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THE HAZARDS OF RADIATION

In the past decade the problems posed by radiation hazards have received more and more attention, particularly with the increasing amount of radiation produced by medical and other sources. Numerous papers and other publications have appeared of which two, published by the Medical Research Council in 1956 and 1960 and entitled *Hazards to man of nuclear and allied radiations*[1] and *Radiological hazards to patients*[2] respectively, are extremely detailed and authoritative. Many questions that were previously the subjects of much speculation are now more definitely answerable on a far surer basis of fact.

There have been notable changes of thought. Formerly it was believed that an individual, exposed to a high dose of radiation, carried for his lifetime thereafter a heightened risk of leukaemia. Now, however, from observations at Hiroshima and Nagasaki and observations on those irradiated in the treatment of ankylosing spondylitis, it can be stated with some confidence that the risk of leukaemia following radiation will decline after the lapse of a decade. It was also thought that the biological effects of a given dose of irradiation were similar, whether given rapidly or slowly. Recent work suggests that a dose given over a long period has less effect than the same 'acute' dose, and this work is supported by earlier findings that genetic damage is related to dose rate.[3]

This change of opinion, therefore, puts far more emphasis on the sudden doses of medical radiology and less on the slower exposure to background and fall-out radiation. Although the subject seems to be highly technical, there are a number of simple facts which amply illustrate the important points, and it appears to be important at this time for the medical profession as a whole to give a great deal of thought to this problem which may affect future generations more than is universally recognized.

1. *The Genetic Hazards of Medical X-rays*

Muller[5,6] in 1950 and 1954 pointed out the danger of irradiating the gonads either of the adult or of the foetus *in utero*. He stated that small doses of irradiation may not harm the foetus directly and yet may produce gene mutations in the foetal gonads which could cause a great deal of harm to subsequent generations. The mutants thus produced are unfortunately nearly all harmful and the effect on the individual usually so slight as to be impossible to detect. Nevertheless, irradiation of the gonads may be detrimental by causing slight undetectable changes in the offspring which, by being passed on to subsequent generations, may eventually be lethal. Also Russell and Russell[7] showed that developmental abnormalities can be produced in the embryos of mammals by irradiation. Most of the gross abnormalities were produced at a time of development which corresponded with the second to the sixth week of human gestation.

The calculated total genetic dose from medical X-rays is 19·3 milliroentgen annually per person, compared with the inescapable dose from background radiation of 85 - 106 milliroentgen, and the gonad dose from fall-out, which is a measure of the genetic consequence of nuclear explosion, of 1·2 milliroentgen per year.

(*a*) *Medical diagnostic radiology*. This source contributes an annual average of 14 milliroentgen per person which is a lower estimate than was made in 1956.[4]

The gonad dose was found to be not excessive and similar to values previously reported for many examinations. It was lower than earlier figures for pelvimetry and salpingography, possibly as a result of the publicity given to these procedures recently. However, owing (mainly) to poor technique, other examinations such as chest radiography showed a high average. Thus, the testis was in the primary beam for 10% of all chest X-rays and the ovary similarly involved in 51% of such X-rays—a very high figure indeed.

Radiology of the chest makes up 5% of the genetic dose from diagnostic radiology. Obstetric radiology contributes one third of the total, and irradiation of the pelvis and femur a further third of the total. Mass miniature X-rays of the chest and dental X-rays contribute only one thousandth part of the annual genetic dose. From these figures it is obvious that the use of simple measures would reduce the gonad dose very considerably.

(*b*) *Radiotherapy* contributes a smaller annual average dose, 5·3 milliroentgen per person, of which only 10% is attributable to the treatment of malignant disease. More than 50% of the total radiotherapy dose comes from treatment of skin conditions and most of the remainder from the treatment of ankylosing spondylitis. Only a very small proportion of the total can be attributed to radioactive isotopes used in diagnosis and treatment.

Two striking and important points are evident from the dose survey: (1) The gonad dose is not reduced in diagnostic radiology by making the beam of an X-ray more penetrating (an optimum is reached at about 70 KV. with 1 millimetre of aluminium filter), and (2) through faulty techniques a large and totally unnecessary genetic dose can be contributed. The same applies to radiotherapy for non-malignant conditions.

Pregnancy in itself poses many particular problems and special precautions should be adopted for pregnant women. These precautions are necessary for every female of childbearing age who might be pregnant, because the embryo often attains its highest degree of radiosensitivity (somatically) before the mother's pregnancy is suspected. However, at any stage of pregnancy irradiation of the mother's abdomen involves irradiation of the foetus and this is a double genetic dose. At present one quarter of the population's annual genetic dose arises from irradiation of the foetus.

For very similar reasons, extensive or repeated X-ray examinations of children and adolescents need to be specially

considered and selected. It is estimated that the total genetic dose can be reduced to about 6 milliroentgen by the adoption everywhere of careful techniques giving low gonadal exposure. Larsson[8] makes the same point in his assessment of the genetic dose in Sweden.

2. *Leukaemia and Radiation*

After the initial report by Stewart *et al.*[9] that acute leukaemia in childhood was much more likely if the mother had been subjected to much X-ray exposure in pregnancy (e.g. pelvimetry), and the demonstration by Court Brown and Abbatt[10] that there was an increased incidence of leukaemia in patients with ankylosing spondylitis treated with deep X-ray therapy, a great deal of thought and research all over the world has been stimulated.

(*a*) *Radiology.* On the whole the danger of maternal X-radiation to the foetus has not been substantiated in so far as the incidence of leukaemia is concerned. Court Brown, Dall, and Bradford Hill[11] showed no increased incidence of leukaemia in 39,166 foetuses of mothers who were known to have had abdominal or pelvic diagnostic X-rays, and this proved true even in 750 women where the X-rays were taken during the first 3 months of pregnancy. In their review of five other surveys conducted by Kjeldsberg,[12] Kaplan,[13] Polhemus and Koch,[14] Ford *et al.*[15] and MacMahon,[16] they point out that the evidence is conflicting. In three of these surveys a greater proportion of mothers of leukaemic children had been irradiated during pregnancy than among mothers of the control children; in one there was no difference and in one the opposite was true. They conclude that 'there is no evidence of any disproportionate occurrence of leukaemia among the children most heavily irradiated, nor among the children who have been irradiated early in intrauterine life'. Lewis,[17] who reviewed the records of Queen Charlotte's Hospital in London, reached similar conclusions.

(*b*) *Exposure to radioactive isotopes.* This is another way in which radiation may cause leukaemia. Radioactive gold and yttrium have been used in the treatment of tumours. Radio-iodine (^{131}I) has been used in large numbers of patients with thyrotoxicosis, and radiophosphorus (^{32}P) has been used in polycythaemia vera.

Pochin, in a review of 18 cases of leukaemia, suggests that there is no evidence at present that radio-iodine treatment is inducing leukaemia. In spite of the work of Wasserman,[18] Schwartz and Ehrlich,[19] and Lawrence,[20] no firm conclusion can be reached at present about the relative incidence of leukaemia in polycythaemic patients who have been irradiated.

(*c*) *Radioactive traces.* This is another source of exposure to radiation. Radioactive chromium (^{51}Cr) is used in blood-volume estimations and in studies on the survival of red cells, radioactive iron (59 Fe) is used in studies on iron metabolism, and radiocobalt (60 Co) is used experimentally in studies on the metabolism of Vitamin B_{12}, to mention only a few which are being used increasingly in research and diagnosis. Although the dose for one estimation may be carefully adjusted, the cumulative dose may be at fault if not carefully watched. The somatic effect of these isotopes is the subject of intensive investigation at present.

What then are the main conclusions to be drawn at the present time from the facts at our disposal?

As regards the genetic hazard of medical X-rays, it would appear from the second report of the Adrian committee on *Radiological hazards to patients*, that there is no need for major restriction in radiological practice, provided that the proper precautions are taken in all instances. This places the responsibility for ensuring that no unnecessary gonadal irradiation occurs on the person requesting the X-ray and on the radiologist and his staff.

Concerning the question of radiation and leukaemia, no cast-iron opinion can be expressed at present. The scientific evidence is still conflicting and it is possible only to attempt a judicious opinion. The important question to be answered is: which will lead to greater human suffering—using or withholding diagnostic abdominal X-rays in pregnant women? This answer will not be available until obstetricians provide data to show to what extent information provided by X-rays has led to reduction in maternal and foetal morbidity and mortality. It does however seem that radiation is a definite danger to the embryo in the first trimester and should always be avoided when possible.

Every member of the medical profession should read the recommendations in the report of the Adrian Committee and do all in his or her power to implement these recommendations in everyday practice.

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PUBLIKASIE VAN DIE APTEKERSWOORDEBOEK

'n Tweetalige Engels-Afrikaanse en Afrikaans-Engelse Aptekerswoordeboek het so pas verskyn. Hierdie woordeboek is bewerk deur 'n verteenwoordigende komitee van die Vaktaalkommissie en sy Sekretariaat in die Vaktaalburo van die Suid-Afrikaanse Akademie vir Wetenskap en Kuns, met die *Voorlopige lys van aptekersterme* van die Akademie as grondslag. Die uitgewers van die woordeboek is die Suid-Afrikaanse Akademie van Wetenskap en Kuns. Dit word versprei deur die Nasionale Boekhandel Beperk, Parow, Port Elizabeth, Bloemfontein, en Johannesburg. Prys: R1.25, posgeld 3c ekstra.

Die verskyning van 'n woordeboek soos hierdie is belangrik uit baie oogpunte. In die eerste plek is dit 'n verdere nuwe mylpaal wat bereik is deur die Afrikaanse vaktaal.

Verder is dit, soos die voorsitter van die vaktaalkommissie in sy voorwoord sê, nie 'n maklike taak om die terminologie van 'n jong en groeiende taal te koördineer nie. Dit is dus wel 'n stap vooruit dat dit moontlik is om die Afrikaanse vakterminologie op landswye basis in so 'n mate te koördineer dat daar nie meer onnodige uiteenlopendheid en misverstand ondervind kan word nie.

Hierdie woordeboek is die vrug van die arbeid van die verteenwoordigende komitee vir die aptekerswoordeboek waarin daar verteenwoordigers dien van die Vaktaalburo, die Suid-Afrikaanse Aptekerskommissie en Aptekersvereniging, die W.N.N.R., die Taaldiensburo, die Witwatersrandse Tegniese Kollege, die Suid-Afrikaanse Spoorweë, die Departement van Onderwys, Kuns en Wetenskap, die aptekers van die Pretoriase Algemene Hospitaal, en lede van die Universiteite van Stellenbosch, Pretoria, Witwatersrand, en Potchefstroom. By die bewerking van die manuskrip in sy finale vorm het ook nog ander belangrike liggame en persone 'n rol gespeel; onder andere het die Taalkomitee van die Universiteit van Stellenbosch, byvoorbeeld, die hele manuskrip deurgewerk en aanbevelings gemaak. Die Aptekerswoordeboek is dus in die ware sin van die woord 'n nasionale kulturele bydrae.

Die verskyning van die woordeboek is ook 'n treffende bewys van die belangrike plek wat die aptekerswese al in ons land ingeneem het. Mediese dienste het in die afgelope aantal jare al meer ontwikkel in gesamentlike dienste. Die geneesheer staan nie meer alleen, soos dit in die verlede die geval was, in die stryd teen siekte en swak gesondheid nie. Hy tree al meer op as leier onder die gelykes van 'n span waarin vervaardigers van farmaseutiese produkte, en aptekers, verpleegsters, fisioterapeute, röntgenterapeute, arbeidterapeute, maatskaplike werkers, en baie ander almal belangrike skakels is. In ons ontwikkelende vaktaal moet die taal en terminologie van die geneesheer self, sowel as van al hierdie groepe persone, weerspieël word.

Daar wag dus nog 'n groot taak vir ons om in die toekoms aan te pak. In die tussentyd wil ons graag alles in ons vermoë doen om die reeds bereikte prestasies te help bestendig. Om hierdie rede wil ons dus graag die algemene gebruik van die *Aptekerswoordeboek* sterk aanbeveel by geneeshere, mediese studente, verpleegsters, vervaardigers van farmaseutiese produkte, aptekers, en al die ander lede van die ‚grotere mediese professie' wat ons hierbo genoem het.