

Radiation,  
Louis Hempelmann and  
Thyroid Cancer:  
An Historical Perspective

# Historical Perspective

- Time horizon
  - 1895 through the Chernobyl accident (1986)
- History
  - How we were exposed
  - How we learned about the effects of these exposures
- Focus
  - Contributions of Louis Hempelmann

# RADIATION AND THE THYROID: FOUR ERAS

- I: The age of exposure
  - 1895 (Roentgen discovers X-Rays) to 1960's
- II: The age of discovery
  - 1950 (Annus mirabilis, 'year of wonders')
- III: The age of call back programs
  - 1974
- IV: The post-Chernobyl age
  - 1986

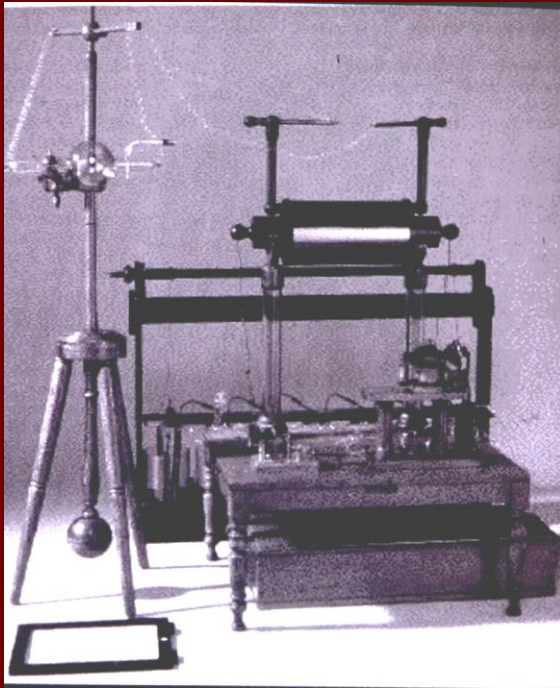
# I: The age of exposure

1895 (Roentgen discovers X-Rays)  
to 1960's



# 1895

# Roentgen Discovers X-Rays



# 1897 OSSEOUS NECROSIS

The Effects of X-Ray Upon Osseous Structure

T.C. Gilchrist

Bulletin of the Johns Hopkins Hospital 18:17;1897

# 1902 CANCER

Demonstration eines Cancroids des rechten Handrueckens,  
das sich nach langdauernder Einwirkung von  
Roengenstrahlen entwickelt hat

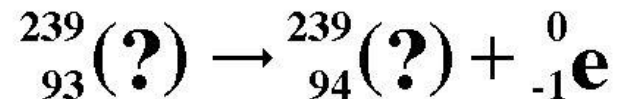
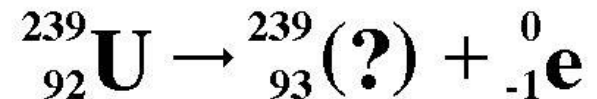
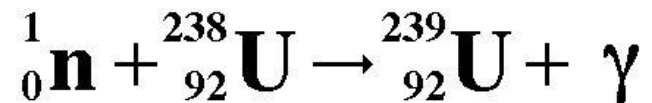
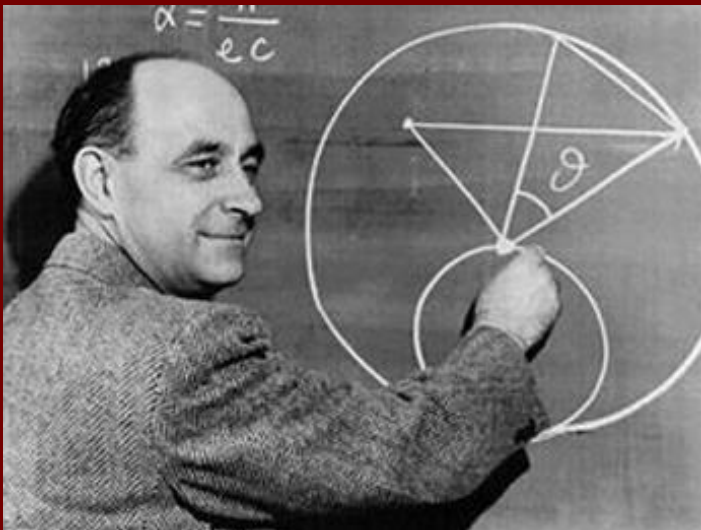
A. Frieben

Fortschr Roentgenstr 6:106-111

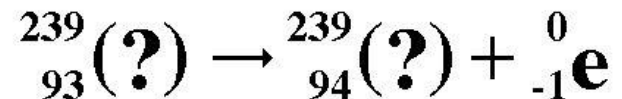
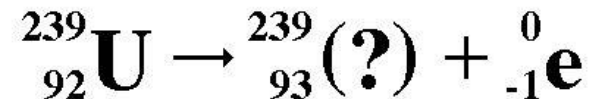
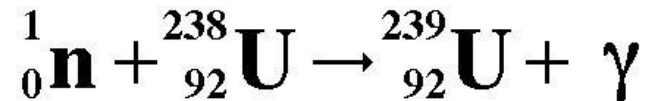
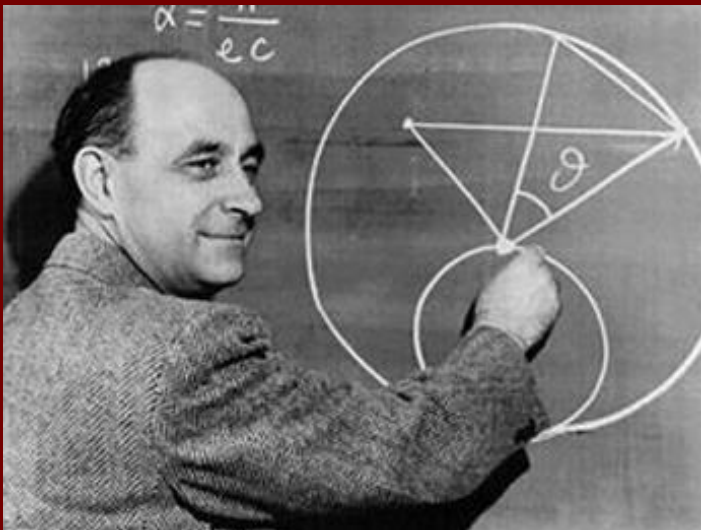
# History of Environmental Radioactivity

**“THE NUCLEAR ERA”**

**In May 1934, Enrico Fermi and his colleagues in Rome bombard uranium for the first time. On October 22, 1934 they discover that paraffin wax slows the neutrons and greatly increases the activity. Fermi and his team become the first humans to cause nuclear fission, but they do not recognize it.**

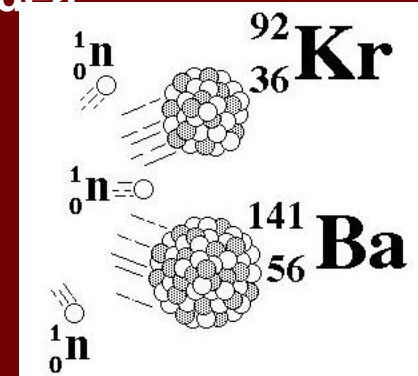
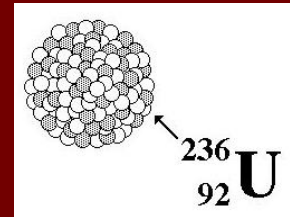
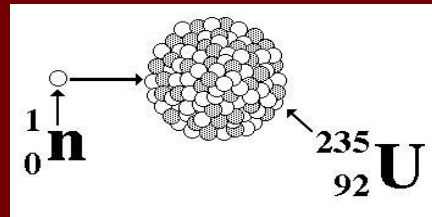
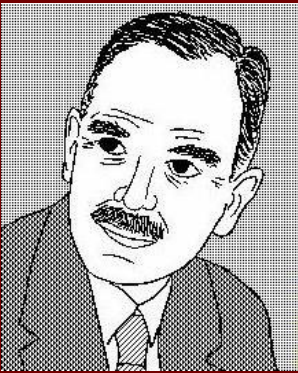


Part of their standard experimental procedure includes covering their uranium samples with a thin sheet of aluminum foil, stopping the fission products from reaching their detectors. It would not be until the beginning of 1939 that nuclear fission would finally be recognized. Writer W.L. Laurence has called this delay the "Great Five Year Miracle that Saved the World"



## December 1938

Hahn and Strassman finally show that two of the products are Barium-139 and Lanthanum-140. They suspect that the uranium atom has been split, but are reluctant to propose such a radical idea.



## January 1939

Hahn communicates his results to Lise Meitner, who, being Jewish, is in exile in Stockholm. Meitner and her nephew, Otto Frisch, work out the details and suggest that the uranium atom has been split into two nuclei of roughly equal size, a process they call **nuclear fission**.







## **February-March 1939**

**Within a week of each other, Frederic Joliot-Curie's team in Paris and Fermi and Szilard at Columbia discover that secondary neutrons are released during uranium fission thus making a chain reaction feasible.**

# Einstein to Roosevelt, August 2, 1939

Leo Szilard believed that atomic bombs were possible and that Nazi Germany might gain an unbeatable lead in developing them. Unable to find official support, and unable to convince Enrico Fermi of the need to continue experiments, Szilard turned to his old friend Albert Einstein...



Albert Einstein  
Old Grove Rd.  
Nassau Point  
Peconic, Long Island  
August 2nd, 1939

F.D. Roosevelt,  
President of the United States,  
White House  
Washington, D.C.

Sir:

Some recent work by E. Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future. Certain aspects of the situation which has arisen seem to call for watchfulness and, if necessary, quick action on the part of the Administration. I believe therefore that it is my duty to bring to your attention the following facts and recommendations:



**September 1, 1939**  
World War II begins.

# THE MANHATTAN PROJECT

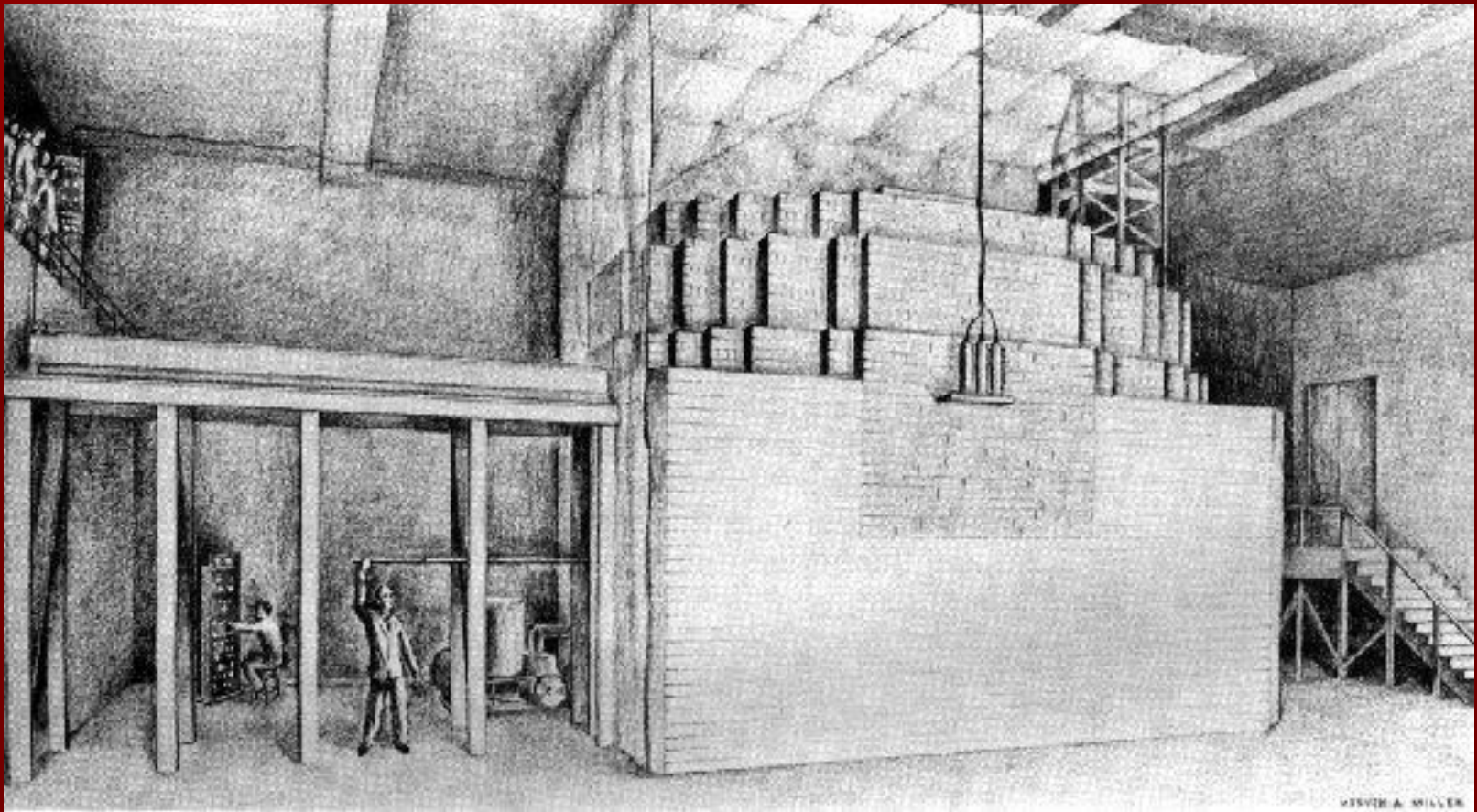
WHAT HAPPENED AT  
THE UNIVERSITY OF  
CHICAGO?



**Stagg Field, circa 1950**



**Artist's Rendering  
of the Event**



(Courtesy of Argonne National Laboratory)

**December 2, 1942** : Under the football stands of Stagg Field at the University of Chicago, Enrico Fermi leads a team of scientists in successfully creating the first controlled nuclear chain reaction.

# WHAT HAPPENED AT OAK RIDGE AND HANFORD?



Plutonium separation building  
(the "canyon" or "Queen Mary") at Hanford.

## 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.



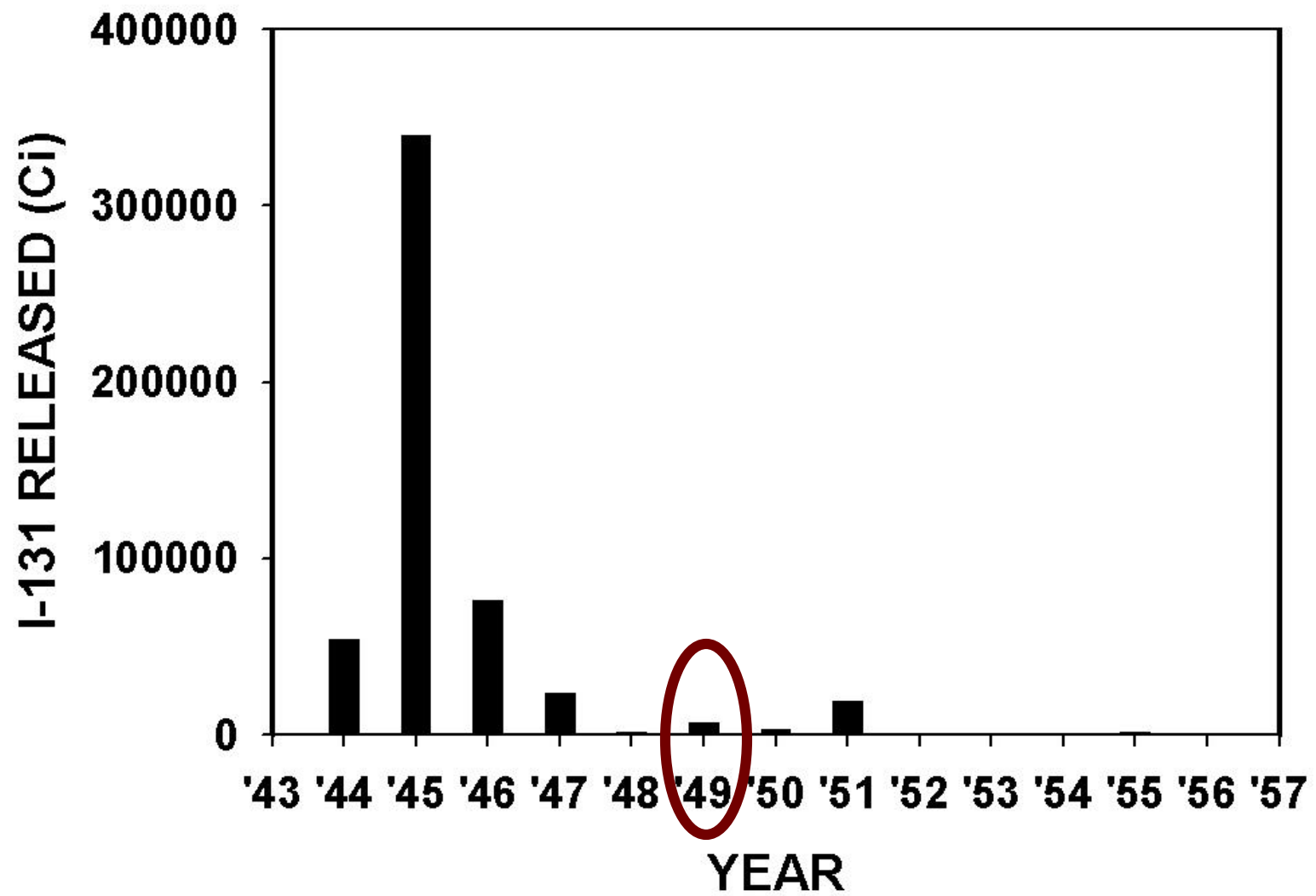
Iodine-131  
concentrates in  
the thyroid.

People were also exposed by . . .

— eating contaminated fruits and vegetables. —

— breathing contaminated air. —





# The Green Run - 1949

**28,000 curies of radioactive gases were released from the Hanford plant, apparently to test methods of detecting nuclear weapons production and testing in foreign countries. This release resulted from the reprocessing of three tons of irradiated uranium fuel that had been allowed to cool only 16 days (rather than the more typical 100-days) after its removal from the reactor.**

**WHAT HAPPENED  
AT LOS ALAMOS?**





## ALAMAGORDO, NM





TRINITY, July 16, 1945

# Hiroshima (August 6, 1945)



**WHAT HAPPENED OVER  
THE PACIFIC?**

**The United States conducted above ground nuclear tests, from 1945 to 1962. After the Limited Test Ban Treaty in 1963, the tests went underground. Right: 6/9/62 Christmas Island (now Kiribati), Pacific Ocean.**



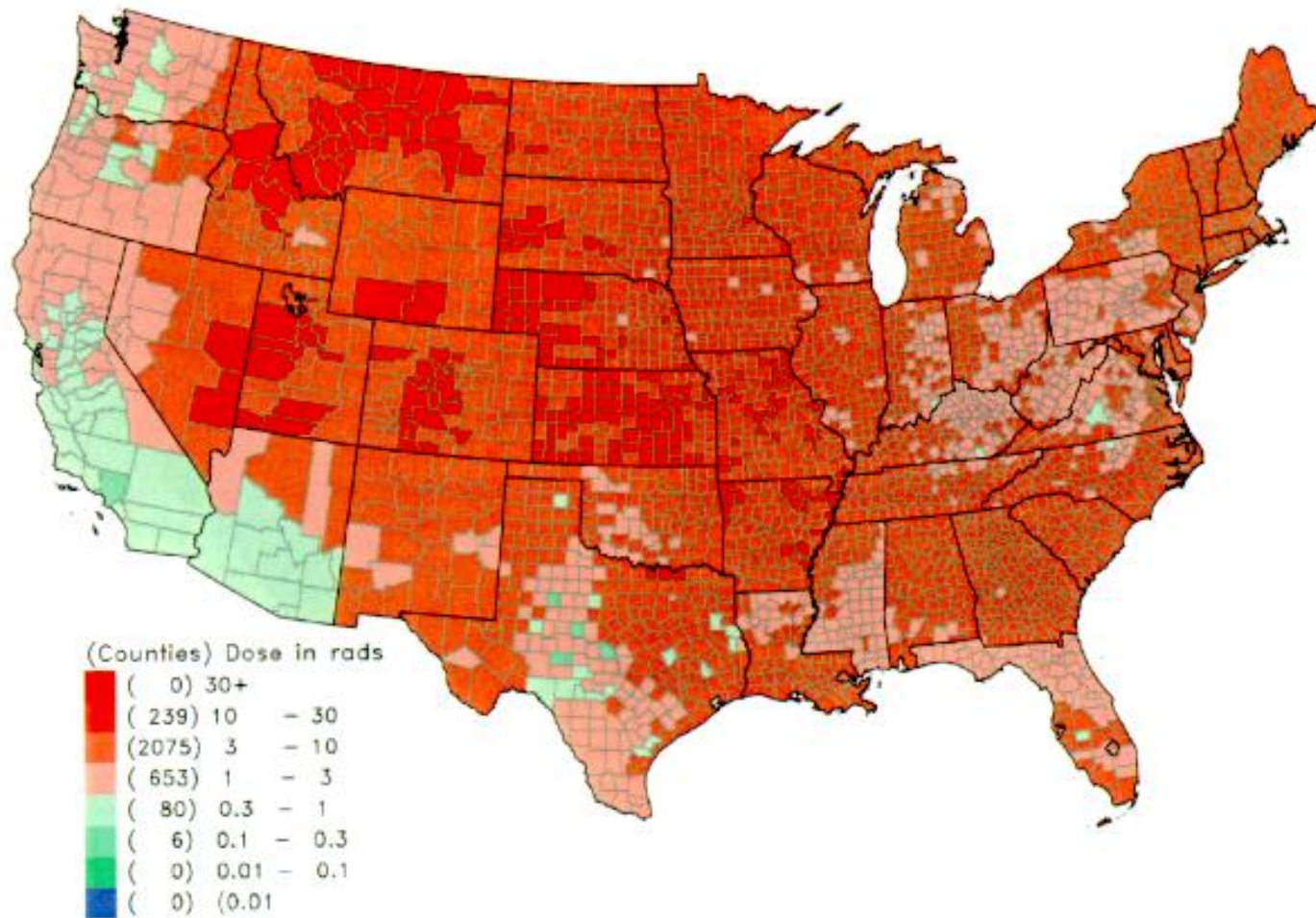




**6/29/58 Enewetak atoll, Pacific Ocean**

# I-131 Exposure from A-Bomb Tests

**Figure 8.10.** Estimates of I-131 thyroid doses for persons born on January 1, 1940 (Average diet; high milk consumption)



Start Over

Back One Page

Remove Last Entry

Clear all Entries

Use these buttons for navigation during data entry. Use of the browser back button may result in loss of data.

For the time period from January 1951 through the end of 1971:

1. Select the state where you lived from the pull-down menu
2. Click "Select County" to view a list of counties in your state
3. Select the type and amount of milk that you consumed from the pull-down menu

**Begin Date**

[more...](#)

January / 1951

**Where did you live?**

[more...](#)

New York / Bronx

[Change](#)

**What type & amount  
of milk did you  
mostly drink?**

[more...](#)

Cow: 1 to 3 glasses/day



4. If you moved to another county before the end of 1971 and/or changed the type or amount of milk that you drank, click -->

[Insert Additional Information](#)

5. When there are no further changes to the information entered above, click -->

[Calculate Dose](#)



# I-131 Thyroid Dose/Risk Calculator for NTS Fallout

Start Over

Modify Inputs

Back One Page

## Estimated thyroid dose from exposure to I-131 in NTS fallout

The best estimate of the thyroid dose you received is **3.9 rad**.

However, no person's dose can be known with complete certainty. It is unlikely that your dose was lower than **1.8 rad** or higher than **11 rad** (this is a [90% uncertainty range](#)).

What is my risk of thyroid cancer?

Calculate Risk

### What is a "rad"?

The "rad" is a unit used to express radiation dose. It is a measure of the energy absorbed in the organ or tissue exposed to radiation.

### How many rad of exposure are in everyday life events?

Everyone is exposed to radiation in the course of everyday life. There is a natural "background" radiation (from, for example, cosmic rays) and on average this background radiation exposes a person's thyroid to about **0.1 rad** per year.

A single chest x-ray gives a thyroid dose to a person of about **0.007 rad**. One transcontinental round-trip flight gives a thyroid dose of about **0.005 rad**.

# “What happened here”

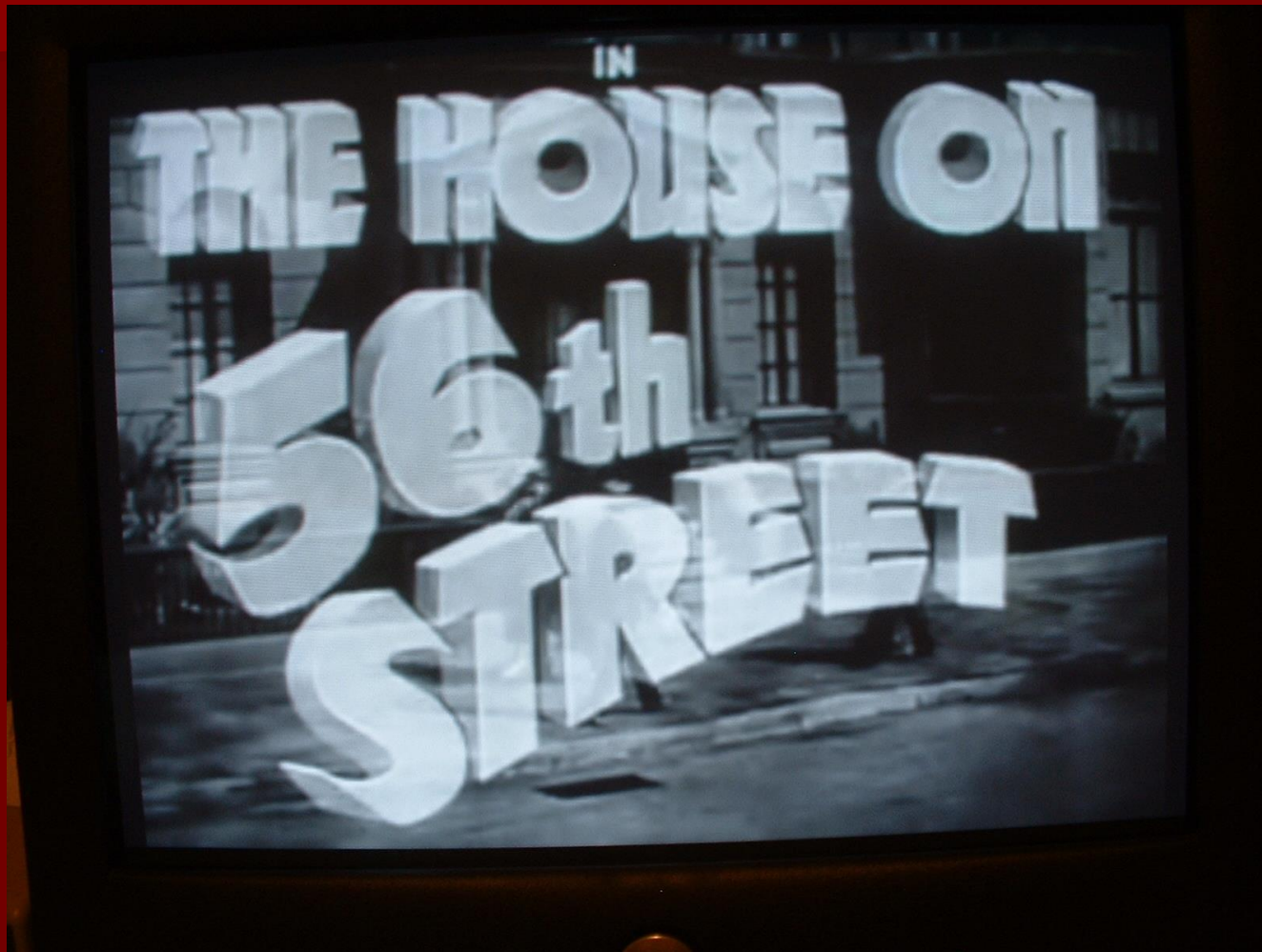
A personal perspective

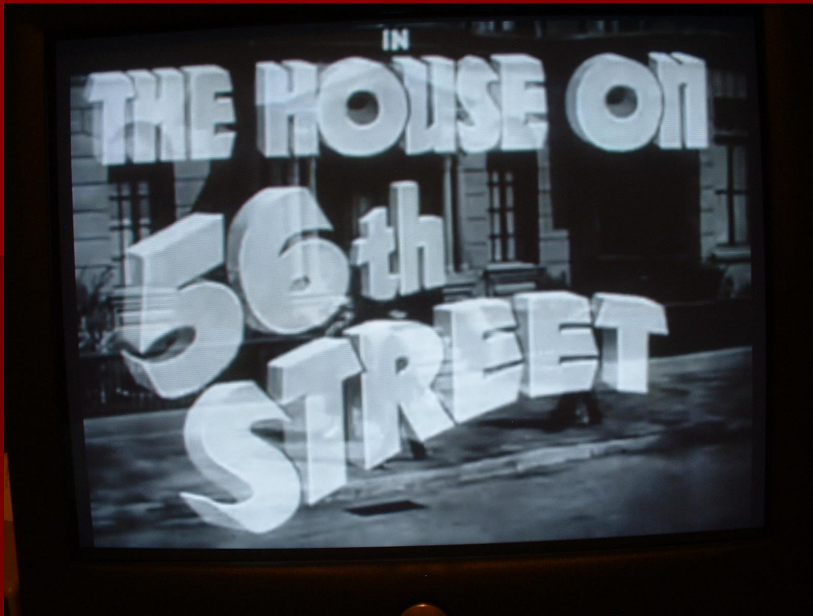
# Dr Leff's Maternity Hospital

- In some U.S. hospitals, every child received radiation treatment to shrink the thymus gland and prevent “crib death”.
- Dr. Leff's Maternity Hospital does not exist anymore. Like millions in my birth cohort, I really do not know if I received such treatments.



# At the Movies





**MOVIE:** It is the World War II period, and Peggy Martin, a showgirl and mistress to London Fiske, marries her love, handsome Monte Van Tyle. They move into the house on 56th street and have a baby, ...

**REALITY:** A clinic to perform tonsillectomies was located in the house on 56<sup>th</sup> Street.  
"Count backwards from 100."  
"When we are finished you can have as much ice cream as you want."

# Michael Reese Hospital

Radiation  
treatment  
was an  
alternative to  
surgical  
tonsillectomy





# THE SATURDAY EVENING POST

AUGUST 14, 1948

15¢

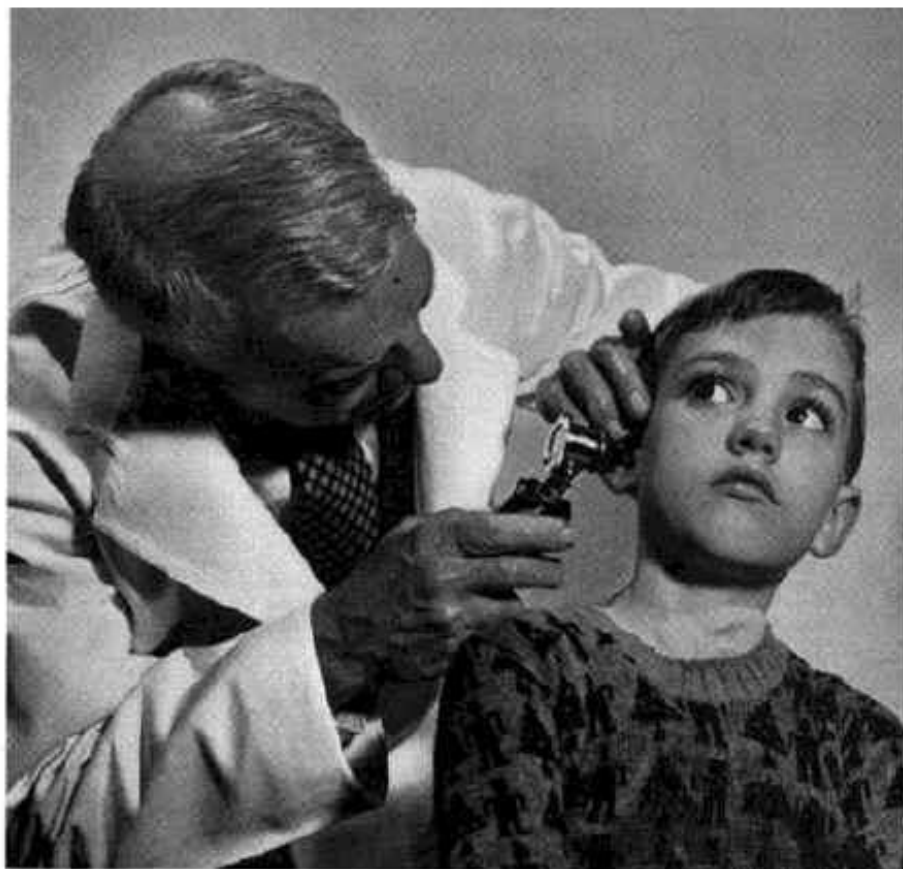
## Will Your Child Be Deaf?

By MYRON STEARNS

An estimated 4,000,000 American children have middle-ear defects that will lead to varying degrees of deafness in later life. But something can be done about it—if it's done in time.

**K**ATHLEEN, my friend Don Cooley's daughter, is eight years old. Last winter, when she was seven, Don and his wife began to be a little worried about her, because she had had so many colds. She seemed to be unduly susceptible to them. Her nose would be blocked, and for days her whole head would be stuffy. Since Don is an unusually well-read citizen who has written a good deal on medical subjects, he wondered if her hearing was being affected. She was dropping behind a little in schoolwork. So he took her to a good otologist, which is the full name medics give to ear doctors.

Kathleen's examination showed that her hearing in the higher tones—far up above high C—which usually makes no difference at all in understanding ordinary conversation, wasn't quite so good as it ought to be. Fortunately, her doctor was thoroughly familiar with the amazing but still little-known story that this article is going to tell you. So he



Dr. Samuel J. Crose, of Johns Hopkins, and a patient. This otologist, a leader in the war on impaired hearing, says: "The public should be taught to think of most deafness as a preventable disease."

a wire called an applicator. Kathleen's nose was given a quick spray with a mild local anesthetic—whiff, whiff—so that she wouldn't be bothered by the wire, which was then gently inserted along what

gun to block the Eustachian tubes. She had three treatments similar to those given to Kathleen.

Within a few weeks Kathleen began a complete metamorphosis. Her hearing improved wonderfully, so

THE SATURDAY EVENING  
**POST**  
AUGUST 14, 1948 15¢



Treatment is easy for an expert: A radon (radium extract) applicator is inserted in the nostril.

# Nasopharyngeal Radium Irradiation

## ■ Children

- By determining the cost of each radium applicator, how many were sold and how much was charged for each treatment, and assuming that the physician did not lose money, the number of treatments was in the millions.

## ■ Adults

- Submariners and aviators who could not accommodate adequately to pressure changes.



“Mom, can we go to the shoe store?”

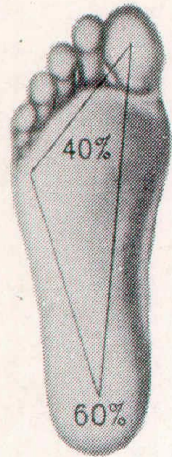


# CERTIFICATE

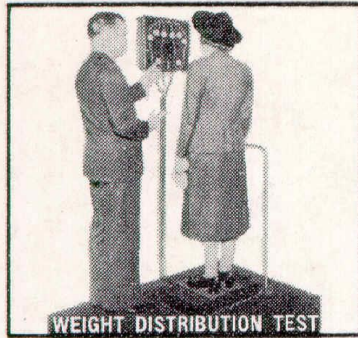
SHOE-FITTING TEST DATA FOR \_\_\_\_\_

1. **ANKLE ROLL**    GOOD ☐    FAIR ☐    POOR ☐

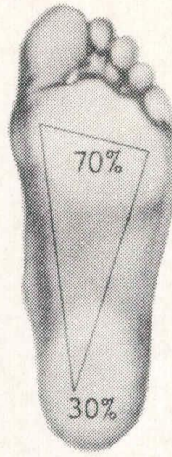
## 2. **WEIGHT DISTRIBUTION**



RIGHT  
WAY

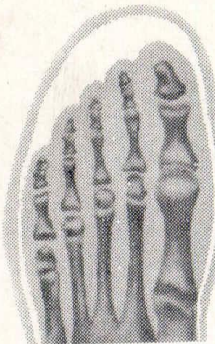


LEFT		RIGHT	
_____ %	BALL	_____ %	
_____ %	OUTER	_____ %	
_____ %	HEEL	_____ %	



WRONG  
WAY

## 3. **X-RAY FITTING TEST**



RIGHT  
WAY



LEFT		RIGHT	
<input type="checkbox"/>	GOOD	<input type="checkbox"/>	
<input type="checkbox"/>	FAIR	<input type="checkbox"/>	
<input type="checkbox"/>	POOR	<input type="checkbox"/>	



WRONG  
WAY

**This scientific way of approaching the problem of poorly-fitted shoes eliminates guesswork. Now you can see for yourself!**





## SCIENTIFIC SHOE FITTING AT ITS BEST

On Dr. Scholl's Fluoroscopic Shoe X-ray you can see the position of the bones in your feet right through the shoe. In addition to this checkup other methods of scientific shoe fitting will be employed here during this special demonstration,

# Dr. Scholl's

SHOE FITTING  
EXPERTS FROM THE  
CHICAGO FACTORY

will be in our store  
**Monday, February 15th**

They bring with them the complete line of Dr. Scholl's Shoes (622 fittings) . . . every size, width and style — for every type foot. X-ray fitting—as well as other Dr. Scholl shoe fitting devices. Now you can obtain the shoe that will give you perfect satisfaction—and if you have foot troubles you will be shown how to obtain relief, quickly and inexpensively. Be sure to attend this great DISPLAY and DEMONSTRATION . . . first of its kind in this city.

**GEO. S. MERCHANT**  
**Winter Garden, Fla.**

# ERA II: The age of discovery

1950 (Annus mirabilis) to  
1973

# Louis Hempelmann

Born: March 5, 1914

Died: June 30, 1993

# Louis Hempelmann

- 1934 A.B. - Washington University, St Louis**
- 1938 M.D. - Washington University (graduated first in class)**
- 1939 Pathology Internship Washington University**
- 1941 House Officer (Medicine) – Peter Bent Brigham Hospital, Boston**
- 1942 Commonwealth Fellow with John Lawrence at Berkeley (4 months)**



# Louis Hempelmann

**1942-46**

**Instructor in Radiology at Washington University**

**1943**

**Arrives at Los Alamos to be health director**



**June 5, 1943**

**Married Elinor Pulitzer (daughter of Joseph Pulitzer II) who had worked for him at Barnes Hospital**

# Louis Hempelmann with J Robert Oppenheimer



# Louis Hempelmann

At Trinity test

## TRINITY, July 16, 1945











# Louis Hempelmann

**August  
1, 1944**

**An accident at Los Alamos occurred when Don Mastick ingested plutonium and Hempelmann pumps stomach**

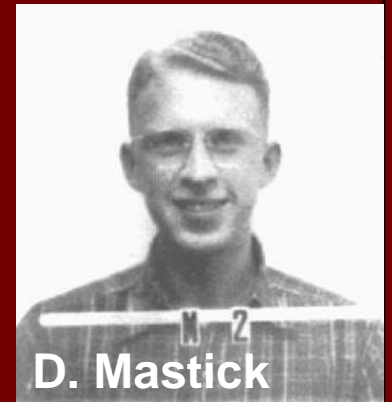
**August,  
1944**

**Hempelmann's letter to J Robert Oppenheimer recommending human experiments**

**August  
16, 1944**

**Oppenheimer approves experiments and provides "product" (plutonium) for them. The goal was to learn how to monitor for exposure**

**Carried out at the University of Chicago and the University of Rochester, these experiments are cited for the lack of full disclosure to the participants, some of whom were terminally ill with cancer.**



# Louis Hempelmann

- 1943-48**    **Health Division Leader at Los Alamos**
- 1948**       **Goes to Boston to study safety measures in the radium industry. Research Associate Harvard, consultant in biophysics Massachusetts General, Special Assistant Division of Biology and Medicine, US Atomic Energy Commission.**
- 1949**       **Article in NEJM about shoe-fitting fluoroscopy**
- 1950**       **University of Rochester**

# 1950

## Duffy and Fitzgerald Recognize Relationship to Thyroid Cancer, Publish Retrospective Series

CANCER OF THE THYROID IN CHILDREN:

A REPORT OF 28 CASES\*†

B. J. DUFFY, Jr., M.D.‡ AND P. J. FITZGERALD, M.D.

*From the Department of Clinical Investigation, Sloan-Kettering Institute; and the  
Department of Pathology, Memorial Hospital, New York, N. Y.*

\*Read at the Annual Meeting of the American Goiter Association,  
Houston, Texas, March 10, 1950.

### JCEM and Cancer, 1950

# Louis Hempelmann

In 1950 Robert W Miller MD was assigned by Atomic Energy Commission to University of Rochester. In his Memoriam to Hempelmann (1993) he wrote:

“In 1950 he [Hempelmann] joined the faculty at the University of Rochester as an Associate Professor of Experimental Radiology. **Benedict Duffy**, who came to a neighboring department soon after, had just published on a case-series of 28 children who had developed thyroid cancer. Surprisingly, 10 had received thymic radiotherapy as infants.

At the same time, *a pediatrician from the Atomic Energy Project* at the University noted that when x-ray films were ordered on small children, fluoroscopy (high dose) was done routinely, as required by the Radiology Department. The Chairman of Radiology believed that fluoroscopy provided better information on a squirming youngster. Pediatricians began to write on the x-ray requests, “Film only, no fluoroscopy.” *An unfriendly interdepartmental meeting led to a change in policy after it was shown that a 3-pound infant had received seven fluoroscopies plus 75 R to the thymus in the first month of life. Soon after, Louis, who was at the meeting, began his now-famous studies of infants who had been given radiotherapy for thymic enlargement.* “

# Louis Hempelmann

- 1950** Thymus radiation study started. Eventually including ~2800 exposed and ~5000 siblings
- 1955** First publication (with C. Lenore Simpson) on radiation and thyroid cancer in a cohort
- 1960-71** Chairman of Radiology at Rochester
- 1968** First dose-response curve published for the relationship between radiation and thyroid cancer (Science)



# Louis Hempelmann

## Thymus study: partial concealment

- 1962** “...the survey was a follow-up study of children treated in infancy for an enlarged thymus gland. No mention was made of X-ray treatments.”
- 1964-5** High risk group (261 of 2872) notified of risk
- 1971** All exposed subjects were notified of risk

# Louis Hempelmann

**1985**                      **Last publication on radiation and  
thyroid cancer**

**June 30, 1993**       **Died in Rochester, NY**

# Louis Hempelmann

- Ahead of his time
  - Proved association (cause) between radiation and thyroid cancer
  - Prospective, controlled cohort study in epidemiology of chronic disease
- A reflection of his time
  - Childhood radiation follow-up surveys and other studies with incomplete disclosure and deception

# Louis Hempelmann

- Changed medical practice although he was not a practicing physician
- Set a standard in epidemiology although he was not a trained epidemiologist
- Was a pioneer in radiation health physics although he was not a trained health physicist
- Chaired a Department of Radiology although he was not a practicing radiologist

# ERA III: The age of call back programs

1974 (Michael Reese  
Hospital) to 1985



**1973: DeGroot and Paloyan notice a  
“Chicago Endemic”**

**Thyroid Carcinoma  
and Radiation  
A Chicago Endemic**

**Leslie DeGroot, M.D.; Edward Paloyan, M.D.**

**JAMA, 1973**

# Michael Reese Hospital

- 4,296 children were irradiated for benign conditions, predominantly enlarged tonsils, between 1939 and the early 1960's



# 1974: Chicago Newspapers Learn of Michael Reese Hospital Study



1976: Wins  
'seal of  
approval'

# *Good Housekeeping*

May 1976



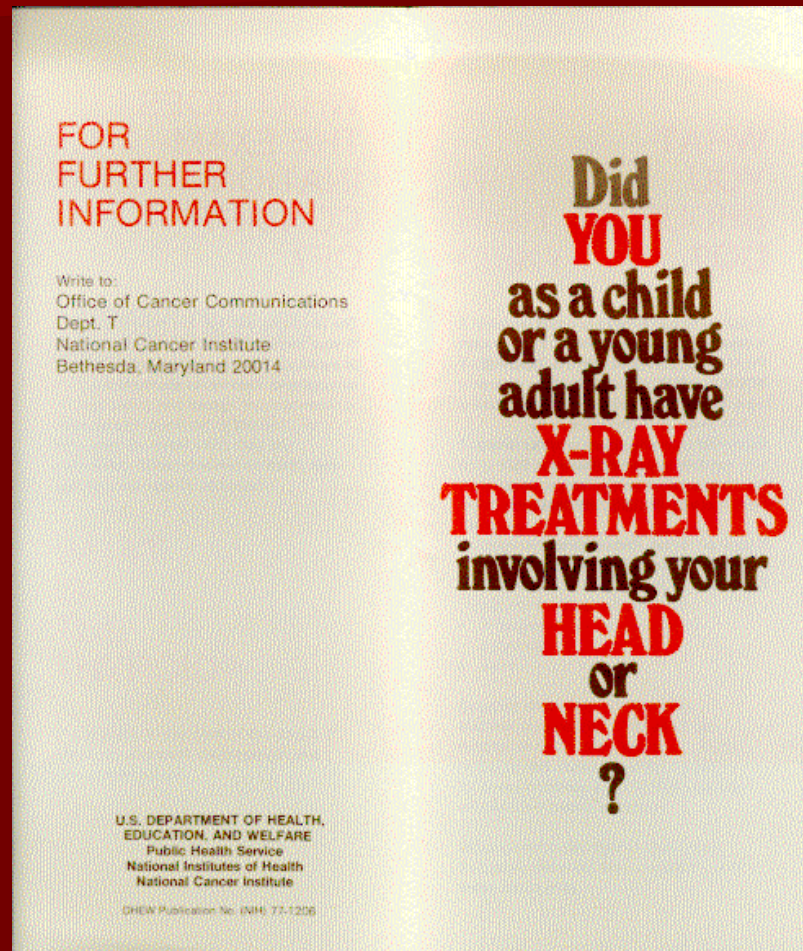
Years ago, as many as a million children with minor illnesses were given a "miracle" cure—a cure now known to cause cancer. Recently, a Chicago hospital launched the most massive recall in medical history. Its purpose: to find and help the victims.

By Charles and Bonnie Remsberg

We thought you would like to see this story which appeared in the May 1976 issue of *Good Housekeeping*, circulation 5.6 million. Additional copies are available from the Department of Public Relations, Michael Reese Hospital and Medical Center, 29th Street and Ellis Avenue, Chicago 60616 (phone: 791-2330).



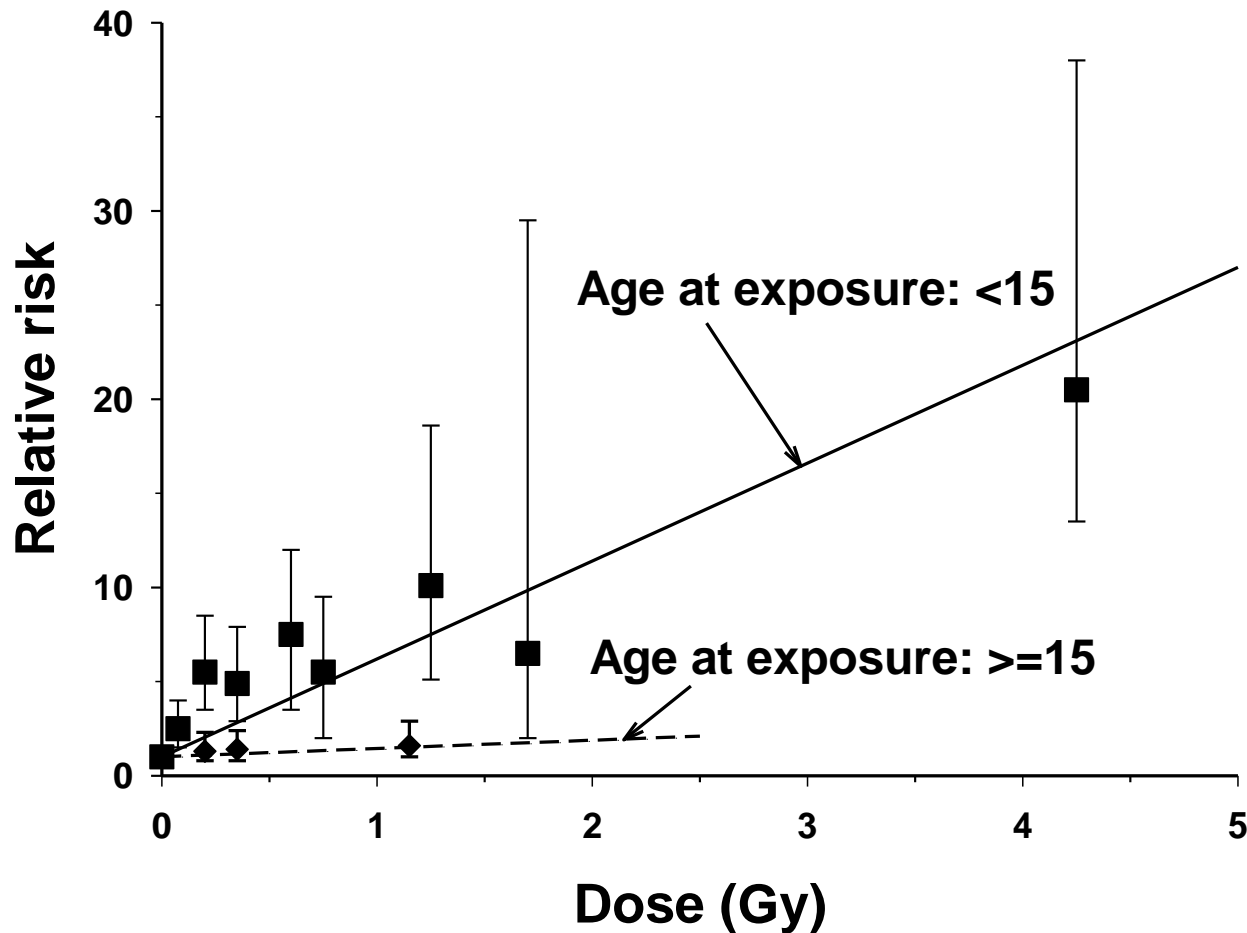
# 1977: NCI/NIH Notification brochures appear





# The pooled analysis

## Dose-response by age at exposure



**Ron E, et al. Radiation Research 1995**

# ERA IV: The age of Chernobyl

1986 to the present

# Where is this?



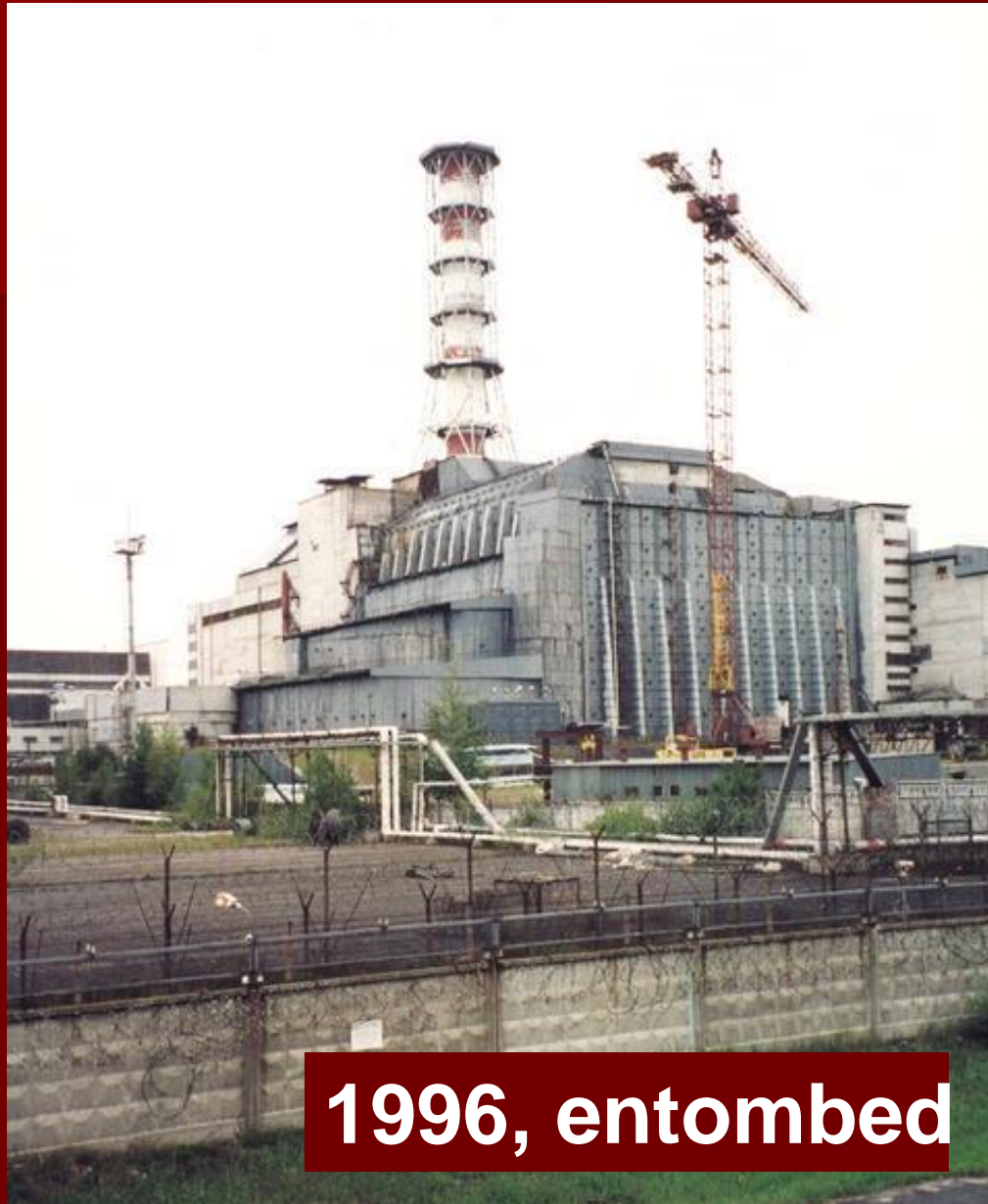
Three Mile Island  
March 28, 1979

# WHAT HAPPENED AT CHERNOBYL?

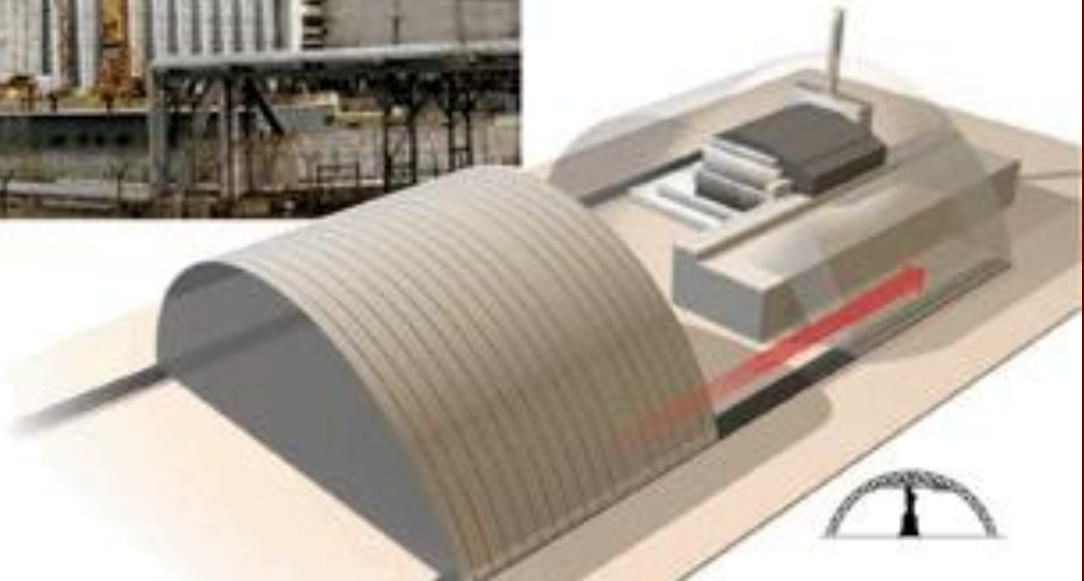
**1986**





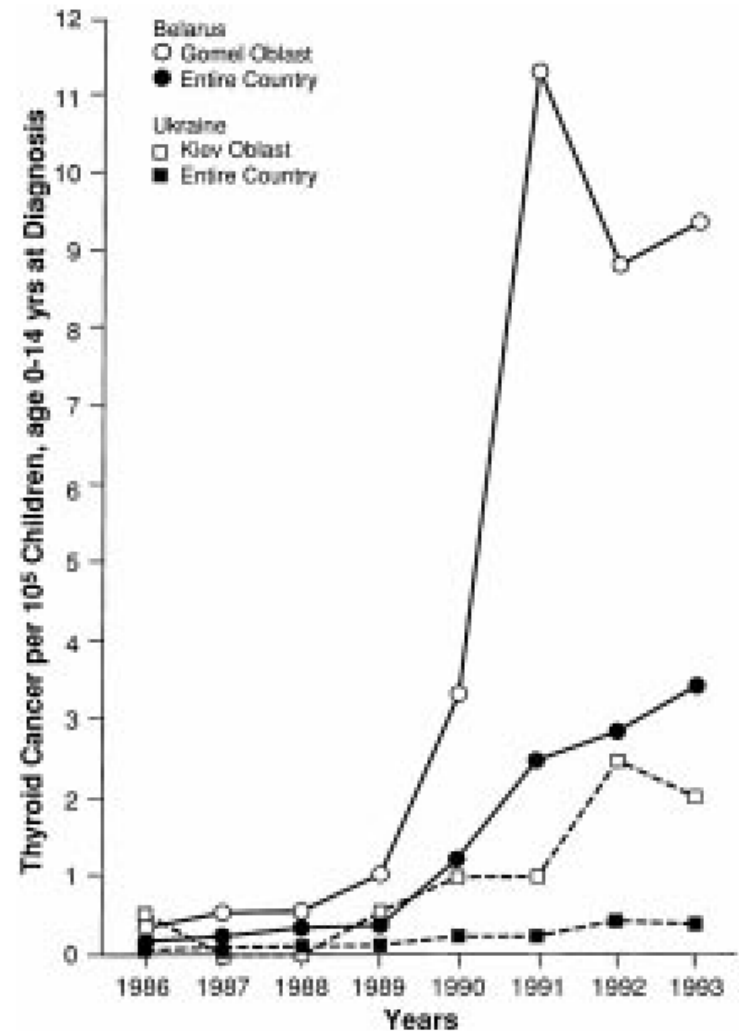


**1996, entombed**



**2006, plan for steel arch cover**

# Childhood thyroid cancer after Chernobyl



*Fig. 1. Annual incidence of thyroid cancer per 100,000 children in Belarus and Ukraine and in the region of each republic with the highest contamination from the Chernobyl accident that began on April 26, 1986. Radioiodine release ended 10 days later. Reproduced with permission [20].*

# THE PRESENT ERA

What remains to be learned?

# Some Unresolved Questions

- Will the U.S. (and world-wide) incidence of thyroid cancer continue to increase?
- If the increase is due, at least in part, to radiation exposure, will more aggressive cases begin to appear?
- Is there a clinical role for screening?
- How do the risks of external and internal radiation (from radioiodines) compare?



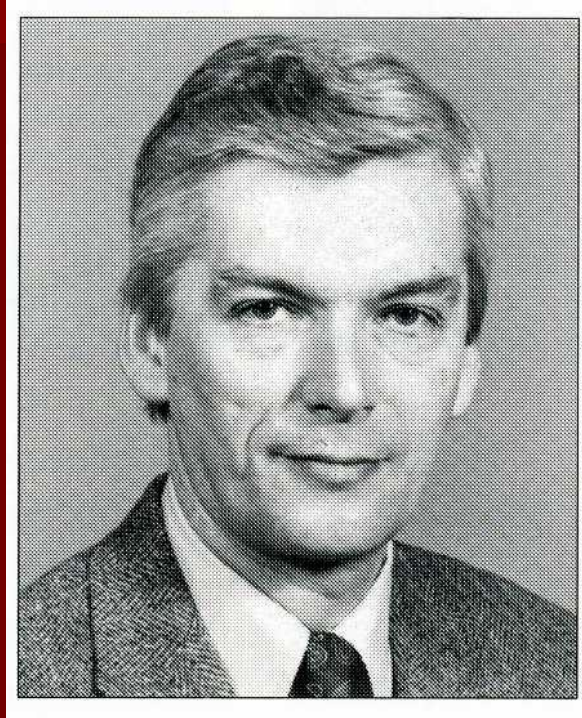
# Some Unresolved Questions

- Why is age at exposure such an important factor for radiation-related thyroid cancer?
- How long beyond 30-40 years do the effects of radiation persist?
- Are there genetic susceptibility factors for radiation exposure?

# Acknowledgements

- Atomic Archive, enhanced edition
- Radiology Department of Rochester University
- Alvin L. Ureles, University of Rochester
- Fred Mettler, University of New Mexico
- Writings of Robert W. Miller (deceased), NCI

# Remembrance



Dr. Clark Sawin

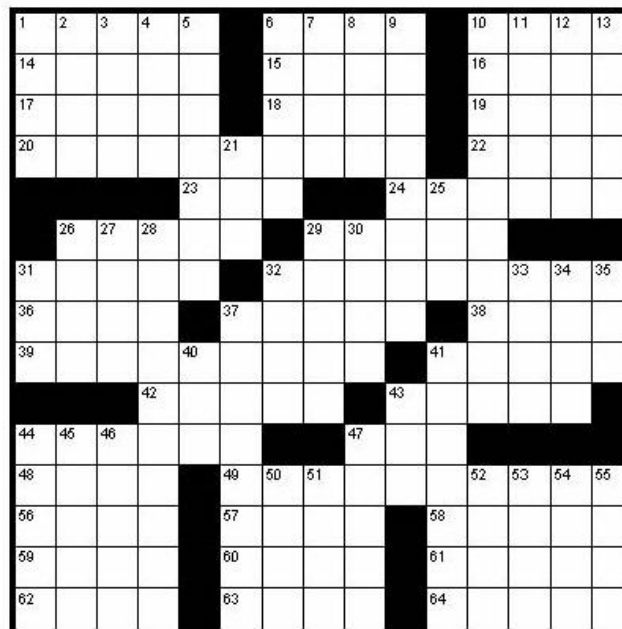




American Thyroid Association, Oct 4, 2007  
In honor of ATA's  
"Puzzle Master"

**ACROSS**

1. Stone or brick worker
6. Santa \_\_\_\_, California
10. Cut into the surface of
14. One who is hostile
15. Cleave or split asunder
- \*16. Most important cause of thyroid cancer
17. Beer mug
18. Ocean liner location
19. Plays on words
- \*20. Type of annual lecture given in honoree's name
22. Make over
23. Schmatte
24. King of the fairies, husband of Titania
26. Matter-of-fact and dry
29. Hitchcock's motel
- \*31. Honoree's given name
32. A female inheritor
36. Precipitation
37. Characteristic of a beach fit for swimming
38. Salesman's goods
39. Opens the gate
- \*41. Honoree's surname
42. Neptune has 13, including Triton
43. Actor Errol, born 1909
44. Stir up trouble
47. Group of lawyers, *abbr.*
48. Persia today
- \*49. City of honoree's epidemiological study
56. Food on an angler's hook
57. Indian prince
58. It is sometimes wild
59. Sicilian spewer
60. Seventh letter of the Greek alphabet, *plural*
61. Unpleasant medical procedure
62. To stagger or sway
63. "The lecture is starting, I'm all \_\_\_\_"



64. Useful button at a bowling alley.

**DOWN**

1. Cause gear teeth to engage
2. Against
3. Observes
4. Leave out
5. Language of Norway, literally "new Norwegian"
6. Founder of an on-line list
7. A computer architecture, *abbr.*
8. Middle layer of the eye
9. Excessive fanaticism
10. A rapid road
11. More faithful
12. Enthusiastic kind of person (slang)
13. Chinese green tea type

21. Sugar \_\_ Robinson
25. Spelling contest
26. Think ahead
27. Means of terrestrial transportation
28. Plant with showy flowers
29. Elaine Marie \_\_\_\_, character on the sitcom Seinfeld
30. International infectious scourge
31. A grade or class of wine, *French*
32. Otto \_\_\_\_, co-discoverer of nuclear fission
- \*33. Homophone for 41-across
34. Poetic name of Ireland
35. Unit of Japanese currency
37. Without having to pay
40. 2,000 pound weight

41. Malicious statement
43. J. Edgar Hoover's org.
44. Filament of cotton or nylon
45. Declaim
46. NE corner of the US
47. Gather a large quantity
50. Pro \_\_\_\_, in proportion
51. Slightly open
52. Unit of inheritance
53. Tints
54. Highest point
55. Vegetarian avoidance

Thank you