

Chapter VII

THE EVOLUTION OF THE MOBILE THERAPY APPARATUS

Our first attempt at mobile x-ray therapy for surgical mumps and erysipelas resulted from the seriousness of the two diseases and the added risk of moving the patient. So in treating these patients, we resorted to the only mobile x-ray apparatus available, the diagnostic unit. This unit, with its limited output, necessitated the use of a small dose, and the idea of repetition of the small dose was a natural consequence. The excellent results which attended the administration of small doses twice each day in these two diseases prompted our use of the same technic when the opportunity to treat gas gangrene first presented itself.

EARLY GAS BACILLUS INFECTION THERAPY

The following comment on the early use of the mobile x-ray therapy unit for the treatment of infections* is quoted from one of our previous reports:

In 1928, under pressure of necessity, a case of gas gangrene was treated with the mobile-x-ray unit, and recovered. The mobile unit was the ordinary unit designed for mobile diagnostic work in general hospitals and rated below 90 kilovolts.

In the first report on the treatment of gas gangrene with the mobile unit, two cases out of eight died; both of those dying had trunk involvement. In the six who recovered, the infection was entirely, or to a great extent, limited to the extremities. From the outcome of these cases, it was thought that probably the mobile unit did not have sufficient kilovoltage to obtain the necessary depth dose to effect a cure in the trunk cases.

This led to a recommendation for the use of higher voltages in treating deep seated or trunk infections. Since the maximum kilovoltage obtainable from the mobile unit had been used in treating the two cases which died, it was apparent that in the future, cases with trunk involvement must be moved to the x-ray department if they were to be treated successfully, or some apparatus producing a higher kilovoltage must be designed to enable the radiologist to treat at the bedside.

* The type of apparatus we have reference to has not as high voltage capacity as that described by Kaplan and Rubinfeld (*Am. J. Roentgenol.* 38:625, October, 1937).

Since no bedside apparatus was available, we started to move these patients to the x-ray department. This was done, on a few occasions, and, as these patients recovered promptly, we felt we were well rewarded for our efforts. In fact, we were so impressed with the results that we decided to treat other infections in the trunk.

Peritonitis, following acute appendicitis and other intra-abdominal infections, is relatively common, and was selected for a trial. The immediate difficulty encountered was that of obtaining the permission of the clinician to move the patient with peritonitis to the x-ray department, and we fully agreed with the clinician that the dangers involved in moving the patient seemed out of proportion to the chances of

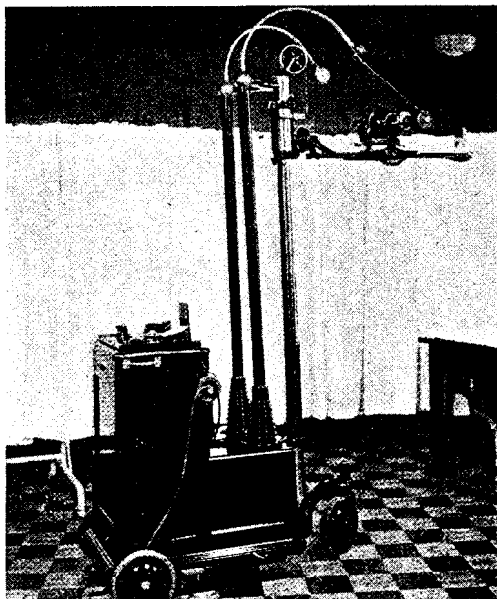


FIG. 10.—Ordinary mobile diagnostic unit. This apparatus was the first to be used for bedside therapy by the authors. It does not have sufficient kilovoltage for treating the trunk, and a larger unit was assembled.

improving his condition. The whole thing then resolved itself into providing some means of treating the patient with peritonitis without disturbing him in any way, and, as no equipment was commercially available for this purpose, we felt that it was our duty to devise some means of providing x-ray treatment at the bedside, for those who were too sick to be moved.

In a short tour of the local x-ray dealers' basements, we were able to select from the stock of obsolete and discarded x-ray equipment, a suitable transformer which was mounted upon a wooden base carrying a tube stand. (See Fig. 10.) We found two such units, and built two

mobile units; they have served our purpose very well. They are not, we hope, the last word in this type of equipment, as we appreciate some deficiencies in this assembly, but we look for a real piece of apparatus to be developed in the near future for this type of work, as we are certain that the result will warrant its production.⁹

Between the presentation of this paper at the American Medical Association meeting in June, 1938, at San Francisco and its second presentation before the Radiological Society of North America at Pittsburgh in December of the same year, two

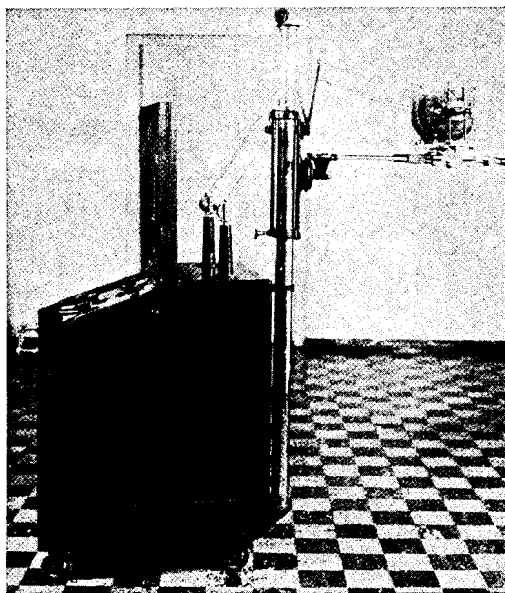


FIG. 11.—First unit used for treatment of inflammatory diseases at bedside; it had adequate kilovoltage for treating all parts of the body.

American manufacturers of x-ray equipment constructed apparatus especially designed for this type of work and displayed the units in their commercial exhibits at this meeting. At the present time several manufacturers of x-ray equipment have mobile units available for bedside therapy.

Figure 11 shows the first unit used for treatment of inflammatory diseases at the bedside which had adequate kilovoltage for treating all parts of the body. It consisted of a discarded stationary transformer equipped with special rollers under a heavy wooden platform which was allowed to project posteriorly sup-

porting the tube stand. The tube carrier was also fastened to the upper border, posterior surface, of the transformer cabinet by a heavy metal strap. A leaded protective screen with a lead glass window in the center was also added, resting on the control board between the operator and the tube. An old universal type Coolidge tube with open-reel, high tension wires made up a useful, but none too safe high tension circuit. This unit was very efficient. The following conclusions were presented in our first report on peritonitis⁹:

This material is merely presented to make available to others who are interested, some clinical facts which we have observed while treating patients with a bedside therapy x-ray apparatus. Practically all of these lesions, with the exception of gas gangrene, may or may not recover when very little is done for them, so nothing can be proven by any series of statistics; cases observed clinically are convincing. As data accumulates relative to the use of the mobile x-ray therapy apparatus, undoubtedly much improvement in technical procedures will result. At the present time we have outlined, in a general way, the technic we have used in treating numerous infections in patients who we thought it advisable to treat without moving to the x-ray department. This is done in the interest of the patient who is too sick to be moved, or is held fast in a room by the oxygen tent, the Wangensteen apparatus, or intra-venous apparatus, all of which are commonly used essentials in treating the seriously sick. We believe that the x-ray is an additional aid in treating some of these patients and that it can be brought to the patient in the form of a mobile unit, having greater kilovoltage than the present day diagnostic (90 kv.) mobile unit.

PRESENT-DAY MOBILE EQUIPMENT

Any discussion of the required equipment for mobile x-ray therapy and prophylaxis at the present time must take into consideration at least three essential features.

1. *Portability or Mobility.*—The term portability would apply particularly when transportation must be rapid, as for residential or military service. The total weight of the unit as well as its mobile features must be considered if it is to be used as frequently as it should be. In a general hospital, the total weight is not so important, but mobility is essential.

2. *Capacity of the Apparatus.*—For prophylactic work, 120 kv. is adequate, and 100 kv. may suffice for even the largest patients. The kilovoltage is the most important feature; but, of course, a high r output is advantageous when a great number

of treatments is given in a short period. For instance, in military service, when operation at times must be continuous, such a consideration would be essential. For the treatment of all types of infections, including pulmonary consolidation and intracranial diseases, an upper limit of 140 kv. seems indicated, but the ideal kilovoltage is yet to be determined.

3. *Cost of Operation.*—The problem of tube life is important. The oil-immersed, shockproof tube heads are much heavier to transport than were the old type radiator tubes, and they are not as easily replaced in case of breakdown. Therefore the tube should be fairly durable to prevent interruption of service under heavy usage; also, it should be as light as possible and, if not shockproof, by all means ray-proof. The shockproof feature may lessen the tube life, increase the weight and lower the tube capacity. These disadvantages may not be entirely justifiable in order to obtain the shockproof feature. The shockproof equipment is, however, rapidly becoming more compact and efficient, and its advantages at the bedside in civilian hospitals far outweigh its disadvantages.

Some may say that these are engineering problems of no clinical importance and therefore should not be discussed here, but a rapid r output, adequate kilovoltage and long tube life as well as the availability of the apparatus for continuous use at the place required are not solely engineering problems; they are to some extent clinical problems, because without these features no opportunity for the clinical application of the x-ray may be possible.

MOBILE UNIT IN THERAPY AND PROPHYLAXIS

From our earliest experiences it appeared that the mobile unit was to be a valuable adjunct in the modern hospital equipment; it is now indispensable, in our opinion. Through its use, some lives may be saved which would otherwise be lost and many prolonged periods of disability can be appreciably shortened. In fact, through its use in prophylaxis many serious complications can be prevented and infections in early stages localized or entirely aborted. Since it is inexpensive to operate and one of the safest major therapeutic measures in use in any hospital, surely no objection to its use can be reasonably maintained.

Certain serious acute infections must necessarily be treated with x-rays. This statement is based on the fact that the mortality and morbidity are extremely low when these conditions are treated with x-rays in reasonably early stages of the disease as compared with the mortality and morbidity figures when these infections are treated by any other known method. In this group fall gas gangrene, acute spreading peritonitis, surgical mumps, carbuncles on the back of the neck and shoulders and on the upper half of the face and Ludwig's angina.

Certain serious complications may also be prevented when given x-ray therapy in their early stages; all of the conditions mentioned in the preceding paragraph fall in this group. The value of x-rays in prophylaxis of gas gangrene, acute spreading peritonitis, acute osteomyelitis and many other infections is well known to a few and is rapidly coming to the attention of the medical profession at large.

Since it is of value in prophylaxis, it will soon be more generally used even prior to the transfer of the injured patient to the large general hospital from the smaller hospitals in outlying districts. Some such procedures have been followed in our state in connection with the transfer of patients with potential and early cases of gas gangrene. There is no reason why an infection should be allowed to develop in any traumatized area without an effort being made to prevent it through the use of low voltage x-rays with low filtration.

Many have observed that when x-rays are given to prevent gas gangrene, other infections also fail to develop. No reason is suggested for this fact; but if one prevents establishment of infection by the rapidly growing organisms such as the gas-formers immediately after the injury, it is possible that the more slowly growing secondary invaders will not have an opportunity to grow, as the wound may be well on the way to recovery before their usual period of incubation has been completed. It is our clinical impression that organisms which grow rapidly are more sensitive to radiation than are the slowly growing varieties, and for this reason we are anxious to treat an area immediately after the injury, as at that time the lessened resistance permits the infection with rapidly growing organisms to become established.

Reference to Figure 32 will reveal that it has been our custom

to give x-rays prophylactically during the three or four days in which the initial invaders establish their growth. If this is done, it appears that the entire sequence of events formerly observed is usually interrupted and no secondary invaders become established. The importance, therefore, of the early prophylactic use of x-rays should be apparent. In peritonitis, if x-rays are used early, the peritonitis subsides immediately, and no prolonged period of drainage due to repeated abscess formation, caused by the more slowly growing pus-forming organisms, is encountered.

Wound infection following injuries such as compound fractures and gunshot wounds is largely preventable. The prevention of osteomyelitis in recent fractures shortens the initial period of hospitalization and eliminates the future periods of disability due to reactivation of the disease. To what extent other infections may be prevented or at least localized has not been fully established, but they will be added to the list from time to time as more experience is gained through the use of x-ray therapy with a mobile unit.

LATE SURGERY—PROPHYLAXIS

In tissues in which gas bacillus infection has once been present, a prophylactic dose of 50 to 60 r should be given once each day for three days following every new trauma, including any surgical measure of any consequence such as the reduction of compound and infected fractures. Not only the involved area but tissues well beyond the affected parts can be reached without danger to the still normal tissues and without disturbing the dressings if they are radiolucent, as they should be.

FOR HOME USE IN CIVIL LIFE

It is not improbable that in a short time a suitable mobile therapy unit will also be in demand for use in civil practice, since many people with diseases which may be well treated with x-rays prefer to remain at home under expert nurses' care. The prompt response to treatment shortens the course of many acute infections. This response is probably the reason why complications and other unwelcome sequelae are practically

never encountered following the early use of x-ray therapy in many acute infections.

SUMMARY

At present it seems that the mobile x-ray unit is desirable: (1) in the ordinary general hospital for prophylaxis and therapy, (2) in industrial surgery for prophylaxis and therapy, (3) in military surgery for prophylaxis and therapy, where, among other things, it simplifies the care of the wounded man at the front, and (4) possibly before long in civil practice for those patients who prefer their home to a hospital during a period of illness.