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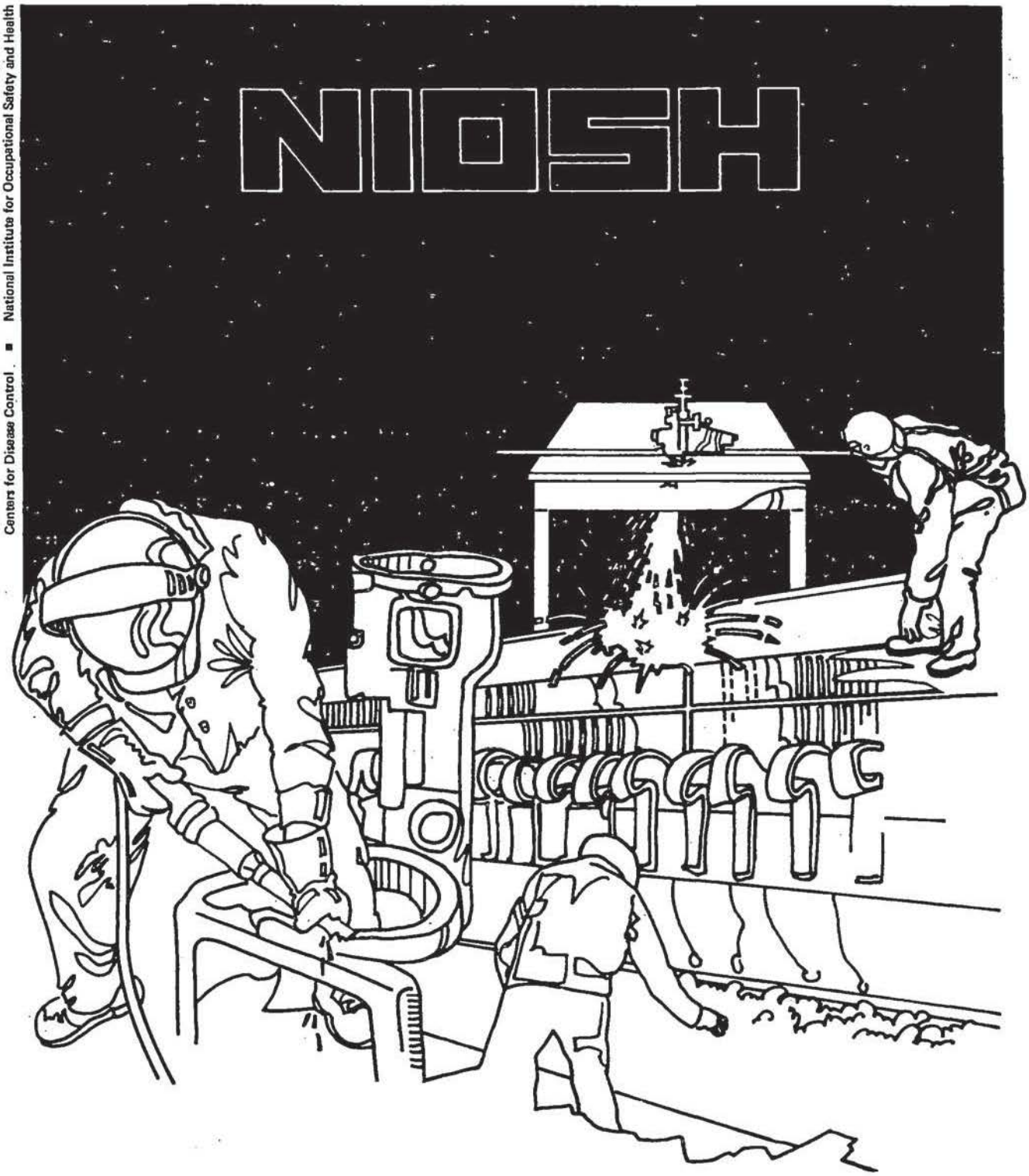

Health Hazard Evaluation Report

HETA 82-338-1266
CENTER FOR MOLECULAR NUTRITION
AND SENSORY DISORDERS
WASHINGTON, D.C.

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

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CENTER FOR MOLECULAR NUTRITION
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I. SUMMARY

In July 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request to conduct a health hazard evaluation at the Center for Molecular Nutrition and Sensory Disorders (administered through the Georgetown University Medical Center, Department of Pediatrics) in Washington, D.C. NIOSH was asked to evaluate workers' exposures to nitrobenzene, pyridine, thiophene, and n-amyl acetate.

Three individuals at the Center use these four compounds routinely to administer smell tests to patients experiencing sensory disorders. The smell tests are conducted using up to nine concentrations of each compound ranging from a dilution of 10^{-9} to the concentrated liquid. Two milliliters of each concentration for the four compounds are kept in small, capped amber bottles for use during testing. The smell test consists of establishing an odor threshold by initially positioning the open bottle containing the 10^{-5} dilution under the patient's nose for about two seconds and increasing or decreasing the concentration as necessary until the patient can detect an odor. This procedure is repeated for each of the four compounds and results in individual patient sessions lasting about one-half hour.

On October 14, 1982, NIOSH conducted an investigation in which brief informal discussions were held with affected employees, ventilation measurements were obtained, and existing work practices were observed. Two of the smell testors reported symptoms of headaches, nausea, dizziness, and fatigue during and after the battery of tests. Both reported that these symptoms usually disappear after leaving the clinic. One smell testor had not experienced any adverse health effects.

Ventilation measurements were obtained using a Kurz Model 480 air velocity meter and indicated that the existing ventilation in the clinic rooms used for the smell tests was adequate. Our observations indicated, however, that direct skin contact with the liquid compounds could occur through the repeated opening and closing of the test bottles since protective gloves were not used. These observations are supported by the results of a previous OSHA inspection conducted on September 9, 1982. This inspection showed that the test compounds were present in detectable quantities on the hands of the two smell test administrators sampled. OSHA's inspection also showed that airborne concentrations of the test compounds were well below any existing occupational health criteria.

NIOSH concludes that skin absorption of the smell test compounds, especially nitrobenzene, is the probable cause of the symptoms reported by the smell test administrators.

Recommendations to minimize skin absorption of the test compounds are described.

KEYWORDS: SIC 8010 (Offices of Physicians and Surgeons), n-amyl acetate, nitrobenzene, pyridine, sensory disorders, smell tests, thiophene.

II. INTRODUCTION

On July 19, 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from an authorized representative of employees at the Center for Molecular Nutrition and Sensory Disorders (administered through the Georgetown University Medical Center, Department of Pediatrics) in Washington, D.C. NIOSH was asked to evaluate workers' exposure to nitrobenzene, pyridine, thiophene, and n-amyl acetate during the administration of smell tests at the center.

III. BACKGROUND

The Center for Molecular Nutrition and Sensory Disorders is located on the ground floor of a small office building approximately two miles from the Georgetown University campus in Washington, D.C. The Center's facilities consist of a reception/waiting area, Director's office, six small examination rooms, and a lab/storage area. The Center has been at this location for a little more than one year. Three individuals at the Center administer smell tests every Thursday to patients experiencing sensory disorders. Four compounds, each having a distinctive odor, are used: nitrobenzene, pyridine, thiophene, and n-amyl acetate. The smell tests are conducted using up to nine concentrations of each compound ranging from a dilution of 10^{-9} to the concentrated liquid. Two milliliters of each concentration for the four compounds are kept in small, capped amber bottles for use during testing. The smell test consists of establishing an odor threshold by initially positioning the open bottle containing the 10^{-5} dilution under the patient's nose for about two seconds and increasing or decreasing the concentration as necessary until the patient can detect an odor. This procedure is repeated for each of the four compounds and results in individual patient sessions lasting about one-half hour.

The Occupational Safety and Health Administration (OSHA) conducted an inspection at the center on September 9, 1982, to evaluate workers' exposure during the smell test procedure. Sixteen skin wipe samples were collected for nitrobenzene, pyridine, and thiophene on both hands of two smell testors before and after washing. One sample was positive for nitrobenzene, four were positive for pyridine, and eight were positive for thiophene. One wipe sample was collected from the exterior of the test bottles containing these same three concentrated liquids and was positive for nitrobenzene. OSHA also collected personal air samples on one smell testor for nitrobenzene, pyridine, and n-amyl acetate. The two nitrobenzene samples resulted in an 8-hour time-weighted average (TWA) exposure of 0.1 parts per million (ppm). The three pyridine samples resulted in a TWA exposure of 0.1 ppm. These exposures are well below the current OSHA standards of 1 ppm and 5 ppm, respectively. Six samples were collected for n-amyl acetate and were all below the detectable limit of 0.3 ppm.

IV. METHODS AND MATERIALS

On October 14, 1982, NIOSH conducted an investigation in which brief informal discussions were held with affected employees, ventilation measurements were obtained, and existing work practices were observed. The ventilation measurements were obtained using a Kurz Model 480 air velocity meter.

V. EVALUATION CRITERIA

All four compounds used at the center for smell tests, nitrobenzene, pyridine, thiophene, and n-amyl acetate, can enter the body through the lungs by inhalation, through the skin by direct contact, and through the digestive system by ingestion.[1,2]

Toxic Effects of Nitrobenzene:

Nitrobenzene is readily absorbed through the skin as either a liquid or vapor and even a small amount absorbed from clothing can cause toxic effects.[1]

Acute or short-term exposure to nitrobenzene is known to cause methemoglobinemia (characterized by a bluish discoloration of the skin), eye irritation, headache, irritability, dizziness, weakness, nausea, vomiting, shortness of breath, and drowsiness. In high concentrations, unconsciousness and death may occur. The onset of these symptoms may be delayed and can also be aggravated by the ingestion of alcohol. Since nitrobenzene affects the ability of the blood to carry oxygen, individuals with blood disorders may be at an increased risk.[1]

Chronic or long-term exposure to nitrobenzene is known to cause anemia, allergic skin reactions, and liver and kidney damage.[1]

The current OSHA standard for nitrobenzene is an 8-hour TWA of 1 ppm.[3] The American Conference of Governmental Industrial Hygienists (ACGIH) also recommends an 8-hour TWA of 1 ppm for nitrobenzene.[4]

Toxic Effects of Pyridine:

Acute or short-term exposure to pyridine is known to cause irritation to the eyes, skin, and mucous membranes. In high concentrations, gastrointestinal disturbances with diarrhea, abdominal pain, nausea, weakness, headache, dizziness, insomnia, nervousness, anorexia, and back pain with increased urinary frequency may occur.[1]

Chronic or long-term exposure to pyridine is known to cause skin irritation and liver, kidney, and central nervous system damage.[1]

The current OSHA standard for pyridine is an 8-hour TWA of 5 ppm.[3] The ACGIH also recommends an 8-hour TWA of 5 ppm for pyridine.[4]

Toxic Effects of Thiophene:

Little information is available concerning the toxic effects thiophene has in humans. However, it is a known central nervous system depressant and acute or short-term exposure to high concentrations may cause narcosis.[2]

No toxic effects from chronic or long-term exposure to thiophene have been reported.

There is currently no applicable occupational health standard for thiophene.

Toxic Effects of n-Amyl Acetate:

Acute or short-term exposure to n-amyl acetate is known to cause irritation to the eyes, nose, and throat. In high concentrations, weakness, drowsiness, and unconsciousness may occur.[1]

Chronic or long-term exposure to n-amyl acetate is known to cause dermatitis.[1]

The current OSHA standard for n-amyl acetate is an 8-hour TWA of 100 ppm.[3] The ACGIH also recommends an 8-hour TWA of 100 ppm for n-amyl acetate.[4]

VI. RESULTS

Two of the smell testors reported symptoms of headaches, nausea, dizziness, and fatigue during and after the battery of tests. Both reported that these symptoms usually disappear after leaving the clinic. One smell testor had not experienced any adverse health effects.

The ventilation measurements indicated that the existing ventilation in the clinic rooms used for the smell tests was adequate when compared to the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) recommended guidelines for medical procedure areas of 7 cfm outdoor air per person in non-smoking areas and 35 cfm outdoor air per person in smoking areas.

Observation of work practices during the administration of smell tests indicated that direct skin contact with the liquid compounds could occur through the repeated opening and closing of the test bottles since protective gloves were not used.

VII. DISCUSSION AND CONCLUSIONS

The symptoms reported by two of the smell test administrators is associated with conducting the smell tests since the symptoms appear only on Thursdays when the tests are conducted. The lack of appreciable airborne vapor concentrations and the presence of detectable quantities of the test compounds on the smell administrators hands, as reported by OSHA, indicate that skin absorption is probably the primary route of exposure. NIOSH's observations substantiated this. The caps for the test bottles have flat liners which permit the vapor condensate to collect on the perimeter of the cap. When the cap is removed, this condensate can drip onto the bottle lip and threads which then flow down the side of the bottle contaminating its exterior. The more times the bottle is handled, the greater the exposure. This exposure could be appreciable in the case of nitrobenzene, which is rapidly absorbed through the skin and is known to produce the symptoms reported. However, pyridine and n-amyl acetate, which are absorbed less rapidly, can also produce similar symptoms and may act in an additive manner in this situation.

VIII. RECOMMENDATIONS

The following recommendations should minimize the risk of absorbing any of the test compounds through the skin.

1. Good quality, solvent-resistant, disposable gloves should be worn by the smell test administrators when conducting the smell tests. These gloves should be changed after each patient session in conjunction with immediate hand washing using a waterless cleaner that will not dry the skin.

2. "Polyseal" caps should be used on the test bottles to reduce the contamination on the bottle exterior. These caps have a polypropylene cone liner that allows the vapor condensate to drip directly into the center of the bottle instead of collecting on the perimeter of the cap.

3. Substitute a less toxic compound for nitrobenzene; one possibility would be benzaldehyde, which has a similar almond-like odor.

IX. REFERENCES

1. National Institute for Occupational Safety and Health. NIOSH/OSHA occupational health guidelines for chemical hazards. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1981. (DHHS (NIOSH) publication no. 81-123).

2. API Toxicological Review: Thiophene and Derivatives. New York, New York: American Petroleum Institute, 1948.

3. Occupational Safety and Health Administration. OSHA safety and health standards. 29 CFR 1910.1000. Occupational Safety and Health Administration, revised 1980.

4. American Conference of Governmental Industrial Hygienists. Threshold limit values for chemical substances and physical agents in the workroom environment with intended changes for 1982. Cincinnati, Ohio: ACGIH, 1982.

5. American Society of Heating, Refrigerating and Air-Conditioning Engineers. ASHRAE Standard 62-1981: Ventilation for Acceptable Indoor Air Quality. Atlanta, Georgia: American Society of Heating, Refrigerating and Air-Conditioning Engineers, 1981.

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Director, Center for Molecular Nutrition and Sensory Disorders
2. Asst. Dean for Research, Georgetown University Medical Center
3. Authorized Representative of Employees, Center for Molecular Nutrition and Sensory Disorders
4. NIOSH, Region III
5. OSHA, Region III

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.