A Guide To

The Hanford Thyroid Disease Study

FINAL REPORT

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FRED HUTCHINSON CANCER RESEARCH CENTER
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About This Guide

Following more than 12 years of scientific research, the Centers for Disease Control and Prevention (CDC) and the Fred Hutchinson Cancer Research Center have released the Hanford Thyroid Disease Study (HTDS) Final Report.

The HTDS, mandated by Congress in 1988, was conducted to determine whether thyroid disease is increased among people who were exposed as children to atmospheric releases of radioactive iodine from the Hanford Nuclear Site (Hanford) in Washington State from 1944 through 1957.

CDC and the Fred Hutchinson Cancer Research Center prepared this guide to help communicate the meaning of the HTDS to the public. The guide summarizes the findings, explains how and why the study was conducted, and includes information about the treatment of thyroid disease.

In the mid-1980s, the U.S. Department of Energy released documents showing that large amounts of radioactive materials, including iodine-131, had been released into the environment from Hanford since the mid-1940s. The public, health officials and scientists were concerned that these materials could have harmed the health of people living in the region.

The HTDS was conducted in response to these concerns. While no study can determine the cause of an individual case of thyroid disease, an epidemiological study, such as the HTDS, provides the best way to determine whether disease has increased in a population exposed to a potentially harmful agent such as radiation.

Over the years, many thousands of people have been involved in the HTDS, including the 3,440 participants of the study. Members of the public, health care officials, physicians, scientists and many others have also been involved.

CDC remains committed to providing useful information to the public about the HTDS and related issues. Please refer to page 22 of this guide for additional sources of information.

Overview of the Hanford Thyroid Disease Study

ABOUT THE HANFORD THYROID DISEASE STUDY

The Hanford Thyroid Disease Study (HTDS) is a scientific study conducted to determine whether the risk of thyroid disease is increased among people exposed to radioactive iodine (iodine-131) from the Hanford Nuclear Site in Washington from 1944 through 1957.

The question was:
"Did exposure to iodine-131 result in increased incidence of thyroid disease?"

Study Focus — Iodine-131 was the primary source of radiation for many people exposed to Hanford's radiation releases. Since iodine-131 concentrates in the thyroid gland when it is inhaled or consumed in contaminated food, the HTDS focused on thyroid disease.

Research Team — The HTDS was managed by the Centers for Disease Control and Prevention (CDC), an agency in the U.S. Department of Health and Human Services. The Fred Hutchinson Cancer Research Center in Seattle, Washington conducted the scientific and technical work. The HTDS Final Report was released in June 2002.

WHAT HAPPENED AT HANFORD (see page 2)

The Hanford Nuclear Site was built in the 1940s in southeastern Washington State to produce plutonium for nuclear weapons.

In the mid 1980s, as a result of public requests, the U.S. Department of Energy released previously unavailable or classified documents about past operations at Hanford. The information showed that large amounts of iodine-131 and other radioactive materials were released into the air from Hanford from 1944 through 1957.

Concerns about the possible health effects of Hanford's radiation led to a decision by Congress to mandate the HTDS in 1988.

HOW WERE PEOPLE EXPOSED TO IODINE-131 FROM HANFORD?

People were exposed to Hanford's iodine-131 through various pathways, including the consumption of contaminated milk.

Iodine-131 concentrates in the thyroid.

HOW THE STUDY WAS CONDUCTED (see page 6)

To study the health effects of Hanford's iodine-131, researchers investigated a group of people with a wide range of radiation doses to the thyroid. In this way, researchers could compare groups of people with similar characteristics (such as lifestyle and diet) but different levels of exposure.

Participant Selection — Other studies suggest that young children may be the most susceptible to the effects of radiation on the thyroid gland. Therefore, the HTDS selected participants who were young children when Hanford releases of iodine-131 were highest. Scientists also ensured that the HTDS participants included many people who lived in areas around Hanford where the highest thyroid radiation doses occurred.

From a sampling of 5,199 birth records, scientists were able to locate 3,440 people who were both willing to participate and able to provide the necessary data for evaluation of thyroid disease.

Data Collection — Participants underwent complete evaluations for thyroid disease, and provided detailed information about the places they lived and the quantities and sources of the food and milk they consumed.

Data Analysis — For each type of thyroid disease, the research team examined how the rates of disease varied in relation to participants' estimated radiation doses from Hanford's iodine-131.

FINDINGS (see page 9)

The HTDS data show that the risk of thyroid disease was about the same regardless of the radiation doses people received from Hanford. In other words, no associations between Hanford's iodine-131 and thyroid disease were observed.

> **Researchers studied all types of thyroid disease, a disease of the parathyroid glands, and abnormalities of the thyroid gland that can be seen on ultrasound examinations.**

> **The percentages of people with each kind of thyroid disease or with ultrasound abnormalities were about the same regardless of their estimated radiation dose from Hanford's iodine-131.**

The findings do not prove that Hanford radiation had no effect on the health of the area population. However, they show that if there is an increased risk of thyroid disease from exposure to Hanford's iodine-131, it is probably too small to observe using the best epidemiologic methods available.

Thyroid disease was found in the study population. This was expected because thyroid disease is common in other populations, especially among older people and women.

Based on a review of other studies, researchers found that the rates of thyroid disease in the HTDS population were generally consistent with the rates of disease detected in other populations.

PUBLIC INVOLVEMENT AND SCIENTIFIC REVIEW (see page 18)

CDC formed a committee of scientists and members of the public to advise CDC on the design and implementation of the study. Members of the public and public interest groups provided input in public meetings and written comments to CDC throughout the study.

At the request of CDC, the National Academy of Sciences peer reviewed the HTDS at key points in the study. Peer review is an independent analysis of a study that provides confidence that the correct methods are being used.

ABOUT THYROID DISEASE (see page 20)

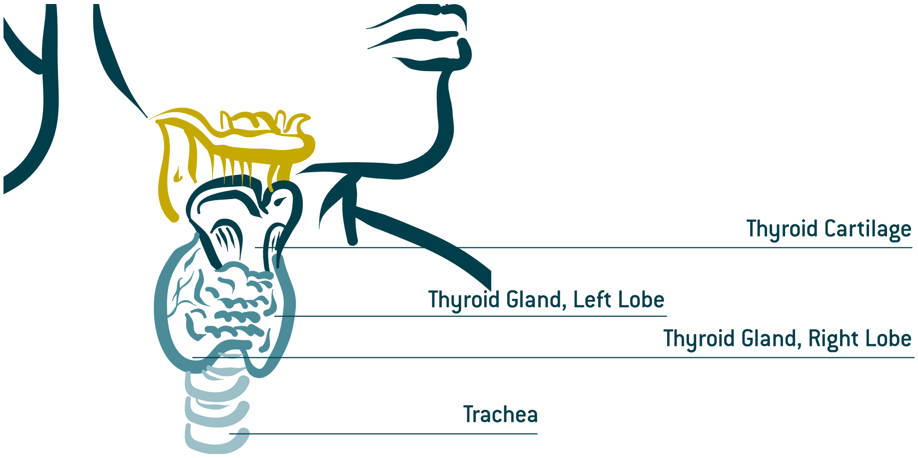
The thyroid gland is located at the base of the neck (see figure below).

Thyroid disease is common in the general population. Thyroid disease includes functional disorders and abnormal growth in the gland, including cancer. Most thyroid problems can be detected and treated.

If you are concerned about exposure to iodine-131 from Hanford or experience thyroid disease symptoms, you are encouraged to see your doctor for a thyroid evaluation.

THYROID GLAND

The thyroid gland is butterfly-shaped, with two lobes about the size of teaspoons. It is located in the front of the neck, below the Adam's apple.



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What Happened? A Brief History of Hanford

SECTION SUMMARY

- **From** 1944 through 1957, large amounts of radioactive materials were released into the atmosphere at Hanford.
- Milk consumption was the major way most people were exposed to Hanford's iodine-131.
- Public concern led to the release of previously classified information about Hanford's operations.
- No other studies are directly comparable to the Hanford situation.

ABOUT THE HANFORD NUCLEAR SITE

The Hanford Nuclear Site occupies about 560 square miles in southeastern Washington State, adjacent to the towns of Pasco, Kennewick and Richland. The facility was the world's first large-scale nuclear production plant. It was constructed in the early 1940s as part of the Manhattan Project to produce plutonium for nuclear weapons.

Over the course of many years, large amounts of radioactive materials (radionuclides) were released into the atmosphere and the Columbia River as part of the plutonium production process.

The major radioactive releases occurred in the form of gases and particles into the air from 1944 through 1957. These releases occurred mainly because of increased production and lack of filter systems. Changes in the production process over the years greatly reduced releases into the air.

Many different kinds of radioactive materials were released. For many people living in the region, most of their dose was due to iodine-131 released into the air.

EXPOSURES TO RADIATION

Iodine-131 was carried by winds to surrounding areas and deposited on vegetation. It was then absorbed in the milk of cows and goats that grazed on the contaminated vegetation. Drinking contaminated milk caused most of the radiation dose for most of the exposed people.

People were also exposed by eating contaminated fruits and vegetables, and by breathing contaminated air.

CLASSIFIED INFORMATION RELEASED

For a long time, details about Hanford's operations were not public. In 1986, as a result of public concerns and requests made through the Freedom of Information Act, the U.S. Department of Energy (DOE) began releasing tens of thousands

What Happened? A Brief History of Hanford

of pages of previously classified or unavailable documents.

The documents revealed to the public, for the first time, that substantial quantities of radionuclides were released into the environment from Hanford.

CDC convened a panel of independent scientists (Hanford Health Effects Review Panel) to evaluate the DOE documents. Two of the panel's most important recommendations were to conduct a study to estimate the radioactive materials released from Hanford and to determine the feasibility of studying the health effects to the thyroid of that exposure.

The panel's recommendations evolved into what are known today as the Hanford Environmental Dose Reconstruction Project (HEDR) and the Hanford Thyroid Disease Study (HTDS).

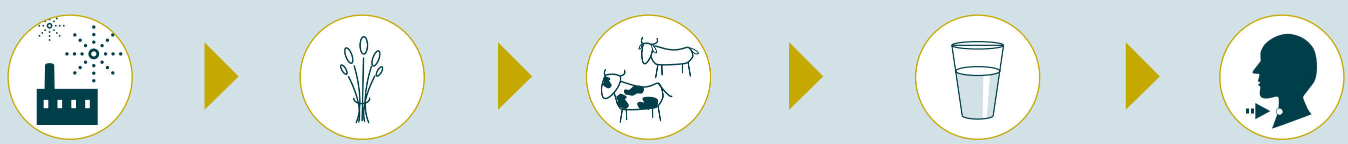
WHY THE HTDS WAS CONDUCTED

The main reason why the HTDS was conducted is that the public, health officials and scientists were concerned about the possible health effects of Hanford's radiation.

Thyroid disease was a particular concern because iodine concentrates in the thyroid gland and the DOE documents showed that large amounts of iodine-131 were released from Hanford. In response to public concerns,

HOW WERE PEOPLE EXPOSED TO IODINE-131 FROM HANFORD?

Most people received most of their dose from contaminated milk.



Iodine-131 released into air.

Iodine-131 was carried by winds and deposited on vegetation, fruits and vegetables.

Cows and goats grazed on the vegetation contaminated by iodine-131.

Iodine-131 passed into cow's and goat's milk and was consumed by area residents.

Iodine-131 concentrates in the thyroid.

People were also exposed by. . .

eating contaminated fruits and vegetables.

breathing contaminated air.

What Happened? A Brief History of Hanford

IN THE LATE 1980s, THE FEDERAL GOVERNMENT BEGAN TWO HANFORD-RELATED STUDIES

Hanford Environmental Dose Reconstruction Project (HEDR)	Hanford Thyroid Disease Study (HTDS)
Purpose > Estimate type and amount of radioactive materials released from Hanford. > Model how radioactive materials moved through the environment and food chain. > Develop computer software for estimating individual doses. > Estimate radiation doses to representative individuals in the Hanford region.	**Purpose** > Study the risk of thyroid disease among persons exposed to radioactive iodine-131 from Hanford.
Conduct of the Study > Began in 1987; final report issued in 1994. > The study was directed by an independent technical steering panel selected by deans of research universities in Washington and Oregon. > The study was conducted by Battelle Pacific Northwest Laboratories originally under contract with the U.S. Department of Energy (DOE). Management responsibility was transferred to CDC in 1993.	**Conduct of the Study** > Began in 1989; final report issued in 2002. > Scientific and technical work were performed by the Fred Hutchinson Cancer Research Center under contract with CDC. > The research team used HEDR computer software together with information provided by HTDS participants to estimate individual radiation doses to the thyroid.

Congress directed CDC to conduct a study of the effects of Hanford's iodine-131 on thyroid disease.

Many people ask, "Didn't we already know that Hanford radiation causes thyroid disease?" Over the years, many studies of other populations have provided compelling reasons to suspect that the risk of thyroid disease might have increased in people who were exposed to Hanford's iodine-131.

Nevertheless, the published literature left room for doubt, since none of the studies examined circumstances quite like those of the Hanford experience. The following are ways other radiation studies are different from the Hanford situation:

Type of radiation exposure – External irradiation by gamma rays (such as the atomic bombings in World War II) or x-rays used in medical treatments may have different effects than iodine-131.

The people who were exposed – People who received iodine-131 for treatment or diagnosis already had, or were likely to have, thyroid diseases, while people exposed to Hanford's iodine-131 were a general population, including some people with good health and some with poor health.

What Happened? A Brief History of Hanford

How big the doses were – Doses of iodine-131 used for medical treatments are much higher than anyone is likely to have received from Hanford's iodine-131. Doses from Chernobyl's fallout were higher as well.

How long people were exposed – External irradiation typically occurs within a few seconds or minutes. Medical exposures of iodine-131 typically occur over days to weeks. Exposure to Chernobyl's fallout occurred from weeks to months. In contrast, many of those exposed to Hanford's iodine-131 were exposed over a period of several years.

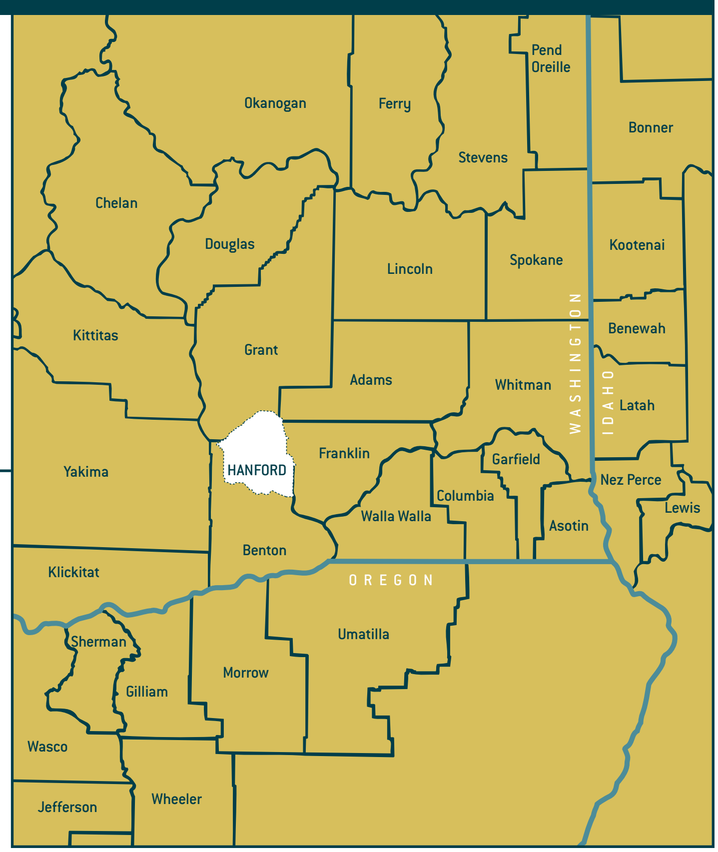
Because other studies have addressed situations different from Hanford in important ways, it was necessary to study people who were actually exposed to Hanford's iodine-131 in order to get the most reliable answer to the question of whether thyroid disease had been increased by Hanford's iodine-131.

No study can determine the cause of an individual case of thyroid disease. However, an epidemiological study, such as the HTDS, provides the best way to determine whether disease has increased in a population exposed to a potentially harmful agent such as radiation. ■

HANFORD NUCLEAR SITE AND SURROUNDING AREAS

Scientists used computer software developed under the HEDR Project to estimate radiation doses to the thyroid that HTDS participants accumulated while living within the HEDR Study Area.

The HEDR Study Area constitutes a 246-by-306 mile area around Hanford.



Source: Hanford Environmental Dose Reconstruction Project (HEDR)

How the Study Was Conducted

SECTION SUMMARY

- > The HTDS studied a group of people from the Hanford region who were young children at the time of the largest radiation releases from Hanford.
- > Each participant attended a medical clinic for a complete diagnostic evaluation for thyroid disease.
- > Scientists analyzed whether study participants with higher radiation doses had more thyroid disease than those with lower doses.
- > Based on information from Native American Tribes and Nations, a study such as the HTDS in Native American populations alone was not feasible because it would have too little chance of detecting any health effects from Hanford's iodine-131.

STUDY GROUP SELECTION

The HTDS study population represents a sampling of people born between 1940 and 1946 to mothers who lived in seven counties in Washington State: Benton, Franklin, Adams, Walla Walla, Okanogan, Ferry and Stevens.

All of the participants were young children at the time of the largest radiation releases from Hanford. It is believed that young children receive a higher dose to the thyroid for the same level of exposure than do adolescents and adults, and that the thyroid gland in young children may be more sensitive to the effects of radiation.

The study participants represent a range of possible doses of iodine-131 from Hanford, from the highest doses to very low doses.

Starting from birth certificates of 5,199 people born between 1940 and 1946, investigators were able to locate 94 percent of the group (4,350 people still living and 527 deceased). Of these, 3,440 were willing and able to participate fully.

Of the 3,440 study participants, 249 moved out of the Hanford region before Hanford operations began and did not move back into the region any time before the end of 1957. They are referred to as "out of area" participants in the HTDS. Because their thyroid doses could not be estimated with the computer models used by the HTDS, out of area participants were included in the data analyses as a separate group (see Figures 1-4 in Findings and Interpretations).

HOW DATA WERE COLLECTED

To estimate participants' radiation doses as precisely as possible, participants were asked to provide detailed information about the sources and amounts of foods and milk they consumed, and where they lived during the years 1944 through 1957. The largest

How the Study Was Conducted

amounts of iodine-131 were released from Hanford during those years, especially in 1945.

Of course, participants could not be expected to remember all the details of their childhood years, so whenever possible the information was obtained from someone with personal knowledge of the participant's early life, often the participant's mother.

In addition, participants attended a medical clinic for a complete diagnostic evaluation for thyroid disease. At the clinic, each participant:

> Completed a personal interview regarding his/her residential history, dietary history, past medical or occupational radiation exposures, and any history of thyroid disease.

> Received a thyroid ultrasound examination.

> Provided a blood sample to test for thyroid function and the presence of antibody markers for autoimmune thyroiditis. Serum calcium was also measured to test for hyperparathyroidism.

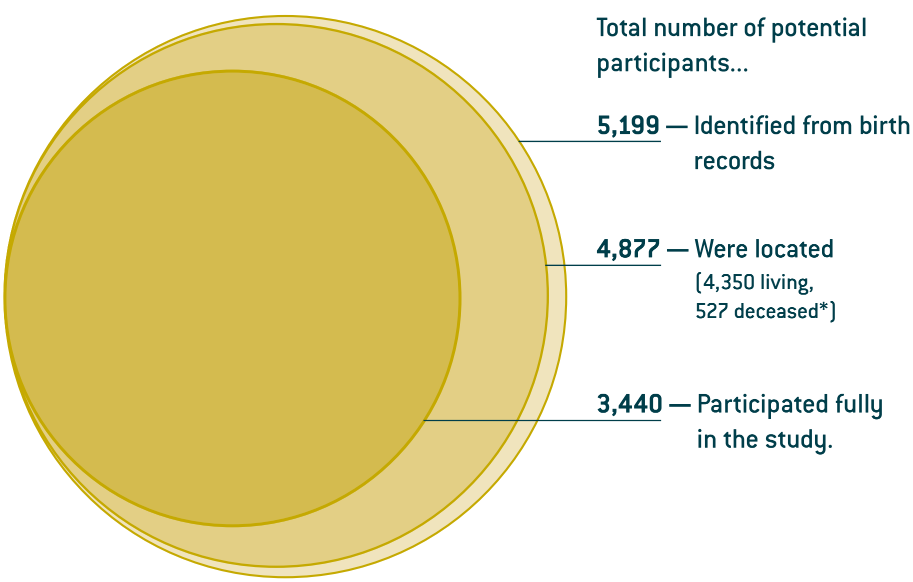
> Received a physical examination of the thyroid by two experienced thyroid physicians, each independently of the other.

If the person had a history of thyroid disease, medical records concerning that disease were also sought.

If any thyroid abnormality was found, the participant was advised to see a health care provider for evaluation or treatment.

The research team estimated each participant's radiation dose to the thyroid. To do this, scientists used computer software developed under the Hanford Environmental Dose Reconstruction Project (HEDR) together with the information provided by the HTDS participants.

HOW MANY PEOPLE PARTICIPATED IN THE HTDS?



*An analysis of the underlying causes of death revealed no indication that thyroid disease or thyroid cancer caused any of the deaths.

HOW DATA WERE ANALYZED

In analyzing the data, researchers looked for what is called a "dose-response." A dose-response is when risk of disease increases with increasing dose of radiation. If a study finds a dose-response, it provides very strong evidence linking radiation to the disease.

In the case of the HTDS, researchers studied how rates of thyroid disease in the study group varied in relation to participants' radiation doses from Hanford's iodine-131.

How the Study Was Conducted

The HTDS is an "internally controlled study." This approach enables researchers to compare groups of people who have similar characteristics (such as age, diet, lifestyle or environment) but different levels of exposure.

This approach of using one population composed of individuals with different levels of exposure has been used extensively in assessing the effects of radiation exposure in human populations.

A less effective approach would be to compare the study group to a separate population presumed to be unexposed to radiation ("unexposed control group"). That approach would be less desirable because thyroid disease may be a function of a number of factors other than exposure to radiation, and those factors may differ considerably between different populations.

Had the HTDS used an unexposed control group from another part of the country, scientists could not have known whether any differences in the rates of disease between the groups were due to a difference in exposure levels or some other factor.

CONSIDERATION OF OTHER SOURCES OF RADIATION

Scientists specifically designed the HTDS to assess the health effects of iodine-131 from Hanford. However, to be sure that any apparent health effects of Hanford's iodine-131 were not actually due to other causes, researchers needed to consider other possible radiation exposures.

For the HTDS, the research team considered exposures due to fallout from nuclear testing at the Nevada Test Site in the 1950s. They also considered exposures that individual study participants may have received from diagnostic or therapeutic irradiation, or from jobs that involved working with radioactive materials. By explicitly accounting for such exposures in the analyses of the data, researchers were able to single out the effects of Hanford radiation.

NATIVE AMERICANS AND THE HTDS

The HTDS research team conducted a feasibility study to determine whether it would be possible to conduct a study like the HTDS of the Native American populations that were exposed to Hanford's iodine-131. Those Tribes and Nations include: Colville, Couer d'Alene, Kalispell, Kootenai, Nez Perce, Spokane, Umatilla, Warm Springs and Yakama.

A separate feasibility study was conducted because it was recognized that aspects of the lifestyles of Native Americans differed from non-Natives, particularly regarding diet, food sources and seasonal residence changes. All of these factors could have affected the dose people received.

Eight of the nine tribes provided tribal-specific information for use in estimating the number of tribal members exposed and the likely magnitude of their radiation dose to the thyroid. Based on these estimates, it was determined that a separate study like the HTDS among Native Americans would not be feasible because it would have too little chance of detecting any health effects from Hanford's iodine-131.

Nevertheless, Native Americans were included in the HTDS if they were identified in the group of 5,199 that made up the study cohort. ■

Findings and Interpretations

SECTION SUMMARY

- The HTDS is a scientific study conducted to determine whether there was an increased risk of developing thyroid disease among people exposed to iodine-131 from Hanford.
- The HTDS data show that the risks of thyroid disease were about the same regardless of the radiation doses people received.
- The findings mean that if there is an increased risk of thyroid disease from exposure to Hanford's iodine-131, it is probably too small to observe using the best epidemiologic methods available.
- Researchers found that the occurrence of thyroid disease in the study group was about the same as has been reported for other populations.

STUDY OBJECTIVE

The HTDS is an epidemiological study conducted to determine whether thyroid disease is increased among people who were exposed as young children to releases of iodine-131 from the Hanford Nuclear Site from 1944 through 1957.

The HTDS was designed to test whether the risk of thyroid disease in a group of people exposed to Hanford's iodine-131 differed in relation to the radiation doses their thyroid glands received. The study cannot determine the cause of an individual's disease.

FINDINGS

The HTDS data show that the risks of thyroid disease were about the same regardless of the radiation doses people received. In other words, no associations between Hanford's iodine-131 and thyroid disease were observed.

The findings do not prove that Hanford radiation had no effect on the health of the area population. However, the findings show that if there is an increased risk of thyroid disease from exposure to Hanford's iodine-131, it is probably too small to observe using the best epidemiologic methods available.

Researchers studied all types of thyroid disease, as well as a disease of the parathyroid glands called hyperparathyroidism, and abnormalities of the thyroid gland that can be seen only on ultrasound examinations.

In each case, the results were the same. The percentages of people with each kind of thyroid disease or with ultrasound abnormalities were about the same regardless of their estimated radiation dose from Hanford's iodine-131. There were no statistically significant dose-responses for any of the diseases or ultrasound abnormalities studied.

Findings and Interpretations

Thyroid disease was found in the study population. This was expected because thyroid disease is common in other populations, especially among older people and women.

Researchers found that the rates of thyroid disease in the HTDS population were generally consistent with the rates of disease detected in other populations.

Thyroid Disease

Researchers studied all kinds of thyroid disease, including thyroid cancer (see Figure 1), benign thyroid nodules (see Figure 2) and hypothyroidism or underactive thyroid (see Figure 3).

For each type of thyroid disease, the study found that people with higher doses had about the same amount of disease as people with lower doses.

Hyperparathyroidism

The study found no evidence that the risk of hyperparathyroidism increased with increasing radiation dose. This disease occurs when the parathyroid glands produce too much parathyroid hormone, resulting in high calcium levels in the body.

However, the study did detect a statistically significant relationship between radiation dose and *decreasing* calcium levels.

Average levels of calcium in the blood were slightly lower — though still within the normal range — in people with higher estimated thyroid radiation doses.

Researchers have no explanation for the finding. Nevertheless, the decrease in calcium levels was so small that even participants with the highest doses had calcium values within the normal range.

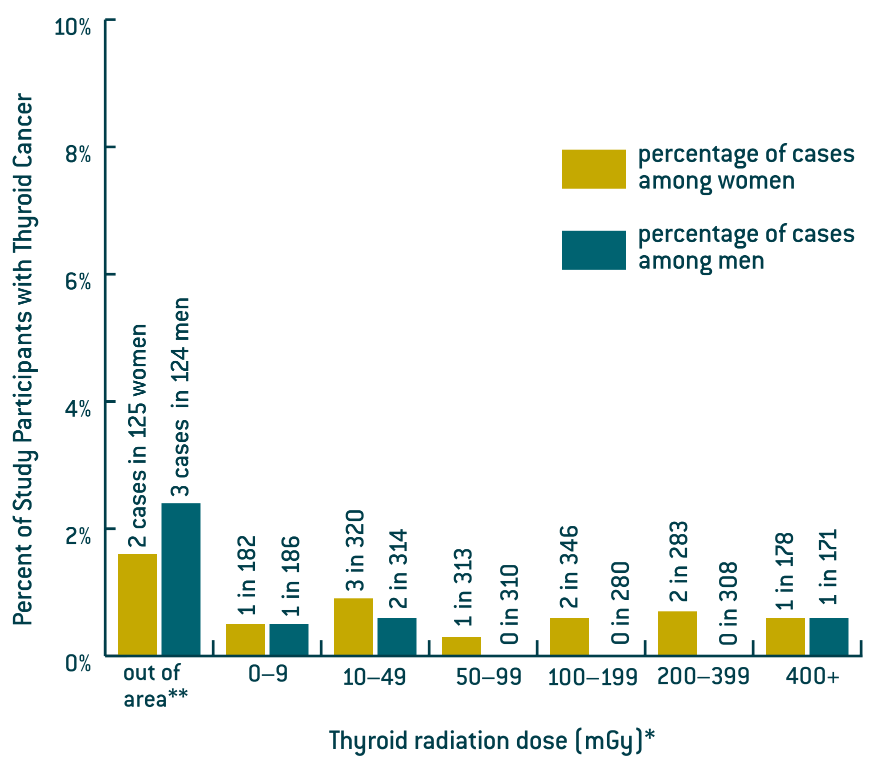
Non-Disease Outcomes

The proportion of participants with thyroid abnormalities that could be seen on their ultrasound examinations did not increase significantly with increasing radiation dose (see Figure 4).

Mortality in the Study Population

Of the 5,199 people originally identified for inclusion in the

Figure 1. OCCURRENCE OF THYROID CANCER AMONG FEMALE AND MALE HTDS PARTICIPANTS



*MilliGray (mGy) is a measure of radiation dose.
**Out of area participants: No dose estimate available (see page 6).

Findings and Interpretations

study, researchers found that 527 were deceased. Researchers were able to locate death certificates for 504 of the 527 deceased individuals. None of the death certificates indicated that any thyroid disease, including thyroid cancer, was responsible for any of the deaths.

Overall mortality rates in the study population were about the same as those in the state of Washington for the same time period. However, mortality rates for non-hereditary causes due to conditions that occurred before or shortly after birth were somewhat higher than those in the state of Washington for the same period. The reasons for this higher death rate are not known, though it is not likely related to Hanford's iodine-131 because increased death rates from these kinds of conditions occurred even before the releases of iodine-131 from Hanford began.

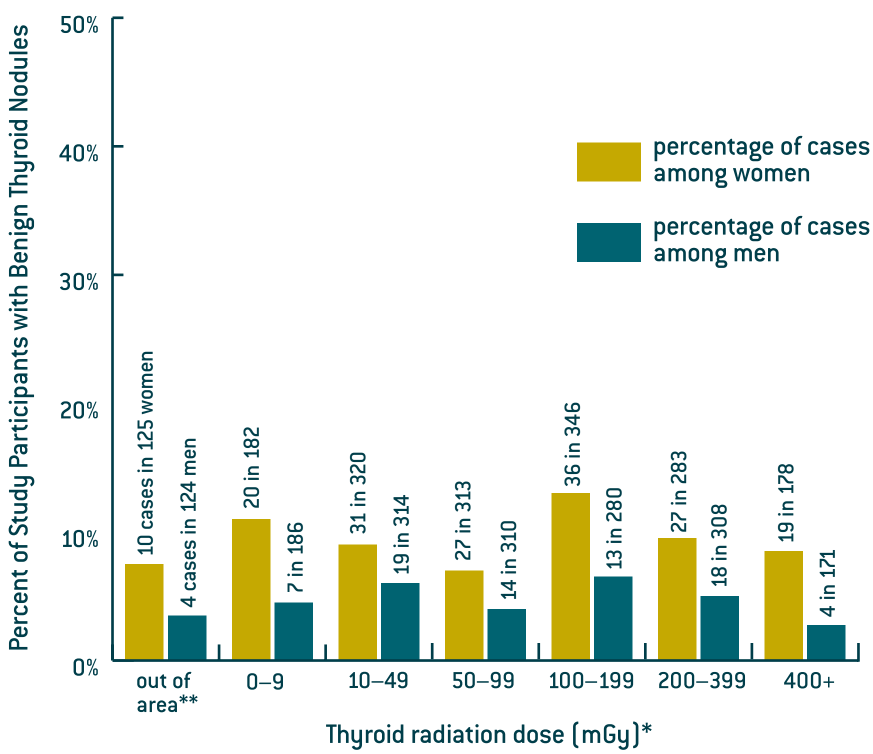
HOW THE PREVALENCE OF THYROID DISEASE IN THE HTDS COMPARES TO OTHER POPULATIONS

People often ask how the occurrence of thyroid disease in the HTDS compares to other populations not exposed to iodine-131 from Hanford. Based on a descriptive analysis of the most comparable information from other studies, the HTDS research team found that the rates of thyroid disease in the study population are generally consistent with the published literature on other populations. In other words, there is no indication that the levels of disease in the HTDS population are any higher than what have been reported around the world in a variety of different circumstances.

There are a number of reasons why a more definitive comparison between the HTDS population and other populations groups is not possible:

> There are no national estimates of thyroid diseases to which the HTDS can be compared. Moreover, populations with different characteristics and different exposures may exhibit very different disease rates.

Figure 2. OCCURENCE OF BENIGN THYROID NODULES AMONG FEMALE AND MALE HTDS PARTICIPANTS



*MilliGray (mGy) is a measure of radiation dose.
**Out of area participants: No dose estimate available (see page 6).

Findings and Interpretations

- > Identification of thyroid disease in a population depends to a large extent on how aggressively one looks for the disease. For example, scientists are much more likely to detect thyroid nodules using ultrasound (such as the HTDS) than they would conducting a routine thyroid examination.
- > Physicians use different definitions of various thyroid and other conditions, making it difficult to compare prevalence of diseases in different populations. Such is the case with both hyperparathyroidism and hypothyroidism.
- > The methods used for detecting thyroid disease and other conditions have changed, making it difficult to compare studies conducted during different time periods. For example, estimates of the prevalence of autoimmune thyroiditis and thyroid nodules vary widely depending on the method of detection.

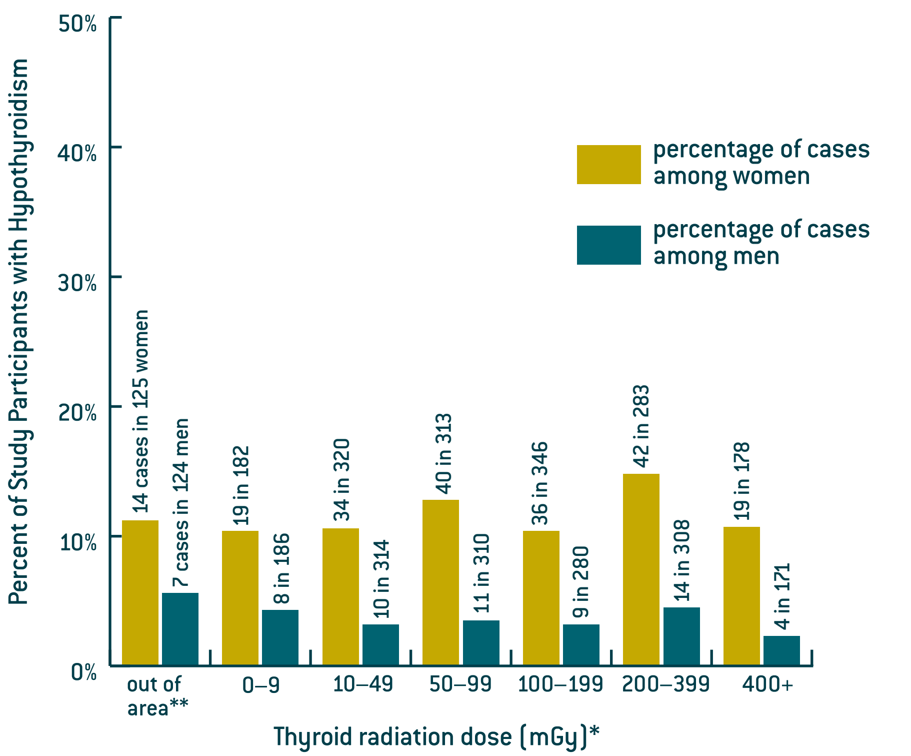
Nevertheless, the best estimates of the prevalence of thyroid diseases, including thyroid cancer, in the general population are consistent with that found in the HTDS population group.

HOW THE HTDS FINDINGS COMPARE TO OTHER RADIATION STUDIES

No other radiation studies are directly comparable to the Hanford situation, and drawing comparisons with other studies is difficult because many factors affect thyroid health. Factors include the type of radiation (internal or external), the doses received, the rate at which the doses were received, how much non-radioactive iodine a person gets in his or her diet, a person's age at the time of exposure, how much time has passed since the exposure and the methods researchers used to search for the disease.

Nevertheless, much can be learned from other radiation studies. For example, scientists agree that high doses of external radiation, as well as high doses of internal radiation received in

Figure 3. OCCURRENCE OF HYPOTHYROIDISM AMONG FEMALE AND MALE HTDS PARTICIPANTS



*MilliGray (mGy) is a measure of radiation dose.
**Out of area participants: No dose estimate available (see page 6).

Findings and Interpretations

short periods of time, increase the risk of certain thyroid diseases. There is also evidence that the risk from radiation is greater for people exposed at younger ages.

Much less is known about situations such as Hanford, where populations are exposed to lower levels of internal radiation from iodine-131 over prolonged periods of time.

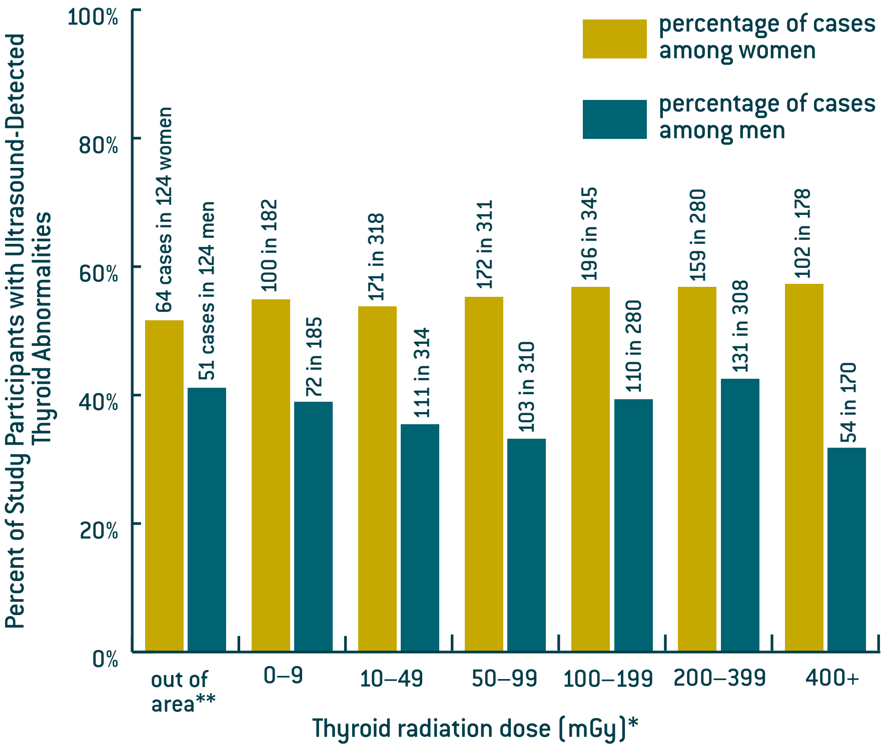
The following is a review of other important radiation studies. (Refer to the chart on page 14.)

External Exposures

Studies of survivors of the atomic bombings of **Hiroshima** and **Nagasaki** during World War II show that people exposed to high levels of external gamma radiation face an increased risk of thyroid cancer. People whose thyroid glands were exposed in childhood to high levels of external radiation from **x-ray treatments** of the head and neck are also at increased risk. (Medical uses of x-ray treatments of children have changed since the 1960s.)

What distinguishes these situations from Hanford is that the exposures were external and not from iodine-131, the radiation doses were much higher and the doses were delivered in very short periods of time.

Figure 4. OCCURRENCE OF ULTRASOUND-DETECTED THYROID ABNORMALITIES AMONG FEMALE AND MALE HTDS PARTICIPANTS



*MilliGray (mGy) is a measure of radiation dose.
**Out of area participants: No dose estimate available (see page 6).

Mix of Internal and External Exposures

Studies show that children and adults exposed to internal and external radiation from nuclear testing in the **Marshall Islands** (largest test in 1954) have an increased risk of thyroid nodules. Other studies show a large increase in thyroid cancer among children exposed to iodine-131 and other radiation from **Chernobyl** in 1986.

Neither situation is directly comparable to Hanford because the radiation received in both instances was a mixture of internal and external exposures, and the doses were higher and delivered over shorter periods of time. In the case of Chernobyl, iodine deficiency in the population

Findings and Interpretations

SUMMARY OF RADIATION STUDIES

Higher Doses ↕ Lower Doses

EXTERNAL EXPOSURES

X-RAY TREATMENT OF CHILDREN

- Exposure to x-ray treatment.
- Exposure lasted seconds to minutes.
- Studied exposure in childhood.
- Exposure resulted in increased risk of thyroid cancer.

HIROSHIMA AND NAGASAKI

- Exposure primarily to gamma rays; some neutron exposure.
- Exposure lasted seconds.
- Studied exposure at all ages.
- Exposure resulted in increased risk of thyroid cancer, with greatest risk in children; limited evidence of an increased risk of autoimmune thyroiditis.

MIX OF INTERNAL AND EXTERNAL EXPOSURES

MARSHALL ISLANDS

- Exposure to iodine-131 plus other internal and external radionuclides.
- Exposure lasted weeks.
- Studied exposure at all ages.
- Exposure resulted in increased risk of thyroid nodules and hypothyroidism, primarily in children.

CHERNOBYL

- Exposure to iodine-131 plus other internal and external radionuclides.
- Exposure lasted days to weeks.
- Studied exposure in childhood.
- Exposure resulted in large increased risk of thyroid cancer in children. Iodine deficiency in the diet may also be a contributing factor.

NEVADA TEST SITE

- Exposure to iodine-131 plus other internal and external radionuclides.
- Exposure lasted weeks to months.
- Studied exposure in children.
- Exposure resulted in increased risk of thyroid nodules; some indication of an increased risk of thyroid cancer.

INTERNAL EXPOSURES

MEDICAL USES OF IODINE-131 FOR TREATMENT

- Exposure to iodine-131.
- Exposure lasted days to weeks.
- Studied exposure at all ages, primarily adults.
- Exposure resulted in increased risk of hypothyroidism (intent of the treatment); no clear evidence of an increased risk of thyroid cancer from iodine-131 exposure.

MEDICAL USES OF IODINE-131 FOR DIAGNOSIS

- Exposure to iodine-131.
- Exposure lasted days to weeks.
- Studied exposure at all ages, primarily adults.
- Exposure not associated with an increased risk of thyroid cancer.

HANFORD

- Exposure almost entirely to iodine-131.
- Exposure lasted months to years.
- Studied exposure in children.
- Exposure not associated with an increased risk of thyroid disease.

may also be a factor in the rate of thyroid disease.

A study of people exposed as children to fallout from nuclear testing in the 1950s at the **Nevada Test Site** is called the Utah Study. This study found an increased risk of thyroid neoplasia, which is a category of disease that the researchers defined to include both thyroid cancer and certain kinds of benign nodules. However, there was no clear evidence that the risk of thyroid cancer alone was increased.

The study is considered the most comparable to the Hanford situation, but there are important differences. While exposure was largely from iodine-131, it also likely included short-lived radioactive iodines as well as external radiation. In addition, the Utah exposures were concentrated over shorter time periods.

Internal Exposures

There have been epidemiological studies of the effect of iodine-131 alone. However, these have all been based on people who received iodine-131 to **treat thyroid disease**, or to **diagnose suspected thyroid disease**. People exposed to radioactive iodine for medical reasons (primarily for the treatment of Graves disease) generally received very high doses. While several studies found an increased risk of thyroid cancer, the researchers concluded this was likely due to the patients' underlying thyroid diseases, not their iodine-131 exposures.

People exposed to radioactive iodine for diagnostic purposes received much lower doses. Studies have not found an increased risk of thyroid cancer associated with diagnostic exposures.

HOW RELIABLE ARE THE RESULTS OF THE HTDS?

An important consideration in any epidemiological study is the reliability of the information. In the case of HTDS, researchers could be confident that their assessments of thyroid disease were very reliable because participants received thorough examinations of their thyroid glands by experienced doctors.

On the other hand, estimating radiation doses to the participants' thyroid glands was inherently uncertain. This is because their doses depended not only on where they lived, but also on the quantities and sources of the food and milk products they consumed when they were infants and young children during 1944 through 1957. Highly accurate recollection of information from so long ago is simply not possible. In addition, the amounts of iodine-131 released from Hanford, and how that iodine-131 moved through the environment, are not known exactly.

In order to account for the effects of this uncertainty about the participants' doses, HTDS researchers performed special statistical analyses. They also examined whether risks of thyroid diseases and thyroid ultrasound abnormalities differed according to where the participants lived and/or how much milk they consumed, rather than their estimated doses. None of these additional analyses led to a conclusion that risks of thyroid disease increased with increasing exposure to Hanford's iodine-131.

No epidemiological study can state with absolute certainty whether or not an exposure (such as Hanford's iodine-131) has affected people's health. Nevertheless, studies such as the HTDS can be conducted in ways, and with enough participants, to provide confidence that if an association exists it is likely small. In the HTDS, scientists did not observe an association using a careful study design, thorough clinical evaluation, and several alternative approaches for estimating radiation dose and analyzing study data. ■

Hanford Thyroid Disease Study Timeline

1986 – 1987

1986 and 1987
U.S. Department of Energy (DOE) releases classified documents describing radiation releases at Hanford.

1986
CDC forms an independent panel of scientists (Hanford Health Effects Review Panel) to evaluate DOE documents.

Hanford Health Effects Review Panel recommends two studies: 1) to estimate radiation doses received by area residents (which became known as the Hanford Environmental Dose Reconstruction Project (HEDR)), 2) to examine the feasibility of studying the potential health effects of iodine-131 among exposed populations (which led to the HTDS).

CDC forms second independent panel (Hanford Historical Documents Review Committee) to continue analysis of DOE documents.

1987
Battelle Pacific Northwest Laboratories begins work on HEDR under DOE contract.

1988 – 1989

1988
DOE forms Technical Steering Panel of scientists, representatives of Native American Tribes and community representatives to oversee HEDR.

Congress directs CDC to conduct a study of thyroid disease in the area around Hanford.

1989
CDC awards contract to Fred Hutchinson Cancer Research Center for HTDS. Work begins on HTDS protocol and pilot study.

1990

1990
HTDS scientists begin public communications with public meetings, mailings, newsletters and toll-free number.

U.S. Department of Health and Human Services appoints HTDS Advisory Committee (scientists, public health officials, public and Native American representatives) to advise CDC on design and implementation of HTDS.

HTDS scientists hold public meetings in Northwest to solicit comments from the public and scientists on pilot study design and protocol.

1991 – 1992

1991
HTDS Advisory Committee meetings begin on a regular basis. All meetings open to the public.

1992
HTDS pilot study design and protocol approved by the Federal Office of Management and Budget and the Institutional Review Board of Fred Hutchinson Cancer Research Center.

1993 – 1994

1993
HEDR funding transferred from DOE to CDC.

1994
HEDR final reports published.

Hanford Thyroid Disease Study Timeline

1995

HTDS Pilot Study Report issued. Full epidemiologic study determined feasible.

National Academy of Sciences conducts peer review of HTDS Pilot Study Report and finds study design to be sound science.

HTDS Advisory Committee reviews pilot study results and recommends proceeding to full epidemiologic study.

1997

National Academy of Sciences conducts peer review of HTDS Analysis Plan (plan that describes how the data would be analyzed).

HTDS Advisory Committee approves HTDS Analysis Plan.

HTDS data collection completed. Data analysis begins.

1998

Fred Hutchinson Cancer Research Center completes HTDS Draft Report. CDC scientists evaluate report.

CDC convenes ad hoc review group of independent scientists who provide written reviews and opinions on HTDS Draft Report.

1999

CDC and Fred Hutchinson Cancer Research Center release HTDS Draft Report for purpose of scientific peer review and public comment. CDC and HTDS scientists hold public meeting in Richland to review draft findings.

CDC holds five-month public comment period on HTDS Draft Report.

National Academy of Sciences conducts peer review of HTDS Draft Report. NAS holds public meeting in Spokane.

2000 – 2002

2000
National Academy of Sciences issues its report and recommendations on HTDS Draft Report.

2000 – 2002
CDC and Fred Hutchinson Cancer Research Center conduct additional technical work based on National Academy of Sciences recommendations, and comments from independent scientists and the public.

2001
CDC conducts audience research to prepare for communication of HTDS Final Report. Research includes discussion groups with HTDS participants, Hanford public, and local government and public interest group representatives.

2002
CDC and Fred Hutchinson Cancer Research Center release the HTDS Final Report.

Public Involvement and Scientific Review

SECTION SUMMARY

- The public commented on design and implementation issues throughout the study.
- The HTDS Advisory Committee provided ongoing advice to CDC on the design and implementation of the study.
- A committee of the National Academy of Sciences peer reviewed the HTDS at three points: Pilot Study, Analysis Plan and HTDS Draft Report.
- CDC convened other independent scientists to review the HTDS Draft Report.

REVIEWERS AND THEIR ROLES

Throughout the study, HTDS researchers received input and suggestions from a wide variety of sources.

The Public

Individuals and public groups provided input in a variety of ways, including participation in public meetings and the HTDS Advisory Committee, and with written comments to CDC.

The research team communicated with the public throughout the study using newsletters, mailers and a toll-free number. Under a separate project funded by the Federal Government, the Hanford Health Information Network provided information about radiation health effects.

The HTDS Advisory Committee

The HTDS Advisory Committee (officially known as the Hanford Thyroid Morbidity Study Advisory Committee) was created to advise CDC on the design and implementation of the study.

The committee was chartered by the U.S. Department of Health and Human Services. Scientists, state health officials, environmental groups, Indian Nations and the public were represented in the group.

The committee met regularly from 1991 through 1999. At each meeting the public was given an opportunity to ask questions and offer their own views on the study.

National Academy of Sciences (NAS)

The NAS is one of the country's most respected scientific organizations. At three points in the study (Pilot Study, Analysis Plan and HTDS Draft Report), an NAS committee peer reviewed the study and made recommendations to the research team. The NAS committee included epidemiologists, statisticians and other scientists.

Peer review is an independent scientific evaluation that helps ensure that a study is of high quality.

Public Involvement and Scientific Review

Independent Scientists

In 1998, CDC convened a group of independent scientists with expertise in thyroid disease, radiation and epidemiology to review the HTDS Draft Report. Their evaluation was made available in a public report.

Other independent scientists offered critical review on the pilot study design and protocol during the early phase of the study.

REVIEW PROCESS

The HTDS involved extensive scientific peer review and public involvement.

Study Design

The study design, or protocol, describes all the methods used for conducting the study, such as recruiting participants and conducting thyroid examinations.

Public interest groups, scientists and members of the public were invited to comment on the protocol in public meetings in the Northwest. They were also encouraged to send written comments to CDC.

The protocol was evaluated by the HTDS Advisory Committee, and approved by CDC, the Institutional Review Board of the Fred Hutchinson Cancer Research Center and the Federal Office of Management and Budget.

Pilot Study

In the early 1990s, researchers began recruiting participants and collecting data for a pilot study to determine the feasibility of a large-scale epidemiologic study. A Pilot Study Report was issued in 1994, peer reviewed by the NAS, and approved by the HTDS Advisory Committee. In 1995, both panels agreed that a full-scale epidemiologic study was feasible. The NAS also recommended that the researchers develop an analysis plan describing how the data would be analyzed.

Analysis Plan

The Analysis Plan was completed in 1997 and peer reviewed by the NAS. It was also reviewed and approved by the HTDS Advisory Committee. In addition, the public was invited to offer its own views on the plan.

HTDS Draft Report

CDC released the HTDS Draft Report in January 1999. An extensive review by the NAS concluded that the study was scientifically sound but had probably overstated the certainty of the findings. The NAS recommended a number of technical revisions and clarifications.

Following the review, the research team conducted additional technical work to address the NAS recommendations as well as those received from the public and other independent scientists. The HTDS Final Report represents completion of the study. ■

THE REVIEWERS AND THEIR ROLES

THE PUBLIC AND PUBLIC INTEREST GROUPS	HTDS ADVISORY COMMITTEE	NATIONAL ACADEMY OF SCIENCES	OTHER INDEPENDENT SCIENTISTS
Participated in public meetings and provided written comments to CDC throughout the study.	Advised CDC on design and implementation issues from 1991 through 1999.	Conducted scientific peer reviews in 1995, 1997 and 1999.	Reviewed various aspects of the science throughout the study.

About Thyroid Disease

SECTION SUMMARY

- Thyroid disease is common, especially among older people and women.
- Checking for thyroid disease involves an evaluation of the thyroid by an experienced doctor.
- If you are concerned about exposure to iodine-131 from Hanford or experience thyroid disease symptoms, you should see your doctor for a thyroid evaluation.

A LOOK AT THYROID DISORDERS

The thyroid gland, located in the front of the neck just below the Adam's apple, takes iodine from the diet and makes thyroid hormone. Thyroid hormone affects a person's physical energy, temperature, weight and mood.

Thyroid diseases generally fall into two broad groups of disorders: abnormal function and abnormal growth (nodules) in the gland. These problems are common in the general population, especially among older people and women. Most thyroid problems can be detected and treated.

Functional disorders are usually related to the gland producing too little thyroid hormone (hypothyroidism) or too much thyroid hormone (hyperthyroidism).

Benign nodules in the thyroid gland are common and do not usually cause serious health problems. These nodules occur when the cell growth within the nodule is abnormal. Nodules can occasionally put pressure on the neck and cause trouble with swallowing, breathing or speaking if they are too large. The thyroid usually functions normally even when nodules are present.

Thyroid cancers are much less common than benign nodules. With treatment, the cure rate for thyroid cancer is more than 90 percent.

CHECKING FOR THYROID DISEASE

Checking for thyroid disease is similar to other kinds of medical evaluations. The doctor considers the patient's medical history, examines the thyroid and may order a blood test or other diagnostic tests.

A standard physical examination of the thyroid gland is done by palpation — that is, feeling the thyroid gland. The doctor feels for the size and texture of the gland, and whether any masses or nodules are present.

Testing for Thyroid Function

There are two standard blood tests of thyroid function: the measurement of thyroid hormone, usually T4, and the measurement of thyrotropin

(TSH). TSH is a hormone secreted from the pituitary gland that controls how much thyroid hormone the thyroid makes.

Abnormal blood tests usually reveal thyroid function problems and not the presence of thyroid nodules or cancer.

Testing for Nodules

If a nodule is found during the physical examination, a test called fine needle aspiration (FNA) biopsy may be done to help find out whether the nodule is cancerous or benign. In addition, a thyroid nuclear scan may help the doctor evaluate thyroid function or nodules. The scan is performed by giving the patient a radioisotope and taking a special picture to see how much of the radioisotope is taken up by the thyroid gland.

A thyroid ultrasound scan is a diagnostic test that shows a picture of the anatomy, or structure, of the thyroid gland. Ultrasound is most often used to determine if a nodule is solid or cystic. Cystic nodules, containing only fluid, are usually benign.

Ultrasound is not usually performed as a routine screening test for thyroid nodules in the general population. The reason is that small, nonpalpable ultrasound abnormalities are very common in people without evidence of thyroid disease.

TREATMENT OF THYROID DISEASE

The treatment of thyroid disease depends on many factors, including the type and severity of the thyroid disorder and the age and overall health of the patient. Treatment must be specific to each individual.

> Thyroid cancer is initially treated with thyroid surgery. Many patients also receive further treatment with iodine-131. Patients treated for thyroid cancer require lifelong thyroid hormone replacement.

> The majority of benign nodules do not require treatment. Patients with benign nodules are usually advised to have periodic follow-up examinations.

> Hypothyroidism usually requires only replacement of thyroid hormone by taking a single daily tablet at a dose adjusted to produce normal thyroid hormone levels.

> Autoimmune thyroiditis is a disorder that may cause hypothyroidism. It usually does not cause symptoms that require treatment unless hypothyroidism develops. In such cases, thyroid hormone replacement is required.

> Treatment of hyperthyroidism may include antithyroid drugs, radioactive iodine-131 or in rare cases, thyroid surgery.

SYMPTOMS OF ABNORMAL THYROID FUNCTION

TOO LITTLE THYROID HORMONE (HYPOTHYROIDISM)	TOO MUCH THYROID HORMONE (HYPERTHYROIDISM)
> Depression or feeling blue	> Nervousness and anxiety
> Trouble concentrating	> Weight loss
> Tiredness	> Tremor (shaking)
> Dry skin and hair	> Fast, irregular pulse
> Weight gain	> Tiredness
> Feeling cold all the time	> Feeling hot all the time

RECOMMENDATION FOR THYROID CHECK-UPS

If you have received regular health care and have no symptoms of thyroid disease, you may not need to see a doctor to check for thyroid disease. However, if you are concerned about being exposed to iodine-131 from Hanford or experience thyroid disease symptoms, you should see your doctor for a thyroid examination. ■

Information Resources

Information about the Hanford Thyroid Disease Study and related topics is available through the Centers for Disease Control and Prevention (CDC) and other agencies in the U.S. Department of Health and Human Services.

CENTERS FOR DISEASE CONTROL AND PREVENTION

Hanford Thyroid Disease Study

> **Write to**
Hanford Thyroid Disease Study
Centers for Disease Control
and Prevention
National Center for
Environmental Health
Radiation Studies Branch
1600 Clifton Road, NE
MS E-39
Atlanta, GA 30333

> **E-mail**
HTDSCommunications@cdc.gov

> **HTDS Web Site**
The HTDS Final Report and public information materials are available at http://www.cdc.gov/nceh/radiation

> **Public Libraries**
The HTDS Final Report can be viewed at the following libraries beginning July 2002:

- University of Washington Health Sciences Library, Seattle, WA
- Seattle Public Library System, Seattle, WA
- King County Public Library System, Seattle, WA
- Gonzaga University Library (Foley Center Library), Spokane, WA
- Richland Library, Richland, WA
- DOE Reading Room, Richland, WA

AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

The Hanford Community Health Project provides a variety of public health materials related to iodine-131 for individuals exposed as young children to releases of iodine-131 from Hanford from 1945 through 1951. The Project is sponsored by the Agency for Toxic Substances and Disease Registry (ATSDR).

For more information:

Hanford Community Health Project
800-207-3996
Hanford@norcmail.uchicago.edu

or

ATSDR Information Center
888-42ATSDR (888-422-8737)
ATSDRIC@cdc.gov

NATIONAL CANCER INSTITUTE

The National Cancer Institute has materials on thyroid cancer and screening, and iodine-131 exposure.

For more information:

http://www.cancer.gov

or

800-4-CANCER (800-422-6237)

The HTDS Research Team

The HTDS was conducted by a team of scientists and physicians with extensive experience in epidemiological research, radiation exposure and thyroid disease.

THE CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC)

CDC protects people's health and safety by preventing and controlling diseases and injuries, providing information on health issues, and promoting healthy living through partnerships with local, national and international organizations.

Paul Garbe, D.V.M., M.P.H.

Scientific Advisor, HTDS; Associate Director for Science, Division of Environmental Hazards and Health Effects, National Center of Environmental Health

Dr. Garbe has worked at CDC for 20 years on issues related to the health effects of environmental hazards. He served in CDC's Epidemic Intelligence Service, and since 1991, has coordinated CDC epidemiology projects which assess relationships between thyroid diseases and environmental radiation exposures.

Mike Donnelly

HTDS Project Manager

Mike Donnelly was CDC's HTDS project officer through 2001 and has been involved in Hanford issues since 1991. He has more than 20 years experience with CDC as a public health advisor working on a variety of public health issues.

FRED HUTCHINSON CANCER RESEARCH CENTER (FHCRC)

The Fred Hutchinson Cancer Research Center is an independent, non-profit research institution, which conducts scientific investigations of the causes and treatments of cancer and other potentially fatal diseases.

Scott Davis, Ph.D.

Principal Investigator, HTDS; Program in Epidemiology, FHCRC; Professor and Chairman, Department of Epidemiology, School of Public Health and Community Medicine, University of Washington

Dr. Davis' research is focused on investigations of the health effects of radiation exposure in human populations, and includes studies of survivors of the atomic bombings in Japan and people exposed to radiation from Chernobyl.

Kenneth J. Kopecky, Ph.D.

Co-investigator, HTDS; Program in Biostatistics, FHCRC; Affiliate Professor, Department of Biostatistics, School of Public Health and Community Medicine, University of Washington

Dr. Kopecky is a biostatistician with extensive experience in research into the health effects of radiation, including studies of Japanese atomic bomb survivors and of people exposed to fallout from Chernobyl. Dr. Kopecky also served as a member of the HEDR Technical Steering Panel.

Thomas Hamilton, M.D., Ph.D.

Co-investigator, HTDS; Clinical Associate Professor, Division of Endocrinology and Metabolism, University of Washington

Dr. Hamilton is a practicing endocrinologist and an expert in the diagnosis and management of thyroid disease. He has conducted research in the Marshall Islands, where he evaluated the risk of thyroid disease among people exposed to fallout from nuclear weapons testing.

June 21, 2002