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A contribution on what the radiologist wants and may expect from the physicist

Modern medicine, in all its branches, has become increasingly dependent on the contribution made by the basic and applied sciences, not only for research, but indeed for everyday clinical practice. But, as yet, in no other clinical specialty does the scientist play such an important and immediate role as does the radiotherapy physicist in the practice of clinical radiotherapy. Indeed, in my opinion, his role should be no less than that of a full partner in the treatment team together with the radiotherapist. It is the purpose of this paper to examine this role in principle, and in general terms, from the point of view of the practising radiologist.

Whilst the division is in some ways artificial and arbitrary, the physicist's contribution to radiotherapy can be considered under two broad headings. Firstly there is the contribution made by the physicist working within his own sphere of specialised knowledge, and without being immediately involved in the treatment of any individual patient. Secondly there is the contribution made at the clinical, or patient, level. This I feel is the vital and sometimes neglected role in which close collaboration between the physicist and the radiotherapist becomes an accepted part of treatment planning in either individual cases, or in the development of new techniques.

As regards the first group, the physicist's responsibilities are usually well understood and accepted. To examine in detail all these various aspects of the physicist's contribution would be completely unnecessary and very tedious; all I propose to do, in fact, is to outline in general terms the main areas of responsibility which belong primarily to the physicist.

IN CONNECTION WITH X-RAY THERAPY APPARATUS

Choice of X-ray plant

Modern X-ray plants, particularly megavoltage equipment, are elaborate and very costly. The manufacturers can call on experts both in X-ray engineering and in persuasion, and the radiotherapist on his own may be readily overwhelmed by such a combination. A physicist, and moreover an experienced radiotherapy physicist, must be intimately concerned with the choice of such apparatus from the very beginning. Under what I consider would be the ideal conditions, this physicist, from past experience, and working in collaboration with the radiotherapist, would be well equipped to consider not only the purely technical aspects of the choice of equipment, but also those aspects of particular clinical importance. He will also have an awareness of the local needs of the situation which will have a vital bearing on the final choice.

The care and maintenance of such a plant

Large departments may require an engineer specifically appointed for this purpose. Alternatively, this is a responsibility which may well devolve upon the physicist.

Dosimetry

In the pre-megavoltage era a minority of radiotherapists advocated treatments in which the measured physical unit of dose was of secondary consideration, the primary consideration being the observed radiation reaction. In the hands of a few very experienced practitioners of the art, this approach may have been satisfactory, but like all forms of art, it suffered from difficulties of communication. Now with the advent of a quality of radiation which does not allow of this approach, certainly in relation to deep-seated tumours at least, dosimetry has become all important. Here the physicist's role is clearly vital and will include everything from the initial calibration of the tube, followed by routine and regular calibration, the provision of data relating to depth doses, isodose charts for plain and wedge fields, F.S.D. correction factors, etc. Much of this work may indeed seem to be dull, routine, and conceivably within the scope of a senior technician. It must be obvious to everyone however, that the

possible disastrous consequences of error in any of the data so supplied are such that the responsibility could only be borne by a senior and graduate scientist.

Radium Laboratory

Whilst the day to day work of this department may be the responsibility of a senior technician, the overall organisation of the practical aspect of the work should be under the direction of the Physics Department or a physicist. I do not intend to go into the detail of all the kinds of work which are undertaken in this department, but obviously they will clearly include everything from the ordering of radio-active sources, to their ultimate destination in or on the patient, and subsequent return. Check measurements of activity, the leak testing of sources, the prevention of loss or damage to radio-active sources, are but a few examples of the routine work. I might add that nowadays the radium laboratory will be concerned with the handling of many of the new, sealed artificial radio-active sources used in radiotherapy such as, for instance, radon seeds, radio-gold grains, tantalum wire and radio-cobalt sources etc. Such extension of the scope and work will clearly bring further responsibility in terms of organisation and control which could only be handled by an experienced physicist.

Radio-isotope Unit

The introduction of artificial radio-active isotopes in everyday clinical medicine has followed different paths in different countries. In the United States, for instance, I believe it is true to say that the clinical specialty immediately concerned organised and developed its own radio-active isotope service. For example the haematologist controlled the introduction of the radio-active phosphorus; the endocrinologist developed the use of radio-active iodine. In the United Kingdom the situation originally developed along different lines. The radio-isotope units, in fact, tended to originate in radiotherapy centres, the reasons being that these centres had the physicists, who understood, and knew how to handle, these new agents, and because the therapists regarded these agents as an extension of their normal armamentarium. Once again, in an established unit, a certain amount of this work could be assigned to senior technicians, but the main responsibility still lies with the physicist. In the larger centres such a unit

would be responsible for ordering the radio-isotopes from the appropriate sources; for the measurement of samples; for the supply of tracer doses, for diagnostic use; the preparation of equipment in connection with the administration of radio-active isotopes; the dispensing of therapeutic quantities; and finally for the in vivo measurements of activity in the patient. I might add that the gradual extension of the use of artificial radio-active isotopes in general medicine has inevitably meant that in the United Kingdom, at least, there has been, of late, some decentralisation in the sense that many general hospitals now have the facilities for doing the relatively simple studies with tracer quantities of radio-active isotopes. Within these hospitals, for instance, the physicist's place may be taken by the hospital pathologist, or indeed by a bio-chemist.

The Health Physics Department

The importance of an organisation whose responsibility is no less than that of the radiation safety of the staff and patients throughout the hospital, cannot be overstated. The nature of this work is clearly such that the responsibility for the organisation of such a department can only be that of an experienced and senior physicist. In the large centres the work involved in such a department is considerable, and may well require the services of a physicist who devotes himself solely to this task. Here again I do not propose to mention, in any detail, the scope of this work, but an important item frequently overlooked is that of the training of staff; this factor alone would require the knowledge and authority of the graduate scientist.

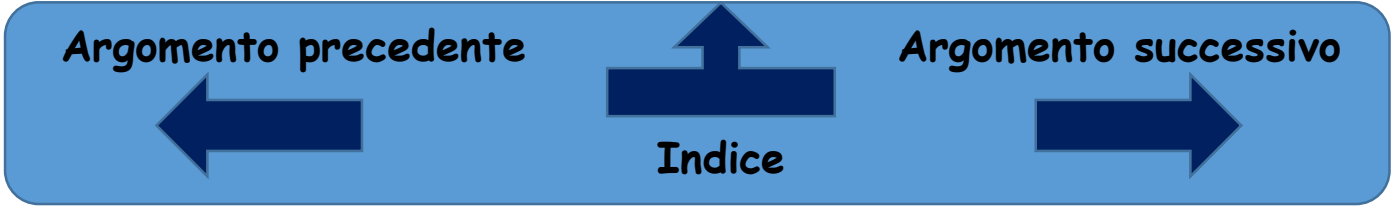
So much for the work of the physicist, working principally within his own department. Now I would like to say a few words about the contribution made by the physicist, in which the key note is collaboration with the radiotherapists in regard to individual treatments by any form of radiotherapy. The scope of this role is wide, much depends upon the willingness of both partners in the treatment team, i.e. the radiotherapist, and the physicist, to co-operate. It is probably true to say that the inherent conservatism of many doctors has been a stumbling block to this type of collaboration in the past, and may in fact persist in some places today. I can only say that the more whole-hearted the co-operation, the more fruitful the partnership. Clearly, however, the only person who can, and must, accept final total responsibility of the patient is the radiotherapist; he is the patient's doctor and this special relationship must be preserved at all costs.

Nevertheless this principle should not prevent the radiotherapist seeking the advice and co-operation of his physicist colleague as much as possible. The isolated consultation, occurring only when some special problem has developed, seems to me to be totally undesirable. In my experience the continuing close co-operation, with opportunities for the physicist to appreciate the clinical problem, serves as a stimulus of inestimable value to both therapist and physicist. The therapist is confronted by the scientific point of view - the physicist by the clinical problem. This seems to me to be the only satisfactory basis for the partnership and there are no insuperable obstacles to this kind of association in everyday clinical radiotherapy. Clearly the local needs of any one department will vary, so therefore will the details of the day-to-day working arrangements. In my own hospital it is customary for the radiotherapist himself to plan and calculate routine treatments, using data provided by the physicist. Thereafter the prescription and calculations are checked by the physicist and amended if need be. In the cases of X-ray therapy where multiple or moving fields are employed, the check may take the form of two dimensional reproduction of the combined isodose pattern. In large departments this work may be undertaken by technicians working under the supervision of the physicist. The same working arrangement can be readily applied in radium work of all kinds, and indeed in any use of solid artificial radio-isotopes. In the field of artificial radioisotopes both tracer and therapeutic techniques owe a great deal to the physicist. The fundamental principles of the tracer study, with its concepts of dynamic equilibria, etc., have been largely calculated by the physicist. The instrumentation and dosimetry are likewise their field of work and responsibility. It is natural and right, therefore, that the physicist should participate at the clinical level, be it in the dispensing of the isotope, its subsequent in vivo measurement, in the analysis and interpretation of results, and finally in the question of dosimetry.

These are but a few examples of the way in which co-operation between therapist and physicist can be achieved. The detail is unimportant - the principle, however, is to my mind, vital for the development of a progressive radiotherapy unit.

And finally I would like to mention, very briefly, the training of radiotherapists. As radiation in one form or another is the very tool of his trade, it is essential that the radiotherapist should have a grasp of its fundamentals, at least. The undergraduate teaching in the average medical

course is clearly inadequate in this subject, and in some way the prospective therapist has to acquire the necessary background in the physics of radiation. It may be argued that this training could be given by, say, the staff of some University Department of Physics or indeed by the student himself attending some extra-mural course of study; but I suggest that both these methods are poor substitutes for teaching by a practising radiotherapy physicist. In the larger centres like my own a formal course of lectures is given by the Physics department, covering the whole syllabus required for the post-graduate qualification. Apart from the obvious merits of such a course of lectures, the trainee radiotherapist is at an early stage in his career brought into close contact with his physicist colleague, and so begins a relationship which should continue throughout his working life.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