

6. References

- Abe, T., Tsuge, I., Kamachi, Y., Torii, S., Utsumi, K., Akahori, Y., Ichihara, Y., Kurosawa, Y. & Matsuoka, H. (1994) Evidence for defects in V(D)J rearrangements in patients with severe combined immunodeficiency. *J. Immunol.*, **152**, 5504–5513
- Abrahamson, A., Bender, M.A., Boecker, B.B., Gilbert, E.S. & Scott, B.R. (1991) *Health Effects Models for Nuclear Power Plant Accident Consequence Analysis. Modifications of Models Resulting from Recent Reports on Health Effects of Ionizing Radiation* (NUREG/CR-4214, Rev. 1, Part II, Addendum 1, LMF-132), Washington DC, United States Nuclear Regulatory Commission
- Adams, L.M., Ethier, S.P. & Ullrich, R.L. (1987) Enhanced *in vitro* proliferation and *in vivo* tumorigenic potential of mammary epithelium from BALB/c mice exposed *in vivo* to γ -radiation and/or 7,12-dimethylbenz[*a*]anthracene. *Cancer Res.*, **47**, 4425–4431
- Ahsan, H. & Neugut, A.I. (1998) Radiation therapy for breast cancer and increased risk for esophageal carcinoma. *Ann. intern. Med.*, **128**, 114–117
- Ajimura, M., Leem, S.H. & Ogawa, H. (1993) Identification of new genes required for meiotic recombination in *Saccharomyces cerevisiae*. *Genetics*, **133**, 51–66
- Akamatsu, Y. & Oettinger, M.A. (1998) Distinct roles of RAG1 and RAG2 in binding the V(D)J recombination signal sequences. *Mol. cell Biol.*, **18**, 4670–4678
- Albertini, R.J., Castle, K.L. & Borchering, W.R. (1982) T-cell cloning to detect the mutant 6-thioguanine-resistant lymphocytes present in human peripheral blood. *Proc. natl Acad. Sci. USA*, **79**, 6617–6621
- Alderson, M.R. & Jackson, S.M. (1971) Long term follow-up of patients with menorrhagia treated by irradiation. *Br. J. Radiol.*, **441**, 295–298
- Allalunis-Turner, M.J., Zia, P.K.Y., Barron, G.M., Mirzayans, R. & Day, R.S., III (1995) Radiation-induced DNA damage and repair in cells of a radiosensitive human malignant glioma cell line. *Radiat. Res.*, **144**, 288–293
- Allwright, S.P.A., Colgan, P.A., McAulay, I.R. & Mullins, E. (1983) Natural background radiation and cancer mortality in the Republic of Ireland. *Int. J. Epidemiol.*, **12**, 414–418
- Alpen, E.L. & Powers-Risius, P. (1981) The relative biological effect of high-Z, high-LET charged particles for spermatogonial killing. *Radiat. Res.*, **88**, 132–143
- Al-Saleem, T., Wessner, L.L., Scheithauer, B.W., Patterson, K., Roach, E.S., Dreyer, S.J., Fujikawa, K., Bjornsson, J., Berstein, J. & Henske, E.P. (1998) Malignant tumors of the kidney, brain, and soft tissues in children and young adults with the tuberous sclerosis complex. *Cancer*, **83**, 2208–2216
- Amsel, J., Waterbor, J.W., Oler, J., Rosenwaike, I. & Marshall, K. (1982) Relationship of site-specific cancer mortality rates to altitude. *Carcinogenesis*, **3**, 461–465
- Anderson, C.W. & Carter, T.H. (1996) The DNA-activated protein-kinase DNA-PK. *Curr. Top. Microbiol. Immunol.*, **217**, 91–111
- Andersson, M., Storm, H.H. & Mouridsen, H.T. (1991) Incidence of new primary cancers after adjuvant tamoxifen therapy and radiotherapy for early breast cancer. *J. natl Cancer Inst.*, **83**, 1013–1017
- Anspaugh, L.R., Ricker, Y.E., Black, S.C., Grossman, R.F., Wheeler, D.L., Church, B.W. & Quinn, V.E. (1990) Historical estimates of external gamma exposure and collective

- external gamma exposure from testing at the Nevada test site. II. Test series after Hardtack II, 1958, and summary. *Health Phys.*, **59**, 525–532
- Antoccia, A., Ricordy, R., Maraschio, P., Prudente, S. & Tanzarella, C. (1997) Chromosomal sensitivity to clastogenic agents and cell cycle perturbations in Nijmegen breakage syndrome lymphoblastoid cell lines. *Int. J. Radiat. Biol.*, **71**, 41–49
- Appleby, J.M., Barber, J.B.P., Levine, E., Varley, J.M., Taylor, A.M.R., Stankovic, T., Heighway, J., Warren, C. & Scott, D. (1997) Absence of mutations in the *ATM* gene in breast cancer patients with severe responses to radiotherapy. *Br. J. Cancer*, **76**, 1546–1549
- Arai, T., Nakano, T., Fukuhisa, K., Kasamatsu, T., Tsunematsu, R., Masubuchi, K., Yamauchi, K., Hamada, T., Fukuda, T. & Noguchi, H. (1991) Second cancer after radiation therapy for cancer of the uterine cervix. *Cancer*, **67**, 398–405
- Araki, R., Fujimori, A., Hamatani, K., Mita, K., Saito, T., Mori, M., Fukumura, R., Morimyo, M., Muto, M., Itoh, M., Tatsumi, K. & Abe, M. (1997) Nonsense mutation at Tyr-4046 in the DNA-dependent protein kinase catalytic subunit of severe combined immune deficiency mice. *Proc. natl Acad. Sci. USA*, **94**, 2438–2443
- Arlett, C.F. & Priestley, A. (1983). Defective recovery from potentially lethal damage in some human fibroblast cell strains. *Int. J. Radiat. Biol.*, **43**, 157–167
- Artuso, M., Esteve, A., Brésil, H., Vuillaume, M. & Hall, J. (1995) The role of the ataxia telangiectasia gene in the p53, WAF1/CIP1(p21)- and GADD45-mediated response to DNA damage produced by ionizing radiation. *Oncogene*, **8**, 1427–1435
- Ash, P. (1980) The influence of radiation on fertility in man. *Br. J. Radiol.*, **53**, 271–278
- Ashmore, J.P., Krewski, D., Zielinski, J.M., Jiang, H., Semenciw, R. & Band, P.R. (1998) First analysis of mortality and occupational radiation exposure based on the National Dose Registry of Canada. *Am. J. Epidemiol.*, **148**, 564–574
- Atahan, I.L., Yildiz, F., Ozyar, E., Uzal, D. & Zorlu, F. (1998) Basal cell carcinomas developing in a case of medulloblastoma associated with Gorlin's syndrome. *Pediatr. Hematol. Oncol.*, **15**, 187–191
- Auvinen, A., Hakama, M., Arvela, H., Hakulinen, T., Rahola, T., Suomela, M., Söderman, B. & Rytömaa T. (1994) Fallout from Chernobyl and incidence of childhood leukaemia in Finland, 1976–92. *Br. med. J.*, **309**, 151–154
- Awa, A. (1997) Analysis of chromosome aberrations in atomic bomb survivors for dose assessment: Studies at the Radiation Effects Research Foundation from 1968 to 1993. *Stem Cells*, **15** (Suppl. 2), 163–173
- Azzam, E.I., de Toledo, S.M., Raaphorst, G.P. & Mitchel, R.E. (1996) Low-dose ionizing radiation decreases the frequency of neoplastic transformation to a level below the spontaneous rate in C3H 10T1/2 cells. *Radiat. Res.*, **146**, 369–373
- Badie, C., Iliakis, G., Foray, N., Alsbeih, G., Pantellias, G.E., Okayasu, R., Cheong, N., Russell, N.S., Begg, A.C., Arlett, C.F. & Malaise, E.P. (1995) Defective repair of DNA double-strand breaks and chromosome damage in fibroblasts from a radiosensitive leukemia patient. *Cancer Res.*, **55**, 1232–1234
- Badie, C., Goodhardt, M., Waugh, A., Doyen, N., Foray, N., Calsou, P., Singleton, B., Gell, D., Salles, B., Jeggo, P., Arlett, C.F. & Malaise, E.-P. (1997) A DNA double-strand break defective fibroblast cell line (180BR) derived from a radiosensitive patient represents a new mutant phenotype. *Cancer Res.*, **57**, 4600–4607

- Baer, R., Heppell, A., Taylor, A.M.R., Rabbitts, P.H., Bouiller, B. & Rabbitts, T.H. (1987) The breakpoint of an inversion of chromosome 14 in a T-cell leukemia: Sequences downstream of the immunoglobulin heavy chain locus are implicated in tumorigenesis. *Proc. natl Acad. Sci. USA*, **84**, 9069–9073
- Banin, S., Moyal, L., Shieh, S.-Y., Taya, Y., Anderson, C.W., Chessa, L., Smorodinsky, N.I., Prives, C., Reiss, Y., Shiloh, Y. & Ziv, Y. (1998) Enhanced phosphorylation of p53 by ATM in response to DNA damage. *Science*, **281**, 1674–1677
- Barabanova, A. & Osanov, D.P. (1990) The dependence of skin lesions on the depth-dose distribution of β -irradiation of people in the Chernobyl nuclear power plant accident. *Int. J. Radiat. Biol.*, **57**, 775–782
- Baral, E., Larsson, L.-E. & Mattsson, B. (1977) Breast cancer following irradiation of the breast. *Cancer*, **40**, 2905–2910
- Barbi, G., Scheres, J.M.J.C., Schindler, D., Taalman, R.D.F.M., Rodens, K., Mehnert, K., Müller, M. & Seyschab, H. (1991) Chromosome instability and X-ray hypersensitivity in a microcephalic and growth-retarded child. *Am. J. med. Genet.*, **40**, 44–50
- Barlow, C., Hirotsune, S., Paylor, R., Liyanage, M., Eckhaus, M., Collins, F., Shiloh, Y., Crawley J.N., Reid, T., Tagle, D. & Wynshaw-Boris, A. (1996) *Atm*-deficient mice: A paradigm of ataxia-telangiectasia. *Cell*, **86**, 159–171
- Bartstra, R.W., Bentvelzen, P.A., Zoetelief, J., Mulder, A.H., Broerse, J.J. & van Bekkum, D.W. (1998) Induction of mammary tumors in rats by single-dose gamma irradiation at different ages. *Radiat. Res.*, **150**, 442–450
- Basco, V.E., Coldman, A.J., Elwood, J.M. & Young, M.E.J. (1985) Radiation dose and second breast cancer. *Br. J. Cancer*, **52**, 319–325
- Batchelor, A.L., Phillips, R.J.S. & Searle, A.G. (1966) A comparison of the mutagenic effectiveness of chronic neutron- and gamma irradiation of mouse spermatogonia. *Mutat. Res.*, **3**, 218–229
- Beamish, H. & Lavin, M.F. (1994) Radiosensitivity in ataxia-telangiectasia: Anomalies in radiation-induced cell cycle delay. *Int. J. Radiat. Biol.*, **65**, 175–184
- Beaty, O., III, Hudson, M.M., Greenwald, C., Luo, X., Fang, L., Wilimas, J.A., Thompson, E.I., Kun, L.E. & Pratt, C.B. (1995) Subsequent malignancies in children and adolescents after treatment for Hodgkin's disease. *J. clin. Oncol.*, **13**, 603–609
- Becciolini, A. (1987) Relative radiosensitivities of the small and large intestine. *Adv. Radiat. Biol.*, **12**, 83–128
- Bendel, I., Schüttmann, W. & Arndt, D. (1978) Cataract of lens as late effect of ionizing radiation in occupationally exposed persons. In: *Late Effects of Biological Effects of Ionizing Radiation*, Vol. 1, Vienna, International Atomic Energy Agency, pp. 309–319
- Beninson, D. (1997) Risk of radiation at low doses. *Health Phys.*, **71**, 122–125
- Benjamin, S.A., Saunders, W.J., Angleton, G.M. & Lee, A.C. (1991) Radiation carcinogenesis in dogs irradiated during prenatal and postnatal development. *J. Radiat. Res.*, **Suppl. 2**, 86–103
- Benjamin, S.A., Saunders, W.J., Lee, A.C., Angleton, G.M., Stephens, L.C. & Mallinckrodt, C.H. (1997) Non-neoplastic and neoplastic thyroid disease in beagles irradiated during prenatal and postnatal development. *Radiat. Res.*, **147**, 422–430

- Bentley, N.J., Holtzman, D.A., Flaggs, G., Keegan, K.S., DeMaggio, A., Ford, J.C., Hoekstra, M. & Carr, A.M. (1996) The *Schizosaccharomyces pombe rad3* checkpoint gene. *EMBO J.*, **15**, 6641–6651
- Beral, V., Fraser, P., Carpenter, L., Booth, M., Brown, A. & Rose, G. (1988) Mortality of employees of the Atomic Weapons Establishment, 1951–82. *Br. med. J.*, **297**, 757–770
- Bethwaite, P.B., Koreth, J., Herrington, C.S. & McGee, J.O. (1995) Loss of heterozygosity occurs at the D11S29 locus on chromosome 11q23 in invasive cervical carcinoma. *Br. J. Cancer*, **71**, 814–818
- Bhatia, S., Robison, L.L., Oberlin, O., Greenberg, M., Bunin, G., Fossati-Bellani, F. & Meadows, A.T. (1996) Breast cancer and other second neoplasms after childhood Hodgkin's disease. *New Engl. J. Med.*, **334**, 745–751
- Biedermann, K.A., Sun, J., Giacca, A.J., Tosto, L.M. & Brown, J.M. (1991) *Scid* mutation in mice confers hypersensitivity to ionizing radiation and a deficiency in DNA double-strand break repair. *Proc. natl Acad. Sci. USA*, **88**, 1394–1397
- Bithell, J.F. & Stewart, A.M. (1975) Pre-natal irradiation and childhood malignancy: A review of British data from the Oxford Survey. *Br. J. Cancer*, **31**, 271–287
- Bithell, J.F., Dutton, S.J., Draper, G.J. & Neary, N.M. (1994) Distribution of childhood leukaemias and non-Hodgkin's lymphomas near nuclear installations in England and Wales. *Br. med. J.*, **309**, 501–505
- Black, D. (1984) *Investigation of the Possible Increased Incidence of Cancer in Western Cumbria*, London, Her Majesty's Stationery Office
- Blayney, D.W., Longo, D.L., Young, R.C., Greene, M.H., Hubbard, S.M., Postal, M.G., Duffey, P.L. & DeVita, V.T., Jr (1987) Decreasing risk of leukemia with prolonged follow-up after chemotherapy and radiotherapy for Hodgkin's disease. *New Engl. J. Med.*, **316**, 710–714
- Blettner, M. & Boice, J.D., Jr (1991) Radiation dose and leukaemia risk: General relative risk techniques for dose–response models in a matched case–control study. *Stat. Med.*, **10**, 1511–1526
- Bliss, P., Kerr, G.R. & Gregor, A. (1994) Incidence of second brain tumours after pituitary irradiation in Edinburgh 1962–1990. *Clin. Oncol.*, **6**, 361–363
- Blunt, T., Finnie, N.J., Taccioli, G.E., Smith, G.C.M., Demengeot, J., Gottlieb, T.M., Mizuta, R., Varghese, A.J., Alt, F.W., Jeggo, P.A. & Jackson, S.P. (1995) Defective DNA-dependent protein kinase activity is linked to V(D)J recombination and DNA repair defects associated with the murine *scid* mutation. *Cell*, **80**, 813–823
- Boder, E. (1985) Ataxia-telangiectasia: An overview. In: Gatti, R.A. & Swift, M., eds, *Ataxia-telangiectasia: Genetics, Neuropathology, and Immunology of a Degenerative Disease of Childhood*. New York, Alan R. Liss, pp. 1–63
- Boder, E. & Sedgwick, R.P. (1963) Ataxia-telangiectasia. A review of 101 cases. In: Walsh, G., ed., *Little Club Clinics in Developmental Medicine*, No. 8, London, Heinemann Medical Books, pp. 110–118
- Boei, J.J.W.A., Vermeulen, S. & Natarajan, A.T. (1997) Differential involvement of chromosomes 1 and 4 in the formation of chromosomal aberrations in human lymphocytes after X-irradiation. *Int. J. Radiat. Biol.*, **72**, 139–145
- Boei, J.J.W.A., Vermeulen, S., Fomina, J. & Natarajan, A.T. (1998a) Detection of incomplete exchanges and interstitial fragments in X-irradiated human lymphocytes using a telomeric PNA probe. *Int. J. Rad. Biol.*, **73**, 599–603

- Boei, J.J.W.A., Vermeulen, S. & Natarajan, A.T. (1998b) Dose-response curves for X-ray induced interchanges and inter-arm intrachanges in human lymphocytes using arm-specific probes for chromosome 1. *Mutat. Res.*, **404**, 45–53
- Boice, J.D., Jr (1992) Radiation and non-Hodgkin's lymphoma. *Cancer Res.*, **52**, 5489–5491
- Boice, J.D., Jr (1996) Risk estimates for radiation exposure. In: Hendee, W.R. & Edwards, F.M., eds, *Health Effects of Exposure to Low-level Ionizing Radiation*, Philadelphia, Institute of Physics Publishing, pp. 237–268
- Boice, J.D., Jr (1997) Radiation epidemiology: Past and present. In: Boice, J.D., Jr, ed., *Implications of New Data on Radiation Cancer Risk* (NCRP Proceedings No. 18), Bethesda, MD, National Council on Radiation Protection and Measurements, pp. 7–28
- Boice, J.D., Jr & Inskip, P.D. (1996) Radiation-induced leukemia. In: Henderson, E.S., Lister, T.A. & Greaves, M.F., eds, *Leukemia*, 6th Ed., Philadelphia, W.B. Saunders, pp. 195–209
- Boice, J.D., Jr & Miller, R.W. (1999) Childhood and adult cancer after intrauterine exposure to ionizing radiation. *Teratology*, **59**, 227–233
- Boice, J.D., Jr, Land, C.E., Shore, R.E., Norman, J.E. & Tokunaga, M. (1979) Risk of breast cancer following low-dose radiation exposure. *Radiology*, **131**, 589–597
- Boice, J.D., Jr, Storm, H.H., Curtis, R.E., Jensen, O.M., Kleinerman, R.A., Jensen, H.S., Flannery, J.T. & Fraumeni, J.F., Jr, eds (1985a) Multiple primary cancers in Connecticut and Denmark. *Natl Cancer Inst. Monogr.*, **68**
- Boice, J.D., Jr, Day, N.E., Andersen, A., Brinton, L.A., Brown, R., Choi, N.W., Clarke, E.A., Coleman, M.P., Curtis, R.E., Flannery, J.T., Hakama, M., Hakulinen, T., Howe, G.R., Jensen, O.M., Kleinerman, R.A., Magnin, D., Magnus, K., Makela, K., Malke, B., Miller, A.B., Nelson, N., Patterson, C.C., Pettersson, F., Pompe-Kirn, V., Primić, M., Prior, P., Ravnihar, B., Skeet, R.G., Skjerven, J.E., Smith, P.G., Sok, M., Spengler, R.F., Storm, H.H., Stovall, M., Tomkins, G.W.O. & Wall, C. (1985b) Second cancers following radiation treatment for cervical cancer. An international collaboration among cancer registries. *J. natl Cancer Inst.*, **74**, 955–975
- Boice, J.D., Jr, Blettner, M., Kleinerman, R.A., Stovall, M., Moloney, W.C., Engholm, G., Austin, D.F., Bosch, A., Cookfair, D.L., Krentz, E.T., Latourette, H.B., Peters, L.J., Schulz, M.D., Lundell, M., Pettersson, F., Storm, H.H., Bell, C.M.J., Coleman, M.P., Fraser, P., Palmer, M., Prior, P., Choi, N.W., Hislop, T.G., Koch, M., Robb, D., Robson, D., Spengler, R.F., von Fournier, D., Frischkorn, R., Lochmüller, H., Pompe-Kirn, V., Rimpela, A., Kjørstad, K., Pejovic, M.H., Sigurdsson, K., Pisani, P., Kucera, H. & Hutchison, G.B. (1987) Radiation dose and leukemia risk in patients treated for cancer of the cervix. *J. natl Cancer Inst.*, **79**, 1295–1311
- Boice, J.D., Jr, Engholm, G., Kleinerman, R.A., Blettner, M., Stovall, M., Lisco, H., Moloney, W.C., Austin, D.F., Bosch, A., Cookfair, D.L., Krentz, E.T., Latourette, H.B., Merrill, J.A., Peters, L.J., Schulz, M.D., Storm, H.H., Björkholm, E., Pettersson, F., Bell, C.M.J., Coleman, M.P., Fraser, P., Neal, F.E., Prior, P., Choi, N.W., Hislop, T.G., Koch, M., Kreiger, N., Robb, D., Robson, D., Thomson, D.H., Lochmüller, H., von Fournier, D., Frischkorn, R., Kjørstad, K.E., Rimpela, A., Pejovic, M.-H., Pompe Kirn, V., Stankusova, H., Berrino, F., Sigurdsson, K., Hutchison, G.B. & MacMahon, B. (1988) Radiation dose and second cancer risk in patients treated for cancer of the cervix. *Radiat. Res.*, **116**, 3–55
- Boice, J.D., Jr, Blettner, M., Kleinerman, R.A., Engholm, G., Stovall, M., Lisco, H., Austin, D.F., Bosch, A., Harlan, L., Krentz, E.T., Latourette, H.B., Merrill, J.M., Peters, L.J.,

- Schulz, M.D., Wactawski, J., Storm, H.H., Björkholm, E., Pettersson, F., Bell, C.M.J., Coleman, M.P., Fraser, P., Neal, F.E., Prior, P., Choi, N.W., Hislop, T.G., Koch, M., Kreiger, N., Robb, D., Robson, D., Thomson, D.H., Lochmüller, H., von Fournier, D., Frischkorn, R., Kjørstad, K.E., Rimpelä, A., Pejovick, M.-H., Pompe Kirn, V., Stankusova, H., Pisani, P., Sigurdsson, K., Hutchison, G.B. & MacMahon, B. (1989) Radiation dose and breast cancer risk in patients treated for cancer of the cervix. *Int. J. Cancer*, **44**, 7–16
- Boice, J.D., Jr, Morin, M.M., Glass, A.G., Friedman, G.D., Stovall, M., Hoover, R.N. & Fraumeni, J.F., Jr (1991a) Diagnostic X-ray procedures and risk of leukemia, lymphoma, and multiple myeloma. *J. Am. med. Assoc.*, **265**, 1290–1294
- Boice, J.D., Jr, Preston, D., Davis, F.G. & Monson, R.R. (1991b) Frequent chest X-ray fluoroscopy and breast cancer incidence among tuberculosis patients in Massachusetts. *Radiat. Res.*, **125**, 214–222
- Boice, J.D., Jr, Harvey, E.B., Blettner, M., Stovall, M. & Flannery, J.T. (1992) Cancer in the contralateral breast after radiotherapy for breast cancer. *New Engl. J. Med.*, **326**, 781–785
- Boice, J.D., Jr, Mandel, J.S. & Doody, M.M. (1995) Breast cancer among radiologic technologists. *J. Am. med. Assoc.*, **274**, 394–401
- Boice, J.D., Jr, Land, C.E. & Preston, D.L. (1996) Ionizing radiation. In: Schottenfeld, D. & Fraumeni, J.F., Jr, eds, *Cancer Epidemiology and Prevention*, 2nd Ed., New York, Oxford University Press, pp. 319–354
- Boivin, J.-F., Hutchison, G.B., Evans, F.B., Abou-Daoud, K.T. & Junod, B. (1986) Leukemia after radiotherapy for first primary cancers of various anatomic sites. *Am. J. Epidemiol.*, **123**, 993–1003
- Boivin, J.-F., Hutchison, G.B., Zauber, A.G., Bernstein, L., Davis, F.G., Michel, R.P., Zanke, B., Tan, C.T.C., Fuller, L.M., Mauch, P. & Ultsch, J.E. (1995) Incidence of second cancers in patients treated for Hodgkin's disease. *J. natl Cancer Inst.*, **87**, 732–741
- Bond, V.P., Fliedner, T.M. & Archambeau, J.O. (1965) *Mammalian Radiation Lethality: A Disturbance in Cellular Kinetics*, New York, Academic Press
- Borek, C. & Sachs, L. (1966) In vitro cell transformation by X-irradiation. *Nature*, **210**, 276–278
- Bosma, G.C., Custer, R.P. & Bosma, M.J. (1983) A severe combined immunodeficiency mutation in the mouse. *Nature*, **301**, 527–530
- Bouffler, S.D., Kemp, C.J., Balmain, A. & Cox, R. (1995) Spontaneous and ionizing radiation-induced chromosomal abnormalities in *p53*-deficient mice. *Cancer Res.*, **55**, 3883–3889
- Bougrov, N.G., Goksu, H.Y., Hasakell, E., Degteva, M.O., Meckbach, R. & Jacob, P. (1998) Issues in the reconstruction of environmental doses on the basis of thermoluminescence measurements in the Techa riverside. *Health Phys.*, **75**, 574–583
- Brada, M., Ford, D., Ashley, S., Bliss, J.M., Crowley, S., Mason, M., Rajan, B. & Traish, D. (1992) Risk of second brain tumour after conservative surgery and radiotherapy for pituitary adenoma. *Br. med. J.*, **304**, 1343–1346
- Bradley, W.E., Belouchi, A. & Messing, K. (1988) The aprt heterozygote/hemizygote system for screening mutagenic agents allows detection of large deletions. *Mutat. Res.*, **199**, 131–138
- Bridges, B.A., Dennis, R.E. & Munson, R.J. (1967) Mutation in *Escherichia coli* B/r WP2 try⁻ by reversion or suppression of a chain-terminating codon. *Mutat. Res.*, **4**, 502–504

- Bridges, B.A., Law, J. & Munson, R.J. (1968) Mutagenesis in *Escherichia coli*. II. Evidence for a common pathway for mutagenesis by ultraviolet light, ionizing radiation and thymine deprivation. *Mol. Gen. Genet.*, **103**, 266–273
- Bridges, B.A., Huckle, J. & Ashwood-Smith, M.J. (1970) X-ray mutagenesis of cultured Chinese hamster cells. *Nature*, **226**, 184–185
- Brill, A.B., Tomonaga, M. & Heyssel, R.M. (1962) Leukemia in man following exposure to ionizing radiation. A summary of the findings in Hiroshima and Nagasaki, and a comparison with other human experience. *Ann. intern. Med.*, **56**, 590–609
- Broerse, J.J., Hollander, C.F. & Van Zwieten, M.J. (1981) Tumor induction in rhesus monkeys after total body irradiation with X-rays and fission neutrons. *Int. J. Radiat. Biol.*, **40**, 671–676
- Broerse, J.J., Hennen, L.A. & Solleveld, H.A. (1986) Actuarial analysis of the hazard for mammary carcinogenesis in different rat strains after X- and neutron irradiation. *Leukemia Res.*, **10**, 749–754
- Broerse, J.J., Hennen, L.A., Klapwijk, W.M. & Solleveld, H.A. (1987) Mammary carcinogenesis in different rat strains after irradiation and hormone administration. *Int. J. Radiat. Biol.*, **51**, 1091–1100
- Brown, K.D., Ziv, Y., Sadanandan, S.N., Chessa, L., Collins, F.S., Shiloh, Y. & Tagle, D. (1997) The ataxia-telangiectasia gene product, a constitutively expressed nuclear protein that is not upregulated following genome damage. *Proc. natl Acad. Sci. USA*, **94**, 1840–1845
- Bryant, P.E. (1984) Enzymatic restriction of mammalian cell DNA using Pvu II and Bam HI: Evidence for the double strand break origin of chromosomal aberrations. *Int. J. Radiat. Biol.*, **46**, 57–65
- Bryant, P.E. & Riches, A.C. (1989) Oncogenic transformation of murine C3H 10T1/2 cells resulting from DNA double-strand breaks induced by a restriction endonuclease. *Br. J. Cancer*, **60**, 852–854
- Budach, W., Hartford, A., Gioioso, D., Freeman, J., Taghian, A. & Suit, H.D. (1992) Tumors arising in SCID mice share enhanced radiation sensitivity of SCID normal tissues. *Cancer Res.*, **52**, 6292–6296.
- Budach, W., Classen, J., Belka, C. & Bamberg, M. (1998) Clinical impact of predictive assays for acute and late radiation morbidity. *Strahlenther. Onkol.*, **174** (Suppl. 3), 20–24
- Bullrich, F., Rasio, D., Kitada, S., Starostik, P., Kipps, T., Keating, M., Albitar, M., Rees, J.C. & Croce, C.M. (1999) *ATM* mutations in B-cell chronic lymphocytic leukemia. *Cancer Res.*, **59**, 24–27
- Bultman, S.J., Russell, L.B., Gutierrez-Espeleta, G.A. & Woychik, R.P. (1991) Molecular characterization of a region of DNA associated with mutations at the *agouti* locus in the mouse. *Proc. natl. Acad. Sci. USA*, **88**, 8062–8066
- Bundesamt für Strahlenschutz (1998) *Radioactivity in the Environment in the Federal Republic of Germany 1994–1995* (BfS-SCHR-16/98), Bremerhafen (in German)
- Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU) (1999) *Environmental Policy, Environmental Radioactivity and Radiation Exposure in the Year 1996*, Bonn (in German)
- Bunger, B.M., Cook, J.R. & Barrick, M.K. (1981) Life table methodology for evaluating radiation risk: An application based on occupational exposures. *Health Phys.*, **40**, 439–455

- van der Burgt, I., Chrzanowska, K.H., Smeets, D. & Weemaes, C. (1996) Nijmegen breakage syndrome. *J. med. Genet.*, **33**, 153–156
- Burkart, W. (1996) Radioepidemiology in the aftermath of the nuclear program of the former Soviet Union: Unique lessons to be learnt. *Radiat. Environ. Biophys.*, **35**, 65–73
- Burkart, W. & Kellerer, A., eds (1994) A first assessment of radiation doses and health effects in workers and communities exposed since 1948 in the Southern Urals. *Sci. total Environ.*, **142**, 1–125
- Buzunov, V., Omelyanetz, N., Strapko, N., Ledoschuk, B., Krasnikova, L. & Kartushin, G. (1996) Chernobyl NPP accident consequences cleaning up participants in Ukraine—Health status epidemiologic study—main results. In: Karaoglou, A., Desmet, G., Kelly, G.N. & Menzel, H.G., eds, *The Radiological Consequences of the Chernobyl Accident* (Proceedings of the First International Conference, Minsk, Belarus, 18–22 March 1996), Luxembourg, Office for Official Publications of the European Communities, pp. 871–878
- Byrne, E., Hallpike, J.F., Manson, J.I., Sutherland, G.R. & Thong, Y.H. (1984) Ataxia-without-telangiectasia. Progressive multisystem degeneration with IgE deficiency and chromosomal instability. *J. neurol. Sci.*, **66**, 307–317
- Caldwell, G.G., Kelley, D., Zack, M., Falk, H. & Heath, C.W., Jr (1983) Mortality and cancer frequency among military nuclear test (Smoky) participants, 1957 through 1979. *J. Am. med. Assoc.*, **250**, 620–624
- Canman, C.E., Wolff, A.C., Chen, C.-Y., Fornace, A.J., Jr & Kastan, M.B. (1994) The p53 dependent G₁ cell cycle checkpoint pathway and ataxia-telangiectasia. *Cancer Res.*, **54**, 5054–5058
- Canman, C.E., Lim, D-S., Cimprich, K.A., Taya, Y., Tamai, K., Sakaguchi, K., Appella, E., Kastan, M.B. & Siliciano, J.D. (1998) Activation of the ATM kinase by ionizing radiation and phosphorylation of p53. *Science*, **281**, 1677–1679
- Cao, L., Alani, E. & Kleckner, N. (1990) A pathway for generation and processing of double-strand breaks during meiotic recombination in *S. cerevisiae*. *Cell*, **61**, 1089–1101
- Cardis, E., Gilbert, E.S., Carpenter, L., Howe, G., Kato, I., Armstrong, B.K., Beral, V., Cowper, G., Douglas, A., Fix, J., Fry, S.A., Kaldor, J., Lavé, C., Salmon, L., Smith, P.G., Voelz, G.L. & Wiggs, LD. (1995) Effects of low doses and low dose rates of external ionizing radiation: Cancer mortality among nuclear industry workers in three countries. *Radiat. Res.*, **142**, 117–132
- Cardis, E., Anspaugh, L., Ivanov, V.K., Likhtarev, I.A., Mabuchi, K., Okeanov, A.E. & Prisyazhniuk, A.E. (1996) Estimated long term health effects of the Chernobyl accident, In: *One Decade after Chernobyl: Summing up the Consequences of the Accident*, Vienna, International Atomic Energy Agency, pp. 241–279
- Carney, J.P., Maser, R.S., Olivares, H., Davis, M.E., Le Beau, M., Yates, J.R., III, Hays, L., Morgan, W.F. & Petrini, J.H.J. (1998) The hMre 11/hRad50 protein complex and Nijmegen breakage syndrome: Linkage of double-strand break repair to the cellular DNA damage response. *Cell*, **93**, 477–486
- Carpenter, L., Higgins, C., Douglas, A., Fraser, P., Beral, V. & Smith, P. (1994) Combined analysis of mortality in three United Kingdom nuclear industry workforces, 1946–1988. *Radiat. Res.*, **138**, 224–238
- Casarett, G.W. (1980) *Radiation Histopathology*, Boca Raton, FL, CRC Press

- Cattanach, B.M., Patrick, G., Papworth, D., Goodhead, D.T., Hacker, T., Cobb, L. & Whitehill, E. (1995) Investigation of lung tumour induction in BALB/cJ mice following paternal X-irradiation. *Int. J. Radiat. Biol.*, **67**, 607–615
- Cattanach, B.M., Papworth, D., Patrick, G., Goodhead, D.T., Hacker, T., Cobb, L. & Whitehill, E. (1998) Investigation of lung tumour induction of C3H/HeH mice, with and without tumour promotion with urethane, following paternal X-irradiation. *Mutat. Res.*, **403**, 1–12
- Cavazzana-Calvo, M., Le Diest, F., De Saint Basile, G., Papadopoulo, D., De Villartay, J.P. & Fischer, A. (1993) Increased radiosensitivity of granulocyte macrophage colony-forming units and skin fibroblasts in human autosomal recessive severe combined immunodeficiency. *J. clin. Invest.*, **91**, 1214–1218
- Cerosaletti, K.M., Lange, E., Stringham, H.M., Weemaes, C.M.R., Smeets, D., Sölder, B., Belohradsky, B.H., Taylor, A.M.R., Karnes, P., Elliott, A., Komatsu, K., Gatti, R.A., Boehnke, M. & Concannon, P. (1998) Fine localization of the Nijmegen breakage syndrome gene to 8q21: Evidence for a common founder haplotype. *Am. J. hum. Genet* **63**, 125–134
- Chadwick, K.H. & Leenhouts, H.P. (1998) Radiation induced chromosome aberrations: Some biophysical considerations. *Mutat. Res.*, **404**, 113–117
- Chan, D.W., Gately, D.P., Urban, S., Galloway, A.M., Lees-Miller, S.P., Yen, T. & Allalunis-Turner, J. (1998) Lack of correlation between ATM protein expression and tumour cell radiosensitivity. *Int. J. Radiat. Biol.*, **74**, 217–224
- Chang, W.P. & Little, J.B. (1992) Delayed reproductive death as a dominant phenotype in cell clones surviving X-irradiation. *Carcinogenesis*, **13**, 923–928
- Chen, G. & Lee, E.Y.H.P. (1996) The product of the *ATM* gene is a 370 kDa nuclear phosphoprotein. *J. biol. Chem.*, **271**, 33693–33697
- Chen, D.-Q. & Wei, L.-X. (1991) Chromosome aberration, cancer mortality and hormetic phenomena among inhabitants in areas of high background radiation in China. *J. Radiat. Res.*, **32** (Suppl. 2), 46–53
- Chen, P.C., Lavin, M.F., Kidson, C. & Moss, D. (1978) Identification of ataxia telangiectasia heterozygotes, a cancer prone population. *Nature*, **274**, 484–486
- Chrzanowska, K.H., Kleijer, W.J., Krajewska-Walasek, M., Bialecka, M., Gutkowska, A., Goryluk-Kozakiewicz, B., Michalkiewicz, J., Stachowski, J., Gregorek, H., Lysón-Wojciechowska, G., Janowicz, W. & Józwiak, S. (1995) Eleven Polish patients with microcephaly, immunodeficiency, and chromosomal instability: The Nijmegen breakage syndrome. *Am. J. med. Genet.*, **57**, 462–471
- Cimprich, K.A., Shin, T.B., Keith, C.T. & Schreiber, S.L. (1996) cDNA cloning and gene mapping of a candidate human cell cycle checkpoint protein. *Proc. natl Acad. Sci. USA*, **93**, 2850–2855
- Clarke, E.A., Kreiger, N. & Spengler, R.F. (1984) Second primary cancer following treatment for cervical cancer. *Can. med. Assoc. J.*, **131**, 553–556
- Clarke, A.R., Gledhill, S., Hooper, M.L., Bird, C.C. & Wyllie, A.H. (1994) p53 dependence of early apoptotic and proliferative responses within the mouse intestinal epithelium following gamma-irradiation. *Oncogene*, **9**, 1767–1773
- Clifton, K.H., Tanner, M.A. & Gould, M.N. (1986) Assessment of radiogenic cancer initiation frequency per clonogenic rat mammary cell in vivo. *Cancer Res.*, **46**, 2390–2395

- Coggle, J.E. (1988) Lung tumour induction in mice after X-rays and neutrons. *Int. J. Radiat. Biol.*, **53**, 585–598
- Cohen, B.L. (1995) Test of the linear-no threshold theory of radiation carcinogenesis for inhaled radon decay products. *Health Phys.*, **68**, 157–174
- Cohen, M.M., Shaham, M., Dagan, J., Shmueli, E. & Kohn, G. (1975) Cytogenetic investigations in families with ataxia-telangiectasia. *Cytogenet. cell. Genet.*, **15**, 338–356
- Cole, J., Arlett, C.F., Green, M.H.L., Harcourt, S.A., Priestley, A., Henderson, L., Cole, H., James, S.E. & Richmond, F. (1988) Comparative human cellular radiosensitivity: II. The survival following gamma-irradiation of unstimulated (G_0) T-lymphocytes, T-lymphocyte lines, lymphoblastoid cell lines and fibroblasts from normal donors, from ataxia-telangiectasia patients and from ataxia-telangiectasia heterozygotes. *Int. J. Radiat. Biol.*, **54**, 929–943
- Commission of the European Communities (1993) *Radiation Atlas. Natural Sources of Ionizing Radiation in Europe* (Report EUR 14470), Luxembourg
- Committee on Medical Aspects of Radiation in the Environment (1996) *Fourth Report. The Incidence of Cancer and Leukaemia in Young People in the Vicinity of the Sellafield Site, West Cumbria: Further Studies and an Update of the Situation since the Publication of the Report of the Black Advisory Group in 1984*, London, Her Majesty's Stationery Office
- Committee on the Biological Effects of Ionizing Radiations (BEIR I) (1972) *The Effects on Populations of Exposure to Low Levels of Ionizing Radiation*, Washington DC, National Academy Press
- Committee on the Biological Effects of Ionizing Radiations (BEIR III) (1980) *The Effects on Populations of Exposure to Low Levels of Ionizing Radiation: 1980*, Washington DC, National Academy Press
- Committee on the Biological Effects of Ionizing Radiations (BEIR IV) (1988) *Health Risks of Radon and other Internally Deposited Alpha-emitters*, Washington DC, National Academy Press
- Committee on the Biological Effects of Ionizing Radiations (BEIR V) (1990) *Health Effects of Exposure to Low Levels of Ionizing Radiation*, Washington DC, National Academy Press
- Committee on the Biological Effects of Ionizing Radiations (BEIR VII) (1998) *Health Effects of Exposure to Low Levels of Ionizing Radiations. Time for Reassessment?* Washington DC, National Academy Press
- Conard, R.A., Paglia, D.E., Larsen, R.P., Sutow, W.W., Dobyns, B.M., Robbins, J., Krotosky, W.A., Field, J.B., Rall, J.E. & Wolff, J. (1980) *Review of Medical Findings in a Marshallese Population Twenty-six Years after Accidental Exposure to Radioactive Fallout* (Brookhaven National Laboratory Report BNL 51261), Springfield, VA, National Technical Information Service
- Conley, M.E., Spinner, N.B., Emanuel, B.S., Nowell, P.C. & Nichols, W.W. (1986) A chromosome breakage syndrome with profound immunodeficiency. *Blood*, **67**, 1251–1256.
- Cook-Mozaffari, P., Darby, S. & Doll, R. (1989) Cancer near potential sites of nuclear installations. *Lancet*, **ii**, 1145–1147
- Cornforth, M.N. & Bedford, J.S. (1985) On the nature of a defect in cells from individuals with ataxia-telangiectasia. *Science*, **227**, 1589–1591
- Court Brown, W.M. & Doll, R. (1957) *Leukaemia and Aplastic Anaemia in Patients Irradiated for Ankylosing Spondylitis*, London, Her Majesty's Stationery Office

- Court Brown, W.M., Doll, R. & Hill, A.B. (1960a) Incidence of leukemia after exposure to diagnostic radiation *in utero*. *Br. med. J.*, **5212**, 1539–1545
- Court Brown, W.M., Doll, R., Spiers, F.W., Duffy, B.J. & McHugh, M.J. (1960b) Geographical variation in leukaemia mortality in relation to background radiation and other factors. *Br. med. J.*, **5188**, 1753–1759
- Cox, B.D. & Lyon, M.F. (1975) X-ray induced dominant lethal mutations in mature and immature oocytes of guinea pigs and golden hamsters. *Mutat. Res.*, **28**, 421–436
- Cox, R., Masson, W.K., Weichselbaum, R.R., Nove, J. & Little, J.B. (1981) The repair of potentially lethal damage in X-irradiated cultures of normal and ataxia telangiectasia human fibroblasts. *Int. J. Radiat. Biol.*, **39**, 357–365
- Crick, M.J. & Linsley, G.S. (1984) An assessment of the radiological impact of the Windscale reactor fire, October 1957. *Int. J. Radiat. Biol.*, **46**, 479–506
- da-Cruz, A.D. & Glickman, B.W. (1997) Nature of mutation in the human *hprt* gene following *in vivo* exposure to ionizing radiation of cesium-137. *Environ. Mol. Mutag.*, **30**, 385–395
- da-Cruz, A.D., Curry, J., Curado, M.P. & Glickman, B.W. (1996) Monitoring *hprt* mutant frequencies over time in T-lymphocytes of people accidentally exposed to high doses of ionizing radiation. *Environ. mol. Mutag.*, **27**, 165–175
- Curtis, R.E. (1997) Second cancers following radiotherapy for cancer. In: Boice, J.D., Jr, ed., *Implications of New Data on Radiation Cancer Risk* (NCRP Proceedings No. 18), Bethesda, MD, National Council on Radiation Protection and Measurements, pp. 79–94
- Curtis, R.E., Boice, J.D., Jr, Stovall, M., Flannery, J.T. & Moloney, W.C. (1989) Leukemia risk following radiotherapy for breast cancer. *J. clin. Oncol.*, **7**, 21–29
- Curtis, R.E., Boice, J.D., Jr, Stovall, M., Bernstein, L., Greenberg, R.S., Flannery, J.T., Schwartz, A.G., Weyer, P., Moloney, W.C. & Hoover, R.N. (1992) Risk of leukemia after chemotherapy and radiation treatment for breast cancer. *New Engl. J. Med.*, **326**, 1745–1751
- Curtis, R.E., Boice, J.D., Jr, Stovall, M., Bernstein, L., Holowaty, E., Karjalainen, S., Langmark, F., Nasca, P.C., Schwartz, A.G., Schymura, M.J., Storm, H.H., Toogood, P., Weyer, P. & Moloney, W.C. (1994) Relationship of leukemia risk to radiation dose following cancer of the uterine corpus. *J. natl Cancer Inst.*, **86**, 1315–1324
- Curtis, R.E., Rowlings, P.A., Deeg, H.J., Shriner, D.A., Socié, G., Travis, L.B., Horowitz, M.M., Witherspoon, R.P., Hoover, R.N., Sobocinski, K.A., Fraumeni, J.F., Jr & Boice, J.D., Jr (1997) Solid cancers after bone marrow transplantation. *New Engl. J. Med.*, **336**, 897–904
- Cuypers, H.T. Selten, G., Quint, W., Zijlstra, M., Maandag, E.R., Boelens, W., van Wezenbeek, P., Melief, C. & Berns, A. (1984) Murine leukemia virus-induced T-cell lymphomagenesis: Integration of proviruses in a distinct chromosomal region. *Cell*, **37**, 141–150
- Cuzick, J. & De Stavola, B. (1988) Multiple myeloma—A case control study. *Br. J. Cancer*, **57**, 516–520
- van Daal, W.A.J., Goslings, B.M., Hermans, J., Ruiter, D.J., Sepmeyer, C.F., Vink, M., Van Vloten, W.A. & Thomas, P. (1983) Radiation-induced head and neck tumours: Is the skin as sensitive as the thyroid gland? *Eur. J. Cancer clin. Oncol.*, **19**, 1081–1086
- Daher, A., Varin, M., Lamontagne, Y. & Oth, D. (1998) Effect of pre-conceptual external or internal irradiation of N5 male mice and the risk of leukemia in their offspring. *Carcinogenesis*, **19**, 1553–1558

- Dalhberg, W.K. & Little, J.B. (1995) Response of dermal fibroblast cultures from patients with unusually severe responses to radiotherapy and from ataxia telangiectasia heterozygotes to fractionated radiation. *Clin. Cancer Res.*, **1**, 785–790
- Damber, L., Larsson, L.-G., Johansson, L. & Norin, T. (1995) A cohort study with regard to the risk of haematological malignancies in patients treated with X-rays for benign lesions in the locomotor system. I. Epidemiological analyses. *Acta oncol.*, **34**, 713–719
- Damewood, M.D. & Grochow, L.B. (1986) Prospects for fertility after chemotherapy or radiation for neoplastic disease. *Fertil. Steril.*, **45**, 443–459
- Darby, S.C. (1991) Contribution of natural ionizing radiation to cancer mortality in the United States. In: Brugge, J., Curran, T., Harlow, E. & McCormick, F., eds, *Origins of Human Cancer: A Comprehensive Review*, Cold Spring Harbor, NY, Cold Spring Harbor Laboratory Press, pp. 183–190
- Darby, S.C. & Doll, R. (1987) Fallout, radiation doses near Dounreay, and childhood leukaemia. *Br. med. J.*, **294**, 603–607
- Darby, S.C., Doll, R., Gill, S.K. & Smith, P.G. (1987) Long-term mortality after a single treatment course with X-rays in patients treated for ankylosing spondylitis. *Br. J. Cancer*, **55**, 179–190
- Darby, S.C., Kendall, G.M., Fell, T.P., O'Hagan, J.A., Muirhead, C.R., Ennis, J.R., Ball, A.M., Dennis, J.A. & Doll, R. (1988) A summary of mortality and incidence of cancer in men from the United Kingdom who participated in the United Kingdom's atmospheric nuclear weapon tests and experimental programmes. *Br. med. J.*, **296**, 332–338
- Darby, S.C., Kendall, G.M., Fell, T.P., Doll, R., Goodill, A.A., Conquest, A.J., Jackson, D.A. & Haylock, R.G. (1993) Further follow up of mortality and incidence of cancer in men from the United Kingdom who participated in the United Kingdom's atmospheric nuclear weapon tests and experimental programmes. *Br. med. J.*, **307**, 1530–1535
- Darby, S.C., Reeves, G., Key, T., Doll, R. & Stovall, M. (1994) Mortality in a cohort of women given X-ray therapy for metropathia haemorrhagica. *Int. J. Cancer*, **56**, 793–801
- Davey, M.P., Bertness, V., Nakahara, K., Johnson, J.P., McBride, O.W., Waldmann, T.A. & Kirsch, I.R. (1988) Juxtaposition of the T-cell receptor α -chain locus (14q11) and a region (14q32) of potential importance in leukaemogenesis by a 14:14 translocation in a patient with T-cell chronic lymphocytic leukaemia and ataxia-telangiectasia. *Proc. natl Acad. Sci. USA*, **85**, 9287–9291
- Davis, F.G., Boice, J.D., Jr, Hrubec, Z. & Monson, R.R. (1989) Cancer mortality in a radiation-exposed cohort of Massachusetts tuberculosis patients. *Cancer Res.*, **49**, 6130–6136
- Day, N.E. & Boice, J.C., Jr, eds (1984) *Second Cancers in Relation to Radiation Treatment for Cervical Cancer: Results of a Cancer Registry Collaboration* (IARC Scientific Publications No. 52), Lyon, IARC Press
- Deeg, H.J., Storb, R. & Thomas, E.D. (1984) Bone marrow transplantation: a review of delayed complications. *Br. J. Haematol.*, **57**, 185–208
- DeGroot, L.J., Reilly, M., Pinnamneni, K. & Refetoff, S. (1983) Retrospective and prospective study of radiation-induced thyroid disease. *Am. J. Med.*, **74**, 852–862
- Degteva, M.O., Kozheurov, V.P. & Vorobiova, M.I. (1994) General approach to dose reconstruction in the population exposed as a result of the release of radioactive wastes into the Techa River. *Sci. total Environ.*, **142**, 49–61

- Degteva, M.O., Kozheurov, V.P., Burmistrov, D.S., Vorobyova, M.I., Valchuk, V.V., Bougrov, N.G. & Shishkina, H.A. (1996) An approach to dose reconstruction for the Urals population. *Health Phys.*, **71**, 71–76
- DeOme, K.B., Miyamoto, M.J., Osborn, R.C., Guzman, R.C. & Lum, K. (1978) Detection of inapparent nodule-transformed cells in the mammary gland tissues of virgin female BALB/cfC3H mice. *Cancer Res.*, **38**, 2103–2111
- Di Majo, V., Coppola, M., Rebessi, S., Saran, A., Pazzaglia, S., Pariset, L. & Covelli, V. (1996) The influence of sex on life shortening and tumor induction in CBA/Cne mice exposed to X rays or fission neutrons. *Radiat. Res.*, **146**, 81–87
- Dolganov, G.M., Maser, R.S., Novikov, A., Tosto, L., Chong, S., Bressan, D.A. & Petrini, J.H.J. (1996) Human Rad50 is physically associated with human Mre11: Identification of a conserved multiprotein complex implicated in recombinational DNA repair. *Mol. cell. Biol.*, **16**, 4832–4841
- Doll R. (1995) Hazards of ionising radiation: 100 years of observations on man. *Br. J. Cancer*, **72**, 1339–1349
- Doll, R. & Wakeford, R. (1997) Risk of childhood cancer from fetal irradiation. *Br. J. Radiol.*, **70**, 130–139
- Doll, R., Evans, H.J. & Darby, S.C. (1994) Paternal exposure not to blame. *Nature*, **367**, 678–680
- Doody, M.M., Mandel, J.S., Lubin, J.H. & Boice, J.D., Jr (1998) Mortality among United States radiologic technologists, 1926–90. *Cancer Causes Control*, **9**, 67–75
- Douglas, A.J., Omar, R.Z. & Smith, P.G. (1994) Cancer mortality and morbidity among workers at the Sellafield plant of British Nuclear Fuels. *Br. J. Cancer*, **70**, 1232–1243
- Draper, G.J., Stiller, C.A., Cartwright, R.A., Craft, A.W. & Vincent, T.J. (1993) Cancer in Cumbria and in the vicinity of the Sellafield nuclear installation, 1963–1990. *Br. med. J.*, **306**, 89–94
- Draper, G.J., Little, M.P., Sorahan, T., Kinlen, L.J., Bunch, K.J., Conquest, A.J., Kendall, G.M., Kneale, G.W., Lancashire, R.J., Muirhead, C.R., O'Connor, C.M. & Vincent, T.J. (1997) Cancer in the offspring of radiation workers: A record-linkage study. *Br. Med. J.*, **315**, 1181–1188
- Dubrova, Y.E., Nesterov, V.N., Krouchinsky, N.G., Ostapenko, V.A., Neumann, R., Neil, D.L. & Jeffreys, A.J. (1996) Human minisatellite mutation rate after the Chernobyl accident. *Nature*, **380**, 683–686
- Dubrova, Y.E., Nesterov, V.N., Krouchinsky, N.G., Ostapenko, V.A., Vergnaud, G., Giraudeau, F., Buard, J. & Jeffreys, A.J. (1997) Further evidence for elevated human minisatellite mutation rate in Belarus eight years after the Chernobyl accident. *Mutat. Res.*, **381**, 267–278
- Dubrova, Y.E., Plumb, M., Brown, J. & Jeffreys, A.J. (1998a) Radiation-induced germline instability at minisatellite loci. *Int. J. Radiat. Biol.*, **74**, 689–96
- Dubrova, Y.E., Plumb, M., Brown, J., Fennelly, J., Bois, P., Goodhead, D. & Jeffreys, A.J. (1998b) Stage specificity, dose response, and doubling dose for mouse minisatellite germline mutation induced by acute radiation. *Proc. natl. Acad. Sci. USA*, **95**, 251–255
- Dulic, V., Kaufmann, W.K., Wilson, S.J., Tlsty, T.D., Lees, E., Harper, J.W., Elledge, S.J. & Reed, S.I. (1994) p53-dependent inhibition of cyclin-dependent kinase activities in human fibroblasts during radiation-induced G₁ arrest. *Cell*, **76**, 1013–1023

- Dunn, G.R. & Kohn, H.I. (1981) Some comparisons between induced and spontaneous mutation rates in mouse sperm and spermatogonia. *Mutat. Res.*, **80**, 159–164
- Easton, D.F. (1994) Cancer risks in A-T heterozygotes. *Int. J. Radiat. Biol.*, **6**, 177–182
- Easton, D.F. (1997) Breast cancer genes—What are the real risks? *Nat. Gen.*, **16**, 210–211
- Easton, D.F., Bishop, T., Ford, D. & Crockford, G.P. and the Breast Cancer Linkage Consortium (1993) Genetic linkage analysis in familial breast and ovarian cancer: Results from 214 families. *Am. J. Hum. Genet.*, **52**, 678–701
- Edling, C., Comba, P., Axelson, O. & Flodin, U. (1982) Effects of low-dose radiation—A correlation study. *Scand. J. Work Environ. Health*, **8** (Suppl. 1), 59–64
- Ehling, U.H. (1965) The frequency of X-ray-induced dominant mutations affecting the skeleton of mice. *Genetics*, **51**, 723–732
- Ehling, U.H. (1966) Dominant mutations affecting the skeleton in offspring of X-irradiated male mice. *Genetics*, **54**, 1381–1389
- Ehling, U.H. (1971) Comparison of radiation- and chemically-induced dominant lethal mutations in male mice. *Mutat. Res.*, **11**, 35–44
- Ehling, U.H. (1985) The induction and manifestation of hereditary cataracts. In: Woodhead, A.V., Shellabarger, C.J., Bond, V. & Hollaender, A., eds, *Assessment of Risk from Low-level Exposure to Radiation and Chemicals*, New York, Plenum, pp. 345–367
- Eker, R. & Mossige, J. (1961) A dominant gene for renal adenomas in the rat. *Nature*, **189**, 858–859
- Ellender, M., Larder, S.M., Harrison, J.D., Cox, R. & Silver, A.R.J. (1997) Radiation-induced intestinal neoplasia in a genetically-predisposed mouse (Min). *Radioprotection*, **32**, 287–288
- Elson, A., Wang, Y., Daugherty, C.J., Morton, C.C., Zhou, F., Campos-Torres, J. & Leder, P. (1996) Pleiotropic defects in ataxia-telangiectasia protein-deficient mice. *Proc. natl Acad. Sci. USA*, **83**, 13084–13089
- Eng, C., Li, F.P., Abramson, D.H., Ellsworth, R.M., Wong, F.L., Goldman, M.B., Seddon, J., Tarbell, N. & Boice, J.D., Jr (1993) Mortality from second tumors among long-term survivors of retinoblastoma. *J. natl Cancer Inst.*, **85**, 1121–1128
- Ethier, S.P. & Ullrich, R.L. (1982) Detection of ductal dysplasia in mammary outgrowths derived from carcinogen-treated virgin female BALB/c mice. *Cancer Res.*, **42**, 1753–1760
- Fabrikant, J.I. (1981) Health effects of the nuclear accident at Three Mile Island. *Health Phys.*, **40**, 151–161
- Fahrig, R. (1975) A mammalian spot test: Induction of genetic alterations in pigment cells of mouse embryos with x-rays and chemical mutagens. *Mol. Gen. Genet.*, **138**, 309–314
- Faulkin, L.J., Mitchell, D.J., Cardiff, R.D., Rosenblatt, L.S. & Goldman, M. (1983) Effects of X irradiation on the growth of normal and hyperplastic mouse mammary gland transplants. *Radiat. Res.*, **94**, 390–403
- Favus, M.J., Schneider, A.B., Stachura, M.E., Arnold, J.E., Ryo, U.Y., Pinsky, S.M., Colman, M., Arnold, M.J. & Frohman, L.A. (1976) Thyroid cancer occurring as a late consequence of head-and-neck irradiation. Evaluation of 1056 patients. *New Engl. J. Med.*, **294**, 1019–1025
- Fegan, C., Robinson, H., Thompson, P., Whittaker, J.A. & White, D. (1995) Karyotypic evolution in CLL: Identification of a new sub-group of patients with deletions of 11q and advanced progressive disease. *Leukemia*, **9**, 2203–2208

- Fehr, P.E. & Prem, M.D. (1973) Post irradiation sarcoma of the pelvic girdle following therapy for squamous cell carcinoma of the cervix. *Am. J. Obstet. Gynecol.*, **116**, 192–200
- Feigin, R.D., Vietti, T.J., Wyatt, R.G., Kaufmann, D.G. & Smith, C.H., Jr (1970) Ataxia-telangiectasia with granulocytopenia. *J. Pediatr.*, **77**, 431–438
- Fischer, A. (1992) Severe combined immunodeficiencies. *Immunodefic. Rev.*, **3**, 83–100
- Fjälling, M., Tisell, L.-E., Carlsson, S., Hansson, G., Lundberg, L.-M. & Odén, A. (1986) Benign and malignant thyroid nodules after neck irradiation. *Cancer*, **58**, 1219–1224
- Flodin, U., Fredriksson, M., Persson, B. & Axelsson, O. (1990) Acute myeloid leukemia and background radiation in an expanded case-referent study. *Arch. environ. Health*, **45**, 364–366
- Folley, J.H., Borges, W. & Yamasaki, T. (1952) Incidence of leukemia in survivors of the atom bomb in Hiroshima and Nagasaki, Japan. *Am. J. Med.*, **13**, 311–321
- Forastiere, F., Valesini, S., Arca, M., Magliola, M.E., Michelozzi, P. & Tasco, C. (1985) Lung cancer and natural radiation in an Italian province. *Sci. total Environ.*, **45**, 519–526
- Forastiere, F., Sperati, A., Cherubini, G., Miceli, M., Biggeri, A. & Axelsson, O. (1998) Adult myeloid leukaemia, geology, and domestic exposure to radon and γ radiation: A case control study in central Italy. *Occup. environ. Med.*, **55**, 106–110
- Foray, N., Priestley, A., Alsbeih, G., Badie, C., Capulas, E.P., Arlett, C.F. & Malaise, E.P. (1997) Hypersensitivity of ataxia-telangiectasia fibroblasts to ionizing radiation is associated with a repair deficiency of DNA double-strand breaks. *Int. J. Radiat. Biol.*, **72**, 271–283
- Ford, M.D., Martin, L. & Lavin, M.F. (1984) The effects of ionizing radiation on cell cycle progression in ataxia telangiectasia. *Mutat. Res.*, **125**, 115–122
- Forman, D., Cook-Mozaffari, P., Darby, S., Davey, G., Stratton, I., Doll, R. & Pike, M. (1987) Cancer near nuclear installations. *Nature*, **329**, 499–505
- Fornace, A.J., Jr & Little, J.B. (1980) Normal repair of DNA single-strand breaks in patients with ataxia-telangiectasia. *Biochim. biophys. Acta*, **607**, 432–437.
- Fraser, P., Carpenter, L., Maconochie, N., Higgins, C., Booth, M. & Beral, V. (1993) Cancer mortality and morbidity in employees of the United Kingdom Atomic Energy Authority. *Br. J. Cancer*, **67**, 615–624
- Friedberg, E.C., Walker, G.C. & Siede, W. (1995) *DNA Repair and Mutagenesis*, Washington DC, American Society for Microbiology (ASM) Press
- Friedberg, E.C., Meira, L.B. & Cheo, D.L. (1998) Database of mouse strains carrying targeted mutations in genes affecting cellular responses to DNA damage. Version 2. *Mutat. Res.*, **407**, 217–226
- Friend, S.H. (1996) Breast cancer susceptibility testing: Realities in the post-genomic era. *Nature Genet.*, **13**, 16–17
- Frome, E.L., Cragle, D.L., Watkins, J.P., Wing, S., Shy, C.M., Tankersley, W.G. & West, C.M. (1997) A mortality study of employees of the nuclear industry in Oak Ridge, Tennessee. *Radiat Res.*, **148**, 64–80 (erratum *Radiat. Res.*, 1997, **148**, 297–298)
- Fry, R.J.M. (1992) The role of animal experiments in estimates of radiation risk. In: Nygaard, O.F., Sinclair, W.K. & Lett, J.T., eds, *Advances in Radiation Biology*, Vol. 16, *Effects of Low Dose Rate Radiation*, San Diego, Academic Press, pp. 181–197
- Fry, R.J., Grosovsky, A., Hanawalt, P.C., Jostes, R.F., Little, J.B., Morgan, W.F., Oleinick, N.L. & Ullrich, R.L. (1998) The impact of biology on risk assessment—Workshop of the

- National Research Council's Board on Radiation Effects Research. *Radiat. Res.*, **150**, 695–705
- Fujii, K., Suzuki, N., Ishijima, S., Kita, K., Sonoda, T., Dezawa, M., Sugita, K. & Niimi, H. (1997) Abnormal DNA synthesis activity induced by X-rays in nevoid basal cell carcinoma syndrome cells. *Biochem. Biophys. Res. Commun.*, **240**, 269–272
- Fürst, C.J., Lundell, M., Holm, L.-E. & Silfversward, C. (1988) Cancer incidence after radiotherapy for a skin hemangioma: A retrospective cohort study in Sweden. *J. natl Cancer Inst.*, **80**, 1387–1392
- Fürst, C.J., Silfversward, C. & Holm, L.-E. (1989) Mortality in a cohort of radiation treated childhood skin hemangiomas. *Acta oncol.*, **28**, 789–794
- Fürst, C.J., Lundell, M. & Holm, L.-E. (1990) Tumors after radiotherapy for skin hemangioma in childhood. A case-control study. *Acta oncol.*, **29**, 557–562
- Fushiki, S., Matsushita, K. & Schull, W.J. (1993) Decelerated migration of neocortical neurones in explant culture after exposure to radiation. *NeuroReproduction*, **5**, 353–356
- Futreal, A., Liu, Q., Shattuck-Eidens, D., Cochran, C., Harshman, K., Tavtigian, S., Bennett, L.M., Haugen-Strano, A., Swensen, J., Miki, Y., Eddington, K., McClure, M., Frye, C., Weaver-Feldhaus, J., Ding, W., Gholami, Z., Söderkvist, P., Terry, L., Jhanwar, S., Berchuck, A., Iglehart, J.D., Marks, J., Ballinger, D.G., Barrett, J.C., Skolnick, M.H., Kamb, A. & Wiseman, R. (1994) *BRCA1* mutations in primary breast and ovarian carcinomas. *Science*, **266**, 120–122
- Gabra, H., Watson, J.E.V., Taylor, K.J., Mackay, J., Leonard, R.C.F., Steel, C.M., Porteous, D.J. & Smyth, J.F. (1996) Definition and refinement of a region of loss of heterozygosity at 11q23.3-q24.3 in epithelial ovarian cancer associated with poor prognosis. *Cancer Res.*, **56**, 950–954
- Game, J.C. (1993) DNA double-strand breaks and the *RAD50-RAD57* genes in *Saccharomyces*. *Cancer Biol.*, **4**, 73–83
- Gardner, M.J., Snee, M.P., Hall, A.J., Powell, C.A., Downes, S. & Terrell, J.D. (1990) Results of a case-control study of leukaemia and lymphoma among young people near Sellafield nuclear plant in west Cumbria. *Br. med. J.*, **300**, 423–429
- Gatti, R.A. (1998) Ataxia-telangiectasia. In: Vogelstein, B. & Kinzler, K.W., eds, *The Genetic Basis of Human Cancer*, New York, McGraw-Hill, pp. 275–300
- Gilbert, E.S., Omohundro, E., Buchanan, J.A. & Holter, N.A. (1993a) Mortality of workers at the Hanford site: 1945–1986. *Health Phys.*, **64**, 577–590
- Gilbert, E.S., Cragle, D.L. & Wiggs, L.D. (1993b) Updated analyses of combined mortality data for workers at the Hanford Site, Oak Ridge National Laboratories, and Rocky Flats Nuclear Weapons Plant. *Radiat. Res.*, **136**, 408–421
- Gilman, E.A. & Knox, E.G. (1998) Geographical distribution of birth places of children with cancer in the UK. *Br. J. Cancer*, **77**, 842–849
- Glanzmann, C., Veraguth, A. & Lütolf, U.M. (1994) Incidence of second solid cancer in patients after treatment of Hodgkin's disease. *Strahlenther. Onkol.*, **170**, 140–146
- Glatstein, E., McHardy-Young, S., Brast, N., Eltringham, J.R. & Kriss, J.P. (1971) Alterations in serum thyrotrophin (TSH) and thyroid function following radiotherapy in patients with malignant lymphoma. *J. clin. Endocrinol.*, **32**, 833–841

- Goldstein, L. & Murphy, D.P. (1929) Etiology of the congenital nervous and immune deficiencies in newborns resulting from in utero exposure to radiation. Part 2. Defective children born after post-conception pelvic irradiation. *Am. J. Roentgenol.*, **22**, 322–331
- Goodhead, D.T. (1988) Spatial and temporal distribution of energy. *Health Phys.*, **55**, 231–240
- Goodhead, D.T. (1994) Initial events in the cellular effects of ionizing radiations: Clustered damage in DNA. *Int. J. Radiat. Biol.*, **65**, 7–17
- Goodhead, D.T., Thacker, J. & Cox, R. (1993) Weiss Lecture. Effects of radiations of different qualities on cells: Molecular mechanisms of damage and repair. *Int. J. Radiat. Biol.*, **63**, 543–556
- Gotoff, S.P., Amirmokri, E. & Liebner, E.J. (1967) Ataxia-telangiectasia. Neoplasia, untoward response to X-irradiation, and tuberous sclerosis. *Am. J. Dis. Child.*, **114**, 617–625
- Gould, M.N. & Clifton, K.H. (1979) Evidence for a unique *in situ* component of the repair of radiation damage. *Radiat. Res.*, **77**, 149–155
- Gould, M.N., Watanabe, H., Kamiya, K. & Clifton, K.H. (1987) Modification of expression of the malignant phenotype in radiation-initiated cells. *Int. J. Radiat. Biol. relat. Stud. Phys. chem. Med.*, **51**, 1081–1090
- Gowen, L.C., Avrutskaya, A.V., Latour, A.M., Koller, B.H. & Leadon, S.A. (1998) BRCA1 required for transcription-coupled repair of oxidative DNA damage. *Science*, **281**, 1009–1012
- Grahn, D., Frystak, B.H., Lee, C.H., Russell, J.J. & Lindenbaum, A. (1979) Dominant lethal mutations and chromosome aberrations induced in male mice by incorporated ^{239}Pu and by external fission neutron and gamma irradiation. In: *Biological Implications of Radionuclides Released by Nuclear Industries*, Vol. I, Vienna, International Atomic Energy Agency, pp. 163–184
- Grahn, D., Carnes, B.A., Farrington, B.H. & Lee, C.H. (1984) Genetic injury in hybrid male mice exposed to low doses of ^{60}Co gamma-rays or fission neutrons. I. Response to single doses. *Mutat. Res.*, **129**, 215–229
- Grahn, D., Lombard, L.S. & Carnes, B.A. (1992) The comparative tumorigenic effects of fission neutrons and cobalt-60 gamma rays in the B6CF₁ mouse. *Radiat. Res.*, **129**, 19–36
- Graw, J., Favor, J., Neuhauser-Klaus, A. & Ehling, U.H. (1986) Dominant cataract and recessive specific locus mutation in offspring of X-irradiated male mice. *Mutat. Res.*, **159**, 47–54
- Green, B.M.R., Hughes, J.S., Lomas, P.R. & Janssens, A. (1992) Natural radiation atlas of Europe. *Radiat. Protect. Dosim.*, **45**, 491–493
- Greenland, S. & Robins, J.M. (1988) Conceptual problems in the definition and interpretation of attributable fractions. *Am. J. Epidemiol.*, **128**, 1185–1197
- Gribbin, M.A., Weeks, J.L. & Howe, G.R. (1993) Cancer mortality (1956–1985) among male employees of Atomic Energy of Canada Limited with respect to occupational exposure to external low-linear-energy-transfer ionizing radiation. *Radiat. Res.*, **133**, 375–380
- Griem, M.L., Kleinerman, R.A., Boice, J.D., Jr, Stovall, M., Shefner, D. & Lubin, J.H. (1994) Cancer following radiotherapy for peptic ulcer. *J. natl Cancer Inst.*, **86**, 842–849
- Griffin, C.S., Hill, M.A., Papworth, D.G., Townsend, K.M., Savage, J.R. & Goodhead, D.T. (1998) Effectiveness of 0.28 keV carbon K ultrasoft X-rays at producing simple and complex chromosome exchanges in human fibroblasts in vitro detected using FISH. *Int. J. Radiat. Biol.*, **73**, 591–598

- Grosovsky, A.J., Drobetsky, E.A., deJong, P.J. & Glickman, B.W. (1986) Southern analysis of genomic alterations in gamma-ray-induced aprt⁻ hamster cell mutants. *Genetics*, **113**, 405–415
- Gusev, B.I., Abylkassimova, Z.N. & Apsalikov, K.N. (1997) The Semipalatinsk nuclear test site: A first assessment of the radiological situation and the test-related radiation doses in the surrounding territories. *Radiat. Environ. Biophys.*, **36**, 201–204
- Gustafson, C.E., Young, J., Leggett, B., Searle, J. & Chenevix-Trench, G. (1994) Loss of heterozygosity on the long arm of chromosome 11 in colorectal tumours. *Br. J. Cancer*, **70**, 395–397
- Gutin, P., Leibel, S. & Sheline G., eds (1991) *Radiation Injury to the Nervous System*, New York, Raven Press
- Hainaut, P., Hernandez, T., Robinson, A., Rodriguez-Tome, P., Flores, T., Hollstein, M., Harris, C.C. & Montesano, R. (1998) IARC database of p53 gene mutations in human tumors and cell lines: Updated compilation, revised formats and new visualisation tools. *Nucl. Acids Res.*, **26**, 205–213
- Hakoda, M., Kamatani, N., Ohtsuka, S. & Kashiwazaki, S. (1991a) Germline and somatic mutations leading to adenine phosphoribosyltransferase (APRT) deficiency. *Adv. Exp. Med. Biol.*, **309B**, 87–90
- Hakoda, M., Yamanaka, H., Kamatani, N. & Kamatani, N. (1991b) Diagnosis of heterozygous states for adenine phosphoribosyltransferase deficiency based on detection of in vivo somatic mutants in blood T cells: Application to screening of heterozygotes. *Am. J. Hum. Genet.*, **48**, 552–562
- Hall, E.J. & Hei, T.K. (1985) Oncogenic transformation with radiation and chemicals. *Int. J. Radiat. Biol. Relat. Stud. Phys. chem. Med.*, **48**, 1–18
- Hall, E.J. & Hei, T.K. (1990) Modulating factors in the expression of radiation-induced oncogenic transformation. *Environ. Health Perspect.*, **88**, 149–155
- Hall, P., Mattsson, A. & Boice, J., Jr (1996) Thyroid cancer after diagnostic administration of iodine-131. *Radiat. Res.*, **145**, 86–92
- Hallquist, A., Hardell, L., Degerman, A., Wingren, G. & Boquist, L. (1994) Medical diagnostic and therapeutic ionizing radiation and the risk for thyroid cancer: A case-control study. *Eur. J. Cancer Prev.*, **3**, 259–267
- Hamlet, R. & Hopewell, J.W. (1988) A quantitative assessment of changes in the dermal fibroblast population of pig skin after single doses of X-rays. *Int. J. Radiat. Biol.*, **54**, 675–682
- Hampton, G.M., Penny, L.A., Baergen, R.N., Larson, A., Brewer, C., Liao, S., Busby-Earle, R.M.C., Williams, A.W.R., Steel, C.M., Bird, C.C., Stanbridge, E.J. & Evans, G.A. (1994) Loss of heterozygosity in cervical carcinoma: Subchromosomal localization of a putative tumor-suppressor gene to chromosome 11q22–q24. *Proc. natl Acad. Sci. USA*, **91**, 6953–6957
- Hancock, S.L., Cox, R.S. & McDougall, I.R. (1991) Thyroid diseases after treatment of Hodgkin's disease. *New Engl. J. Med.*, **325**, 599–605
- Hancock, S.L., Tucker, M.A. & Hoppe, R.T. (1993) Breast cancer after treatment of Hodgkin's disease. *J. natl Cancer Inst.*, **85**, 25–31
- Hanford, J.M., Quimby, E.H. & Frantz, V.K. (1962) Cancer arising many years after radiation therapy. Incidence after irradiation of benign lesions in the neck. *J. Am. med. Assoc.*, **181**, 404–410

- Harper, K., Lorimore, S.A. & Wright, E.G. (1997) Delayed appearance of radiation-induced mutations at the Hprt locus in murine hemopoietic cells. *Exp. Hematol.*, **25**, 263–269
- Hartley, K.O., Gell, D., Smith, G.C.M., Zhang, H., Divecha, N., Connelly, M.A., Admon, A., Lees-Miller, S.P., Anderson, C.W. & Jackson, S.P. (1995) DNA-dependent protein kinase catalytic subunit: A relative of phosphatidylinositol 3-kinase and the ataxia telangiectasia gene product. *Cell*, **82**, 849–856
- Harvey, E.B. & Brinton, L.A. (1985) Second cancer following cancer of the breast in Connecticut, 1935–82. *Natl Cancer Inst. Monogr.*, **68**, 99–112
- Harvey, E.B., Boice, J.D., Jr, Honeyman, M. & Flannery, J.T. (1985) Prenatal X-ray exposure and childhood cancer in twins. *New Engl. J. Med.*, **312**, 541–545
- Hatch, M.C., Beyea, J., Nieves, J.W. & Susser, M. (1990) Cancer near the Three Mile Island nuclear plant: Radiation emissions. *Am. J. Epidemiol.*, **132**, 397–412
- Hattchouel, J.-M., Laplanche, A. & Hill, C. (1995) Leukaemia mortality around French nuclear sites. *Br. J. Cancer*, **71**, 651–653
- Hawkins, M.M., Draper, G.J. & Kingston, J.E. (1987) Incidence of second primary tumours among childhood cancer survivors. *Br. J. Cancer*, **56**, 339–347
- Hawkins, M.M., Kinnier Wilson, L.M., Stovall, M.A., Marsden, H.B., Potok, M.H., Kingston, J.E. & Chessells, J.M. (1992) Epipodophyllotoxins, alkylating agents, and radiation and risk of secondary leukaemia after childhood cancer. *Br. med. J.*, **304**, 951–958
- Hawkins, M.M., Kinnier Wilson, L.M., Burton, H.S., Potok, M.H.N., Winter, D.L., Marsden, H.B. & Stovall, M.A. (1996) Radiotherapy, alkylating agents, and risk of bone cancer after childhood cancer. *J. natl Cancer Inst.*, **88**, 270–278
- Hecht, F. & Hecht, B.K. (1985) Ataxia-telangiectasia breakpoints in chromosome rearrangements reflect genes important to T and B lymphocytes. In: Gatti, R.A. & Swift, M., eds, *Ataxia Telangiectasia: Genetics, Neuropathology, and Immunology of a Degenerative Disease of Childhood*, New York, Alan R. Liss, pp. 189–195
- Hecht, F. & Hecht, B.K. (1990) Cancer in ataxia-telangiectasia patients. *Cancer Genet. Cytogenet.*, **46**, 9–19
- Hei, T.K., Piao, C.Q., Willey, J.C., Thomas, S. & Hall, E.J. (1994) Malignant transformation of human bronchial epithelial cells by radon-simulated alpha-particles. *Carcinogenesis*, **15**, 431–437
- Hempelmann, L., Pifer, J.W., Burke, G.J., Terry, R. & Ames, W.R. (1967) Neoplasms in persons treated with X-rays in infancy for thymic enlargement. A report on the third follow-up survey. *J. natl Cancer Inst.*, **38**, 317–341
- Hendry, J.H. & Thames, H.D. (1986) The tissue-rescuing unit. *Br. J. Radiol.*, **59**, 628–630
- Henry-Amar, M. (1983) Second cancers after radiotherapy and chemotherapy for early stages of Hodgkin's disease. *J. natl Cancer Inst.*, **71**, 911–916
- Henshaw, P.S. & Hawkins, J.W. (1944) Incidence of leukemia in physicians. *J. natl Cancer Inst.*, **4**, 339–346
- Herbst, R.A., Larson, A., Weiss, J., Cavenee, W.K., Hampton, G.M. & Arden, K.C. (1995) A defined region of loss of heterozygosity at 11q23 in cutaneous malignant melanoma. *Cancer Res.*, **55**, 2494–2496
- Herzog, K.-H., Chong, M.J., Kapsetaki, M., Morgan, J.I. & McKinnon, P.J. (1998) Requirement for Atm in ionizing radiation-induced cell death in the developing central nervous system. *Science*, **280**, 1089–1091

- Heyn, R., Haerberlen, V., Newton, W.A., Ragab, A.H., Raney, R.B., Tefft, M., Wharam, M., Ensign, L.G. & Maurer, H.M. (1993) Second malignant neoplasms in children treated for rhabdomyosarcoma (Intergroup Rhabdomyosarcoma Study Committee). *J. Clin. Oncol.*, **11**, 262–270
- Higurashi, M. & Cohen, P.E. (1973) *In vitro* chromosomal radiosensitivity in 'chromosomal breakage syndromes'. *Cancer*, **32**, 380–383
- Hildreth, N.G., Shore, R.E., Hempelmann, L.H. & Rosenstein, M. (1985) Risk of extrathyroid tumors following radiation treatment in infancy for thymic enlargement. *Radiat. Res.*, **102**, 378–391
- Hildreth, N.G., Shore, R.E. & Dvoretzky, P.M. (1989) The risk of breast cancer after irradiation of the thymus in infancy. *New Engl. J. Med.*, **321**, 1281–1284
- Hill, C. & Laplanche, A. (1990) Overall mortality and cancer mortality around French nuclear sites. *Nature*, **347**, 755–757
- Hino, O., Klein-Szanto, A.J., Freed, J.J., Testa, J.R., Brown, D.Q., Vilensky, M., Yeung, R.S., Tartof, K.D. & Knudson, A.G. (1993) Spontaneous and radiation-induced renal tumors in the Eker rat model of dominantly inherited cancer. *Proc. natl Acad. Sci. USA*, **90**, 327–331
- Hjalmar, U., Kulldorff, M. & Gustafsson, G. on behalf of the Swedish Child Leukaemia Group (1994) Risk of acute childhood leukaemia in Sweden after the Chernobyl reactor accident. *Br. med. J.*, **309**, 154–157
- Hoel, D.G. & Li, P. (1998) Threshold models in radiation carcinogenesis. *Health Phys.*, **75**, 241–250
- Hoffman, D.A., Lonstein, J.E., Morin, M.M., Visscher, W., Harris, S.H., III & Boice, J.D., Jr (1989) Breast cancer in women with scoliosis exposed to multiple diagnostic X rays. *J. natl Cancer Inst.*, **81**, 1307–1312
- Holliday, R. (1989) Chromosome error propagation and cancer. *Trends Genet.*, **5**, 42–45
- Holm, L.-E., Hall, P., Wiklund, K., Lundell, G., Berg, G., Bjelkengren, G., Cederquist, E., Ericsson, U.-B., Hallquist, A., Larsson, L.-G., Lidberg, M., Lindberg, S., Tennvall, J., Wicklund, H. & Boice, J.D., Jr (1991) Cancer risk after iodine-131 therapy for hyperthyroidism. *J. natl Cancer Inst.*, **83**, 1072–1077
- Hopewell, J.W., Coggle, J.E., Wells, J., Hamlet, R., Williams, J.P. & Charles, M.W. (1986) The acute effects of different energy beta-emitters on pig and mouse skin. *Br. J. Radiol.*, **Suppl. 19**, 47–51
- Horwich, A. & Bell, J. (1994) Mortality and cancer incidence following radiotherapy for seminoma of the testis. *Radiother. Oncol.*, **30**, 193–198
- Houldsworth, J. & Lavin, M.F. (1980) Effect of ionizing radiation on DNA synthesis in ataxia telangiectasia cells. *Nucleic Acids Res.*, **8**, 3709–3720
- van der Houven van Oordt, C.W., Schouten, T.G., van Krieken, J.H., van Dierendonck, J.H., van der Eb, A.J. & Breuer, M.L. (1998) X-ray-induced lymphomagenesis in E μ -*pim-1* transgenic mice: An investigation of the co-operating molecular events. *Carcinogenesis*, **19**, 847–853
- Howe, G.R. (1995) Lung cancer mortality between 1950 and 1987 after exposure to fractionated moderate-dose-rate ionizing radiation in the Canadian fluoroscopy cohort study and a comparison with lung cancer mortality in the atomic bomb survivors study. *Radiat. Res.*, **142**, 295–304

- Howe, G.R. & McLaughlin, J. (1996) Breast cancer mortality between 1950 and 1987 after exposure to fractionated moderate-dose-rate ionizing radiation in the Canadian fluoroscopy cohort study and a comparison with breast cancer mortality in the atomic bomb survivors study. *Radiat. Res.*, **145**, 694–707
- Hoyes, K.P., Wadson, P.J., Sharma, H.L., Hendry, J.H. & Morris, I.D. (1998) Mutation studies in lacI transgenic mice after exposure to radiation or cyclophosphamide. *Mutagenesis*, **13**, 607–612
- Hrubec, Z., Boice, J.D., Jr, Monson, R.R. & Rosenstein, M. (1989) Breast cancer after multiple chest fluoroscopies: Second follow-up of Massachusetts women with tuberculosis. *Cancer Res.*, **49**, 229–234
- Huda, W. & Sourkes, A.M. (1989) Radiation doses from chest X-rays in Manitoba (1979 and 1987). *Radiat. Prot. Dosim.*, **28**, 303–308
- Hulse, E.V. (1980) Tumor incidence and longevity in neutron and gamma irradiated rabbits, with an assessment of RBE. *Int. J. Radiat. Biol.*, **37**, 633–652
- Huo, Y.K., Wang, Z., Hong, J.-H., Chessa, L., McBride, W.H., Perlman, S.L. & Gatti, R.A. (1994) Radiosensitivity of ataxia-telangiectasia, X-linked agammaglobulinemia, and related syndromes using a modified colony survival assay. *Cancer Res.*, **54**, 2544–2547
- Husain, A., He, G., Venkatraman, E.S. & Spriggs, D.R. (1998) *BRCA1* up-regulation is associated with repair-mediated resistance to *cis*-diamminedichloroplatinum(II). *Cancer Res.*, **58**, 1120–1123
- Hutchinson, F. (1995) Analysis of deletions induced in the genome of mammalian cells by ionizing radiation. *J. Mol. Biol.*, **254**, 372–380
- IAEA (International Atomic Energy Agency) (1988) *The Radiological Accident in Goiânia*, Vienna
- IAEA (International Atomic Energy Agency) (1997) *Low Doses of Ionizing Radiation: Biological Effects and Regulatory Control* (IAEA-TECDOC-976), Vienna
- IAEA (International Atomic Energy Agency) (1998) *Planning the Medical Response to Radiological Accidents* (Safety Report Series No. 4), Vienna
- IARC (1987) *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans*, Suppl. 7, *Overall Evaluations of Carcinogenicity: An Update of IARC Monographs Volumes 1 to 42*, Lyon, IARC Press
- IARC (1992) *IARC Monographs on the Evaluation of Carcinogenic Risk to Humans*, Vol. 55, *Solar and Ultraviolet Radiation*, Lyon, IARC Press
- IARC Study Group on Cancer Risk among Nuclear Industry Workers (1994) Direct estimates of cancer mortality due to low doses of ionising radiation: An international study. *Lancet*, **344**, 1039–1043
- Ichihara, Y., Matsuoka, H., Tsuge, I., Okada, J., Torii, S., Yasui, H. & Kurosawa, Y. (1988) Abnormalities in DNA rearrangements of immunoglobulin gene loci in precursor B cells derived from a X-linked agammaglobulinemia patient and a severe combined immunodeficiency patient. *Immunogenetics*, **27**, 330–337
- Ichimaru, M., Ishimaru, T. & Belsky, J.L. (1978) Incidence of leukemia in atomic bomb survivors belonging to a fixed cohort in Hiroshima and Nagasaki, 1950–71. Radiation dose, years after exposure, age at exposure, and type of leukemia. *J. Radiat. Res.*, **19**, 262–282

- ICRP (International Commission on Radiological Protection) (1991a) *1990 Recommendations of the International Commission on Radiological Protection* (ICRP Publication 60; *Annals of the ICRP*, Vol. 21), Oxford, Pergamon Press
- ICRP (International Commission on Radiological Protection) (1991b) *Addendum 1 to ICRP Publication 53. Radiation Dose to Patients from Radiopharmaceuticals*, Oxford, Pergamon Press
- ICRP (International Commission on Radiological Protection) (1991c) *The Biological Basis for the Dose Limitation in the Skin* (ICRP Publication 59; *Annals of the ICRP*, Vol. 22, No. 2), Oxford, Pergamon Press
- ICRP (International Commission on Radiological Protection) (1999) *Genetic Susceptibility to Cancer* (ICRP Publication 79), Amsterdam, Elsevier Science
- Inskip, P.D., Monson, R.R., Wagoner, J.K., Stovall, M., Davis, F.G., Kleinerman, R.A. & Boice, J.D., Jr (1990a) Cancer mortality following radium treatment for uterine bleeding. *Radiat. Res.*, **123**, 331–344
- Inskip, P.D., Monson, R.R., Wagoner, J.K., Stovall, M., Davis, F.G., Kleinerman, R.A. & Boice, J.D., Jr (1990b) Leukemia following radiotherapy for uterine bleeding. *Radiat. Res.*, **122**, 107–119
- Inskip, P.D., Harvey, E.B., Boice, J.D., Jr, Stone, B.J., Matanoski, G., Flanneru, J.T. & Fraumeni, J.F., Jr (1991) Incidence of childhood cancer in twins. *Cancer Causes Control*, **2**, 315–324
- Inskip, P.D., Kleinerman, R.A., Stovall, M., Cookfair, D.L., Hadjimichael, O., Moloney, W.C., Monson, R.R., Thompson, W.D., Wactawski-Wende, J., Wagoner, J.K. & Boice, J.D., Jr (1993) Leukemia, lymphoma, and multiple myeloma after pelvic radiotherapy for benign disease. *Radiat. Res.*, **135**, 108–124.
- Inskip, P.D., Stovall, M. & Flannery, J.T. (1994) Lung cancer risk and radiation dose among women treated for breast cancer. *J. natl Cancer Inst.*, **86**, 983–988
- Inskip, P.D., Ekblom, A., Galanti, M.R., Grimelius, L. & Boice, J.D., Jr (1995) Medical diagnostic X rays and thyroid cancer. *J. natl Cancer Inst.*, **87**, 1613–1621
- Ivanov, V.K., Tsyb, A.F., Konogorov, A.P., Rastopchin, E.M. & Khait, S.E. (1997a) Case-control analysis of leukaemia among Chernobyl accident emergency workers residing in the Russian Federation, 1986–1993. *J. Radiat. Prot.*, **17**, 137–157
- Ivanov, V.K., Tsyb, A.F., Gorsky, A.I., Maksyutov, M.A., Rastopchin, E.M., Konogorov, A.P., Korelo, A.M., Biryukov, A.P. & Matyash, V.A. (1997b) Leukaemia and thyroid cancer in emergency workers of the Chernobyl accident: Estimation of radiation risks (1986–1995). *Radiat. environ. Biophys.*, **36**, 9–16
- Ivanov, V.K., Tsyb, A.F., Nilova, E.V., Efendiev, V.F., Gorsky, A.I., Pitkevich, V.A., Leshakov, S.Y. & Shiryayev, V.I. (1997c) Cancer risks in the Kaluga oblast of the Russian Federation 10 years after the Chernobyl accident. *Radiat. environ. Biophys.*, **36**, 161–167
- Ivanov, V.K., Rastopchin, E.M., Gorsky, A.I. & Ryvkin, V.B. (1998) Cancer incidence among liquidators of the Chernobyl accident: Solid tumors, 1986–1995. *Health Phys.*, **74**, 309–315
- Jablon, S. & Kato, H. (1970) Childhood cancer in relation to prenatal exposure in atomic-bomb radiation. *Lancet*, **ii**, 1000–1003
- Jablon, S., Hrubec, Z. & Boice, J.D., Jr (1991) Cancer in populations living near nuclear facilities. A survey of mortality nationwide and incidence in two states. *J. Am. med. Assoc.*, **265**, 1403–1408

- Jacobsen, G.K., Mellemgaard, A., Engelholm, S.A. & Møller, H. (1993) Increased incidence of sarcoma in patients treated for testicular seminoma. *Eur. J. Cancer*, **29A**, 664–668
- Janatipour, M., Trainor, K.J., Kutlaca, R., Bennett, G., Hay, J., Turner, D.R. & Morley, A.A. (1988) Mutations in human lymphocytes studied by an HLA selection system. *Mutat. Res.*, **198**, 221–226
- Janower, M.L. & Miettinen, O.S. (1971) Neoplasms after childhood irradiation of the thymus gland. *J. Am. med. Assoc.*, **215**, 753–756
- Jaspers, N.G.J., Gatti, R.A., Baan, C., Linssen, P.C.M.L. & Bootsma, D. (1988) Genetic complementation analysis of ataxia telangiectasia and Nijmegen breakage syndrome: A survey of 50 patients. *Cytogenet. Cell Genet.*, **49**, 259–263
- Jeggo, P.A., Carr, A.M. & Lehmann, A.R. (1998) Splitting the ATM: Distinct repair and checkpoint defects in ataxia-telangiectasia. *Trends Genet.*, **14**, 312–316
- Jenner, T.J., de Lara, C.M., O'Neill, P. & Stevens, D.L. (1993) The induction and rejoining of DNA double strand breaks in V79-4 mammalian cells by γ - and α -irradiation. *Int. J. Radiat. Biol.*, **64**, 265–273
- Jensen, R.D. & Miller, R.W. (1971) Retinoblastoma: Epidemiologic characteristics. *New Engl. J. Med.*, **285**, 307–311
- Jensen, R.H., Langlois, R.G., Bigbee, W.L., Grant, S.G., Moore, D., 2nd, Pilinskaya, M., Vorobtsova, I. & Pleshanov, P. (1995) Elevated frequency of glycophorin A mutations in erythrocytes from Chernobyl accident victims. *Radiat. Res.*, **141**, 129–135
- Johansson, L., Larsson, L.-G. & Damber, L. (1995) A cohort study with regard to the risk of haematological malignancies in patients treated with X-rays for benign lesions in the locomotor system. II. Estimation of absorbed dose in the red bone marrow. *Acta oncol.*, **34**, 721–726
- Johnson, D.K., Stubbs, L.J., Culiati, C.T., Montgomery, C.S., Russell, L.B. & Rinchik, E.M. (1995) Molecular analysis of 36 mutations at the mouse pink-eyed dilution (p) locus. *Genetics*, **141**, 1563–1571
- Johnson, J.C., Thaul, S., Page, W.F. & Crawford, H. (1997) Mortality of veteran participants in the CROSSROADS nuclear test. *Health Phys.*, **73**, 187–189
- Jongmans, W., Vuillaume, M., Chrzanowska, K., Smeets, D., Sperling, K. & Hall, J. (1997) Nijmegen breakage syndrome cells fail to induce the p53-mediated DNA damage response following exposure to ionizing radiation. *Mol. cell. Biol.*, **17**, 5016–5022
- Joslyn, G., Carlson, M., Thliveris, A., Albertsen, H., Gelbert, L., Samowitz, W., Groden, J., Stevens, J., Spirio, L., Robertson, M., Sargeant, L., Krapcho, K., Wolff, E., Burt, R., Hughes, J.P., Warrington, J., McPherson, J., Wasmuth, J., Le Paslier, D., Abderrahim, H., Cohen, D., Leppert, M. & White, R. (1991) Identification of deletion mutations and three new genes at the familial polyposis locus. *Cell*, **66**, 601–613
- Jung, M., Kondratyev, A., Lee, S., Dimtchev, A. & Dritschilo, A. (1997) ATM gene product phosphorylates I κ B- α . *Cancer Res.*, **57**, 24–27
- Kadhim, M.A., Macdonald, D.A., Goodhead, D.T., Lorimore, S.A., Marsden, S.J. & Wright, E.G. (1992) Transmission of chromosomal instability after plutonium alpha-particle irradiation. *Nature*, **355**, 738–740
- Kadhim, M.A., Lorimore, S.A., Hepburn, M.D., Goodhead, D.T., Buckle, V.J. & Wright, E.G. (1994) Alpha-particle-induced chromosomal instability in human bone marrow cells. *Lancet*, **344**, 987–988

- Kadhim, M.A., Lorimore, S.A., Townsend, K.M., Goodhead, D.T., Buckle, V.J. & Wright, E.G. (1995) Radiation-induced genomic instability: Delayed cytogenetic aberrations and apoptosis in primary human bone marrow cells. *Int. J. Radiat. Biol.*, **67**, 287–293
- Kakunaga, T. & Yamasaki, H., eds (1985) *Transformation Assay of Established Cell Lines: Mechanisms and Application* (IARC Scientific Publications No. 67), Lyon, IARC Press
- Kaldor, J.M., Day, N.E., Band, P., Choi, N.W., Clarke, E.A., Coleman, M.P., Hakama, M., Koch, M., Langmark, F., Neal, F.E., Pettersson, F., Pompe-Kirn, V., Prior, P. & Storm, H.H. (1987) Second malignancies following testicular cancer, ovarian cancer and Hodgkin's disease: An international collaborative study among cancer registries. *Int. J. Cancer*, **39**, 571–585
- Kaldor, J.M., Day, N.E., Clarke, E.A., Van Leeuwen, F.E., Henry-Amar, M., Fiorentino, M.V., Bell, J., Pedersen, D., Band, P., Assouline, D., Koch, M., Choi, W., Prior, P., Blair, V., Langmark, F., Pompe-Kirn, V., Neal, F., Peters, D., Pfeiffer, R., Karjalainen, S., Cuzick, J., Sutcliffe, S.B., Somers, R., Pellae-Cosset, B., Pappagallo, G.L., Fraser, P., Storm, H. & Stovall, M. (1990a) Leukemia following Hodgkin's disease. *New Engl. J. Med.*, **322**, 7–13
- Kaldor, J.M., Day, N.E., Pettersson, F., Clarke, E.A., Pedersen, D., Mehnert, W., Bell, J., Høst, H., Prior, P., Karjalainen, S., Neal, F., Koch, M., Band, R., Choi, W., Pompe-Kirn, V., Arslan, A., Zanén, B., Belch, A.R., Storm, H., Kittelmann, B., Fraser, P. & Stovall, M. (1990b) Leukemia following chemotherapy for ovarian cancer. *New Engl. J. Med.*, **322**, 1–6
- Kaldor, J.M., Day, N.E., Bell, J., Clarke, E.A., Langmark, F., Karjalainen, S., Band, P., Pedersen, D., Choi, W., Blair, V., Henry-Amar, M., Prior, P., Assouline, D., Pompe-Kirn, V., Cartwright, R.A., Koch, M., Arslan, A., Fraser, P., Sutcliffe, S.B., Høst, H., Hakama, M. & Stovall, M. (1992) Lung cancer following Hodgkin's disease: A case-control study. *Int. J. Cancer*, **52**, 677–681
- Kaldor, J.M., Day, N.E., Kittelmann, B., Pettersson, F., Langmark, F., Pedersen, D., Prior, P., Neal, F., Karjalainen, S., Bell, J., Choi, W., Koch, M., Band, P., Pompe-Kirn, V., Garton, C., Staneczak, W., Zarén, B., Stovall, M. & Boffetta, P. (1995) Bladder tumours following chemotherapy and radiotherapy for ovarian cancer: A case-control study. *Int. J. Cancer*, **63**, 1–6
- Kaplan, M.M., Garnick, M.B., Gelber, R., Li, F.P., Cassady, J.R., Sallan, S.E., Fine, W.E. & Sack, M.J. (1983) Risk factors for thyroid abnormalities after neck irradiation for childhood cancer. *Am. J. Med.*, **74**, 272–280
- Karlsson, P., Holmberg, E., Johansson, K.-A., Kindblom, L.-G., Carstensen, J. & Wallgren, A. (1996) Soft tissue sarcoma after treatment for breast cancer. *Radiother. Oncol.*, **38**, 25–31
- Karlsson, P., Holmberg, E., Lundberg, L.M., Nordborg, C. & Wallgren, A. (1997) Intracranial tumors after radium treatment for skin hemangioma during infancy—A cohort and case-control study. *Radiat. Res.*, **148**, 161–167
- Karlsson, P., Holmberg, E., Lundell, M., Mattsson, A., Holm, L.-E. & Wallgren, A. (1998) Intracranial tumors after exposure to ionizing radiation during infancy. A pooled analysis of two Swedish cohorts of 28,008 infants with skin hemangioma. *Radiat. Res.*, **150**, 357–364
- Kastan, M.B., Zhan, O., El-Deiry, W.S., Carrier, F., Jacks, T., Walsh, W.V., Plunkett, B.S., Vogelstein, B. & Fornace, A.J. (1992) A mammalian cell cycle checkpoint pathway utilizing *p53* and *GADD45* is defective in ataxia-telangiectasia. *Cell*, **71**, 587–597

- Kaul, A., Bauer, B., Bernhardt, J., Nosske, D. & Veit, R. (1997) Effective doses to members of the public from diagnostic application of ionizing radiation in Germany. *Eur. Radiol.*, **7**, 1127–1132
- Keegan, K.S., Holtzman, D.A., Plug, A.W., Christenson, E.R., Brainerd, E.E., Flagg, G., Bentley, N.J., Taylor, E.M., Meyn, M.S., Moss, S.B., Carr, A.M., Ashley, T. & Hoekstra, M.F. (1996) The Atr and Atm protein kinases associate with different sites along meiotically pairing chromosomes. *Genes Dev.*, **10**, 2423–2437
- Kellerer, A.M. & Nekolla, E. (1997) Neutron versus gamma-ray risk estimates. Inferences from the cancer incidence and mortality data in Hiroshima. *Radiat. Environ. Biophys.*, **36**, 73–83
- Kemp, C.J., Wheldon, T. & Balmain, A. (1994) *p53*-Deficient mice are extremely susceptible to radiation-induced tumorigenesis. *Nature Genet.*, **8**, 66–69
- Kennedy, A.R., Fox, M., Murphy, G.R. & Little, J.B. (1980) Relationship between X-ray exposure and malignant transformation in C3H 10T1/2 cells. *Proc. natl Acad. Sci. USA*, **77**, 7262–7266
- Kerangueven, F., Eisinger, F., Noguchi, T., Allione, F., Wargniez, V., Eng, C., Padberg, G., Theillet, C., Jacquemier, J., Longy, M., Sobol, H. & Birnbaum, D. (1997) Loss of heterozygosity in human breast carcinomas in the ataxia telangiectasia, Cowden disease and *BRCA1* gene regions. *Oncogene*, **14**, 339–347
- Khanna, K.K., Beamish, H., Yan, J., Hobson, K., Williams, R., Dunn, I. & Lavin, M.F. (1995) Nature of G1/S cell cycle checkpoint defect in ataxia-telangiectasia. *Oncogene*, **11**, 609–618
- Khanna, K.K., Keating, K.E., Kozlov, S., Scott, S., Gatei, M., Hobson, K., Taya, Y., Gabrielli, B., Chan, D., Lees-Miller, S.P. & Lavin, M.F. (1998) ATM associates with and phosphorylates p53: Mapping the region of interaction. *Nature Genet.*, **20**, 398–400
- Khoo, V.S., Liew, K.H., Crennan, E.C., D'Costa, I.M. & Quong, G. (1998) Thyroid dysfunction after mantle irradiation of Hodgkin's disease patients. *Australas. Radiol.*, **42**, 52–57
- Kim, M.-G., Schuler, W., Bosma, M.J. & Marcu, K.B. (1988) Abnormal recombination of *Igh* D and J gene segments in transformed pre-B cells of *scid* mice. *J. Immunol.*, **141**, 1341–1347
- Kingston, J.E., Hawkins, M.M., Draper, G.J., Marsden, H.B. & Kinnier Wilson, L.M. (1987) Patterns of multiple primary tumours in patients treated for cancer during childhood. *Br. J. Cancer*, **56**, 331–338
- Kinlen, L.J. (1993a) Childhood leukaemia and non-Hodgkin's lymphoma in young people living close to nuclear reprocessing sites. *Biomed. Pharmacother.*, **47**, 429–434
- Kinlen, L.J. (1993b) Can paternal preconceptional radiation account for the increase of leukaemia and non-Hodgkin's lymphoma in Seascale? *Br. med. J.*, **306**, 1718–1721
- Kinlen, L.J., Hudson, C.M. & Stiller, C.A. (1991) Contacts between adults as evidence for an infective origin of childhood leukaemia: An explanation for the excess near nuclear establishments in West Berkshire. *Br. J. Cancer*, **64**, 549–554
- Kinlen, L.J., Clarke, K. & Balkwill, A. (1993) Paternal preconceptional radiation exposure in the nuclear industry and leukaemia and non-Hodgkin's lymphoma in young people in Scotland. *Br. med. J.*, **306**, 1153–1158

- Kinsella, T. (1989) Effects of radiotherapy and chemotherapy on testicular function. In: Burger, E.J., Jr, Scialli, A.E., Tardiff, R.G. & Zenick, H., eds, *Sperm Measures and Reproductive Success, Prog. clin. biol. Res.*, **302**, New York, Alan Liss, pp. 157–171
- Kirk, K.M. & Lyon, M.F. (1982) Induction of congenital anomalies in offspring of female mice exposed to varying doses of X-rays. *Mutat. Res.*, **106**, 73–83
- Kirk, K.M. & Lyon, M.F. (1984) Induction of congenital malformations in the offspring of male mice treated with X-rays at pre-meiotic and post-meiotic stages. *Mutat. Res.*, **125**, 75–85
- Knox, E.G., Stewart, A.M., Kneale, G.W. & Gilman, E.A. (1987) Prenatal irradiation and childhood cancer. *J. Soc. Radiol. Prot.*, **7**, 177–189
- Knudson, A.G., Jr (1984) Genetic predisposition to cancer. *Cancer Detect. Prev.*, **7**, 1–8
- Ko, L.J. & Prives, C. (1996) p53: Puzzle and paradigm. *Genes Dev.*, **10**, 1054–1072
- Kohn, H.I. & Kallman, R.F. (1954) Testes weight loss as a quantitative measure of X-ray injury in the mouse, hamster and rat. *Br. J. Radiol.*, **27**, 586–591
- Kohn, H.I. & Melvold, R.W. (1976) Divergent X-ray-induced mutation rates in the mouse for H and '7-locus' groups of loci. *Nature*, **259**, 209–210
- Koike, M., Takeuchi, S., Park, S., Hatta, Y., Yokota, J., Tsuruoka, N. & Koeffler, H.P. (1999) Ovarian cancer: Loss of heterozygosity frequently occurs in the ATM gene, but structural alterations do not occur in this gene. *Oncology*, **56**, 160–163
- Komatsu, K., Matsumura, S., Tauchi, H., Endo, S., Kodama, S., Smeets, D., Weemaes, C. & Oshimura, M. (1996) The gene for Nijmegen breakage syndrome (V2) is not located on chromosome 11. *Am. J. hum. Genet.*, **58**, 885–888
- Kony, S.J., de Vathaire, F., Chompret, A., Shamsaldim, A., Grimaud, E., Raquin, M.-A., Oberlin, O., Brugières, L., Feunteun, J., Eschwège, F., Chavaudra, J., Lemerle, J. & Bonaiti-Pellié, C. (1997) Radiation and genetic factors in the risk of second malignant neoplasms after a first cancer in childhood. *Lancet*, **350**, 91–95
- Koshurnikova, N.A., Bysogolov, G.D., Bolotnikova, M.G., Khohryakov, V.F., Kreslov, V.V., Okatenko, P.V., Romanov, S.A. & Shilnikova, N.S. (1996) Mortality among personnel who worked at the Mayak complex in the first years of its operation. *Health Phys.*, **71**, 90–93
- Koshurnikova, N.A., Bolotnikova, M.G., Ilyin, L.A., Keirim-Markus, I.B., Menshikh, Z.S., Okatenko, P.V., Romanov, S.A., Tsvetkov, V.I. & Shilnikova, N.S. (1998) Lung cancer risk due to exposure to incorporated plutonium. *Radiat. Res.*, **149**, 366–371
- Kossenko, M.M., Degteva, M.O., Vyushkova, O.V., Preston, D.L., Mabuchi, K. & Kozheurov, V.P. (1997) Issues in the comparison of risk estimates for the population in the Techa River region and atomic bomb survivors. *Radiat. Res.*, **148**, 54–63
- Kozheurov, V.P. & Degteva, M. (1994) Dietary intake evaluation and dosimetric modelling for the Techa River residents based on in vivo measurements of strontium-90 in teeth and skeleton. *Sci. total Environ.*, **142**, 63–72
- Kuljis, R.O., Xu, Y., Aguila, M.C. & Baltimore, D. (1997) Degeneration of neurons, synapses, and neuropil and glial activation in a murine *Atm* knockout model of ataxia-telangiectasia. *Proc. natl Acad. Sci. USA*, **94**, 12688–12693
- Laake, K., Ødegård, Å., Andersen, T.I., Bukholm, I.K., Kåresen, R., Nesland, J.M., Ottestad, L., Shiloh, Y. & Børresen-Dale, A.-L. (1997) Loss of heterozygosity at 11q23.1 in breast carcinomas: Indication for involvement of a gene distal and close to ATM. *Genes Chromosomes Cancer*, **18**, 175–180

- Lagakos, S.W. & Mosteller, F. (1986) Assigned shares in compensation for radiation-related cancers. *Risk Anal.*, **6**, 345–357
- Lakin, N.D., Weber, P., Stankovic, T., Rottinghus, S.T., Taylor, A.M.R. & Jackson, S.P. (1996) Analysis of the ATM protein in wild-type and ataxia-telangiectasia cells. *Oncogene*, **13**, 2707–2716
- Land, C.E., Boice, J.D., Jr, Shore, R.E., Norman, J.E. & Tokunaga, M. (1980) Breast cancer risk from low-dose exposures to ionizing radiation: Results of parallel analysis of three exposed populations of women. *J. natl Cancer Inst.*, **65**, 353–376
- Land, C.E., Hayakawa, N., Machado, S.G., Yamada, Y., Pike, M.C., Akiba, S. & Tokunaga, M. (1994a) A case-control interview study of breast cancer among Japanese A-bomb survivors. I. Main effects. *Cancer Causes Control*, **5**, 157–165
- Land, C.E., Hayakawa, N., Machado, S.G., Yamada, Y., Pike, M.C., Akiba, S. & Tokunaga, M. (1994b) A case-control interview study of breast cancer among Japanese A-bomb survivors. II. Interactions with radiation dose. *Cancer Causes Control*, **5**, 167–176
- Land, C.E., Saku, T., Hayashi, Y., Takahara, O., Matsuura, H., Tokuoka, S., Tokunaga, M. & Mabuchi, K. (1996) Incidence of salivary gland tumors among atomic bomb survivors, 1950–1987. Evaluation of radiation-related risk. *Radiat. Res.*, **146**, 28–36
- Lange, E., Gatti, R.A., Sobel, E., Concannon, P. & Lange, K. (1993) How many A-T genes? In: Gatti, R.A. & Painter, R.B., eds, *Ataxia-telangiectasia*, Heidelberg, Springer-Verlag, pp. 37–54
- Langlois, R.G., Bigbee, W.L. & Jensen, R.H. (1986) Measurements of the frequency of human erythrocytes with gene expression loss phenotypes at the glycophorin A locus. *Hum. Genet.*, **74**, 353–362
- Langlois, R.G., Akiyama, M., Kusunoki, Y., DuPont, B.R., Moore, D.H., 2nd, Bigbee, W.L., Grant, S.G. & Jensen, R.H. (1993) Analysis of somatic cell mutations at the glycophorin A locus in atomic bomb survivors: A comparative study of assay methods. *Radiat. Res.*, **136**, 111–117
- Lavin, M.F. & Davidson, M. (1981) Repair of strand breaks in superhelical DNA of ataxia telangiectasia lymphoblastoid cells. *J. Cell Sci.*, **48**, 383–391
- Lavin, M.F., Le Poidevin, P. & Bates, P. (1992) Enhanced levels of radiation-induced G2 phase delay in ataxia telangiectasia heterozygotes. *Cancer Genet. Cytogenet.*, **60**, 183–187
- Lavin, M.F., Bennett, I., Ramsay, J., Gardiner, R.A., Seymour, G.J., Farrell, A. & Walsh, M. (1994) Identification of a potentially radiosensitive subgroup among patients with breast cancer. *J. natl Cancer Inst.*, **86**, 1627–1634
- Lee, W., Chiacchierini, R.P., Shleien, B. & Telles, N.C. (1982) Thyroid tumors following ^{131}I or localized X-irradiation to the thyroid and pituitary glands in rats. *Radiat. Res.*, **92**, 307–319
- van Leeuwen, F.E., Klokman, W.J., Stovall, M., Hagenbeek, A., van den Belt-Dusebout, A.W., Noyon, R., Boice, J.D., Jr, Burgers, J.M. & Somers, R. (1995) Roles of radiotherapy and smoking in lung cancer following Hodgkin's disease. *J. natl Cancer Inst.*, **87**, 1530–1537
- Lévêque, B., Debauchez, C.I., Desbois, J.-C., Feingold, J., Barbet, J. & Marie, J. (1966) [Immunological and lymphocytic anomalies in the ataxia telangiectasia syndrome: Analysis of personal observations.] *Ann. Pediatr.*, **13**, 2710–2725 (in French)
- Le Vu, B., de Vathaire, F., Shamsaldin, A., Hawkins, M.M., Grimaud, E., Hardiman, C., Diallo, I., Vassal, G., Bessa, E., Campbell, S., Panis, X., Daly-Schveitzer, N., Lagrange, J.-L., Zucker, J.-M., Eschwège, F., Chavaudra, J. & Lemerle, J. (1998) Radiation dose, chemo-

- therapy and risk of osteosarcoma after solid tumours during childhood. *Int. J. Cancer*, **77**, 370–377
- Levy, A.R., Goldberg, M.S., Hanley, J.A., Mayo, N.E. & Poitras, B. (1994) Projecting the lifetime risk of cancer from exposure to diagnostic ionizing radiation for adolescent idiopathic scoliosis. *Health Phys.*, **66**, 621–633
- Lewis, E.B. (1963) Leukemia, multiple myeloma and aplastic anemia in American radiologists. *Science*, **142**, 1492–1494
- Li, F.P., Cassidy, J.R. & Barnett, R.N. (1974) Cancer mortality following irradiation in infancy for hemangioma. *Radiology*, **113**, 177–178
- Lieber, M.R. (1997) The FEN-1 family of structure-specific nucleases in eukaryotic DNA replication, recombination and repair. *Bioessays*, **19**, 233–240
- Lim, D.-S. & Hasty, P. (1996) A mutation in mouse *rad51* results in an early embryonic lethal that is suppressed by a mutation in *p53*. *Mol. Cell Biol.*, **16**, 7133–7143
- Lim, D.-S., Kirsch, D.G., Canman, C.E., Ahn, J.H., Ziv, Y., Newman, L.S., Darnell, R.B., Shiloh, Y. & Kastan, M.B. (1998) ATM binds to β -adaptin in cytoplasmic vesicles. *Proc. natl Acad. Sci. USA*, **95**, 10146–10151
- Limoli, C.L., Corcoran, J.J., Milligan, J.R., Ward, J.F. & Morgan, W.F. (1999) Critical target and dose and dose-rate responses for the induction of chromosomal instability by ionizing radiation. *Radiat. Res.*, **151**, 677–685
- Lindberg, S., Karlsson, P., Arvidsson, B., Holmberg, E., Lunberg, L.M. & Wallgren, A. (1995) Cancer incidence after radiotherapy for skin haemangioma during infancy. *Acta oncol.*, **34**, 735–740
- Linos, A., Gray, J.E., Orvis, A.L., Kyle, R.A., O'Fallon, M. & Kurland, L.T. (1980) Low dose radiation and leukemia. *New Engl. J. Med.*, **302**, 1101–1105
- Little, M.P. & Boice, J.D., Jr (1999) Comparison of breast cancer incidence in the Massachusetts tuberculosis fluoroscopy cohort and in the Japanese atomic bomb survivors. *Radiat. Res.*, **151**, 218–224
- Little, J.B., Gorgojo, L. & Vetrovs, H. (1990) Delayed appearance of lethal and specific gene mutations in irradiated mammalian cells. *Int. J. Radiat. Oncol. Biol. Phys.*, **19**, 1425–1429
- Little, J.B., Nagasawa, H., Pfenning, T. & Vetrovs, H. (1997) Radiation-induced genomic instability: Delayed mutagenic and cytogenetic effects of X rays and alpha particles. *Radiat. Res.*, **148**, 299–307
- Little, M.P., de Vathaire, F., Shamsaldin, A., Oberlin, O., Campbell, S., Grimaud, E., Chavaudra, J., Haylock, R.G.E. & Muirhead, C.R. (1998a) Risks of brain tumour following treatment for cancer in childhood: Modification by genetic factors, radiotherapy and chemotherapy. *Int. J. Cancer*, **78**, 269–275
- Little, M.P., De Vathaire, F., Charles, M.W., Hawkins, M.M. & Muirhead, C.R. (1998b) Variations with time and age in the risks of solid cancer incidence after radiation exposure in childhood. *Stat. Med.*, **17**, 1341–1355
- Little, M.P., Weiss, H.A., Boice, J.D., Jr, Darby, S.C., Day, N.E. & Muirhead, C.R. (1999) Risks of leukemia in Japanese atomic bomb survivors, in women treated for cervical cancer and in patients treated for ankylosing spondylitis. *Radiat. Res.*, **152**, 280–292
- Liu, V.F. & Weaver, D.T. (1993) The ionizing radiation-induced replication protein A phosphorylation response differs between ataxia telangiectasia and normal human cells. *Mol. Cell Biol.*, **13**, 7222–7231

- Lloyd, D.C. & Purrott, R.J. (1981) Chromosome aberration analysis in radiological protection dosimetry. *Rad. Protect. Dosim.*, **1**, 19–28
- Löblich, M., Rydberg, B. & Cooper, P.K. (1995) Repair of X-ray-induced DNA double-strand breaks in specific *Not I* restriction fragments in human fibroblasts: Joining correct and incorrect ends. *Proc. natl Acad. Sci. USA*, **92**, 12050–12054
- Löblich, M., Cooper, P.K. & Rydberg, B. (1998) Joining of correct and incorrect DNA ends at double-strand breaks produced by high-linear energy transfer radiation in human fibroblasts. *Radiat. Res.*, **150**, 619–626
- Loeb, L.A. (1998) Cancer cells exhibit a mutator phenotype. *Adv. Cancer Res.*, **72**, 25–56
- van Lohuizen, M., Verbeek, S., Krimpenfort, P., Domen, J., Saris, C., Radaszkiewicz, T. & Berns, A. (1989) Predisposition to lymphomagenesis in *pim-1* transgenic mice: Cooperation with *c-myc* and *N-myc* in murine leukemia virus-induced tumours. *Cell*, **56**, 673–682
- Lotem, J. & Sachs, L. (1993) Hematopoietic cells from mice deficient in wild-type p53 are more resistant to induction of apoptosis by some agents. *Blood*, **82**, 1092–1096
- Loucas, B.D. & Cornforth, M.N. (1998) Postirradiation growth in HAT medium fails to eliminate the delayed appearance of 6-thioguanine-resistant clones in EJ30 human epithelial cells. *Radiat. Res.*, **149**, 171–178
- Lowe, S.W., Schmitt, E.M., Smith, S.W., Osborne, B.A. & Jacks, T. (1993) p53 is required for radiation-induced apoptosis in mouse thymocytes. *Nature*, **362**, 847–849
- Lumniczky, K., Antal, S., Unger, E., Wunderlich, L., Hidvegi, E.J. & Safrany, G. (1998) Carcinogenic alterations in murine liver, lung, and uterine tumors induced by in utero exposure to ionizing radiation. *Mol. Carcinog.*, **21**, 100–110
- Lundell, M. & Holm, L.-E. (1995) Risk of solid tumors after irradiation in infancy. *Acta oncol.*, **34**, 727–734
- Lundell, M. & Holm, L.-E. (1996) Mortality from leukemia after irradiation in infancy for skin hemangioma. *Radiat. Res.*, **145**, 595–601
- Lundell, M., Hakulinen, T. & Holm, L.-E. (1994) Thyroid cancer after radiotherapy for skin hemangioma in infancy. *Radiat. Res.*, **140**, 334–339
- Lundell, M., Mattsson, A., Hakulinen, T. & Holm, L.-E. (1996) Breast cancer after radiotherapy for skin hemangioma in infancy. *Radiat. Res.*, **145**, 225–230
- Lundell, M., Mattson, A., Karlsson, P., Holmberg, E., Gustafsson, A. & Holm, L.-E. (1999) Breast cancer risk after radiotherapy in infancy. A pooled analysis of two Swedish cohorts of 17 202 infants. *Radiat. Res.*, **151**, 626–632
- Lüning, K.G. & Eiche, A. (1976) X-ray-induced recessive lethal mutations in the mouse. *Mutat. Res.*, **34**, 163–174
- Lüning, K.G. & Searle, A.G. (1971) Estimates of the genetic risks from ionizing radiation. *Mutat. Res.*, **12**, 291–304
- Luongo, C. & Dove, W.F. (1996) Somatic genetic events linked to the *Apc* locus in intestinal adenomas of the Min mouse. *Genes Chromosomes Cancer*, **17**, 194–198
- Lyon, M.F. (1970) X-ray induced dominant lethal mutation in male guinea-pigs, hamsters and rabbits. *Mutat. Res.*, **10**, 133–140
- Lyon, M.F., Phillips, R.J.S. & Fisher, G. (1979) Dose–response curves for radiation-induced gene mutations in mouse oocytes and their interpretation. *Mutat. Res.*, **63**, 161–173
- Lyon, M.F., Phillips, R.J.S. & Fisher, G. (1982) Use of an inversion to test for induced X-linked lethals in mice. *Mutat. Res.*, **92**, 217–228

- Mabuchi, K., Soda, M., Ron, E., Tokunaga, M., Ochikubo, S., Sugimoto, S., Ikeda, T., Terasaki, M., Preston, D.L. & Thompson, D.E. (1994) Cancer incidence in atomic bomb survivors. Part I: Use of the tumor registries in Hiroshima and Nagasaki for incidence studies. *Radiat. Res.*, **137** (Suppl. 2), S1–S16
- MacMahon, B. (1962) Prenatal X-ray exposure and childhood cancer. *J. natl Cancer Inst.*, **28**, 1173–1191
- MacMahon, B. (1985) Prenatal X-ray exposure and twins. *New Engl. J. Med.*, **312**, 576–577
- MacMahon, B. (1989) Some recent issues in low-exposure radiation epidemiology. *Environ. Health Perspect.*, **81**, 131–135
- MacMahon, B. (1992) Leukemia clusters around nuclear facilities in Britain. *Cancer Causes Control*, **3**, 283–288
- Mah, K., Van Dyk, J., Keane, T. & Poon, P.Y. (1987) Acute radiation-induced pulmonary damage: A clinical study on the response to fractionated radiation therapy. *Int. J. Radiat. Oncol. Biol. Phys.*, **13**, 179–188
- Maier, U., Ehrenböck, P.M. & Hofbauer, J. (1997) Late urological complications and malignancies after curative radiotherapy for gynecological carcinomas: A retrospective analysis of 10,709 patients. *J. Urol.*, **158**, 814–817
- Maisin, J.R., Wambersie, A., Gerber, G.B., Gueulette, J., Mattelin, G. & Lambiet-Collier, M. (1983) Life shortening and disease incidence in BALB/c mice following a single d(50)-Be neutron or gamma exposure. *Radiat. Res.*, **94**, 374–389
- Maisin, J.R., Wambersie, A., Gerber, G.B., Mattelin, G., Lambiet-Collier, M., De Coster, B. & Gueulette, J. (1988) Life shortening and disease incidence in C57BL mice after single and fractionated gamma and high-energy neutron exposure. *Radiat. Res.*, **113**, 300–317
- Malkin, D. (1998) The Li-Fraumeni syndrome. In: Vogelstein, B. & Kinzler, K.W., eds, *The Genetic Basis of Human Cancer*, New York, McGraw-Hill, pp. 393–407
- Malkin, D., Li, F.P., Strong, L.C., Fraumeni, J.F., Jr, Nelson, C.E., Kim, D.H., Kassel, J., Gryka, M.A., Bischoff, F.Z., Tainsky, M.A. & Friend, S.H. (1990) Germ line p53 mutations in a familial syndrome of breast cancer, sarcomas, and other neoplasms. *Science*, **250**, 1233–1238
- March, H.C. (1944) Leukemia in radiologists. *Radiology*, **43**, 275–278
- Marder, B.A. & Morgan, W.F. (1993) Delayed chromosomal instability induced by DNA damage. *Mol. Cell Biol.*, **13**, 6667–6677
- Marshall, E. (1984) Juarez: An unexpected radiation accident. *Science*, **223**, 1152–1154
- Mason, T.J. & Miller, R.W. (1974) Cosmic radiation at high altitudes and US cancer mortality, 1950–1969. *Radiat. Res.*, **60**, 302–306
- Matanoski, G.M., Seltser, R., Sartwell, P.E., Diamond, E.L. & Elliott, E.A. (1975a) The current mortality rates of radiologists and other physician specialists: Deaths from all causes and from cancer. *Am. J. Epidemiol.*, **101**, 188–198
- Matanoski, G.M., Seltser, R., Sartwell, P.E., Diamond, E.L. & Elliott, E.A. (1975b) The current mortality rates of radiologists and other physician specialists: Specific causes of death. *Am. J. Epidemiol.*, **101**, 199–210
- Matsuo, T., Tomonaga, M., Bennett, J.M., Kuriyama, K., Imanaka, F., Kuramoto, A., Kamada, N., Ichimaru, M., Finch, S.C., Pisciotta, A.V. & Ishimaru, T. (1988) Reclassification of leukemia among A-bomb survivors in Nagasaki using French–American–British (FAB) classification for acute leukemia. *Jpn. J. clin. Oncol.*, **18**, 91–96

- Matsuura, S., Weemaes, C., Smeets, D., Takami, H., Kondo, N., Sakamoto, S., Yano, N., Nakamura, A., Tauchi, H., Endo, S., Oshimura, M. & Komatsu, K. (1997) Genetic mapping using microcell-mediated chromosome transfer suggests a locus for Nijmegen breakage syndrome at chromosome 8q21-24. *Am. J. hum. Genet.*, **60**, 1487–1494
- Matsuura, K., Balmukhanov, T., Tauchi, H., Weemaes, C., Smeets, D., Chrzanowska, K., Endou, S., Matsuura, S. & Komatsu, K. (1998) Radiation induction of p53 in cells from Nijmegen breakage syndrome is defective but not similar to ataxia-telangiectasia. *Biochem. biophys. Res. Commun.*, **26**, 602–607
- Mattsson, A., Rudén, B.-I., Hall, P., Wilking, N. & Rutqvist, L.E. (1993) Radiation-induced breast cancer: Long-term follow-up of radiation therapy for benign breast disease. *J. natl Cancer Inst.*, **85**, 1679–1685
- Mattsson, A., Rudén, B.-I., Palmgren, J. & Rutqvist, L.E. (1995) Dose- and time-response for breast cancer risk after radiation therapy for benign breast disease. *Br. J. Cancer*, **72**, 1054–1061
- Mattsson, A., Hall, P., Rudén, B.-I. & Rutqvist, L.E. (1997) Incidence of primary malignancies other than breast cancer among women treated with radiation therapy for benign breast disease. *Radiat. Res.*, **148**, 152–160
- Matutes, E., Brito-Babapulle, V., Swansbury, J., Ellis, J., Morilla, R., Dearden, C., Sempere, A. & Catovsky, D. (1991) Clinical and laboratory features of 78 cases of T-prolymphocytic leukaemia. *Blood*, **78**, 3269–3274
- Maxon, H.R., Saenger, E.L., Thomas, S.R., Buncher, C.R., Kereiakes, J.G., Shafer, M.L. & McLaughlin, C.A. (1980) Clinically important radiation-associated thyroid disease. A controlled study. *J. Am. med. Assoc.*, **244**, 1802–1805
- Maxon, H.R., Saenger, E.L., Buncher, C.R., Thomas, S.R., Kereiakes, J.C., Shafer, M.L. & McLaughlin, C.A. (1981) Radiation-associated carcinoma of the salivary glands: A controlled study. *Ann. Otol.*, **90**, 107–109
- McBlane, J.F., van Gent, D.C., Ramsden, D.A., Romeo, C., Cuomo, C.A., Gellert, M. & Oettinger, M.A. (1995) Cleavage at a V(D)J recombination signal requires only RAG1 and RAG2 proteins and occurs in two steps. *Cell*, **83**, 387–395
- McCulloch, E.A. & Till, J.E. (1960) The radiation sensitivity of normal mouse bone marrow cells, determined by quantitative marrow transplantation into irradiated mice. *Radiat. Res.*, **13**, 115–125
- McCulloch, E.A. & Till, J.E. (1962) The sensitivity of cells from normal mouse bone marrow to γ -radiation *in vitro* and *in vivo*. *Radiat. Res.*, **16**, 822–832
- McLaughlin, J.R., Kreiger, N., Sloan, M.P., Benson, L.N., Hilditch, S. & Clarke, E.A. (1993a) An historical cohort study of cardiac catheterization during childhood and the risk of cancer. *Int. J. Epidemiol.*, **22**, 584–591
- McLaughlin, J.R., Clarke, E.A., Nishri, E.D. & Anderson, T.W. (1993b) Childhood leukemia in the vicinity of Canadian nuclear facilities. *Cancer Causes Control*, **4**, 51–58
- McLaughlin, J.R., King, W.D., Anderson, T.W., Clarke, E.A. & Ashmore, J.P. (1993c) Paternal radiation exposure and leukemia in offspring: The Ontario case-control study. *Br. med. J.*, **307**, 959–965
- Medina, D. (1979) Serial transplantation of chemical carcinogen-induced mouse mammary ductal dysplasias. *J. natl Cancer Inst.*, **62**, 397–405

- Meistrich, M.L. & Van Beek, M.E.A.B. (1990) Radiation sensitivity of the human testis. *Adv. Radiat. Biol.*, **14**, 227–268
- Meistrich, M.L., Vassilopoulou-Sellin, R. & Lipshultz, L.I. (1997) Gonadal dysfunction. In: De Vita, V.T., Jr, Hellman, S. & Rosenberg S.A., eds, *Principles and Practices of Oncology*, 5th Ed., Philadelphia, PA, J.B. Lippincott Raven, pp. 2758–2773
- Mendonca, M.S., Fasching, C.L., Srivatsan, E.S., Stanbridge, E.J. & Redpath, J.L. (1995) Loss of a putative tumor suppressor locus after gamma-ray-induced neoplastic transformation of HeLa x skin fibroblast human cell hybrids. *Radiat. Res.*, **143**, 34–44
- Mendonca, M.S., Temples, T.M., Farrington, D.L. & Bloch, C. (1998a) Evidence for a role of delayed death and genomic instability in radiation-induced neoplastic transformation of human hybrid cells. *Int. J. Radiat. Biol.*, **74**, 755–64
- Mendonca, M.S., Howard, K., Fasching, C.L., Farrington, D.L., Desmond, L.A., Stanbridge, E.J. & Redpath, J.L. (1998b) Loss of suppressor loci on chromosomes 11 and 14 may be required for radiation-induced neoplastic transformation of HeLa x skin fibroblast human cell hybrids. *Radiat. Res.*, **149**, 246–55
- Mengle-Gaw, L., Albertson, D.G., Sherrington, P.D. & Rabbitts, T.H. (1988) Analysis of a T-cell tumor-specific breakpoint cluster at human chromosome 14q32. *Proc. natl Acad. Sci. USA*, **85**, 9171–9175
- Merriam, G.R., Jr, Szechter, A. & Focht, E.F. (1972) The effects of ionising radiation on the eye. *Front. Rad. Ther. Oncol.*, **6**, 346–385
- Mettler, F.A., Jr, Hempelmann, L.H., Dutton, A.M., Pifer, J.W., Toyooka, E.T. & Ames, W.R. (1969) Breast cancer neoplasms in women treated with X-rays for acute postpartum mastitis. A pilot study. *J. natl Cancer Inst.*, **43**, 803–811
- Mettler, F.A., Jr, Upton, A., Kelsey, C.A., Ashby, R.N., Rosenberg, R.D. & Linver, M.N. (1996) Benefits versus risks from mammography: A critical reassessment. *Cancer*, **77**, 903–909
- Michaelis, J., Keller, B., Haaf, G. & Kaatsch, P. (1992) Incidence of childhood malignancies in the vicinity of West German nuclear power plants. *Cancer Causes Control*, **3**, 255–263
- Michaelis, J., Kaletsch, U., Burkart, W. & Grosche, B. (1997) Infant leukaemia after the Chernobyl accident (Letter to the Editor). *Nature*, **387**, 246
- Miki, Y., Swensen, J., Shattuck-Eidens, D., Futreal, P.A., Harshman, K., Tavtigian, S., Liu, Q., Cochran, C., Bennett, L.M., Ding, W., Bell, R., Rosenthal, J., Hussey, C., Tran, T., McClure, M., Frye, C., Hattier, T., Phelps, R., Haugen-Strano, A., Katcher, H., Yakumo, K., Gholami, Z., Shaffer, D., Stone, S., Bayer, S., Wray, C., Bogden, R., Dayananth, P., Ward, J., Tonin, P., Narod, S., Bristow, P.K., Norris, F.H., Helvering, L., Morrison, P., Rosteck, P., Lai, M., Barrett, J.C., Lewis, C., Neuhausen, S., Cannon-Albright, L., Goldgar, D., Wiseman, R., Kamb, A. & Skolnick, M.H. (1994) A strong candidate for the breast and ovarian cancer susceptibility gene *BRCA1*. *Science*, **266**, 66–71
- Miller, R.W. (1969) Delayed radiation effects in atomic-bomb survivors. *Science*, **166**, 569–574
- Miller, K.M. (1992) Measurements of external radiation in United States dwellings. *Radiat. Protect. Dosim.*, **45**, 535–539
- Miller, R.W. (1995) Delayed effects of external radiation exposure: A brief history. *Radiat. Res.*, **144**, 160–169
- Miller, M.E. & Chatten, J. (1967) Ovarian changes in ataxia telangiectasia. *Acta paediatr. scand.*, **56**, 559–561

- Miller, R.W. & Mulvihill, J.J. (1956) Small head size after atomic irradiation. *Teratology*, **14**, 355–358
- Miller, A.B., Howe, G.R., Sherman, G.J., Lindsay, J.P., Yaffe, M.J., Dinner, P.J., Risch, H.A. & Preston, D.L. (1989) Mortality from breast cancer after irradiation during fluoroscopic examinations in patients being treated for tuberculosis. *New Engl. J. Med.*, **321**, 1285–1289
- Modan, B., Chetrit, A., Alfandary, E. & Katz, L. (1989) Increased risk of breast cancer after low-dose irradiation. *Lancet*, **i**, 629–631
- Mohr, U., Dasenbrock, C., Tillmann, T., Kohler, M., Kamino, K., Hagemann, G., Morawietz, G., Campo, E., Cazorla, M., Fernandez, P., Hernandez, L., Cardesa, A. & Tomatis, L. (1999) Possible carcinogenic effects of X-rays in a transgenerational study with CBA mice. *Carcinogenesis*, **20**, 325–332
- Mole, R.H. (1974) Antenatal irradiation and childhood cancer: Causation or coincidence? *Br. J. Cancer*, **30**, 199–208
- Mole, R.H. (1990) Childhood cancer after prenatal exposure to diagnostic x-ray examinations in Britain. *Br. J. Cancer*, **62**, 152–168
- Mole, R.H., Papworth, D.G. & Corp, M.J. (1983) The dose–response of X-ray induction of myeloid leukaemia in male CBA/H mice. *Br. J. Cancer*, **47**, 285–291
- Møller, H., Mellemsgaard, A., Jacobsen, G.K., Pedersen, D. & Storm, H.H. (1993) Incidence of second primary cancer following testicular cancer. *Eur. J. Cancer*, **29A**, 672–676
- Monson, R.R. & MacMahon, B. (1984) Prenatal X-ray exposure and cancer in children. In: Boice, J.D., Jr & Fraumeni, J.F., Jr, eds, *Radiation Carcinogenesis: Epidemiology and Biological Significance*, New York, Raven Press, pp. 97–105
- Morales, M.D., González, F.A., Villegas, A., del Potro, E., Díaz Mediavilla, J., Martínez, R., Alvarez, A. & Colomé, J.A. (1992) [Second neoplasms as a late complication of the treatment of Hodgkin's disease]. *Sangre*, **37**, 429–433 (in Spanish)
- Morgan, J.L., Holcomb, T.M. & Morrissey, R.W. (1968) Radiation reaction in ataxia-telangiectasia. *Am. J. Dis. Child.*, **116**, 557–558
- Morgan, W.F., Day, J.P., Kaplan, M.I., McGhee, E.M. & Limoli, C.L. (1996) Genomic instability induced by ionizing radiation. *Radiat. Res.*, **146**, 247–258
- Morgan, S.E., Lovly, C., Pandita, T.K., Shiloh, Y. & Kastan, M. (1997) Fragments of ATM which have dominant-negative or complementing activity. *Mol. cell. Biol.*, **17**, 2020–2029
- Morrell, D., Cromartie, E. & Swift, M. (1986) Mortality and cancer incidence in 263 patients with ataxia-telangiectasia. *J. natl Cancer Inst.*, **77**, 89–92
- Morrell, D., Chase, C.L. & Swift, M. (1990) Cancers in 44 families with ataxia-telangiectasia. *Cancer Genet. Cytogenet.*, **50**, 119–123
- Morris, C., Mohamed, R. & Lavin, M.F. (1983) DNA replication and repair in ataxia-telangiectasia cells exposed to bleomycin. *Mutat. Res.*, **112**, 67–74
- Moser, A.R., Luongo, C., Gould, K.A., McNeley, M.K., Shoemaker, A.R. & Dove, W.F. (1995) *Apc^{Min}*: A mouse model for intestinal and mammary tumorigenesis. *Eur. J. Cancer*, **31A**, 1061–1064
- Moulder, J.E. & Fish, B.L. (1997) Age dependence of radiation nephropathy in the rat. *Radiat. Res.*, **147**, 340–353
- Muirhead, C.R. & Kneale, G.W. (1989) Prenatal irradiation and childhood cancer. *J. Radiol. Prot.*, **9**, 209–212

- Muirhead, C.R., Butland, B.K., Green, B.M.R. & Draper, G.J. (1991) Childhood leukaemia and natural radiation (Letter to the Editor). *Lancet*, **337**, 503–504
- Muirhead, C.R., Goodill, A.A., Haylock, R.G.E., Vokes, J., Little, M.P., Jackson, D.A., O'Hagan, J.A., Thomas, J.M., Kendall, G.M., Silk, T.J., Bingham, D. & Berridge, G.L.C. (1999) Occupational radiation exposure and mortality: Second analysis of the National Registry for Radiation Workers. *J. Radiol. Prot.*, **19**, 3–26
- Mulcahy, R.T., Gould, M.N. & Clifton, K.H. (1980) The survival of thyroid cells: *in vivo* irradiation and *in situ* repair. *Radiat. Res.*, **84**, 523–528
- Muller, H.J. (1927) Artificial transmutation of the gene. *Science*, **66**, 84–87
- Nagasawa, H. & Little, J.B. (1983) Comparison of kinetics of X-ray-induced cell killing in normal, ataxia-telangiectasia and hereditary retinoblastoma fibroblasts. *Mutat. Res.*, **109**, 297–308
- Nagasawa, H., Kraemer, K. H., Shiloh, Y. & Little J.B. (1987) Detection of ataxia telangiectasia heterozygous cell lines by postirradiation cumulative labelling index: Measurements with coded samples. *Cancer Res.*, **47**, 398–402
- Nambi, K.S.V. & Soman, S.D. (1987) Environmental radiation and cancer in India. *Health Phys.*, **52**, 653–657
- Nandakumar, A., Davis, S., Moolgavkar, S., Witherspoon, R.P. & Schwartz, S.M. (1991) Myeloid leukaemia following therapy for a first primary cancer. *Br. J. Cancer*, **63**, 782–788
- Natarajan, A.T. & Obe, G. (1984) Molecular mechanisms involved in the production of chromosomal aberrations. III. Restriction endonucleases. *Chromosoma*, **90**, 120–127
- Natarajan, A.T., Ramalho, A.T., Vyas, R.C., Bernini, L.F., Tates, A.D., Ploem, J.S., Nascimento, A.C. & Curado, M.P. (1991a) Goiania radiation accident: Results of initial dose estimation and follow up studies. *Prog. clin. Biol. Res.*, **372**, 145–553
- Natarajan, A.T., Vyas, R.C., Wiegant, J. & Curado, M.P. (1991b) A cytogenetic follow-up study of the victims of a radiation accident in Goiania, Brazil. *Mutat. Res.*, **247**, 103–111
- Natarajan, A.T., Boei, J.J.W.A., Vermeulen, S. & Balajee, A.S. (1996) Frequencies of X-ray induced pericentric inversions and centric rings in human blood lymphocytes detected by FISH using chromosome arm specific probes. *Mutat. Res.*, **372**, 1–7
- Natarajan, A.T., Santos, S.J., Darroudi, F., Hadjidikova, V., Vermeulen, S., Chatterjee, S., Van den Berg, M., Grigorova, M., Sakamoto-Hojo, E.T., Granath, F., Ramalho, A.T. & Curado, M.P. (1998) ¹³⁷Cesium-induced chromosome aberrations analyzed by fluorescence in situ hybridization: Eight years follow up of the Goiânia radiation accident victims. *Mutat. Res.*, **400**, 299–312
- National Council on Radiation Protection and Measurements (1987a) *Exposure of the Population in the United States and Canada from Natural Background Radiation* (NCRP Report No. 94), Bethesda, MD
- National Council on Radiation Protection and Measurements (1987b) *Genetic Effects from Internally Deposited Radionuclides* (NCRP Report No. 89), Bethesda, MD
- National Council on Radiation Protection and Measurements (1989) *Exposure of the US Population from Diagnostic Medical Radiation* (NCRP Report No. 100), Bethesda, MD
- National Council on Radiation Protection and Measurements (1997) *Uncertainties in Fatal Cancer Risk Estimates Used in Radiation Protection* (NCRP Report No. 126), Bethesda, MD
- National Radiological Protection Board (1991) *Committed Equivalent Organ Doses and Committed Effective Doses from Intakes of Radionuclides* (NRPB-R245), Chilton, Oxfordshire

- National Radiological Protection Board (1996) *Risk from Deterministic Effects of Ionizing Radiation* (Documents of the NRPB Vol. 7, No. 3), Chilton, Oxfordshire
- Neel, J.V. (1991) Update on the genetic effects of ionizing radiation. *J. Am. med. Assoc.*, **266**, 698–701
- Neel, J.V., Satoh, C., Goriki, K., Asakawa, J., Fujita, M., Takahashi, N., Kageoka, T. & Hazama, R. (1988) Search for mutations altering protein charge and/or function in children of atomic bomb survivors: Final report. *Am. J. hum. Genet.*, **42**, 663–676
- Neel, J.V., Schull, W.J., Awa, A.A., Satoh, C., Kato, H., Otake, M. & Yoshimoto, Y. (1990) The children of parents exposed to atomic bombs: Estimates of the genetic doubling dose of radiation for humans. *Am. J. hum. Genet.*, **46**, 1053–1072
- Neglia, J.P., Meadows, A.T., Robison, L.L., Kim, T.H., Newton, W.A., Ruymann, F.B., Sather, H.N. & Hammond, G.D. (1991) Second neoplasms after acute lymphoblastic leukemia in childhood. *New Engl. J. Med.*, **325**, 1330–1336
- Neugut, A.I., Murray, T., Santos, J., Amols, H., Hayes, M.K., Flannery, J.T. & Robinson, E. (1994) Increased risk of lung cancer after breast cancer radiation therapy in cigarette smokers. *Cancer*, **73**, 1615–1620
- Neugut, A.I., Ahsan, H. & Antman, K.H. (1997a) Incidence of malignant pleural mesothelioma after thoracic radiotherapy. *Cancer*, **80**, 948–950
- Neugut, A.I., Ahsan, H., Robinson, E. & Ennis, R.D. (1997b) Bladder carcinoma and other second malignancies after radiotherapy for prostate carcinoma. *Cancer*, **79**, 1600–1604
- Newsham, I.F., Hadjistilianov, T. & Cavenee, W.K. (1998) Retinoblastoma. In: Vogelstein, B. & Kinzler, K.W., eds, *The Genetic Basis of Human Cancer*, New York, McGraw-Hill, pp. 363–391
- Nicolas, N., Moshous, D., Cavazzana-Calvo, M., Papadopoulo, D., de Chasseval, R., Le Deist, F., Fischer, A. & de Villartay, J.-P. (1998) A human severe combined immunodeficiency (SCID) condition with increased sensitivity to ionizing radiations and impaired V(D)J rearrangements defines a new DNA recombination/repair deficiency. *J. exp. Med.*, **188**, 627–634
- Nishisho, I., Nakamura, Y., Miyoshi, Y., Miki, Y., Ando, H., Horii, A., Koyama, K., Utsunomiya, J., Baba, S., Hedge, P., Markham, A., Krush, A.J., Petersen, G., Hamilton, S.R., Nilbert, M.C., Levy, D.B., Bryan, T.M., Preisinger, A.C., Smith, K.J., Su, L.-K., Kinzler, K.W. & Vogelstein, B. (1991) Mutations of chromosome 5q21 genes in FAP and colorectal cancer patients. *Science*, **253**, 665–669
- Noguchi, K., Shimizu, M. & Anzai, I. (1986) Correlation between natural radiation exposure and cancer mortality in Japan (I). *J. Radiat. Res.*, **27**, 191–212
- Nomura, T. (1982) Parental exposure to X rays and chemicals induces heritable tumours and anomalies in mice. *Nature*, **296**, 575–577
- Nomura, T. (1983) X-ray-induced germ-line mutation leading to tumors. Its manifestation in mice given urethane post-natally. *Mutat. Res.*, **121**, 59–65
- Nomura, T. (1984) Induction of persistent hypersensitivity to lung tumorigenesis by in utero X-radiation in mice. *Environ. Mutag.*, **6**, 33–40
- Nomura, T. (1986) Further studies on X-ray and chemically induced germ-line alterations causing tumors and malformations in mice. In: Ramel, C., Lambert, B. & Magnusson, J., eds, *Genetic Toxicology of Environmental Chemicals, Part B: Genetic Effects and Applied Mutagenesis*, New York, Alan R. Liss, pp. 13–20

- Nomura, T. (1989) Role of radiation-induced mutations in multigeneration carcinogenesis. In: Napalkov, N.P., Rice, J.M., Tomatis, L. & Yamasaki, H., eds, *Perinatal and Multigeneration Carcinogenesis* (IARC Scientific Publications No. 96), Lyon, IARC, pp. 375–387
- Nomura, T., Nakajima, H., Hatanaka, T., Kinuta, M. & Hongyo, T. (1990) Embryonic mutation as a possible cause of in utero carcinogenesis in mice revealed by postnatal treatment with 12-*O*-tetradecanoylphorbol-13-acetate. *Cancer Res.*, **50**, 2135–2138
- Norman, A. & Withers, H.R. (1992) Mammography screening for A-T heterozygotes. *Cell Biol.*, **77**, 137–140
- Norman, A., Kagan, A.R. & Chan, S.L. (1988) The importance of genetics for the optimization of radiation therapy. A hypothesis. *Am. J. clin. Oncol.*, **11**, 84–88
- Nowell, P.C. (1976) The clonal evolution of tumor cell populations. *Science*, **194**, 23–28
- Oakberg, E.F. & Clark, E. (1964) Species comparisons of radiation response of the gonads. In: Carlson, W.D. & Gassner, F.X., eds, *Effects of Ionizing Radiation on the Reproductive System*, New York, Pergamon Press, pp. 11–24
- Obe, G., Johannes, C. & Schulte-Frohlinde, D. (1992) DNA double-strand breaks induced by sparsely ionizing radiation and endonucleases as critical lesions for cell death, chromosomal aberrations, mutations and oncogenic transformation. *Mutagenesis*, **7**, 3–12
- Oberfield, S.E., Allen, J.C., Pollack, J., New, M.I. & Levine, L.S. (1986) Long-term endocrine sequelae after treatment of medulloblastoma: Prospective study of growth and thyroid function. *J. Pediatr.*, **108**, 219–223
- Okeanov, A.E., Cardis, E., Antipova, S.I., Polyakov, S.M., Sobolev, A.V. & Bazulko, N.V. (1996) Health status and follow-up of the liquidators in Belarus. In: Karaoglou, A., Desmet, G., Kelly, G.N. & Menzel, H.G., eds, *The Radiological Consequences of the Chernobyl Accident* (Proceedings of the First International Conference, Minsk, Belarus, 18–22 March 1996), Luxembourg, Office for Official Publications of the European Communities, pp. 851–859
- Otake, M. & Schull, W.J. (1984) *In utero* exposure to A-bomb radiation and mental retardation: A reassessment. *Br. J. Radiol.*, **57**, 409–414
- Otake, M. & Schull, W.J. (1990) Radiation-related posterior lenticular opacities in Hiroshima and Nagasaki atomic bomb survivors based on the DS86 dosimetry system. *Radiat. Res.*, **121**, 3–13
- Otake, M. & Schull, W.J. (1998) Radiation-related brain damage and growth retardation among the prenatally exposed atomic bomb survivors. *Int. J. Radiat. Biol.*, **74**, 159–171
- Padovani, L., Caporossi, D., Tedeschi, B., Vernole, P., Nicoletti, B. & Mauro, F. (1993) Cytogenetic study in lymphocytes from children exposed to ionizing radiation after the Chernobyl accident. *Mutat. Res.*, **319**, 55–60
- Padovani, L., Stronati, L., Mauro, F., Testa, A., Appolloni, M., Anzidei, P., Caporossi, D., Tedeschi, B. & Vernole, P. (1997) Cytogenetic effects in lymphocytes from children exposed to radiation fall-out after the Chernobyl accident. *Mutat. Res.*, **395**, 249–254
- Painter, R.B. & Young, B.R. (1980) Radiosensitivity in ataxia-telangiectasia: A new explanation. *Proc. natl Acad. Sci. USA*, **77**, 7315–7317
- Pampfer, S. & Streffer, C. (1989) Increased chromosome aberration levels in cells from mouse fetuses after zygote X-irradiation. *Int. J. Radiat. Biol.*, **55**, 85–92
- Parker, L., Craft, A.W., Smith, J., Dickinson, H., Wakeford, R., Binks, K., McElveney, D., Scott, L. & Slovak, A. (1993) Geographical distribution of preconceptional radiation doses to fathers employed at the Sellafield nuclear station. *Br. med. J.*, **307**, 966–971

- Parkin, D.M., Cardis, E., Masuyer, E., Friedl, H.P., Hansluwka, H., Bobev, D., Ivanov, E., Sinnaeve, J., Augustin, J., Plesko, I., Storm, H.H., Rahu, M., Karjalainen, S., Bernard, J.L., Carli, P.M., L'Huillier, M.C., Lutz, J.M., Schaffer, P., Schraub, S., Michaelis, J., Möhner, M., Staneczek, W., Vargha, M., Crosignani, P., Magnani, C., Terracini, B., Kriauciunas, R., Coebergh, J.W., Langmark, F., Zatonski, W., Merabishvili, V., Pompe-Kirn, V., Barlow, L., Raymond, L., Black, R., Stiller, C.A. & Bennett, B.G. (1993) Childhood leukaemia following the Chernobyl accident: The European Childhood Leukaemia-Lymphoma Incidence Study (ECLIS). *Eur. J. Cancer*, **29A**, 87–95
- Parkin, D.M., Clayton, D., Black, R.J., Masuyer, E., Friedl, H.P., Ivanov, E., Sinnaeve, J., Tzvetansky, C.G., Geryk, E., Storm, H.H., Rahu, M., Pukkala, E., Bernard, J.L., Carli, P.M., L'Huillier, M.C., Ménégos, F., Schaffer, P., Schraub, S., Kaatsch, P., Michaelis, J., Apjok, E., Schuler, D., Crosignani, P., Magnani, C., Terracini, B., Stengrevics, A., Kriauciunas, R., Coebergh, J.W., Langmark, F., Zatonski, W., Tulbure, R., Boukhny, A., Merabishvili, V., Plesko, I., Kramárová, E., Pompe-Kirn, V., Barlow, L., Enderlin, F., Levi, F., Raymond, L., Schüler, G., Torhorst, J., Stiller, C.A., Sharp, L. & Bennett, B.G. (1996) Childhood leukaemia in Europe after Chernobyl: 5 year follow-up. *Br. J. Cancer*, **73**, 1006–1012
- Parshad, R., Price, F.M., Bohr, V.A., Cowans, K.H., Zujewski, J.A. & Sanford, K.K. (1996) Deficient DNA repair capacity, a predisposing factor in breast cancer. *Br. J. Cancer*, **74**, 1–5
- Patel, U., Bhimani, R. & Frenkel, K. (1992) Mechanism of mutagenicity by 5-hydroperoxymethyl-2'-deoxyuridine, an intermediate product of ionizing radiation, in bacteria. HPMdU bacterial mutagenicity and oxidation of DNA bases. *Mutat. Res.*, **283**, 145–156
- Paterson, M.C. & Smith, P.J. (1979) Ataxia-telangiectasia: An inherited human disorder involving hypersensitivity to ionizing radiation and related DNA-damaging chemicals. *Ann. Rev. Genet.*, **13**, 291–318
- Pearce, N., Winkelmann, R., Kennedy, J., Lewis, S., Purdie, G., Slater, T., Prior, I. & Fraser, J. (1997) Further follow-up of New Zealand participants in United Kingdom atmospheric nuclear weapons tests in the Pacific. *Cancer Causes Control*, **8**, 139–145
- Peller, S. & Pick, P. (1952) Leukemia and other malignancies in physicians. *Am. J. med. Sci.*, **224**, 154–159
- Peterson, R.D.A., Kelly, W.D. & Good, R.A. (1964) Ataxia-telangiectasia: Its association with a defective thymus, immunological-deficiency disease, and malignancy. *Lancet*, **i**, 1189–1193
- Peto, J., Easton, D.F., Matthews, F.E., Ford, D. & Swerdlow, A.J. (1996) Cancer mortality in relatives of women with breast cancer: The OPCS Study. Office of Population Censuses and Surveys. *Int. J. Cancer*, **65**, 275–283
- Petridou, E., Trichopoulos, D., Dessypris, N., Flytzani, V., Haidas, S., Kalmanti, M., Kolioukas, D., Kosmidis, H., Piperopoulou, R. & Tzortzotou, F. (1996) Infant leukaemia after *in utero* exposure to radiation from Chernobyl. *Nature*, **382**, 352–353
- Petrini, J.H.J., Walsh, M.E., DiMare, C., Chen, X.-N., Korenberg, J.R. & Weaver, D.T. (1995) Isolation and characterization of the human *MRE11* homologue. *Genomics*, **29**, 80–86
- Petersson, F., Fotiou, S., Einhorn, N. & Silfverswärd, C. (1985) Cohort study of the long-term effect of irradiation for carcinoma of the uterine cervix. Second primary malignancies in the pelvic organs in women irradiated for cervical carcinoma at Radiumhemmet 1914–1965. *Acta radiol. oncol.*, **24**, 145–151

- Pettersson, F., Ryberg, M. & Malaker, B. (1990) Second primary cancer after treatment of invasive carcinoma of the uterine cervix, compared with those arising after treatment for in situ carcinomas. An effect of irradiation? A cancer registry study. *Acta obstet. gynecol. scand.*, **69**, 161–174
- Pierce, D.A., Shimizu, Y., Preston, D.L., Vaeth, M. & Mabuchi, K. (1996) Studies of the mortality of atomic bomb survivors. Report 12, Part I. Cancer: 1950–1990. *Radiat. Res.*, **146**, 1–27
- Pilinskaya, M.A. (1996) The results of selective cytogenetic monitoring of Chernobyl accident victims in the Ukraine. *Health Phys.*, **71**, 29–33
- Plowman, P.N., Bridges, B.A., Arlett, C.F., Hinney, A. & Kingston, J.E. (1990) An instance of clinical radiation morbidity and cellular radiosensitivity, not associated with ataxia-telangiectasia. *Br. J. Radiol.*, **63**, 624–628
- Pobel, D. & Viel, J.-F. (1997) Case-control study of leukaemia among young people near La Hague nuclear reprocessing plant: The environmental hypothesis revisited. *Br. med. J.*, **314**, 101–106
- Pollycove, M. (1995) The issue of the decade: Hormesis. *Eur. J. Nucl. Med.*, **22**, 399–401
- Pollycove, M. (1998) Nonlinearity of radiation health effects. *Environ. Health Perspectives*, **106** (Suppl. 1), 363–368
- Ponnaiya, B., Cornforth, M.N. & Ullrich, R.L. (1997) Induction of chromosomal instability in human mammary cells by neutrons and gamma rays. *Radiat. Res.*, **147**, 288–294
- Potish, R.A., Dehner, L.P., Haselow, R.E., Kim, T.H., Levitt, S.H. & Nesbit, M. (1985) The incidence of second neoplasms following megavoltage radiation for pediatric tumors. *Cancer*, **56**, 1534–1537
- Potten, C.S & Hendry, J. H., eds (1995) *Radiation and Gut*, Amsterdam, Elsevier
- Pottern, L.M., Kaplan, M.M., Larsen, P.R., Silva, J.E., Koenig, R.J., Lubin, J.H., Stovall, M. & Boice, J.D., Jr (1990) Thyroid nodularity after childhood irradiation for lymphoid hyperplasia: A comparison of questionnaire and clinical findings. *J. clin. Epidemiol.*, **43**, 449–460
- Preston, D.L., Kusumi, S., Tomonaga, M., Izumi, S., Ron, E., Kuramoto, A., Kamada, N., Dohy, H., Matsuo, T., Nonaka, H., Thompson, D.E., Soda, M. & Mabuchi, K. (1994) Cancer incidence in atomic bomb survivors. Part III: Leukemia, lymphoma and multiple myeloma, 1950–1987. *Radiat. Res.*, **137**, S68–S97
- Preston-Martin, S., Paganini-Hill, A., Henderson, B.E., Pike, M.C. & Wood, C. (1980) Case-control study of intracranial meningiomas in women in Los Angeles County, California. *J. natl Cancer Inst.*, **65**, 67–73
- Preston-Martin, S., Thomas, D.C., Yu, M.C. & Henderson, B.E. (1989) Diagnostic radiography as a risk factor for chronic myeloid and monocytic leukaemia (CML). *Br. J. Cancer*, **59**, 634–644
- Pride, G.L. & Buchler, D.A. (1976) Carcinoma of vagina 10 or more years following pelvic irradiation therapy. *Am. J. Obstet. Gynecol.*, **127**, 513–517
- Prise, K.M. (1994) Use of radiation quality as a probe for DNA lesion complexity. *Int. J. Radiat. Biol.*, **65**, 43–48
- Prisyazhniuk, A.E., Pjatak, O.A., Buzanov, V.A., Reeves, G.K. & Beral, V. (1991) Cancer in the Ukraine, post-Chernobyl (Letter to the Editor). *Lancet*, **338**, 1334–1335

- Prisyazhniuk, A.E., Gristchenko, V., Zakordonets, V., Fouzik, N., Slipeniuk, Y. & Ryzhak, I. (1995) The time trends of cancer incidence in the most contaminated regions of the Ukraine before and after the Chernobyl accident. *Radiat. environ. Biophys.*, **34**, 3–6
- Puck, J.M. (1994) Molecular basis for three X-linked immune disorders. *Hum. mol. Genet.*, **3**, 1457–1461
- Rahu, M., Tekkel, M., Veidebaum, T., Pukkala, E., Hakulinen, T., Auvinen, A., Rytömaa, T., Inskip, P.D. & Boice, J.D., Jr (1997) The Estonian study of Chernobyl cleanup workers: II. Incidence of cancer and mortality. *Radiat. Res.*, **147**, 653–657
- Ramalho, A.T. & Nascimento, A.C. (1991) The fate of chromosomal aberrations in ^{137}Cs -exposed individuals in the Goiânia radiation accident. *Health Phys.*, **60**, 67–70
- Ramalho, A.T., Nascimento, A.C., Littlefield, L.G., Natarajan, A.T. & Sasaki, M.S. (1991) Frequency of chromosomal aberrations in a subject accidentally exposed to ^{137}Cs in the Goiânia (Brazil) radiation accident: Intercomparison among four laboratories. *Mutat. Res.*, **252**, 157–160
- Ramalho, A.T., Curado, M.P. & Natarajan, A.T. (1995) Lifespan of human lymphocytes estimated during a six year cytogenetic follow-up of individuals accidentally exposed in the 1987 radiological accident in Brazil. *Mutat. Res.*, **331**, 47–54
- Ramalho, A.T., Costa, M.L. & Oliveirira, M.S. (1998) Conventional radiation–biological dosimetry using frequencies of unstable chromosome aberrations. *Mutat. Res.*, **404**, 97–100
- Ramsay, J., Birrell, G. & Lavin, M. (1998) Testing for mutations of the ataxia telangiectasia gene in radiosensitive breast cancer patients. *Radiother. Oncol.*, **47**, 125–128
- Ramus, S.J., Bobrow, L.G., Pharoah, P.D., Finnigan, D.S., Fishman, A., Altaras, M., Harrington, P.A., Gayther, S.A., Ponder, B.A. & Friedman, L.S. (1999) Increased frequency of TP53 mutations in BRCA1 and BRCA2 ovarian tumours. *Genes Chromosomes Cancer*, **25**, 91–96
- Rary, J.M., Bender, M.A. & Kelly, T.E. (1975) A 14/14 marker chromosome lymphocyte clone in ataxia-telangiectasia. *J. Hered.*, **66**, 33–35
- Redpath, J.L. & Antoniono, R.J. (1998) Induction of an adaptive response against spontaneous neoplastic transformation in vitro by low-dose gamma radiation. *Radiat. Res.*, **149**, 517–20
- Refetoff, S., Harrison, J., Karanfilski, B.T., Kaplan, E.L., De Groot, L.J. & Bekerman, C. (1975) Continuing occurrence of thyroid carcinoma after irradiation to the neck in infancy and childhood. *New Engl. J. Med.*, **292**, 171–175
- Reznikoff, C.A., Brankow, D.W. & Heidelberger, C. (1973a) Establishment and characterization of a cloned line of C3H mouse embryo cells sensitive to postconfluence inhibition of division. *Cancer Res.*, **33**, 3231–3238
- Reznikoff, C.A., Bertram, J.S., Brankow, D.W. & Heidelberger, C. (1973b) Quantitative and qualitative studies of chemical transformation of cloned C3H mouse embryo cells sensitive to postconfluence inhibition of cell division. *Cancer Res.*, **33**, 3239–3249
- Rhim, J.S., Yoo, J.H., Park, J.H., Thraves, P., Salehi, Z. & Dritschilo, A. (1990) Evidence for the multistep nature of in vitro human epithelial cell carcinogenesis. *Cancer Res.*, **50** (Suppl.), 5653S–5657S
- Rhim, J.S., Thraves, P., Dritschilo, A., Kuettel, M.R. & Lee, M.S. (1993) Radiation-induced neoplastic transformation of human cells. *Scanning Microsc.*, **7**, 209–216
- Riballo, E., Critchlow, S.E., Teo, S.H., Doherty, A.J., Priestley, A., Broughton, B., Kysela, B., Beamish, H., Plowman, N., Arlett, C.F., Lehmann, A.R., Jackson, S.P. & Jeggo, P.A.

- (1999) Identification of a defect in DNA ligase IV in a radiosensitive leukaemia patient. *Curr. Biol.*, **19**, 699–702
- Ribeiro, G.G., Magee, B., Swindell, R., Harris, M. & Banerjee, S.S. (1993) The Christie Hospital breast conservation trial: An update at 8 years from inception. *Clin. Oncol. R. Coll. Radiol.*, **5**, 278–283
- Richardson, S., Monfort, C., Green, M., Draper, G. & Muirhead, C. (1995) Spatial variation of natural radiation and childhood leukaemia incidence in Great Britain. *Stat. Med.*, **14**, 2487–2501
- Rinchik, E.M., Bell, J.A., Hunsicker, P.R., Friedman, J.M., Jackson, I.J. & Russell, L.B. (1994) Molecular genetics of the brown (p) locus region of mouse chromosome 4. I. Origin and molecular mapping of radiation- and chemical-induced lethal brown deletions. *Genetics*, **137**, 845–854
- Rio, P.G., Pernin, D., Bay, J.-O., Albuissou, E., Kwiatkowski, F., De Latour, M., Bernard-Gallon, D.J. & Bignon, Y.-J. (1998) Loss of heterozygosity of *BRCA1*, *BRCA2* and *ATM* genes in sporadic invasive ductal breast carcinoma. *Int. J. Oncol.*, **13**, 849–853
- Robinette, C.D., Jablon, S. & Preston, D.L. (1985) *Mortality of Nuclear Weapons Test Participants*, Washington DC, National Academy Press, pp. 1–47
- Roman, E., Doyle, P., Maconochie, N., Davies, G., Smith, P.G. & Beral, V. (1999) Cancer in children of nuclear industry employees: Report on children under 25 years from nuclear industry family study. *Br. med. J.*, **318**, 1443–1450
- Ron, E. (1996) Thyroid cancer. In: Schottenfeld, D. & Fraumeni, J.F., Jr, eds, *Cancer Epidemiology and Prevention*, 2nd Ed., New York, Oxford University Press, pp. 1000–1021
- Ron, E. & Modan, B. (1980) Benign and malignant thyroid neoplasms after childhood irradiation for tinea capitis. *J. natl Cancer Inst.*, **65**, 7–11
- Ron, E., Kleinerman, R.A., Boice, J.D., Jr, LiVolsi, V.A., Flannery, J.T. & Fraumeni, J.F., Jr (1987) A population based case-control study of thyroid cancer. *J. natl Cancer Inst.*, **79**, 1–12
- Ron, E., Modan, B., Boice, J.D., Jr, Alfandary, E., Stovall, M.A., Chetrit, A. & Katz, L. (1988a) Tumors of the brain and nervous system after radiotherapy in childhood. *New Engl. J. Med.*, **319**, 1033–1039
- Ron, E., Modan, B. & Boice, J.D., Jr (1988b) Mortality after radiotherapy for ringworm of the scalp. *Am. J. Epidemiol.*, **127**, 713–725
- Ron, E., Modan, B., Preston, D., Alfandary, E., Stovall, M. & Boice, J.D., Jr (1989) Thyroid neoplasia following low-dose radiation in childhood. *Radiat. Res.*, **120**, 516–531
- Ron, E., Modan, B., Preston, D., Alfandary, E., Stovall, M. & Boice, J.D., Jr (1991) Radiation-induced skin carcinomas of the head and neck. *Radiat. Res.*, **125**, 318–325
- Ron, E., Boice, J.D., Jr, Hamburger, S. & Stovall, M. (1994) Mortality following radiation treatment for infertility of hormonal origin or amenorrhea. *Int. J. Epidemiol.*, **23**, 1165–1173
- Ron, E., Lubin, J.H., Shore, R.E., Mabuchi, K., Modan, B., Pottern, L.M., Schneider, A.B., Tucker, M.A. & Boice, J.D., Jr (1995) Thyroid cancer after exposure to external radiation: A pooled analysis of seven studies. *Radiat. Res.*, **141**, 259–277
- Ron, E., Preston, D.L., Kishikawa, M., Kobuke, T., Iseki, M., Tokuoka, S., Tokunaga, M. & Mabuchi, K. (1998a) Skin tumor risk among atomic-bomb survivors in Japan. *Cancer Causes Control*, **9**, 393–401

- Ron, E., Doody, M.M., Becker, D.V., Brill, A.B., Curtis, R.E., Goldman, M.B., Harris, B.S., 3rd, Hoffman, D.A., McConahey, W.M., Maxon, H.R., Preston-Martin, S., Warshauer, M.E., Wong, F.L. & Boice, J.D., Jr (1998b) Cancer mortality following treatment for adult hyperthyroidism. Cooperative Thyrotoxicosis Therapy Follow-up Study Group. *J. Am. med. Assoc.*, **280**, 347–355
- Rosen, F.S., Cooper, M.D. & Wedgwood, R.J.P. (1984) The primary immunodeficiencies. *New Eng. J. Med.*, **311**, 300–310
- Rosin, M.P. & Ochs, H.D. (1986) In vivo chromosomal instability in ataxia-telangiectasia homozygotes and heterozygotes. *Hum. Genet.*, **74**, 335–340
- Rowley, M.J., Leach, D.R., Warner, G.A. & Heller, C.G. (1974) Effects of graded doses of ionizing radiation on the human testis. *Radiat. Res.*, **59**, 665–678
- Royce, P.C., MacKay, B.R. & DiSabella, P.M. (1979) Value of postirradiation screening for thyroid nodules. A controlled study of recalled patients. *J. Am. med. Assoc.*, **242**, 2675–2678
- Rubin, P. & Casarett, G.W. (1968) *Clinical Radiation Pathology*, Philadelphia, PA, W.B. Saunders
- Rudolph, N.S., Nagasawa, H., Little, J.B. & Latt, S.A. (1989) Identification of ataxia telangiectasia heterozygotes by flow cytometric analysis of X-ray damage *Mutat. Res.*, **211**, 19–29
- Ruifrok, A.C.C., Mason, K.A., Hunter, N. & Thames, H.D. (1994) Changes in the radiation sensitivity of mouse skin during fractionated and prolonged treatments. *Radiat. Res.*, **139**, 334–343
- Russell W.L. (1951) X-ray induced mutations in mice. *Cold Spring Harbor Symp. Quant. Biol.*, **16**, 327–336
- Russell W.L. (1962) An augmenting effect of dose fractionation on radiation-induced mutation rate in mice. *Proc. natl Acad. Sci. USA*, **48**, 1724–1727
- Russell, W.L. (1977) Mutation frequencies in female mice and the estimation of genetic hazards or radiation in women. *Proc. natl Acad. Sci. USA*, **74**, 3523–3527
- Russell, W.L. & Kelly, E.M. (1982) Specific locus mutation frequencies in mouse stem cells spermatogonia at very low radiation doses. *Proc. natl Acad. Sci. USA*, **74**, 539–541
- Russell, L.B. & Major, M.H. (1957) Radiation-induced presumed somatic mutations in the house mouse. *Genetics*, **42**, 161–175
- Russell, L.B. & Rinchik, E.M. (1993) Structural differences between specific-locus mutations induced by different exposure regimes in mouse spermatogonial stem cells. *Mutat. Res.*, **288**, 187–195
- Russo, G., Isobe, M., Gatti, R., Finan, J., Batuman, O., Huebner, K., Nowell, P.C. & Croce, C.M. (1989) Molecular analysis of a t(14;14) translocation in leukemic T-cells of an ataxia telangiectasia patient. *Proc. natl Acad. Sci. USA*, **86**, 602–606
- Ryan, P., Lee, M.W., North, B. & McMichael, A.J. (1992) Amalgam fillings, diagnostic dental X-rays and tumours of the brain and meninges. *Eur. J. Cancer*, **28B**, 91–95
- Ryberg, M., Lundell, M., Nilsson, B. & Pettersson, F. (1990) Malignant disease after radiation treatment of benign gynaecological disorders. A study of a cohort of metropathia patients. *Acta oncol.*, **29**, 563–567
- Saar, K., Chrzanoska, K.H., Stumm, M., Jung, M., Nurnberg, G., Wienker, T.F., Seemanová, E., Wegner, R.D., Reis, A. & Sperling, K. (1997) The gene for the ataxia-telangiectasia

- variant, Nijmegen breakage syndrome, maps to a 1-cM interval on chromosome 8q21. *Am. J. hum. Genet.*, **60**, 605–610
- Sabatier, L., Lebeau, J. & Dutrillaux, B. (1994) Chromosomal instability and alterations of telomeric repeats in irradiated human fibroblasts. *Int. J. Radiat. Biol.*, **66**, 611–613
- Sadamoto, S., Suzuki, S., Kamiya, K., Kominami, R., Dohi, K. & Niwa, O. (1994) Radiation induction of germline mutation at a hypervariable mouse minisatellite locus. *Int. J. Radiat. Biol.*, **65**, 549–557
- Saddi, V., Curry, J., Nohturfft, A., Kusser, W. & Glickman, B.W. (1996) Increased hprt mutant frequencies in Brazilian children accidentally exposed to ionizing radiation. *Environ. mol. Mutag.*, **28**, 267–275
- Sanford, K.K. & Parshad, R. (1990) Detection of cancer-prone individuals using cytogenetic response to X-rays. In: Obe, G. & Natarajan, A.T., eds, *Chromosomal Aberrations: Basic and Applied Aspects*, Berlin, Springer-Verlag, pp. 113–120
- Sankaranarayanan, K. (1991) Ionizing radiation and genetic risks. III. Nature of spontaneous and radiation-induced mutations in mammalian in vitro systems and mechanisms of induction of mutations by radiation. *Mutat. Res.*, **258**, 75–97
- Sankaranarayanan, K. (1996) Environmental chemical mutagens and genetic risks: Lessons from radiation genetics. *Environ. Mol. Mutag.*, **28**, 65–70
- Sasaki, S., Kasuga, T., Sato, F. & Kawashima N. (1978a) Late effects of fetal mice X-irradiated at middle or late intra-uterine stage. *Gann*, **69**, 167–177
- Sasaki, S., Kasuga, T., Sato, F. & Kawashima, N. (1978b) Induction of hepatocellular tumor by X-ray irradiation at perinatal stage of mice. *Gann*, **69**, 451–452
- Savage, J.R.K. (1976) Classification and relationships of induced chromosomal structural changes. *J. med. Genet.*, **13**, 103–22
- Savage, J.R. (1979) Chromosomal aberrations at very low radiation dose rates. *Nature*, **277**, 512–513
- Savitsky, K., Sfez, S., Tagle, D.A., Ziv, Y., Sartiel, A., Collins, F.S., Shiloh, Y. & Rotman, G. (1995) The complete sequence of the coding region of the ATM gene reveals similarity to cell cycle regulators in different species. *Hum. mol. Genet.*, **4**, 2025–2032
- Savkin, M.N., Titov, A.V. & Lebedev, A.N. (1996) Distribution of individual and collective exposure doses for the population in Belarus in the first year after the Chernobyl accident. *Bulletin of the All-Russian Medical and Dosimetry State Registry*, Issue 7, Moscow, pp. 87–113
- Schaaper, R.M., Kunkel, T.A. & Loeb, L.A. (1982) Depurination of DNA as a possible mutagenic pathway for cells. *Basic Life Sci.*, **20**, 199–211
- Schmahl, W. (1988) Synergistic induction of tumours in NMRI mice by combined foetal X-irradiation with low doses and ethylnitrosourea administered to juvenile offspring. *Carcinogenesis*, **9**, 1493–1498
- Schneider, G. & Burkart, W. (1998) [Health risks of ionizing radiation]. *Radiologe*, **38**, 719–725 (in German)
- Schneider, A.B., Shore-Freedman, E., Ryo, U.Y., Bekerman, C., Favus, M. & Pinsky, S. (1985) Radiation-induced tumors of the head and neck following childhood irradiation. Prospective studies. *Medicine (Baltimore)*, **64**, 1–15

- Schneider, A.B., Ron, E., Lubin, J., Stovall, M. & Gierlowski, T.C. (1993) Dose–response relationships for radiation-induced thyroid cancer and thyroid nodules: Evidence for the prolonged effects of radiation on the thyroid. *J. clin. Endocrinol. Metab.*, **77**, 362–369
- Schofield, P.N. (1998) Impact of genomic imprinting on genomic instability and radiation-induced mutation. *Int. J. Radiat. Biol.*, **74**, 705–710
- Schröder, J.H. (1971) Attempt to determine the rate of radiation-induced recessive sex-linked lethal and detrimental mutations in immature germ cells of the house mouse (*Mus musculus*). *Genetics*, **68**, 35–57
- Schwartz, J.L., Ashman, C.R., Atcher, R.W., Sedita, B.A., Shadley, J.D., Tang, J., Whitlock, J.L. & Rotmensch, J. (1991) Differential locus sensitivity to mutation induction by ionizing radiations of different LETs in Chinese hamster ovary K1 cells. *Carcinogenesis*, **12**, 1721–1726
- Schwarz, K., Hansen-Hagge, T.E., Knobloch, C., Friedrich, W., Kleihauer, E. & Bartram, C.R. (1991) Severe combined immunodeficiency (SCID) in man: B cell-negative (B⁻) SCID patients exhibit an irregular recombination pattern at the J_H locus. *J. exp. Med.*, **174**, 1039–1048
- Scott, D. & Zampetti-Bosseler, F. (1982) Cell cycle dependence of mitotic delay in X-irradiated normal and ataxia-telangiectasia fibroblasts. *Int. J. Radiat. Biol.*, **42**, 679–683
- Scott, D., Spreadborough, A.R., Jones, L.A., Roberts, S.A. & Moore, C.J. (1996) Chromosomal radiosensitivity in G₂-phase lymphocytes as an indicator of cancer predisposition. *Radiat. Res.*, **145**, 3–16
- Scott, D., Barber, J.B.P., Levine, E.L., Burrill, W. & Roberts, S.A. (1998) Radiation-induced micronucleus induction in lymphocytes identifies a high frequency of radiosensitive cases among breast cancer patients: A test for predisposition? *Br. J. Cancer*, **77**, 614–620
- Scully, R., Chen, J., Plug, A., Xiao, Y., Weaver, D., Feunteun, J., Ashley, T. & Livingston, D.M. (1997) Association of BRCA1 with Rad51 in mitotic and meiotic cells. *Cell*, **88**, 265–275
- Searle, A.G. (1974) Mutation induction in mice. In: Lett, J.T., Adler, H. & Zelle, M.R., eds, *Advances in Radiation Biology*, Vol. 4, New York, Academic Press, pp. 131–207
- Searle, A.G. & Beechey, C.V. (1985) A specific locus experiment with mainly dominant visible results (Abstract). *Genet. Res.*, **545**, 224
- Searle, A.G. & Beechey, C.V. (1986) The role of dominant visibles in mutagenicity testing. In: Ramel, C., Lambert, B. & Magnusson, J., eds, *Genetic Toxicology of Environmental Chemicals, Part B, Genetic Effects and Applied Mutagenesis*, New York, Alan R. Liss, pp. 511–518
- Sedgwick, R.P. & Boder, E. (1991) Ataxia-telangiectasia (208900; 208910; 208920). In: Vinken, P.J., Bruyn, G.W., Klawans, H.L. & Vianney de Jong, J.M.B., eds, *Hereditary Neuropathies and Spinocerebellar Atrophies*, Amsterdam, Elsevier, pp. 347–423
- Seemanová, E. (1990) An increased risk for malignant neoplasms in heterozygotes for a syndrome of microcephaly, normal intelligence, growth retardation, remarkable facies, immunodeficiency and chromosomal instability. *Mutat. Res.*, **238**, 321–324
- Sega, G.A., Sotomayor, R.E. & Owens, J.G. (1978) A study of unscheduled DNA synthesis induced by X-rays in the germ cells of male mice. *Mutat. Res.*, **49**, 239–257
- Selby, P.B. & Selby, P.R. (1977) Gamma-ray-induced dominant mutations that cause skeletal abnormalities in mice. I. Plan, summary of results and discussion. *Mutat. Res.*, **43**, 357–375

- Seltser, R. & Sartwell, P.E. (1965) The influence of occupational exposure to radiation on the mortality of American radiologists and other medical specialists. *Am. J. Epidemiol.*, **81**, 2–22
- Selvanayagam, C.S., Davis, C.M., Cornforth, M.N. & Ullrich, R.L. (1995) Latent expression of *p53* mutations and radiation-induced mammary cancer. *Cancer Res.*, **55**, 3310–3317
- Seymour, C.B., Mothersill, C. & Alper, T. (1986) High yields of lethal mutations in somatic mammalian cells that survive ionizing radiation. *Int. J. Radiat. Biol. Relat. Stud. Phys-Chem. Med.*, **50**, 167–179
- Seyschab, H., Schindler, D., Friedl, R., Barbi, G., Boltshauser, E., Fryns, J.P., Hanefeld, F., Korinthenberg, R., Krägeloh-Mann, I., Scheres, J.M., Schinzel, A., Seemanová, E., Tommerup, N. & Hoehn, H. (1992) Simultaneous measurement, using flow cytometry, of radiosensitivity and defective mitogen response in ataxia telangiectasia and related syndromes. *Eur. J. Pediatr.*, **151**, 756–760
- Sharan, S.K., Morimatsu, M., Albrecht, U., Lim, D.-K., Regel, E., Dinh, C., Sands, A., Eichele, G., Hasty, P. & Bradley, A. (1997) Embryonic lethality and radiation hypersensitivity mediated by Rad51 in mice lacking *Bcr2*. *Nature*, **386**, 804–810
- Shellabarger, C.J., Bond, V.P., Aponte, G.E. & Cronkite, E.P. (1966) Results of fractionation and protraction of total-body radiation on rat mammary neoplasia. *Cancer Res.*, **26**, 509–513
- Shellabarger, C.J., Chmelevsky, D. & Kellerer, A.M. (1980) Induction of mammary neoplasms in the Sprague-Dawley rat by 430-keV neutrons and X-rays. *J. natl Cancer Inst.*, **64**, 821–833
- Shieh, S.-Y., Ikeda, M., Taya, Y. & Prives, C. (1997) DNA damage-induced phosphorylation of *p53* alleviates inhibition by MDM2. *Cell*, **91**, 325–334
- Shiloh, Y. (1997) Ataxia-telangiectasia and the Nijmegen breakage syndrome: Related disorders but genes apart. *Annu. Rev. Genet.*, **31**, 635–662
- Shiloh, Y., Tabor, E. & Becker, Y. (1982a) The response of ataxia-telangiectasia homozygous skin fibroblasts to neocarzinostatin. *Carcinogenesis*, **3**, 815–820
- Shiloh, Y., Tabor, E. & Becker, Y. (1982b) Colony-forming ability of ataxia-telangiectasia skin fibroblasts is an indicator of their early senescence and increased demand for growth factors. *Exp. Cell Res.*, **140**, 191–199
- Shiloh, Y., Tabor, E. & Becker, Y. (1983) Abnormal response of ataxia-telangiectasia cells to agents that break the deoxyribose moiety of DNA via a targeted free radical mechanism. *Carcinogenesis*, **4**, 1317–1322
- Shiloh, Y., Parshad, R., Sanford, K.K. & Jones, G.M. (1986) Carrier detection in ataxia-telangiectasia (Letter to the Editor). *Lancet*, **i**, 689–690
- Shimizu, Y., Kato, H. & Schull, W.J. (1990) Studies of the mortality of A-bomb survivors. 9. Mortality, 1950–1985: Part 2. Cancer mortality based on the recently revised doses (DS86). *Radiat. Res.*, **121**, 120–141
- Shimizu, Y., Pierce, D.A., Preston, D.L. & Mabuchi, K. (1999) Studies of the mortality of atomic bomb survivors. Report 12. Part 11. Noncancer mortality 1950–1990. *Radiat. Res.*, **151**, 374–389
- Shin, M.K., Russell, L.B. & Tilghman, S.M. (1997) Molecular characterization of four induced alleles at the *Ednrb* locus. *Proc. natl Acad. Sci. USA*, **94**, 13105–13110

- Shore, R.E., Albert, R.E. & Pasternack, B.S. (1976) Follow-up study of patients treated by X-ray epilation for tinea capitis; resurvey of post-treatment illness and mortality experience. *Arch. environ. Health*, **31**, 17–24
- Shore, R.E., Woodard, E.D., Pasternack, B.S. & Hempelmann, L.H. (1980) Radiation and host factors in human thyroid tumors following thymus irradiation. *Health Phys.*, **38**, 451–465
- Shore, R.E., Albert, R.E., Reed, M., Harley, N. & Pasternack, B. (1984) Skin cancer incidence among children irradiated for ringworm of the scalp. *Radiat. Res.*, **100**, 192–204
- Shore, R.E., Woodard, E., Hildreth, N., Dvoretzky, P., Hempelmann, L. & Pasternack, B. (1985) Thyroid tumors following thymus irradiation. *J. natl Cancer Inst.*, **74**, 1177–1184
- Shore, R.E., Hildreth, N., Woodard, E., Dvoretzky, P., Hempelmann, L. & Pasternack, B. (1986) Breast cancer among women given X-ray therapy for acute postpartum mastitis. *J. natl Cancer Inst.*, **77**, 689–696
- Shore, R.E., Hildreth, N., Dvoretzky, P., Andresen, E., Moseson, M. & Pasternack, B. (1993) Thyroid cancer among persons given X-ray treatment in infancy for an enlarged thymus gland. *Am. J. Epidemiol.*, **137**, 1068–1080
- Sikpi, M.O., Dry, S.M., Freedman, M.L. & Lurie, A.G. (1992) Mutations caused by gamma-radiation-induced double-strand breaks in a shuttle plasmid replicated in human lymphoblasts. *Int. J. Radiat. Biol.*, **62**, 555–562
- Siliciano, J.D., Canman, C.E., Taya, Y., Sakaguchi, K., Appella, E. & Kastan, M.B. (1997) DNA damage induces phosphorylation of the amino terminus of p53. *Genes Dev.*, **11**, 3471–3481
- Sinclair, W.K. (1964) X-ray-induced heritable damage (small-colony formation) in cultured mammalian cells. *Radiat. Res.*, **21**, 584–611
- Sinclair, W.K. (1998) The linear no-threshold response: Why not linearity? *Med. Phys.* **25**, 285–290
- Skandalis, A., da-Cruz, A.D., Curry, J., Nohturfft, A., Curado, M.P. & Glickman, B.W. (1997) Molecular analysis of T-lymphocyte HPRT⁻ mutations in individuals exposed to ionizing radiation in Goiania, Brazil. *Environ. Mol. Mutag.*, **29**, 107–116
- Skomedal, H., Helland, Å., Kristensen, G.B., Holm, R. & Børresen-Dale, A.-L. (1999) Allelic imbalance at chromosome region 11q23 in cervical carcinoma. *Eur. J. Cancer*, **35**, 659–663
- van Sloun, P.P., Wijnhoven, S.W., Kool, H.J., Slater, R., Weeda, G., Van Zeeland, A.A., Lohman, P.H.M. & Vrieling, H. (1998) Determination of spontaneous loss of heterozygosity mutations in *Aprt* heterozygous mice. *Nucl. Acids Res.*, **26**, 4888–4894
- Smith, P.G. & Doll, R. (1981) Mortality from cancer and all causes among British radiologists. *Br. J. Radiol.*, **54**, 187–194
- Smith, L.E. & Grosovsky, A.J. (1993) Evidence for high-frequency allele loss at the *aprt* locus in TK6 human lymphoblasts. *Mutat. Res.*, **289**, 245–254
- Socolow, E.L., Hashizume, A., Neriishi, S. & Niitani, R. (1963) Thyroid carcinoma in man after exposure to ionizing radiation. A summary of the findings in Hiroshima and Nagasaki. *New Engl. J. Med.*, **268**, 406–410
- Southern, E.M. (1975) Detection of specific sequences among DNA fragments separated by gel electrophoresis. *J. mol. Biol.*, **98**, 503–517
- Spector, B.D., Filipovich, A.H., Perry, G.S., III & Kersey, J.H. (1982) Epidemiology of cancer in ataxia-telangiectasia. In: Bridges, B.A. & Harnden, D.G., eds, *Ataxia-Telangiectasia—*

- A Cellular and Molecular Link between Cancer, Neuropathology and Immune Deficiency*, New York, John Wiley & Sons, pp. 103–138
- Spengler, R.F., Cook, D.H., Clarke, E.A., Olley, P.M. & Newman, A.M. (1983) Cancer mortality following cardiac catheterization: A preliminary follow-up study on 4,891 irradiated children. *Pediatrics*, **71**, 235–239
- Sproston, A.R.M., West, C.M.L. & Hendry, J.H. (1997) Cellular radiosensitivity in human severe-combined-immunodeficiency (SCID) syndromes. *Radiother. Oncol.*, **42**, 53–57
- Stacey, M., Thacker, S. & Taylor, A.M. (1989) Cultured skin keratinocytes from both normal individuals and basal cell naevus syndrome patients are more resistant to gamma-rays and UV light compared with cultured skin fibroblasts. *Int. J. Radiat. Biol.*, **56**, 45–58
- Stanbridge, E.J. (1990) Human tumor suppressor genes. *Annu. Rev. Genet.*, **24**, 615–657
- Stankovic, T., Weber, P., Stewart, G., Bedenham, T., Murray, J., Byrd, P.J., Moss, P.A.H. & Taylor, A.M.R. (1999) Inactivation of ataxia telangiectasia mutated gene in B-cell chronic lymphocytic leukaemia. *Lancet*, **353**, 26–29
- Starostik, P., Manshour, T., O'Brien, S., Freireich, E., Kantarjian, H., Haidar, M., Lerner, S., Keating, M. & Albitar, M. (1998) Deficiency of the ATM protein expression defines an aggressive subgroup of B-cell chronic lymphocytic leukemia. *Cancer Res.*, **58**, 4552–4557
- Steiner, M., Burkart, W., Grosche, B., Kaletsch, U. & Michaelis, J. (1998) Trends in infant leukaemia in West Germany in relation to in utero exposure due to the Chernobyl accident. *Radiat. environ. Biophys.*, **37**, 87–93
- Stevens, W., Thomas, D.C., Lyon, J.L., Till, J.E., Kerber, R.A., Simon, S.L., Lloyd, R.D., Elghany, N.A. & Preston-Martin, S. (1990) Leukemia in Utah and radioactive fallout from the Nevada test site. A case-control study. *J. Am. med. Assoc.*, **264**, 585–591
- Stewart, A., Webb, J. & Hewitt, D. (1958) A survey of childhood malignancies. *Br. med. J.*, **5086**, 1495–1508
- Stilgenbauer, S., Schaffner, C., Litterst, A., Liebisch, P., Gilad, S., Bar-Shira, A., James, M.R., Lichter, P. & Dohner, H. (1997) Biallelic mutations in the ATM gene in T-prolymphocytic leukemia. *Nature Med.*, **3**, 1155–1159
- Stjernfeldt, M., Samuelsson, L. & Ludvigsson, J. (1987) Radiation in dwellings and cancer in children. *Pediatr. Hematol. Oncol.*, **4**, 55–61
- Stoppa-Lyonnet, D., Girault, D., LeDeist, F. & Aurias, A. (1992) Unusual T cell clones in a patient with Nijmegen breakage syndrome. *J. med. Genet.*, **29**, 136–137.
- Stoppa-Lyonnet, D., Soulier, J., Laugé, A., Dastot, H., Garand, R., Sigaux, F. & Stern, M.-H. (1998) Inactivation of the ATM gene in T-cell prolymphocytic leukemias. *Blood*, **91**, 3920–3926
- Storer, J.B., Mitchell, T.J. & Fry, R.J.M. (1988) Extrapolation of the relative risk of radiogenic neoplasms across mouse strains and to man. *Radiat. Res.*, **114**, 331–353
- Storm, H.H., Iversen, E. & Boice, J.D., Jr (1986) Breast cancer following multiple chest fluoroscopies among tuberculosis patients. A case-control study in Denmark. *Acta radiol. oncol.*, **25**, 233–238
- Storm, H.H., Andersson, M., Boice, J.D., Jr, Blettner, M., Stovall, M., Mouridsen, H.T., Dombernowsky, P., Rose, C., Jacobsen, A. & Pedersen, M. (1992) Adjuvant radiotherapy and risk of contralateral breast cancer. *J. natl Cancer Inst.*, **84**, 1245–1250
- Stratton, M.R. & Wooster, R. (1996) Hereditary predisposition to breast cancer. *Curr. Opin. Genet. Dev.*, **6**, 93–97

- Straub, W., Miller, M., Sanislow, C. & Fishbeck, W. (1982) Radiation and risk for thyroid cancer. Atypical findings of a community thyroid recall program. *Clin. nucl. Med.*, **6**, 272–276
- Straume, T., Langlois, R.G., Lucas, J., Jensen, R.H., Bigbee, W.L., Ramalho, A.T. & Brandao-Mello, C.E. (1991) Novel biodosimetry methods applied to victims of the Goiania accident. *Health Phys.*, **60**, 71–76
- Stumm, M., Seemanová, E., Gatti, R.A., Sperling, K., Reis, A. & Wagner, R.-D. (1995) The ataxia-telangiectasia-variant genes 1 and 2 show no linkage to the A-T candidate region on chromosome 11q22-23. *Am. J. hum. Genet.*, **57**, 960–962
- Su, L.-K., Kinzle, K.W., Vogelstein, B., Preisinger, A.C., Moser, A.R., Luongo, C., Gould, K.A. & Dove, W.F. (1992) Multiple intestinal neoplasia caused by a mutation in the murine homolog of the APC gene. *Science*, **256**, 668–670
- Sullivan, K.E., Veksler, E., Lederman, H. & Lees-Miller, S.P. (1997) Cell cycle checkpoints and DNA repair in Nijmegen breakage syndrome. *Clin. Immunol. Immunopathol.*, **82**, 43–48
- Suzuki, K. (1997) Multistep nature of X-ray-induced neoplastic transformation in mammalian cells: Genetic alterations and instability. *J. Radiat. Res. Tokyo*, **38**, 55–63
- Swift, M., Morrell, D., Massey, R.B. & Chase, C.L. (1991) Incidence of cancer in 161 families affected by ataxia-telangiectasia. *New Engl. J. Med.*, **325**, 1831–1836
- Szabo, C.I. & King, M.C. (1995) Inherited breast and ovarian cancer. *Hum. mol. Genet.*, **4**, 1811–1817
- Taalman, R.D.F.M., Jaspers, N.G.J., Scheres, J.M.J.C., de Wit, J. & Hustinx, T.W.J. (1983) Hypersensitivity to ionizing radiation, in vitro, in a new chromosomal breakage disorder, the Nijmegen breakage syndrome. *Mutat. Res.*, **112**, 23–32
- Taalman, R.D.F.M., Hustinx, T.W.J., Weemaes, C.M.R., Seemanová, E., Schmidt, A., Passarge, E. & Scheres, J.M.J.C. (1989) Further delineation of the Nijmegen breakage syndrome. *Am. J. med. Genet.*, **32**, 425–431
- Taghian, A., de Vathaire, F., Terrier, P., Le, M., Auquier, A., Mouriessse, H., Grimaud, E., Sarrazin, D. & Tubiana, M. (1991) Long-term risk of sarcoma following radiation treatment for breast cancer. *Int. J. Radiat. Oncol. Biol. Phys.*, **21**, 361–367
- Takeuchi, S., Koike, M., Park, S., Seriu, T., Bartram, C.R., Taub, H.E., Williamson, I.K., Grewal, J., Taguchi, H. & Koeffler, H.P. (1998) The *ATM* gene and susceptibility to childhood T-cell acute lymphoblastic leukaemia. *Br. J. Haematol.*, **103**, 536–568
- Tao, Z.-F. & Wei, L.X. (1986) An epidemiological investigation of mutational diseases in the high background radiation area of Yangjiang, China. *J. Radiat. Res.*, **27**, 141–150
- Taylor, L.S. (1981) The development of radiation protection standards (1925–1940). *Health Phys.*, **41**, 227–232
- Taylor, A.M.R. & Butterworth, S.V. (1986) Clonal evolution of T-cell chronic lymphocytic leukaemia in a patient with ataxia telangiectasia. *Int. J. Cancer*, **37**, 511–516
- Taylor, A.M.R., Harnden, D.G., Arlett, C.F., Harcourt, S.A., Lehmann, A.R., Stevens, S. & Bridges, B.A. (1975) Ataxia-telangiectasia: A human mutation with abnormal radiation sensitivity. *Nature*, **4**, 427–429
- Taylor, A.M., Metcalfe, J.R., Oxford, J.M. & Harnden, D.G. (1976) Is chromatid-type damage in ataxia-telangiectasia after irradiation at G_0 a consequence of defective repair? *Nature*, **260**, 441–443

- Taylor, A.M.R., Lowe, P.A., Stacey, M., Thick, J., Campbell, L., Beatty, D., Biggs, P. & Formstone, C.J. (1992) Development of T-cell leukaemia in an ataxia telangiectasia patient following clonal selection in t(X;14)-containing lymphocytes. *Leukemia*, **6**, 961–966
- Taylor, A.M.R., Metcalfe, J.A., Thick, J. & Mak, Y.-F. (1996) Leukemia and lymphoma in ataxia-telangiectasia. *Blood*, **87**, 423–438
- Terzaghi, M. & Little, J.B. (1976) X-radiation-induced transformation in a C3H mouse embryo-derived cell line. *Cancer Res.*, **36**, 1367–74
- Thacker, J. (1992) Radiation-induced mutation in mammalian cells at low doses and dose rates. *Adv. Radiat. Biol.*, **16**, 77–124
- Thacker, J., Stephens, M.A. & Stretch, A. (1978) Mutation to ouabain-resistance in Chinese hamster cells: Induction by ethyl methanesulphonate and lack of induction by ionising radiation. *Mutat. Res.*, **51**, 255–270
- Thames, H.D. & Hendry, J.H. (1987) *Fractionation in Radiotherapy*, London, Taylor & Francis
- Thomas, D., Darby, S., Fagnani, F., Hubert, P., Vaeth, M. & Weiss, K. (1992) Definition and estimation of lifetime detriment from radiation exposures: Principles and methods. *Health Phys.*, **63**, 259–272
- Thomas, D.B., Rosenblatt, K., Jimenez, L.M., McTiernan, A., Stalsberg, H., Stemhagen, A., Thompson, W.D., McCrea Curnen, M.G., Satariano, W., Austin, D.F., Greenberg, R.S., Key, C., Kolonel, L.N. & West, D.W. (1994) Ionizing radiation and breast cancer in men (United States). *Cancer Causes Control*, **5**, 9–14
- Thompson, D.E., Mabuchi, K., Ron, E., Soda, M., Tokunaga, M., Ochikubo, S., Sugimoto, S., Ikeda, T., Terasaki, M., Izumi, S. & Preston, D.L. (1994) Cancer incidence in atomic bomb survivors. Part II: Solid tumors, 1958–1987. *Radiat. Res.*, **137** (Suppl. 2), S17–S67
- Tibbetts, R.S., Brumbaugh, K.M., Williams, J.M., Sarkaria, J.N., Cliby, W.A., Shieh, S.-Y., Taya, Y., Prives, C. & Abraham, R.T. (1999) A role for ATR in the DNA damage-induced phosphorylation of p53. *Genes Dev.*, **13**, 152–157
- Tinkey, P.T., Lembo, T.M., Evans, G.R., Cundiff, J.H., Gray, K.N. & Price, R.E. (1998) Post-irradiation sarcomas in Sprague-Dawley rats. *Radiat. Res.*, **149**, 401–404
- Tirmarache, M., Rannou, A., Mollie, A. & Sauve, A. (1988) Epidemiological study of regional cancer mortality in France and natural radiation. *Radiat. Prot. Dosim.*, **24**, 479–482
- Tokarskaya, Z.B., Okladnikova, N.D., Belyaeva, Z.D. & Drozhko, E.G. (1997) Multifactorial analysis of lung cancer dose–response relationships for workers at the Mayak nuclear enterprise. *Health Phys.*, **73**, 899–905
- Tokunaga, M., Land, C.E., Tokuoka, S., Nishimori, I., Soda, M. & Akiba, S. (1994) Incidence of female breast cancer among atomic bomb survivors, 1950–1985. *Radiat. Res.*, **138**, 209–223
- Tomonaga, M., Matsuo, T., Carter, R.L., Bennett, J.M., Kuriyama, K., Imanaka, F., Kusumi, S., Mabuchi, K., Kuramoto, A., Kamada, N., Ichimaru, M., Pisciotta, A.V. & Finch, S.C. (1991) *Differential Effects of Atomic Bomb Irradiation in Inducing Major Leukemia Types: Analysis of Open-city Cases including the Life Span Study Cohort Based upon Updated Diagnostic Systems and the Dosimetry System 1986 (DS86)* (RERF TR 9-91), Hiroshima, Radiation Effects Research Foundation

- Trapeznikov, A.V., Pozolotina, V.N., Chebotina, M.Y., Chukanov, V.N., Trapeznikova, V.N., Kulikov, N.V., Nielsen, S.P. & Aarkrog, A. (1993) Radioactive contamination of the Techa river; the Urals. *Health Phys.*, **65**, 481–488
- Travis, E.L. (1987) Relative radiosensitivity of the human lung. *Adv. Radiat. Biol.*, **12**, 205–238
- Travis, L.B., Curtis, R.E., Stovall, M., Holowaty, E.J., Van Leeuwen, F.E., Glimelius, B., Lynch, C.F., Hagenbeek, A., Li, C.-Y., Banks, P.M., Gospodarowicz, M.K., Adami, J., Wacholder, S., Inskip, P.D., Tucker, M.A. & Boice, J.D., Jr (1994) Risk of leukemia following treatment for non-Hodgkin's lymphoma. *J. natl Cancer Inst.*, **86**, 1450–1457
- Travis, L.B., Curtis, R.E., Glimelius, B., Holowaty, E.J., Van Leeuwen, F.E., Lynch, C.F., Hagenbeek, A., Stovall, M., Banks, P.M., Adami, J., Gospodarowicz, M.K., Wacholder, S., Inskip, P.D., Tucker, M.A. & Boice, J.D., Jr (1995) Bladder and kidney cancer following cyclophosphamide therapy for non-Hodgkin's lymphoma. *J. natl Cancer Inst.*, **87**, 524–530
- Travis, L.B., Curtis, R.E., Storm, H., Hall, P., Holowaty, E., Van Leeuwen, F.E., Kohler, B.A., Pukkala, E., Lynch, C.F., Andersson, M., Bergfeldt, K., Clarke, E.A., Wiklund, T., Stoter, G., Gospodarowicz, M., Sturgeon, J., Fraumeni, J.F., Jr & Boice, J.D., Jr (1997) Risk of second malignant neoplasms among long-term survivors of testicular cancer. *J. natl Cancer Inst.*, **89**, 1429–1439
- Travis, L.B., Holowaty, E., Bergfeldt, K., Lynch, C.F., Kohler, B.A., Wiklund, T., Curtis, R.E., Hall, P., Andersson, M., Pukkala, E., Sturgeon, J. & Stovall, M. (1999) Risk of leukemia after platinum-based chemotherapy for ovarian cancer. *New Eng. J. Med.*, **340**, 351–357
- Tsyb, A.F., Stepanenko, V.F., Pitkevich, V.A., Ispenkov, E.A., Sevan'kaev, A.V., Orlov, M., Dmitriev, E.V., Sarapul'tsev, I.A., Zhigareva, T.L. & Prokof'ev, O.N. (1990) [Around the Semipalatinsk proving grounds: The radioecological situation and the population radiation doses in Semipalatinsk Province (based on data from the report of the Interdepartmental Commission.) *Med. Radiol. Mosk.*, **35**, 3–11 (in Russian)
- Tucker, M.A., Meadows, A.T., Boice, J.D., Jr, Hoover, R.N. & Fraumeni, J.F., Jr (1984) Cancer risk following treatment of childhood cancer. In: Boice, J.D., Jr & Fraumeni, J.F., Jr, eds, *Radiation Carcinogenesis: Epidemiology and Biological Significance*, New York, Raven Press, pp. 211–224
- Tucker, M.A., D'Angio, G.J., Boice, J.D., Jr, Strong, L.C., Li, F.P., Stovall, M., Stone, B.J., Green, D.M., Lombardi, F., Newton, W., Hoover, R.N. & Fraumeni, J.F., Jr (1987a) Bone sarcomas linked to radiotherapy and chemotherapy in children. *New Engl. J. Med.*, **317**, 588–593
- Tucker, M.A., Meadows, A.T., Boice, J.D., Jr, Stovall, M., Oberlin, O., Stone, B.J., Birch, J., Voûte, P.A., Hoover, R.N. & Fraumeni, J.F., Jr for the Late Effects Study Group (1987b) Leukemia after therapy with alkylating agents for childhood cancer. *J. natl Cancer Inst.*, **78**, 459–464
- Tucker, M.A., Jones, P.H.M., Boice, J.D., Jr, Robison, L.L., Stone, B.J., Stovall, M., Jenkin, R.D.T., Lubin, J.H., Baum, E.S., Siegel, S.E., Meadows, A.T., Hoover, R.N. & Fraumeni, J.F., Jr for the Late Effects Study Group (1991) Therapeutic radiation at a young age is linked to secondary thyroid cancer. *Cancer Res.*, **51**, 2885–2888
- Tucker, M.A., Murray, N., Shaw, E.D., Ettinger, D.S., Mabry, M., Huber, M.H., Feld, R., Shepherd, F.A., Johnson, D.H., Grant, S.T., Aisner, J. & Johnson, B.E. (1997) Second

- primary cancers related to smoking and treatment of small-cell lung cancer. Lung Cancer Working Cadre. *J. natl Cancer Inst.*, **89**, 1782–1788
- Tupler, R., Marseglia, G.L., Stefanini, M., Prosperi, E., Chessa, L., Nardo, T., Marchi, A. & Maraschio, P. (1997) A variant of the Nijmegen breakage syndrome with unusual cytogenetic features and intermediate cellular radiosensitivity. *J. med. Genet.*, **34**, 196–202
- Turker, M., Walker, K.A., Jennings, C.D., Mellon, I., Yusufji, A. & Urano, M. (1995) Spontaneous and ionizing radiation induced mutations involve large events when selecting for loss of an autosomal locus. *Mutat. Res.*, **329**, 97–105
- Uhrhammer, N., Bay, J., Pernin, D., Rio, P., Grancho, M., Kwiatkowski, F., Gosse-Brun, S., Daver, A. & Bignon, Y. (1998) Loss of heterozygosity at the *ATM* locus in colorectal carcinoma. *Oncol. Rep.*, **6**, 655–658
- Ulrich, H. (1946) Incidence of leukemia in radiologists. *New Engl. J. Med.*, **234**, 45–46
- Ulrich, R.L. (1980) Effects of split doses of X rays or neutrons on lung tumor formation in RFM mice. *Radiat. Res.*, **83**, 138–145
- Ulrich, R.L. (1983) Tumor induction in BALB/c female mice after fission neutron or gamma irradiation. *Radiat. Res.*, **93**, 506–515
- Ulrich, R.L. & Ponnaiya, B. (1998) Radiation-induced instability and its relation to radiation carcinogenesis. *Int. J. Radiat. Biol.*, **74**, 747–754
- Ulrich, R.L. & Storer, J.B. (1979a) Influence of γ irradiation on the development of neoplastic disease in mice. I. Reticular tissue tumors. *Radiat. Res.*, **80**, 303–316
- Ulrich, R.L. & Storer, J.B. (1979b) Influence of γ irradiation on the development of neoplastic disease in mice. II. Solid tumors. *Radiat. Res.*, **80**, 317–324
- Ulrich, R.L. & Storer, J.B. (1979c) Influence of γ irradiation on the development of neoplastic disease in mice. III. Dose-rate effects. *Radiat. Res.*, **80**, 325–342
- Ulrich, R.L., Jernigan, M.C. & Adams, L.M. (1979) Induction of lung tumors in RFM mice after localized exposures of X rays and neutrons. *Radiat. Res.*, **80**, 464–473
- Ulrich, R.L., Jernigan, M.C., Satterfield, L.C. & Bowles, N.D. (1987) Radiation carcinogenesis: Time–dose relationships. *Radiat. Res.*, **111**, 179–184
- Ulrich, R.L., Bowles, N.D., Satterfield, L.C. & Davis, C.M. (1996) Strain-dependent susceptibility to radiation-induced mammary cancer is a result of differences in epithelial cell sensitivity to transformation. *Radiat. Res.*, **146**, 353–355
- UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation) (1972) *Ionizing Radiation Levels and Effects, Vol. 2, Effects*, New York, United Nations
- UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation) (1986) *Genetic and Somatic Effects of Ionizing Radiation* (United Nations Sales Publication E.86.IX.9), New York, United Nations
- UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation) (1988) *Sources, Effects and Risks of Ionizing Radiation. 1988 Report to the General Assembly with Annexes* (United Nations Sales publication E.88.IX.7), New York, United Nations
- UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation) (1993) *Sources and Effects of Ionizing Radiation. 1993 Report to the General Assembly* (United Nations Sales publication E.94.IX.2), New York, United Nations
- UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation) (1994) *Sources and Effects of Ionizing Radiation, 1994 Report to the General Assembly with*

Scientific Annexes (United Nations Sales Publication E.94.IX.11), New York, United Nations

- Upton, A.C. (1968) Radiation carcinogenesis. In: Busch, H., ed., *Methods in Cancer Research*, Vol. 4, New York, Academic Press, pp. 53–82
- Upton, A.C. (1981) Health impact of the Three Mile Island accident. *Ann. N.Y. Acad. Sci.*, **365**, 63–75
- Upton, A.C. (1999) The linear–nonthreshold dose–response model: A critical reappraisal. In: NCRP Proceedings No. 21, Bethesda, MD, National Council on Radiation Protection and Measurements, pp. 9–31
- Upton, A.C., Randolph, M.L. & Conklin, J.W. (1970) Late effects of fast neutrons and gamma-rays in mice as influenced by the dose rate of irradiation: Induction of neoplasia. *Radiat. Res.*, **41**, 467–491
- Urlaub, G. & Chasin, L.A. (1980) Isolation of Chinese hamster cell mutants deficient in dihydrofolate reductase activity. *Proc. natl Acad. Sci. USA*, **77**, 4216–4220
- Urquhart, J.D., Black, R.J., Muirhead, M.J., Sharp, L., Maxwell, M., Eden, O.B. & Jones, D.A. (1991) Case–control study of leukaemia and non-Hodgkin’s lymphoma in children in Caithness near the Dounreay nuclear installation. *Br. med. J.*, **302**, 687–692
- Varon, R., Vissinga, C., Platzer, M., Cerosaletti, K.M., Chrzanowska, K.H., Saar, K., Beckmann, G., Seemanová, E., Cooper, P.R., Nowak, N.J., Stumm, M., Weemaes, C.M.R., Gatti, R.A., Wilson, R.K., Digweed, M., Rosenthal, A., Sperling, K., Concannon, P. & Reis, A. (1998) Nibrin, a novel DNA double-strand break repair protein, is mutated in Nijmegen breakage syndrome. *Cell*, **93**, 467–476
- de Vathaire, F., Francois, P., Hill, C., Schweisguth, O., Rodary, C., Sarrazin, D., Oberlin, O., Beurtheret, C., Dutreix, A. & Flamant, R. (1989) Role of radiotherapy and chemotherapy in the risk of second malignant neoplasms after cancer in childhood. *Br. J. Cancer*, **59**, 792–796
- de Vathaire, F., Francois, P., Schlumberger, M., Schweisguth, O., Hardiman, C., Grimaud, E., Oberlin, O., Hill, C., Lemerle, J. & Flamant, R. (1992) Epidemiological evidence for a common mechanism for neuroblastoma and differentiated thyroid tumour. *Br. J. Cancer*, **65**, 425–428
- de Vathaire, F., Hardiman, C., Shamsaldin, A., Campbell, S., Grimaud, E., Hawkins, M., Raquin, M., Oberlin, O., Diallo, I., Zucker, J.M., Panis, X., Lagrange, J.L., Daly-Schveitzer, N., Lemerle, J., Chavaudra, J., Schlumberger, M. & Bonaiti, C. (1999a) Thyroid carcinomas after irradiation for a first cancer during childhood. *Arch. intern. Med.*, **159**, 2713–2719
- de Vathaire, F., Hawkins, M.M., Campbell, S., Oberlin, O., Raquin, M.-A., Schlienger, J.-Y., Shamsaldin, A., Diallo, I., Bell, J., Grimaud, E., Hardiman, C., Lagrange, J.-L., Daly-Schveitzer, N., Panis, X., Zucker, J.-M., Sancho-Garnier, H., Eschwège, F., Chavaudra, J. & Lemerle, J. (1999b) Second malignant neoplasms after a first cancer in childhood: Temporal pattern of risk according to the type of treatment. *Br. J. Cancer*, **79**, 1884–1893
- Venkateswarlu, D. & Leszczynski, J. (1998) Tautomeric equilibria in 8-oxopurines: Implications for mutagenicity. *J. Comput. Aided Mol. Des.*, **12**, 373–382
- Viel, J.-F., Pobel, D. & Carré, A. (1995) Incidence of leukaemia in young people around the La Hague nuclear waste reprocessing plant: A sensitivity analysis. *Stat. Med.*, **14**, 2459–2472

- Vincent, R.A., Jr, Sheriden, R.B., III & Huang, P.C. (1975) DNA strained breakage repair in ataxia-telangiectasia fibroblast-like cells. *Mutat. Res.*, **33**, 357–366
- Virgilio, L., Isobe, M., Narducci, M.G., Carotenuto, P., Camerini, B., Kurosawa, N., Rushdi, A.-A., Croce, C.M. & Russo, G. (1993) Chromosome walking on the *TCL1* locus involved in T-cell neoplasia. *Proc. natl Acad. Sci. USA*, **90**, 9275–9279
- Virgilio, L., Narducci, M.G., Isobe, M., Billips, L.G., Cooper, M.D., Croce, C.M. & Russo, G. (1994) Identification of the *TCL1* gene involved in T-cell malignancies. *Proc. natl Acad. Sci. USA*, **91**, 12530–12534
- Virgilio, L., Lazzeri, C., Bichi, R., Nibu, K.-I., Narducci, M.G., Russo, G., Rothstein, J.L. & Croce, C.M. (1998) Deregulated expression of *TCL1* causes T cell leukemia in mice. *Proc. natl Acad. Sci. USA*, **95**, 3885–3889
- Vorechovsky, I., Luo, L., Dyer, M.J., Catovsky, D., Amlot, P.L., Yaxley, J.C., Feroni, L., Hammarström, L., Webster, A.D.B. & Yuille, M.A.R. (1997) Clustering of missense mutations in the ataxia-telangiectasia gene in a sporadic T-cell leukaemia. *Nat. Genet.*, **17**, 96–99
- Vorobtsova, I.E. & Kitaev, E.M. (1988) Urethane-induced lung adenomas in the first-generation progeny of irradiated male mice. *Carcinogenesis*, **9**, 1931–1934
- Vorobtsova, I.E., Aliyakparova, L.M. & Anisimov, V.N. (1993) Promotion of skin tumors by 12-*O*-tetradecanoylphorbol-13-acetate in two generations of descendants of male mice exposed to X-ray irradiation. *Mutat. Res.*, **287**, 207–216
- Waghray, M., Al-Sedairy, S., Ozand, P.T. & Hannan, M.A. (1990) Cytogenetic characterization of ataxia telangiectasia (AT) heterozygotes using lymphoblastoid cell lines and chronic γ -irradiation. *Hum. Genet.*, **84**, 532–534
- Waha, A., Sturme, C., Kessler, A., Koch, A., Kreyer, E., Fimmers, R., Wiestler, O.D., von Deimling, A., Krebs, D. & Schmutzler, R.K. (1998) Expression of the ATM gene is significantly reduced in sporadic breast carcinomas. *Int. J. Cancer*, **78**, 306–309
- Walburg, H.E. & Cosgrove, G.E. (1969) Reticular neoplasms in irradiated and unirradiated germ free mice. In: Mirand, E.A. & Back, N., eds, *Germ-Free Biology*, New York, Plenum, pp. 135–141
- Wald, N. (1971) Haematological parameters after acute radiation injury. In: *Manual on Radiation Haematology*, Vienna, International Atomic Energy Agency, pp. 253–264
- Walter, S.D., Meigs, J.W. & Heston, J.F. (1986) The relationship of cancer incidence to terrestrial radiation and population density in Connecticut, 1935–1974. *Am. J. Epidemiol.*, **123**, 1–14
- Wang, J.-X., Inskip, P.D., Boice, J.D., Jr, Li, B.-X., Zhang, J.-Y. & Fraumeni, J.F., Jr (1990a) Cancer incidence among medical diagnostic X-ray workers in China, 1950 to 1985. *Int. J. Cancer*, **45**, 889–895
- Wang, Z., Boice, J.D., Jr, Wei, L., Beebe, G.W., Zha, Y., Kaplan, M.M., Tao, Z., Maxon, H.R., III, Zhang, S., Schneider, A.B., Tan, B., Wesseler, T.A., Chen, D., Ershow, A.G., Kleinerman, R.A., Littlefield, L.G. & Preston, D. (1990b) Thyroid nodularity and chromosome aberrations among women in areas of high background radiation in China. *J. natl Cancer Inst.*, **82**, 478–485
- Watanabe, K.K., Kang, H.K. & Dalager, N.A. (1995) Cancer mortality risk among military participants of a 1958 atmospheric nuclear weapons test. *Am. J. public Health*, **85**, 523–527

- Watters, D., Khanna, K.K., Beamish, H., Birrell, G., Spring, K., Kedar, P., Gatei, M., Stenzel, D., Hobson, K., Kozlov, S., Zhang, N., Farrell, A., Ramsay, J., Gatti, R. & Lavin, M.F. (1997) Cellular localisation of the ataxia-telangiectasia (ATM) gene products and discrimination between mutated and normal forms. *Oncogene*, **14**, 1911–1921
- Weemaes, C.M.R., Hustinx, T.W.J., Scheres, J.M.J.C., van Munster, P.J.J., Bakkeren, J.A.J.M. & Taalman, R.D.F.M. (1981) A new chromosomal instability disorder: The Nijmegen breakage-syndrome. *Acta paediatr. scand.*, **70**, 557–564
- Weemaes, C.M.R., Smeets, D.F.C.M. & van der Burgt, C.J.A.M. (1994) Nijmegen breakage syndrome: A progress report. *Int. J. Radiat. Biol.*, **66**, 185–188
- Wei, L.-X. & Wang, J.-Z. (1994) Estimate of cancer risk for a large population continuously exposed to higher background radiation in Yangjiang, China. *Chin. med. J.*, **107**, 541–544
- Wei, L.-X., Zha, Y.-G., Tao, Z.-F., He, W.-H., Chen, D.-Q. & Yuan, Y.-L. (1990) Epidemiological investigation of radiological effects in high background radiation areas of Yangjiang, China. *J. Radiat. Res.*, **31**, 119–136
- Weichselbaum R.R., Nove, J. & Little, J.B. (1978) Deficient recovery from potentially lethal radiation damage in ataxia telangiectasia and xeroderma pigmentosum. *Nature*, **271**, 261–262
- Weinberg, C.R., Brown, K.G. & Hoel, D.G. (1987) Altitude, radiation, and mortality from cancer and heart disease. *Radiat. Res.*, **112**, 381–390
- Weiss, H.A., Darby, S.C. & Doll, R. (1994) Cancer mortality following X-ray treatment for ankylosing spondylitis. *Int. J. Cancer*, **59**, 327–338
- Weiss, H.A., Darby, S.C., Fearn, T. & Doll, R. (1995) Leukemia mortality after X-ray treatment for ankylosing spondylitis. *Radiat. Res.*, **142**, 1–11
- Weissenborn, U. & Streffer, C. (1988) Analysis of structural and numerical chromosomal anomalies at the first, second, and third mitosis after irradiation of one-cell mouse embryos with X-rays or neutrons. *Int. J. Radiat. Biol.*, **54**, 381–394
- Weissenborn, U. & Streffer, C. (1989) Analysis of structural and numerical chromosomal aberrations at the first and second mitosis after X irradiation of two-cell mouse embryos. *Radiat. Res.*, **117**, 214–220
- West, C.M. & Hendry, J.H. (1992) Intrinsic radiosensitivity as a predictor of patient response to radiotherapy. *Br. J. Radiother.*, **Suppl. 24**, 146–152
- White, S.C. (1992) 1992 assessment of radiation risk from dental radiograph. *Radiology*, **21**, 118–126
- Wiggs, L.D., Johnson, E.R., Cox-DeVore, C.A. & Voelz, G.L. (1994) Mortality through 1990 among white male workers at the Los Alamos National Laboratory: Considering exposures to plutonium and external ionizing radiation. *Health Phys.*, **67**, 577–588
- Wijnhoven, S.W., Van Sloun, P.P., Kool, H.J., Weeda, G., Slater, R., Lohman, P.H.M., Van Zeeland, A.A. & Vrieling, H. (1998) Carcinogen-induced loss of heterozygosity at the *Aprt* locus in somatic cells of the mouse. *Proc. natl Acad. Sci. USA*, **95**, 13759–13764
- Wilkinson, G.S., Tietjen, G.L., Wiggs, L.D., Galke, W.A., Acquavella, J.F., Reyes, M., Voelz, G.L. & Waxweiler, R.J. (1987) Mortality among plutonium and other radiation workers at a plutonium weapons facility. *Am. J. Epidemiol.*, **125**, 231–250
- Winegar, R.A., Lutze, L.H., Hamer, J.D., O'Loughlin, K.G. & Mirsalis, J.C. (1994) Radiation-induced point mutations, deletions and micronuclei in *lacI* transgenic mice. *Mutat. Res.*, **307**, 479–487

- Wing, S., Shy, C.M., Wood, J.L., Wolf, S., Cragle, D.L. & Frome, E.L. (1991) Mortality among workers at Oak Ridge National Laboratory: Evidence of radiation effects in follow-up through 1984. *J. Am. med. Assoc.*, **265**, 1397–1402
- Wing, S., Richardson, D., Armstrong, D. & Crawford-Brown, D. (1997) A reevaluation of cancer incidence near the Three Mile Island nuclear plant: The collision of evidence and assumptions. *Environ. Health Perspectives*, **105**, 52–57
- Wingren, G., Hatschek, T. & Axelson, O. (1993) Determinants of papillary cancer of the thyroid. *Am. J. Epidemiol.*, **138**, 482–491
- Wingren, G., Hallquist, A. & Hardell, L. (1997) Diagnostic X-ray exposure and female papillary thyroid cancer: A pooled analysis of two Swedish studies. *Eur. J. Cancer Prev.*, **6**, 550–556
- Withers, H.R. (1967) The dose–survival relationship for irradiation of epithelial cells of mouse skin. *Br. J. Radiol.*, **40**, 187–194
- Withers, H.R. (1989) Failla Memorial Lecture. Contrarian concepts in the progress of radiotherapy. *Radiat. Res.*, **119**, 395–412
- Withers, H.R. & Elkind, M.M. (1970) Microcolony survival assay for cells of mouse intestinal mucosa exposed to radiation. *Int. J. Radiat. Biol.*, **17**, 261–267
- Withers, H.R., Hunter, N., Barkley, H.T., Jr & Reid, B.O. (1974) Radiation survival and regeneration characteristics of spermatogenic stem cells of mouse testis. *Radiat. Res.*, **57**, 88–103
- Withers, H.R., Peters, L.J. & Kogelnik, H.D. (1980) The pathobiology of late effects of irradiation. In: Meyn, R.E. & Withers, H.R., eds, *Radiation Biology in Cancer Research*, New York, Raven Press, pp. 439–448
- Withers, H.R., Mason, K.A. & Thames, H.D., Jr (1986) Late radiation response of kidney assayed by tubule-cell survival. *Br. J. Radiol.*, **59**, 587–595
- Wong, F.L., Boice, J.D., Jr, Abramson, D.H., Tarone, R.E., Kleinerman, R.A., Stovall, M., Goldman, M.B., Seddon, J.M., Tarbell, N., Fraumeni, J.F., Jr & Li, F.P. (1997) Cancer incidence after retinoblastoma. Radiation dose and sarcoma risk. *J. Am. med. Assoc.*, **278**, 1262–1267
- Worgul, B.V., David, J., Odrich, S., Merriam, G.R., Jr, Medvedovsky, C., Merriam, J.C., Trokel, S.L. & Geard, C.R. (1991) Evidence of genotoxic damage in human cataractous lenses. *Mutagenesis*, **6**, 495–499
- Xu, Y., Ashley, T., Brainerd, E.E., Bronson, R.T., Meyn, S.M. & Baltimore, D. (1996) Targeted disruption of *ATM* leads to growth retardation, chromosomal fragmentation during meiosis, immune defects, and thymic lymphoma. *Genes Dev.*, **10**, 2411–2422
- Yalow, R.S. (1994) Concerns with low-level ionizing radiation. *Mayo Clin. Proc.*, **69**, 436–440
- Yalow, R.S. (1995) Radiation risk and nuclear medicine: An interview with a Nobel Prize winner. *J. nucl. Med.*, **36**, 24N
- Yamazaki, V., Wegner, R.-D. & Kirchgessner, C.U. (1998) Characterization of cell cycle checkpoint responses after ionizing radiation in Nijmegen breakage syndrome cells. *Cancer Res.*, **58**, 2316–2322
- Yandell, D.W., Dryja, T.P. & Little, J.B. (1990) Molecular genetic analysis of recessive mutations at a heterozygous autosomal locus in human cells. *Mutat Res.*, **229**, 89–102
- Yoshimoto, M., Kasumi, F., Fukami, A., Nishi, M., Kajitani, T. & Sakamoto, G. (1985) The influence of family history of cancer, irradiation and anticancer medication (mitomycin C)

- on the occurrence of multiple primary neoplasms with breast cancer—Statistical analysis by the person–year method. *Jpn. J. clin. Oncol.*, **15**, 191–199
- Young, R.W. (1987) Acute radiation syndrome. In: Conklin, J.J. & Walker, R.I., eds, *Military Radiobiology*, New York, Academic Press, pp. 165–190
- Yuille, M.A.R., Coignet, L.J.A., Abraham, S.M., Yaqub, F., Luo, L., Matutes, E., Brito-Babapulle, V., Vorechovský, I., Dyer, M.J.S. & Catovsky, D. (1998) ATM is usually rearranged in T-cell prolymphocytic leukaemia. *Oncogene*, **16**, 789–796
- Zajac-Kaye, M. & Ts'o, P.O. (1984) DNAase I encapsulated in liposomes can induce neoplastic transformation of Syrian hamster embryo cells in culture. *Cell*, **39**, 427–437
- Zampetti-Bosseler, F. & Scott, D. (1981) Cell death, chromosome damage and mitotic delay in normal human, ataxia telangiectasia and retinoblastoma fibroblasts after X-irradiation. *Int. J. Radiat. Biol.*, **39**, 547–558
- Zaridze, D.G., Arkadieva, M.A., Day, N.E. & Duffy, S.W. (1993) Risk of leukaemia after chemotherapy in a case–control study in Moscow. *Br. J. Cancer*, **67**, 347–350
- Zaridze, D.G., Li, N., Men, T. & Duffy, S.W. (1994) Childhood cancer incidence in relation to distance from the former nuclear testing site in Semipalatinsk, Kazakhstan. *Int. J. Cancer*, **59**, 471–475
- Zhang, N., Chen, P., Khanna, K.K., Scott, S., Gatei, M., Kozlov, S., Watters, D., Spring, K., Yen, T. & Lavin, M.F. (1997) Isolation of full-length ATM cDNA and correction of the ataxia-telangiectasia cellular phenotype. *Proc. natl Acad. Sci. USA*, **94**, 8021–8026
- Zhang, N., Chen, P., Gatei, M., Scott, S., Khanna, K.K. & Lavin, M.F. (1998) An anti-sense construct of full-length ATM cDNA imposes a radiosensitive phenotype on normal cells. *Oncogene*, **17**, 811–818
- Zippin, C., Bailar, J.C., III, Kohn, H.I., Lum, D. & Eisenberg, H. (1971) Radiation therapy for cervical cancer: Late effects on life span and on leukemia incidence. *Cancer*, **28**, 937–942
- Ziv, Y., Bar-Shira, A., Pecker, I., Russell, P., Jorgensen, T.J., Tsarfati, I. & Shiloh, Y. (1997) Recombinant ATM protein complements the cellular A-T phenotype. *Oncogene*, **15**, 159–167