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URANIUM MINERS HEALTH

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HEARINGS ON SAFETY AND HEALTH STANDARDS

BUREAU OF LABOR STANDARDS

U. S. DEPARTMENT OF LABOR

20 November 1968

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BIOGRAPHY

Geno Saccomanno, born July 4, 1915, at Spring Glen, Utah; pre-college education, Spring Glen and Price, Utah; B.S. and M.S. degrees, 1938 and 1940, University of Utah; Ph.D. and M.D. and Pathology training all at St. Louis University, 1940-1948. Pathologist, St. Mary's Hospital and Veterans Administration Hospital, Grand Junction, Colorado, 1948 to present. Society memberships include: Colorado Medical Society, American Medical Association, American Board of Pathology, American College of Pathology, and Sigma Xi. Publications: About 15.

RADIATION EXPOSURE OF URANIUM MINERS

LABOR DEPARTMENT HEARINGS

November 20, 1968

Radiation exposure of uranium miners has attracted considerable interest in recent years (1) (2). Most of this interest has been directed at the evaluation of radon gas inhaled by miners in the uranium mines. Radon gas in the uranium mines has been linked or identified as a carcinogenic agent producing cancer of the lung (3). The exact role of radon gas as it affects the bronchial epithelium is not known. The levels of radon gas and its daughter products have varied markedly since uranium mining started on the Colorado Plateau in 1930, being very high in the late 40's and early 50's (4).

This discussion today centers upon whether or not the 1 WL should be lowered. There is some evidence that this level should not be lowered and it is my candid opinion that probably it should be raised. There is evidence that other factors play a most important role and should be given proper evaluation. The following facts are based on experience with the uranium miners, their habits, and, most important, on extensive work done on the miners, relative to sputum, tumors, etc., with attempts to encourage them to quit cigarette smoking.

My presentation, if I may, will consist of three main avenues of discussion and these are:

- 1) Synergism of cigarette smoking and radon daughters as the

carcinogenic agent of cancer of the lung in uranium miners.

- 2) The banning of cigarette smoking in the uranium mines with encouragement that miners cease cigarette smoking altogether.
- 3) Predicted and actual number of deaths in uranium miners with cancer of the lung.

Since cancer of the lung in uranium miners who are non-cigarette smokers is almost unheard of, and since the incidence of cancer of the lung is increased in cigarette-smoking, uranium miners at least four-fold over and above the incidence levels of heavy cigarette smokers (40 cig/day), then it must be admitted conclusively that cigarette smoking and mining develop a synergistic effect of these two toxic agents, producing a potent carcinogenic agent.. (Fig. 1 and 3)

The 1968 supplement to the 1967 Public Health Service Review, "The Health Consequences of Smoking", and the many other publications on research of cigarette smoking as a causative agent of cancer of the lung proves that cigarette smoking causes cancer of the lung. This data is voluminous, conclusive, and unequivocally proves cause and effect (5). I don't believe there is any question about the fact that cigarette smoking causes cancer of the lung, as well as cancers elsewhere in the human body.

In a recent publication, "Radiation Exposure of Uranium Miners", the NAS (National Academy of Sciences) et. al. (6) advisory committee to

the Federation Council summarized well the smoking habits of uranium miners and the incidence of cancer among cigarette smoking and non-cigarette smoking uranium miners. (Page 21)

"6.14 Among the white underground miners in the U. S. Public Health Service Study Group, 78 per cent were smokers and 22 per cent non-smokers. Sixty of the 62 deaths from lung cancer to date have occurred in smokers. The number of lung cancer deaths expected on the basis of general population rates was 10.1. Given a relative risk of 10 for smokers vis-a-vis non-smokers, these expected deaths would have broken down as 0.3 in non-smokers and 9.8 in smokers. The deaths in excess of 10.0--that is, 51.9 deaths--are the deaths attributable to uranium mining. If these deaths occurred independently of smoking, we would expect to find them distributed by smoking habits in the same proportion as the mining population; that is, 22 per cent of them, or 11.4 deaths, would have been in non-smokers. The occurrence of only two deaths in non-smokers is not likely to be due to chance (p 0.01)." In short, this actually means that there is a very potent synergistic effect in cigarette smoking and radon daughters, and that, in the absence of cigarette smoke, I do believe that cancer of the lung would be nearly non-existent on the Colorado Plateau.

Why, then, the concern about radon levels in uranium mines? The answer probably lies in the fact that we can control radon levels, but we are incapable of controlling cigarette smoking among uranium miners.

Some of the uranium producers have presented programs on the hazards of cigarette smoking in the hopes that some of the miners would shed the habit.

There is some evidence in the literature that there exists a possible potentiating or carcinogenic action of two other agents in the development of cancer of the lung, for example: Kotin and Wiseley (7), "where mouse-adapted influenza virus and an aerosol of ozonized gasoline are both essential irritants in the production of cancer of the lung". Since, I believe that cancer of the lung in uranium miners is caused by the synergistic effect of cigarette smoking and radon--and since the radon daughters are of such short life (less than two hours) (Fig. 4)--then, assuming that the synergism of cigarette smoke and radon daughters potentiate to injure the respiratory epithelium, the possibility exists that this combination may be interrupted by not allowing cigarette smoking while in the mine, when the air inspired contains radon. (Fig. 1) Naturally, it would be preferable that uranium miners not smoke cigarettes at all, but the second best thing is that they should not smoke while mining uranium. This has not been evaluated, but might be of sufficient importance, particularly since it is not known how and when this synergism takes place, that cigarette smoking should be banned in the uranium mines. Cigarette smoking is not allowed in coal mines because of the potential explosion of gases. Possibly cigarette smoking should be banned in uranium mines

for a different type of gas explosion.

The Woodward Fondiller report, "Probable Numbers and Costs Through 1985 of Lung Cancer Cases Among Uranium Miners", February 2, 1967, (8) presented estimates of the number of uranium miners who will die of cancer of the lung. The predicted peak (Extrapolation) was expected in 1972. This, exclusive of the many factors which may change the expected, was based on the assumption that 5,000 WLM would yield one cancer of the lung.

A record has been kept at St. Mary's Hospital on all of the deaths in uranium miners from cancer of the lung since 1955, and the curve produced follows that prepared by the above, but 1966, 1967, and 1968 have failed to yield the expected and predicted number of cancers of the lung. (Fig 2) Our figures include all known cases of lung cancers among uranium miners, including those that have died from this disease in other hospitals on the Plateau, but do not include a search from the Social Security files on deaths in this population, and therefore, other cases conceivably might have died elsewhere and are unknown to us. Our data can be assumed to be reasonably accurate, however, particularly since our curves followed essentially the same plane prior to and including 1965. This sudden down-trend in the curve may be due to many factors, and some are listed below:

- 1) Our data may not include all of the cases of uranium miners who have died from cancer of the lung. A long time has

passed since the early 50's and some of these cases may have wandered to all parts of the world and their deaths would not be known to us. This is unlikely to account for so many cases, particularly since our curves paralleled quite closely up to 1965.

- 2) Our data has not been evaluated completely, statistically, but, although crude, it is probably very correct. We have not had a single death from cancer of the lung in a uranium miner at St. Mary's Hospital in Grand Junction, Colorado, since July 20, 1968.
- 3) The effects of WLM damage may have been reduced with time. The damaged tissue may recover, as the damage of cigarette smoke is reversible.
- 4) Present 1 WL to 3 WL may not be injurious or even accumulative, producing no effect.
- 5) The mining population has changed and many of the miners have less WLM than was predicted.
- 6) Ventilation practices may have removed other toxic agents which may have played some unknown role of carcinogenesis.
- 7) Injury at lower levels may have selectively removed those miners who were ultra-sensitive to radon alone, cigarette smoke alone, or combinations thereof. In other words, there may have existed a group of miners who were ultra-sensitive and those died in the early segment of the curve.

8) Error of assumptions in the original curve values.

SUMMARY: There is little evidence available from present data which indicates that a 1 to 3 WL is injurious to health. No evidence is available to indicate the WLM accumulated at these low levels causes cancer of the lung, and therefore the 1 WL should not be lowered.

There is evidence available that the predicted number of cancer of the lung, based on the thesis that 5,000 WLM would yield one cancer of the lung, is in error.

I believe it to be a fact that cigarette smoking and radon daughters synergistically cause cancer of the lung. Since radon and radon daughters are short lived, it would seem that cigarette smoking should be banned while miners are underground mining uranium.

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ATMOSPHERE (NON-MINING)DEGREE CARCINOGENICITY

1) Non-cigarette smoker -----	Non-miner-----	**+
2) Cigarette smoker--10 cig/day -----	Non-miner -----	*****
3) Cigarette smoker--40 cig/day -----	Non-miner -----	*****

ADD URANIUM MINING

4) Non-cigarette smoker -----	+ Radon -----	*
5) Cigarette smoker -----	+ Radon, and
smoking in the mine ----- | *****

***** |
| 6) Cigarette smoker ----- | + Radon, but not
smoking in the mine ----- | *.?.? Synergism can not take place
because only one of the factors is
present??? |

Therefore:

1. Breathing of Radon laden air alone in Uranium Mines has little carcinogenic effect.
2. Breathing of Radon laden air in a Uranium Mine by a cigarette smoker produces a potent synergistic carcinogenic agent.
3. Cigarette smoking outside a mine, but no smoking of cigarettes while in Uranium Mines would not allow the combination of the short-lived radon and cigarette products to combine in synergism, and would not be carcinogenic.

* = 5.deaths/100,000 population/year

Fig I. Synergism of short life Radon gas and cigarette smoke in Uranium Mines.

700

LUNG CANCER CASES PER 100,000 POPULATION PER YEAR

Showing Relative Incidence Among 10,000 Uranium Miners
With Variables in the Cigarette and Non-Cigarette Smokers

Fig. 3. Lung Cancer Cases - Calculated on basis of Deaths

For 10,000 Population per year. Source: SACRAMENTO, CA.

Relative α Energy Dose Rate (Percent of Rate at End of 8 Hr. Shift)

Decay of α Energy Dose
Rate to Lungs following 8
Hr. Exposure at Constant
Radon Daughter Concentration

Prepared by: R.W. SWINDELL
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Fig. 4.

Time after End of Shift (Hrs.)