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Chairman:
E. J. CHALLIS
Secretary:
~~REBECCA BEAN~~ N.W. BEAN

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REPORT ON VINYL CHLORIDE MONOMER

Yours faithfully,

N. W. Bean,
Secretary.

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THE TOXICITY OF VINYL CHLORIDE MONOMER (VCM)

The VCM story started in 1966 when Lefevre of Solvay in Belgium described a condition which has since become known as 'Acro-osteolysis', which had occurred in men cleaning out autoclaves used in the polymerisation of VCM in the manufacture of polyvinylchloride.

Very briefly, the process takes place in three stages.

(a) Vinyl Chloride Monomer is made by the chlorination of ethylene to form ethylene dichloride and this is then cracked to give Vinyl Chloride Monomer and Hydrochloric Acid.

(b) The Vinyl Chloride Monomer, which is a gas, then passes into a large autoclave where it is reacted under pressure with water, a plasticiser and a catalyst to form a slurry of polyvinylchloride (PVC).

(c) This PVC slurry then passes to a drying plant and is then further processed to a powder.

In the first stage of the process, i.e. the manufacture of the monomer, the background levels of VCM in the atmosphere are of the order of ten parts per million.

On the autoclave floor the levels of VCM in the atmosphere are in the range of 50 to 100 parts per million.

During the polymerisation, PVC powder tends to stick to the side of the autoclave and it is necessary therefore that they should be cleaned, and until recent years this had to be done by hand and men going into the autoclaves with scrapers after the autoclave had been evacuated and purged of any gases. There are difficulties in getting rid of all the gas before opening the manhole at the top of the autoclave with the result that a puff of un-reacted Vinyl Chloride Monomer, albeit it momentarily, is given off to plant atmosphere and the concentration of VCM at this particular point of time is of the order of one thousand parts per million.

It should be noted therefore that it is at this stage of the operation that the highest exposure to VCM is experienced and it is also possible that in the process of scraping off the PVC powder from the side of the autoclave, that further exposure also occurs to pockets of VCM trapped behind the powder.

Since Lefevre published his account of Acro-osteolysis many other cases have occurred throughout the world and I believe I am correct in saying that almost without exception the condition has only affected autoclave men.

The main features of 'Acro-osteolysis' are bony changes which typically involve the terminal phalanges of the fingers, but changes in other parts of the skeleton, such as the sacro-iliac joints, the patella and the toes have been noted. These bony changes are often preceded by Raynaud's phenomenon and are associated with scleroderma. It is apparent therefore that Acro-osteolysis is a systemic disease.

In ICI there have been four cases - two of Raynaud's phenomenon only and the other two with involvement of bone.

Since the occurrence of these cases conditions have been greatly improved in that many of the autoclaves are now cleaned mechanically by high pressure water jets. In some of the older plants where manual cleaning still continues the frequency with which men have to go into the autoclave has been reduced very considerably (about once per shift).

In 1970, Professor Viola of Solvay in Italy became interested in this condition and tried to reproduce it in animals, by exposing rats to very high concentrations of VCM (i.e. 30,000 parts per million). He failed in this particular objective purported to show that he had found tumours of the ceruminous gland (and this is a common site in rats for the induction of tumours) and tumours of the lung. He published his findings in 1971.

This work was of course examined and did in fact come into disrepute because of dissatisfaction with the strain of rats that he used, his technique and his interpretation of the findings.

A European group of manufacturers in Italy, France and Belgium, with which ICI was associated, took the matter a stage further and sponsored Professor Maltoni, Bologna, to carry out further animal experimental work.

He exposed rats to VCM at concentrations from 10,000 parts per million down to fifty parts per million and reproduced the tumours of the ceruminous gland which Viola had reported. He also discovered angiosarcomata of the liver and nephroblastomata of the kidney. These are extremely rare tumours (for instance, angiosarcomata of the liver in the U.S. numbers about two dozen a year). These tumours were produced at all levels of concentration down to 250 parts per million, but there was none at fifty parts per million. Neither were there any tumours detected in his controls or in rats exposed to similar concentrations of vinyl acetate.

The next stage was to see if any of these effects could be found in VCM exposed operators, and at the ICI Hillhouse plants a survey of the death certificates of all VCM exposed operators over the last 30 years or so was carried out. This survey included men who had died in service, pensioners and men who at some time or other had left our employment. Up to the end of 1972 this study showed no statistically significant difference in the cancer death rate of the VCM group and a control population. Neither was there any incidence of the rare tumours of liver and kidney found by Maltoni.

In the Runcorn area records were inadequate to show up VCM exposed employees over the years and so the causes of death of all pensioners and those employees dying in service were examined and no primary tumours of the liver were discovered. An investigation is now being carried out to trace the causes of death of those ex-employees who for various reasons left the Company.

At this time Maltoni was still continuing with animal experimental work in three main fields.

i) He was trying to pinpoint more accurately the no effect level in rats by exposing them to levels of 200, 150 and 100 parts per million.

ii) He was exposing rats to concentrations of 10,000 down to 50 parts per million for four months only as this was considered to be equivalent to the working life of an average man.

iii) He was also carrying out a quick test on pregnant female rats to see if he could produce any ill effects in their offspring.

iv) He was also repeating his original experiment in the rat on hamsters and exposing them to levels of VCM of 10,000 down to 50 parts per million.

By this time the Manufacturing Chemists Association in the USA had become interested in this problem and were doing similar work on the rat, mouse and hamster.

The MCA also commissioned a firm called Tabershaw Cooper to carry out a survey of causes of death which involved the examination of records of approximately 4,000 VCM operators.

The situation at Christmas therefore was as follows:-

1) Professor Maltoni had produced evidence that Vinyl Chloride Monomer was carcinogenic to the rat.

2) There was no evidence whatever at that time of any carcinogenic effect in man and indeed the survey carried out at ICI Hillhouse complex had been reassuring.

3) The Tabershaw Cooper investigation was well under way and the results were expected at the end of February and it seemed reasonable to await these results before taking any further action.

On Boxing Day however Dr Johnson of B F Goodrich contacted ICI by telephone and reported that he had found two suspected cases of death from angiosarcomata of the liver in men who had worked on their Louisville Plant and had been exposed to VCM. In the next few weeks he reported two further cases from the same plant.

I It was of course very necessary to validate the histological findings. All VCM exposed employees on both manufacturing sites were informed of the position and a few days later detailed discussions, in which Dr Murray took part, were held with the shop stewards and supervisors involved in the process.

Our customers, the Ministry of Agriculture, Fisheries and Food, and the DHSS, who had been generally in the picture for some time, were brought up to date. The TUC and the Factory Inspectorate were informed of the facts on the 22nd and the 23rd January, 1974 respectively.

A press statement was put out by the Company.

ASI 000017658

During these few weeks ICI was busy up-dating its examination of causes of death at its Hillhouse Factory and it was during this process that one case of angiosarcoma

autoclaves for twenty years from 1946 to 1966.

All concerned were immediately informed of this discovery.

ICI has established a strong technical team which is now urgently investigating ways and means of reducing exposure to VCM to the lowest possible level.

Close contact is being maintained with PVC manufacturers, especially in Europe and the United States.

A number of important meetings at which ICI has been represented have taken place in America and the following is a summary of some of the important points that arose out of these meetings.

The first of these meetings was at the MCA headquarters in Washington on 25th January, 1974 when Dr Johnson of B F Goodrich described their four cases of angiosarcoma of the liver.

Case 1: Died 1971, aged 38 years with fifteen years' service. Eight years as an autoclave operator which was followed by a few months working with chemicals such as vinylidene chloride, vinyl acetate, methanol and ethylene dichloride. He then continued as an autoclave operator for a further six years.

Case 2: Died 1973, aged 49 years with 22 years' service. All his service was as an autoclave operator.

Case 3: Died 1973, aged 58 years with 29 years' service. He spent eleven years on the autoclaves but there was also exposure to vinylidene chloride, methanol and vinyl acetate. After a period of one year in the drying area he then spent a further fifteen years on the autoclaves.

Case 4: Died 1968, aged 43 years with 19 years' service. He was employed on the autoclaves for seventeen years and during the last nine years of service was also exposed to vinylidene chloride, vinyl acetate and methanol.

It seemed that all four cases of angiosarcoma had been exposed for long periods to high levels of VCM, but the actual levels are not known.

Although B F Goodrich have had a number of cases of acro-osteolysis none of the men who died of angiosarcoma and who were all autoclave workers had suffered from this condition.

As soon as B F Goodrich had confirmed the finding of deaths from angiosarcomata amongst their employees they informed NIOSH of the situation who immediately set up a special committee with a view to making recommendations concerning future work practices.

An approach was also made to the Kentucky State Board of Health as this is necessary by Statute. The Kentucky State Board of Health will now await NIOSH recommendations.

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Employees on the effected plant were seen by plant management and told of the situation.

Tabershaw-Cooper were brought in to carry out an in-depth investigation into the records of all VCM/PVC employees - past and present - including a plant at Niagara, which although now closed was their first plant.

An account was given at this meeting of the work being carried out by Tabershaw-Cooper. To date 4,400 records have been examined. So far 122 deaths have been identified and 102 death certificates obtained. A further 1,600 to 1,800 records are outstanding with an expected 30 to 40 more deaths to be investigated. It is now known that this work is not likely to be completed before April.

No death suspected as being due to angiosarcoma of the liver has been identified although it is admitted that the remaining 1,600 to 1,800 records will cover the older plants.

The Manufacturing Chemists Association decided to set up immediately a number of Committees.

- 1) A Medical Committee with a broad remit to investigate any possible means of applying meaningful surveillance.
- 2) A committee to study work practices (including transport) with the broad remit to reduce exposure.
- 3) A committee to study methods of analysis and monitoring.

The UK has two representatives (Dr Duck of BP and Dr Dufield of ICI) on the Medical Committee. ICI also has a representative on each of the two other committees.

At a meeting in the States on the 14th February Professor Maltoni reported that in the rats that had now been exposed to VCM for 12 months he had found a subcutaneous angiosarcoma of neck, 2 angiosarcomata of peritoneum, 1 angiosarcoma of uterus and 1 angiosarcoma of lung.

2 subcutaneous angiosarcomata had also been discovered in the twenty week offspring of the pregnant rats which had been exposed to VCM.

On the 15th February a meeting was held in the States of the Medical Committee to consider possible methods of health surveillance. The following suggestions were put forward:-

- i) A full medical history
- ii) A full occupational history
- iii) A cancer background history
- iv) A physical examination including x-ray of both hands and chest.

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- v) Complete blood count with platelets (? thrombocytopenia).
- vi) Liver function tests - Bilirubin, SGOT and SGPT, alkaline phosphatase, lactic dehydrogenase,

Total blood protein, albumin, blood urea, urine analysis with microscopic examination, FEV 1 and FVC.

Whilst these latter meetings were in progress news was received from B F Goodrich of two further cases and it is believed that another case has been discovered at Union Carbide.

The particulars of these three cases are not yet to hand.

This then is the situation up to date.

KPW:L
25th February, 1974

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