

SVEN FORSSMAN

OCCUPATIONAL POISONING BY TRICHLORETHYLENE*

Trichlorethylene is widely used as a solvent in various industries. Among the chlorinated hydrocarbons it is one of the least toxic.

Inhalation of trichlorethylene vapors may cause both acute and chronic intoxications. The symptoms in the acute intoxication are slight irritation of the mucous membranes, dizziness, headache and fatigue, later unconsciousness and in severe cases death due to medullary paralysis.

A worker who is daily exposed to a sufficient quantity of trichlorethylene fumes may be chronically more or less strongly affected, which manifests itself as a slight intoxication with fatigue, sleepiness and so forth. If, however, the exposure comes to an end, the symptoms soon disappear. Even if this exposure is repeated daily for years, with almost constant symptoms, these should scarcely be designated as a chronic poisoning, but instead as repeated slight acute poisonings or as «chronic trichlorethylene effect».

In certain cases, however, the symptoms remain for some time after the exposure has come to an end. Probably only these cases are justly to be designated as chronic poisoning.

A part of the trichlorethylene absorbed is excreted with the urine as trichloroacetic acid. In the urine from exposed workers concentrations as high as 500 mg of trichloroacetic acid/litre urine are not unusual. There is probably a relation between the degree of intoxication and the concentration of trichloroacetic acid in urine in continuously exposed workers. The urine concentration thus seems to be a valuable indicator on the degree of exposure.

The constant exposure to trichlorethylene, which gives rise to an excretion of trichloroacetic acid of less than 20 mg per litre urine, does not entail, or entails only in exceptional cases, any definite trichlorethylene effects, whereas with urine-values of over 20 mg/l one sees such effects in an increasing percentage of cases directly proportional to the excretion. Thus, with values of between 40 and 75 mg per litre, such effects occur in about half of the cases, and with an excretion exceeding 100 mg, trichlorethylene effects are very common. In cases with more than 200 mg/litre urine the symptoms may be of such an intensity that sickleave may be necessary. Preventive measures are described.

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Trichlorethylene is widely used as a solvent in various industries. It has definite advantages as solvent as it is not inflammable and as its fumes mixed with air are not explosive. Trichlorethylene is a colourless liquid of boiling point 87° C. It is volatile at usual room temperature and air saturated at 25° C contains 9.2 per cent trichlorethylene. Among the chlorinated hydrocarbons trichlorethylene is one of the least toxic.

From the hygienic point of view trichlorethylene has, however, certain disadvantages (for literature see *Borbély* 1948, *Hamilton and Hardy* 1949, *Hunter* 1944, *Patty* 1949). Inhalation of trichlorethylene vapors may cause both acute and chronic intoxications. If vapors are heated above 150° C the very toxic gas phosgene is formed.

In industry trichlorethylene is used to degrease metals, to extract fats, oils and resins, as solvent for tar, pitch and rubber, in dry cleaning and as insecticide. The technical measures of preventing inhalation of trichlorethylene vapors are in many industries unsatisfactory. A large number of employed persons are therefore exposed in their daily work to inhalation of trichlorethylene.

PHARMACOLOGY

Trichlorethylene exerts its action in the same way as other volatile anaesthetics. It has also been widely used to produce analgesia for surgical operations and delivery. In some German industries about 35 years ago exposed workers got trigeminal neuritis and due to this experience trichlorethylene was used for some years to treat trigeminal neuralgia. It has later been shown that trichlorethylene has no specific effect on the trigeminal nerve and the effect on the neuralgic pains was part of the general analgetic effect of trichlorethylene. Only very few cases of neuritis optica have been described due to trichlorethylene intoxication and it seems doubtful, if trichlorethylene as such can produce this damage. In moderate doses trichlorethylene does not seem to have any specific action on heart or circulation. Toxic liver injuries are rare and the few cases described are probably caused by contamination of the trichlorethylene (*Hunter et al.* 1947). Kidney injuries do not occur in cases of trichlorethylene intoxications.

Most of the trichlorethylene absorbed in the lungs is excreted with the exhaled air when the patient is removed from exposure. A smaller part of the absorbed trichlorethylene is excreted as such in the urine or after conversion to trichloroacetic acid (for literature see *Fabre* 1949, *Frant and Westendorp* 1950).

ACUTE INTOXICATION

Acute intoxications in industries occur usually in connection with some accidents, when workers are suddenly exposed to high concentration of trichlorethylene in the air. The symptoms are slight

irritation of the mucous membranes, dizziness, headache and fatigue, later unconsciousness and in severe cases death due to medullary paralysis.

The diagnose is usually not difficult due to the heavy exposure. The principal therapy is removal from exposure. If necessary artificial respiration and oxygen must be used. The patients will usually recover in a few days completely and after-effects are usually extremely rare.

CHRONIC INTOXICATION

Certain writers consider it doubtful whether any real chronic poisoning exists. In order to decide this question it is important to distinguish certain concepts. A worker who is daily exposed to a sufficient quantity of trichlorethylene fumes may be chronically more or less strongly affected, which manifests itself as a slight intoxication with fatigue, sleepiness and so forth. (If, however, the exposure comes to an end, the symptoms soon disappear. Even if this exposure is repeated daily for years, with almost constant symptoms, these should scarcely be designated as a chronic poisoning, but instead as repeated slight acute poisonings or as »chronic trichlorethylene effect«.

In certain cases, however, the symptoms remain for some time after the exposure has come to an end. (Probably only these cases are justly to be designated as chronic poisoning.) More severe cases of this kind are probably, however, relatively rare. Thus, from 1937 — when trichlorethylene poisoning was recognized as an occupational disease in Sweden — to 1945 only a few cases led to disability entitling the sufferers to compensation according to the Compensation for Occupational Diseases Act.

Thus the symptoms usually found among workers daily exposed to trichlorethylene vapors are in most cases due to a daily repeated slight acute intoxication and the symptoms will usually disappear a short time — a few days to a few weeks — after the removal from exposure.

The chronic symptoms most commonly found among exposed workers were a abnormal fatigue and an increased need of sleep. A number of cases of diffuse gastric symptoms were reported. Vasomotor skin-phenomena in connection with the consumption of alcohol were found, increased psychical irritability, impaired capacity for concentration, headache, painful sensation in the cardiac region and dyspnoea also occurred.

Various writers have mentioned other symptoms in cases of chronic intoxications as conjunctivitis, skin-rashes, loss of appetite, joint symptoms, pains in the back, impaired memory, uneasy, dreamvitiated sleep, emotional outbursts and epileptic fits. These

symptoms were according to our experience very rare or were not found at all. Trichlorethylene-narcomania was very seldom found.

The age of the exposed workers does not seem to be very important to the symptoms of trichlorethylene intoxications. However, it must be mentioned, that in our material none of the exposed workers was younger than 18 years. It does not seem to be any definite difference in the frequency of intoxications between men and women, although it would appear that headache and the sensation of sickness have been more common signs of trichlorethylene exposure among women than among men.

The duration of exposure may be of importance in that way that the same symptoms may be produced by exposure to higher concentration during shorter time as by exposure to lower concentration during longer time.

As mentioned above part of the trichlorethylene absorbed is excreted with the urine as trichloroacetic acid. This excretion is very slow. After a single exposure of a normal man to trichlorethylene vapors during 10 minutes the urine may contain trichloroacetic acid for one to two weeks. Due to this slow excretion the trichloroacetic acid will cumulate in the organism after repeated exposures. In the urine from exposed workers concentrations as high as 500 mg trichloroacetic acid/litre urine are not unusual. If exposed workers are removed from exposure the excretion of trichloroacetic acid will often continue for 3—5 weeks.

There is probably a relation between the degree of intoxication and the concentration of trichloroacetic acid in urine in continuously exposed workers. The urine concentration thus seems to be valuable indicator on the degree of exposure. Although the individual susceptibility to trichlorethylene is quite different in different individuals there seems to be a general relation between intoxication and urine concentration. According to our experience this relation is as follows (Forssman 1945, Forssman and Ahlmark 1946, 1948 and 1950 in press).

The constant exposure to trichlorethylene, which gives rise to an excretion of trichloroacetic acid of less than 20 mg per litre of urine, does not entail, or entails only in exceptional cases, any definite trichlorethylene effects, whereas with urine-values of over 20 mg/l one sees such effects in an increasing percentage of cases directly proportional to the excretion. Thus, with values of between 40 and 75 mg per litre, such effects occur in about half of the cases, and with an excretion exceeding 100 mg trichlorethylene effects are very common. In cases with more than 200 mg/litre urine the symptoms may be of such an intensity that sickleave may be necessary (see also Frant and Westendorp 1950).

In order to use the diagnosis »chronic trichlorethylene intoxication« the worker should have the usual diffuse nervous symptoms referred above, which however are non-specific. The

clinical examination will usually show no objective signs of intoxication, but it is very important through a careful clinical examination to exclude other causes to these symptoms. It is also of great value to prove the exposure and also to estimate the degree of exposure through analysis on trichloroacetic acid in urine.

Removal from exposure will usually be the only therapy and in most cases the symptoms will disappear within a few days to a few weeks.

PREVENTIVE MEASURES

To prevent the inhalation of trichloroethylene vapors among workers handling trichloroethylene the enclosure of the process is most effective as for instance in dry-cleaning, degreasing operations or extractions. If this is not possible, local exhaust ventilation will have to be provided. If still trichloroethylene will contaminate the air of the working room the general ventilation will have to be improved or the workers will have to use personal protective equipment masks. The use of masks will have to be limited to short periods of the working day as the workers usually find them uncomfortable. The pressure air-line mask is preferable but if it is not possible to use this type, a suitable filter mask will have to be provided and the filters will have to be exchanged before the total filter absorption capacity has been used (for literature see *Brandt 1947, Patty 1949*).

Analysis of the urine from exposed workers at regular intervals will be of value to control the effectivity of the technical preventive measures mentioned above. Urine concentration of 20 mg trichloroacetic acid/litre is according to our limited experience what we think to be a maximum allowable concentration at constant exposure to trichloroethylene. If higher urine concentrations, thus indicating higher degree of exposure, are found, preventive measures against inhalation of trichloroethylene vapors will have to be improved. If the degree of exposure is very high and introducing effective preventive measures will take a long time, it may be of value to have the workers to work with trichloroethylene during only a certain time, for instance a month, and then for about the same time remove them from exposure to some other work. Circulation of the workers in this way may be of value during a limited time during which time the preventive measures will have to be improved.

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SADRŽAJ

PROFESIONALNO OTROVANJE TRIKLORETIENOM

Trikloretilen se mnogo upotrebljava kao otapalo u raznim industrijama. Među kloriniranim ugljikovodicima trikloretilen je jedan od najmanje otrovnih. Kod radnika, koji udišu pare trikloretilena, mogu se razviti akutna i kronična otrovanja. Simptomi akutnih otrovanja su ovi: laka iritacija sluznica, vrtoglavica, glavobolja i umor, kasnije nastaje nesvjestica i, u teškim slučajevima, smrt zbog paralize u meduli.

Radnici, koji su svakog dana izvrgnuti većim količinama trikloretilenskih para, mogu oboljeti od više ili manje teških kroničnih oštećenja. Takva se kronična oštećenja manifestiraju u obliku laganog otrovanja s umorom, pospanošću i t. d. Ako ekspozicija prestane, simptoma brzo nestaje. I onda, kad se takva ekspozicija ponavlja godinama svakog dana, s gotovo konstantnim simptomima, ipak ne treba takve slučajeve označiti kao kronična otrovanja, već kao ponovljena akutna otrovanja ili kao »kronični trikloretilenski efekt«.

U pojedinim slučajevima, međutim, simptomi se, kad prestane ekspozicija, ne gube. Vjerojatno samo te slučajeve možemo označiti kao kronična otrovanja.

Dio apsorbiranog trikloretilena izlučuje se u mokraći kao trikloroctena kiselina. Vrlo često se može u mokraći otrovanih radnika naći koncentracija trikloroctene kiseline od 500 mg/l mokraće. Kod radnika, koji su kontinuirano izvrgnuti parama trikloretilena, vjerojatno postoji relacija između stupnja otrovanja i koncentracije trikloroctene kiseline u mokraći. Koncentracije trikloroctene kiseline u mokraći, čini se, da su korisne kod ocjenjivanja stupnja ekspozicije.

Konstantna ekspozicija trikloretilenu, kod koje otrovani izlučuju u mokraći manje od 20 mg/l trikloroctene kiseline, ne će biti štetna. Količine preko 20 mg/l možemo smatrati kao opasne. Ako kod jedne grupe radnika nademo vrijednosti od 40 do 75 mg/l trikloroctene kiseline na litru mokraće, onda možemo biti sigurni, da ćemo kod polovice od njih naći oštećenja uzrokovana trikloretilenom. Kod grupe radnika, kod kojih ustanovimo koncentracije, koje prelaze 100 mg/l, naći ćemo u 100% slučajeva oštećenja trikloretilenom. Kad je koncentracija trikloroctene kiseline veća od 200 mg/l mokraće, bit će simptomi otrovanja tako teški, da će u svim takvim slučajevima radnici biti nesposobni za rad. Opisane su preventivne mjere.

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