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THE EDITOR—SIR,
TIME, DOSE AND FRACTIONATION FACTORS IN
RADIOTHERAPY

In a recent article published in your Journal, Orton and Ellis (1973) introduced an interesting simplification in the use of the NSD concept in practical radiotherapy. The method described involves the use of what are called the time, dose and fractionation factors (TDF). The TDF has been defined as

$$TDF = n \cdot d^{1.538} \cdot x^{-0.169} \cdot 10^{-3} \dots (1)$$

where n is the number of fractions, d the dose per fraction, and x a constant whose value depends on the number of fractions/week.

Orton and Ellis have published calculated values of the TDF factors tabulated against the number of fractions and the dose per fraction. In attempting to use these tables to solve problems of fractionation in clinical radiotherapy, we felt that it would be more convenient if these factors were tabulated against the total dose (D) rather than the dose per fraction, because most radiotherapists are used to thinking in terms of statements such as "6,000 rads, 30 fractions, 5 fractions/week" rather than statements such as "200 rads/fraction, 30 fractions, 5 fractions/week". Accordingly, we have modified equation (1) by substituting for d the quantity D/n and equation (1) becomes:

$$TDF = \frac{D^{1.538} \cdot x^{-0.169} \cdot 10^{-3}}{n^{0.538}} \dots (2)$$

Using equation (2), we calculated the TDF factors for various values of D and n using a digital computer and prepared tables, showing the TDF against the dose D for various fractionation schedules (from one to five fractions per week). Table I shows an abridged version of these tables for 5 fractions/week. Its use is illustrated by means of the following examples.

TABLE I
TDF FACTORS (5 FRACTIONS/WEEK)

Total dose (rad)	Number of fractions					
	5	10	15	20	25	30
1,000	16	11	9	8	7	6
1,500	31	21	17	15	13	12
2,000	48	33	26	23	20	18
2,500	67	46	37	32	28	26
3,000	89	61	49	42	37	34
3,500	113	78	62	54	47	43
4,000	139	95	77	66	58	53
4,500	166	114	92	79	70	63
4,600	172	118	95	81	72	66
4,633	174	119	96	82	73	67
4,700	178	122	98	84	75	68
5,000	195	135	108	93	82	74
5,500	226	156	125	107	95	86
5,533	228	157	126	108	96	87
5,600	232	160	129	110	98	89
6,000	259	178	143	123	109	99

Example 1

Change a protocol of 5,000 rads in 25 fractions, 5 fractions/week to 20 fractions, 5 fractions/week.

Solution: The TDF for 5,000 rads, 25 fractions, 5 fractions/week (Table I) is 82. Using the same table, we find that the

same TDF is obtained for 20 fractions, 5 fractions/week with a total dose of 4,633 rads.

Example 2

A split-course radiotherapy protocol consists of two parts, each of 2,500 rads in 10 fractions at 5 fractions/week separated by a rest period of 20 days. What total dose delivered without a rest period in 30 fractions at 5 fractions/week will be biologically equivalent.

Solution: The TDF for the first 2,500 rads in 10 fractions at 5 fractions/week = 46. The decay factor for 20 days rest after a duration of 12 days = 0.90 (see Orton and Ellis, 1973). TDF for the second 2,500 rads in 10 fractions at 5 fractions/week = 46.

Total TDF for original protocol = $(46 \times 0.9) + 46 = 87$.

With 30 fractions, 5 fractions/week, the same TDF of 87 will be obtained at 5,533 rads. In other words, the total dose has to be increased by 533 rads.

The answers to the above two problems are of course the same as those obtained by Orton's original tables but we feel that the tables constructed on the basis of total dose are a little more practical to use.

Detailed computerized data showing TDF values tabulated against dose in steps of 100 rads and fractions in steps of two can be obtained from the authors for a nominal charge.

Yours etc.,
GOPALA U. V. RAO, Sc.D.
TAPAN A. HAZRA, M.D.

Division of Radiotherapy,
Department of Radiology,
The Johns Hopkins Hospital,
Baltimore, Maryland, 21205.

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ORTON, C. G., and ELLIS, F., 1973. A simplification in the use of the NSD concept in practical radiotherapy. *British Journal of Radiology*, 46, 529-537.

THE EDITOR—SIR,
SECULAR CHANGES IN THYROID UPTAKE

It may be of interest to compare the changes in the normal range of thyroïdal radioiodine uptake as reported by Kirkman (1974) with those we have reported (Keeling and Williams, 1972). The main feature is the similarity of the findings: a "drift" of the average uptake in a group of euthyroid subjects to lower values over the last (approximately) decade and a half, with latterly a reduction in the magnitude of the change. In both Kirkman's and our studies the results suggested that a small reduction was continuing but in neither series were the recent results significantly different from those obtained in the middle to later 1960s.

In contrast to Kirkman we recorded ¹³¹I uptake at 24 hours as well as at four hours following administration of the dose. A similar effect was recorded for both times of measurement. From Kirkman's Fig. 3 it would appear that in a euthyroid group in Cardiff a mean uptake figure at four hours of about 33 per cent would be expected in the early 1960s in contrast to a mean value of about 22 per cent ten years later. We reported (Keeling and Williams, 1972) a mean value for such a group in London in the late 1950s of 23 per cent and in 1972 of 19.8 per cent. These lower values and the smaller change are worth noting in relation to what we earlier considered our normal four-hour uptake range (15-35 per cent with the higher value suspect as being too high). The slightly higher range quoted by Kirkman

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suggests a population which is less iodine replete than a comparable London population and this would be consistent with the greater secular change reported from Cardiff, on the assumption that increased iodine intake is the cause.

These observations, as well as those from the U.S.A. reporting greater secular changes, show that the radioiodine uptake test, well-known to be poor in differentiating hypothyroidism from euthyroidism, is becoming progressively less useful as a discriminant between hyperthyroidism and euthyroidism. As we pointed out in our earlier report increased iodine repletion can also affect the estimation of protein bound iodine (PBI) in a similarly disadvantageous manner. Thus the time is rapidly approaching when it would be advisable to replace as a thyroid function screening test both the radioiodine uptake and the PBI by an alternative unaffected by dietary habits or by self-medication with iodized preparations. Currently such

alternatives are the Free Thyroxine Index or the Effective Thyroxine Ratio.

Yours etc..

D. H. KEELING.

Nuclear Medicine Department,
Plymouth General Hospital,
Plymouth PL4 7JJ.

E. S. WILLIAMS.

Institute of Nuclear Medicine,
The Middlesex Hospital Medical School,
London W1N 7RL.

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Book reviews

Clinical Cardiac Radiology. By Keith Jefferson and Simon Rees, xi + 314 pp. (London, Butterworths), £15.

The plain film in cardiac disease often receives a raw deal in text-books. It is the poor relation of the lungs and mediastinum in works on the chest and all too often takes second place to contrast studies in writings devoted to cardiac radiology. It is perhaps for this reason that radiologists sometimes fail to extract extremely important haemodynamic information from the plain radiograph, information that can be as accurate as that obtained at cardiac catheterization. Part of the problem lies in the lack of clear-cut criteria for many of the radiological signs. For example, plethora and oligemia are obviously important but since various authors advise evaluating these phenomena in such different ways, the general reader is likely to remain confused. The publication of *Clinical Cardiac Radiology* is bound to clear up some of this confusion. The work is based on the analysis of the plain chest film in 1,500 patients, all of whom had undergone cardiac catheterization and angiocardiology at the National Heart Hospital in London. The series is fairly representative of the kind of cases seen in cardiac departments up and down the country, but with fewer congenital anomalies requiring treatment very early in life and rather more adult patients with cyanotic heart disease.

Doctors Jefferson and Rees have faced up squarely to the problem of the lack of objectivity of so many of the signs. Not only do they state criteria—specific or vague as the case may be—but they also provide an analysis of their own accuracy. The casual reader should not be deceived by the appendix "Computer Correlations of Radiographic Signs and Haemodynamic Data", a slightly pompous title for a series of numerical generalizations; the statistics given in the main text, one of the major achievements of the book, are more relevant and often more detailed than those in the appendix.

The book is divided into two halves. The first deals with the general radiology of the heart, lungs and other systems in cardiac disorders. Lung changes are related to the known haemodynamics. A special chapter is devoted to skeletal changes, based on a recent St. Cyres lecture given by Keith Jefferson. The second half deals with specific entities grouped according to clinical presentation, stressing differential diagnosis and the assessment of the relative haemodynamic importance of particular lesions. There are 500 reproductions including angiocardiograms but the contrast studies are only used to illustrate plain film findings. There are many references but more would have been welcome.

This book is an important contribution to cardiac

radiology. It is clearly the end result of a great deal of thought and hard work. It is written in a style that is not always easy to read—brevity is no doubt a virtue but it may lead to complexity of expression and therefore difficulty in comprehension. It will be of little use to the examination candidate wishing to polish off heart disease in a weekend. It will, however, be indispensable to those who wish to have a thorough understanding of an often poorly appreciated subject and will prove a constant source of reference to help solve many of the problems which occur in day to day practice.

PETER ARMSTRONG.

The Newborn Chest. By Richard L. Wesenberg, pp. xii + 300, illus., 1973 (Maryland, U.S.A., Harper & Row), \$20.00.

It is a pleasure to recommend this marvellous monograph to radiologists concerned in the care of neonatal respiratory diseases. The development of neonatal intensive care units and advances in thoracic surgery over the last ten years, have resulted in a radical change in the management of these infants. Unfortunately, and probably inevitably, the benefits have been accompanied by some disadvantages. Complications of treatment, particularly of respirator therapy, have added a whole new spectrum of diagnostic problems. Certain disorders such as the Wilson Mikity syndrome and transient tachypnoea of the newborn have only recently been recognised. More than ever before the radiologist needs to understand the pathology and disordered physiology as well as the radiological patterns if he is to contribute meaningfully to the treatment of the neonate.

Until now this sort of information was widely disseminated throughout the literature. Dr. Richard Wesenberg has done an admirable job in assembling the facts and presenting them in a clear readable manner. Almost 40 different medical and surgical conditions are discussed. One of the best features of the book, which is aimed at paediatricians as well as radiologists, is the lucid exposition of the clinical findings, pathology and pathophysiology. The quality of the reproductions is in keeping with the excellent descriptions of the X-ray appearances. Problem areas are intelligently discussed—the possible and impossible realistically assessed. There are useful well-chosen case reports in each chapter which again emphasize how far one can go in making a diagnosis.

This elegantly produced informative book is bound to be an invaluable guide to the radiologists and paediatricians who face these challenging problems.

P. ARMSTRONG.