The Factors Affecting Tumour Oxygenation

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T. The case for oxygenation in Radiotherapy rests with the assumption that anoxic centers exist in tumours. A method for detecting such centers is still lacking and the limits of oxygen diffusion in tissues can be estimated from theoretical considerations only. In this paper such estimates will be reviewed. In view of the recent work by Kolstad on the intercapillary distances in carcinomas of the cervix uteri the case of oxygen diffusing from a capillary may be of special interest. The equilibration time course for diffusion at right angles to a capillary into the tissue will be illustrated with data obtained from a simple electrical analogue. For intercapillary distances of a few hundred microns this equilibration time is relatively short

(several seconds) and the pO₂ at a point between capillaries will follow closely the changes in the pO₂ of the capillaries. The capillary pO₂

however

will also depend on blood flow and diffusion in the direction parallel to the capillary.

Polographic

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measurements of the pO₂ in human tumours by Evans and Naylor give the average pO₂ over the surface of the electrode which, most likely, will be close to the capillary pO₂. Using this data it may be estimated how long it will take to raise the pO₂ of the anoxic cells between two adjacent capillaries above 12 mm Hg for a given increase in the partial pressure of the breathed oxygen. Such estimates of the time course of the pO₂ depend on whether all anoxic cells are considered viable and have to be oxygenated or only those which had a pO₂ between 1 and 12 mm Hg. It has been found in this laboratory that HeLa cells cannot survive in the absence of oxygen.

M. Mice of the strain C3H/Km were inoculated subcutaneously with an isogenic transplanted sarcoma of spontaneous origin

and the tumors were allowed to grow for 10–14 days. Tumors were then irradiated in situ with 250 kv X-rays in either of two conditions: (a) in mice breathing air during irradiation or (b) in mice which had been killed by nitrogen asphyxiation 5 minutes prior to the start of irradiation. Tumor cell surviving fractions were then obtained by endpoint dilution assay: the tumors were excised from their hosts

minced in Hanks' solution

and made into a single cell suspension with the aid of mild trypsinization. The counted suspension was serially diluted in 5-fold steps and appropriate dilutions were inoculated into four separate subcutaneous sites in isogenic normal recipient mice (16 inocula/cell dilution). After scoring tumor takes in all sites for at least 100 days after in-

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