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HUMAN ILLNESSES IN EMPLOYED PERSONS ATTRIBUTED TO EXPOSURE TO PESTICIDES
CONTAINING METHYL BROMIDE WITH EMPHASIS ON CASES REPORTED BY
PHYSICIANS IN CALIFORNIA IN 1976

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SUMMARY

In 1976, of 1,452 occupational exposures to pesticides reported by physicians in California, 40 involved exposures to methyl bromide. Methyl bromide is an effective, low cost, efficient fumigant, especially useful for control of nematodes, fungi and weed seeds in soil, insects in grain and commodities, and termites in structures. Several million pounds are used each year in California. It is highly toxic to man and must be used with great care. Extensive use experience has resulted in a body of safe-use information. Most applications are properly made without excessive exposure. Occupational deaths have apparently been avoided in recent years, but at least 30 cases of occupational illness are reported each year from exposure to this pesticide. Some of these exposed workers are left with permanent damage to the eye, brain, and to other body tissues. Seventy-seven labels of products containing methyl bromide were reviewed and most were considered deficient in providing adequate safety information. Statements on the hazards of skin absorption were most notably lacking. It is recommended that consideration be given to limiting registration of methyl bromide products to those containing chloropicrin as a warning agent. This would require the establishment of additional exemptions or tolerances for chloropicrin on fruits, vegetables and nuts. The promulgation of additional worker-safety regulations for uses of fumigants such as methyl bromide is proposed.

INTRODUCTION

This report supplements a similar report dated July 15, 1976, that summarized occupational health problems with use of methyl bromide as a pesticide prior to December 31, 1975.

Methyl bromide is a colorless, nearly odorless gas at room temperature which is applied as a pesticide from pressurized containers in which it exists in the liquid state. The boiling point is +3.5° C. It is a general-purpose fumigant used primarily for soil fumigation to control nematodes and weed seeds. It is also used as a commodity fumigant to control pests on grains, nuts, vegetables, and to fumigate structures

infested with insects. Methyl bromide is applied to the soil as a gas either by injection into the soil or by release under tarps above the surface of the soil. In most applications, the soil is covered with a tarp to prevent premature escape of the gas. Commodities are fumigated either in a fumigation chamber or under a tarp.

7,164,324 pounds of methyl bromide were reported used in California in 1975. The major uses were: (1) agricultural soil fumigation, 6,094,244 lbs.; (2) potting soil fumigation, 619,931 lbs.; (3) commodity fumigation, (includes grain, fruit and nuts) 65,183 lbs.; (4) structural fumigation, 112,113 lbs.; and (5) other uses, 272,789 lbs. Typical application rates in soil are 0.002-0.01 lbs/ft² of surface area or 100-400 lbs/acre, in bulk grain 2-4 lbs/1000 ft³, and as a space fumigant 1-3 lbs/100 ft³.

Since methyl bromide is almost odorless except in high concentrations, about 90 percent of the pesticides that contain methyl bromide are applied with chloropicrin added, usually to provide a safety warning. Pure methyl bromide is used principally in commodity fumigation; such as fruits and nuts since tolerances for chloropicrin for these items have not been set. Chloropicrin -- which is essentially a tear gas -- is usually used in low concentrations to warn persons of leakage of the nearly odorless methyl bromide during application and also to prevent exposure to methyl bromide before it has dissipated. The quantity of chloropicrin added to pesticides that contain methyl bromide ranges from as low as 0.25 percent up to 67 percent. In higher concentrations, chloropicrin is also an effective fumigant and is very toxic to man. Most products as presently marketed contain from 0.25 percent to no more than 5 percent with the trend towards decreasing amounts. However, even one or two percent chloropicrin can be toxic to plants and to man, so care must be taken with its use. Exposure of a person to high concentrations of chloropicrin will warn the exposed individual, but may also render him incapable of removing himself from exposure.

The danger of applying methyl bromide without chloropicrin is indicated by a study of the human exposure incidents that occurred in 1975 and 1976. Of 38 exposure incidents reported in which the composition of the pesticide that contained methyl bromide was known, 15 were caused by pesticides that contained only methyl bromide even though application of pure methyl bromide as a pesticide accounts for only about 10 percent of the total usage. The addition of small quantities of chloropicrin as a warning agent should help to reduce the number of exposures resulting in illness. As little as 0.25 percent will suffice for this purpose, at least for the early part of the fumigation procedure.

The LC₅₀ of methyl bromide to rats is 1,000 ppm. The threshold limit value for a continuous 8-hour day, 40-hour week, is 15 ppm in air. Acute vapor toxicity occurs with exposure at levels above 200 ppm. Exposure to levels of 2,000 ppm can be fatal in one hour. In addition to being inhaled in gaseous form, methyl bromide in liquid or gaseous form can cause surface chemical burns to the skin and diffuse rapidly through the skin to enter the circulatory system. In the body, it may cause severe lung irritation and cumulative damage to the heart, kidneys, and nervous system. Illnesses resulting from methyl bromide exposure may have a latency period before onset from a few hours to as long as three days. One particularly hazardous characteristic of methyl bromide lies in the fact that it is much more dense than air. A worker may therefore be

exposed to hazardous levels via the skin on his legs and feet, and not be aware of it. In addition, if a canister gas mask or a self-contained air-supplied mask is used, the worker may not understand that the fumigant is passing through his skin. The gas mask can thus give a false sense of security.

OCCUPATIONAL ILLNESSES DUE TO EXPOSURE TO METHYL BROMIDE
DURING 1976 IN CALIFORNIA

A total of 40 physician's reports of presumed occupational over-exposure to pesticides containing methyl bromide were reported in 1976. Of these, nearly half were due to uncoupling or breakage of hoses holding the gas under pressure or improper application techniques.

Many cases involved uncoupling or breakage of pressurized hoses that released the fumigant to the working environment. Most of these could have been prevented by precautionary safety inspections and use of more durable equipment. Employers are responsible for the maintenance of safe equipment. Not all these exposure incidents were due to equipment failure or human error, additional diligence in employee safety supervision is required.

Many of the incidents in which workers are exposed to methyl bromide are through accidents. Large amounts of this fumigant are used each year. Due to this extensive usage, its high toxicity and extremely volatile nature, it is to be expected that a number of accidental exposure incidents will occur. Adverse effects on users may be greatly mitigated by availability and diligent use of proper safety equipment.

Many of the illnesses reported in 1976 could have been prevented or greatly reduced in severity, had respirators and/or face shields been available and worn. Many of the workers who became injured apparently knew the potential of hazards from methyl bromide. Diligent use of personal protective devices may improve the safety record of methyl bromide. Having a good safety program is necessary when this fumigant is being used.

In 1976, there were 33 percent (40 vs. 30) more exposure incidents involving methyl bromide than in 1975. In 1975, no incident involved more than three persons. In 1976, there was one incident in which six firemen had exposure symptoms. It should be noted that although there were more exposure cases, those occurring in 1976 seemed to be significantly less serious.

<u>Reasons for Exposure</u>	<u>Type of Exposure</u>			<u>Total</u>
	<u>Systemic</u>	<u>Eye</u>	<u>Skin</u>	
Handling Fumigant	3	0	1	4
Accident During Operation	8	4	6	18
Exposed to Fumigated Materials and Containers	2	1	1	4
Container Disposal and Cleanup	1	0	1	2
Firemen Exposed at Spill	6	0	0	6
Unknown	3	1	2	6
Totals	23	6	11	40

SUMMARIES OF CASES OF OCCUPATIONAL EXPOSURE INCIDENTS
INVOLVING METHYL BROMIDE IN CALIFORNIA IN 1976

SYSTEMIC ILLNESSES

Six firemen experienced mild bromide poisoning subsequent to exposure to methyl bromide. They had answered a call concerning a methyl bromide leak; there was no fire. Five of the men developed headaches, two experienced dizziness, and two others felt light-headed. One reported nausea and one a metallic taste in his mouth. All were examined and released for two to five days of rest before returning to work.

A termite control fumigator inhaled methyl bromide when he accidentally knocked off his respirator. He was nauseated for several days, vomiting often. He was treated with diuretics and an increased salt intake.

An employee was involved in applying methyl bromide in a field for two days when he began suffering from abdominal cramps and dyspnea. He was admitted to a hospital for one week for observation.

A man sorting nuts was exposed to methyl bromide when fumigation operations were being conducted in the next room. The nuts being fumigated were placed under a tarp which was weighted at the edges. He was diagnosed as having "gastritis secondary to chemical inhalation." He was examined in an emergency room and released. This method of fumigation is unacceptable because it presents undue risk to nearby workers. Subsequent to the commissioner's inspection, this firm has ceased fumigating by this method.

An applicator of methyl bromide accidentally sprayed it directly on his face. He complained of nausea, a dry throat and a "tight feeling" on the left side of his face. He was given medication and released.

A truck driver was unloading leaking cylinders of methyl bromide when he inhaled the fumes. He experienced symptoms of methyl bromide poisoning including headache. He was examined and given supportive medication.

While training to be a fumigator for a nut marketing concern, an employee was exposed to methyl bromide gas. He was attempting to change cylinders on the application apparatus. He complained of dizziness, headache and slurred speech. After examination and one day of hospitalization for observation, he was released.

Another "trainee" had reentered an apartment building to relight the gas pilot lights. The building had been fumigated with 99.5 percent methyl bromide with 0.5 percent chloropicrin by a licensed structural pest control firm. The building was said to have been aired out prior to entry, but 12 hours after entry, the man was suffering "severe epigastric pain with marked emesis, elevated blood pH, and elevated WBC with a left shift." The patient was examined and admitted to a hospital for treatment.

A nursery employee was fumigating with methyl bromide when a hose fitting came loose. Several minutes after exposure, he had a tight chest, was short of breath, and was coughing. He was treated by a physician.

A man was disconnecting tubing from methyl bromide cylinders. Some methyl bromide remained in the tubing and was inhaled by the employee. He had an inflamed trachea and nasal mucosa and was treated by a physician.

A worker was assisting with the loading of a cylinder of 99.5 percent methyl bromide onto a truck when the valve on it opened partially. In attempting to close it, it opened further. The man spraying the cylinder with water became poisoned while another man working on the cylinder itself did not develop symptoms. Symptoms observed were eye and nose irritation from the chloropicrin and skin burns from the methyl bromide.

A man applying 100 percent methyl bromide to soil was sprayed in the face when the nozzle came off the injection hose. He experienced mild symptoms of methyl bromide poisoning and was placed in a hospital under observation for two days.

An employee was opening a can of methyl bromide. In doing so, some was spilled on his hands and face and some was inhaled. Dizziness ensued and he was given oxygen. He refused admission to a hospital and left the physician's office against his advice.

A commodity fumigation worker was exposed to methyl bromide while emptying a fumigation chamber. Symptoms seen were said to be those typical of methyl bromide exposure; treatment was rendered by a physician.

A fumigation worker was cutting plastic tubing which contained methyl bromide under pressure. It sprayed in his face but not his eyes. No symptoms were encountered.

A man was fumigating nuts in bins without wearing any protective safety devices. Apparently no respirators were available for this employee. The man experienced chest pains, was examined and released.

A carpenter was exposed to methyl bromide. He became nauseated, dizzy, short of breath and his eyes burned. The physician's diagnosis was "mild bilateral conjunctivitis, vertigo and nausea secondary to inhalation of toxic fumes." Decadron and Benadryl were administered and the patient was released.

A warehouseman was fumigating bins with methyl bromide when a leak was discovered. He attempted to repair it and following that, complained of additional illness symptoms. The examining physician doubted that methyl bromide was the cause of the illness and diagnosed a possible viremia.

EYE

An assistant fumigator was attempting to fumigate a boxcar. The tubing he was using was kinked. When the methyl bromide was turned on, the end of the tube pulled out of the car due to the kink. Some of the spray entered one eye. He complained of blurred vision; treatment was administered. The worker had not been wearing eye protection.

A worker was preparing to fumigate with 1.5 lb. cans of methyl bromide when an accident caused him to drop the apparatus which then leaked. The methyl bromide got into his eyes and mouth, but only the eye was

affected; his conjunctiva was inflamed. Bacitracin ointment and Darvon pills were prescribed by the physician.

A laborer who was handling methyl bromide cylinders along with another laborer suffered a slight superficial corneal burn. An accident during handling resulted in some of the fumigant entering his eye.

A nursery worker was attempting to fumigate some planting soil when the dispensing apparatus leaked methyl bromide into his eyes. Apparently the wrong harness was being used for this size cylinder. The patient was taken to the hospital as a precautionary measure. No symptoms were observed.

A forklift operator was moving raisins in a warehouse that had been recently fumigated. The room was said to have been aired for 24 hours with exhaust fans. He developed "acute conjunctivitis with large pre-auricular nodes." Tetracycline and Neosporin were prescribed.

A fumigator was spraying a leaking cylinder of methyl bromide with water. Immediately after the incident, his eyes and nose were irritated, probably from the 0.5 percent chloropicrin in the fumigant. No other symptoms were observed. Upon examination, bromide and transaminase levels in the blood were elevated, indicating methyl bromide exposure.

SKIN INJURIES

An exterminator spilled methyl bromide on his ankle and foot resulting in second and third degree burns. He was examined in an emergency room and treated.

A structural fumigator was sprayed with methyl bromide from the waist down. First degree burns resulted. He was examined, the burns were treated and he was released.

A man was fumigating tree holes when the probe he was using plugged up with dirt. The obstruction apparently came free and the methyl bromide squirted on his boot. That evening he noticed a blister. This employee apparently didn't realize the dangers present when contact with methyl bromide occurs; otherwise he would have at least rinsed his foot upon contact. His burn was treated by a physician and he was released.

While transferring methyl bromide from a 175 lb. cylinder to a smaller container, the sight glass on the pipe ruptured. The employee supervising was splashed in the face. The burns resulting were treated with skin cream.

A man fumigating with methyl bromide dropped some on his feet. This resulted in a second degree skin burn.

A gardener was kneeling on the ground while applying methyl bromide to the soil. The fumigant went through his trousers and caused an erythematous rash on the skin. Kenalog and Benedryl were prescribed for relief.

A fumigator disconnected tubing containing methyl bromide, causing it to spill on him. He didn't report this to his employer until the next day.

First and second degree burns resulted. The employer seemed to realize that there had been a lack of awareness of potential dangers on the part of his employees, and agreed to remedy the situation.

A county employee was breaking methyl bromide ampules when one sprayed on his legs and feet. Depo-Medrol and ice compresses were prescribed by the physician for the resultant contact dermatitis.

Some methyl bromide escaped from its container when it was standing in water. An employee of the firm removed his glove and put his hand in the water. Apparently, methyl bromide dissolved in the water irritated his hand. The physician diagnosed the problem as dermatitis.

An employee of a methyl bromide manufacturing plant got some on his finger. This resulted in blistering of the finger.

A fumigation worker was exposed to methyl bromide while near a boxcar fumigation operation.

DISCUSSION

The 40 human exposure cases in employees discussed above are typical for those which have occurred in recent years. There were 30 cases in 1975 and a similar number in other recent years. There were six occupational fatalities and sizable numbers of recovered cases of overexposure that were left with serious permanent effects during the decade of the 1950's. Improved safety and regulatory programs appear to have minimized excessive exposure in recent years since occupational fatalities are apparently not occurring and fewer life-threatening exposures are being seen even though total usage has increased considerably. Some deaths that were diagnosed as myocardial infarction that followed excessive methyl bromide occupational exposure a few days earlier are highly suspect as possibly having been due to the methyl bromide.

Of the nonfatal incidents which still occur, there is often a finding of inadequate training, supervision, or availability of printed information on safe handling. All 77 labels of pesticides that contain methyl bromide that are currently registered for use in California were reviewed for adequacy of safe use instructions. Based upon the evaluation of 205 human occupational exposure incidents that occurred in California in 1971-76 that were studied by the authors, it is concluded that none of these labels adequately describe the hazards from skin absorption. The Dow Chemical Company had some of the best wording on this subject in its labeling. It is to be admitted that the one-pound containers often used have limited labeling space, making it difficult to place all the necessary information on the product label. In several of the situations of misuse, the supplemental literature (labeling) in the packing cases that hold the one-pound containers apparently was not received by the ultimate user. Some of the supplemental labeling honestly assesses the hazards of misuse while other labeling literature minimizes or fails to mention several important safety principles. The California Department of Health and the California Department of Food and Agriculture determined it was desirable to issue information sheets to summarize safety information often missing from some labels.

It is recommended that in the registration review process that all the labels and labeling on products that contain methyl bromide be reviewed to correct certain common deficiencies:

1. Most labels fail to make it apparent that there is a serious risk of absorbing up to fatal amounts of methyl bromide in the liquid or gaseous form through the skin, even though the label instructions on wearing a black canister gas mask or an air-supplied face mask are carefully followed.
2. Most labels do not refer to the problem of methyl bromide layering out in low areas in highly toxic concentrations.
3. Labels should stress that methyl bromide must be kept within confined spaces and then thoroughly planned and adequate ventilation procedures must be followed before workers reenter fumigated areas.

Halide leak detectors should not be overrelied upon as they often are not positive until levels well above the threshold limit values are reached. Work procedures should be planned so that gas levels are so low that gas masks are not needed. Gas masks should only have to be available for emergency short-time use.

4. Labels should not stress that gas masks are to be put on when chloropicrin is noted and then imply that routine work may proceed. Under these circumstances, chloropicrin then ceases to be a warning agent and skin absorption of methyl bromide is occurring.
5. More stress needs to be placed on the need for water to be immediately available for washing should liquid methyl bromide be sprayed into the eyes or on the skin. Permanent eye damage and severe skin damage and subsequent systemic absorption must be avoided.
6. Labels should stress that up to fatal doses of methyl bromide can be absorbed from a single exposure or from several lower level cumulative exposures without symptoms becoming evident for several hours or days. In California, some cases of onset of illness off the job have resulted in incarceration for presumed: marijuana intoxication, alcohol intoxication, and sudden onset of insanity.
7. Return of used containers or proper disposal must be stressed. Accidental release of gaseous methyl bromide from an abandoned container in Belmont, California, in 1973 resulted in severe lung damage and other systemic effects including some permanent central nervous system damage in several of 24 exposed firemen attempting to move the container. Some were affected even though they were wearing chemical protective sealed suiting and supplied air masks.

The California Department of Health has recommended that all uses of pure methyl bromide as a pesticide be phased out because of the safety hazards. The problem to be faced in accomplishing this is the lack of established residue clearances for chloropicrin for fruits, vegetables, and nuts. Consideration should be given to establishment of such clearances immediately.

The California Department of Food and Agriculture and the California

Department of Health are willing to work with the Environmental Protection Agency in the development of a model precautionary statement for labels of pesticides containing methyl bromide and then in reviewing the proposed revised labels.

Most fumigation facilities in California do not provide adequate protection for workers in the vicinity or those actually engaged in the fumigation operation. Entire rooms are sometimes used as fumigation chambers without adequate prevention of leaks or complete ventilation. Actual fumigation chambers also suffer from the same problems. Purging of chambers, in many cases, results in unsafe discharge of the fumigant. Often a chamber is not even used. A tarp is often used for commodity fumigation and then removed by unprotected employees. Because most facilities are still deficient, availability and use of protective clothing is recommended for the protection of fumigation workers in the short term. Medical supervision is needed for some workers.

Solution to the problem lies in upgrading present physical facilities with modern, safety engineered facilities which protect the worker from the fumigant. In a properly engineered environment, there should be minimal need for protective clothing and personal protective equipment. It is recommended that consideration be given to adding the attached proposed regulations to the existing worker safety regulations of the California Department of Food and Agriculture.