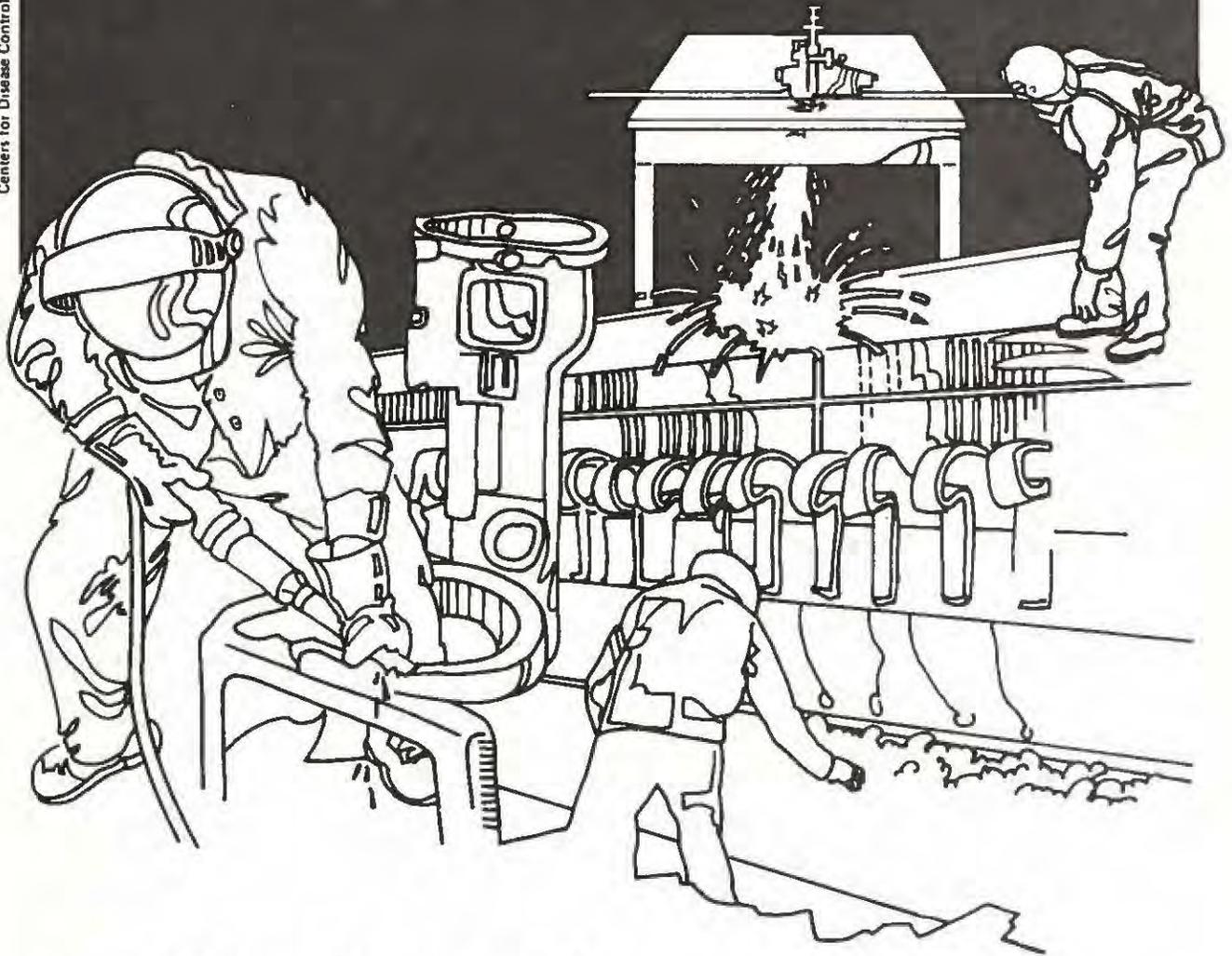


NIOSH



Health Hazard Evaluation Report

HETA 83-227-1466
PUGET SOUND NAVAL SHIPYARD
BREMERTON, WASHINGTON

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.

HETA 83-227-1466
May 1984
PUGET SOUND NAVAL SHIPYARD
BREMERTON, WASHINGTON

NIOSH Investigators:
Arvin G. Apol
Roy G. Parrish, M.D.

I SUMMARY

In May 1983, the National Institute for Occupational Safety and Health (NIOSH) was asked to determine if exposure to 2-ethoxyethanol, a solvent used in some paints at the Puget Sound Naval Shipyard (PSNS), Bremerton, Washington, was the cause of nasal and rectal bleeding experienced by seven painters. In August 1983, a NIOSH physician met with the PSNS physician, reviewed the medical records of these seven painters and of one additional painter, and interviewed five of the painters.

Review of the medical records and medical interviews revealed that three painters had episodes of rectal bleeding; two had episodes of nasal bleeding; and three had episodes of both rectal and nasal bleeding. Most of the episodes of rectal bleeding lasted 1-3 days, and the number of rectal bleeding episodes ranged from one to several intermittent episodes extending over a few months. At present none of the painters reports any bleeding. Physical examination revealed hemorrhoids in three of the four who were examined, and this was felt to be the most probable source of bleeding in these three. Physical examination in the fourth painter, done two months after the bleeding episode, showed minor irritation of the crypts, but no active bleeding. In the two others, the examining physicians felt that the rectal bleeding was secondary to nosebleeds in one painter and that no determination of the source of bleeding could be made in the other due to the interval between the bleeding episode and the exam. The medical records and interviews of the affected painters did not implicate exposure to 2-ethoxyethanol as the cause of the rectal bleeding.

Of the five painters reporting nosebleeds, two had a single episode. The other three had recurrent, intermittent bleeding over a period of a few weeks. The irritant effects of 2-ethoxyethanol vapors could have contributed to the nosebleeds; however, due to the use of supplied air respirators, significant inhalation of the vapors was unlikely. It seems more probable that drying of the nasal mucosa secondary to weather or respirator use or a minor trauma to the nasal mucosa caused the nasal bleeding episodes. The PSNS management stated that 2-ethoxyethanol could be removed from use. In December 1983, it was confirmed that 2-ethoxyethanol was no longer being used.

On the basis of this investigation, NIOSH determined that nasal and rectal bleeding experienced by seven painters was probably not caused by exposure to 2-ethoxyethanol. This is based on examination of the medical records and interviews with the affected painters and a literature search that showed no studies associating nasal and rectal bleeding with exposure to 2-ethoxyethanol. However, NIOSH recommends that 2-ethoxyethanol (2EE) be regarded in the workplace as having the potential to cause adverse reproductive effects, including teratogenesis. Recommendations to reduce exposure to 2-ethoxyethanol are included in this report.

KEYWORDS: SIC 3731 (Ship Building and Repairing) 2-ethoxyethanol (2EE)[other synonyms: ethylene glycol monoethyl ether (EGM); ethyl cellosolve; cellosolve].

II INTRODUCTION

In May 1983, the National Trades Council, Bremerton, Washington, requested NIOSH to determine if exposures to 2-ethoxyethanol, a solvent used in some paints at the Puget Sound Naval Shipyard (PSNS), was the cause of nasal and rectal bleeding experienced by seven of the two hundred twenty painters in Shop 71. An initial visit was made on July 18, 1983. On August 23, a NIOSH physician met with the PSNS physician, reviewed the PSNS medical records of these seven painters, and interviewed five of them. An interim report was provided on January 2, 1984.

III BACKGROUND

The Puget Sound Naval Shipyard refurbishes navy ships. There are approximately 10,000 employees at this facility. During refurbishment, the interior and exterior are painted. One of the paints used is the Mare Island Paint and its counterpart is Rule 66 paint. Both are epoxy-polyamide paints and differ only in their solvent. The Rule 66 paint contains 2-ethoxyethanol in lieu of butyl alcohol and naphtha in the Mare Island Paints. From February 1983 to July 1983, the average 2-ethoxyethanol usage was about 250 gallons per month.

The protective equipment used by the painters when painting with the Mare Island paints or the Rule 66 paints were: (1) supplied air respirator when spray painting; (2) cartridge (air purifying) respirators when cleaning equipment or when roller or brush painting; (3) cotton gloves or disposable gloves; and (4) coveralls and headcovers. The PSNS has a respirator test fit program for workers who wear respirators.

IV EVALUATION DESIGN AND METHODS

The NIOSH medical officer met with the PSNS physician who had seen the seven painters; reviewed the PSNS medical records of these seven painters and one additional painter; and interviewed five of the eight painters (one was retired, one was on leave, and one was unavailable for interview).

V EVALUATION CRITERIA

A. Environmental Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. Often the NIOSH recommendations are lower than the corresponding OSHA standards,

i.e., 2-Ethoxyethanol. The NIOSH recommendations are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational disease.

The 8-hour time weighted average permissible exposure level for 2-ethoxyethanol is 200 ppm. The American Conference of Government Industrial Hygienist's Threshold Limit Value is 50 ppm with a recommended reduction to 5 ppm. NIOSH urges employers to voluntarily assess how their workers may be exposed to 2-ethoxyethanol and to reduce exposure to the lowest extent possible.

B. Toxicity and Medical Criteria

Glycol Ethers

The glycol ethers (2-methoxyethanol [2ME] and 2-ethoxyethanol [2EE]), are widely-used industrial solvents which are miscible both with water and with a large number of other solvents. They have a wide variety of uses in industry because of their versatile solvent properties. Some of these uses include cleaning and thinning agents and coatings such as epoxies, wood stains, varnishes, paints and inks (2).

Glycol ethers, in general, have low acute toxicity when administered in single doses. The liquid glycol ethers can be mildly irritating to the skin and eyes. The vapors can irritate the eyes, nose, and throat, causing burning or itching. But glycol ethers can penetrate the skin or be inhaled without causing irritation, so that irritation is not a good warning of exposure (1,2).

Overexposure to any glycol ether can cause anemia, a low number of red blood cells. Symptoms of anemia may include tiredness, weakness, and shortness of breath, particularly during or just after exertion. Mild anemia often does not cause symptoms but can be diagnosed by having a blood test (1,2).

Overexposure to one of the glycol ethers, 2ME, has caused central nervous system (brain) effects in workers. The symptoms included confusion, tiredness, loss of appetite, loss of weight, headache, nausea, vomiting and trembling hands. These symptoms were greatly improved when exposure was reduced or eliminated (1,2).

Both 2EE and 2ME caused serious birth defects in the offspring of test animals exposed during pregnancy. In addition, these two ethers injured the testes and sperm of exposed test animals, damage that can result in infertility. These birth defects and testicular damage occurred at levels near the permissible exposure level for workers. The animals showed no other evidence of harm that might give a warning of overexposure. There is no information on whether or not these chemicals affect the human reproductive system (1,2,3).

There is insufficient information available at the present time to enable an assessment of the cancer producing potential of the glycol ethers (2).

Nasal Bleeding

Probably the most common cause of nosebleed is nose picking, leading to tearing of the rich network of veins in the front part of the nose. Minor nosebleeds may also appear in the course of viral infections of the upper respiratory tract. Several bacterial infections may be accompanied by nosebleeds. In addition, there are several other causes of nosebleed, including low humidity in the air, hypertension, bleeding disorders, acute sinusitis, especially involving the ethmoid sinus, and tumors of the nose and paranasal sinuses. Episodes of bleeding or the severity of attacks are frequently increased in people taking aspirin (3).

Some compounds encountered in the occupational setting have been associated with acute nosebleed. They are usually chemicals that irritate and damage the lining of the nose, particularly caustic materials, such as strong acids and bases. Additional compounds associated with acute nosebleed include: beryllium, oxalic acid, selenium, vanadium; and those associated with chronic nosebleed include: benzene, carbon tetrachloride, proteolytic enzymes, hexamethyl-pararosaline, phosphine, phthalic anhydride, tetranitromethyl aniline, tetryl, trimethyl benzenes, and xylenes (4).

Rectal Bleeding

Small amounts of bright red blood on the surface of the stool and toilet tissue are often caused by hemorrhoids, which are very common in the adult population; such bleeding is generally precipitated by the strained passage of hard stool. This bleeding is usually mild and intermittent. However, a rare patient may have such prolonged and

massive bleeding as to develop an iron-deficiency anemia. Bleeding is a more common symptom of hemorrhoids than is pain (5). Anal fissures and fistulas may also be accompanied by bleeding. In addition to these common sources of rectal bleeding, several other causes exist which are associated with problems in other parts of the small or large bowel. These problems include colonic polyps, inflammatory bowel disease, colonic diverticula, and cancer of the colon.

It is unlikely that a chemical encountered in the workplace would produce rectal bleeding.

VI RESULTS AND DISCUSSION

Review of the medical records and medical interviews revealed that three painters had episodes of rectal bleeding; two had episodes of nasal bleeding; and three had episodes of both rectal and nasal bleeding. Onset of bleeding is depicted in Figure 1.

Most of the episodes of rectal bleeding lasted 1-3 days, and the number of rectal bleeding episodes ranged from one to several intermittent episodes extending over a few months. At present none of the painters reports any bleeding. Most described the presence of blood on the stool or on toilet paper, although there was one description of the blood in the toilet bowl water. Physical examination revealed hemorrhoids in three of the four who were examined, and this was felt to be the most probable source of bleeding in these three. Physical examination in the fourth painter, done two months after the bleeding episode, showed minor irritation of the crypts, but no active bleeding. In the two others, the examining physicians felt that the rectal bleeding was secondary to nosebleeds in one painter and that no determination of the source of bleeding could be made in the other due to the interval between the bleeding episode and the exam. It is unusual to find bright red blood in the stool as a result of a nosebleed unless a significant amount of blood is swallowed and it passes through the digestive tract rapidly. Thus, it is unclear to NIOSH whether the explanation given above can account for the blood in this painter's stool.

Of the five painters reporting nosebleeds, two had a single episode. The other three had recurrent, intermittent bleeding over a period of a few weeks. One of these was treated with cautery.

Several of the painters noted that in the course of painting, particularly when painting the interior of a ship, their gloves and coveralls frequently became saturated with paint. Their hands and/or skin elsewhere on their body were thus exposed to the paint and solvents with the potential for skin absorption.

VII SUMMARY AND CONCLUSIONS

Neither the temporal occurrence of bleeding, probable etiology of bleeding, nor the known toxic effects of 2EE suggests that the episodes of rectal bleeding in the six painters at PSNS were caused by exposure to 2EE.

The irritant properties of 2EE may have contributed to the nosebleeds in some of the workers if they were exposed to the vapors during work. However, since supplied air respirators were reportedly used by all the painters, significant inhalation exposure to the vapors is unlikely. It seems more probable that drying of the nasal mucosa, secondary to either the weather or respirator use, or minor trauma to the nasal mucosa caused the nasal bleeding episodes. Thus, NIOSH does not feel that the observed bleeding resulted from exposure to 2EE at PSNS.

NIOSH recommends that 2-ethoxyethanol (2EE) be regarded in the workplace as having the potential to cause adverse reproductive effects, including teratogenesis. Exposure should be limited to only those workers essential to the process or operation, and workplace exposure levels should be minimized. Less hazardous solvents should be substituted where practicable. Because there have been several studies that reported reproductive effects as a result of skin absorption, every effort should be made to eliminate skin exposure.

In a letter to NIOSH from the Director of Occupational Safety and Health, PSNS, dated July 22, 1983, it was stated that "because Shop 71 is not satisfied with the 2-ethoxyethanol thinner that there would be no problem in switching from 2-ethoxyethanol to high flash naphtha." On December 2, 1983, both the union and the PSNS industrial hygienist confirmed that 2-ethoxyethanol is no longer used and in the future would only be used in an emergency.

VIII RECOMMENDATIONS

1. If bleeding recurs or new bleeding appears, painters should immediately see either a plant physician or their personal physician. If they see their personal physician, the plant physician should be notified so that a record can be kept in a central location.
2. In light of the potential adverse health effects, and the potential for skin absorption, worker exposure to 2EE should be controlled. There are four basic methods of limiting worker exposure to 2ME and 2EE, none of which is a simple industrial hygiene or management decision. Careful planning and thought should be used prior to implementation. These are (6):

a. Product Substitution. The substitution of an alternative material with a lower potential health risk is an important method for reducing exposure. Extreme care must be used when selecting substitutes. Although the test results for some structurally related glycol ethers reported in this bulletin seem to suggest less hazardous compounds, the testing is not yet sufficient to identify a glycol ether substitute for 2ME and 2EE. Possible health effects and potential exposures of alternatives to 2ME and 2EE should be fully evaluated prior to selection.

b. Contaminant Controls. Airborne concentrations of 2ME and 2EE can be most effectively controlled at the source of contamination by enclosure of the operation and use of local exhaust ventilation. Guidelines for selected processes and operations can be found in NIOSH's Recommended Industrial Ventilation Guidelines (36). When enclosing a process or operation, a slight vacuum should be used to create negative pressure so that leakage will cause external air to flow into the enclosure and minimize contamination of the workplace. This can be accomplished with a well-designed local exhaust ventilation system that physically encloses the process as much as possible, with sufficient capture velocity to keep the contaminant from entering the workplace atmosphere. The design of ventilation systems should take into account the reactive characteristics of 2ME and 2EE.

Ventilation equipment should be checked at least every three months to ensure adequate performance. System effectiveness should also be checked soon after any change in production, process, or control that might result in significant increases in airborne exposure to 2ME and 2EE.

c. Worker Isolation. If feasible, workers may be isolated from direct contact with the work environment by the use of automated equipment operated from a closed control booth or room. The control room should be maintained at a greater air pressure than that surrounding the process equipment so that air flows out of, rather than into, the room. This type of control will not protect workers who must perform process checks, adjustments, maintenance, and related operations. Therefore, special precautions are often necessary to prevent or limit worker exposure in these situations and frequently involve the use of personal protective equipment.

d. Personal Protective Equipment. Personal protective equipment, which may include goggles, gloves, coveralls, footwear, and respirators, should not be the only means of preventing or minimizing exposure during routine operations. Since 2ME and 2EE can penetrate the skin, personal protective clothing and equipment should be selected that is impermeable to 2ME and 2EE.

IX REFERENCES

1. Hazard Evaluation System and Information Service, Hazard Alert: Glycol Ethers. Berkeley, California, 1982. Hazard Evaluation System and Information Service, State of California, Department of Health Services/Department of Industrial Relations.
2. Hazard Evaluation System and Information Service, The Toxicity of Glycol Ethers. Berkeley, California, 1982. Hazard Evaluation System and Information Service, State of California, Department of Health Services/Department of Industrial Relations.
3. Isselbacher, KJ and Popp, JW. Chapter 38: Hematemesis and Melena. From Principles of Internal Medicine, Ninth Edition, Edited by Isselbacher et al.
4. Daugaard, J. Symptoms and Signs in Occupational Disease: A Practical Guide. Copenhagen, Munksgaard (Year Book Medical Publishers) 1978, page 21.
5. Spiro, HM. Clinical Gastroenterology. New York, MacMillan 1970.
6. NIOSH Current Intelligence Bulletin 39. May 2, 1983, Glycol Ethers (2-Methoxyethanol, 2-Ethoxyethanol).

X AUTHORSHIP AND ACKNOWLEDGEMENTS

Report prepared by:

Arvin G. Apol
Industrial Hygienist

Roy G. Parrish, M.D.
Medical Officer
Medical Section

Originating Office: Hazard Evaluation and Technical
Assistance Branch
Division of Surveillance, Hazard
Evaluations and Field Studies

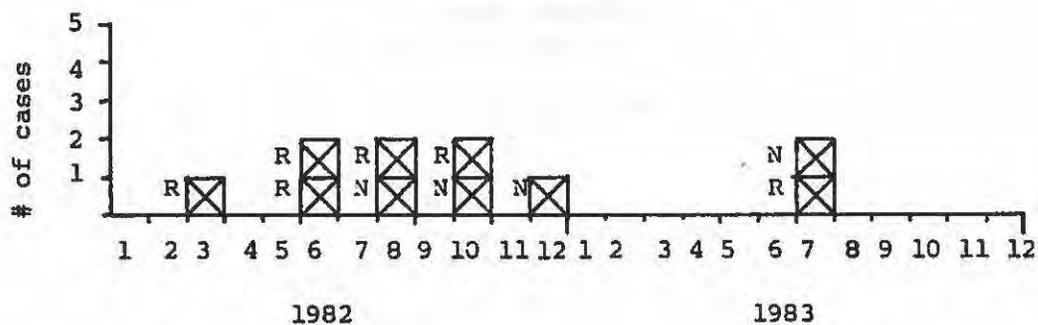
XI DISTRIBUTION AND AVAILABILITY OF REPORT

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 the NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Puget Sound Naval Shipyard, Bremerton, Washington.
2. National Trade Council, Bremerton, Washington.
3. U. S. Department of Labor, Occupational Safety and Health Agency (OSHA), Region X, Seattle, Washington.

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.

Figure 1. Onset of Bleeding Episodes. Shop 71,
 Puget Sound Naval Shipyard, Bremerton, Washington,
 1982-1983. (N = Nosebleed; R = Rectal Bleeding)



DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
ROBERT A. TAFT LABORATORIES
4676 COLUMBIA PARKWAY, CINCINNATI, OHIO 45226

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE. \$300

Third Class Mail



POSTAGE AND FEES PAID
U.S. DEPARTMENT OF HHS
HHS 396