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
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.

(Courtesy of Argonne National Laboratory)
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.
I-131 RELEASED (Ci)

YEAR

'43 '44 '45 '46 '47 '48 '49 '50 '51 '52 '53 '54 '55 '56 '57

ATA - 2007 Radiation, Louis Hempelmann and Thyroid Cancer
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
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 Kiritimati), 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)
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

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 -->

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

Insert Additional Information

Calculate Dose
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?

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

THE HOUSE ON 56th STREET
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 56th Street. “Count backwards from 100.” “When we are finished you can have as much ice cream as you want.”
Radiation treatment was an alternative to surgical tonsillectomy.
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.

KATHLEEN, my friend Don Cook'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 unusually susceptible to them. Her nose would be blocked, and for days her whole head would be stuffy. Since Don is an unusually well-posted 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 oto-laryngologist, which is the tall name medics give to ear doctors.

Kathleen's examination showed that her hearing was 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
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
   LEFT
   □% BALL □% OUTER □% HEEL □%
   RIGHT
   □% BALL □% OUTER □% HEEL □%

3. X-RAY FITTING TEST
   LEFT
   □ GOOD □ FAIR □ POOR □
   RIGHT
   □ GOOD □ FAIR □ POOR □

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

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

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1934</td>
<td>A.B. - Washington University, St Louis</td>
</tr>
<tr>
<td>1938</td>
<td>M.D. - Washington University (graduated first in class)</td>
</tr>
<tr>
<td>1939</td>
<td>Pathology Internship Washington University</td>
</tr>
<tr>
<td>1941</td>
<td>House Officer (Medicine) – Peter Bent Brigham Hospital, Boston</td>
</tr>
<tr>
<td>1942</td>
<td>Commonwealth Fellow with John Lawrence at Berkeley (4 months)</td>
</tr>
</tbody>
</table>
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

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</thead>
<tbody>
<tr>
<td>1943-48</td>
<td>Health Division Leader at Los Alamos</td>
</tr>
<tr>
<td>1948</td>
<td>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.</td>
</tr>
<tr>
<td>1949</td>
<td>Article in NEJM about shoe-fitting fluoroscopy</td>
</tr>
<tr>
<td>1950</td>
<td>University of Rochester</td>
</tr>
</tbody>
</table>
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.


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)
<table>
<thead>
<tr>
<th>Year</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1962</td>
<td>“…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.”</td>
</tr>
<tr>
<td>1964-5</td>
<td>High risk group (261 of 2872) notified of risk</td>
</tr>
<tr>
<td>1971</td>
<td>All exposed subjects were notified of risk</td>
</tr>
</tbody>
</table>
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

Past X-ray patients hunted

Neck X-Ray Patients Are Cancer Targets

CHICAGO (UPI) - Michael Reese Hospital officials are looking for about 2,000 X-ray patients who are now being traced.

X-ray patients are sought, will be tested for cancer

CHICAGO (UPI) - Michael Reese Hospital officials are looking for answers to 3,200 former patients asking them to undergo an examination.

Chicago medical center

Thousands of persons being traced

During the depression, radiation was used as a method of inducing the immune system to fight cancer. Michael Reese Hospital and others began testing the patients who were operated on.

Recent studies have shown that the procedure was harmful.
1976: Wins ‘seal of approval’

Good Housekeeping

May 1976

THE HOSPITAL THAT CARED!

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 Rensberg

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: 791-2530).
1977: NCI/NIH Notification brochures appear
The pooled analysis

Dose-response by age at exposure

Dose (Gy)
0 1 2 3 4 5
Relative risk
0 10 20 30 40
Age at exposure: <15
Age at exposure: >=15

ERA IV: The age of Chernobyl

1986 to the present
Where is this?

Three Mile Island
March 28, 1979
WHAT HAPPENED AT
CHERNOBYL?
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. Radiocesium 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
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
16. 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. Makes over
25. Schnitte
24. King of the fairies,
husband of Tinker Bell
26. Facts of fact and

day
29. Hitchcock's model
*31. Honoree's given
name
32. A female inheritor
36. Precipitation
37. Characteristic of a
beach fit for
swimming
38. Sailor's goods
39. Opens the gate
*41. Honoree's surname
42. Neptune has 13,
including Triton
45. Actor Emile, born 1909
46. Stir up trouble
47. Group of lawyers,
nee
48. Persia today
*49. City of honoree's
anthropological study
56. Food on an angler's
hook
57. Indian prince
89. Scion of the
90. Seventh letter of the
Greek alphabet, plural
61. Unpleasant medical
procedure
62. To stagger or sway
63. "The lecture is
starting, I'm all ____"

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 online
list
7. A computer
architecture, abbr.
8. Middle layer of the
eye
9. Excessive fanaticism
10. A rapid lead
11. More faithful
12. Enthusiastic kind of
person (olag)
13. Chinese green tea
40. Useful button at a
bowling alley
41. Sugar ____ Robinson
42. Spelling contest
43. Think ahead
44. Means of terrestrial
transporation
45. Plant with showy
flowers
49. Elaine Marie ____
character on the
sitcom "Seinfeld"
50. International
infectious scourge
51. A grade or class of
wine, French
52. Otto ____ co
discoverer of nuclear
fusion
53. Homophone for 41-
across
54. Poetic name of
Ireland
55. Unit of Japanese
currency
57. Without having to pay
59. 2,000 pound weight
60. Malicious statement
63. J. Edgar Hoover's
org
64. Filament of cotton
or nylon
66. Declaim
67. Ni corner of the US
69. Catch a large
quantity
70. Pro ____ in
proportion
71. Slightly open
74. Unit of inheritance
75. Tints
77. Highest point
78. Vegetarian
avoidance

American Thyroid Association, Oct 4, 2007

Radiation, Louis Hempelmann and Thyroid Cancer
Thank you