Tumour and normal tissue effects of accelerated neon ions

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Heavy ions generated by the Bevalac at the Lawrence Berkeley Laboratory in Berkeley, California, are currently under investigation for use in clinical radiotherapy. To determine the r.b.e. for tumour and normal tissues and the oxygen enhancement ratio (o.e.r.) of the neon ions, we have exposed the EMT6 tumour, mouse jejunum and oesophagus in the plateau and distal spread-out Bragg peak regions of the neon beam. The r.b.e. was greater in the distal peak than in the plateau and greater for hypoxic cells than oxic cells at all dose-levels. The r.b.e. increased with decrease of neon dose per fraction. At comparable dose-levels, the r.b.e. was greater for the tumour than for the jejunal crypt cells in the distal peak. For esophageal lethality the r.b.e. was 1·13 in the plateau and 1·50 in the distal peak. At a dose of 200 rad per fraction the o.e.r. decreased from 2·9 for ^{137}Cs to 2·7 for neon plateau and 1·5 for neon distal peak. Neon ion irradiation seems potentially more advantageous than 15 MeV neutrons and low-LET radiation for clinical use because of increased relative depth-dose distribution in tissue, decreased o.e.r. and possible greater therapeutic ratio.

Survival of cells from different types of animal tumour after irradiation with fast neutrons

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Studies of the response of various normal tissues have shown a considerable spectrum of radiosensitivities of the constituent cells to X-irradiation. The differences involve the shoulder-widths as well as the slopes of the exponential part of the survival curves. Similar but somewhat smaller differences are observed after irradiation with 15 MeV neutrons. The differences between the sensitivities of cells to neutrons and X-rays are mainly attributed to differences in the influence of the accumulation of sublethal damage.

To investigate whether there are also systematic differences in radiosensitivity among various types of tumour, cell-survival characteristics have been studied with 300 kV X-rays and 15 MeV neutrons for nine different tumour cell-lines in culture. The cell cultures were derived from a number of experimental tumours transplantable in rats or mice, including carcinomas, sarcomas and a lymphoma.

The survival curves of the different cell-lines show large variations in radiosensitivity to X-rays as well as to 15 MeV neutrons. Largest and smallest doses required to cause 50 per cent, 10 per cent and 1 per cent survival differ by factors of 4·6, 3·4 and 3·2, respectively, for X-rays and by factors of 3·5, 3·0 and 2·9, respectively, for 15 MeV neutrons. R.b.e. values of 15 MeV neutrons range from 1·8 to 3·3 for the 50 per cent survival level, but are much more similar at lower percentages survival. It can be concluded that fast neutrons will only provide a clinical advantage for combinations of specific tumour types and the specific normal tissue which is considered to be dose-limiting for the radiotherapy treatment considered.

Slow repair after X-rays or fast neutrons

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The response of mouse lung to different treatment methods has been assessed using the LD/50 between 40 and 180 days after irradiation of the thorax.

Previous investigations indicated the existence of a slow repair process occurring between doses of X-rays, with a half-time of about 100 hours. The work has been repeated with both X-rays and fast neutrons, using two doses separated by intervals of time ranging from