

MANUFACTURING CHEMISTS ASSOCIATION

1825 CONNECTICUT AVENUE, N.W. WASHINGTON, D. C. 20009 (202) 483-6126

*Kenex Copy to:
W. M. Smith
Ray Cross
J. L. Watson
A. K. McMillan*

July 24, 1973

JUL 26 1973

J. T. BARR

To the Designated Contacts of Companies
supporting the Acroosteolysis Registry
and Consultation Center (The University
of Michigan)

Dear Sirs:

Distributed herewith is the status report
recently received from Dr. Dinman, the previous Di-
rector of the Acroosteolysis Registry and Consultation
Center.

At this time we have not been informed who
will take over the duties of directing this project,
as Dr. Dinman leaves for his new assignment as Corporate
Medical Director of the Aluminum Company of America.
You will be informed on this point by a supplemental
mailing as soon as we have this information.

Sincerely,

Kenneth D. Johnson/mb

Kenneth D. Johnson, Ph.D.
Assistant Technical Director
Occupational Health

KDJ:mb

Enclosure

RECEIVED

AUG 1 1973

A. K. McMILLAN

AP00042531

REPORT OF ACROOSTEOLYSIS REGISTRY

1970-73

by

The Institute of Environmental and Industrial Health

The University of Michigan
School of Public Health
Ann Arbor, Michigan

June 1973

Bertram D. Dinman, M.D.
Director

AP00042532

REPORT OF ACROOSTEOLYSIS REGISTRY

1970-73

I. Introduction

A. Participation - Of the 19 corporations that elected to participate in the original 1967-69 MCA Study of Acroosteolysis (AOL), all but four agreed to participate in the subsequent AOL Registry Program of The University of Michigan. Thus from the 32 plants engaged in PVC synthesis and/or compounding, 27 agreed to participate in the Registry activity.

However, with the passage of time and despite repeated communications, there was a progressive decrement in these numbers. By June 1973 among those 15 agreeing to participate, only eight corporations (i.e., 12 plants) provided the data requested.

The reasons for this decrement are a reflection of plant closings, turnover in medical and administrative personnel which impaired communication, plus an inevitable slackening of concern. The last stemmed in fact from the 1969 Report: for many corporations it appeared that the AOL problem did not affect their operations. In addition, as the delineation of the AOL problem became more clear by virtue of the Report, previous concerns were somewhat abated.

The net result was to impair any ability of the Registry to define the prevalence of the problem, or to clarify what direction the problem was taking. Further, it made difficult any valid indication of whether changes in polycleaning techniques was having any impact upon the trend of AOL occurrence.

B. Present Status and Limitations of Population Base - Of a total population of 5011 workers in the original 1967 study, only a total PVC population of 1332 could be accounted for in the Registry as of 1970-71. It is of interest to note that this represented 50% of the population in 1967 at the reporting plants, i.e., plant population among 1970-71 reporting plants was 50% of their 1967 enrollment. If the assumption is made that the plants providing no information also decreased their population by 50%, it might be estimated that presently there are approximately 1173 employees engaged in PVC operations among the non-reporting plants. Thus among the 19 corporations originally participating it might be estimated that as of this date there are 2505 employees in PVC synthesis and compounding.

So that one would not be tempted to consider the present population base as representing a valid 50% sample for the 1970-71 population at risk, the selection process whereby corporations elected to continue (v.s.) should make it clear that those participating represent a very biased population. This bias is also clearly apparent from review of Table I which indicates that participation was in some part conditioned by perceptions of management of the extent of the problem in their individual corporations. For these reasons, any attempt to consider the presently available data as

	<u>No. of Diagnoses</u>		
	1967	1970	% Lost
Dx Cat #3	74	25	33
Dx Cat #4	16	3	19
Dx Cat #5	25	9	36

Table I.: Diagnoses Made in All Plants in 1967 vs Diagnoses From Plants Not Reporting in 1970-71.

AP00042533

representative of a valid population base for epidemiologic analysis would be totally inappropriate. Accordingly, the best this report can do is to present tabulations of present data plus other information which has been derived from the literature or experience of the Registry.

II. Present Status of AOL in the PVC Industry

A. Definition of AOL - By definition, active AOL was defined as Raynauds phenomenon associated with x-ray defects. Specifically the x-ray defects were considered significant if they demonstrated more than one marginal tuft defect, transverse defect(s) with or without distal phalanx resorption or fragmentation. There were 22 cases of active AOL discovered in the original 1967 survey in addition to three inactive cases.

Inactive AOL was defined as the presence of the above x-ray changes or a "collar button" type or shortened distal phalange(s) in the absence of Raynauds phenomenon. Shortened, stubby distal phalanges were considered as highly suspicious, especially among workers with a present or past history of Raynauds phenomenon.

B. Present Status of AOL Among Reporting Plants in the United States - As of this report, the present status of AOL in the PVC industry as known to the Registry is as shown in Table II.

Corporation Code No.	Reported 1967	Reported 1972
2	17	23
4	3	No response
11	2	2
14	3	Plant closed
18	0	1
20	0	1
X*	—	—
Total	25	28

Table II: Cases Reported to Registry, as of 1972.

*This corporation did not participate in 1967. Under new management, it has reported in 1972.

If we assume that the cases seen in 1967 in corporations 4 and 14 still exist, the total cases in the Registry at this time should number 33. Whether new cases have developed in those two organizations is not known at this time.

AP00042534

C. Clinical Features of New Cases.

1. As of this report, the following tabulation describes the previous status of these newly discovered cases:

Previous Raynauds only	2
Previous nonspecific x-ray without Raynauds	2
New AOL previously unknown	4

2. Discussion - Examination of the details of this data suggests the possibility that AOL may be manifestations of two etiologically different conditions. This possibility is suggested because:

- 1) Two cases have gone on to show healing bone changes characteristic of AOL without apparent history of Raynauds;
- 2) The incidence of Raynauds in plants polymerizing PVC which have not had cases of AOL since 1961 is 0.56% (i.e., two cases among 357 males) vs 0.2% in compounding plants in 1967;
- 3) Recent discussions with Suciu (who originally reported in their Rumanian literature) (1) indicates that he still sees Raynauds in PVC workers, yet has never succeeded in detecting x-ray changes of the hands.

The question might be raised whether the Raynauds and dermatoc manifestations represent a response to one etiologic agent in the PVC polymerization process, and that the bone changes are due to a second agent. Given the small numbers involved above, this possibility is at best speculative, nevertheless, consideration of this question should not place an additional burden upon ongoing medical surveillance programs.

3. Atypical Forms of AOL - One polycleaner who has manifested Raynauds in 1967 still had this condition in 1970-71 and in addition had by then developed a transverse defect of the ulnar styloid. A history of injury or fracture could not be established in this man's previous data. We suggest that this represents, an atypical form of Acroosteolysis.

D. The Roentgenographic Course of AOL

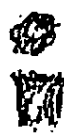
1. Previous Concept and Proposed New Course of AOL - in the published reports derived from the 1967 survey (2), it was indicated that the radiographic sequence of change was as indicated diagrammatically:



Marginal
Defect
Stage 1



Plus
Transverse
Defect
Stage 2



Distal
Fragmentation
Stage 3



Total
Resorption
Stage 4



Shortening,
Healing
Stage 5

AP00042535

However, we have found one case of AOL which over a four-year period went from Steps 1 to 3 to 2. Whether he will ultimately go to 4 or 5 cannot be absolutely predicted. However, we would suspect on the basis of previous end stages seen that he will go on to a minimal shortened terminal digit indicated in Step 5.

Discussions with Dr. J. J. LaFevre in Brussels revealed that he similarly had observed this new sequence of events. Thus it would appear that the transverse defect, rather than being an early stage of AOL, actually represented a later stage in the process.

2. Proposed New Natural History of AOL - We would suggest that the bone manifestations of AOL go through the following steps:

Former Stage

Proposed Stage

1



Step #1 Marginal Defect

2



Step #2 Partial Decalcification Distal Tip

3



Step #3 Total Decalcification with Collapse of Distal Tip

4



Step #4 Partial Recalcification of Distal Tip with Transverse Discontinuity

5



Step #5 Recalcification of Distal Tip with Shortening

AP00042536

If these are indeed the case, it would appear that the process represents a decalcification of the osteoid matrix. To what extent there is a decrease in the osteoid matrix itself is not clear; that there is an end decrease in the healed bone mass suggests that this is a process which also involves the matrix. Thus the condition appears to be combination of osteomalacia-like (i.e., decalcification) and osteoporotic-like (i.e., decrease in osteoid matrix) change. Bone biopsy would further aid in delineation.

III. Present Practices Utilized Reactor Cleaning

A. Reactor Cleaning Practices, 1967

Of the 27 synthesis plants surveyed the practices utilized were:

<u>Method</u>	<u>No.</u>	<u>% of Response</u>
Hand cleaning only	18	67%
Hi-pressure water only	2	7.5%
Solvent only	2	7.5%
Combined		
Hand and water jet	3	11%
Hand and solvent	2	7.5%

B. Reactor Cleaning Processes, 1972

Of the 10 synthesis plants responding, the reactor cleaning processes utilized were:

<u>Method</u>	<u>No.</u>	<u>% of Response</u>
Hand cleaning only	4	50%
Hi-pressure water jet only	0	0
Solvent only	0	0
<u>Combinations</u>	<u>No.</u>	<u>% of Response</u>
Hand and Hi-pressure water	3	30%
Hand and solvent	1	10%
All three methods	2	20%

On the basis of reported man-months spent in each process in 1970, the distribution of actual time spent in cleaning reactors by various methods are as follows:

<u>Method</u>	<u>Man-months</u>	<u>% Total</u>
Hand cleaning	292	22%
Hi-pressure water jet	28	2%
Solvent	0	0
Combined		
Hand and water jet	859	64%
Hand and solvent	36	43%
Hand and water jet and solvent	122	
Total	1337	

AP00042537

C. Discussion

It appears that hand cleaning alone is less frequently employed today than has been the case in the past. On the other hand, solvent cleaning while still used, is not used to the exclusion of other methods among the companies reporting. The decrease from 1967 to 1970 in solvent use may be more apparent than real; one company which used this method in 1967 did not report in 1970; the other corporation which used solvent cleaning in 1967 now uses water plus solvent. Further, what appears to be uncommon usage of solvent is probably more apparent than real. That is, little actual working time is involved in transferring solvent from reservoir to reactor and out again.

In the two plants reporting in 1970-72 with new cases, hand cleaning and high water pressure jets are used. Those corporations previously known to have cases of AOL appear to have made increased use of high pressure water jet to augment hand scrapping (except in one case).

REFERENCES

- (1) Suciu, L., Drejman, I., and Valeskai, M., Investigation of the Diseases Caused by Vinyl Chloride, *Med. intera* (Bucharest), 15:967-78, 1963.
- (2) Dodson, V.N., Dinman, B.D., Whitehouse, W.M., Nasr, A.N.M., and Magnuson, H.J., Occupational Acroosteolysis III. A. Clinical Study, *Archives of Environmental Health* 22:83-91, 1971.

AP00042538

Mr. J. A. Marts

October 10, 1972

Mr. J. F. Odom

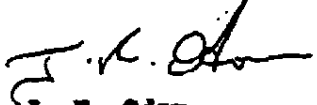
Mr. A. K. McMillan ✓

PVC Operations
Acroastaolysis (AOL) Program

Enclosed is the complete package of information relative to our participation in the AOL Program. Some of the groundwork has already been laid as noted in memos.

I would suggest you coordinate the initiation of this program with L. Floman, B. Pulaski and E. Primesu. Ron Beech should be able to give you some input also.

We need to start this immediately. If I can lend you assistance, let me know. Mrs. Pulaski should be able to establish schedule, etc. on X-Rays and interpretation by Dr. Barnes.


J. F. Odom

JFO/ka

Enclosure

RECEIVED
OCT 12 1972
A. K. McMILLAN

AP00042539



Air Products and Chemicals
INC.

ESCAMBIA PLANT
INTEROFFICE MEMORANDUM

To: Mr. R. E. Davis Date: January 28, 1972
From: R. W. Beech Copies: E. M. Spurlock
A. K. McMillan
W. C. Wilde
Re: AOL

I have supplied Mr. Spurlock with all information concerning AOL of which I have a copy. This includes the MCA report which was subsequently published in the Archives of Environmental Health - Volume 22, January, 1971.

I believe the X-Ray program should start immediately and also the program should include a questionnaire similar to that used in the MCA study to indicate possible susceptibility to AOL.

Mr. Spurlock will be supplied a list of employees and their current jobs. Also, we will establish record keeping procedures on each employee to determine length of time on each job and duties performed for each job. Especially records of reactor entry will be maintained.

R. W. Beech

R. W. Beech

RWB:fls

1. Dr. BARNES STUDY - A.C. A.C.A. Report
2. Rm Supply list of Employees
3. Then schedule men to Barnes during days

AP00042540



Date January 5, 1972

INTER-OFFICE
MEMORANDUM

Subject PVC Operations

Acroosteolysis (AOL) Program

To Distribution Below

Confidential

*ODD HAS
12.3.72*

(Location, Organization, or Department)

From T. L. Carey

Valley Forge

(Location, Organization, or Department)

Effective immediately, the attached AOL PROGRAM shall be implemented for PVC operations at the Escambia plant and the Calvert City plant.

This program for monitoring AOL has been developed as a result of studies made by John Barr in consultation with Martin Spurlock, Ron Beech and Dick Harvey.

TLCarey/d
attachment

Distribution:

A. R. Adams	A. K. McMillan ✓
J. T. Barr	H. W. Smith
J. L. Cost	W. Mayo Smith
R. B. Cross	E. M. Spurlock
R. Fleming (2)	H. L. Watson
G. J. Mantell	

(all with attachments)

T. Carey

*31 1972
A. K. McMillan*

AP00042541

PVC OPERATIONS
CALVERT CITY AND ESCAMBLA PLANTS
AOL PROGRAM

1. X-ray the hands of present PVC production workers who have participated in reactor cleaning to establish a base line for present conditions. Those to be included are polymer building operators, pilot plant operators, laborers (utility men or trainees) and dryer operators, if they have been involved in reactor cleaning. Not included are baggers, maintenance men, compound operators, or supervisors.
2. As a part of pre-employment physical examinations, include hand x-ray studies for all personnel to be assigned to PVC operations. This shall include personnel transferred from other operations who may be involved in reactor cleaning.
3. An annual x-ray examination shall be performed on the specified employees and the records maintained on each plant with the work histories of the employees involved.
4. Each plant shall have x-ray films read by a competent radiologist. Background information on AOL shall be furnished him. Such information would include MCA report and article by Dr. Dinman. If required, a consulting arrangement should be developed with the University of Michigan Institute of Environmental and Industrial Health or other competent specialist.
5. Review and update existing work procedures, protective equipment and instructions for reactor cleaning and establish formal procedures which contain requirements for operator compliance. Emphasize enforcement to supervisors.
6. Continue work on plant modifications such as solvent cleaning, that will reduce personnel exposure.
7. Continue participation in the MCA and Vinyl Chloride Safety Association studies to enable us to provide maximum protection for personnel.

AP00042542

EVC - AOL Program -
Production

Confidential
Mr. Sparlock
D. Davis
Lee

H. L. Watson

Calvert City

T. L. Carey

Calvert City

I have John Barr's memo to W. M. Smith in Allentown (the subject of which is proposed AOL program continuance, dated October 1, 1971).

I would like to have John Barr make a trip to Pensacola in order to look at the requirements for this program at Pensacola and see if we can come up with a uniform program for both locations. At least, I would like to have his recommendations.

At the same time, I think it might be of value if John would take enough time to review the manufacturing procedures, techniques and/or procedures in sufficient detail to make a comparison and hopefully indicate some practices that might be utilized by the other plant.

TLCarey/d

cc: A.K. McMillan ✓
A. R. Adams

RL

P. S. - R. Fleming has commented on the need to X-ray new employees and says he believes that we need to X-ray only those who would reasonably be expected to have continuing exposure.

RECEIVED
NOV 11 1971
A. K. McMillan

AP00042543



Date January 5, 1972

INTER-OFFICE
MEMORANDUM

Subject PVC Operations

Acroosteolysis (AOL) Program

To Distribution Below

From T. L. Carey

Valley Forge

(Location, Organization, or Department)

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TLCarey/d
attachment

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R. B. Cross	E. M. Spurlock
R. Fleming (2)	H. L. Watson
G. J. Mantell	

(all with attachments)

T. L. Carey

RECEIVED

JAN 31 1972

A. K. McMillan

PVC OPERATIONS
CALVERT CITY AND ESCAMBIA PLANTS
AOL PROGRAM

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5. Review and update existing work procedures, protective equipment and instructions for reactor cleaning and establish formal procedures which contain requirements for operator compliance. Emphasize enforcement to supervisors.
6. Continue work on plant modifications such as solvent cleaning, that will reduce personnel exposure.
7. Continue participation in the MCA and Vinyl Chloride Safety Association studies to enable us to provide maximum protection for personnel.

AP00042545

Mr. T. L. Carey

February 23, 1971

A. K. McMillan

Occupation AOL from PVC Operations

The Archives of Environmental Health Study Report of January, 1971, indicates the AOL condition is clearly associated with hand cleaning of PVC reactors. Of the 5,011 employees examined there were 25 definite cases of AOL and all had been involved in hand cleaning reactors. The probability of developing AOL is one case in 32 for workers in reactor cleaning and one case in 140 workers for the total PVC study population. Work practices such as (1) use cleaning methods used, (2) use of gloves, (3) reactor evacuation procedure have a strong influence on the occurrence of AOL. Method of entry of the agent causing AOL is also not established and the writers were inclined toward the respiratory method of entry rather than absorption through the skin.

The report recommends:

- (1) More extensive use of high pressure water and solvent cleaning
- (2) Good ventilation of reactors
- (3) Use of gloves in reactor cleaning.

Our reactor evacuation and cleaning procedures strongly favor good experience with regard to AOL. Use of chemical cleaning for all reactors will be accomplished this year. As additional precautions, we will see that gloves are worn by reactor cleaners (this is now required but may not be rigorously followed) and that explosimeters used to check reactors are calibrated on pentane as recommended in the study. I suggest that base line X-rays of the hands of PVC personnel be taken at the time that all reactors are converted to the chemical cleaning process. The medical questionnaire (in study) should also be

AP00042546

Mr. T. L. Carey

-2-

February 23, 1971

completed at this time. X-rays should be repeated on an annual basis until such time as we consider AOL not to be a problem in our operation.

A. K. McMillan

/ms
attachment

AP00042547

2

ESCAMBIA CHEMICAL CORPORATION
INTEROFFICE MEMORANDUM

To: Mr. A. K. McMillan

Date: February 25, 1971

From: R. W. Beech

Copies:

Re: Summation: Institution of Environmental and
Industrial Health Report on Occupational
Acroosteolysis

This condition is clearly associated with hand cleaning of reactors. Workers engaged in other phases of PVC manufacturing do not appear to bear risk of developing AOL. Incidence of cases are low with only 25 definitive cases out of 5,011 employees having 21,510 man years experience in various phases of VCM and PVC manufacturing. Of the 25 definitive cases all had been involved in hand cleaning of reactors and 24 of 25 had symptoms of Reynauds* phenomenon as a concomitant disorder. Indeed the probability of AOL developing was one case per 32 workers for reactors cleaners vs. one case per 140 workers for the PVC study population.

At this time work practices, rather than any one specific ingredient or combination in process, appear to determine whether this disease will occur.

In those plants using high pressure water lances or chemical cleaning, there were possible cases in only one. Those plants with AOL provided gloves for reactor cleaners, but inconsistent usage was observed and frequently airing out of the reactor was short cut.

The etiological agent (s) causing AOL is not known nor is the method of entry. In view of the systemic characteristics of the disease, the writers were inclined toward the respiratory method of entry rather than absorption through the skin.

*Cold, white fingers brought on by hand or body chilling or both.

AP00042548

The writers recommended:

1. More extensive employment of high pressure water and solvent cleaning.
2. Adequate ventilation of the reactors prior to entry. This should be checked with a flammable vapor indicator with a scale of greater sensitivity than 1% of the lower explosive limit of vinyl chloride.
3. An intimate review of the procedures and actual practice of those procedures for reactor hand cleaning.

They also concluded that with the present knowledge of AOL is such that catagoric statements as to preventive measures is not justified.

With the use of solvent cleaning (currently scheduled for completion in June). I do not believe we should make any changes in our current procedure. Any X-ray work should be delayed until just prior to advent of solvent cleaning. This will establish a base from which to judge future X-rays.

R. W. Beech

R. W. Beech

AP00042549

Mr. T. L. Carey

February 23, 1971

A. K. McMillan

Occupation AOL from PVC Operations

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AP00042550

Mr. T. L. Carey

-2-

February 23, 1971

completed at this time. X-rays should be repeated on an annual basis until such time as we consider AOL not to be a problem in our operation.

A. K. McMillan

/ms
attachment

AP00042551

MEMO

TO Mr. Casey
FROM Lund

- ☐ Please Handle ☐ Please see me
☐ Please Call ☐ Information - Please return

It would be wise of us to follow the procedure on some of the older PVC employees into clean history. Especially if Erickson will read them for us.

OCT 25 1966

How
10

E. H. Lund
TION
M. H. Lund

for 19, 1966

to. Casey, Gabbott,
Call, Holliston,
for, Madison and
the

in meeting
by B. F.
too late

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AP00042552

Date _____

MEMO

TO: Mr. Carey

FROM: Appendix

☐ Please Handle

☐ Please see me

☐ Please Call

☐ Information - Please return

Have the X-ray taken
during annual physical +
send to Goodrich for reading.

Martini

Forrest
Lace
Enginger
Koschman
Pleasant
Rivers

OK go ahead
to

TION

Mar 10, 1966

Mr. Carey, Gabbett,
Bill, Hamilton,
Lar, Litchfield and
Joa

SA meeting
by B. F.
Feb 1966

From Eric-
a copy of
onal data
a check
Koschman
Litchfield

SA meeting
by B. F.
Feb 1966

SA meeting
by B. F.
Feb 1966

SA meeting
by B. F.
Feb 1966

ENTAILMENTAL OBSERVATION

and under conditions of blinding except of the color of the object.

2. Nature of stimulus: (1) which subject was...
which gave identification at a level of 1% of the total
personal. Consistency of the degree of the
subject's own rating, however, 15 of the total subjects
were total identification.

3. Nature of stimulus: (2) which subject was...
which gave identification at a level of 1% of the total
personal. Consistency of the degree of the
subject's own rating, however, 15 of the total subjects
were total identification.

AP00042553

ESCAMBIA CHEMICAL CORPORATION

INTEROFFICE MEMORANDUM

To: File

Date: October 19, 1966

From: W. Mayo Smith

Copies: Messrs. Carey, Gabbett,
Hansell, McMillan,
Mikler, Smith and
Voughn

Re: INTER-OFFICE PROJECT

We were invited to attend an ICA meeting in Cleveland on October 6 initiated by B. F. Goodrich. The notice was received too late to enable us to attend.

The attached data was obtained from Firestone Plastic Company. Considerable detail is given and references where additional data might be obtained. It is suggested that if Goodrich chooses to perform the heavy program to do accept Goodrich's invitation and send the film to the expert Rootingologists.

W. Mayo Smith, President of Firestone Plastic Company, is the Director of Research and Development of Goodrich. W. Mayo Smith is the

WMS:lav

ATTACH: There are two slides of the same material. One is a negative and the other is a positive. The slides are of the same material. The slides are of the same material. The slides are of the same material.

Goodrich discontinued this service.

There is a main diagnosis of the material. The material is of the same type of material. Slides were taken of the material. Slides were taken of the material. Slides were taken of the material.

Extent of damage: Goodrich is a member of the ICA. Goodrich is a member of the ICA. Goodrich is a member of the ICA. Goodrich is a member of the ICA.

Goodrich is a member of the ICA. Goodrich is a member of the ICA. Goodrich is a member of the ICA. Goodrich is a member of the ICA.

AP00042554

RECEIVE

OCT 19 1966

Firestone Plastics Company

DIVISION OF THE FIRESTONE TIRE & RUBBER COMPANY

HARVEY S. FIRESTONE - FOUNDER

MAYO SMITH

GENERAL OFFICES

P. O. BOX 889

POTTSTOWN, PENNSYLVANIA 18466

POTTSTOWN, PENNSYLVANIA

October 12, 1966

Dr. W. Mayo Smith
Escambia Chemical Corp.
Wilton, Connecticut

Dear Dr. Smith:

Mr. L. B. Kuhn has given me your letter of October 7 concerning the MCA Meeting held October 6 at Cleveland, Ohio. The following is a condensation pertaining to this meeting which was held under the auspices of the MCA Medical Advisory Committee. It was their intention to disseminate certain information to the PVC manufacturing industry relating to a medical problem concerning reactor cleaning personnel. In dealing with this intelligence we were advised not to make it public, to the press or other periodicals, at this time.

Mr. Nantz, President of B. F. Goodrich, Dr. Rex Wilson, Medical Director of Goodrich and Mr. William McCormick, Toxicologist of Goodrich were the chief sources of information.

1. Several years ago one Goodrich PVC (suspension type) plant reported a number of cases of soreness in finger tips of their personnel. This was accompanied by skin blanching and slower recovery of temperature of the hand than normal.
2. X-Ray is the main diagnostic tool and this showed that the terminal finger bone was actually subjected to some type of erosion. Slides were shown to demonstrate typical cases. Colored photoslides of hands were also shown and these indicated a blunting effect of the finger tips plus a modest color change.
3. Extent of disease: Goodrich reports cases in three of their five installations at a level of 1% of the total personnel. Concentration of the disease was in the reactor cleaning area, wherein 6% of the total personnel were found afflicted.
4. Early diagnosis was termed a type of finger SCLERODERMA sometimes accompanied with a RAYNAUD'S phenomenon.

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Escambia Chemical Corp.
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5. Cause: Not specifically known. It is believed that the disease is the result of contact with some chemical but proof that it is solely vinyl chloride monomer does not presently exist. Goodrich have X-Rayed their monomer plant personnel and have found no cases. It is fair to say that contact with monomer on the finger tips is greatest for the polymerization reactor cleaning personnel. Goodrich have also X-Rayed one complete synthetic rubber plant and found no evidence of the disease.

It was further mentioned that vinyl monomer intoxication was not related to this disease. In short, reactor operators that might have been exposed to VC gas did not show effects of the disease.

6. Publications: Goodrich found no data published in this country regarding this problem. The following foreign articles were found and translations are available from Goodrich:

CORDIER, et al
Cahiers de Medicin du Travail, Jan. 1966

Suciu, et al
Medicina Interna (Bucharest)
15; 967-78 (August 1963)

We were advised not to disclose any of the data given us because the total medical and legal complications just aren't fully known.

7. Miscellaneous Goodrich information -

- a. Of the approximate 30 cases - three were not in a PVC area. The overwhelming evidence indicates there is no problem in other areas of processing of PVC resins.
- b. Length of service is not clearly relatable to the disease; some personnel have shown positive effects within three years and some have not shown effects after 15 years.
- c. All cases taken off the reactor cleaning job have shown improvement at different rates.
- d. New personnel are X-Rayed upon starting work and then every six months thereafter to note changes.

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- e. Reactor cleaners are required to wear cotton gloves which have been coated with plastisol. Prior to this time it was up to the individual to decide if he wanted to wear gloves. *With little with plastic coated gloves in white OK Little J.*
- f. Personnel relations: Goodrich personnel were advised that there appeared to be a hand problem and that the cause was being sought. They had no problems with the bargaining unit and all cooperated in the X-Ray task. *OK Little J. with little with plastic coated gloves in white OK Little J.*

Generally X-Ray negatives were given to the personal doctors of the individuals involved. In short, Goodrich have encountered no kickback and have considered these cases for compensation although there has been no claim paid to date.

- g. X-Ray - Since the task of reading X-Rays requires an expert - Roentgenologist, Goodrich stated they would be pleased to have their expert read any and all X-Rays free of charge. This is important since it is the only way to eliminate reading and interpretation as a variable.

Generally the majority did not know whether they did or did not have a problem. However, Carbide and Goodyear have done X-Ray work. Carbide indicated that they had uncovered four cases while none were reported for Goodyear. We were also advised that the various organizations' medical staffs could make contact with Dr. Rex Wilson of Goodrich for the translations of the foreign articles previously mentioned.

I trust that this will help in your understanding as to what transpired at this meeting. However, if there is anything further we can do please advise.

Very truly yours,

FIRESTONE PLASTICS COMPANY

C. J. Kleinert

C. J. Kleinert
Production and Technical Manager
Chemicals

Copy:
L. Spauld 2-26-70

CJK/rc

cc: Mr. L. B. Kuhn

AP00042557

AKM
Mr. H. W. Smith

February 2, 1971

W. A. Miller

w/o encl.: R. Fleming
D. Holland
W. H. Smith
T. L. Carey
G. H. Spurlack ✓

Occupational Acroosteolysis

In reply to your letter of January 11, 1971 on the above subject, please be advised that this subject was brought to our attention in October, 1966 by Dr. Mayo Smith after a meeting of the ICA Medical Advisory Committee.

After some discussion, it was agreed that we would X-ray our employees during their annual medical examination and accept the offer by Goodrich to read the X-rays at no cost.

During the period from January, 1967 through January, 1968, X-rays were made of the hands of all PVC Operators and Supervisors. Only one operator showed any abnormalities. The X-rays made in January, 1967 of one operator showed some destruction of the right hand. A follow-up X-ray was made two months later and indicated a slight increase in the destruction of one finger with healing in two fingers. As a result of these X-rays, we transferred this operator to the Ammonia-Refrigeration area. Ten months later, an X-ray showed acroosteolysis of both hands. We could not follow-up on this case because the operator disappeared. Efforts were made to locate the operator through his ex-wife, his mother and father, the Sheriff's Department, Social Security Department, etc., without any results.

Goodrich discontinued the reading of X-rays from other companies when the Manufacturing Chemists' Association became involved in a study on an industry-wide basis, therefore, we discontinued our X-ray program.

Beginning on March 1, 1967, all personnel engaged in cleaning PVC reactors have been required to wear cotton gloves coated with plastisol.

AP00042558

Mr. H. W. Smith

-2-

February 2, 1971

Water blasting equipment has been installed in reactor cleaning service for approximately two years. At the present time, a chemical cleaning system is being installed which should eliminate the cleaning of reactors by hand methods except in extreme cases involving a large build up of polymer.

Translation copies of articles by Cordier and Suciu on this subject are enclosed for your information.

W. A. Miller
W. A. Miller

HAM:kc

Enclosure

AP00042559

REACTOR ENTRY PERMIT

Date _____ Reactor No. _____ Employee Entering _____

Time _____ Attendant _____

NOTE: The attendant must stay on the third floor and look into the reactor the entire time a man is inside

Entering Shift
Operator Supervisor

1. Valves tagged and blanks installed
 - a. VCl monomer line
 - b. Demineralized water line
 - c. Vacuum Line
 - d. Overhead recovery, XA, and ZB line
2. Drop valve open and opening clear
 - a. Remove flush flange
 - b. Install blind between ell and block valve
 - c. Back up valve closed and tagged
3. Blower hose in reactor and fan in operation
4. Hydraulic system
 - a. Inlet valve closed and tagged
 - b. Agitator stopped
 - c. Outlet valve closed tight and bleed open.
5.
 - a. Temperature controller on manual
 - b. Maintain flow of cooling water
 - c. Steam valve blocked
6. Ladder in reactor and secured outside manhole
7. Reactor checked for gas at manhole and dump valve. Air must be coming out the bottom.
(by explosimeter) *CALIBRATED ON PENTANE LEL = 1.15%*
8. Proper tools supplied (drop light should not be put in reactor until reactor is gas free)
9. Harness on with rope attached by snap. Spare wristlets and rope available for attendant.
10. Harness rope secured outside manway.
11. Reactor ready for entry
12. Rupture disc checked and nozzle open (by Supervisor)
13. Work Completed. Reactor ready for use. (checked by Senior or Supervisor.)

SPECIAL PRECAUTIONS:

Reactor not to be entered if gas is present. If an unusual condition arises in the operation, the man must be called out of the reactor. This reactor entry permit is not a substitute for a hot work permit.

Shift supervisor on relieving shift must check and co-sign all above items.

Cotton Gloves coated with plastisol are required

AP00042560

E. M. Spurluck

January 11, 1971

W. M. Smith

Occupational Acroosteolysis (AOL)

H. W. Smith

From PVC Operations

E. M. S.

JAN 29 1971

cc: R. Fleming
D. Holland
W. Miller ✓

The matter of occupational acroosteolysis is not new; various papers have been presented, as well as a number of clinical investigation reports circulated. The attached study, extracted from the January 1971 edition of Archives of Environmental Health, has through its completeness put most of the data in one place.

The report indicates that the incidence of AOL is low, but I am concerned with the possibility of our employees contracting this affliction. As the medical outcome of AOL is not reversible, and the bone damage could lead to permanent partial or even permanent total disability, it is my opinion that a formal program should be instituted to determine if we have people in various stages of this disorder. This program should cover all employees engaged in the cleaning of PVC reactors, both in the laboratory and production phases. It is with reluctance, that I propose the use of radiography as the method of determination of the presence of AOL. The reluctance on my part is based on the fact that X-ray exposure is cumulative, and must be held to a minimum. But, as the clinical studies indicate, it is just about the only method which provides a good diagnosis.

In addition to a medical program, there are several opinions expressed in the report which we may want to consider in the cleaning of reactor vessels. The proposed program should include the following:

Reactor cleaning

1. All persons involved in the cleaning of reactors shall use adequate protective clothing. Gloves, overalls, boots etc. must be impervious to PVC residue. This equipment must be thoroughly cleaned after each use.
2. Adequate breathing masks (dual filter) shall be used.
3. Water-Jet cleaning or solvent cleaning of the reactors should be investigated.
4. Proper ventilation of the reactor shall be accomplished prior to entry.
5. The proper disposal of reactor waste should be outlined in order that environmental codes are not violated.

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Medical Program

1. All persons involved in reactor cleaning should have a base line X-ray of the hands, with Ro-x-ray once a year.
2. A medical questionnaire of the type illustrated on pages 62 and 63 of the report should be instigated.
3. The medical personnel involved in the interpretation of the questionnaire and X-rays should be informed of AOL problems via a copy of this report.

I would appreciate your comments, as well as comments from those shown on the distribution of this memo, so that a formalized procedure may be presented to control AOL exposure problems.

HWS:rh

Howard V. Smith
Howard V. Smith
Industrial Safety Engineer

Copies:

L. Bush

F. Riddle

AP00042562

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Occupational Acroosteolysis

I. An Epidemiological Study

Bertram D. Dinman, MD; Warren A. Cook; Walter M. Whitehouse, MD; and
Harold J. Magnuson, MD, Ann Arbor, Mich; and Theodore Ditchcock, MD, Phoenix, Ariz

An epidemiological study was performed covering 5,011 employees with 21,510 man-years experience in various phases of vinyl chloride (VC) and polyvinyl chloride (PVC) manufacturing in 32 plants throughout the United States and Canada. The total number of definitive cases of acroosteolysis (AOL) was 25; 18 other individuals were under suspicion. This condition is clearly associated with the hand cleaning of polymerizers. Workers engaged in either phases of VC or PVC manufacturing do not appear to be at risk of developing AOL. The importance of Raynaud's phenomenon as a concomitant of AOL is emphasized. Several statistical approaches for rapid medical survey are suggested. Acroosteolysis appears to be a systemic rather than local disease. Presently, neither the etiological agent nor its portal of entry is known.

WITH THE emergence of a new clinical entity, occupational acroosteolysis (AOL),¹ it became a manifest responsibility of the polyvinyl chloride (PVC) industry to define more clearly the character, extent, and possible causes of this disorder. Though individual corporations might survey their employees, a statistically valid construction of the problem could not be developed without collation of the health experience of all PVC producers. To maintain the privacy of pro-

prietary information associated with details of manufacture, some disinterested group was needed to evaluate operating processes, as these might relate to the causation of AOL. Accordingly, the Manufacturing Chemists' Association requested the Institute of Industrial Health (Institute of Environmental and Industrial Health as of Jan 1, 1970) to conduct an epidemiological survey of the PVC industry in the United States and Canada to meet their responsibility to the workers and the public.

The institute was requested to determine the extent of the problem among PVC workers. By establishing a specific job association with AOL, it was hoped to determine where the risk of incurring AOL arose within the PVC process. It was important to determine whether AOL was associated only with the synthesis stage or if those handling the finished polymer also might be affected.

The primacy of this consideration stems from the widespread use of the polymer in the fabrication of a multitude of manufactured goods that enter general commerce. While the number of workers engaged in the chemical synthesis of PVC is relatively small, there are thousands of small manufacturers engaged in the fabrication of products derived from this versatile plastic.

Further, it was hoped that the epidemiological and industrial hygiene² investigation might define more precisely how variations in manufacturing processes might relate to variations in the prevalence of AOL among PVC producers. Medical and industrial hygiene studies might furnish some clues to the precise etiological agent(s) as well as suggest preventive measures that might be applied in the industry.

In addition, it was planned that a small,

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From the Institute of Environmental and Industrial Health (Dr. Dinman), the Department of Environmental and Industrial Health, School of Public Health (Mr. Cook), the Department of Radiology, School of Medicine (Dr. Whitehouse), and the School of Public Health (Dr. Magnuson), University of Michigan, Ann Arbor, and the Department of Radiology, Good Samaritan Hospital, Phoenix, Ariz (Dr. Ditchcock).

Reprint requests to Institute of Environmental and Industrial Health, University of Michigan, Ann Arbor 48104 (Dr. Dinman).

NAME _____ Soc. Sec. No. _____ (5-13)

RACE W N Other _____ AGE _____ SEX M F
(14) (15-16) (17)

DEPT. NO. _____ (18-19)

COMPANY SERVICE DATE _____
Month Year
(20-21) (22-23)

Do Not Write in This Box

Corp. _____ (1-2)

Plnt. _____ (3-4)

ARE YOU (RIGHT) (LEFT) HANDED?
(24)TO ANSWER THE FOLLOWING QUESTIONS, PUT A CIRCLE AROUND YOUR
ANSWER. FOR EXAMPLE: MONDAY IS THE DAY AFTER

SUNDAY (YES) (NO)

Have you noticed SUDDEN whiteness, blanching, or
paleness of the fingers of your RIGHT HAND (YES) (NO) 25
LEFT HAND (YES) (NO)Have you noticed a sudden redness or blueness of
the fingers of your RIGHT HAND (YES) (NO) 26
LEFT HAND (YES) (NO)IF YOU HAVE NOTICED ANY OF THE ABOVE,
are these changes brought on by cold (YES) (NO) (DON'T KNOW) 27HAVE YOUR HANDS OR FINGERS BEEN BOTHERED
WITH ANY OF THE FOLLOWING:Tingling or pins-and-needles feeling RIGHT HAND (YES) (NO) 28
LEFT HAND (YES) (NO)Warm feeling in hands or fingers RIGHT HAND (YES) (NO) 29
LEFT HAND (YES) (NO)Cold feeling in hands or fingers RIGHT HAND (YES) (NO) 30
LEFT HAND (YES) (NO)Numbness, fingers fall asleep RIGHT HAND (YES) (NO) 31
LEFT HAND (YES) (NO)Stiffness, fullness, or tightness of fingers RIGHT HAND (YES) (NO) 32
LEFT HAND (YES) (NO)Frequent tenderness, soreness, or pain at fingertips RIGHT HAND (YES) (NO) 33
LEFT HAND (YES) (NO)Have you noticed
your hands,
Thickening

White, raw

Whitish pink

Shiny skin

Small, raw
less than 1
(NOT include)Have you been
Pits or scars
Ridges or cracksHave you used
at work in the
(DAILY) ()Have you ever
crushed a finger
If yes, was
Which finger

in This Box

(1-2)

(3-4)

UND YOUR

ES) (NO)

ES) (NO) 25
ES) (NO)

(NO) 26
(NO)

NOT KNOW) 27

ES) (NO) 28
ES) (NO)

ES) (NO) 29
ES) (NO)

ES) (NO) 30
ES) (NO)

ES) (NO) 31
ES) (NO)

ES) (NO) 32
ES) (NO)

ES) (NO) 33
ES) (NO)

Have you noticed any of the following changes of the skin of your hands, wrists, or arms:

Thickening of the skin *(YES) (NO) 34
*If yes, is it on (HANDS) (WRISTS) (ARMS)

White, raised patches of skin *(YES) (NO) 35
*If yes, is it on (HANDS) (WRISTS) (ARMS)

Whitish pimples *(YES) (NO) 36
*If yes, is it on (HANDS) (WRISTS) (ARMS)

Shiny skin patches *(YES) (NO) 37
*If yes, is it on (HANDS) (WRISTS) (ARMS)

Small, raised areas, or lumps less than 1/2 inch around *(YES) (NO) 38
(NOT including warts)
*If yes, is it on (HANDS) (WRISTS) (ARMS)

Have you been bothered by these fingernail troubles:

Pits or scars of the fingernails (YES) (NO) 39
Ridges or cracking of the fingernails (YES) (NO) 40

Have you used hand-held power tools or air-driven tools at work in the past six years:

(DAILY) (ONCE A WEEK) (LESS THAN ONCE A WEEK) (NEVER) 41

Have you ever broken, fractured, or crushed a finger? (YES) (NO) 42

If yes, was it the (RIGHT) or (LEFT) hand?

Which finger was injured (Thumb) (Thumb) 43
(Index) (Index)
(Middle) (Middle)
(Ring) (Ring)
(Little) (Little)

selected sample of workers affected with AOL be studied in the clinical research unit of the University of Michigan Medical Center.² Previously, Rousch and co-workers¹ performed an extensive clinical evaluation of a group of such workers. Subsequent examinations here were designed to determine whether any new clinical features had developed since those prior studies.

Polyvinyl Chloride Manufacturing: A Brief Review

A more definitive description of the process whereby PVC is synthesized, finished, and compounded is reported elsewhere in this issue.³ A brief review of the operation is appropriate to the premises underlying the epidemiological considerations.

Vinyl chloride (VC), together with water, peroxide catalysts, and other additives, are placed in a reactor where polymerization is completed after ten to 16 hours. Unreacted VC is exhausted from the reaction vessel and the suspension or emulsion of the plastic transferred to equipment for dewatering and drying. Following ventilation of the reactor, one or two workers enter the vessel to remove the residue from its surfaces, using putty knives or chisels.

Sixteen plants, in addition to synthesizing, also compound PVC while five plants are engaged only in compounding the resin.

Methods

Survey Techniques.—Nineteen corporations known to be engaged in the polymerization of VC were assessed. The workers who served as the study populations were employed in 32 plants in the United States and Canada. All employees who worked at the time of the survey, or in the past, in any capacity in plants manufacturing VC, PVC, or in compounding such resin were surveyed. In multiple-product plants, all workers having any possible exposure to the PVC process were studied. This population underwent medical survey, work history questionnaires, and hand x-ray filming.

The self-completion medical questionnaire was designed to probe for signs of Raynaud's phenomenon or symptoms associated with peripheral vascular insufficiency. In addition, questions were posed to disclose skin or dermal appendage abnormalities, use of power tools, and hand-injury history.

X-ray films of both hands were requested from the cooperating plants; specific directions

concerning film type, exposure factors, technique, and identification were sent to each plant. The x-ray films, when forwarded to the institute, were coded and transmitted without identification to two radiologists for independent interpretation. The findings were recorded on a specifically designed checklist which was then returned for statistical collation. Hand x-ray films that served as controls were drawn from 2,407 men over age 18; this represented the entire male population of the town of Tecumseh, Mich.

Work history questionnaires were completed by each individual employee or by the personnel department at each plant or both. These forms recorded work assignments between Jan 1, 1961, through Dec 31, 1966; each worker noted the first and last month of assignment for each specific assignment during that period. At each plant, a team of investigators converted local job designations to standard job titles. These are listed in the paper on the industrial hygiene aspects.³

Pilot Run

In order to determine the reliability of survey techniques and recording methodological patterns, a pilot run was carried out at one large plant. Following this, minor modification of procedures and forms was accomplished.

Epidemiological Design.—Acroosteolysis appeared to consist of characteristic x-ray film abnormalities and Raynaud's phenomenon. Since the latter would be expected to occur only infrequently in a population not at risk of developing AOL, it could be used as a prime indicator of the existence of AOL. Thus, we hoped to establish an initial distinction between two populations, i.e., one having AOL and the other not having it.

Comparison of prevalence of defects with the Tecumseh control population of 2,407 men suggested that all defects occurred in the PVC population with a greater frequency than in the control population (Table 1). However, the significance of this finding was clouded by an unavoidable bias which minimized the value of the Tecumseh population as a control group, i.e., identification marks which could not be readily obliterated were present on these control films.

Furthermore, as is apparent from previous discussions of the x-ray film abnormalities, linear radiolucent defects could be confused with old trauma, the absence of a tuft might

follow amputation, and fused phalanges consistent with a congenital defect. Defects such as resorption of the shafts, loss of the tufts, and clubbing were each amenable to subjective error. Furthermore, these defects could result from other bony injury. Even multiple involvement could be consistent with these possibilities. Because problems did exist, divergent film interpretation was found (Table 2).

Because of these poses of first appraisal, the phalangeal tuft was considered as indicative of roentgenologists into the presence of existence of marginal fragment(s) (defect 3), transverse resorption (defect 4), distal portion of finger considered as possibly bony defect of AO radiologist and if defects could not be followed up subsequently there was a history involved finger or if x-ray film lesions were trauma, these indicated from suspicion.

Other x-ray film specific nature are with the later stage themselves considered ray film findings of phalanges (defect 5) or of the soft-tissue clubbing looked with suspicion involving multiple whether they were 2 to 5).

In addition to

more factors, technicians were sent to each on forwarded to the transmitted without logists for independent findings were recorded checklist which was cal collation. Hand controls were drawn 18; this represented on of the town of

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arent from previous film abnormalities. could be confused nce of a tuft might

follow amputation, or short- ened phalanges could be consistent with a congenital defect. Defects such as scler- osis of the shaft, widening of the tuft, and soft-tissue clubbing were each suscepti- ble to subjective reader error. Furthermore, each of these defects could arise from other bony disease or injury. Even multiple finger involvement could be con- sistent with these etiological possibilities. Because these problems did exist, signif- icant divergencies in x-ray film interpretations were found (Table 2).

Because of these complexities, for the pur- poses of first appraisal, marginal defects of the phalangeal tuft (defect 1) were not con- sidered as indicative of AOL unless both roentgenologists independently concurred as to the presence of this abnormality. The existence of marginal defects with residual fragment(s) (defect 2), transverse defects (defect 3), transverse defect with distal frag- mentation (defect 4), and total resorption of distal portion of phalanx (defect 5) were considered as possibly diagnostic of the bony defect of AOL if found by only one radiologist and if other causes for these defects could not be eliminated. Every man with any of these five aberrations was fol- lowed up subsequent to the field survey. If there was a history of trauma involving the involved finger or if the appearance of these x-ray film lesions was clearly consistent with trauma, these individuals were eliminated from suspicion.

Other x-ray film defects of an even less specific nature are known to be associated with the later stages of AOL but are not in themselves considered diagnostic. These x-ray film findings included sclerosis of the phalanges (defect 7), widening of the tuft (defect 8) or of the shaft (defect 9), and soft-tissue clubbing (defect 10). Finally, we looked with suspicion upon any bony defects involving multiple fingers regardless of whether they were AOL-specific (ie, defects 2 to 5).

In addition to those defects previously

Table 1.—Prevalence of X-Ray Film Defects in Control and PVC Populations

	Defect No.	Control, N = 2,407		PVC Population, N = 5,011	
		No.	%	No.	%
Marginal defect	1	44	1.83	321	5.41
Marginal defect, with residual fragment	2	5	0.21	35	0.70
Transverse defect	3	6	0.25	40	0.80
Transverse defect, with distal fragmentation	4	0	...	21	0.42
Total resorption of distal portion phalanx	5	2	0.08	9	0.18
Sclerosis, with resorption	6	1	0.004	15	0.30
Shortening	7	11	0.45	63	1.26
Widening of tuft	8	4	0.17	43	0.86
Widening of shaft	9	1	0.004	7	0.14
Soft-tissue clubbing	10	2	0.08	40	0.80
Total	55	75	3.16	594	11.87

reported to occur in conjunction with AOL, those x-ray film abnormalities unrelated to AOL were grouped as defect 11.

Combining the x-ray film findings and Raynaud's, several diagnostic criteria were set up (Table 3). The diagnostic criteria for category 0 consisted of essentially normal workers while category 1 included individuals having x-ray film abnormalities which by history or radiographic evaluation or both were found to be consistent with old trauma, disease other than AOL, congenital or fami- lial defects, etc. The history of persons in diagnostic category 3 disclosed cold-induced finger blanching unassociated with x-ray film abnormalities, clearly meeting our crite- ria for AOL. Category 4 consisted of persons without Raynaud's phenomenon and sugges- tive, though not diagnostic, x-ray films for AOL. Category 5 included those with classi- cal AOL x-ray film defects (2 to 5 and 1, 6, and 7 without and with concurrence, respec- tively) and Raynaud's phenomenon. Cate- gory 6 had typical AOL bone abnormalities (as diagnosed in category 5) but without Raynaud-positive replies to the medical questionnaire.

Computational and Statistical Analysis.

—Medical and work questionnaires and x-ray film reports were checked for complete- ness. They were then coded, verified, punched, and stored in an electronic com- puter. Quality control checking of the punch cards, using a 25% sample, revealed an er- ror of 0.1% among these cards.