehensively trained. These estimates do not include the needs of examination centers. For the latter, an additional 100 might be considered. Officially the estimated total need is 1,047.

The Office of the Surgeon General is making every effort to identify all specialists and to assign such men in accordance with their particular qualifications. It can be said that any deviations from this policy occur secondarily, following assignment of the individual to an administrative unit.

The bulk of roentgenologic needs is being provided by services of already qualified roentgenologists—doctors coming into the Service or those already in the Service, who have had extensive experience in this specialty.

Auxiliary instruction of officers in roentgenology is being provided at the Army Medical School in Washington, D. C. Two courses are now being conducted, in alternate months. The shorter of these deals with the special examinations conducted at induction centers. It is intended for qualified roentgenologists and deals entirely with the particular applications of the specialty with respect to photoroentgenology and the stipulations provided by our regulations. This course is limited to two weeks.

Much more important for our consideration at this time would seem to be the matter of emergency training for those 500 who, it is believed, need not have such a wide range of roentgenologic knowledge or experience but whose duties would be important as assistants in the actual theatre of operations. At the present time, it is our opinion that most of this training can be accomplished within the Army itself, though it may be found, before long, that some of it will have to be given in other teaching centers. The schedule which is being followed for our Intensive Basic Course in Roentgenology is reproduced here.

It will be noted that this course consists

of: didactic lectures, for 133 hours over a period of four weeks; conferences, 12 hours; special problem investigations, 44 hours; examination periods, 3 hours. In this way, eight hours a day for six days a week—a total of 192 hours—are applied to this course. It will be noted that no time is allotted to positioning or actual roentgenography. These phases of the subject are covered by a Technical Manual—TM 8-240. Six hours are allotted to identification of controls for both mobile units and stationary units. Seven types of controls are utilized and the presentations are by way of initiating answers by the officer rather than by abstract descriptions of the equipment. Every phase of instruction is presented with demonstrations, and throughout the course attentiveness is enforced by interval questioning. For the diagnostic sections, general procedures are described and demonstrated and roentgenographic studies are presented by lantern slides. Direct and indirect evidence is described by way of roentgen criteria. It is strongly emphasized that the analysis of the roentgenologist should be based upon: first, an orderly study of the film evidence and a listing of roentgenologic criteria; second, a consideration as to what collaborative evidence might be gained by obtaining roentgenographic studies of portions of the body other than that under primary investigation; third, a consideration of such factors as the age of the patient, sex, nationality and race, occupation, etc., in relation to the general incidence of the suspected condition; fourth, the history; fifth, the physical findings; sixth, the laboratory findings. It is repeatedly emphasized that the roentgenologist is a consultant and as such he must not limit his considerations to a picture. He must be an investigative scientist.

In summarizing these aspects, may I repeat the two basic thoughts:

(1) The Army needs more roentgenologists; it needs them urgently; it needs them, now. Where instruction requirements are indicated, the course must be

INTENSIVE BASIC COURSE IN ROENTGENOLOGY

| | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|--------------------|--|--|--|--|---|--------------------------|
| FIRST WEEK | | | | | | |
| A.M. 8-9 | Outline of course Plan of special problems | Special problems | Special problems | Special problems | Special problems | Special problems |
| 9-10 | Roentgenology Roentgen physics Roentgenography Roentgen diagnosis Roentgen therapy | Special problems | Special problems | Special problems | Special problems | Special problems |
| 10-11 | Radium Radium physics Radium therapy | Rheostats Solenoids Choke coils | Rectification Mechanical Thermionic Inverse suppressors | Mobile units | Technical factors (Ma., Kv.P., T. and D.) | Processing chemicals |
| 11-12 | Nature and origin of x-rays | Transformer Step-up Step-down | Detailed wiring diagrams | Line requirements | Physiology and treatment of electrical shock | Film processing testings |
| P.M. 1-2 | The Electron Static Chemical thermo Piezo imbalances | Auto-transformers Volt selectors Line compensators | Dissected stationary units | Handling of controls, stationary units | Films Cardboard holders Cassettes | Examination |
| 2-3 | Magnetism Terrestrial Natural Artificial Electro- | Measuring instruments | Handling of controls, mobile | Stationary units | Film handling Captioning Filing | Conference W.R.G.H. |
| 3-4 | Electric currents Units of electricity | X-ray tubes Filament Circuits | Military courtesies Customs of the service | Facilities of a post chaplain's duties | Organization Medical Service Surgical Service | Conference W.R.G.H. |
| 4-5 | Dynamos Motors | Simple wiring diagrams | Mobile units | Stationary units | Dark room construction features | Conference W.R.G.H. |
| SECOND WEEK | | | | | | |
| A.M. 8-9 | Special problems | Special problems | Special problems | Special problems | Special problems | Special problems |
| 9-10 | Special problems | Special problems | Special problems | Special problems | Special problems | Special problems |
| 10-11 | Roentgenographic quality Distortion | Photoroentgenography The camera | Stereoscopy | Fractures of extremities | Tumors of bone | Arthritic lesions |
| 11-12 | Detail | Layout of examining center | Caliper technic | Bone infections (extremities) | Metabolic bone diseases | Arthritic lesions |
| P.M. 1-2 | Contrast | Single emulsion film | Kilovoltage variations | Bone infections (extremities) | Metabolic bone diseases | Film interpretation |
| 2-3 | Secondary radiation Diaphragms Cones Grids | High kilovoltage chest technic | Roentgen diagnosis: normal bones | Tumors of bone | Lesions of the joints: classification | Conference W.R.G.H. |
| 3-4 | Density | The processing of men | Organization of N. P. Section laboratory service | Medical supplies | Efficiency reports Leaves | Conference W.R.G.H. |
| 4-5 | Common film errors | Preservation of films | Anomalies in the extremities | Tumors of bone | Arthritic lesions | Conference W.R.G.H. |

concise—much shorter than that usually required for fellows in roentgenology at teaching institutions.

(2) To meet this emergency need the

present policy is to utilize the services of those already qualified, to the best advantage—*i.e.*, by assignments to their specialty; to complement these services by

INTENSIVE BASIC COURSE IN ROENTGENOLOGY—*continued*

| | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|-------------|--------------------------------------|--|---|--|---|--|
| THIRD WEEK | | | | | | |
| A.M. 8-9 | Special problems | Special problems | Special problems | Special problems | Special problems | Special problems |
| 9-10 | Special problems | Special problems | Special problems | Special problems | Special problems | Special problems |
| 10-11 | Non-arthritic lesions of joints | Spondylitis | The skull: blastic lesions | Fractures Infections of paranasal sinuses | Thoracic cage and pleurae | Induction Board examinations |
| 11-12 | Non-arthritic lesions of joints | Tumors in and about the spine | The skull: intracranial lesions | Neoplasms of paranasal sinuses | Mediastinum | Photoroentgenology: cardiac configurations |
| P.M. 1-2 | Non - arthritic lesions of joints | Film interpretation | Facial - maxillary conditions: general | Film interpretation | Lung fields | Examination |
| 2-3 | Film interpretation | Film interpretation | Facial - maxillary fractures and infections | Fluoroscopy | Heart: generalities | Conference W.R.C.H. |
| 3-4 | Film interpretation | The skull: general considerations | Facial - maxillary neoplasms | Radiation incurred during fluoroscopy | Cardiac mensuration | Conference W.R.C.H. |
| 4-5 | The spine: development and anomalies | The skull: lytic lesions | Paranasal sinuses and mastoids: general | The thorax: general | Heart: abnormalities of configuration | Conference W.R.C.H. |
| FOURTH WEEK | | | | | | |
| A.M. 8-9 | Special problems | Special problems | Special problems | Special problems | Special problems | Roentgenological activities in the theatre of operations |
| 9-10 | Special problems | Special problems | Special problems | Special problems | Special problems | Roentgenological activities in the theatre of operations |
| 10-11 | Photoroentgenology | Gastro-intestinal pathology: the esophagus | Lesions of the colon | Lesions of the ureter and bladder | Treatment of deep-seated neoplasm | Field x-ray equipment |
| 11-12 | Photoroentgenology | The stomach | General abdominal studies | Intravenous studies | Property: requisitioning of, and responsibilities for | Foreign body localization |
| P.M. 1-2 | Diseases of gall-bladder, etc. | The small intestine | Spinography | Studies of the pelvis | Administration of an x-ray department | Presentations Special problems |
| 2-3 | Diseases of gall-bladder, etc. | Barium enemas: general | Planigraphy | Roentgen therapy: generalities | Field x-ray equipment | Presentations Special problems |
| 3-4 | Gastro-intestinal series: general | Fluoroscopy | Genito-urinary studies: general | Treatment of dermatosis | Written examination | Presentations Special problems |
| 4-5 | Fluoroscopy | Lesions of the colon | Lesions of the kidney | Treatment of superficial neoplasm | Written examination | Graduation |

the services of doctors who may not have a fully adequate background but who have manifested an inclination toward radiology and who might be guided by a four weeks' didactic lecture course and subsequent supervision. These latter might be con-

sidered as comparable to fellows in a radiological department.

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DISCUSSION

W. Edward Chamberlain, M.D. (Philadelphia): I was under the impression that a fairly well qualified

roentgenologist would be required at the station hospital, especially as he would be by himself. It is here that epidemic diseases are likely to be picked up, as, for example, pneumonia.

Major de Lorimier: That is quite true, and has been taken into consideration. For a station hospital of 500 to 750 beds—and some have as many as 1,000 beds—the roentgenologist may have the rank of Major. But it is to be borne in mind that many station hospitals are much smaller—250, 150, 50, or even 25 beds—and to these no roentgenologist is allotted.

Arthur C. Christie (Washington, D. C.): I believe we would all like to know how much training these men should have after they complete the basic course which Major de Lorimier has outlined. Undoubtedly most of the men who are taking this course have had some radiological experience and may not require much additional training. It seems to me, however, important that we should know just about how far to undertake to train those men who go through the Army course with little preceding

basic experience and how long a period will be required for such training.

Major de Lorimier: That is a question that I hoped might be answered by someone else. It is the present policy of the Training Division of the Office of the Surgeon General to limit the courses given by the Army Medical College to one month. (Some technicality with which I am not familiar seems to enter into this question.) I understand, however, that efforts are being made to change this.

Those who are enrolled for this intensive course are doctors who have had x-ray equipment in their offices, who, for example, have been assigned to a small station hospital and, feeling the need for further training, have requested such a course as this. None of this group has had a fellowship in radiology. The officers who have come to us for courses in photoroentgenology have for the most part held fellowships and are therefore well trained. As regards these auxiliary trainees there seems to be no formulated plan beyond that which I have mentioned.