necessary. Treatment by vaccine, either autogenous or stock, or by injections of immunogen or collosol manganese has not, in my experience, had the success hoped for.

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A PRELIMINARY NOTE ON LOW-VOLTAGE X-RAY THERAPY

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During recent years one of the most interesting developments of radiation therapy has been the use of higher and higher voltages in x -ray treatment, and it is perhaps a little surprising to find at the same time a parallel development taking place in the field of relatively low voltages of the order of 50 kV. It is true that this potential could be reached many years ago, but technical progress in x -ray tube and generator design, coupled with the "shock-proofing" of the equipment, have opened up new fields of usefulness, of which advantage is now being taken. In addition, dosage may now be measured and accurately controlled in a way previously impossible, so that even the very high dosage rates available from such equipment as we describe below now present little danger or difficulty in the handling.

Schaefer and Witte¹ have employed x -ray tubes for gynaecological purposes which may be inserted into the body cavities, while Sauerbruch, Chaoul, and Adam² have used x -ray tubes at small focal skin distances with considerable success. It is chiefly the work of Chaoul³ which has led to the experimental investigations described below.

We do not wish to discuss here the theoretical justifications of such techniques in treating lesions relatively near the surface, but we may note what, as stated by exponents of the method, they are.

1. There is no difference between the clinical effects of the same dose of x -radiations of different wave-lengths, the important factors being the energy absorbed per cubic centimetre and the time spacing of the irradiations.

2. The healthy surrounding tissues should be spared irradiation as much as possible, so as to expedite and aid subsequent repair, while

3. The distribution of radiation in the tissues with small focal skin distances is similar to that obtained with radium surface applicators and "bombs." In addition, the high dosage rates available from x -ray apparatus make possible the treatment of a large number of patients in a given time with an initial financial outlay which is small compared with that involved in the purchase of the equivalent radium. The difference due to dosage rate is supposed to be of little importance provided the fractionation of the radiation is maintained.

Owing to the generosity of Sir Herbert Austin, who provided clinical and experimental apparatus, we have recently had the opportunity of treating a number of malignant and non-malignant conditions with a low-voltage x -ray plant of the type used by Chaoul. A similar plant, again thanks to Sir Herbert Austin, is in use in the General Hospital, Birmingham, under the direction

of Dr. Bromley. Close co-operation has been arranged between the Birmingham and London experience. We have, in addition, made physical investigations of the radiations.

The present note is an account of first impressions. It cannot be too strongly emphasized that we have as yet not had time to see more than the preliminary stages of results, but these seemed of sufficient interest and promise to justify the publication of some information on the subject.

Physical Conditions of Irradiation

The x rays were generated at a constant voltage of approximately 60 kV, with 4 mA tube current. The tube is so designed as to have the source of radiation at one end of an earthed metal tube, the rays emerging through the target of gold-plated nickel and the water-cooling jacket. These normally constitute the sole filters employed, in all equivalent to approximately 0.2 mm. nickel. The mean wave-length is roughly 0.32 A.U. A series of physical measurements of spectra, half-value layers, "back-scatter," percentage depth doses, etc., have been made, and it is hoped that they will be published shortly. Only a few of the results are given here.

The field on the irradiated skin is limited by metal applicators slipped on to the end of the tube, these applicators also ensuring the focal skin distance desired. The latter is usually 5 cm. or 3 cm., while the applicator may be either circular or elongated according to the lesion to be treated. Applicators of special shapes and sizes are easily constructed in a workshop of moderate resources. With 5 cm. focal skin distance and 4 cm. diameter circular field, the depth doses along the centre axis of the beam are as follows:

Depth in cm.	Percentage of Surface Dose
1	68
2	44
3	29
4	19

With smaller fields and smaller focal skin distances the values are naturally less. For instance, with 3 cm. focal skin distance at 1 cm. deep we have 53 per cent., at 2 cm. deep 28 per cent. of the surface dose. It is interesting to note that for the first 3 cm. of tissue there is fair agreement between the depth doses of the x -ray beam using 5 cm. focal skin distance and those obtained with a radium "bomb" at 4 cm. focal skin distance. For longer depths the radium, of course, gives somewhat larger percentage values. The dosage rate in air at 5 cm. focal skin distance, 60 kV and 4 mA, is approximately 110 r/min., while with "back-scatter" this normally increases to about 130 r/min. All doses are defined with back-scatter. This dosage rate is approximately twenty-five times that obtained from a 1-gram radium "bomb" at the same focal skin distance.

Clinical Effects

The daily dose per field used by Chaoul, and also by us, is 400 r with back-scatter. The total dose per field is not arbitrarily selected, but depends somewhat on the reaction of the lesion to treatment. Usually, by about the fourth day the skin immediately surrounding the lesion, and purposely included in the field, has developed a mild degree of erythema, while during the next few days a pigmentation often occurs. The extent of both erythema and pigmentation depends very markedly on the usual factors, such as region of the body, condition of the skin, vascularity of the subcutaneous stratum, coloration of the patient, etc. The edge of the erythematous area is very sharply marked, corresponding to the rim of the applicator, and although measurement shows often a 40 per cent. difference between the dose received at the

centre of the field and that at the edge, the skin reaction appears quite uniform over the whole area. Regression of the lesion is occasionally noticeable even by the third day.

The total dosage is usually 5,000 to 6,000 *r* per field, spread over about fifteen days, but irradiation up to this limit is continued until the erythema is well developed. The resulting skin reaction appears similar in all respects to that following radium treatment, with the exception of a shorter period of development. After intense irradiation skin sloughing results, but epithelialization rapidly proceeds from the periphery to cover the area with a pale scar. The sharply localized action of the beam renders the patient free from constitutional after-effects, so that a number of areas may be treated at one session, limited only by such factors as time and convenience. Even as many as six separate fields require only about twenty minutes to complete, the 400 *r* per field being obtained in about three minutes.

Our experience in the matter of resultant skin reactions and subsequent healing have been in close accord with those described by Chaoul and his collaborators. It is also of considerable interest to note the rough agreement between the dose in "roentgens" of long wave-length *x*-rays with that of gamma rays required to produce a similar reaction in lesion or skin.

Indications

The following types of cases readily (according to Chaoul) admit of treatment by such low-voltage therapy.

Skin cancer, such as rodent ulcer and epitheliomata. Accurate measurement of the lesion is not essential, and the applicator is chosen of suitable size and shape adequately to cover the lesion. If the latter does not exceed 4 cm. in diameter a single field will suffice, but for larger areas multiple fields become necessary. This technique is being developed. We have treated several cases of this type with initially satisfactory results.

Buccal Cancer.—This comprises squamous epitheliomata of lips, floor of mouth, alveolus, tongue, cheek, palate and tonsil, pharynx. The applicator is readily introduced and clamped into position, a gag being quite unnecessary. We find in agreement with Chaoul that the short exposure of three minutes is readily tolerated by the patient, even when the applicator is applied directly to the post-pharyngeal wall. A local anaesthetic is sometimes but rarely required. Once the primary lesion has been adequately irradiated, lymphatic drainage areas may be treated with more penetrating *x*-radiations should prophylactic measures be regarded as indicated. From Chaoul's results up to this early date it appears that this group is especially suited to low-voltage *x*-ray treatment. We may remark that in our small experience such advantages as complete absence of reaction in the tongue after treatment of, say, lip carcinoma, and absence of action on the salivary glands, both owing to the strict localization of the beam and short time of actual treatment per day, are matters of more than little importance to the patient.

Mammary Cancer.—For this type of case the method has a limited sphere of usefulness. Cases which have reached the fulminating stage can be greatly benefited. Post-operative recurrent nodules yield readily to treatment. Owing to the superficial nature of the dosage distribution there is little danger of lung fibrosis, even when large doses are administered to a thoracic wall stripped of adipose tissue. Naturally, elimination of any group of recurrent nodules does not prevent the appearance of other nodules in the mammary area, but the patient is spared unnecessary suffering and disfigurement.

Cancer of the Cervix.—A series of over a hundred cases have been treated by Witte and Schaefer, using slightly

higher voltages and somewhat different technique. The applicator is introduced per vaginam and directed on to the lesion. Angulation of the applicator makes it possible to irradiate growths which have advanced to the vaginal vaults. The technique, of which we have no experience, is more specialized, but results equal to those obtained with radium are claimed.

Deep-seated Lesions.—These lesions present a notable opportunity for co-operation between surgeon and radiologist. Thus in the case of cancer of the rectum a preliminary operation may be performed, resecting the coccyx and the lower portion of the sacrum after the establishment of colostomy. The wound is plugged and kept open for the duration of the treatment. The applicator may be introduced into the cleft with the aperture directly on to the tumour surface. The extension of the method to other sites, such as stomach, oesophagus, larynx, or prostate, may easily be visualized, provided a satisfactory surgery of access is developed and tumours rendered directly accessible to irradiation. We may finally note that benign lesions react in a manner very similar to that experienced with gamma rays.

Conclusions

Our experience of this low-voltage method is at the moment limited to the treatment of some forty cases, including cancer of the lower lip (2), of floor of mouth (2), of tongue (1), of pharyngeal wall (1), rodent ulcers (several), epitheliomata of skin (5), primary breast cancer (4), recurrent breast cancer (several), leucoplakia vulvae (1), urethral caruncle (1), recurrent melanotic sarcoma (1), pigmented hairy moles (4), cancer of rectum (1), keloid (2).

There can be no doubt that the method has many advantages in its own field, and it is well to remember that the latter is as yet scarcely defined. The complete and accurate control of dosage in regard both to amount and to location, the large number of fields it is possible to irradiate in a short time, the extremely sharp limitation of the beam and consequent avoidance of reaction in structures adjacent to those being treated, are immediately obvious on making use of low-voltage *x*-ray therapy. How the ultimate results of this technique will compare with those more commonly now in use we cannot say, but at least it deserves careful and prolonged study.

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The National Association for the Prevention of Tuberculosis has issued a list of its propaganda publications and cinematograph films; several of the leaflets have been recently revised, and new films are being made. One of the newer films, which describes the work in progress at the Burrow Hill Sanatorium Colony for Boys, was selected by the British Film Institute for exhibition to a League of Nations committee at Geneva as being the best British production of the year in regard to technique and propaganda value. Films more suitable for exhibition to medical practitioners and others with special knowledge deal with the pathogenesis of the disease, the part played by the nurse in the campaign, and the measures taken in an open-air school. Small pamphlets are available for distribution to patients or parents; they deal with such subjects as the protection of children, the diet in tuberculosis, disinfection, and after-care. Leaflets and posters are supplied for display in consulting rooms and elsewhere. Applications for the list and specimen copies should be addressed to the offices of the N.A.P.T., Tavistock House North, Tavistock Square, W.C.1.