

# This Week's Citation Classic

**Gray L H, Conger A D, Ebert M, Hornsey S & Scott O C A.** The concentration of oxygen dissolved in tissues at the time of irradiation as a factor in radiotherapy. *Brit. J. Radiol.* 26:638-48, 1953.  
[Radiotherapeutic Research Unit, Hammersmith Hospital, London, England]

The relationship between oxygen tension and radiosensitivity was measured, using mouse and chick cells. It was shown that oxygen might sensitize a tumour to X rays, more than the normal tissues. Oxygen had less effect on the response of cells to neutrons. [The *SCI*<sup>®</sup> indicates that this paper has been cited over 240 times since 1961.]

O.C.A. Scott  
Radiotherapy Research Unit  
Institute of Cancer Research  
Royal Cancer Hospital  
Sutton, Surrey SM2 5PX  
England

July 10, 1981

"It is sad that Hal Gray is no longer with us to write his recollections of 'Gray *et al.*' His vivid personality, tremendous enthusiasm tempered by caution and humility, and his unqualified love of scientific work made the period when these investigations were carried out the most memorable in the working life of the surviving authors.

"There are some things which Gray would not have included; notably, any reference to his own modesty. He refused to be the first author, until a 'mutiny in the ship's company' forced him to put his name at the head of the list. This paper has not always been quoted correctly, and we might mention that we did not 'discover the oxygen effect,' nor were we

the first to suggest the importance of oxygen in radiotherapy. We may have been the first to suggest the use of oxygen to improve the therapeutic index in radiation treatment, and this may account for the paper's frequent citation.

"The work was commenced in the autumn of 1952, to fill in gaps in existing knowledge, and was published in December 1953. Alan Conger was asked to establish the relationship between oxygen concentration and radiosensitivity for a *mammalian* cell, which he did in record time. I showed that an allogeneic tumour could be sensitized to X rays by oxygen, without obvious increase in skin reaction. An unexpected finding was the importance of tumour size. Shirley Hornsey counted degenerating cells in culture (this was the pre-Puck era!) but her data still look good. Michael Ebert's contribution from pure radiation chemistry was an example of the fruitful collaboration between chemists and biologists, which has been a feature of radiation research.

"The recent reports of randomized clinical trials with hyperbaric oxygen, which had their origin in this work, are encouraging.<sup>1</sup>

"Gray's outstanding ability to put together information from different sources, and build it into a logically coherent structure, provided the driving force for the team. And driving force was necessary! Our working conditions were primitive; mice, scientists, and equipment were crammed together in one small room.

"The consequences of this paper are still in evidence, not only in relation to oxygen, but also the development of hypoxic sensitizers and neutron therapy."<sup>2</sup>

1. Henk J M & Smith C W. Radiotherapy and hyperbaric oxygen in head and neck cancer. *Lancet* 2:104-5, 1977.

2. Adams G E. Hypoxic cell sensitizers for radiotherapy. (Becker F F, ed.) *Cancer: a comprehensive treatise*. New York: Plenum Press, 1975. p. 181-223.