



The B.F. Goodrich Company

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June 10, 1966

Dr. Carl Dernehl - Union Carbide Corporation  
Dr. E. Kenwin Harris - Imperial Chemical Industries, Ltd.  
/ Dr. Emmet Kelly - Monsanto Company  
Dr. Marcel Lafevre - Solvay & Cie.  
~~Dr. W.O. Duncan Murray - The Distillers Company, Ltd.~~

Gentlemen:

In accordance with our understanding at our Cincinnati meeting, enclosed is a copy of the summary of The B.F. Goodrich Company hand cases.

Of course, the confidentiality of this data is exceedingly important.

Very truly yours,

W.E. McCormick, Manager  
Department of Industrial  
Hygiene and Toxicology

Enclosure

WEM:js

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SUMMARY OF MEETING  
CINCINNATI, OHIO  
June 6 & 7, 1966

HAND DISEASE OCCURRING DURING POLYMERIZATION OF POLYVINYL CHLORIDE

The individuals attending, the companies represented, and the agenda are listed in the attachments.

CONCLUSIONS:

1. There is no question but that skin lesions, absorption of bone of the terminal joints of the hands, and circulatory changes can occur in workers associated with the polymerization of PVC.
2. The mechanism, actual causative agent, or portal of entry, are not known.
3. It seems this condition is reversible.
4. It is a condition of low incidence, occurring in approximately one per cent of those exposed.
5. The amount of time necessary and the extent of exposure necessary to produce this condition are unknown.

The meeting opened with B. F. Goodrich representative, W. E. McCormick giving a narrative account of their experiences. Attention was called to the occurrence of this condition at their Louisville plant in July, 1964, but they found the two cases gave a history dating back to 1957 and 1959. They have X-rayed the hands of all their workers in their PVC plants in the United States and Canada, and one of their ~~nearest plants~~. They are carrying out these examinations at six-month intervals. Their experience is summarized on Attachment 3.

There are several interesting items that were presented during their discussion. One man was a packer in a "hy-car" and, presumably, had no exposure to PVC. They had a serious case in a laboratory supervisor who had 25 years laboratory experience and no plant work. Two men were instrument men at the time the condition was found. It should be made clear that work histories are not completely accurate.

Goodrich used the criteria for symptoms of any complaint of aching, blanching, or sensitivity to cold of the hands, of more than a minor nature. The X-ray criteria ranged from a minimum of a somewhat moth eaten appearance similar to a chip fracture, to an extensive lysis of the bone.

Goodrich took their 22 most serious cases and picked 22 control cases with no disease and tried to correlate statistically a group of variables. These variables were age, weight, height, type of resin, type of monomer, type of catalyst, wearing of gloves, personal sanitation, trouble with hands, trouble with hands prior to employment with B. F. Goodrich, relatives trouble with hands, abnormal sweating, allergies, history of gout, sports activity, and hand temperature measurement. The only positive correlation was in height, type of

resin (emulsion-type seems less likely to cause disease), trouble with hands, and hand temperature measurement. The last two were obvious and the significance of the height was not explained.

A review of the medical findings on the 20 worst cases (18 with X-rays and 2 with only severe symptoms) was presented by Dr. George Roush, of the University of Cincinnati.

1. Initial Symptom

a) Raynaud's Phenomenon	8
Sudden onset usually, probably all true symptoms. Three complained of feet.	
b) Pain in Fingers (not too severe)	4
c) Swelling and tenderness in fingers	4
d) Nodular swelling	1
e) Thickening of skin on fingers	1
f) No symptoms	2

It should be noted that none of these workers has complained at the dispensary about his hands in the past few years.

2. Frequency of Symptoms by questioning after admission to hospital

a) Raynaud's Symptoms Hands	16
b) Raynaud's Symptoms Hands & Feet	3
c) Tenderness of Hands	11
d) Swelling of Hands	9
e) Sweating of Hands (marked)	8
f) Thickened Skin	5
g) Nodules on Hands	4
h) Stiffness of Fingers	4
i) Loss of Moons on Fingernails	3
j) Shortened Fingers	2
k) Pain in Knees	2

3. Findings

Every laboratory test in the book was run and all came back negative.

Physical examination showed all healthy people with the findings limited to the hands.

a) Stubbiness of Fingers	8
b) Skin Nodules on Hands	8
c) Thickened Skin on Hands	7
d) Moist Hands	6
e) Skin Nodules on Forearms	4
f) Cold Hands	3
g) Loss of Moons on Fingernails	2

The skin nodules were in the subcutaneous tissue and ranged between 5 and 10 millimeters in diameter, non-tender, and on external surface of hands. They went up to the elbow of the ulna and were on the bony prominences. They are not fixed. The histopathology showed some increase in collagen but very little loss of elastic tissue. In fact, there isn't too much characteristic about it.

The fingers themselves show some fullness or bulbosity at the ends and are reddened.

X-rays of the hands, feet, cervical spine, esophagus, a few skulls, elbows, and knees were carried out. Positive findings were limited to the hands, although two cases may have had some change in the esophageal motility. The X-rays of the hands show the destructive phase ranging from a notching of the tuft to a complete absence of the distal phalanx. It showed a reparative phase with the intermixing of the lysis and bony growth. The healed, burned out deformity showed a stubby collar button-type phalanx.

Angiograms of the vessels were similar to those of scleroderma. with diminution of number and size in the palmar vessels.

Skin temperature measurements and response to immersion in ice water for 15 minutes was somewhat equivocal; although, on the whole, there was a lessening of ability to stand this type of cold. (Carbide found no difference)

Of these 20 people, 6 developed Raynaud's Phenomenon with skin nodules, 5 improved and one did not improve. The 6 others developed only Raynaud's symptoms and of these, 3 improved. They are all removed from their jobs.

ALVAY DATA

Dr. Lefevre confused the situation by having individuals who had generalized symptoms of fainting, weakness, low blood pressure, sleeping in the daytime, insomnia at nighttime, as well as tingling of the hands and feet. He said his cardinal sign was tenderness on pressing the lateral side of the finger. He listed the cases and the year of onset.

a) Belgium

There was one case that started work in 1960, developed symptoms in 1962, was X-rayed in 1963, and was off work for two years. A second case began work in 1961, developed symptoms and had X-rays in 1963, and was out of work until 1965.

b) Spain

One case started work in 1961, developed symptoms in 1964, and was X-rayed in 1965. Another case came to work in 1964, developed symptoms and had a positive X-ray in 1965. The third one began work in 1965, had symptoms later that year, and went off work in 1966.

c) France

They had 5 cases. One started to work in 1952, one in 1960, one in 1961, and two in 1962. It was hard to figure out when they had symptoms but all were positive on X-ray in 1965. It is confusing to tell whether these workers had any symptoms and, presumably, they did not lose time.

d) Italy

They had two cases. One started work in 1954, and one in 1962. Both showed positive X-rays when examined in 1965. Here, too, whether they lost work or had symptoms is not understood.

e) Germany

One-half of the workers were examined and all were negative.

f) Austria

One-third of the workers were examined and all were negative.

What all this means is very confusing. Dr. Lefevre tries to infer that something happened around 1962 or 1963 which caused the trouble. This is conjecture.

### ICI EXPERIENCE

They examined and X-rayed 588 people connected with PVC, of whom 150 were polycleaners. There were two positive cases by X-ray and no symptoms in any of the other people. Their cases are described in attachments 4 and 5. Case No. 1 spent all his time in emulsion polymerization areas. Case 2 was on granular or pearl polymerization since October 1962.

### BRITISH GEON EXPERIENCE

Dr. Duncan Murray stated that they X-rayed 300 people who were polycleaners at one time, with average service of 18 months out of a total of 600 cases. They were examined by the plant physician, who thought there was more redness than normal in these workers, but the X-rays were all negative. They used both emulsion and granular polymerization.

### UNION CARBIDE EXPERIENCE

Dr. Dernehi stated they X-rayed 16 autoclave cleaners at Charleston, where both types of resins are made. Twelve of these have worked 20 years or more cleaning autoclaves. All were negative clinically. All were X-rayed, with two people having conditions which might be traumatic or might be real.

They had 7 men at Texas City who were X-rayed and all were negative. They also had 38 other autoclave cleaners there who had 17 X-rays. They had various problems with their hands (injuries) from 1951 to 1964. They were all negative. They do some kind of water cleaning of their autoclaves and, presumably, are going to solvent cleaning.

### MONSANTO EXPERIENCE

I stated that we had this one case out of 98 X-rays, which was believed traumatic by us but believed by the Goodrich X-ray specialist to be a case. It is interesting to note this man has symptoms of Raynaud's disease.

### DISCUSSION RESULTS:

1. Only 44 cases out of 4500 people X-rayed. One per cent incidence.
2. Gloves probably are no good in preventing it.
3. Attempt to correlate onset of symptoms with introduction of various compounds in the plants proved inconclusive.
4. Solvay and Goodrich people believe the problem started in 1962 and 1963.
5. Dr. Kehoe philosophized that the problem will show up an occasional case on the basis of individual sensitivity. He believes the situation is due to volatile exposures in the autoclave, which obviously could be removed. He has not discarded the trauma of digging but does not believe it is a

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primary factor. He is definite that animal experimentation at the present time is of no value.

6. Mr. Vittone, from Goodrich, believes there is considerable monomer adhered to the walls of the reactor and likens its action to ethyl chloride, which is a well known anesthetic.

CLOSING REMARKS:

ICI has made their two cases public to the Radiological Society of England, as well as to the factory inspectors.

B. F. Goodrich has told their 20 cases at Louisville it was work connected. Seven cases have applied for Workmen's Compensation for partial permanent disability or for disfigurement.

Carbide will check a few more catalyst operators, as well as vinyl monomer operators. They have 31 more polycleaners to X-ray.

Solvay has had contact with the Belgian Government. Three cases in France are out of work and in Spain no contact with the government so far.

Considerable discussion was related to what to do about notifying the other manufacturers of the problem. It was stated by one of the Goodrich people that only 25% of the PVC production in the United States, although 100% of that in the United Kingdom, was represented. (I find it hard to believe the accuracy of this statement)

I gathered that Goodrich was going to tell the member companies of the MCA something of the problem within the next few months.

It was also thought that there might be some solution to the problem on an epidemiological basis. This would necessitate an outside the industry confidential repository such as the Kettering Institute, for the various mixtures that went into the autoclave in the various companies, so they could see if they could make some sort of correlation between ingredients and cases. This was just in the talking stage and no one promised anything.

FINAL ACTIONS:

1. We meet again in one year or so and compare notes.
2. Dr. Wilson of B. F. Goodrich will act as a central clearing house for people to write in and let him know about developments in their own organizations; i.e., legal action, government inquiries, new cases, clues to cause, etc.