Perspective: National Cancer Institute Summary Report About Estimated Exposures and Thyroid Doses Received from Iodine 131 in Fallout After Nevada Atmospheric Nuclear Bomb Tests

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Background

The intersection of politics and science sometimes engenders puzzling projects. A 15-year governmental initiative to calculate iodine 131 exposures attributable to atmospheric nuclear testing in the United States is a fine example.

Recognizing that this project represents the principal federally mandated study of national health risks from atmospheric nuclear testing, clinicians might well ask, Why focus on the distribution of this isotope, which has a short half-life and is associated with thyroid cancer—an almost negligible cause of cancer mortality—while ignoring more worrisome isotopes? Why focus on an individual isotope at all, when most existing epidemiologic risk studies focus on total tissue dose from all sources? Why dwell on 131I-induced thyroid cancer and ignore leukemias?

Appreciating the medico-legal-scientific-political-strategic polka surrounding any study addressing the health risks of atmospheric nuclear testing, one recognizes both the barriers to such an attempt and possible reasons why the questions listed earlier have remained unanswered.

Enacted on January 4, 1983, Public Law 97-414, section 7(a), directs the Secretary of Health and Human Services to, among other things, “develop . . . assessments of the risks of thyroid cancer that are associated with thyroid doses of iodine-131” and “estimate the thyroid doses of iodine-131 that are received by individuals from nuclear bomb fallout . . . and develop assessments of the exposure to iodine-131 that the American people received from the Nevada atmospheric nuclear bomb tests.”

The Secretary delegated this task to the National Cancer Institute (NCI) in 1983. On August 1, 1997, 15 years after the legislative request, the NCI issued a news release summarizing the findings. The actual NCI summary report, titled “Estimated Exposures and Thyroid Doses Received by the American People from Iodine-131 in Fallout Following Nevada Atmospheric Nuclear Bomb Tests,” weighing in at 1,000 pages, was released in October 1997.

The report deals only with 131I exposure and does not contain estimates of attributable thyroid cancers. The Institute of Medicine, a part of the National Academy of Sciences, has been contracted by NCI to generate estimates of thyroid cancer risk. The Institute of Medicine’s report, unfortunately delayed, is due to be released in September 1998. Meanwhile, according to the NCI, “persons concerned about fallout exposure should consult a health professional.”
This review summarizes the NCI report and offers some information to help health professionals deal with the NCI report’s potential “fallout.”

Methodology

Figure 1 illustrates the steps involved in generating estimates of thyroid dose attributable to $^{131}$I from Nevada test site nuclear explosions. For each step, significant uncertainty about sampling error, assumptions, and so forth propagates down the chain. Compounding this uncertainty, variables relating to individual characteristics (such as age, dietary habits, source of milk and foodstuffs, and so forth) can dramatically alter thyroid dose estimates for particular individuals. Stepwise review of methodology facilitates appropriate interpretation of the dose estimates reported. Unless otherwise noted, all factual statements derive from the report itself.

History of Nuclear Testing at the Nevada Test Site

Located only 65 miles northwest of Las
Vegas, Nevada, the Nevada Test Site (NTS) encompasses 1,350 square miles and measures at its widest points 35 miles in east-west width and 55 miles in north-south length. An additional zone of 4,120 square miles of restricted federally owned land buffers the NTS on three sides, effectively creating a 5,470-square-mile desert reserve of unpopulated land, the largest such area in the continental United States.

To decrease the lead time and expense associated with weapons development, nuclear testing in the United States shifted from the distant Pacific atolls of Bikini and Eniwetak to the NTS in 1951. Between January 1951 and October 1958, the United States conducted 119 nuclear tests, including 97 atmospheric tests, 2 shallow cratering tests, and 20 deep underground tests. A voluntary nuclear-test moratorium began in October 1958 and lasted until the Soviet Union exploded a 57-megaton bomb—the largest ever—on September 1, 1961. Fortunately, with the signing of the Limited Test Ban Treaty on August 5, 1963, further atmospheric testing ceased.

From 1961 through 1992, however, more than 800 underground tests were conducted. On October 2, 1992, President Bush announced a unilateral moratorium on all nuclear testing, and this remains in effect.

As documented by near-site measurements at the NTS, radioactive debris from nuclear explosions remains largely contained when such tests are conducted underground. Significant release of $^{131}$I appears to be almost exclusively restricted to ground-level and above-ground nuclear explosions.

Volatile elements such as $^{131}$I collect in the particulate matter swept up in the
radioactive mushroom cloud generated by such blasts. Such radioactive mushroom clouds frequently extend more than 10 kilometers into the sky and are subsequently distributed by upper-atmosphere winds over vast distances. Particulate debris associated with such clouds can take several months, and perhaps years, to fall back to earth. Precipitation (“wet deposition”) substantially increases the return of such particulate debris. Because $^{131}$I has a half-life of 8.04 days and usually decays to xenon $^{131}$, a stable isotope, the early (within days) deposition of fallout particles appears most significant with respect to health effects from $^{131}$I.

Ninety-nine percent of the $^{131}$I activity released into the atmosphere because of nuclear testing at the NTS, an estimated total of 150 MCi, resulted from 90 tests conducted mostly from 1951 to 1958. Table 1 lists the periods associated with the release of most of the detectable $^{131}$I.

### Table 1

| Date                  | Test Series       | Total Release of $^{131}$I (kCi) | Release Rate/ Month (kCi) |
|-----------------------|-------------------|----------------------------------|--------------------------|
| October–November 1951 | Buster-Jangle     | 10,540                           | 5,270                    |
| April–June 1952       | Tumbler-Snapper   | 15,480                           | 5,160                    |
| March–June 1953       | Upshot-Knothole   | 36,756                           | 9,189                    |
| February–May 1955     | Teapot            | 24,480                           | 6,120                    |
| February–October 1957 | Plumbbob          | 57,628                           | 6,403                    |

### Estimating the Deposition of $^{131}$I on the Ground

In the 1950s, measurement of radioactive contamination generally consisted of assessment of gross $\beta$ activity. Specific measurement of $^{131}$I in the environment appeared impractical before 1960 and was rarely done. Fortunately, however, “close-in measurements,” “aerial sampling” by aircraft, and “specific radiochemical data” relating to the radioactive cloud generated by the explosions yielded sufficiently detailed compositional information to permit reasonable estimates of $^{131}$I in relation to total $\beta$ activity. Because the half-life of $^{131}$I is only 8.04 days, the activity of $^{131}$I present in the 30-year-old samples has disappeared. Such measurements cannot be confirmed today using modern equipment.

During the period of interest, environmental monitoring programs in place both near the NTS and throughout the United States did capture systematic measurements of total $\beta$ activity in the air and deposited on (sticky) gummed film. One project collected samples from approximately 95 sites throughout the United States. Such measurements of $\beta$ activity do permit reasonable estimates of $^{131}$I deposition at distant sites throughout the United States.

Three procedures were used to estimate the $^{131}$I deposition in counties of the
United States for which no direct monitoring data are available. First, if measurements of gross β activity in neighboring counties are sufficient, these, together with precipitation data, can be converted to direct estimates of 131I deposition. By interpolation (refined using special statistical techniques), estimates for all counties in the United States can be generated.

Second, when β measurements are too sparse for reasonable interpolation, estimates from the nearest county are combined with county precipitation data to yield an approximation.

Third, in situations in which surface deposition values still cannot be estimated reliably, wet deposition (i.e., that associated with precipitation, usually the major source of deposition) can be calculated based on a meteorologic model that simulates the transport of radioactive cloud debris (and 131I) according to observed wind patterns.

Figure 2 depicts the total activity of 131I deposited per unit area of ground for all tests combined.

Transfer of 131I from Ground Deposition to Fresh Cows’ Milk and Other Routes of 131I Exposure

Dairy cows consume pasture grasses, water, and other feed contaminated with fallout containing 131I, then secrete 131I in their milk. Bovine exposure routes other than pasture consumption constitute only 2% to 4% of total time-integrated concentration in milk when cows graze on land distant from the NTS; however, such routes can be important for sites close to the NTS.

The NCI report includes the calculation of doses to both cows and people attributable to routes other than the pasture-cow-milk chain, but doses from such routes are generally less significant. The methods used for calculating thyroid dose attributable to such routes parallel the methods used for the pasture-cow-milk chain. For humans, such alternative routes include 131I absorbed from air, foodstuffs, goats’ milk, cottage cheese, eggs, leafy vegetables, and mothers’ milk.

Pasture grazing of dairy cows varies considerably with locale and season. Important factors with respect to 131I transfer include the mass interception factor by vegetation, the mean time of retention of 131I on vegetation (about 1 week), the amount of contaminated pasture ingested by cows, and the transfer coefficient from feed to milk for cows.

For average grazing and feeding practices on representative farms, time-integrated 131I concentrations in fresh cows’ milk were estimated for each county for every test. The average time-integrated concentrations for all tests combined, by county, varied from a low of 10 to 20 nCi per liter for California to a high of 5,000 nCi per liter for parts of Idaho. The report contains specific county-by-county information.

Although contaminated cows’ milk is the principal route by which 131I enters the human food chain, goats’ milk contains approximately 10 times the concentration of radioiodine found in cows’ milk. Fortunately, few individuals routinely consumed goats’ milk during the period in question, but this factor can be significant in individual cases.

Milk Distribution, Processing, and Consumption

Because 131I has a half-life of only 8.04 days, even short delays caused by the processing and transport of milk can decrease the 131I eventually ingested by humans. During the 1950s, approximately 50% of the milk produced in the United States was consumed as fresh fluid milk, and most of the rest was used in the manufacturing of dairy products such as cheese.

During the early 1950s, milk was usually produced close to where it was consumed (within 300 km). Later, with refrigerated tank cars and reduced transportation costs, bulk processing methods
resulted in a greater delay between production and consumption. Because radioactive decay is not sensitive to changes in temperature, such practices decreased the $^{131}I$ activity in ingested milk, particularly in urban centers. Delays between production and consumption averaged 1, 2, 3, and 4 days for areas the report characterized as farm, rural non-farm, urban—same milk region, and urban—different milk region, respectively.2

Milk consumption varies surprisingly as a function of geography (higher in midwestern and northern states), age (highest for those 5 to 15 years old), and gender (females less than males during this period). Based on US Department of Agriculture surveys and using 1954 as the most representative year, the report gives milk consumption estimates for each state and for each age group.

THYROID DOSE CALCULATIONS

The product of milk consumption rate times time-integrated $^{131}I$ in cows’ milk times the thyroid dose conversion factor appropriate to the individual considered equals the thyroid dose received as a result of a given test. The report contains specific data for each test.

Because of the small size of an infant’s thyroid and the avidity with which radiiodine is concentrated in the thyroid, the thyroid dose conversion factor is highest for infants 0 to 2 months old (15 mrad per nCi) and gradually decreases with age until it plateaus beyond age 20 (1.3 mrad per nCi for men and 1.8 mrad per nCi for women). This means that for a given time-integrated concentration of $^{131}I$ in fresh milk, infants are affected to a far greater degree than are adults.

Thus, age at time of exposure represents a key variable in estimating an individual’s thyroid dose from a particular test. For this reason and because of the geographic variation in $^{131}I$ ground deposition, cumulative individual doses must be calculated on a test-by-test basis and then summed.

For calculation of total thyroid dose for a given individual, dose contributions from other routes are also summed. Because all routes of $^{131}I$ exposure for all tests must be considered, calculation of the dose to specific individuals requires considerable discipline and patience. The report cites detailed examples of how to do this, however, and the necessary tables are contained in the report’s voluminous appendices.2

The report offers a convenient shortcut for assessing dose for particular individuals based on a series of computer-generated, color-coded maps of the continental United States. The report offers maps illustrating total thyroid dosage for individuals born in 1930, in 1945, and for each year from 1950 through 1960 as well as for 1962.2 For each birth year, maps corresponding to “milk from backyard cow,” “no milk consumption,” “average milk consumption,” and “high milk consumption” are offered.

In this and other sections of the report, the important issue of uncertainty is addressed on two levels. First, assumptions made to quantify estimates (and, indeed, to quantify the uncertainty) may not always apply. This can generate difficult-to-quantify systematic errors. Second, although cumulative uncertainties for average dose calculations can be reasonably approximated, those for individual dose can be much larger and probably are not precisely quantifiable.

Summary of Cumulative Thyroid Dose Estimates

Nuclear explosions at the NTS resulted in delivery of an average thyroid dose of 2 rad per person for the approximately 160 million people residing in the United States during the 1950s. Uncertainties attributable to the quality of the data, interpolative techniques employed, assumptions made, models used, and so forth combine to make the estimated uncertainty of this average thyroid dose a fac-
Individuals residing in certain counties experienced a higher-than-average total thyroid dose. The highest average total doses (12 to 16 rad) were seen in Meagher County, Montana, and Custer, Gem, Blaine, and Lemhi counties, Idaho, near the Continental Divide. Total average thyroid doses of 9 to 12 rad were seen in many other western counties, mostly in Montana. For those living in such areas and born between 1945 and 1958, the dose can be significantly higher than the per capita average.

Figure 3 depicts average per capita thyroid dose from $^{131}$I from all routes and for all tests combined. For milk drinkers born 1945 to 1958, the total thyroid dose can be much higher than that depicted in Figure 3. For individuals drinking fresh goats’ milk during this period, cumulative dose may be more than 10 times higher. The report’s color-coded dose maps describing dose by birth year and milk consumption category (described earlier) are helpful in assessing individual dose more accurately.

Table 2, which is taken directly from the NCI report, summarizes total thyroid dose for representative individuals residing at the indicated locations and consuming average amounts of milk. The table reveals that date of birth and place of residence can alter an individual’s dose estimate considerably.

Putting the dose estimates in perspective, average thyroid dose per year from cosmic rays, natural background, and other sources has been estimated at 0.1 rad per year. Summing this annual “natural” dose over a 10-year period (a method similar to that used for calculating cumulative $^{131}$I dose in the NCI re-
port), the cumulative dose is 1.0 rad. Persons receiving diagnostic radioiodine for thyroid scanning receive a total thyroid dose of approximately 1.1 Gy, or 110 rad per scan. Persons receiving therapeutic radioiodine for ablation of the thyroid (such as in treatment of thyrotoxicosis) receive total thyroid tissue doses of 10 to 100 Gy, or 1,000 to 10,000 rad.

**131I and Thyroid Cancer**

As mentioned earlier, the Institute of Medicine report relating 131I exposure to thyroid cancer should be completed by September 1998. The difficulty of assessing dose-response relationships for the generally low-dose exposures identified represents a challenge. Radioepidemiologic data for the dose range of interest appear to be scant.

Although a high rate of thyroid cancer was among the first abnormalities detected in studies of those surviving the Hiroshima and Nagasaki explosions, the exposures in these instances were mixed external and internal, with the former predominating. The relative biologic effectiveness (RBE) differs significantly for different types of radiation (e.g., neutron radiation has a much higher RBE than does gamma radiation). Also, type of dose (i.e., continuous versus intermittent), frequency of exposure, and dose per exposure can alter the RBE of a given total dose dramatically.

What do we know about the radio-biologic effect of 131I, especially with respect to thyroid cancer? In Sweden, 35,074 patients receiving diagnostic 131I (estimated total thyroid dose, 110 rad per scan) have been studied carefully, and based on experience with external x-ray radiation, a substantially higher rate of thyroid cancers was anticipated. No increase in thyroid cancers was detected, however. A German study of almost 14,000 patients similarly treated also failed to detect any carcinogenic effect associated with such a dose.

Iodine 131 radiation to the thyroid appears, at worst, far less carcinogenic to the thyroid than external x-rays or

| Place of Residence | Father born 9/15/27 | Mother born 10/10/29 | Child born 10/1/51 | Child born 9/15/52 | Child born 11/28/56 |
|--------------------|---------------------|---------------------|-------------------|-------------------|-------------------|
| Los Angeles        | 0.03                | 0.03                | 0.3               | 0.06              | 0.02              |
| Salt Lake City     | 1.3                 | 1.4                 | 10.0              | 8.9               | 5.5               |
| Denver             | 1.1                 | 1.1                 | 10.0              | 8.9               | 5.5               |
| Chicago            | 0.7                 | 0.7                 | 6.6               | 5.8               | 2.9               |
| New York           | 0.5                 | 0.6                 | 5.0               | 3.8               | 2.2               |
| Tampa              | 0.3                 | 0.3                 | 1.7               | 0.8               | 2.2               |

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gamma rays. Whether this is because of the relatively slow dose rate attributable to the 8.04 day half-life or the distribution of absorbed $^{131}$I within the gland (i.e., within colloid follicles) remains speculative.

Treatment of specific conditions such as thyrotoxicosis with $^{131}$I requires higher doses, usually 10 to 100 Gy (1,000 to 10,000 rad). Thyroid cancer has never been linked to treatment with such doses, probably because of the loss of cellular function associated with such relatively high doses.\(^8\)

The studies mentioned earlier fail to link increased cancer risk with $^{131}$I thyroid doses higher than 110 rad. The impact of lower doses, particularly their effect on children, remains undetermined. Age at exposure may significantly modify the carcinogenic effect of $^{131}$I.\(^4\)

In 1986, fallout (including $^{131}$I) related to the Chernobyl nuclear disaster in the Ukraine fell most heavily in the Gomel region of Belarus. From 1989 to 1991, pediatric thyroid cancer, which was previously rare (one or two cases a year), increased dramatically (an apparent rate of more than 100 cases per year).\(^9-11\) Although hampered by registry problems, imprecise dosimetry, and other difficulties, studies of thyroid cancer in areas affected by Chernobyl fallout certainly suggest significant radiocarcinogenesis in pediatric age groups. Presumably, this is caused by iodine isotopes, of which $^{131}$I is the most significant, but other isotopes and compounds may also contribute to this apparent carcinogenesis.

**Evaluation of Patients with Thyroid Nodules**

Fine-needle aspiration techniques and improvements in cytologic analysis have largely replaced other modalities in the evaluation of thyroid nodules.\(^12-16\) For nodules that are small or difficult to palpate, ultrasound-guided fine-needle aspiration works well. Ultrasound is also useful in screening the rest of the gland for occult nodules.

For patients presenting with a thyroid nodule, with or without a history of thyroid radiation, evaluation begins with history, which should note especially documented growth, voice change, and other symptoms.

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Physical examination should include not only detailed palpation of the thyroid but also detailed examination of the neck for adenopathy. Palpation of the thyroid and cervical nodes is best conducted with the examiner standing behind the patient, reaching around to the front of the neck and gently compressing the soft tissues. Papillary thyroid cancers are usually firm to palpation. Follicular neoplasms tend to be softer and can sometimes mimic benign colloid nodules. Cervical adenopathy caused by thyroid cancer is usually found in the middle and lower jugular nodes and also in the posterior triangle. This is sometimes the first sign of a thyroid malignancy.

The physical examination also should include detailed examination of the oropharynx and, if possible, indirect laryngoscopy. A thyroid nodule or firm neck node in a patient who does not have oropharyngeal pathology, particularly if the patient is a nonsmoker, sug-
gests the possibility of thyroid malignancy. Ipsilateral impairment of vocal chord motion is particularly worrisome.

Tests useful in evaluating thyroid function include levels of thyroid-stimulating hormone (TSH) and free thyroxine (FT4). Although such tests are useful for identifying the hypersecretion associated with a “hot” nodule (almost always benign), such functional tests alone fail to identify thyroid cancer.

In situations of equivocal examination, difficult to localize abnormalities, or suspicion of contralateral disease, neck ultrasonography offers a sensitive means of cancer detection.17

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Currently, fine-needle aspiration is the main diagnostic procedure in a patient with a thyroid nodule.14-18 Malignant or equivocal aspirates should prompt surgical intervention. Benign nodules sometimes can be managed with hormonal suppression (i.e., enough thyroid hormone to suppress TSH to subnormal levels), with surgery reserved for refractory or growing nodules. When follow-up examination documents growth of a nodule, surgical treatment is indicated regardless of results of initial cytologic studies. In a patient with a history of neck irradiation, the threshold for surgical treatment should be low. A worrisome, firm nodule, particularly in the context of previous pediatric cervical irradiation, usually merits surgical treatment.

The extent of thyroidectomy for thyroid cancer remains controversial. For patients with a history of neck irradiation, however, most experts recommend total thyroidectomy.18 In patients without such a history and with no risk factors for aggressive disease (such as age older than 45 years, extrathyroidal extension, large size, and metastases), studies with 20-year follow-up document that unilateral lobectomy-isthmusectomy generates excellent survival (99%) with less morbidity than is seen with total thyroidectomy.19

Adjuvant treatment of thyroid carcinoma includes routine hormonal suppression sufficient to depress TSH to subnormal levels. Patients with risk factors for more aggressive disease (who should be treated with total thyroidectomy, as mentioned earlier) also should be treated with radioiodine.18, 20

Survival Rates for Patients with Thyroid Cancer

Figure 4 depicts 10-year survival rates for 53,856 patients in the United States with the indicated thyroid malignancies accessioned to the National Cancer Data Base (NCDB) between 1985 and 1995. Detailed information concerning patterns of care and stage-stratified survival is available for this cohort, the largest reported to date.20a.

Based on experience with radiation-associated thyroid malignancies after the Chernobyl nuclear accident and after the explosions at Hiroshima and Nagasaki, most such radiation-associated malignancies appear to be of papillary or follicular histology. In the Hiroshima and Nagasaki studies, occult tumors less than 1.5 cm in size frequently were discovered at autopsy. Higher rates of medullary or anaplastic cancers were not observed.21

Based on the experience after the Chernobyl accident, the pediatric population appears to be at greatest risk of
fallout-induced thyroid malignancy. Survival rates for young patients with thyroid cancer are of interest. According to unpublished data from the aforementioned NCDB cohort, overall 5-year relative survival rates for patients less than 20 years old at time of diagnosis are 99% for papillary cancers (N = 631) and 100% for follicular cancers (N=73).

Comprehensive assessment of survival for papillary and follicular thyroid neoplasms probably requires two to three decades of follow-up, however. In a retrospective survey of papillary or follicular cancer in 106 patients younger than 20 years who had a longer (16-year median) follow-up, cumulative cancer mortality was 2%. Thus, mortality for pediatric patients with papillary and follicular cancer does seem low. However, the prognosis of radiation-induced neoplasms may differ from that of similar, non–radiation-induced neoplasms.

Conclusion and Critique
The nationwide distribution of fallout containing $^{131}$I from United States atmospheric testing at the NTS appears to have resulted in abnormal thyroid radiation exposure for most persons born between 1945 and 1958, with contamination of the human food chain representing the major source. The average
cumulative thyroid dose per capita is in the range of 1 to 4 rad, but the average dose for some regions is as high as 16 rad. Persons born between 1945 and 1958 who resided in high-deposition areas and consumed milk received much higher doses. Fortunately, the cumulative thyroid dose attributable to $^{131}$I received by most persons in the United States appears to be relatively low.

In contrast to external neck irradiation, which is associated with thyroid carcinogenesis, thyroid radiation from $^{131}$I has yet to be specifically linked to increased rates of thyroid cancer. Pediatric patients are underrepresented in existing radioepidemiologic incidence studies, however. High rates of pediatric thyroid cancers have been observed in regions affected by the Chernobyl nuclear disaster, and this is presumably because of exposure to $^{131}$I, but other isotopes, carcinogenic compounds, and other factors might also contribute.

Neither the true extent of environmental contamination of the continental United States nor the health effect attributable to fallout from atmospheric nuclear testing has been satisfactorily reported.

Overall, thyroid cancer has an excellent prognosis, and this also appears true for younger patients. Given the relatively low number of expected cases of thyroid cancer attributable to the identified $^{131}$I contamination and the remarkably good prognosis of papillary and follicular thyroid cancer, the $^{131}$I contamination associated with atmospheric nuclear bomb tests conducted from 1951 to 1958 cannot be viewed as a significant national health problem.

The NCI report largely ignores contamination attributable to other isotopes associated with atmospheric nuclear testing and completely ignores the potential adverse health effects of these isotopes. In fairness, however, section 7(a) of Public Law 97-414 specifically targets $^{131}$I and thyroid cancer. At the intersection of politics and science, some paths may indeed be blocked. The report does seem to invite exploration of the “blocked paths,” however, as does section 7(b) of the same law. By highlighting sources of information and analytic techniques, the report illuminates despite its omissions.

Legitimate difficulties in assessing radiocarcinogenesis include the challenge of accurate dosimetry and the differing RBE attributable to various types of radiation, various isotopes, various dose rates, and other factors. Health effects from radiation are usually expressed in terms appropriate to mixed-source dosage (e.g., the sievert, which represents the absorbed tissue dose in grays multiplied by a weighting factor appropriate to the RBE of the radiation). The report focuses on rad to the thyroid from $^{131}$I alone.

The forthcoming Institute of Medicine report concerning health risks from the reported $^{131}$I contamination must consider all the factors mentioned earlier, generating, it is hoped, more than a large question mark in the process.

As of this writing, no satisfactory report has been made of the true extent of environmental contamination of the continental United States or of the health effects attributable to fallout from atmospheric nuclear testing. Given social, legal, scientific, and political realities, such a report may never emerge.
Environmental $^{131}\text{I}$ contamination from atmospheric nuclear bomb tests conducted at the NTS from 1951 to 1958 exposed Americans nationwide to a cumulative average dose of 1 to 4 rad to the thyroid gland. By comparison, 10 years of exposure to natural background sources of thyroid radiation results in a cumulative dose of 1 rad.

Americans living in certain high-deposition areas received an average cumulative thyroid dose of as much as 16 rad. Individual dose rates vary considerably as a function of age at the time of exposure, site of residence, and dietary habits with respect to milk consumption. The individual cumulative thyroid dose for persons born between 1945 and 1958 may be significantly higher than the reported averages for their locale. The NCI report contains voluminous data tables permitting detailed calculations of individual dose. Additionally, color-coded dose maps allow one to approximate individual dose conveniently.

Translation of cumulative thyroid dose attributable to $^{131}\text{I}$ to predictions of increased rates of thyroid cancer appears problematic and is the subject of further study. In contrast to studies of patients receiving external thyroid irradiation, existing studies of patients treated with $^{131}\text{I}$ for diagnostic and therapeutic medical purposes do not document increased rates of thyroid cancer. An Institute of Medicine task force is expected to issue a report on this subject in September 1998.

This review also briefly summarizes the evaluation, diagnosis, and treatment of patients with papillary and follicular thyroid cancers. Data from 53,856 patients with thyroid cancer accessioned to the NCDB from 1985 to 1995 document extremely high survival rates for patients in the United States with papillary and follicular thyroid cancer.20a

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**American Cancer Society Great American Smokeout**

**November 19, 1998**

November 19, 1998, marks the 22nd year of the American Cancer Society’s Great American Smokeout. This nationwide event is designed to help smokers quit and to call attention to tobacco control issues year round.

The Smokeout now also targets smokeless tobacco, second-hand smoke, and cigar smoking.

Nearly 70% of smokers report they want to quit smoking but cannot. Over the years, the Smokeout has provided an important impetus to help smokers quit the habit for good. Last year, 24% of smokers (about 11,280,000 people) reported they participated in the Smokeout, and of those, 19% reported they were smoking less or not at all up to 5 days later.

Further information, for both health professionals and patients, is available from your local American Cancer Society.