

#251. INTOXICATION BY VINYL CHLORIDE POLYMERS AND/OR
THEIR ADDITIVES

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Translation of: "Zur Intoxikation durch Vinylchlorid-
-Polymerisate und/oder deren Begleitstoffe," Z. Haut-Geschl.
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The complex pattern of damage as the result of handling a plastic became known to us when a situation arose involving difficulties in differential diagnosis. The synopsis of the individual findings, job history data, and the literature on the subject enabled us to discover an occupational disease caused by long-term skin contact with vinyl chloride polymers (PVC) and/or their additives.

Juehe and Lange [6] published in 1972 a short article on "Skin Changes of the Sclerodermal Type, Raynaud's Syndrome and Acroosteolysis in Workers in the PVC Manufacturing Industry" (see also [7]). They were able to show that nothing of the kind had been reported in the German literature (see also [15]).

The case histories we have chosen as examples should contribute to propagating knowledge of damage caused by a particular set of industrial circumstances in the attempt to ensure that intoxication by vinyl chloride polymers and/or their additives, which occurs today with variegated symptoms, including extracutaneous symptoms, no longer escapes diagnosis — as we must suppose it does at the present time.

Patient observation: Mr. E. B., Identification No.: 22 28 06 021; telephone installer, age 50, admitted to FUB Steglitz Skin Clinic in December 1972; admission No. 1376610.

Case history: First difficulties about 4 years ago on the hands: swelling mainly on the left, paresthesia, weakness; continuous intensification of these symptoms over the years, increasingly painful radiating sensations in the hand and forearm. Two years ago, clear tendency to hardening of the thus far edematous swellings of hands, in particular the forearms, with discomfort upon moving fingers and hands and motoricity when writing; whitish finger color after cold stimulus. Arthralgia at the lower extremities, discomfort of the upper abdomen, severe discomfort through sinistral acoustic phenomena such as hissing and whistling, etc., with damage to the right ear and hearing impairment which had been present since childhood. For years, symptomatic treatment under the diagnosis of a rheumatic disease.

Hospitalized for in-patient investigation with progressive scleroderma suspected.

Skin findings upon admission: Both hands with tight, pronounced, pitting edema, more distinct on the left than on the right side, and the skin was firmly attached to the underlying tissues; diffuse skin patches; pileous areas unaffected. Pale whitish-yellowish appearance of the integument of the hands, striking intensification of the pale color tone when the fist was clenched. Clear

dermatosclerosis of both forearms with relatively sharply defined ramifications of these phenomena toward the distal upper arm. Remaining integument and frenulum of the tongue without striking changes; in the center face and over the cheek bones discrete telangiectasis which apparently had existed for some years (Figures 1 and 2).



Figure 1. Edema of the Hand Which Can Still be Pitted, Skin Attached to Underlying Tissues. Pale color of the region involved, face and frenulum of tongue without changes.

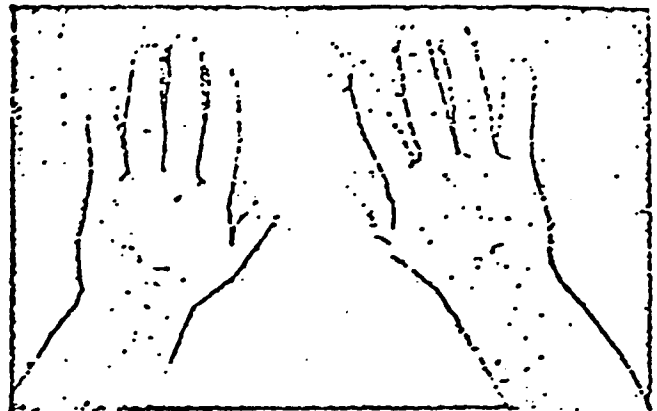


Figure 2. Edema of the Hands More Noticeable on the Left Than on the Right, Diffuse Skin Patches, Pileous Regions Predominantly Intact. Dermatosclerosis on both forearms.

Tentative diagnosis upon admission: Progressive scleroderma; edematous or sclerosing stage. Disease of the rheumatic type with pseudoscleroderma in the upper extremities.

Further findings:

No abnormal results or values in the following: ESR/differential blood count/electrophoresis/IV glucose/IS uric acid/IS total cholesterol/IS triglyceride/IS creatinine/IS GOT/IS GPT/IS alkaline phosphatase/Quick test/IS iron/IS CPK/ urine status/total porphyrin, porphobilinogen delta-aminolevulinic acid, hydroxyproline in the urine/IS sodium/IS potassium/IS total calcium/IS inorganic phosphate/Wassermann reaction/rheumatoid factor/AST/Quantitative immunoglobulin/C₃ and C₄ complement/antinuclear antibodies/direct immunofluorescence investigation of the skin area involved for IgG, IgA, IgM, C₃, fibrin inclusions.

X-ray investigation: Area kymogram of heart/thoracic organs/shoulder joints, elbow joints, knee joints, ankle joints, and iliosacral joints, esophagus/gastrointestinal tract/excretion urogram/kidney x-ray/EKG/lung function test/capillaroscopy.

Neurological and ophthalmological consultant investigation.

Pathological results:

X-ray investigation: Both hands with striated translucence near the joints in the region of the proximal and middle phalanges, arteriography of

the hand: all finger arteries visualized only after intra-arterial administration of Prisco; no morphological vascular changes.

Visual lymphography of the upper extremities: Condition of primary lymph nodes more obvious on the left than on the right.

ENG: Somewhat myopathic form of the mU potential of the digital flexor, attributable to the edema.

Histological investigation (file No.: 1563/72; He¹/vG¹/tunica elastica/ toluidine blue/ alcian blue/Giemsa (Figures 3 and 4): epidermis with lamellar orthohyperkeratosis, circumscribed acanthosis and [Translator's Note: 4 words illegible] cutis and subcutis clearly edematized, occasional visualization of metachromatized material. Impressive damage of the tunica elastica with rupture of fibers and swelling of fiber fragments. Broadening of the collagen bundle of fibers and dissociation of the connective tissue by the interstitial edema. In the subepidermal region striated zones with incipient homogeneous visualization of the connective tissue. Striking packing of individual dermal arterioles, sometimes broadened and evident homogenized media of smaller vessels, with Umbonate prominences, [Translator's Note: half of a line illegible]. There was sometimes a perivascular round-cell proliferation, consisting mainly of lymphocytes, with infrequent histiocytes and mast cells. Dilated lymph capillaries. Pronounced swelling of dermal nerves, with clear formation of vacuoles inside them. Appendages of the skin without change.



Figure 3. Edematized Corium, Dissociated and Sometimes Widened Collagen Bundles of Fibers. Thickened tunica media of smaller vessels, swollen endothelia; perivascular round-cell proliferation. Dilation of lymph capillaries. Large increase in volume of dermal nerve cords. Magnification X 90.

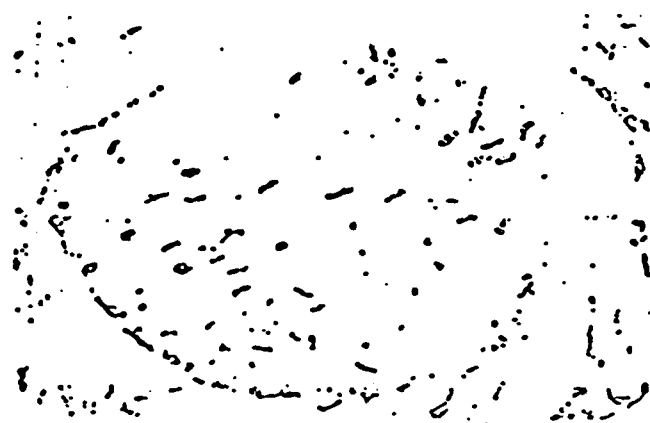


Figure 4. Increase in Volume of Fiber Bundles, Clear Vacuolization. Magnification [Translator's Note: a 3 digit number beginning with 7, last 2 digits are illegible].

¹Translator's Note: expansion unknown.

Electron microscope findings: Considerable lymph dilation with a high degree of flattening of the endothelium and thickening of the lymph (Figure 5a). High degree of interstitial protein-rich edema with relaxation and, in parts, considerable dissociation of the previously paraplasmic substances (Figure 5b); interfibrillar edema of the collagen fibers, no destruction of collagen (average period approximately 640 Å), swelling and local destruction on and in the elastic fibers (moth-eaten appearance) and clumping of elastic fiber material (Figures 6a and b). [Translator's Note: illegible word] blood vessels (arterioles and capillaries) with swelling of the endothelium, sporadic small perivascular round-cell infiltrates (lymphocytes and histiocytes), also disseminated mast cells, partially triggering the typical granula. Pronounced perineural and endoneural edema (Figure 7a): axon edema in medullated and non-medullated nerves, also local destruction and vacuoles in the axon. No destruction in the myelin sheath, no cell reactions (Figures 7b and c).

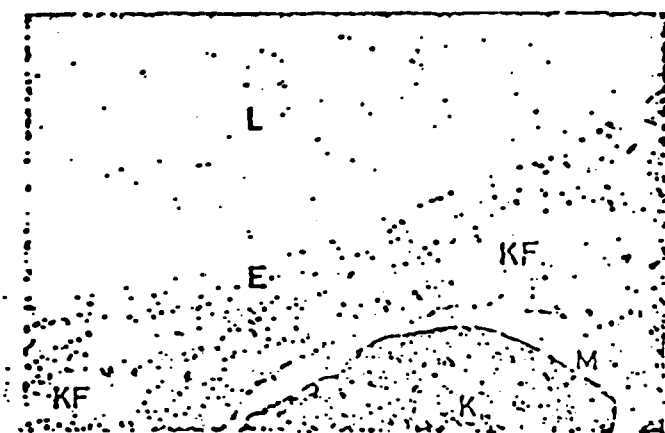


Figure 5a. Electron Microscope of a Strongly Dilated Lymph Capillary Filled with Thickened Lymph (L) with Considerably Flattened Endothelium (E). Pericapillary slanting and diagonal sections of collagen fibrils (KF), moderately intense interfibrillar edema. At the bottom, section of a mesenchymal cell (M) with nucleus (K). Electron microscope magnification X 16,000.

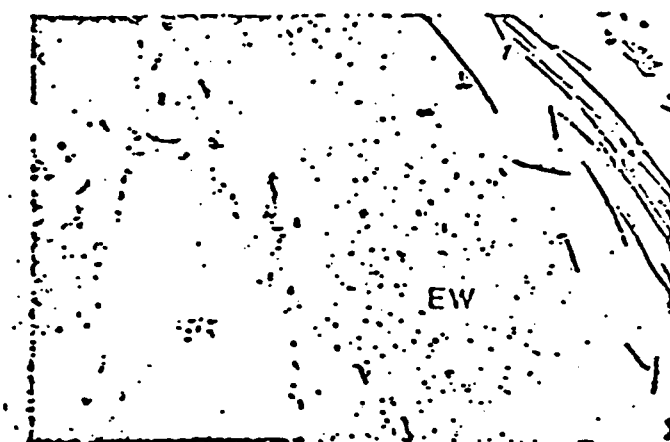


Figure 5b. Electron Microscope Magnification of a Section of the Corium: Considerable Protein-Rich Edema (EW) with Dissociation of the Previously Existing Fibers and Fibrils. Destruction in and on the elastic fibers (EF) looking moth-eaten. Electron microscope magnification X 12,800.

Audiogram: December 1972 combined bilateral hearing difficulty; late January 1973 clear damage to the cochlea as well.

Further x-ray investigations: vertebral block, cervical vertebrae 2/3; osteochondrosis and spondylosis deformans C5 to C7; slight degree of scoliotic false posture, slight osteochondrous changes and spondylosis deformans of the thoracic vertebrae; marked changes in the area of L 5 to S 1; upper and lower jaw merely lacunar.

Orthopedic Consultant investigation: Incipient degenerative changes of the spine; no connection could be made with the skin changes.



Figure 6a. (Upper Right) u.b.²: Electron Microscope Magnification of a Section of the Corium: Considerable Interstitial Edema with Dissociation of Collagen Fibrils (KF) and Elastic Fibers (EF). Cytoplasm and karyoplasm (K) of the fibrocytes (F) normal. Electron microscope magnification X 12,000. Inset: Magnification of destruction in and on the elastic fibers (†). Electron microscope magnification X 19,000.

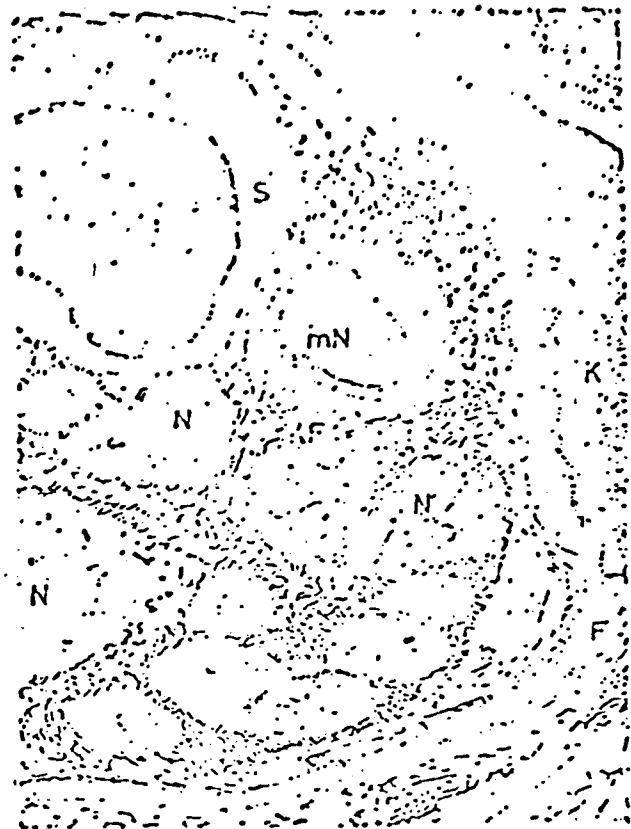


Figure 7a. Electron Microscope Magnification of a Section of the Corium with Medullated (mN) and non-medullated (N) nerves: clear perineural and endoneural edema. Schwann's cells (S) are normal. Perineurally, one normal fibrocyte (F) and collagen fibrils (KF). Electron microscope magnification X 16,000.

Tentative diagnosis: Edema or dermatosclerosis of the upper extremities, of unclear etiology.

Job background: For the past ten years had been laying polyvinyl chloride (PVC) pipe. Sealing the pipe with thin fluids' (PVC glues containing e.g., butynol and tetrahydrofuran (Tangit glue made by Henkel)). The glue was applied with a rag held in the left hand so that the glue flowed more intensively over the left hand and forearm than the right, and a layer of adhesive film accumulated. After work, this was removed either by rubbing or with butanol or methylene chloride.

Final diagnosis: Intoxication by vinyl chloride polymers and/or their additives.

²Translator's Note: expansion unknown.



Figure 7b. Electron Microscope Magnification of a Cross Section of Non-medullated Nerves (N) of the Corium: Local Destruction (f) in the Axon and Marginal Thickenings. Electron microscope magnification X 40,000.



Figure 7c. Electron Microscope Magnification of Section of Non-medullated (N) and Medullated (mN) Nerve from the Corium with Axon Edema (f). Myelin sheath (My) intact. Electron microscope magnification X 26,400.

Epicrisis: The 50-year-old telephone installer fell sick about 4 years ago with swelling, paresthesia and weakness of the hands, especially the left hand; these changes became more pronounced in the course of time; painful sensations appeared in the hand-forearm region; tendency to edematous swelling leading to sclerosing; fingers turned whitish when scratched. For years, unsuccessful attempts at treatment with the disease of a rheumatoid disease, admitted for in-patient treatment with the tentative diagnosis of progressive scleroderma. When he was admitted to the hospital the skin changes showed signs of the edematous and sclerosing stage of progressive scleroderma, they also pointed to so-called pseudoscleroderma [5] with various basic conditions, e.g., a disease of the rheumatoid type. The laboratory diagnosis and morphological and functional findings, taken on the basis of suspected progressive scleroderma or rheumatoid disease, ruled out the tentative diagnosis and pointed to damage by vinyl chloride polymers and/or their additives on the basis of job history and pertinent literature.

Discussion

The course and symptoms of the disease of our patient fitted well into the variegated clinical spectrum of poisoning by PVC and/or additives, as may be gathered from the literature on the subject [1, 3, 6, 7, 8, 14, 15, 16]: with (probable) dependence on factors given by the individual type of work, changes appear with a specific set of subjective symptoms (Table 1), functional (Table 2), and morphological changes (Tables 3, 4, and 5), with differential accentuation and for overlapping of individual symptoms in accordance with rules which are not initially clear. Incorrect diagnosis of the changes, i.e., ascribing them to a rheumatoid disease or progressive (acro-)scleroderma is frequent; this is also found in the case history of our patient.

It should be pointed out that, in particular, the typical location and prominence of the bone lesions are pathognomonic in nature. The distinguishing characteristic of acroosteolysis ([11], see also discussion of nomenclature and nosology of disease groups) may be delimited by x-ray examination from the familiar acroosteolysis, the idiopathically unfamiliar acroosteolysis, and

familiar osteosclerosis with acroosteolysis [9, 16] and should — after precise analysis of the clinical symptoms and the course of the disease taken together with job history — in the future be classified as occupational poisoning.

TABLE 1. SPECTRUM OF SUBJECTIVE SYMPTOMS
(Almost exclusively in the arm and leg regions, and very little in the shoulder girdle)

Sensation of cold
Burning, tingling and feelings of numbness, weakness and tension
Arthralgia, pain caused by pressure, various pronounced sporadic painful sensations
Also:
Discomfort of the upper abdomen, hissing in the ears, dizziness

TABLE 2. SPECTRUM OF FUNCTIONAL CHANGES
(Almost exclusively in the upper extremities, not always bilateral)

Paling of one or more fingers
(dead finger phenomenon)
After cold stimuli, when clenching the fist, or in particular positions of the arm;
Raynaud's syndrome
or Raynaud-like syndrome
Spontaneously or after cold stimuli
Movement impeded
Spasms of the hand arteries and/or brachial arteries
Also:
Visual impairment, liver function disturbances

TABLE 3. SPECTRUM OF MACROMORPHOLOGICAL SKIN CHANGES
(Almost exclusively in upper extremities)

Moderate bluish, pale-whitish, ivory-colored, dirty yellowish, and bright colors.
Nodular, knotty, plaque-like, undulated, more or less raised and xanthoma-like infiltrations.
Diffuse skin patches, pileation retained
Shortened and watch-glass-like nails
Swelling of hands or fingers and/or forearm
Extension of changes to forearm or upper arm region
Drumstick fingers
Impairment of skin's ability to slide over the supporting tissues
Tight edematous waxy sclerotic consistency of integument
Also:
Bloated mask-like facial features
Flattish indurations in the cheek region

In studying the contamination of the air in the vicinity of shaft-type driers, when drying polychlorovinyl resin, vinyl chloride was not found in 82.3% of the samples. In the remaining samples its content varied from 0.7 to 0.12 mg/l, while the air samples in which vinyl chloride was found were collected in the vicinity of the fresh resin, in areas not equipped with local exhaust fans.

In areas where driers using the V. I. Stroganov system are in operation, there is a significant contamination of the air by dust from the finished product. The dust escapes when the examination doors of the furnace are opened (in case the technological process is disturbed), during the crushing and sifting of the resin. The dust concentrations of polychlorovinyl resin at the oven varied from 20 to 567 mg/m³, while the crushing and sifting processes as well as the bagging, produced from 25.5 to 62.5 mg/m³.

In some cases, the vicinity of shaft-type driers was found to have a high air temperature (23-37.5° with an outside temperature of 11.5-23.5°).

In order to improve the sanitary working conditions for those engaged in the operation of shaft-type driers, it is necessary to equip all areas with raw materials to be dried with a local mechanical exhaust fan. It must also be provided in places where the finished product is likely to produce dust that could enter the air.

Drum-type driers are used for drying coarse, fine, granular and firable materials; brown and anthracite coal, sand, clay, phosphorites, grain, granulated sugar, sawdust and the like.

In the operation which we examined, the drum-type drier was used for drying crystalline salts of the sulfates of ammonium and sodium.

A drum-type drier (Figure 5) consists of a rotating drum, 2 m in diameter and 10 m long, connected at one end with a furnace and at the other end with a loading bunker for the dry product as well as a gas pipe for trapping the furnace gases which have been exhausted. There are metal shelves inside the drum. The drum is rotated by an electric motor, acting through a gearbox.

The ammonium and sodium sulfate salts to be dried are fed into the drier by a screw conveyor. Drying is carried out using furnace gases at temperatures up to 220°. The dried salt is transported by a screw conveyor and an elevator to the bunker for storing the finished product.

The operation of the apparatus consists of monitoring the instruments and adjusting the salt drying process.

In the course of drying salts in a drum-type drier, the air is not contaminated by toxic substances because a vacuum is produced in the drier.

Meteorological conditions in production areas near driers are unfavorable. In winter the air temperature was 18-32° and in summer from 21-35°. The highest temperatures were recorded at the window of a drum-type furnace through which the operator checks the feed of salts into the drier. An air shower should be provided at this point.

TABLE 4. SPECTRUM OF MICROMORPHOLOGICAL SKIN CHANGES

Flattening of rete function
 Interstitial edema, deposition of metachromatic, fine-granular, and
 filamentary materials
 Plate-like fibrosis of the corium near the epidermis, thickening of
 collagen fibers and edematous relaxation of the collagen fiber
 bundle
 Fragmentation or circumscribed clumping of the tunic elastica
 Thickening of dermal arteries, hypertrophy of the tunica media,
 fibrosis of the intima, endarteriitis or endarteriolitis
 Dilation of lymph capillaries
 Inflammatory and predominantly lymphocytic perivascular proliferation
 with few histiocytes, involvement of mast cells
 Degeneration of finest nerve fibers

TABLE 5. SPECTRUM OF X-RAY CHANGES
 (Almost exclusively phalanges of the hand — often
 excluding ringed fingers)

Cortical changes
 Circumscribed rarification
 Crescent-shaped defects
 Periarticular erosion of interphalangeal joints
 Striated translucence to the extent of osteolysis of the pseudo-fracture
 type
 Central osteolysis
 Shortening and/or swelling of the ends of the phalanges
 Acroosteolysis
 Circumscribed (reparative) structural thickening
 Also:
 Osteolysis of ulna, radius, clavicle, patella
 Widening of iliosacral foramina

Our data and deductions on the etiology of the syndrome are extremely scanty. PVC was synthesized by Regnault in 1835 (see [12]), and large-scale manufacture began in 1927 [10] and the first publication reporting damage caused by handling PVC appeared in Romania in 1963 [13]. In 1957, the German literature still contained no mention to danger to the health in discussion of the syndrome [10]. Other patterns of damage are mentioned [2] especially the acutely toxic ones [4]. Weichardt [15] found in 1970 that, despite the fact that Germany produces no less PVC than other countries, no disease attributable to it has been found; in 1972 Juehe and Veltman [7] and Juehe and Lange [6] published their observations on the topic.

From the relevant publications [1, 3, 8, 10, 15, 16] it can be deduced that only long-term close skin contact with incomplete VC polymers or various medium-to-high molecular intermediates (resins) and/or their aggressive additives such as plasticizers, stabilizers, accelerators, inhibitors, etc., lead to chronic toxicity. The characteristic pattern of damage is thus far known only in workers in the PVC manufacturing industry who have to scrape off the residue, whose exact composition is unknown, from autoclave walls

(polycleaner [16]). On the other hand, diseases of the kind described here never appeared in those working with completely depolymerized, inert, and physiologically harmless plastics [16].

It is found from the literature that the pattern of damage is to be interpreted as the result of factors which may be chemical, mechanical (continuous scratching and scraping with polycleaners) or individual (only 3.0 to 4.5% of people doing the same kind of work are involved [1, 16]).

On the basis of the job history of our patient, who for years had to spread liquid PVC in his work as a telephone installer, no decisive pathogenic roles can obviously be ascribed to the "mechanical" factor described above.

For the "individual" factor it should be noted that it is probably to be seen as individual contact of various intensities with the responsible agent. The degree of strictness with which the individual observes or supervises the work instructions can also explain the varying frequency with which the syndrome is to be observed, and the differing periods (months to years) before the symptoms became patent. The job history of our patient instructively supports this interpretation of the "individual" factor: he was injured earlier and more extensively because of his special job causing his extremities to be coated with the film-like "special" polymer.

The mechanism by which the "chemical" industrial toxicological factor comes into play can in the first instance only be sketched: the subjective symptoms and functional changes — supported by macromorphological and micro-morphological findings — point to a (initial?) neurovascular disturbance.

More details will be given on the etiology and pathogenesis of the syndrome in a later publication [13].

For prognosis and therapy of the disease after discontinuance of harmful contact while on the job, we may say that the skin changes revert spontaneously [6, 8] and the latter can be promoted whenever possible by physical therapy, as observed in our patient. However the bone lesions can progress even after work is suspended, finally terminating and recovering.

Summary

Case histories of chronic intoxication caused by intensive, long-lasting skin contact with incomplete vinyl chloride polymerization products and resins and/or their additives are presented. Paresthesia, functional, and macromorphological and micromorphological changes build up to a variegated pattern of symptoms. A syndrome of scleroderma-like dermatosis, Raynaud's and dead finger syndromes and pathognomonic bone defects are characteristic. When these symptoms are taken together with the occupational circumstances, this easily misinterpretable disease can be diagnosed.

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139485m Nitrogen oxides, nuclear weapon testing, Concorde, and stratospheric ozone. Goldsmith, P.; Tuck, A. F.; Foot, J. S.; Simmons, E. L.; Newson, R. L. (Meteorol. Off., Bracknell, Engl.). *Nature (London)* 1973, 241(5118), 545-51 (Eng). The prodn. of NO_x in the shock wave of explosions assoc. with the testing of nuclear weapons in the atm. is calcd. and compared with that expected from the engine exhaust products of fleets of Concorde, each flying in the stratosphere for >10 hr every day of the year. NO_x injections into the stratosphere from past nuclear explosions are equiv. to large nos. of fully operational Concorde. Anal. of the O₃ records reveal no detectable changes in the total atm. O₃ during and after periods of nuclear weapon testing implying that massive NO_x injections into the stratosphere do not upset the O₃ layer.

139486n Spectrophotometric determination of small amounts of dimethyl sulfate in air. Tomczyk, Danuta; Bajerska, Jadwiga (Ostrodek Badaw.-Rozwojowy Przem. Barwnikow, Zgierz, Pol.). *Chem. Anal. (Warsaw)* 1973, 18(3), 543-9 (Pol). Me₂SO₄ was absorbed in pyridine, N-methylpyridinium sulfate heated with 0.2N NaOH, and the resulting glutacetaldehyde (I) was reacted with PhNH₂ at pH 5.5 to form I dianil whose absorbance was measured at 484 nm (molar absorptivity 3.4 × 10⁴). The method permits the detn. of 0.15 γ-(CH₃)₂SO₄/l. of air with an error ≤5%.

139487p Emission spectrographic determination of non-homogeneity of laboratory samples of industrial dusts. Rokosz, Andrzej; Grąpiel, Andrzej (Univ. Jagiellonski, Cracow, Pol.). *Chem. Anal. (Warsaw)* 1973, 18(3), 593-8 (Pol). Dust samples were fused with K₂S₂O₇ and Co₂O₃ (internal std.) and excited in an a.c. arc; anal. lines were: Fe I 297.3, Zn I 334.5, Pb I 280.2, Si I 288.2, Al I 308.2, Ca I 364.4, Mg II 280.3, Mn I 279.8, Cr II 284.9, Cu I 327.4, and Co I 308.7 nm. Nonhomogeneity was judged from the scattering of the relative intensity of the anal. lines of the elements and internal std. The method was used at random to investigate dusts from the marten steel smelting process.

139488q Exhaust emission of the Otto engine during knocking combustion. Eberan-Eberhorst, Robert; Gruden, Dusan; Schwarzbauer, Gerd (Inst. Verbrennungskraftmasch. Kraftfahrwes., Tech. Hochsch. Wien, Vienna, Austria). *Erdoel Kohle, Erdgas, Petrochem. Brennst.-Chem.* 1972, 25(12), 715-18 (Ger). Varying air: fuel rate, compression ratio or ignition advance produces engine knock and also influence exhaust emissions. Combustion temp. raises with knock as does the NO_x emission. The hydrocarbon emission is lower with knock than normal, providing air: fuel rate or ignition changes have caused knock, but higher due to changes of the compression rate. The HCN-, HCHO- and O₂-emissions, as well as odor, increase rapidly with knock intensity. Knock intensity 0-100 was measured with the standard knockmeter in the ASTM-CFR-Test engine (MOZ).

139489r Accurate measurement of cadmium in airborne particulates. Zdrojewski, A.; Quickert, N.; Dubois, L. (Chem. Div., Environ. Prot. Serv., Ottawa, Ont.). *Int. J. Environ. Anal. Chem.* 1973, 2(4), 331-41 (Eng). The accurate and rapid measurement of Cd in airborne particulates is described, with particular ref. to high-vol. air samples collected on glass fiber filters. The method involves the acid digestion of a part of the filter followed by anal. using at. absorption spectroscopy. The use of both conventional flame at. absorption and at. absorption with a graphite furnace atomizer was studied. The Cd detns. were free of matrix error. Small interferences by other elements could be accurately taken into account. For a typical air sample of 2000 m³, the Cd amt. can be detd. with accuracy down to ~2 ng/m³. Detns. below this level are possible at the expense of the speed and simplicity of the method. The possibility of a non-uniform distribution of Cd on the exposed filter, and the chance of accidental contamination of the filter or prepd. sample by traces of Cd are also discussed.

139490j Fossil fuel burning and carbon dioxide. Pessimistic view. Pytkowicz, R. M. (USA). *Comments Earth Sci., Geophys.* 1972, 3(1), 15-22 (Eng). From *Nucl. Sci. Abstr.* 1973, 28(3), 5002. The impact of the combustion of fossil fuels on the CO₂ concn. in the atm. and the consequences for Earth ecosystems are postulated. The rate of fossil fuel consumption increased an av. 4.5%/yr during the past century causing a steady buildup in atm. and oceanic CO₂. Mechanisms by which CO₂ is removed from the atm. and sea water by oceanic sedimentary processes are reviewed. Calcs. show that by 1966 man had produced and injected into the atm. 95 times the CO₂ removed by oceanic sedimentary processes, which are primarily biogenic. If CO₂ levels in the atm. continue to increase catastrophic warming of the surface of the earth will

occur, possibly during the next century, and will melt polar ice caps, decreasing the albedo of the Earth's surface, slowing the deep circulation of the oceans and the cycling of nutrients in the oceans, increasing sea level, flooding coastal plains, and increasing weathering processes and changing both animal and plant ecosystems to the detriment of human populations.

139491k Atmospheric releases from Tarapur. Abraham, P. Pattnaik, D.; Paramesvaran, S. (Bhabha At. Res. Cent. Bombay, India). *Indian J. Environ. Health* 1971, 13(3), 171-8 (Eng). The safeguard features engineered into the Tarapur At. Power Station, India, to minimize, control, and monitor the atm. pollutants from the station are described. The limit prescribed for the effluents from the station are discussed. The γ spectra of the effluents are presented and the radioactive isotopes are identified. The major constituents of the gaseous waste are isotopes of Xe and Kr. Data on actual releases are given. The max. value of activity released is very much less than the max. permissible release.

139492m Concentrations of uranium in the air of a uranium refinery and in urine of the workers. Okabayashi, H.; Iik, M.; Watanabe, S.; Hongo, S.; Suzuki M. (Natl. Inst. Radio Sci., Chiba, Japan). *Hoken Butsuri* 1972, 7(3), 151-5 (Japan). U concns. in the refinery air were 9.6×10^{-11} to 3.7×10^{-9} g/l and in the urine of the workers, 3.9×10^{-7} to 3.6×10^{-4} g/l. The concn. in the air was higher than background by an order of 2-4 and that in the urine was higher than that in the general public. These high levels in the urine are due to inhalation of higher concns. of air borne U in the working environment.

139493n Work hygiene and effectiveness of health measure in the manufacture of chlorinated terpenes. Ashirova, S. A. (USSR). *Nauch. Tr. Leningrad. Gos. Inst. Usosresh. Vrach.* 1971, No. 98, 26-30 (Russ). Chlorinated terpenes are widely used as insecticides. For agricultural purposes aquatic emulsion of polychloropropene (I) and polychlorocamphene (II) are used. They are toxic to humans, penetrating through respiration and alimentary canals and skin. The max. permissible concn. of I and II in working areas is 0.2 mg/m³. Camphene, α-pinene, I, II, and Cl were detd. in 3180 samples of factory air. For 90% of the samples the concn. of I was 1.5-10 times greater than the max. permissible concn. During II prodn. the max. permissible concn. was exceeded 5- or 6-fold. The skin penetration rate was high. The skin of employees in 3 factories was studied. By shift end, the concn. on uncovered parts of the skin and esp. hands was 0.3-10 mg/dm². The highest concn., 2.9-10 mg/dm², was on the skin of operators pouring the II. The covered parts of skin had a concn. of 0-0.4 mg/dm². Medical examinations show that 1/3 of the tested workers had nervous system changes and 2/3 had subatrophic and atrophic respiratory organ changes.

139494p Effects of asbestos on the pleurae. Lesobre, R. Hagenue, A.; Legrand, M. (Cent. Pneumol., Hop. Beaujon Clichy, Fr.). *Nouv. Presse Med.* 1973, 2(22), 1491-4 (Fr). Thoracotomy and necropsic findings following exposure to asbestos dust are described. The primary lesion, the hyaline pleural plaque, devoid of clinical symptoms, seldom contains any asbestos fiber. Later these plaques become calcified and the calcification continues even after termination of asbestos exposure. In 15-20 years some workers developed pachypleuritis. Benign recidiving exudative pleuresia can be produced by asbestos dust; this may develop into mesothelioma, esp. with exposure to crocidolite.

139495q Technical progress in the chemical industry and industrial hygiene. Arkhipov, A. S.; Marchenko, E. N.; Filatova, V. S.; Egorov, Yu. L.; Novoselova, T. I.; Martynova, A. P. (Tsentr. Inst. Uoversh., Moscow, USSR). *Gig. Tr. Prof. Zabol.* 1973, (8), 1-5 (Russ). The effective use of equipment, architectural design, ventilation methods, waste recycling and final treatment, and measurement and elimination of fumes, gas, and aerosol emissions are described.

139496r Hygienic evaluation of working conditions in some chemical plants operating in the open air. Filatova, V. S.; Vinogradova, V. K.; Bashkurova, L. S. (Inst. Gig. Tr. Prof. Zabol., Gorki, USSR). *Gig. Tr. Prof. Zabol.* 1973, (8), 8-11 (Russ). Key technol. equipment at 2 new NH₃ and vinyl chloride plants were placed in the open air. Working conditions and industrial hygiene at these plants are satisfactory.

139497s Changes in working conditions and health status of workers of oil refineries in connection with technical progress. Mukhametova, G. M.; Polyanskii, V. A.; Sukhanova, V. A.; Mustaeva, N. A.; Ostrovskaya, R. S.; Braginskaya, L. L.; Makar'eva, L. M.; Gazizov, M. F.; Emel'yanova, A. P. (Inst. Gig. Prof. Zabol., Ufa, USSR). *Gig. Tr. Prof. Zabol.* 1973, (8), 5-8 (Russ). A comparative anal. exams. of workers at the Ufa refineries made in 1957-60 and 1970-71 showed substantial favorable changes in health (with a service record up to 10 yr). The number of persons with asthenic and neurasthenic syndromes, hypotension, anemia, thrombocytopenia, and chronic gastritis greatly declined. Some functional characteristics of the liver improved. Persons examd. in 1970-71 still had

in intracellular media in all persons under study. The Ca level in blood plasma decreased with age. The K level in intracellular media increased with age, that in intercellular liqs. was practically const. These findings agree with the literature data of the effect of occupational stresses as in this case high atm. air temp., noise, vibrations and industrial dust on electrolyte metabolism.

E. Strossberg

23182f Importance of polonium-210 determination in the urine of workers in uranium mines. Panov, D.; Petrovic, D.; Novak, L.; Djordjevic, V. (Inst. Labor Med. Radiol. Prot., Belgrade, Yugoslavia). *Suvrem. Med.* 1972, 23(11), 6-10 (Bulg.). A study of 299 workers in the uranium mines of Yugoslavia who were exposed to Rn as well as rats living under the same conditions showed that it is not possible to det. the contamination by Rn and its degradation products by testing the urine for ^{210}Po . No correlation exists between the concs. of ^{210}Po in the urine and the concn. of Rn in the work environment.

J. J. Pohl

23183g Hand tremor induced by industrial exposure to inorganic mercury. Wood, Ronald W.; Weiss, Ann B.; Weiss, Bernard (Sch. Med. Dent., Univ. Rochester, Rochester, N. Y.). *Arch. Environ. Health* 1973, 26(5), 249-52 (Eng.). Hand tremor in 2 subjects with industrial Hg exposure decreased after cessation of exposure and the subjects became asymptomatic after 3.5 months. The extent of hand tremor was evaluated by requiring the subjects to maintain a force of 10-40 g with the forefinger on a finger trough attached to a strain gauge. Performance improved after the subjects were removed from Hg exposure.

Raymond Zehnpenning

23184h Sanitary-hygienic appraisal of working conditions during the welding of metal covered with protective coats. Protzenko, G. A.; Danilov, V. I.; Timchenko, A. N.; Nenartovich, A. V.; Trubilko, V. I.; Savchenkov, V. A. (Khark. Nauchno-Issled. Inst. Gig. Tr. Profzabol., Kharkov, USSR). *Avtomat. Starka* 1973, 26(2), 65-8 (Russ.). Air samples were taken using a specially equipped welder's helmet and analyzed for dust, phenol, CO, HF, acrolein, phthalic anhydride, NO_2 , Mn, and SiO_2 . Tests were run with and without general ventilation. Weldings were both hand-operated and automatic on a 10-mm coated steel plate. Gas-cutting was also examd. The coatings were a glyphtalic (I) a phenol-formaldehyde (II) and a polyethylene (III), in 25 μm thickness. The results are compared with the max. permissible concns. I is the least and III the most objectionable II, with ZnO , is toxic.

Olaf Thomsen

23185j Hygienic certification of the building projects development, and reconstruction of plants producing organochlorine products. Levina, M. M.; Filatova, V. S.; Belaya, E. G.; Ashirova, S. A.; Tikhomirov, Yu. P.; Levin, A. L.; Mostinskaya, R. Z.; Kuznetskii, B. E. (Inst. Gig. Tr. Profzabol., Gorki, USSR). *Gig. Sanit.* 1973, (4), 86-7 (Russ.). Certification of building plans, development, and reconstructions of plants manufg. PVC along with a favorable solution of sanitary-hygienic problems appear to depart from hygienic requisites. Poor ventilation in plants manufg. vinyl chloride, polychloroprene, and trichloroethylene is poor and does not conform to stds. Architectural modifications should be employed to effect hygienic stds.

John Howe Scott

23186k Studies of combustion with a sludge burner. Wiesenberger, J. (Ger.). *Wasser, Luft Betr.* 1973, 17(1), 24-6 (Ger.). A 40 to 1500 kg/hr sludge burner burns combustible industrial waste sludges with a min. of soot or CO. The sludge is atomized in the nozzle by a stream of compressed air or steam and elec. fired. The burner fires into a suitably insulated muffle furnace chamber from which combustion products may be removed for anal. Using a 100 kg/hr model burner, old crankcase oil and lacquer solvent wastes were burned with a min. of soot or CO. Less flammable materials can be totally burned if other flammable gases are used in place of compressed air or steam. J. H. Leftin

23187m Aircraft Emissions: Impact on Air Quality and Feasibility of Control (Office of Air Programs APTD-0757). United States Environmental Protection Agency, Office of Air Programs (USEPA, Off. Air Programs: Research Triangle Park, N.C.). 1972, 60 pp.

23188n Air Pollution Aspects of Emission Sources: Pulp and Paper Industry. A Bibliography with Abstracts (United States Environmental Protection Agency Publication No. AP-121). United States Environmental Protection Agency, Air Pollution Technical Information Center (USEPA, Air Pollut. Tech. Inform. Cent.: Research Triangle Park, N.C.). 1973, 166 pp.

23189p Air Pollution Translations: A Bibliography With Abstracts, Vol. 3 (United States Environmental Protection Agency Publication No. AP-120). United States Environmental Protection Agency, Information Services Division (USEPA, Air Pollut. Tech. Inform. Cent.: Research Triangle Park, N.C.). 1973, 250 pp.

23190g Absorber for purifying sulfur dioxide-containing flue

gases. Gustavsson, K. A. G. (Aktiebolag Bahco Ventilation, Swed. 352,817 (Cl. B 01d), 15 Jan 1973, Appl. 6973/71, 28 May 1971; 6 pp. The app. consists of an absorption column with a limestone suspension at its bottom, a tube reaching immediately above the absorbent surface and through which flue gases pass from the bottom carrying drops of absorbent to the top of the column, a circulation line from the top of the column to its bottom for returning sepd. absorbent to the bottom, and a mill located in the circulation line for grinding the recirculated absorbent.

I. G. Zewi

23191h Determination of microamounts of some substances in air. Gaziev, G. A.; Sotnikov, E. E.; Filippova, S. A. U.S.S.R. 366,409 (Cl. G 01n), 16 Jan 1973, Appl. 29 Sep 1970. From *Otkrytiya, Izobret., Prom. Obrabtsy, Tovarnye Znaki* 1973 50(7), 84. The analyzed sample of air was passed through a entrainment separator filled with a fine-grained absorbent (during cooling) to conc. the substances being analyzed, followed by heating and blowing the concd. substances with a gas carrier into the gas analyzer for further detn. and recording. To increase the accuracy of anal., air was partly absorbed together with analyze substances. During subsequent heating, air behaved as a carrier for supplying the substances into the gas analyzer.

23192j Test tube for carbon dioxide measurement. Auegesellschaft G.m.b.H. Ger. Offen. 2,151,693 (Cl. G 01n), 19 Apr 1973, Appl. P 21 51 693.8, 13 Oct 1971; 5 pp. The measuring range of CO_2 test tubes, useful for automotive exhaust gases, was extended by an Al_2O_3 -supported KOH prelayer. The layer was made by drying in vacuo at 100° a mixt. contg. Al_2O_3 (0.1-0.5 mm) 100 g and KOH (28 g KOH in 72 ml H_2O) 15 ml and moistening with H_2O 1 ml. A 20 mm long bed of this mass absorbed 1 vol. % CO_2 at test gas vols. of 0.1 l.

23193k Oxidation catalyst for exhaust gases. Watanabe Seito; Uchida, Sumio; Kori, Yoshizo; Kawakami, Akira; Okamoto, Osamu (Hitachi Makuseru Co., Ltd.) Japan. Kokai 73 27,988 (Cl. 13(9)G11), 13 Apr 1973, Appl. 71 61,334, 12 Aug 1971; 3 pp. A perovskite-type $\text{A}_2\text{B}_{1-x}\text{MeO}_3$ (A, alk. earth metals; B, rare earth metals; Me, Fe group metals; x, 0.01-0.9 oxidn. catalyst for exhaust gases from a car or chem. plants) i prep. by heating the acetate mixt. at 900° for 6 hr, powdering, mixing with NH_4HCO_3 , pressing in a pipe-form, and heating at 1200° for 1 hr to obtain a sinter of 85% porosity. It works well even at 1000° for long periods and is not poisoned by Pb, S and S compds.

K. Kodama

23194m Adsorbent of poisonous gases. Inagaki, Foshir Japan. Kokai 73 27,989 (Cl. 13(9)G112), 13 Apr 1973, Appl. 71 60,973, 13 Aug 1971; 4 pp. N and S oxides in exhaust gases are adsorbed on a spinel-type oxide contg. one or more transition metals, e.g. Cu, Ti, V, Cr, Mn, and Fe groups and one or more alk. earth metals on active carbon and desorbed by dil. NaOH soln.

K. Kodama

23195n Device for recycling exhaust gas for a heat engine. Cusson, Charles (Pan American Chemical Co. Inc.) S. Africa. 72 01,665 (Cl. C 10k), 25 Oct 1972, Fr. Appl. 71 12,730, 09 Apr 1971; 6 pp. The exhaust gases of a heat engine are recycled to reduce the amt. of NO_2 in the final effluent. The exhaust gases are recycled below the discharge for return to the intake; the gases are passed into a catalytic purifn. unit where the vol. rec cycle of exhaust gases is varied with supply of fuel to the engine.

Henry H. Ginsberg

23196p Smoke abatement in the desulfurization of pig iron Braetsch, Peter; Domalski, Willi; Behrens, Manfred (Stahlwerke Peine-Salzgitter A.-G.) Ger. Offen. 2,150,965 (Cl. C 21c), 26 Apr 1973, Appl. P 21 50 965.9-24, 13 Oct 1971; 9 pp. The development of smoke in the desulfurization of pig iron was reduced by adding soda-cement-fluorite mixts. contg. 50-70% Na metasilicate for fixation of the volatile Na_2O formed by decomposition of the soda. A mixt. contg. soda 63, portland cement 28 and fluorite 9% was suitable for the desulfurization of Fe at $1350-1400^\circ$.

23197q Removal of sulfur oxides from chimney gas. Tanaka, Takushi; Hattori, Hiroshi; Matsumoto, Seiji (Saka Chemical Industry Co., Ltd.) Japan. Kokai 73 26,689 (Cl. 13(9)F2), 07 Apr 1973, Appl. 71 52,227, 13 Jul 1971; 6 pp. SO_2 in chimney gas are 94% removed by passing, at 10 ml/min for 30 hr, through a column of 800 g of 4-6 mm diam. pellets contg. SrCO_3 , which are prep. by mixing SrCO_3 with bentonite or diatomaceous earth and pitch, molding, and igniting at 700° . The pellets are regenerated by treating with 20% Na_2CO_3 at 30° for 3 hr. CaCO_3 and BaCO_3 are unsuitable. K. Kodama

23198r Potassium sulfate recovery in the purification of sulfur dioxide-containing waste gases. Von Semel, Georg; Schibilla, Eduard; Stewer, Wolfgang (Uhde, Friedrich G.m.b.H.) Ger. Offen. 2,147,427 (Cl. B 01d), 29 Mar 1973, Appl. P 21 47,427.1, 23 Sep 1971; 7 pp. The waste gases from a power plant contg. N, CO, and CO_2 contaminated with SO_2 are freed from SO_2 by washing with a KOH-KCl soln. obtained as waste liquor from a diaphragm electrolytic plant. The K_2SO_4 formed in the countercurrent washing process is oxidized by air or O-enriched air at $50-100^\circ/3-24$ atm and KCl is added to the oxidized soln. to lower the soly. of K_2SO_4 . The K_2SO_4 is filtered off and the fil-

23149. KONIETZKO, H., I. ELSTER, K. VETTER and H. WEICHARDT. (Inst. Arbeitsmed., Univ. Tueb., Frundsbergstr. 31, 7400 Tuebingen, W. Ger.) Felduntersuchungen in Loesungsmittelbetrieben. 2. Telemetrische EEG-Überwachung bei Loesungsmittelarbeitern an Trichloräthylen-Waschanlagen. [Field studies in solvent factories; 2. Telemetric EEG-control in workers of a solvent factory on trichloroethylene-basins.] ZENTRALBL ARBEITSGESUNDHEITSSCHUTZ 23(5): 129-133. Illus. 1973. --Telemetric EEG controls were done in 6 healthy males working on open basins containing trichloroacetic acid and trichloroethanol. The results were compared with the concentrations of these compounds in the air and blood trichloroethanol levels. Comparative controls were made in 4 of these workers on other days under similar working conditions but without exposure to the chemicals. The EEG change determined in 4 workers during exposure was the appearance of α waves with increased amplitudes. --D. S.

23150. NOVAKOVA, SP., S. DINOVA and S. DANON. (United Res. Inst. Ind. Hyg. Labor Prot., Sofia, Bulg.) Eksperimental'noe obosnovanie predel'no dopustimoi kontsentratsii patorana v vode vodocemov. [An experimental basis for maximal permissible concentrations of patoran in surface waters.] GIG SANIT 38(3): 86-89. Illus. 1973. [In Russ.] --The toxic effect and the permissible concentrations in water of the pesticide patoran (N-4-bromphenyl-N'-methyl bromide) were studied. Tests at concentrations of 0.125, 0.25, 0.5, 1, 2, 4, 8 and 16 mg/l revealed that patoran has an adverse effect on the organoleptic properties of water. A threshold was observed at 0.2 mg/l. Concentrations up to 20 mg/l did not affect the self-purification of reservoirs. At a concentration of 50 mg/l, patoran prolonged the existence of microorganisms. In acute experiments in rats, the LD₅₀ was 3875 mg/kg. In acute and semiacute experiments, patoran inhibited tissue respiration and oxidative-reductive processes in cells and led to toxic damage to liver, kidneys and spleen, including a tendency toward development of cirrhosis of the liver. Chronic experiments in 210 white rats over a 6 mo. period under 5 experimental conditions at daily doses of 0.1-80 mg/kg revealed that above 0.1 mg/kg, patoran adversely affected white and red blood cells, disturbed enzyme equilibrium, inhibited tissue respiration and cellular oxidation-reduction processes and affected the liver, kidneys and spleen. Changes were dose-related. The limiting sign of damaging effects of patoran is its influence on the organoleptic properties of water. It is concluded that 0.20 mg/l is the maximum permissible levels of patoran in reservoirs. --M. D. S.

23151. FEL'DMAN, N. G. and M. V. VENDILO. (F. F. Erisman Inst. Hyg., Moscow, USSR.) Del'stvie alifatticheskikh spirtov na zritel'nyi analizator (neurohistologicheskoe issledovanie). [Effect of aliphatic alcohols on the visual analyzer (neurohistological investigation).] GIG TR PROF ZABOL 17(3): 55-56. 1973. [In Russ.] --Adult rabbits were subjected daily for 6-7 mo. to 4-hr inhalation of aliphatic alcohols (methanol, hexanol, heptanol, nonyl alcohol and decyl alcohol) to refine the level of the maximum allowable concentration in air of work zones. Neurohistological investigations were conducted after killing the experimental animals. An investigation of the optic nerve, chiasma, and tract showed phenomena of irritation of the majority of nerve fibers, expressed by corkscrew-like convolutions of the fine nerve fibers and infiltration of protoplasm along the course of the thick fibers. These phenomena were accompanied by proliferation of neuroglia hyperemia of the vessels and dilation of the perivascular spaces. Maximum changes were noted on passage of the chiasma into the optic tract and minimum changes in the optic nerve. A comparison of the results of the neurohistological and electrophysiological investigations established the similarity of methanol and the other alcohols with respect to the character and expressivity of action on the visual analyzer. The neurophysiological data confirmed the need to reduce the maximum allowable concentration of methanol and other aliphatic alcohols to levels not causing functional and morphological changes of the visual analyzer. --M. D. S.

23152. KASKEVICH, L. M. and V. P. BEZUGLYI. (Inst. Hyg. Toxicol. Pestic. Polym. Plast. Subst., Kiev, USSR.) Sostoyanie zdorov'ya, rabotayushchikh s tetrametilthiuramdisulfidom (TMTD) v usloviyakh kontrolya i semennykh laboratoriy i semennykh zavodov. [State of health of persons working with tetramethylthiuram disulfide (TMTD) at seed control laboratories and seed farms.] GIG TR PROF ZABOL 17(3): 49-51. 1973. [In Russ.] --The majority of the 195 examined persons having occupational contact with tetramethylthiuram disulfide (TMTD) at seed control laboratories and seed farms had a poor tolerance for this preparation, which was expressed by irritation of the upper air passages and complaints indicating its general toxic effect (headaches, fatigue, pains in the heart region, etc.). The most frequently observed changes were in the cardiovascular system, predominantly in the form of myocardial dystrophy (21.5) and the hepatobiliary system (22%). Liver pathology was manifested more often by hepatocystitis and more rarely by chronic hepatitis of toxic-chemical etiology of a mild degree predominantly, with feebly expressed disturbances of the protein production, carbohydrate, and urobilin excretory functions of the liver. In 7.5% of the examinees thyroid

pathology was noted, including hyperplasia, diffuse enlargement of the II-III degree, and in 1 case cancer. In persons working with TMTD for a long time, hematological changes, characterized by the development of moderate hypochromic anemia and a tendency toward leukopenia with neutropenia and eosinopenia, and changes in monocytes were noted. The data obtained indicate the need for close medical control when working with TMTD with the conduction of hematological investigations. --M. D. S.

23153. ILICHKINA, A. G. (Dep. Communal Hyg., Leningr. Sanit.-Hyg. Med. Inst., Leningrad, USSR.) Eksperimental'nye dannye k gigenicheskomu normirovaniyu digidroperekisli meta-dizopropilbenzola v vode vodocemov. [Experimental data for hygienic standardization of dihydroperoxide meta-disopropylbenzene in surface waters.] GIG SANIT 38(3): 108-110. 1973. [In Russ.] --Quantitative chemical analysis of dihydroperoxide meta-disopropylbenzene (DHP-M) was done in surface waters. Stability, stimulating effect on growth of saprophytic microflora, bacteriostatic and bactericidal effects were evaluated. DHP-M had an adverse effect on the process of mineralization of N-containing organic substances. Toxicological studies were done in white rats, rabbits and chick embryos. Concentrations of DHP-M should not exceed 1 mg/l. Toxicological data was the limiting factor. --M. D. S.

23154. EVANS, J. C., R. J. EVANS, A. HOLMES, R. F. HOUNAM, DIANE M. JONES, A. MORGAN and M. WALSH. (Health Phys. and Med. Div., At. Energy Res. Establ., Harwell, Berks., Engl., UK.) Studies on the deposition of inhaled fibrous material in the respiratory tract of the rat and its subsequent clearance using radioactive tracer techniques: I. UICC crocidolite asbestos. ENVIRON RES 6(2): 180-201. Illus. 1973. --Radioactive tracer methods were used to study the distribution of crocidolite [possible cause of tumors in miners] between the upper and lower respiratory tracts after single short inhalation exposures of the nose only type. The UICC [International Union Against Cancer] standard reference sample of crocidolite revealed that 50 ± 5% of the deposited asbestos was in the lower respiratory tract. After 30 days the lung content of crocidolite was reduced to 73% of the initial value. Autoradiography was used to study the distribution of asbestos within the lung immediately after exposure and after 30 days. The clearance of crocidolite from the respiratory tract was also followed by the measurement of radioactivity in feces. --C. M. M.

23155. GOKINA, M. S. Funktsional'noe sostoyanie miokarda i sosudistyl tonus u rabochikh, podvergavshikhsya dilitel'nomu vozdeistviyu kisli ugleroda. [Functional state of the myocardium and vascular tone of workers exposed for a long time to the effect of carbon monoxide.] GIG TR PROF ZABOL 17(3): 51-52. 1973. [In Russ.] --The contractile ability of the myocardium and vascular tone of worker exposed for a long time to CO in small concentrations was investigated. The vascular tone of 203 workers was studied by oscillography, and the propagation velocity of the pulse wave and functional state of the myocardium were determined by electro- and polycardiography with the use of functional tests: orthostatic with physical exercise and nitroglycerin. Initial signs of diffuse involvement of the myocardium and hypoxia, which intensified after physical exercise and an orthostatic position, were established on the ECGs of 12.3% of the workers examined over a 6-yr period. The contractile ability of the myocardium did not change in a considerable number of the workers (78). Mechanisms with a long service period and mechanics with short service had initial signs of decreased contractile ability of the myocardium, elicited by means of the functional test with nitroglycerin. There was a direct relation between the level of the average diastolic arterial pressure and propagation velocity of the pulse wave. --M. D. S.

23156. STULOVA, E. A. (Clin. Branch, Gorki Inst. Ind. Hyg. Occup. Dis., Dzerzhinsk, USSR.) Kharakteristika sostoyaniya termoregulyatsii pri khronicheskoi intoksikatsii vinilkloridom. [Characteristics of the state of thermoregulation in chronic vinyl chloride poisoning.] GIG TR PROF ZABOL 17(3): 53-55. 1973. [In Russ.] --The state of thermoregulation in chronic vinyl chloride poisoning, which often occurs with subfebricity but sometimes with a more appreciable increase of temperature (to 38-39°C), was studied in 40 men and 56 women aged from 25-45 yr working in contact with vinyl chloride for 3-15 yr. The data obtained showed that different manifestations of thermoregulatory disturbances are observed in persons with chronic vinyl chloride poisoning. The acrophothermia, a decrease of the rate of arterial flow, spasm of capillaries and spasm of medium caliber arteries that were noted in the patients unconditionally disturbed heat emission, but it was difficult to attribute these disturbances to the state of the peripheral circulation. A clinical physiological analysis of the data indicated that the disturbances were due to impairment of the functioning of the hypothalamic-brain stem structures. This is confirmed by the fact that they are combine with disturbance of heat production. Thermoregulation should be studied for early detection of chronic vinyl chloride poisoning. --M. D. S.

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Occupational carcinogenesis

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Occupational carcinogenesis is one of the most interesting, tragic, important and difficult fields in oncology.

It is interesting from the scientific point of view because it represents, dramatically, an experiment in carcinogenesis made on humans and it may teach us a lot about the natural history of tumours. It is tragic from a human point of view, because work which is per se a natural necessity of life, should not, at least, cause cancer. It is socially important because oncogenic factors increasingly are produced and diffused in occupational environments. Moreover from the factories they spread to the general environment, so that they come to be an ecological problem. Finally, occupational carcinogenesis is a difficult field to approach, because the care of the workers' health is often in conflict with the productive interests of the factories.

Industry has done a lot for experimental carcinogenesis, related to occupational cancer; often however the result is merely to prove the carcinogenic effect in animals of agents which have already proved to be carcinogenic for man: this is equivalent to saying that many people die of cancer but some make their living from cancer. On the other hand emotional arguments should be avoided. Thus I am aware that speaking on occupational carcinogenesis is a complex and difficult task.

Experimental carcinogenesis did not start with the experiment of Yamagiwa and Ichikawa in 1915, but rather in the 16th century with the observation of the so-called 'mountain disease' in miners of Joachimsthal. This disease was recognized at the end of the last century as pulmonary carcinoma, which we now know is due to radio-active pollution, present in those mines. In 1775 Percival Pott in 'Chirurgical Observations' described a cancer of the scrotum in chimney sweepers and he correlated it with the black soot. In 1894 Unna reported on the frequency of skin cancer found in maritime workers, and he considered it due to excessive exposure to sun light. In 1895 Rehn, a surgeon from Frankfurt, reported at the congress of the German Society of Surgeons, 3 cases of bladder tumours found among 45 workers from a factory which produced fuchsine. He thought that the tumours were caused by aniline, but in fact it was shown, several decades later, that they were due to other aromatic amines. In 1902 at a meeting of the Medical Society of Hamburg, Friebe presented a case of a cutaneous tumour found on the hand of an employee of a factory producing X-ray apparatus. This employee used his hand for radiological demonstrations.

The frequency of reports on occupational cancer has been increasing with the increase of industrialization, mainly due to the progress of chemistry. The most important thing to do in occupational carcinogenesis is to try to recognize occupations which may represent an oncogenic risk, and to identify the agent or agents which cause the risk, and also to try to assess the degree of risk. If the risk is related to an agent already known to be oncogenic for man, its detection in the occupational environment should be considered sufficient for undertaking preventive measures. On the other hand if the risk is related to agents, whose effects on workers have not yet been studied and are therefore not yet known, then we have to evaluate the risk they represent for workers. This can be done by means of epidemiological investigations and experimental testing. Most oncogenic occupational agents have been identified on the basis of retrospective epidemiological studies.

The progress in and the development of this branch of oncology should facilitate systematic experimental testing of agents heavily released in the occupational environ-

ment. In other words *epidemiological evidence in man should be avoided*. Experimental tests on animals are the more relevant to man, the more they reproduce the conditions of human exposure and eventually induce in animals the same tumours that they induce in man. In this case, the results of experimental tests may be considered largely equivalent to epidemiological evidence in man.

On the other hand if an agent causes any kind of tumour in animals, in whatever experimental conditions, it should be considered potentially carcinogenic for man. To consider an agent definitely carcinogenic for man on such a basis, would be an excess, but no time should be lost before retesting it in more appropriate conditions. To reproduce experimentally the conditions of occupational exposure is often difficult and costly. Furthermore we have to consider that the number of agents in the occupational environment is large and increasing.

Thus, new agents to which workers may be exposed should be submitted first to the easiest and quickest tests, however incomplete those tests may be. Then, for those agents inducing tumours in the experimental animals in these conditions, more precise and sophisticated experimental tests should be devised. The validity of experimental testing and the prerequisites for validity have been a matter of long discussions in international

TABLE 1 *Incidence of subcutaneous sarcomas in rats, following local injection of some inorganic pigments*

Treatment	No. of animals	No. of tumours
Chromium yellow (lead chromate)	40	26
Chromium orange (lead chromate)	40	26
Molybdenum orange (lead chromate and molybdenum chromate)	40	36
Cadmium yellow (cadmium sulphide)	40	15
Iron red (iron oxide)	40	1
Iron yellow (iron oxide)	40	0
Controls	60	0

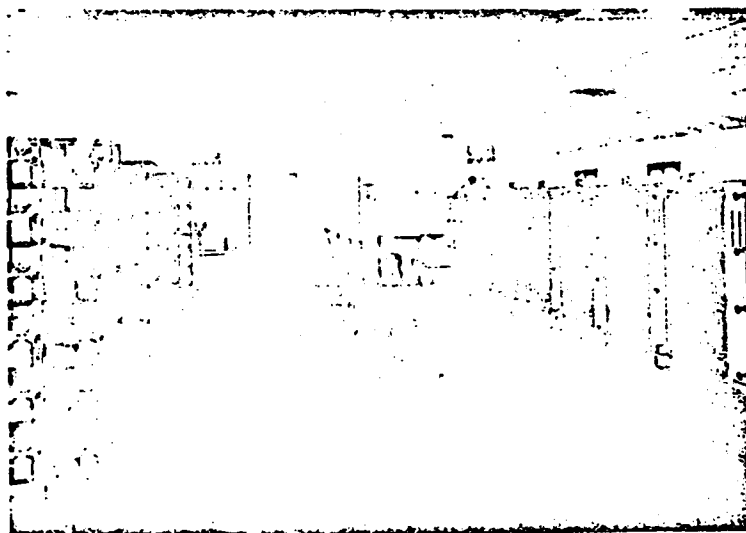


FIG. 1 *Apparatus for inhalation of controlled doses of gaseous compounds, in the Experimental Unit of the Istituto di Oncologia di Bologna.*

meetings and commissions, but of course, in the meantime the existing occupational exposure continues. Also, imperfect testing, for example the subcutaneous injection in the rat of compounds, to which man is exposed mainly by the respiratory route, may give some idea of their potential oncogenic risk.

In Table 1, data are reported on the induction of tumours (sarcomas) at the site of the subcutaneous injection of some inorganic pigments. From these data it clearly appears that chromium and cadmium pigments should be considered riskier than iron pigments. From what has been said before, the compounds shown to be carcinogenic in these conditions, should now be tested by inhalation. The latter way of exposure implies the availability of a complex apparatus for continuous inhalation of controlled doses. The apparatus is quite rare, as we discovered when we wanted to build one and we were not able to find any model in our own or any neighbouring country. Now an apparatus for inhalation of gaseous compounds has been functioning for more than two years in the experimental unit of our institute (Fig. 1).

With this apparatus we are now performing a carcinogenicity bioassay of vinyl chloride monomer (VC) and of vinyl acetate monomer (VA), which are (particularly the first) of great industrial importance. VC is used in the preparation of polyvinyl chloride resin, as a copolymer in saran and other plastics, as a solvent and as a chemical intermediate, and it is at present produced at a rate of 12,000,000 tons per year. Early results on these bioassays are shown in Table 2.

Zymal glands carcinomas, liver angiosarcomas have never been observed as occurring spontaneously in our breed of Sprague-Dawley rats.

Only 3 cases of spontaneously occurring Zymal glands carcinomas in rats (Sprague-Dawley) have been recorded in 1962. To our knowledge, no spontaneous nephroblastomas and liver angiosarcomas of rats have been reported in the literature. As far as we know, nephroblastomas have never been reported to be experimentally induced in rats; liver angiosarcomas have been induced in this species by dichloromethylene.

Although liver is the preferential site for onset of angiosarcomas, such kind of tumours have been observed in other tissues and organs; therefore VC should be considered in our experimental conditions generally carcinogenic for endothelia.

Zymal glands tumours and nephroblastomas may be bilateral; liver angiosarcomas are often multifocal.

Epidemiological investigations and medical controls should be undertaken on exposed workers. Would such neoplasia unhappily be found in man, given the rarity of these tumours in both animals and humans, it would be a precise indication of the high value of experimental testing in predicting the oncogenic potential of environmental agents and would strengthen the recommendation on the necessity of such bioassays before any new industrial compound is produced and widespread in large scale.

Another means of revealing the oncogenic risk of an agent is to examine the exposed working populations with methods which make it possible to assess the incidence of cancer precursors. The incidence of such precursors has been studied by us by exfoliative cytology among asymptomatic, apparently healthy workers exposed to risk, namely among workers exposed to aromatic amines (urine cytology), and among workers exposed to chromates (sputum cytology). The incidence of cellular atypias in these two groups of workers is shown in Tables 3 and 4. It far exceeds the expected incidence.

To evaluate in medical and legal terms the risks represented by occupational oncogenic agents, we must consider that:

1. a direct relation exists between dose (amount and length of exposure) and neoplastic response;
2. the oncogenic agents produce mainly non-reversible changes, which may continue to develop when the exposure is interrupted;
3. the oncogenic agents (occupational or generally environmental) may be additive in their effects.

According to our knowledge the occupational carcinogenic agents may be classified as:

- (a) definite carcinogens, when epidemiological evidence exists,

TABLE 2 Preliminary results of carcinogenicity bioassay of vinyl chloride monomer (VC) and of vinyl acetate (VA) (From C. Maltoni, G. Lefemine and L. Gualano, in press)

Groups and treatment	Animals (Sprague-Dawley rats)		Animals with tumours					
	Total	Survivors	Zymbal glands carcinomas (A)	Nephroblastomas (B)	Angiosarcomas		Other type and/or site	Total
					Liver (C)	Other sites		
I VA 2,500 ppm.	96	15	-	-	-	-	-	-
II VC 10,000 ppm.	69	-	13	3	6	-	5 (H)	27
III VC 6,000 ppm.	72	5	5	3	8	1 (D)	1 (I)	18
IV VC 2,500 ppm.	74	16	2	4	6	3 (E)	1 (L)	16
V VC 500 ppm.	67	15	2	3	5	2 (F)	1 (M)	13
VI VC 250 ppm.	67	20	-	3	1	2 (G)	2 (N)	8
VII VC 50 ppm.	64	35	-	-	-	-	-	-
VIII No treatment	68	33	-	-	-	-	-	-
Total	577	139	22	16	26	8	10	82

(A) Metastases to lung. (B) Metastases to liver and/or to lung and spleen. (C) Metastases to lung. (D) Angiosarcomas in subcutaneous fibrous angio. (E) 2 intrabdominal angiosarcomas (1 next to spleen and 1 next to ovary); 1 ossifying angiosarcoma of neck. (F) 1 pulmonary angiosarcoma; 1 angiosarcoma of uterus. (G) 1 intrabdominal angiosarcoma (next to spleen); 1 intrathoracic ossifying angiosarcoma. (H) 2 zymbal glands adenomas; 1 neurilemmoma of the ear; 1 mammary carcinoma; 1 cystoadenocarcinoma of ovary. (I) Sebaceous gland carcinoma of skin. (L) Zymbal glands adenoma. (M) Minimal deviation hepatoma. (N) zymbal glands adenoma; 1 salivary glands carcinoma.

TABLE 3 Frequency of cellular atypias among workers exposed to aromatic amines in 4 North Italian dye-stuff factories

Factory	No. of workers under control	Cytological classes (Papanicolaou)									
		I	I-II	II	II-III	III	III-IV	IV	IV-V	V	
A	232	48	46	114	14	7	1	1	1	1	
B	159	58	20	49	25	5	1	1	1	1	
C	40	11	8	7	3	8	1	2	2	2	
D	41	16	15	9	1	1	1	1	1	1	
Total	472	133	89	179	43	20	3	4	4	1	

TABLE 4 Frequency of adenomatous typical and atypical hyperplasia, and of squamous metaplasia and dysplasia, in workers exposed to chromium compounds in one Northern Italian factory

Type of occupation	Length	Length of exposure (years)		Typical adenomatous hyperplasia		Atypical adenomatous hyperplasia		Squamous metaplasia		Squamous dysplasia	
		No.	%	No.	%	No.	%	No.	%	No.	%
Production of chromates and dichromates	Up to 5	25	3	12	—	—	—	24	96	4	16
	6-10	14	3	21	1	1	7	12	86	3	21
	11-15	13	3	23	3	3	23	12	92	4	30
	Over 15	17	—	—	1	1	6	15	88	4	23
	Total	69	9	13	5	5	7	63	91	15	22
Production of chromium pigment	Up to 5	14	1	7	—	—	—	14	100	—	—
	6-10	17	1	6	—	—	—	14	82	2	12
	11-15	8	1	12	—	—	—	6	75	1	12
	Over 15	8	2	25	—	—	—	8	100	2	25
	Total	47	5	10	—	—	—	42	89	5	10

(b) highly suspected carcinogens, when strong experimental and/or some epidemiological evidence is present,

(c) potential carcinogens, when experimental data give some indication of carcinogenic action of a compound on an experimental animal.

According to their effects, the carcinogenic agents may be classified as strong or medium.

The agents, which have been definitively proved or are suspected to be oncogenic for man on an epidemiological basis, are listed in Table 5, together with the target tissues and the degree of evidence. The list of the agents present in the occupational environment, which, on an experimental basis should be considered highly suspect or potentially carcinogenic for man, is reported in Table 6.

TABLE 5 *Agents proved or suspected to be oncogenic for workers on an epidemiological basis*

Agents	Evidence	Tumours
U.V. radiations	+	Skin carcinomas
X-rays	+	Skin carcinomas Leukaemias
Uranium ore	+	Pulmonary carcinomas
Arsenic	(+)	Skin carcinomas (lung carcinomas)
Asbestos	+	Lung carcinomas Pleural mesotheliomas (abdominal malignancies)
Chromium	+	Lung carcinomas
Nickel	+	Lung carcinomas Carcinomas of nasal and paranasal cavities
Iron ore	(+)	Lung carcinomas
Bis-chloromethyl ether	+	Lung carcinomas
Benzene	+	Leukaemias
Isopropyl alcohol	(+)	Carcinomas of paranasal cavities
Soot, tars, mineral oils, cutting oils	+	Skin carcinomas
Carbon black	+	Lung carcinomas
Mustard gas	+	Laryngeal carcinomas
Aromatic amines	+	Bladder and upper urinary tract carcinomas

TABLE 6 *Agents suspected to be carcinogenic for workers on an experimental basis*

Beryllium	Pesticides (DDT, aldrin, dieldrin, Aramite, DMDT, Amizol, Thiuram)
Cadmium	Thiourea and related compounds
Cobalt	Tannins
Lead	Detergents
Selenium	Alkylating agents
Zinc	Nitrosamines
Carbon tetrachloride	Azo-dyes
Chloroform	Oestrogens
Vinyl chloride	

In Italy carcinogenic occupational risk exists for workers who are:

- (a) exposed to chromates, mainly the ones working in factories where chromates are produced;
- (b) exposed to nickel, mainly the ones exposed to nickel-carbonyl;
- (c) exposed to asbestos, mainly the ones who extract it from its natural source, or workers in factories where asbestos is used for manufacturing;
- (d) in factories making shoes, purses and raincoats, exposed to benzene;
- (e) in factories producing carbon black from mineral oils; and
- (f) in the dye and rubber industries, exposed to aromatic amines.

In our country occupational tumours have been observed in many of the above mentioned workers. 21 lung carcinomas have been found among less than 200 workers in a chromate factory in Northern Italy. Pleural mesotheliomas have been discovered among workers in asbestos mines. A number of leukaemias have been found among shoe-makers, who were heavily exposed to benzene, in factories in Lombardy (Vigevano), Bologna Province and Tuscany. The incidence of bladder and other urinary tract carcinomas among workers in 5 Italian dye-stuff factories are shown in Table 7. In these factories workers had been exposed to β -naphthylamine, benzidine, α -naphthylamine, Auramine, fuchsin, 3,3'-dichlorobenzidine. Now in our country the production of β -naphthylamine and benzidine has been withdrawn. One may conclude that prevention of occupational carcinogenesis is a very urgent problem.

The methods of prevention may be summarized as follows:

1. correct experimental testing of all newly used agents;
2. up to date epidemiological data from various categories of workers exposed to risk;
3. legislative measures forbidding the production and the utilization of agents which have been shown to be oncogenic on an epidemiological and/or an experimental basis, especially if the said agents are strong carcinogens;
4. measures of technical protection, when weak or doubtful carcinogens continue to be produced or employed; these protective measures should be periodically examined by Public Health Inspectors;
5. specific medical checks to make possible, on the one hand, the early detection of preneoplastic lesions and tumours, and on the other, the quantitative evaluation of the risks through the incidence of these changes.

It is my opinion that the value of medical checks is mainly to evaluate the risk that is epidemiological. Early detection of occupational tumours which, as already shown, are mainly located in the respiratory and urinary tract, has been, I think, over-emphasized. We know that these tumours are multicentric. In other words all the target apparatus is in some way affected by the carcinogenic process.

TABLE 7 *Frequency of carcinomas of the urinary tract among workers of 5 Italian dye-stuff factories exposed to aromatic amines*

Factory	Total No. of exposed workers	No. of workers with carcinoma		
		Bladder	Renal pelvis and ureters	Total
A	286	17	1	18
B	386	87	5	92*
C	213	44	—	44
D	135	4	—	4
E	135	7	1	8
Total	1,155	159	7	166

* In 1 case bladder and upper urinary tract tumours were coexistent.

Concerning the urinary tract, in a systematic histological study, I have seen that in patients with bladder tumours, dysplastic and cancerous foci may be detected from renal pelvis to urethra. Therefore it is obvious that in such conditions early diagnosis can achieve very little. We may diagnose some tumours quite early, but on the basis of 15 years' experience with periodic checks of workers exposed to high risk, I doubt that periodical medical examination has a real bearing in saving people with occupational cancer although detected early, or in prolonging their life span. Thus my position is in sharp contrast with those who claim to 'protect' (!) workers exposed to carcinogenic risk with medical examinations. *I do believe that the potentialities of medical examinations should be evaluated at an international level.*

In conclusion, I would like to emphasize the need of a close collaboration among scientists, public health services, workers unions and industries, to evaluate the risks and to devise preventive measures for avoiding or minimizing occupational tumours.

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