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METHODOLOGY TO ASSESS THE IODINE-131 TRANSFERRED TO COW'S MILK AS A RESULT OF THE NEVADA NUCLEAR WEAPONS TESTS OF THE 1950'S

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An assessment of the exposure to Iodine-131 (I-131) that the people living in the conterminous United States (US) received from the atmospheric weapons tests conducted at the Nevada Test Site, during the 1950's, is being carried out by the National Cancer Institute in response to Public law 97–414. The main pathway to man from fallout I-131 is via the grass-cow-milk foodchain (Eisenbud and Wrenn 1963).

To assess the exposures for the average person in each of the counties in the U.S. the following estimates must be made for each of the most important tests:
— the activities of I-131 deposited on soil and pasture grass,
— the resulting I-131 concentrations in cows' milk
— the quantity of I-131 ingested by man.

These tests were conducted during the 1950's when very few direct measurements were made. As a result, this assessment relies on estimates of I-131 fallout based on monitoring measurements of total beta activity collected at that time. A more detailled description of this methodology can be found in Bouvile et al. (1988).

ESTIMATE OF DEPOSITION DENSITITES

Meteorological modeling and the re-analysis of historical monitoring data are two complementary methods used to estimate the I-131 that was deposited on the ground across the U.S.

For the meteorological modeling technique which is essentially used when fallout data are not available, the dispersal of the radioactive cloud formed after the atmospheric detonation is analyzed using routine weather maps that were provided by the U.S. Weather Service. The amount of the radioactivity in the cloud is assumed to remain confined between the altitudes of adjacent trajectories unless they are partially removed by wet precipitation processes. The fraction of the fallout that is removed by precipitation is derived empirically using the gummed-film data. A more detailed description of this method can be found in Hoecker and Machta (1988).

During the 1950's, the Environmental Measurements Laboratory (EML) monitored for long-range fallout deposition in the U.S. using gummed-film collectors. A sticky surface was exposed to the atmosphere for 24 hours before collection and then it was counted for gross beta activity. The number of monitoring stations varied during the decade from about 40 to 100 stations across the U.S. Beck (1984, 1988) re-analyzed the available gummed-film data, together with other less extensive fallout data, and derived daily depositions of I-131. The depositions are associated with daily precipitation measured during the same 24-hour periods. The deposition densities in counties where no data was available were estimated using interpolation techniques that take into account the daily gummed-film data and precipitation.

ESTIMATION OF I-131 CONCENTRATION IN FRESH COWS' MILK

The time-integrated concentration in fresh cow's milk can be calculated with the following equation:

$$IC = DG \times F^* \times Teff \times PI \times fm$$

where: DG = deposition density
F^* = mass interception coefficient
Teff = effective mean time of retention
PI = pasture intake by dairy cows
fm = intake-to-feed transfer coefficient

The amount of fallout that is intercepted by the pasture grass (F^*) is influenced by the amount of precipitation at the time of deposition and the size of the particles. The size of the fallout particles decrease with increased distance from the site of the detonation until a plateau is reached. The effective mean time of retention (Teff) determines the length of time the particles remain on the pasture grass. This is determined as a function of the radioactive half-life of I-131 and the weathering half-time of the fallout particles on the grass.

The amount of contaminated pasture grass consumed by the dairy cows (PI) in each county of the U.S. is estimated based on state-wide information provided by the U.S. Department of Agriculture and the Dairy Herd Improvement Association. The total daily dry matter intake of cows is estimated based on the average weight of the cows and the daily production of milk. The fraction of this total that is provided by pasture intake was estimated by agricultural experts. An estimate of pasture intake is provided for each week of the pasture season for every state. This methodology is described in more detail in another paper (Dreicer et al. 1988).

ESTIMATION OF I-131 INTAKE BY MAN

The last step is to estimate how much I-131 is consumed by the average person as a result of I-131 contaminated milk. This involves estimating: how much milk is produced, how it is utilized, where it is distributed for consumption and how much milk the average individual consumes. Using statistical data from the U.S.

Department of Agriculture, and the U.S. Department of Commerce, estimates were made for milk production and utilization for each county in the 1950's. The assumption was made that the amount of milk that was available for fluid use was consumed first by the local population. If there was more milk available than was needed, the surplus was distributed to an area where additional milk was needed to satisfy the needs of the population. The distribution of the milk resulted in the mixing of milk with different I-131 concentrations, and therefore has an impact on the concentration of I-131 in the milk consumed by the population. In this assessment it is assumed that the farther the distance the milk is distributed, the longer the time between production and consumption. This allows for a longer time period for the I-131 in the milk to decay (8,04 day half-life), resulting in a lower concentration in the milk available for consumption.

The consumption of milk by individuals has been shown to be influenced by factors such as age, sex and the region of the country. In this assessment the per caput consumption rates for these categories, pertaining to the 1950's will be used.

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