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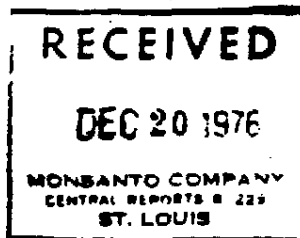
(ON THE SO-CALLED VINYL CHLORIDE DISEASE ,
(a new occupational disease) >

[Über die sog. Vinylchlorid-Krankheit
(eine neue Berufskrankheit)]

S. Jühe, C.-E. Lange, G. Stein and G. Veltman

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ON THE SO-CALLED VINYL CHLORIDE DISEASE*
(a new occupational disease)

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Introduction

In recent decades the plastics industry has marketed a multitude of synthetic products. Their production and processing requires continuous and effective observation and testing because of the possible of health-damaging effects.

Most of the injuries which have become known from the individual types of plastics are either acute toxic dermatoses (e. g., from methyl methacrylate in the production of polymethylmethacrylate - Plexiglas), where there can occasionally be percutaneous penetration (e. g., for acrylonitrile in the manufacture of polyacrylonitrile - Dralon), or results of inhalation and absorption of the corresponding plastic vapors (e. g., pulmonary edema after inhalation of Teflon vapors) which can occur in the polymerization or even in the processing of plastics [24].

Quantitatively, the starting material (the so-called monomer) plays the most important part in the origin of these disease syndromes. Another possibility for injury arises from the presence of the so-called adjuvants or additives needed for the progress of the chemical process, such as the plasticizers, hardeners, fillers, smoothers, catalysts, stabilizers or antioxidants. Furthermore, toxic intermediates

*Lecture held at the Lower Rhine association for natural and healing sciences, Bonn on June 13, 1973.

can occur during the production process. Even with the largely inactive end products, one must take hypersensitivity into account or, if finely divided plastic masses have penetrated into the organism and remain there for a long time, foreign body reactions (e. g., after excessive use of hairsprays with polyvinylpyrrolidone particles: diffuse interstitial pulmonary fibrosis resembling the Hamman-Rich syndrome) and perhaps even a carcinogenic effect. Finally, one must consider the possibility of damage from monomers even when there is decomposition of the polymers (degradation) in processing or application of the end product due to high temperature or other causes [14].

A disease picture which we were able to observe in Germany for the first time last year also belongs in this group of diseases [11, 12, 20, 21]. It appears predominantly but, as we assume today, not solely in autoclave workers in the industry manufacturing polyvinyl chloride (PVC). It had become well known in the foreign literature as "occupational acroosteolysis" or "occupational acroosteolysis syndrome" [2,3 4,6,7,9,22, 23,25].

Today, however, on the basis of our more extensive investigations [13, 15] we believe that this is a very complex syndrome. It is probably triggered by long-term exposure to vinyl chloride (VC), and is expressed in a connective tissue process which is not yet explained, with fibrosing of the skin and the vascular system, and probably also in the parenchymatous organs, the lungs and liver, which we studied. Thus, this syndrome gains the character of a systemic disease, with serious prognosis in the advanced stage. It extends, therefore, far beyond the disease picture previously described under the name of "occupational acroosteolysis". Thus, we have separated ourselves from this symptom-linked designation and called the

new comprehensive syndrome the "so-called vinyl chloride disease ([16] - extensive presentation and more literature citations).

Polyvinylchloride Manufacture

VC ($\text{CH}_2=\text{CHCl}$) is a colorless gas with an aromatic odor and narcotic action, which is heavier than air. The maximum worksite concentration was established as 100 ppm in 1970 [10]. The polymerization of VC to PVC goes on in large autoclaves in which the reaction mixture of water, the so-called additives, and the VC is kept in motion by a rotating propellor at 50-55°C until the desired degree of polymerization is attained. In the suspension process, the reaction mixture, after the excess VC is sucked away, is pumped into a mixture holder and, through other supply tanks, introduced to centrifuges in which the polymer is separated from the aqueous phase. After drying and separation by particle size, one obtains the finished powdery white polymer. In the emulsion process, the reaction mixture, with other additives (emulsifiers) is sprayed into a spray-drying tower containing hot air, so that the polymer in the sprayed emulsion droplets is immediately dried and separated at the filters [3, 6, 7].

After the reaction mixture is drained off, the autoclave is opened and sprayed with water, using a high-pressure gun. If it is not clean after that, it is filled with water. After the water is drained, one or two workers climb into the autoclave and remove the coatings on the inner wall, which are often quite solid, with trowels or occasionally even with hammers and chisels.

VC and other gaseous compounds can get into the work area air with the following opportunities:

1. Amounts of gas perceptible by odor escape from the mixing and storage tanks, from the centrifuges and at the spray-drying tower, as well as from the inlet and outlet lines, the drying system and the sieving system. (The odor threshold may be about 50-100 ppm, but, of course, it is subject to individual variation.)
2. On each cleaning of the autoclave with the water spray gun, the residual gas escapes into the autoclave. This can be a considerable amount, so that it is possible to reach the concentration at which the autoclave workers experience a prenarctic syndrome (numbness, dizziness, nausea [18, 19]).
3. In particular, the workers who clean the inner walls of the autoclaves with trowel and chisel are exposed to the gases which diffuse out of the wall deposits or occur in holes in the polymer deposits. The air analyses near the inner wall of the reactor, i. e., in the region where the hands and faces of the workers are exposed, showed concentrations of 600-1,000 ppm.
4. Large amounts of gas are liberated through leaks (at the valves, for instance) on loaded autoclaves and through insufficient VC recovery.

The predominant portion of the residual gas from autoclaves consists of VC (chemical analysis: 90% VC, 8.5% carbon dioxide, small amounts of vinyl acetate, trichloroethylene and nitrogen, traces of argon) [5].

Our Observations and Study Results

Since the beginning of 1972 we have investigated 10 workers, aged 29 - 40 years, at a plant producing PVC. They had come to us because of the clinical skin changes. They had worked from 1 3/4 to 12 years, and the average latent period to the appearance of the first symptoms was about 2 years. The general complaints included increased sweating (7 patients); frequent feeling of dizziness (5 patients); occasional nausea at the work place (3 patients); reduced vision; poor hearing; and headaches. As the first symptoms of the disease, 7 patients noted increased feeling of coldness in the region of individual fingers or hand, connected with numbness and itching. Pressure sensitivity at the finger tips, looseness of the nails, and club-like swelling of individual fingertips were each noted by one patient. For 6 patients, the skin symptoms started on fingers 1-3 of the right hand, and only for 3 patients on the 2d or 2d and 3d fingers of the left hand. They can be arranged as follows (Table 1).

Table 1. SUMMARY OF THE CLINICAL SKIN CHANGES IN 10 PATIENTS
WITH THE SO-CALLED VINYL CHLORIDE DISEASE

No.	Patient	Cold Sensitivity (R: with Raynaud syndrome)	Drumstick finger	Hourglass nail	Sclerodermic skin changes
1	S.G.	+	+	+	+
2	O.S.	+	+	Koilonychia	+
3	D.Z.	+(R)	-	-	-
4	J.F.	+(R)	-	-	-
5	H.D.	-	+	+	+
6	A.W.	-	+	+	+
7	H.A.	+(R)	+	+	+
8	M.C.	+	+	+	+
9	S.W.	+(R)	-	-	+
10	K.H.	-	+	+	+
	Sum	7	7	6	8

1. In 7 patients there was increased sensitivity to cold in the hands, and usually in the feet as well. With 4 of these it was even possible to provoke a Raynaud phenomenon repeatedly in cold exposure tests (Figure 1, p. 7, top).
2. In 7 patients there were drumstick-like, clubby swellings of the terminal phalanges of one or of almost all fingers. In correlation with the X-ray changes yet to be presented, these were predominantly on the fingers of the right hand (Figure 2, p. 7, center).
3. The nails of the fingers affected were curved up in an hourglass shape (see Figure 2) except for one patient in which koilonychia developed. But in contrast to "true" drumstick fingers, we found not only a clubby swelling, but a distinct shortening of the terminal phalanges and of the finger nails.
4. Eight patients had the very characteristic skin changes similar to scleroderma: infiltrations which were very firm, relatively sharply bounded, whitish to ivory-colored, usually raised above the skin level, and of the size of cereal grains to small nodules, or even more, plate-shaped (Figure 3). We saw such indurations most often above the basal joints of the fingers and in the immediate vicinity of the Proc. styloideus ulnae, at the ulnar side of the back of the hand, and at the distal third of the inner side of the lower arm, with distinct reduction proximally, and less frequently on the extensor sides of the fingers, distal to the olecranon and in the face (malar and zygomatic bone regions).

Samples were excised from the right or left hand of all patients. In all, even those who showed clinically only a Raynaud syndrome without palpable infiltrations, there were essentially the same changes (Table 2): more or less expressed, distinct hyperorthokeratosis (Figure 4); increasing narrowing of the epidermis with gradual flattening of the epidermis-cutis

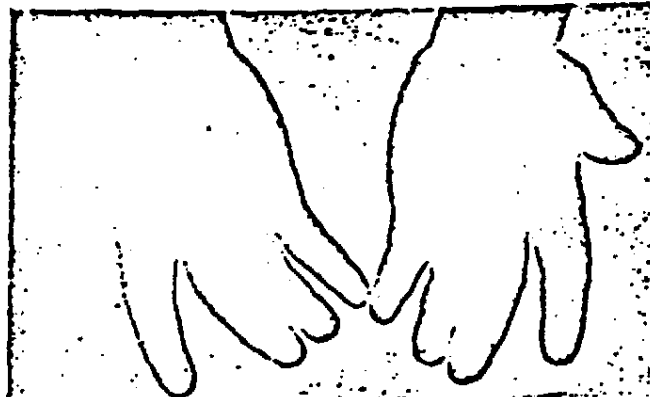


Figure 1.

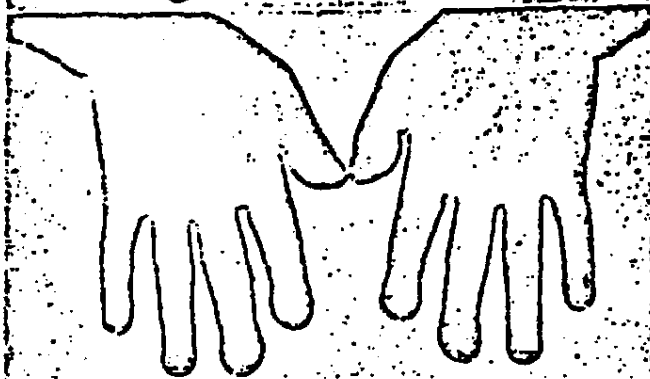


Figure 2.

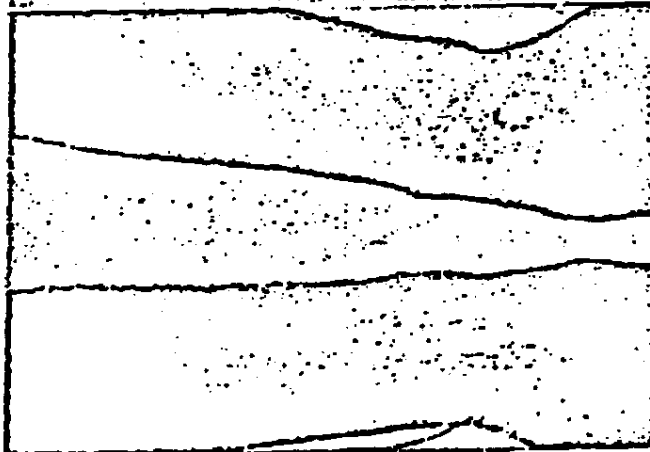


Figure 3.

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Table 2. HISTOLOGIC CHANGES IN THE SKIN OF 10 PATIENTS WITH SO-CALLED VINYL CHLORIDE DISEASE.

No.	Patient	Epidermis (a: hyper- ortho- keratosis; b: atrophy)	Cutis 1. Collagen a: multipli- cation; b: homogen- ization	Cutis 2. Elastic Fibers a: reduction b: fragment- ation	Cutis 3. Vessels	Tissue Status
1	S.O.	a b	a b	a b	capillaries with endo- thelial swell- ing in the subepithelial boundary layers	edema in central corium, perivascular infiltrates
2	O.S.	- b	a b	- b	normal	sclerotic
3	D.Z.	a b	---	- b	normal	collagenous connective tissue very densely packed
4	J.F.	a -	---	a b	occasional expanded capillaries in the upper corium	normal
5	H.D.	- b	a b	a b	vessel walls swollen in central and upper corium	severe edema in corium

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Table 2. Continued.

No.	Patient	Epidermis (a: hyper- ortho- keratosis; b: atrophy)	Cutis 1. Collagen a: Multipli- cation; b: homogen- ization	Cutis 2. Elastic Fibers a: reduction b: fragment- ation	Cutis 3. Vessels	Tissue Status
6	A.W.	a b	a b	a b	normal	corium edema; loose, predominantly lympho- cytic infiltration
7	H.A.	a b	a -	a b	normal	slight lymphocytic infiltration
8	M.C.	a b	a b	a b	Distinct wall thickening of central and deep corium	moderate edema; loose lymphocytic infil- tration
9	S.W.	a -	a -	- -	partial wall thickening	normal
10	K.H.	a -	a b	a b	capillaries expanded and increased in upper corium	deeper corium sclerotic

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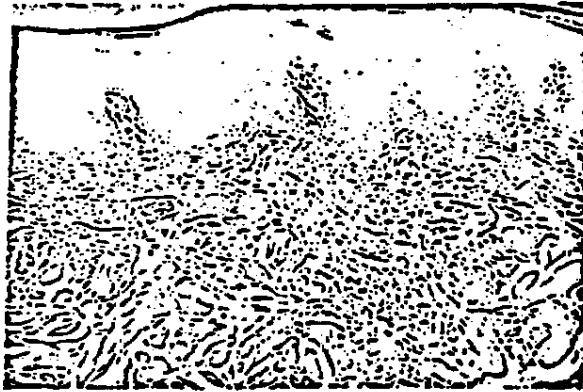


Figure 4. Hyperorthokeratosis. Increased and expanded capillaries, some with endothelial swelling and a loose, sparse, predominantly lymphocytic infiltration. Broadened collagenous bundles with few nuclei. (hematoxylin-eosin stain).

boundary, in which the papillary bodies vanish first, while the retial patterns can remain for a longer period. The cutis occasionally shows considerable broadening with multiplication of usually nucleus-poor, swollen and/or homogeneous collagenous bundles with the skin appendages being "walled about", or with the sweat glands being pushed higher on (pressure) atrophy of the sebaceous glands and hair follicles (Figures 5 and 6). The elastic fibers show distinct to considerable rarefaction, splitting up, and fragmentation (Figures 7 and 8). In the subepidermal boundary layers, one sees multiplied and expanded capillaries with endothelial swelling. Likewise, the vessels of the central and lower corium occasionally show distinct wall thickening. The entire cutis shows moderate intracellular edema and a loose, usually sparse, predominantly lymphocytic infiltration occasionally between the collagenous bundles and with some regularity around the vessels.



Figure 5. Swollen and homogeneous collagenous bundles.
(Hematoxylin-eosin stain).



Figure 6. Multiplication of the expanded, swollen and
homogenized collagenous bundle with the sweat glands
"walled off". (Hematoxylin-eosin stain).



Figure 7. Severe rarefaction and fragmentation of the elastic fibers. (Elastic staining).

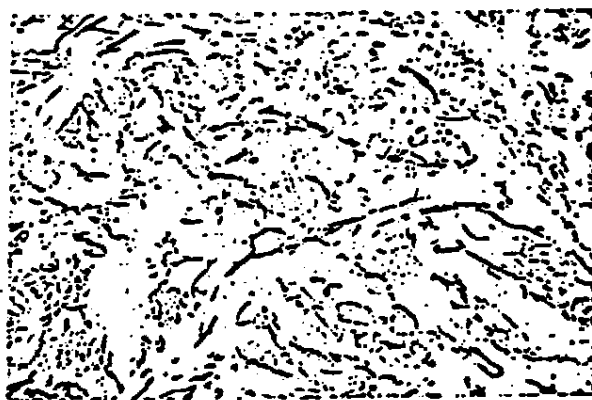


Figure 8. Almost complete rarefaction and splitting up of the elastic fibers. (Elastic staining).

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Table 3. BONE CHANGES IN 10 PATIENTS WITH THE SO-CALLED VINYL CHLORIDE DISEASE

No.	Patient	Hand Skeleton			Foot Skeleton			Other Skeleton	
		Osteoporosis (atrophy)	Marginal defects (Proc. ung.)	Banded osteolyses (terminal phalanges)	Osteoporosis (atrophy)	Marginal defects (Proc. ung.)	Banded osteolyses (terminal phalanges)	Arthritis	Bone Cysts
1	S.G.	—	+	+	—	(+)	—	+	+
2	O.S.	+	+	+	+	—	—	—	+
3	L.Z.	+	—	—	—	—	—	—	—
4	J.F.	—	+	—	—	—	—	—	—
5	H.D.	—	—	+	—	+	—	—	—
6	A.W.	—	+	—	—	—	—	+	+
7	H.A.	+	+	+	—	—	—	+	—
8	M.C.	—	+	+	—	(+)	—	—	—
9	S.W.	+	+	—	+	—	—	—	+
10	K.H.	+	—	+	—	—	—	+	+
		5	6	6	2	1(2)	0	4	5

13

The bone changes were particularly impressive (Table 3). They appear to be the major symptom, and have led to the name of "occupational acroosteolyses" in the Anglo-American literature.



Figure 9. Banded osteolyses in the bases of the Proc. unguitales of the 2d-4th fingers of the left and the 1st-3d and 5th fingers of the right hand, which extend into the shaft in some terminal phalanges. Some small bone fragments or sequesters can be detected in the resorption bands. A "fracture line" runs through the Proc. unguitalis of the 4th finger at the right (1962).

Typical banded or striped osteolyses appeared in the hands of 6 patients at the bases of the Processi unguitales, predominantly in the first through third fingers on both sides, with shortening of the terminal phalanges affected. In some cases the Proc. unguitales separated by the osteolyses show small bone fragments or sequestered bones (Figures 9 and 10). Six patients showed bone defects at the margins of the Proc. unguitales, and 5 a diffuse bone atrophy in the hand skeleton.

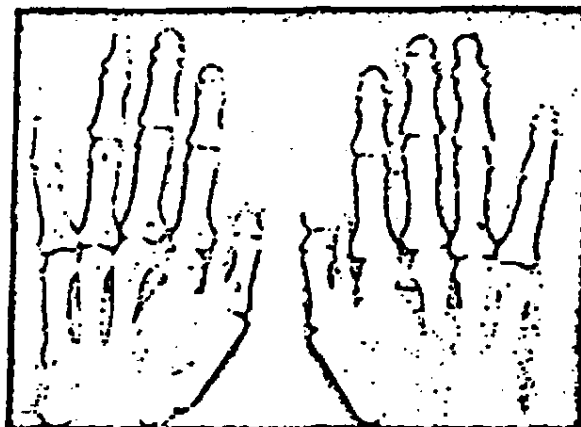


Figure 10. Control picture 10 years after the first investigation (3 years after termination of work in occupation). The Proc. unguicularis have in part built up again. On the other hand, the osteolysis has advanced farther proximally in the shaft. The Processi sit at the stumps of the terminal phalanges with a gap which is still clearly detectable. The "fracture line" running through the Proc. unguicularis of the 4th finger of the right hand is no longer demonstrable. The terminal phalanx of the 5th finger of the right hand appears as a structurally intact but shortened terminal phalanx.

One patient had, instead of an acroosteolysis, a distinct fungiform broadening of the Proc. unguicularis with zones of condensation at the transition of the Proc. unguicularis to the shaft, broadening of the shaft, and also shortening of the finger terminal phalanges. In the foot skeleton, unspecific changes such as atrophy and small marginal defects of the Proc. unguicularis appear in 4 cases; and typical marginal separations of the Proc. unguicularis of both big toes in one case. The ileosacral joints of 4 patients showed unsharp contours and sclerosing. Many cystic lightenings appeared in the region of the caput humeri and of the

Proc. styloideus ulnae in five patients.

Banded osteolyses of PVC workers have been described by several authors. There are also literature reports of the bone margin defects mentioned, of the osteoporosis, and of the sclerosing of the ileosacral joint. Because of the small number of patients, we cannot yet decide whether the striking frequency of bone cysts is characteristic of the syndrome in our patients. In order to clarify the question of reversibility of the acroosteolyses, observations already published and discussed by us on the observation of one patient for a course of illness which has been longer than ten years [12, 20, 21] may contribute. According to that, the osteolytic process proceeds from distal to proximal in the terminal phalanges. At the same time there is partial bone development in the region of the Proc. unguiculares and fusing of the "fracture fragments". The terminal phalanges remain shortened, however, and there has not yet been restitutio ad integrum.

The previously mentioned principal symptoms, Raynaud syndrome, skin indurations and bone lesions - even though only rarely banded osteolyses in this form - recall to the dermatologist the long-known syndrome of progressive scleroderma, in which the corresponding connective tissue alterations regularly occur, also in the internal organs in the sense of visceral participation, especially for the lungs, heart, upper gastrointestinal tract and kidneys. For that reason, we have carried out careful studies on all patients, with particular attention to the vascular system, the blood-forming system, the liver, spleen, lungs, the nerve system and digestive tract, as well as to exclude an autoaggression disease. Here, we were able to collect many findings, described for the first time, on various organ systems (Table 4): thrombocytopenia, splenomegaly, limitation of liver function,

TABLE 4. SUMMARY OF THE MOST IMPORTANT FINDINGS IN ALL THE PATIENTS WITH THE SO-CALLED VINYL CHLORIDE DISEASE

No.	Patient	Skin changes		Circulatory disturbance	Bone changes	Thrombo-cytopenia	Spleno-megaly (2)	Liver changes	Ventila-tion and/or diffu-sion dist-urbance
		a) clinical	b) histol-ogical						
1	S.O.	+	+	+	+	+	+	+	+
2	O.S.	+	+	+	+	+	+	+	+
3	D.Z.	—	+	+(R)	—	+	—	—	—
4	J.F.	—	+	+(R)	—	+	+	—	+
5	H.D.	+	+	—	+	++	++	+	+
6	A.W.	+	+	—	+	++	++	+	—
7	H.A.	+	+	+(R)	+	++	+	Esophageal varices	+
8	M.C.	+	+	+	+	+	+	Portal fibr.*	+
9	S.W.	+	+	+(R)	—	+	+	+	+
10	K.H.	+	+	—	+	+	++	+	+
11	L.M.	—	+	—	—	+++	+++	+	+
								Esophageal varices	
12	F.S.	—	—	+	—	+	++	portal fibr.	+
								Esophageal varices	
13	B.K.	—	+	+	—	+	++	portal fibr.	+
								Esophageal varices	
								portal fibr.	
Sum		8	12	9	7	13	12	12	11

+ = 150 000—90 000 μ
 ++ = 90 000—50 000 μ
 +++ = <50 000

+ = Enlargement as far as the costal arch
 ++ = Enlargement beyond the costal arch
 +++ = Enlargement beyond the costal arch

*fibr. - fibrosis.

periportal fibrosis, portal hypertonia, esophageal varices, partial insufficiency with indications of restrictive changes.

These results, as well as the fact that we could detect three other autoclave workers who showed no clinical skin changes and no acroosteolyses, but a striking agreement with the previously collected internal findings, stimulated us to a very attentive search directed toward possible other patients. As a result, we now have study findings from 45 (of a total of 128) workers in this PVC-manufacturing plant. They are summarized in Table 5 [15].

Table 5. FREQUENCY OF CLINICAL, SCINTIGRAPHIC, X-RAY FINDINGS AND PATHOLOGIC LABORATORY FINDINGS IN 45 WORKERS AT A PLANT MANUFACTURING PVC.

1.	Scleroderma-like changes	8 investigated
2.	Raynaud syndrome	4 investigated
3.	Acroosteolysis of the hands	6 investigated
4.	Increased liver enzyme values (transaminases, LDH, AP, SP)	8 investigated
5.	Increased BSP retention (7-27 percent retention after 45 minutes)	23 investigated
6.	Thrombocytopenia (17,000 - 140,000/ μ)	37 investigated
7.	Splenomegaly (scintigraphy)	25 investigated
8.	Varices of esophagus and/or gastric fundus (MDP, splenoportography)	7 investigated

Studies of the vascular system for diagnostic and pathogenetic explanation of the previously mentioned symptoms led to the following findings:

The skin temperature of the hands was reduced in 6 patients (up to 10°C below the normal). In the cold exposure test, the rewarming time was extended in 9 patients (up to 60 minutes).

A Raynaud syndrome could be triggered for individual or all fingers of both hands in 4 of them. There was no oscillographic or plethysmographic indication for reduced circulation of the extremities.

Distinct vessel changes could be demonstrated by arteriography in 7 patients with acroosteolyses and scleroderma-like changes or Raynaud syndrome. They extend from a slight narrowing of the vascular lumens for the finger arteries through distinct delay of the filling time, extensive stenoses and total closings in the region of the basal and middle phalanx, especially in the fingers with acroosteolyses, to complete segmentary occlusions or even failure of filling of the arteries along the whole length of the finger. The other fingers show a distinctly denser vascular net. Investigations by capillary microscopy on 4 patients who showed clinical circulatory disturbances but no Raynaud syndrome showed ampulla-like expansions of the capillary loops, such as are described in the Raynaud syndrome. To the extent that we can yet judge, there appears to be a relation between the duration of exposure and the extent of the angiographic findings, to the extent that the patient exposed more than 11 years showed the most severe changes (Prof. Dr. Schlüssel, Prof. Dr. Schober, Siegburg City Hospital; Private Lecturer Dr. Belz, Radiographic Clinic, (Dr. P. Thurn, Director)).

In almost all those studied we found slight to severe thrombopenia with values between 17,000 and 140,000 per μ l, with the lower limit of normality at 150,000 per μ l. These reduced thrombocyte numbers actually appear to be the first symptom which can be objectively determined. This may be of importance for future continuous industrial medical studies. The blood picture and the bone marrow studies showed, aside from an occasional slight reticulocytosis between 16 and 20%, no indication of injury to the blood-forming system.

In particular, there were no signs of osteomyelosclerosis or fibrosis (Medical Clinic; Prof. Dr. H.-J. Dengler, Director).

More than half of the patients investigated so far showed splenomegaly with occasional enlargement extending beyond the costal arch (scintigraphic findings)(Dr. Schneider, Institute for Clinical and Experimental Nuclear Medicine; Prof. Dr. C. Winkler, Director).

The hypersplenism resulting from this might perhaps be responsible for the thrombopenia regularly observed, even though thrombopenia occurs without splenomegaly and there is no direct relation between the severity of the thrombopenia and the extent of the splenomegaly.

Liver damage can be demonstrated just as often with normal palpation findings, based on the laboratory chemical, X-ray, scintigraphic, laparoscopic and histologic findings: Slight to moderate increased BSP retention (maximum: 26.5%; upper boundary range in 14 patients between 5 and 7% in 14 patients; slight increase of the transaminases in the range of 20-32 mU/ml (6 patients) and of the alkaline phosphatase up to 86 mU/ml (4 patients). In 6 patients there were also slight changes in the coagulogram (Institute for Experimental Hematology and Blood Transfusion Methods; Prof. Dr. H. Egli, Director).

In striking contrast to these changes, which were discrete except for the increased BSP retention, the laparoscopic picture showed netlike or superficial capsular fibrosis. In individual cases there was arching or protrusion of the surface and histologically, a distinct periportal, septal and intra-lobular fibrosing in the sense of a chronically toxic liver injury, such as can occur after long-term intoxication with chlorinated hydrocarbons [15].

The deviations in the electrophoretic pattern could be explained in the same way (differing increase of the immunoglobulins in changing composition, reduction of the β -1-A complement fraction). The esophageal varices seen in 7 patients (gastrointestinal series; Radiologic Clinic) might be direct hemodynamic and life-threatening consequences of the liver changes. Changes in the respiratory tract could also be established with striking frequency. Most of the patients (8) showed functional disturbances in the sense of partial insufficiency and indications of predominantly restrictive changes (Prof. Dr. Schwabe, Medical Clinic).

Review and Discussion

These findings justify our opinion that this is a new occupational disease. We concede that the name "so-called vinyl chloride disease" cannot be certain until accurate work-site analyses and, if possible, animal experimental investigations have finally confirmed our suspicion. There are already bases for arguing that VC could be of causative significance for the appearance of this disease picture:

1. Gas analyses which have been published have shown that the residual gas in question consists of 90% VC while other gases such as vinyl acetate or trichloroethylene occur only in amounts which hardly come into question as causes for such damages.
2. The various additives can be eliminated as causes because the bone changes, themselves rare, were observed in various countries by various authors for the same production process. But it can hardly be assumed that any additive which might have been used at random here

would have led to these striking changes.

3. The narcotic action of VC is well known. In the case history, one of the workers we studied reported that at times VC occurs at various points in the production process in such quantities as to cause lassitude, dizziness and nausea.
4. The occurrence of the Raynaud syndrome has been observed in plants which make only the monomer, but not PVC.

The pathogenesis is not yet explained. In all of the organ systems which we studied, there was change in the connective tissue or the vascular connective tissue. Because of the high morbidity for predominantly young men in only a single very special occupational sector and the complex nature of the disease picture, we would prefer to believe in a toxic occurrence. The cause of the thrombocytopenia still remains unclear. The question of why the disease picture can occur with or without circulatory disturbances, skin and bone changes, can perhaps be explained from the activity at work. All the patients who have these changes were active as autoclave cleaners for at least some time.

Now if, as assumed, this substance has a toxic action percutaneously and by inhalation, then the close contact with the polymer deposits on manual inner cleaning of the autoclaves would have considerable importance in the origin of the disease particular. In addition, we have as yet found scleroderma-like skin changes only in the areas of the unclothed skin parts.

In view of the visceral involvement, and particularly in respect to the question of portal fibrosis, the prognosis must be made only with reservation. At least, the reversibility of the clinical phenomena, which has been repeatedly advanced in the literature cannot yet be confirmed.

The existing findings also provide extensive differential diagnostic delimitation from progressive sclerodermia, with which it has been brought into close connection because it is also a disease affecting the vascular connective tissue system:

1. In our patients, we do not see the findings described as early symptoms of progressive sclerodermia: shortening and sclerosing of the tongue ligaments and esophageal sclerosis.
2. As far as is known now, the skin changes appear only on the uncovered parts of the body.
3. The disease picture does not lead to the severe sclerodermic changes with their sequelae, such as the claw position of the hand, atrophy and the cone-like narrowing of the finger. On the contrary, there is club-like swelling and shortening of the terminal finger phalanges with narrowing of the nail plates.
4. In contrast to progressive sclerodermia, in which the changes of the elastic fibers are less expressed, the histologic picture shows distinct to considerable fragmentation and rarefaction of the elastic fibers.

5. Searches for antinuclear factors, LE cells and rheumatic factors, often pathologic in progressive sclerodermia, gave no indication for the presence of an autoimmune disease.
6. In progressive sclerodermia, the bone changes begin at the distal end of the Proc. unguicularis with bone atrophy, rarefaction or osteolysis. This advances proximally and leads to the picture of "pointed terminal phalanges". Banded acroosteolyses are exceptional in progressive sclerodermia.
7. When internal organs are involved, the heart, lungs and kidneys are more involved than the liver and spleen in progressive sclerodermia.
8. In the early stages of the so-called vinyl chloride disease there is apparently a certain capability for recovery, particularly of the skin phenomena. In the advanced stage, we must consider the prognosis as more serious than had been assumed before, in view of the hemodynamic sequelae which have become known (esophageal varices). It is not comparable, however, with the fatal outcome of progressive sclerodermia.

Preventive measures should start with improvement of the working conditions: gas analyses at the work site, development of better ventilation systems to take away the vapors or smoke, automatic cleaning equipment for the autoclaves, avoidance of high temperatures (above 350°C) which can cause decomposition of the plastic. Furthermore, persons with liver disease should not be hired. It would also be reasonable for the workers to have regular followup studies with thrombocyte determination. The industries which do further processing -

especially those in which there is danger of renewed degradation in the production processes - should be included.

The problem for insurance law is clear. The disease picture must be recognized as an indemnifiable occupational disease in the sense of the 7th Decree on extension of accident insurance to occupational diseases, under part A of the attached list: diseases caused by chemical substances. According to our information, this is to occur through the union also.

Summary

A survey is presented on a syndrome seen for the first time in Germany. That syndrome called "occupational acroosteolysis" so far, is diagnosed mostly in autoclave workers in the industry producing PVC. Results are reported on detailed examinations on lesions of the skin, bones, vascular and hemopoietic systems, liver, spleen and lungs. These results suggest that this very complex syndrome (systemic disease) is due to prolonged exposure to vinyl chloride. The connective tissue undergoes an unknown alteration, together with fibrosation of the skin and of the vascular system, and perhaps of the lungs and liver as well. The author suggests that the syndrome be renamed "vinyl chloride disease".

On the strength of the legal regulations in the German Federal Republic, this syndrome should be recognized as an indemnifiable occupational disease.