Radioactive discharges from the proposed Forsmark nuclear waste disposal project in Sweden and European Law

Submission to the Swedish Nacka Environmental Court

8th September 2017

Christopher Busby

Scientific Secretary, European Committee o n Radiation Risk

1117 Latvian Academy of Sciences, Riga

christo@greenaudit.org

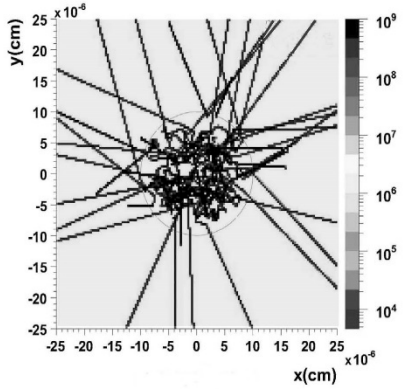
www.greenaudit.org

www.llrc.org

www.euradcom.eu

ECRR

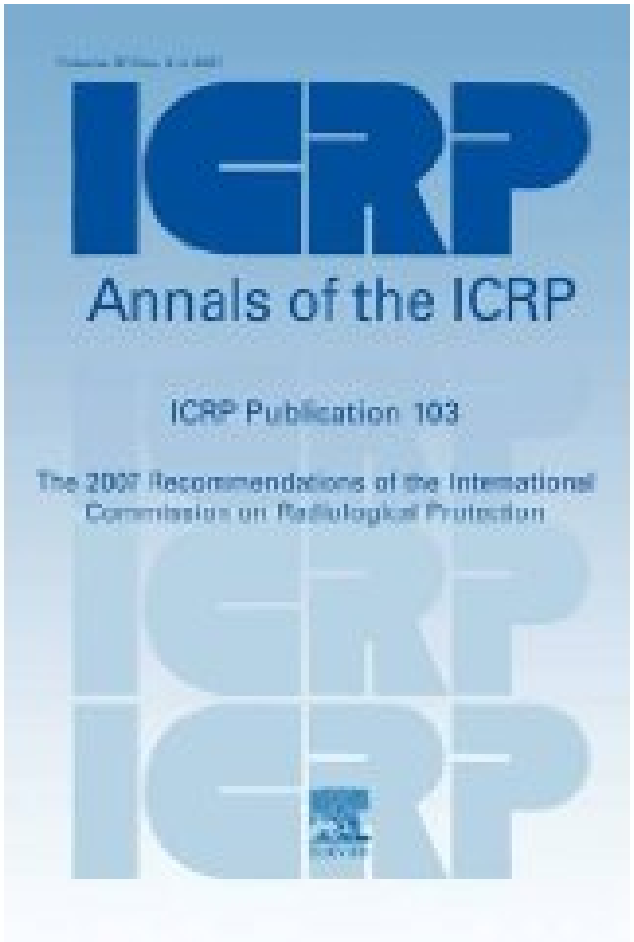
2010 Recommendations of the European Committee on Radiation Risk



The Health Effects of Exposure to Low Doses of Ionizing Radiation

Regulators' Edition: Brussels 2010

The ICRP radiation risk model, developed in 1952 and currently still the basis of legal limits for exposures is based on external irradiation epidemiology of the Japanese A-Bomb external exposed groups.



The EURATOM BSS suicide clause

- Currently and from May 2000: Under Article 6.2 of the Council Directive 96/29/Euratom of 13 May 1996:

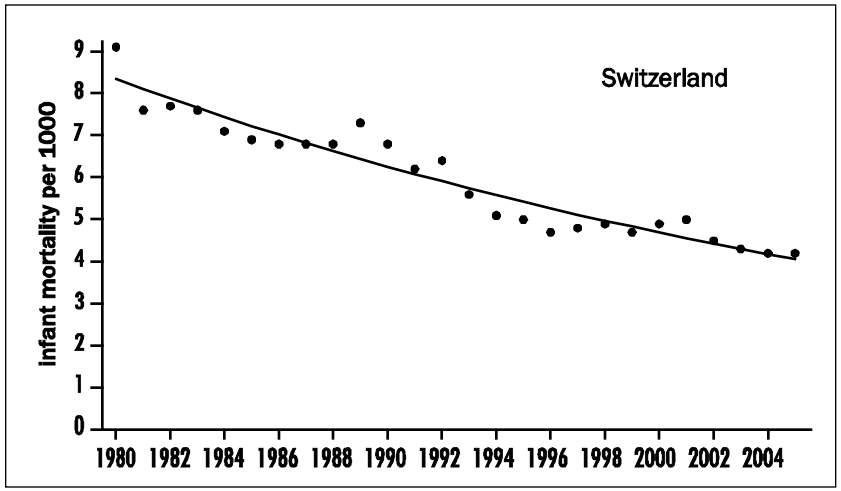
- *Existing classes or types of practice may be reviewed as to Justification* ***whenever new and important evidence about their efficacy or consequences is acquired***

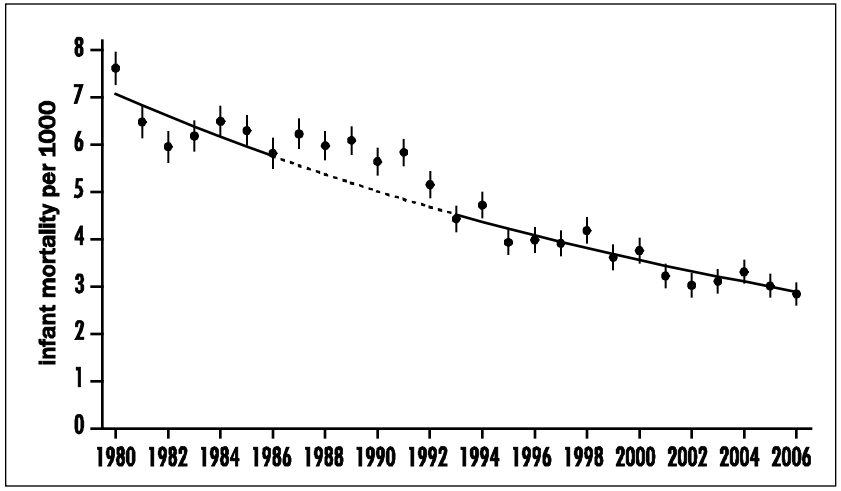
- From 2018: Under Article 19(2) of the Council Directive 2013/59 of 5th Dec 2013:
-
- *Member States shall consider a review of existing classes or types of practices with regard to their justification* ***whenever there is new and important evidence about their efficacy or potential consequences.***

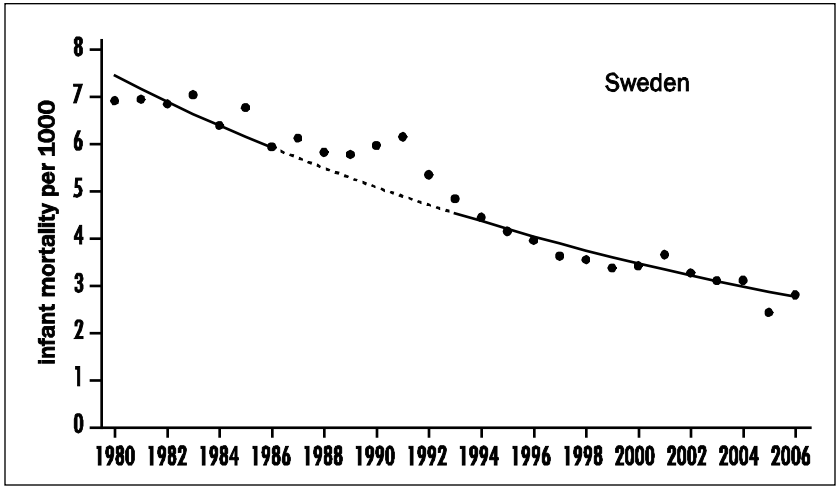
JUSTIFICATION:
Ionizing radiation causes harmful biological effects

- Cell death
- Organ damage
- Organism death (including infant deaths)
- Heritable damage (Congenital malformations)
- Lifespan shortening
- Cancer
- Heart and circulatory system disease

Trend of infant mortality rates in Finland, Switzerland and Sweden, 1980 - 2006, and undisturbed trend line. Chernobyl effects based on official statistical data (Korblein, 2008) .

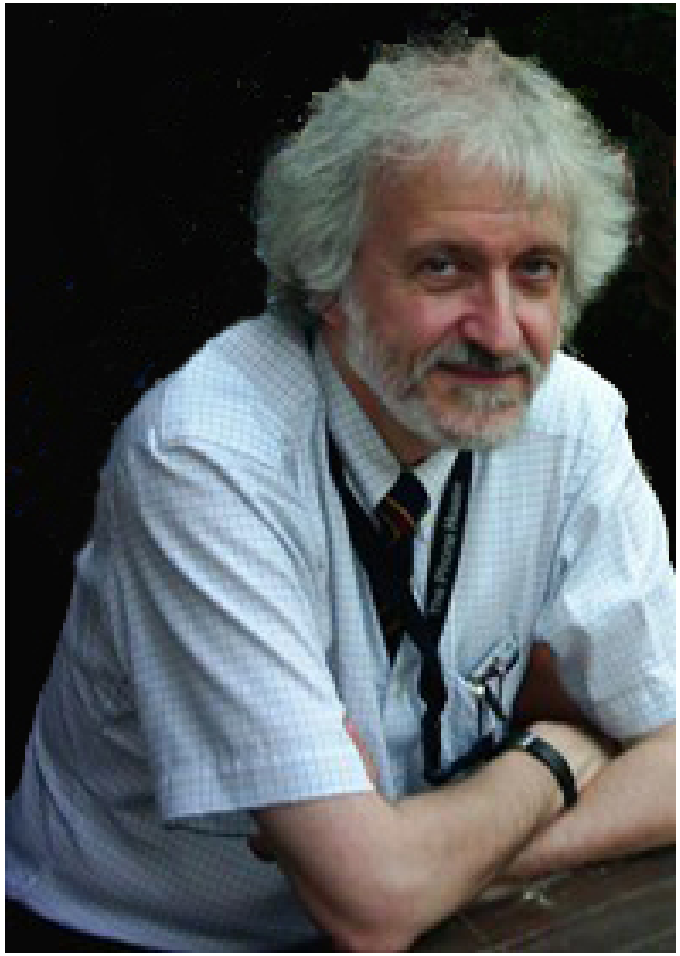






For 20 years the Scientific Secretary of the ICRP was Dr Jack Valentin until March 2009. He has been the editor of many of the ICRP reports Including the 2007 report.

My discussion with him was recorded at an open meeting in Stockholm on 22nd April 2009 after he had resigned. he stated that the ICRP risk model could not be used to predict the health effects of radiation exposures in human populations because the errors for certain internal exposures could be as high as 900-fold, and that the official risk agencies had been wrong in not looking at Chernobyl effects, but as Secretary he did what he was told. The video is on youtube.



Lars Erik Holm states that the death yield of the Chernobyl accident was restricted to a few cleanup workers . Holm was Chairman of ICRP until he was made Medical Officer of Health for Sweden!

Policy Information Network on Child Health and Environment (PINCHE)

- Van den Hazel P, Zuurbier M, Bistrup M L, **Busby C**, Fucic A, Koppe JG et al (2006) Policy and science in children's health and environment: Recommendations from the PINCHE project. *Acta Paediatrica* S 453 114-119
- Koppe JG, Bartonova A, Bolte G, Bistrup ML, **Busby C**, Butter M et al (2006) Exposure to multiple environmental agents and their effects. *Acta Paediatrica* S 453 106-114
- Van den Hazel P, Zuurbier M, Babisch W, Bartonova A, Bistrup M-L, Bolte G, **Busby C** et al, (2006) 'Today's epidemics in children: possible relations to environmental pollution' *Acta Paediatrica* S 453 18-26
- **Busby C** and Fucic A (2006) Ionizing Radiation and children's health: PINCHE conclusions *Acta Paediatrica* S 453 81-86

EHT Environmental Health and Toxicology

Open Access

Volume: 31, Article ID: e2016001, 13 pages
http://dx.doi.org/10.5620/eht.e2016001

• Review Article

eISSN: 2233-6567

Genetic radiation risks: a neglected topic in the low dose debate

Inge Schmitz-Feuerhake[1], Christopher Busby[2], Sebastian Pflugbeil[3]

[1]*University of Bremen, Bremen Germany;* [2]*Environmental Research SIA, Riga, Latvia;* [3]*German Society for Radiation Protection, Berlin, Germany*

Objectives To investigate the accuracy and scientific validity of the current very low risk factor for hereditary diseases in humans following exposures to ionizing radiation adopted by the United Nations Scientific Committee on the Effects of Atomic Radiation and the International Commission on Radiological Protection. The value is based on experiments on mice due to reportedly absent effects in the Japanese atomic bomb (A-bomb) survivors.

Methods To review the published evidence for heritable effects after ionising radiation exposures particularly, but not restricted to, populations exposed to contamination from the Chernobyl accident and from atmospheric nuclear test fallout. To make a compilation of findings about early deaths, congenital malformations, Down's syndrome, cancer and other genetic effects observed in humans after the exposure of the parents. To also examine more closely the evidence from the Japanese A-bomb epidemiology and discuss its scientific validity.

Results Nearly all types of hereditary defects were found at doses as low as one to 10 mSv. We discuss the clash between the current risk model and these observations on the basis of biological mechanism and assumptions about linear relationships between dose and effect in neonatal and foetal epidemiology. The evidence supports a dose response relationship which is non-linear and is either biphasic or supralinear (hogs-back) and largely either saturates or falls above 10 mSv.

Conclusions We conclude that the current risk model for heritable effects of radiation is unsafe. The dose response relationship is non-linear with the greatest effects at the lowest doses. Using Chernobyl data we derive an excess relative risk for all malformations of 1.0 per 10 mSv cumulative dose. The safety of the Japanese A-bomb epidemiology is argued to be both scientifically and philosophically questionable owing to errors in the choice of control groups, omission of internal exposure effects and assumptions about linear dose response.

Keywords Congenital malformation, Down´s syndrome, Environmental radioactivity, Internal radiation, Low level effects, Sex-ratio, Still birth

Correspondence: Christopher Busby
1117 Latvian Academy of Sciences, Riga, LV-1050, Latvia
Tel: +44-7989428833
Fax: +44-1970630215
E-mail: christo@greenaudit.org

Received: October 17, 2015
Accepted: January 20, 2016
Published: January 20, 2016

This article is available from: http://e-eht.org/

Introduction

The most serious effects of ionizing radiation–hereditary defects in the descendants of exposed parents–had been already detected in the 1920s by Herman Joseph Muller. He exposed fruit flies–*drosophila*–to X-rays and found malformations and other disorders in the following generations. He concluded from his investigations that low dose exposure, and therefore even natural background radiation, is mutagenic and there is no harmless dose range for heritable effects or for cancer induction. His work was honoured by the Nobel Prize for medicine in 1946. In the 1950s Muller warned about the effects on the hu-

Schmitz-Feuerhake, Busby, Pflugbeil 2016

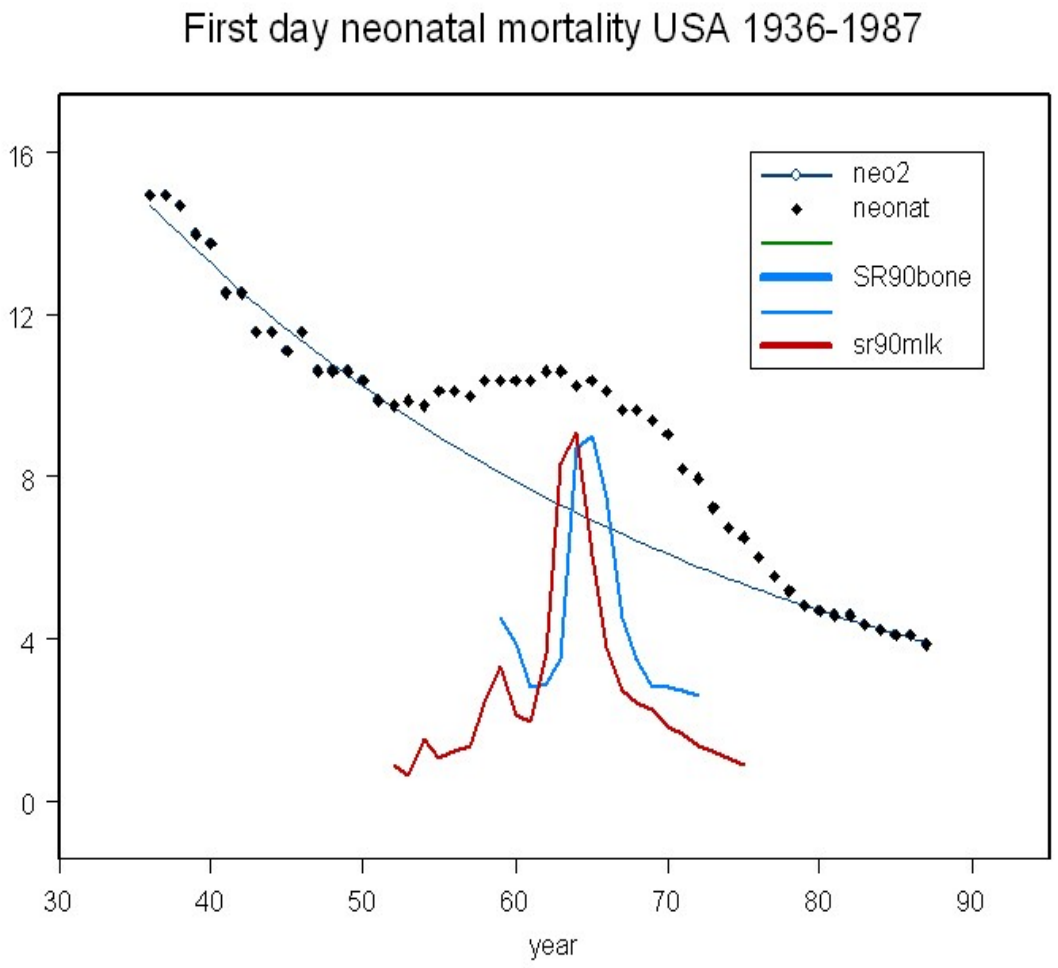
- **Objectives** To investigate the accuracy and scientific validity of the current very low risk factor for hereditary diseases in humans following exposures to ionizing radiation adopted by the United Nations Scientific Committee on the Effects of Atomic Radiation and the International Commission on Radiological Protection. The value is based on experiments on mice due to reportedly absent effects in the Japanese atomic bomb (A-bomb) survivors.
- **Methods** To review the published evidence for heritable effects after ionising radiation exposures particularly, but not restricted to, populations exposed to contamination from the Chernobyl accident and from atmospheric nuclear test fallout. To make a compilation of findings about early deaths, congenital malformations, Down's syndrome, cancer and other genetic effects observed in humans after the exposure of the parents. To also examine more closely the evidence from the Japanese A-bomb epidemiology and discuss its scientific validity.
- **Results** Nearly all types of hereditary defects were found at doses as low as one to 10 mSv. We discuss the clash between the current risk model and these observations on the basis of biological mechanism and assumptions about linear relationships between dose and effect in neonatal and foetal epidemiology. The evidence supports a dose response relationship which is non-linear and is either biphasic or supralinear (hogs-back) and largely either saturates or falls above 10 mSv.

- **Conclusions** We conclude that the current risk model for heritable effects of radiation is unsafe. The dose response relationship is non-linear with the greatest effects at the lowest doses. Using Chernobyl data we derive an excess relative risk for all malformations of 1.0 per 10 mSv cumulative dose. The safety of the Japanese A-bomb epidemiology is argued to be both scientifically and philosophically questionable owing to errors in the choice of control groups, omission of internal exposure effects and assumptions about linear dose response.

Radiation genotoxicity.

The 1946 Nobel prize for medicine was awarded to Herman J Muller for his discovery and subsequent work on the mutations caused by X-rays which he discovered in 1926. By the 1950s Muller warned about the radioactive contamination being caused by the atmospheric nuclear tests causing genetic effects. His warnings turned out to be accurate.

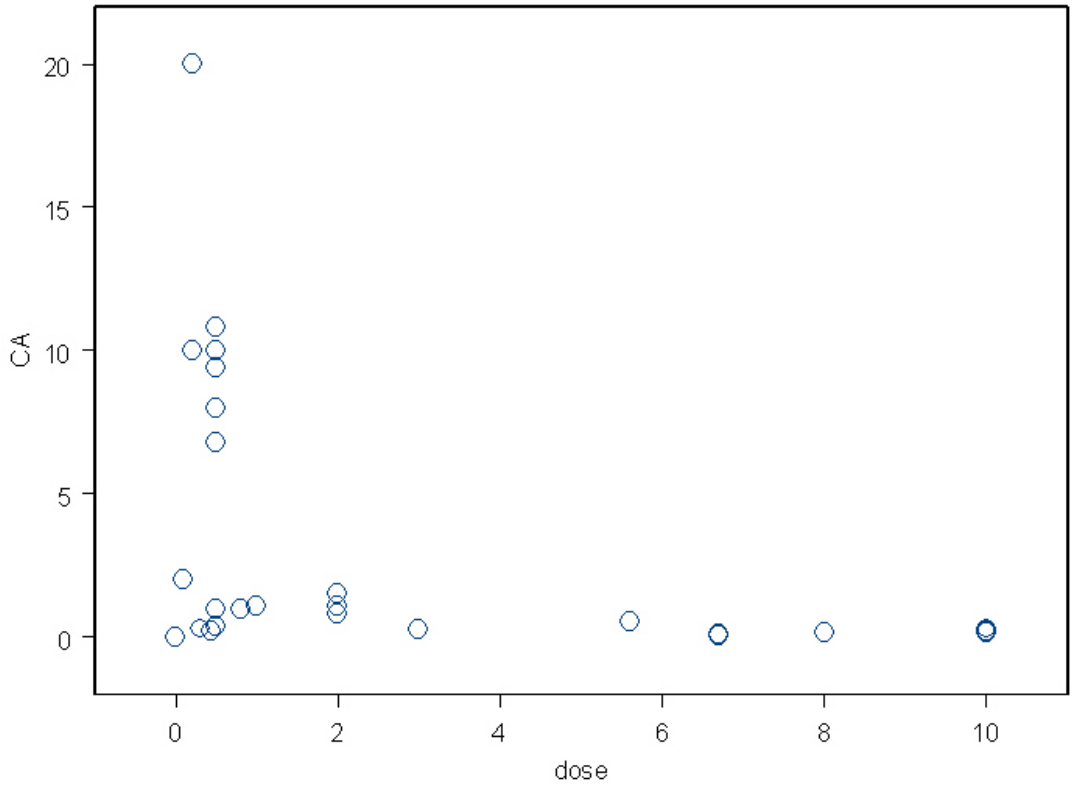
Effects of the 1960s atmospheric testing (from Busby 2017, International Conference on Pharmacology and Toxicology Paris, June 22, 2017; in Press)



New and important evidence on heritable effects included

- Lazjuk GI, Nikolaev DL, Novikova IV. Changes in registered congenital anomalies in the Republic of Belarus after the Chernobyl accident. Stem Cells 1997;15 Suppl 2:255-260
- Feshchenko SP, Schröder HC, Müller WE, Lazjuk GI. Congenital malformations among newborns and developmental abnormalities among human embryos in Belarus after Chernobyl accident. Cell Mol Biol (Noisy-le-grand) 2002;48(4):423-426
- Kulakov VI, Sokur TN, Volobuev AI, Tzibulskaya IS, Malisheva VA, Zikin BI, et al. Female reproductive function in areas affected by radiation after the Chernobyl power station accident. Environ Health Perspect 1993;101 Suppl 2:117-123
- Petrova A, Gnedko T, Maistrova I, Zafranskaya M, Dainiak N. Morbidity in a large cohort study of children born to mothers exposed to radiation from Chernobyl. Stem Cells 1997;15 Suppl 2:141-150
- Wertelecki W. Malformations in a Chernobyl-impacted region. Pediatrics 2010;125(4):e836-e843
- Wertelecki W, Yevtushok L, Zymak-Zakutnia N, Wang B, Sosyniuk Z, Lapchenko S, et al. Blastopathies and microcephaly in a Chernobyl-impacted region of Ukraine. Congenit Anom (Kyoto) 2014;54(3):125-149
- Akar N, Ata Y, Aytekin AF. Neural tube defects and Chernobyl? Paediatr Perinat Epidemiol 1989;3(1):102-103
- Caglayan S, Kayhan B, Menteşoğlu S, Aksit S. Changing incidence of neural tube defects in Aegean Turkey. Paediatr Perinat Epidemiol 1989;3(1):62-65
- Güvenc H, Uslu MA, Güvenc M, Ozekici U, Kocabay K, Bektaş S. Changing trend of neural tube defects in eastern Turkey. J Epidemiol Community Health 1993;47(1):40-41
- Mocan H, Bozkaya H, Mocan MZ, Furtun EM. Changing incidence of anencephaly in the eastern Black Sea region of Turkey and Chernobyl. Paediatr Perinat Epidemiol 1990;4(3):264-268
- Kruslin B, Jukić S, Kos M, Simić G, Cviko A. Congenital anomalies of the central nervous system at autopsy in Croatia in the period before and after the Chernobyl accident. Acta Med Croatica 1998;52(2):103-107
- Moumdjiev N, Nedkova V, Christova V, Kostova S. Influence of the Chernobyl reactor accident on the child health in the region of Pleven, Bulgaria. In: International Pediatric Association. Excerpts from the 20th International Congress of Pediatrics; 1992 Sep 5-10; Rio de Janeiro, Brazil. Vevey: Nestlé Nutrition Services; 1992, p. 57
- Zieglowski V, Hemprich A. Facial cleft birth rate in former East Germany before and after the reactor accident in Chernobyl. Mund Kiefer Gesichtschir 1999;3(4):195-199 (German).
- Scherb H, Weigelt E. Cleft lip and cleft palate birth rate in Bavaria before and after the Chernobyl nuclear power plant accident. Mund Kiefer Gesichtschir 2004;8(2):106-110 (German).
- Lotz B, Haerting J, Schulze E. Changes in fetal and childhood autopsies in the region of Jena after the Chernobyl accident; 1996 [cited 2016 Jan 28]. Available from: http://www.meb.uni-bonn. de/gmds/abstracts/0095e.html (German).

Biphasic dose response. (From Busby 2017 in Press)



January 2017 letter to Fredrik Hassel SSM

- Dr Christopher Busby
- Sodra Jordbrovagen 25, 13765 Jordbro
- Sweden
- +44 7989 428833, +46 7039 99069
- For the purposes of this issue please reply to: radiationappeals@gmail.com

-
-
- EURATOM BSS Directives
- National Contact Point: HASSEL Fredrik (Deputy Director General)
- SSM (Swedish Radiation Safety Authority
- By email: registrator@ssm.se
- cc. fredrik.hassel@ssm.se
- mats.persson@ssm.se
- charlotte.dahlberg@ssm.se

- **Justification of radiation exposures of members of the public and workers: review of existing practices; New and important information.**

Sweden National Competent Authority

- SSM
- Euratom Contact: Fredrik Hassel
- Written to several times between Jan 2017 and March 2017 by myself and Ditta Rietuma.
- Eventually I had to come to the SSM headquarters in Stockholm where he had agreed to meet me. But he was not there.
- Several letters and emails more resulted finally in a letter from him stating that SSM was not responsible for re-Justification and it was the job of the ICRP.

Sweden and re-Justification of the BSS

- Mr Hassel is wrong. The legal responsibility rests with the Member State and with its Competent Authority, here Mr Hassel.
- ICRP is, like ECRR, an independent organisation. ICRP left Sweden shortly after 2010 and is now in Canada.
- SSM should have therefore examined the issues of New and Important Evidence and acted.
- Ditta Rietuma and I wrote a letter of complaint to the Swedish Environment Ministry and also to the Justice Chancellor. We have not had any acceptable responses from either Ministry, but perhaps this is one reason why I was invited to make this presentation.

Further Actions

- I am presenting this and other supporting evidence to the UK Energy Minister in London on 12th September
- Failure of the Swedish State to act on the legal issue will result in a formal letter to the European Commission requiring an Intervention and an application to the European Court over the issue of the failure of the Swedish State to trigger a provision in law that affects its citizens from harm to their health.
- Similar actions are being developed in other EU States.

Peer Review literature

- A peer review paper on this issue and naming Mr Hassel was published in the journal *Pediatric Dimensions* last month.
- A further paper on the issue, also naming Mr Hassel and reporting the responses of the Swedish Ministries and Justice Chancellor is being published next month.
- The issue will not go away and Forsmark will not be permitted because releases will kill children.

Peer Review Article

- Busby Christopher (2017) Child health and ionizing radiation: Science, Politics and European Law. *Pediatric Dimensions.* 2(3) 1-4 doi:10.15761/PD.1000150

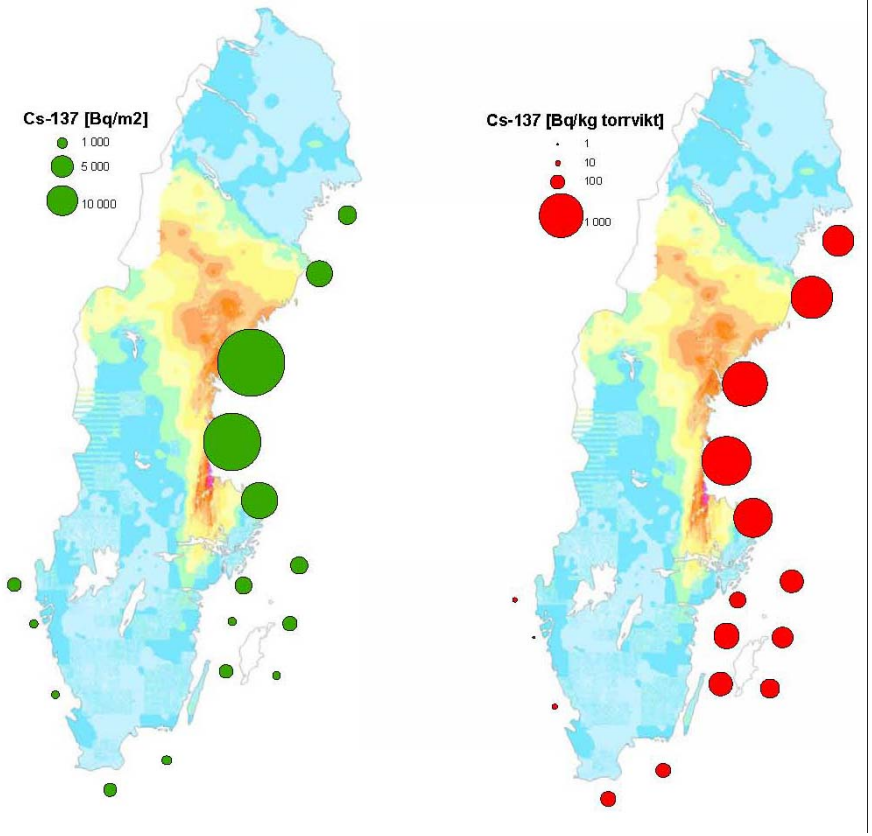
The history of Science has been full of major changes in scientific models. But none of these, from Galileo, Newton, Einstein, etc. can have had quite the public health impact as the revelation that internal radionuclide exposures are so genotoxic and that the model employed to quantify these exposures is totally unsafe. Politicians and radiation risk agencies and experts are now caught between human health and economic (nuclear energy, fracking) and military (nuclear weapons, depleted uranium) projects which depend upon permitting radioactive contamination.

Forsmark and the Baltic Sea

The Baltic Sea is already the most Radioactive in the world.

The map is from HELCOM 2009

sediments



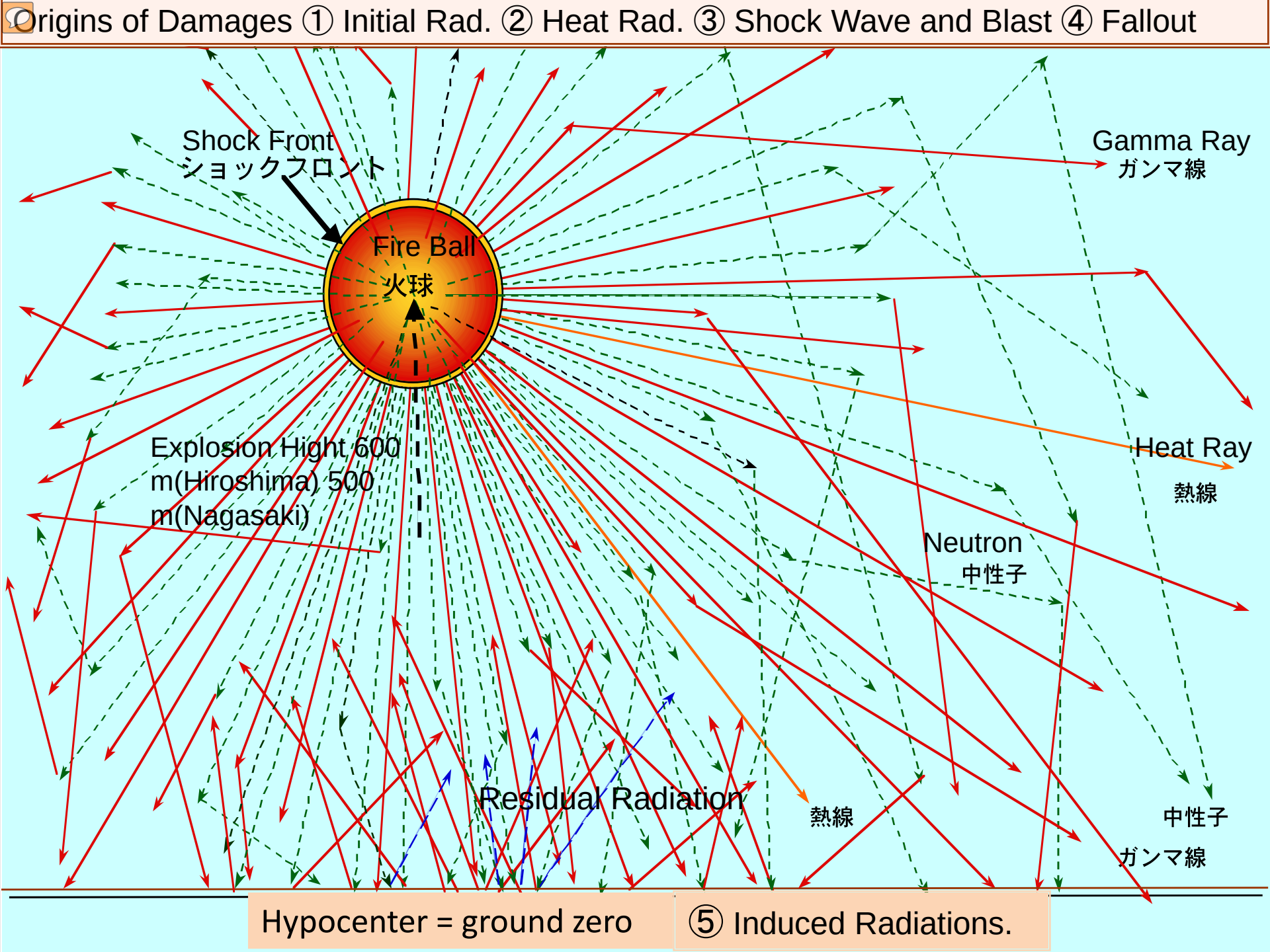
Montaigne 1533-1592

A wise man may be wrong, or a hundred men, or several Nations, and since even human nature, as we know it, goes wrong for several centuries on this matter or on that, how can we be certain that it occasionally stops going wrong, and that in this century it is not mistaken?

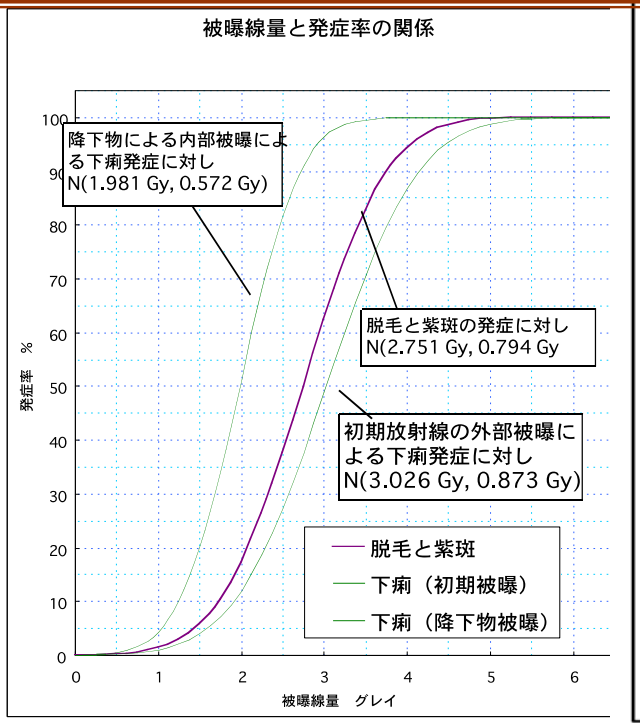
Japanese LSS failures

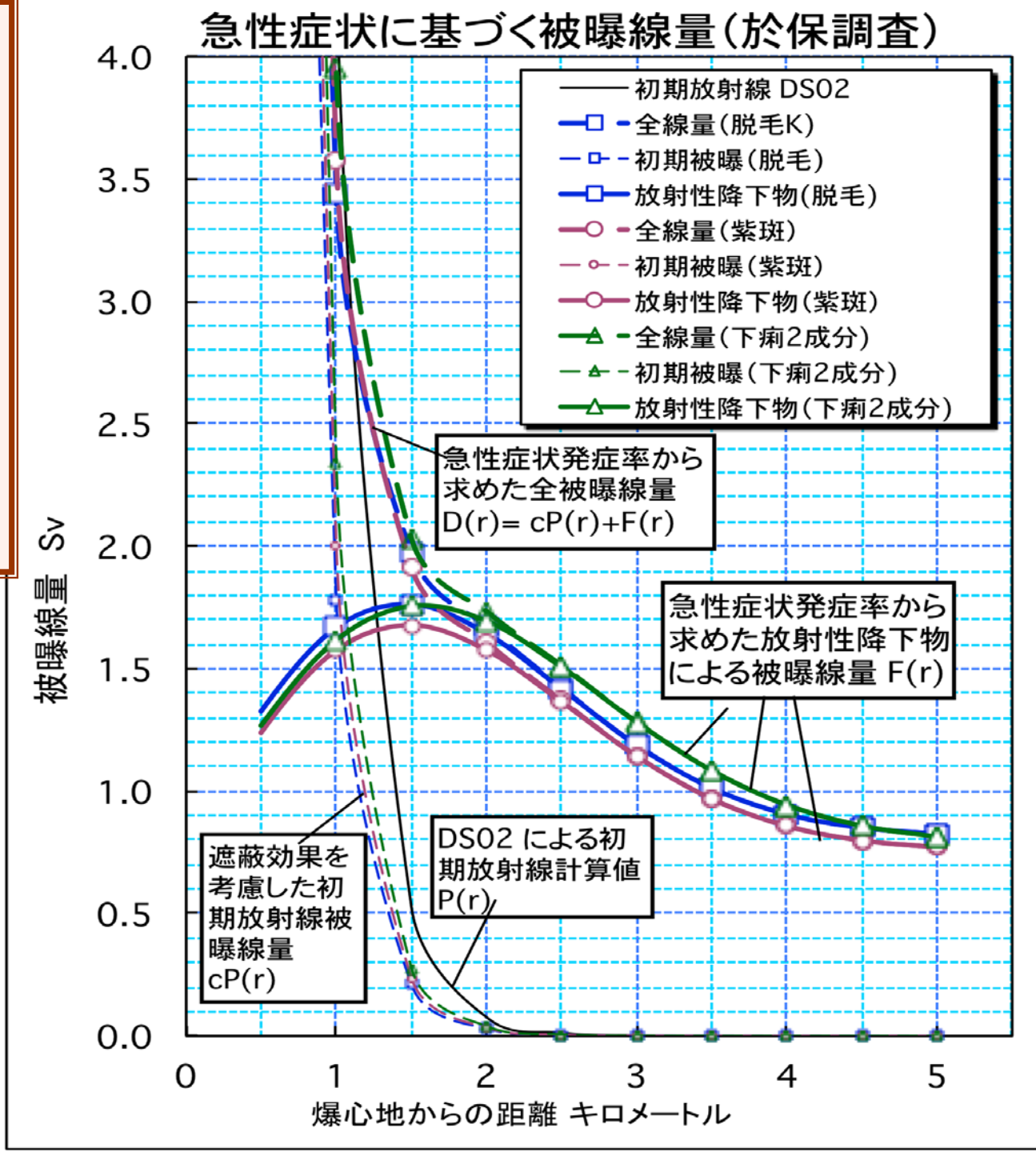
- Busby Christopher. Invited Letter to the Editor on “The Hiroshima Nagasaki survivor studies. Discrepancies between results and general perception.” By Bernard R Jordan. *Genetics*. 2016; 204(4) 1627-1629

- Control group Not in City zero dose abandoned 1973
- Sex Ratio errors (Padmanabhan 2009); genetic effects clear
- Sawada non cancer deterministic effects at 5km due to Uranium particles
- Wanatabe 2009 3-fold excess in lowest dose group using adjacent prefecture controls


Origins of Damages ① Initial Rad. ② Heat Rad. ③ Shock Wave and Blast ④ Fallout
Shock Front
ショックフロント
Fire Ball
火球
Gamma Ray
ガンマ線
Explosion Hight 600 m(Hiroshima) 500 m(Nagasaki)
Heat Ray
熱線
Neutron
中性子
Residual Radiation
熱線
中性子
ガンマ線
Hypocenter = ground zero
⑤ Induced Radiations.

3種の急性症状の発症率を共通した初期放射線被曝と放射性降下物被曝で再現。下痢は初期放射線による外部被曝と降下物の内部被曝の違いを示している





Sawada used RERF published data on immediate (deterministic) radiation effects

- Epilation (hair loss)
- Diarrhea

He used data on the external absorbed dose required to cause these. The published data show that individuals as far as 6km from the hypocentre developed these conditions. There was no direct radiation from the detonation further than 2km. The effects, equivalent to about 1.0 Sv were due to the fallout and rainout, the “black rain”.

This falsifies the whole LSS study since all the dose groups will have received this biological damage and comparisons between them to obtain risk coefficients will be meaningless. This also includes the LSS studies of heritable effects.

LSS and heritable effects

- The US army geneticists James Neel and William Schull in charge of the heritable effects study in the LSS data apparently found no human effects whatever.
- Since the studies were begun 7 years after the detonation and Japanese Hibakushas (survivors) were anxious about their status, this may have been one cause.
- The main cause will have been the fact that all dose groups being compared had been equivalently exposed to internal Uranium and Plutonium particulates and other fission-products from the bombs.
- Examination of sex-ratio between the NIC and other groups showed a profound effect. But this was ignored as it could not be understood.
- Because of this, the ICRP and current risk models give a relative risk coefficient of 0.02 per Sievert. That means the doubling dose for heritable effects is 50Sv. Death of the individual occurs at 2Sv.

Chernobyl

- The most valuable datasets to establish the true dose coefficients for the heritable effects of internal exposures are from countries contaminated by the Chernobyl disaster.
- By 2015 many different studies had been carried out in different countries with different levels of contamination.
- These studies, and their implications for human health were reviewed by Schmitz-Feuerhake et al. 2016.

Chernobyl and heritable effects

- Schmitz-Feuerhake I, Busby C, Pflugbeil P Genetic Radiation Risks-A Neglected Topic in the Low Dose Debate. Environmental Health and Toxicology. 2016. 31 Article ID e2016001. http://dx.doi.org/10.5620/eht.e2016001
- At least 20 different studies in different countries showed statistically significant increases in congenital malformation rates at measured and UN estimated absorbed doses less than 5mSv.

ISF Methods

- To review the published evidence for heritable effects after ionising radiation exposures particularly, but not restricted to, populations exposed to contamination from the Chernobyl accident and from atmospheric nuclear test fallout. To make a compilation of findings about early deaths, congenital malformations, Down's syndrome, cancer and other genetic effects observed in humans after the exposure of the parents. To also examine more closely the evidence from the Japanese A-bomb epidemiology and discuss its scientific validity.

ISF Results

- Nearly all types of hereditary defects were found at doses as low as one to 10 mSv. We discuss the clash between the current risk model and these observations on the basis of biological mechanism and assumptions about linear relationships between dose and effect in neonatal and foetal epidemiology. The evidence supports a dose response relationship which is non-linear and is either biphasic or supralinear (hogs back) and largely either saturates or falls above 10 mSv.

ISF Conclusions

- We conclude that the current risk model for heritable effects of radiation is unsafe. The dose response relationship is non-linear with the greatest effects at the lowest doses. Using Chernobyl data we derive an excess relative risk for all malformations of 1.0 per 10 mSv cumulative dose. The safety of the Japanese A-bomb epidemiology is argued to be both scientifically and philosophically questionable owing to errors in the choice of control groups, omission of internal exposure effects and assumptions about linear dose response.
- **Keywords** Congenital malformation, Down´s syndrome, Environmental radioactivity, Internal radiation, Low level effects, Sex ratio, Still birth

Some examples (1) Belarus

Lazjuk et al 1997 (Belarus National Genetic Monitoring Register) anencephaly, spina bifida, cleft palate, limb reduction defects, esophageal atresia, anorectal atresia, Downs syndrome, Multiple malformations: 80% increase 1987-94 vs. 1982-85 at 6.7mSv $p<.05$ gradient 49% at 0.44mSv.

Whole of Belarus: all congenital malformations increased from 12.5 per 1000 in 1985 to 17.5 in 1994.

Increase in frequency stabilised by State abortion intervention program.

7 other independent studies of areas of Belarus published by different groups with different levels of contamination, all below 10mSv confirmed the increases. (see ISF 2016 for list).

Lazjuk GI, Nikolaev DL, Novikova IV. Changes in registered congenital anomalies in the Republic of Belarus after the Chernobyl accident. Stem Cells 1997;15 Suppl 2:255-260.

More examples

- 23. Feshchenko SP, Schröder HC, Müller WE, Lazjuk GI. Congenital malformations among newborns and developmental abnormalities among human embryos in Belarus after Chernobyl accident. Cell Mol Biol (Noisy-le-grand) 2002;48(4):423-426.
- 24. Bogdanovich IP. Comparative analysis of the death rate of children, aged 0-5, in 1994 in radiocontaminated and conventionally clean areas of Belarus. In Medicobiological effects and the ways of overcoming the Chernobyl accident consequence. Minsk-Vitebsk: Ministry of Emergency and Chernobyl Problems of Belarus and Academy of Sciences of Belarus; 1997, p. 4 (Russian).
- 25. Savchenko VK. The ecology of the Chernobyl catastrophe: scientific outlines of an International Programme of Collaborative Research. Paris: United Nations Educational Scientific and Organisation; 1995, p. 83.
- 26. Kulakov VI, Sokur TN, Volobuev AI, Tzibulskaya IS, Malisheva VA, Zikin BI, et al. Female reproductive function in areas affected by radiation after the Chernobyl power station accident. Environ Health Perspect 1993;101 Suppl 2:117-123.
- 27. Petrova A, Gnedko T, Maistrova I, Zafranskaya M, Dainiak N. Morbidity in a large cohort study of children born to mothers exposed to radiation from Chernobyl. Stem Cells 1997;15 Suppl 2:141-150.
- 28. Shidlovskii PR. General morbidity of the population in districts of the Brest region. Zdra-voohranenie Belorussii (Minsk) 1992;1:8- 11 (Russian).
- 29. Wertelecki W. Malformations in a Chernobyl-impacted region. Pediatrics 2010;125(4):e836-e843.
- 30. Wertelecki W, Yevtushok L, Zymak-Zakutnia N, Wang B, Sosyniuk Z, Lapchenko S, et al. Blastopathies and microcephaly in a Chernobyl-impacted region of Ukraine. Congenit Anom (Kyoto) 2014;54(3):125-149.
- 31. Godlevsky I, Nasvit O. Dynamics of health status of residents in the Lugyny district after the accident of the ChNPS. In Imanaka T, editor. Research activities about the radiological consequences of the Chernobyl NPS accident and social activities to assist the sufferers by the accident. Osaka: Kyoto University Research Reactor Institute; 1998, p. 149-156.
- 32. Akar N, Ata Y, Aytekin AF. Neural tube defects and Chernobyl? Paediatr Perinat Epidemiol 1989;3(1):102-103.
- 33. Caglayan S, Kayhan B, Menteşoğlu S, Aksit S. Changing incidence of neural tube defects in Aegean Turkey. Paediatr Perinat Epidemiol 1989;3(1):62-65.
- 34. Güvenc H, Uslu MA, Güvenc M, Ozekici U, Kocabay K, Bektaş S. Changing trend of neural tube defects in eastern Turkey. J Epidemiol Community Health 1993;47(1):40-41.
- 35. Mocan H, Bozkaya H, Mocan MZ, Furtun EM. Changing incidence of anencephaly in the eastern Black Sea region of Turkey and Chernobyl. Paediatr Perinat Epidemiol 1990;4(3):264-268.

And

- 36. Moumdjiev N, Nedkova V, Christova V, Kostova S. Influence of the Chernobyl reactor accident on the child health in the region of Pleven, Bulgaria. In: International Pediatric Association. Excerpts
- from the 20th International Congress of Pediatrics; 1992 Sep 5-10; Rio de Janeiro, Brazil. Vevey: Nestlé Nutrition Services; 1993, p. 57. 1992, p. 57.
- 37. Kruslin B, Jukić S, Kos M, Simić G, Cviko A. Congenital anomalies of the central nervous system at autopsy in Croatia in the period before and after the Chernobyl accident. Acta Med Croatica 1998;52(2):103-107.
- 38. Zieglowski V, Hemprich A. Facial cleft birth rate in former East Germany before and after the reactor accident in Chernobyl. Mund Kiefer Gesichtschir 1999;3(4):195-199 (German).
- 39. Scherb H, Weigelt E. Cleft lip and cleft palate birth rate in Bavaria before and after the Chernobyl nuclear power plant accident. Mund Kiefer Gesichtschir 2004;8(2):106-110 (German).
- 40. Korblein A. Fehlbildungen in bayern nach tschernobyl. Strahlentelex 2004;416-417:4-6 (German).
- 41. Government of Berlin West, Section of Health and Social Affairs. Annual health report. Berlin: Government of Berlin West; 1987 (German).
- 42. Lotz B, Haerting J, Schulze E. Changes in fetal and childhood autopsies in the region of Jena after the Chernobyl accident; 1996 [cited 2016 Jan 28]. Available from: http://www.meb.uni-bonn. de/gmds/abstracts/0095e.html (German).
- 44. Busby C, Cato MS. Increases in leukemia in infants in Wales and Scotland following Chernobyl: evidence for errors in statutory risk Estimates. Energy Environ 2000;11(2):127-139.

Non-Chernobyl reports of excess heritable damage at low doses

- Hanford USA workers children Sever et al 1988
- Sellafield workers stillbirths Parker et al 1996
- Liquidators Obninsk CA Tsyb 2004
- Liquidators Bryansk CA Matveenko 2005
- Liquidators Russia CA Lyaginskaya et al 2009
- British Nuclear test Veterans Rabbitt Roff 1999
- British Nuclear Test Veterans Busby et al 2013
- 3 Studies of CA following Uranium weapons in Fallujah Iraq Alaani et al,2010,2012. Busby et al 2011

Fallujah Iraq: Uranium weapons

- ALAANI, S., AL-FALLOUJI, M., **BUSBY, C***., HAMDAN, M.. Pilot study of congenital anomaly rates at birth in Fallujah, Iraq, 2010. Journal of the Islamic Medical Association of North America, North America, 44, Aug. 2012. Available at: <http://jima.imana.org/article/view/10463>.
- Alaani Samira Tafash Muhammed, **Busby Christopher***, Hamdan, Malak and Blaurock-Busch Eleonore (2011) Uranium and other contaminants in hair from the parents of children with congenital anomalies in Fallujah, Iraq *Conflict Health* 5, 1-15
- **Busby, Chris***; Hamdan, Malak; Ariabi, Entesar. (2010) Cancer, Infant Mortality and Birth Sex-Ratio in Fallujah, Iraq 2005–2009. *Int. J. Environ. Res. Public Health* 7, no. 7: 2828-2837.

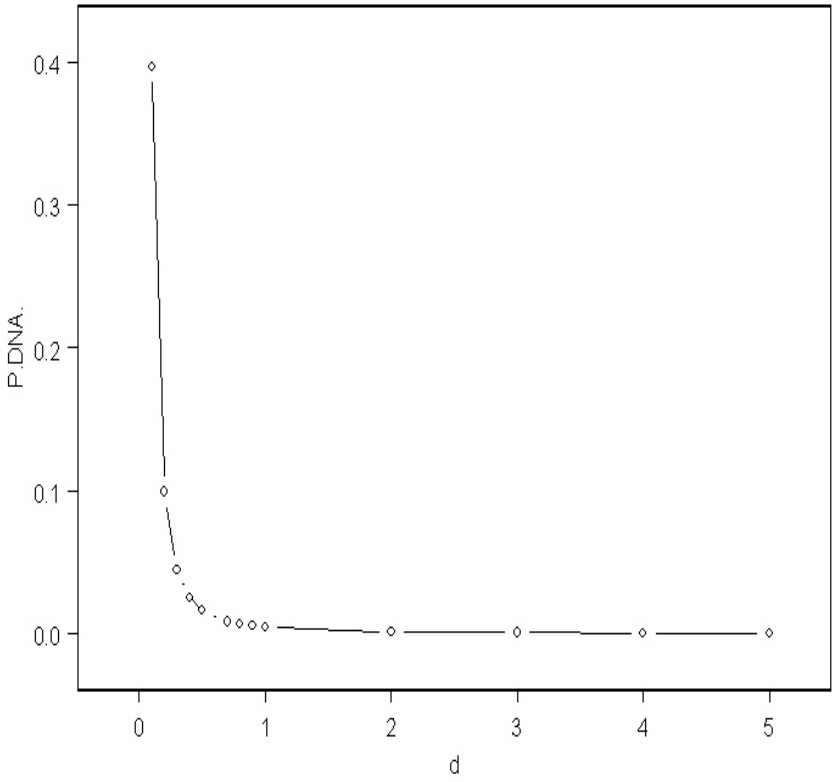
British Nuclear Test Veterans Busby et al 2013

- Busby C and de Messieres M (2014) Miscarriages and congenital conditions in offspring of the British Nuclear Atmospheric test Program. *Epidemiology* 2014, 4:4 http://dx.doi.org/10.4172/2161-1165.1000172
- Questionnaire epidemiological study of members of the British Nuclear Test Veterans Association. Comparison with National EUROCAT data and controls.
- Congenital Malformation in children OR = 9.8; in grandchildren OR = 8.3. Miscarriages OR = 2.7.
- Similar effects found by Rabbitt Roff. Note the genomic component.

Theoretical Explanations

- The effects are due to the dose to the DNA, or rather the ionization density at the DNA. This is very much greater than the mean tissue dose for those internal radionuclides with chemical affinity for DNA. This is reviewed in:
- Busby Christopher (2013). Aspects of DNA Damage from Internal Radionuclides, New Research Directions in DNA Repair, Prof. Clark Chen (Ed.), ISBN: 978-953-51-1114-6, InTech, DOI: 10.5772/53942. Available from: http://www.intechopen.com/books/new-research-directions-in-dna-repair/aspects-of-dna-damage-from-internal-radionuclides

Ionization density at the DNA is a function of proximity of the radionuclide to the DNA



Approximate probability of a track interception of a DNA target modelled as a strip of 0.1 x 1 µ by distance
in µ from target. In this model, the maximum probability is 0.5 for a nuclide located on the surface of a flat strip.

From Busby 2013

What are the main contaminants of concern, those with affinity for DNA?

- Uranium-238, Uranium-235, Uranium-234
- Strontium-90
- Barium-140
- Radium-226, Radium-224
- Tritium
- Plutonium(?)

Uranium. Uranium particles

- There is a wealth of published evidence for the heritable damage induced by Uranium at very low doses both as particulates and as a groundwater contaminant.
- Busby Christopher (2015) Editorial: Uranium Epidemiology. *Jacobs Journal of Epidemiology and Preventive Medicine* 1(2)- 009

- Busby Christopher (2015) Editorial: Epidemiology and the Effects of Radioactive Contamination: Time for a New Approach. *Jacobs Journal of Epidemiology and Preventive Medicine* 1(1)- 02;

- Guseva Canu I, Laurier D, Caër-Lorho S, Samson E, Timarche M, Auriol B, Bérard P,
- Collomb P, Quesned B, Blanchardone E (2010) Characterisation of protracted lowlevel
- exposure to uranium in the workplace: A comparison of two approaches. *International*
- *Journal of Hygiene and Environmental Health* 213 (2010) 270–277

- Guseva Canu, Irina, Garsi, Jerome-Philippe, Cae°r-Lorho Sylvaine, Jacob SophieCollomb,
- Philippe, Acker Alain, Laurier Dominique (2012) Does uranium induce circulatory
- ? First results from a French cohort of uranium workers *Occup. Envir. Med*. OEM
- Online First, published on March 3, 2012 as 10.1136/oemed-2011-100495

- Guseva Canu I, Jacob S Cardis E, Wild P Cae°r –Lorho S, Auriol B, Garsi JP, Tirmarche
- M, Laurier D (2010) Uranium carcinogenicity in humans might depend on the
- physical and chemical nature of uranium and its isotopic composition: results from
- pilot epidemiological study of French nuclear workers. Cancer Causes Control DOI
- 10.1007/s10552-011-9833-5

Radium

- Recent study of fracking in Pennsylvania supports earlier research identifying significant health effects from Radium contamination of groundwater.
- Busby Christopher and Mangano Joseph J. There's a world going on underground—infant mortality and fracking in Pennsylvania. Journal of Environmental Protection. 8(4) 2017 doi: 10.4236/jep.2017.84028

Strontium-90

- The anomalous genetic effects of Sr-90 have been known since the 1963 paper by Luning and Frolen.
- Luning KG, Froelen H, Nelson A and Roennbaeck C: Genetic Effects of Strontium-90 injected into male mice. Nature 1963; 197: 304-5

Male mice were injected with Caesium-137, Strontium-90 and saline and mated immediately. The dams were killed before the births occurred and foetal death rates examined. There was no effect with the Cs-137 but a significant increase in foetal death in the Sr-90 group.

A 1970 study by Lyaginskaya in the Soviet Union used rats and determined the cause of death was congenital heart defects.

The European Committee on Radiation Risk (ECRR)

www.euradcom.eu

- Was formed in 1998 to address the internal exposure risk problem. It created its new model in 2003, updated in 2010 and being updated for 2017.
- Internal radionuclide tissue doses are weighted by individual factors which are determined from epidemiology and from biochemical measures of DNA affinity and theoretical studies. This gives the "Genetic Dose".
- The unit Müller (Mü) for Genetic Dose was recently suggested by the sub-committee on Units and Measurements of the International Foundation on Research on Radioactivity Risk in Stockholm in 2016 and will be adopted in 2017 by the ECRR main committee.
- Reports of the ECRR are provided as free downloads from the website.

Radiation exposure and the law

In Europe, the exposure to ionizing radiation is controlled by the EURATOM 96/29 Basic Safety Standards Directive, the BSS.

This is law in all Member States. It contains Article 6.2 which states that the basis for Justifying exposures (i.e. the dose limits) must be re-addressed if “new and important evidence” emerges as to the efficacy and accuracy of its underlying models appears.

There is currently a legal challenge in the UK, Sweden, Ireland, France and Germany requiring such re-justification on the basis that the post-Chernobyl evidence, coupled with the discovery of the fatal problems of the Japanese LSS has shown the ICRP model on which the BSS depends,to be fatally flawed for internal exposures, and as a consequence, millions of people have suffered and will suffer genetic effects, as Herman Muller accurately predicted in 1952.