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BEACON BOWL
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I. SUMMARY

On September 23, 1988 the National Institute for Occupational Safety and Health (NIOSH) received a request from the general manager of Beacon Bowl in Barstow, California, to evaluate possible health effects, specifically dermatological problems, related to the use of a preparation called Uvitex Optical Bleach (OB) (Ciba-Geigy) [chemical name: 2,2'-(2,5-thiophenediyl) bis (5-tert-butylbenzoxazole)], a fluorescent whitening agent (FWA) added to bowling lane dressing oils (lane conditioners) and applied to lane surfaces.

NIOSH investigators conducted an initial survey at the facility on January 18-19, 1989, to interview affected employees and patrons, administer a questionnaire, review material safety data sheets (MSDSs), and obtain information on the use of Uvitex. During the initial survey ten of 14 individuals complained of a work-related or bowling-related skin rash.

A NIOSH medical officer and a consulting dermatologist returned to the facility on January 22-26, 1990, to interview affected employees, administer a questionnaire, conduct skin patch testing, and to examine the skin of affected employees. Six of 24 individuals complained of a work-related skin rash. In the opinion of the consulting dermatologist, none of the observed conditions were consistent with contact dermatitis. Of the 24 individuals who had undergone skin patch testing, none had shown any reaction to three concentrations of Uvitex.

Although certain individuals may be susceptible and develop skin sensitization to FWAs such as Uvitex, there was no evidence that such reactions occurred during the course of this investigation. The investigation did not resolve the issue of whether there were chronic health effects from exposure to this FWA, although there are no documented chronic health effects from other uses of similar FWAs. The investigators recommend that employees working directly with Uvitex, and employees that develop skin reactions to Uvitex, use protective gloves to prevent direct contact with Uvitex.

KEYWORDS: SIC 7933 (Bowling alleys)
Uvitex Optical Bleach (OB), 2,2'-(2,5-thiophenediyl) bis (5-tert-butylbenzoxazole)], fluorescent whitening agent, bowling lane oils, bowling lane dressing, bowling lane conditioners, allergic dermatitis, skin patch testing.

II. INTRODUCTION

On September 23, 1988 the National Institute for Occupational Safety and Health (NIOSH) received a request from the general manager of Beacon Bowl in Barstow, California, to conduct a health hazard evaluation (HHE). Concern had been raised over the possible health effects, specifically dermatological problems, related to the use of a preparation called Uvitex Optical Bleach (OB) (Ciba-Geigy) [chemical name: 2,2'-(2,5-thiophenediyl) bis (5-tert-butylbenzoxazole)], a fluorescent whitening agent (FWA) added to bowling lane oils and applied to lane surfaces.

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III. BACKGROUND

Bowling is a very popular sport in the United States. There are currently over 7 million sanctioned bowlers and over 8000 bowling establishments. Each of these centers employs from 20-60 employees in a variety of jobs ranging from managerial and clerical jobs, to service-oriented clerks and bar/restaurant employees, to workers involved with the upkeep and maintenance of the lanes and the equipment.

Starting January 1, 1988, bowling alleys wishing to retain both American Bowling Congress (ABC) and Women's International Bowling Conference (WIBC) certification, and therefore be eligible to host sanctioned leagues and championships, were required by ABC and WIBC to use a lane oil additive, Uvitex-OB. The additive is used to facilitate confirmation by representatives of the ABC that lane oil was not applied to the bowling alley surface to the advantage of a bowler. In the event of a bowler scoring a 298, 299, or 300 or rolling a total of over 800, in a three game series, the lane is temporarily closed until an ABC representative tests the lane to officially sanction the high score. To test that the lane oil was applied correctly and within the rules of the ABC, a tape laying device is used by the ABC representative. This device lays down a strip of adhesive across the oiled surface of the lane (sticky side down) to capture a layer of the lane oil. Another strip is then laid across (sticky side up) beneath the first layer of tape and a sandwich created, trapping the lane oil between the two strips. This tape strip is then run through a reader that tests the consistency and pattern of the oil application by fluorescence detection.

The mandated use of Uvitex followed a three-month trial conducted in 1986. At that time proprietors mixed the Uvitex-OB with lane oil in a 999 parts per million (ppm) concentration. The concentration of the additive was

ultimately decreased to a premixed solution of 333 ppm.
Proprietors of bowling alleys purchase a premixed solution of the Uvitex and any one of a variety of lane oils sanctioned by the ABC. The premixed solution contains refined mineral oil, the Uvitex, and in some cases up to 20% solvent. The choice of using solvent depends upon preferences of individual proprietors and some establishments, including Beacon Bowl, prefer not to use any solvents in this mixture. Mechanics at the bowling alleys usually pour the Uvitex/lane oil into a lane oil tank and use a wick and roller to apply it. Application of this product is done twice a day for each of the lanes, and the procedure is similar in most bowling alleys. Exposure for the mechanics occurs while they pour the solution into the tanks and during the application. Any further maintenance or cleaning of the bowling lanes or the pin-setting machines brings the workers into contact with already applied material. Furthermore, because of the nature of the lane oils, the mixture is ultimately deposited on shoes, bowling balls, tables, and other surfaces throughout the bowling alley, exposing all workers to Uvitex.

Beacon Bowl began using the additive in 1986 during the trial period. At that time one individual developed skin problems characterized by skin cracking/dryness/bleeding and a skin rash. Although the dermatologic problem resolved after the three-month trial period, the employee did not associate the use of the additive with the skin complaints. When Beacon Bowl began using the additive in early 1988, the individual's previous skin complaints returned. Skin patch testing using both the Uvitex and oil mixture and plain oil, conducted by a local physician in April 1988, reportedly indicated skin sensitization to the Uvitex mixture.

At that time, Beacon Bowl employed 26 people, four of whom were mechanics having direct contact with the Uvitex mixture. Of this group, one mechanic had complaints of skin problems but did not seek medical attention. At least 14 patrons had complained of a variety of ailments since the introduction of the Uvitex, including skin problems and eye irritation. From April 1988 to August 1989, Beacon Bowl refused to continue to use the additive. To regain the lost ABC and WIBC sanctioning, Uvitex was re-introduced into the bowling alley on August 7, 1989 and is currently being used.

IV. METHODS

Phase One

Phase One was conducted by a NIOSH industrial hygienist and a medical officer, and took place on January 18-19, 1989, after Uvitex was withdrawn from use at Beacon Bowl. During the initial site visit, information was obtained on the use of Uvitex and on health problems thought to be related to the use of this product. Observations were made of the oil application and stripping processes, and material safety data sheets (MSDS) were reviewed for several oil formulations, as well as for other products used at this facility.

At that time, a medical questionnaire was distributed to employees to obtain information on work history, work practices, and work-related medical problems. Also, a survey of patrons bowling in the morning league and evening leagues was conducted. The medical officer conducted personal medical interviews with several individuals who had a possible bowling-related medical problem. The officer also conducted a review of medical records at the office of a local physician who had examined three of the employees.

Phase Two

Phase Two was conducted on January 22-26, 1990, after the re-introduction of Uvitex. At that time a NIOSH medical officer and a consulting dermatologist returned to repeat a medical questionnaire, to seek out individuals with skin complaints, and to obtain full medical histories and examine the skin of affected workers. Skin patch tests were conducted to determine if allergic or irritant skin reactions occurred with exposure to bowling lane oils and a variety of concentrations of Uvitex.

The skin patch test is used to identify specific chemicals responsible for allergic contact dermatitis. Employed for almost a century, the patch test has become widely used, mostly by dermatologists. When appropriately interpreted, patch test reactions are acceptable as "scientific proof" of a substance being the cause of dermatitis. The opportunity to select the site of application and the ability to use only a minute quantity of test substance and confine it to a small area are the most important advantages of patch testing. However, the test does not completely duplicate actual exposure, in which sweating, friction, and multiple exposures may play important roles.

Under the direction of the consulting dermatologist, who was experienced with skin patch testing, five skin patch tests were applied to the upper backs of 24 employees. The skin patch tests included: 0.01% Uvitex in petrolatum (Uvitex-P), 0.03% Uvitex-P (equal to the 333 ppm solution used in the bowling alleys as mandated by the ABC), 0.3% Uvitex-P, Respond Lane Oil (oil and 333 ppm Uvitex) and Bensoil (oil alone). A small amount of the substance was put into an 8-mm diameter aluminum cup (Finn Chamber) containing a filter paper disc, which became saturated with the substance. This holding device was then applied to the skin of the back using non-allergenic tape. The placement of the substances tested was recorded by the dermatologist.

The patch test cup and tape were checked for placement 24 hours after being applied. They were removed 48 hours after placement and the results interpreted by the dermatologist. Because some tests turn positive after an additional period, another reading took place 24 hours after test removal (72 hours after application).

At each test reading, it is common practice to note the result as negative or positive, and grade the positive results on a quantitative scale. The International Contact Dermatitis Research Group has recommended a 1+ to 3+ scoring system with 1+ representing erythema (redness) and edema (swelling), 2+ showing vesicles (small blisters), and 3+ being a severe reaction with bullae (large blisters). A doubtful reaction, showing only erythema is indicated as '?'. The important point in evaluating a positive test response is to determine whether this is a true positive reaction caused by allergy, or a non-specific irritant reaction (denoted by IR). Irritant reactions usually do not spread from the test site and typically decrease in intensity from the earlier to the late reading. Still, the distinction between an allergic and irritant reaction can be very difficult to make.

One individual with a past history of skin sensitization underwent a modified regimen. Only three skin patch tests were applied: 0.01% Uvitex-P, Bensoil (oil alone), and a skin lotion. The results were recorded at 48 hours.

Participation was by informed consent. Participation was limited to adults 18 years of age or older who were currently employed at the Beacon Bowl. Each study participant was notified by personal letter of his/her test results.

V. RESULTS

Phase One

The questionnaire was completed by 14 of 26 employees (54%). This group included the full range of job descriptions at Beacon Bowl and included nine females and five males in the age range 25 to 49 years (mean age 38). Of this group, 13 (93%) were also league bowlers. All 14 individuals experienced symptoms during the period January 1, 1988 to January 18, 1989, that they felt were work-related. These symptoms included: headache (12 people); skin rash (10); eye irritation (10); nose irritation (8); joint pains (8); abdominal discomfort (3); hives (3); and breathing difficulties (2). Except for three complaints of a skin rash which occurred daily, and one complaint of a headache, which also occurred daily, the other symptoms were described as occurring intermittently in the workplace. Seven individuals experienced their symptoms only in the workplace and did not have the symptoms while at home after work, during the weekends, or during vacations. The rest (7) also experienced their symptoms during time periods away from work.

Nine individuals complained of a work-related skin rash and one individual complained of a skin rash related only to bowling. The rash was described as red and itchy, sometimes with scaling and bleeding, sometimes with bumps and sores. The location of the rash varied, but common sites included: face, neck, chest, arms, palms, and fingers. All ten individuals described the onset of the rash as occurring in 1988. Six of these employees had a history of previous allergies. All described improvements in their skin problems after Uvitex was removed from Beacon Bowl.

Of 160 bowlers who had bowled in the morning and late evening leagues on January 18-19, 130 (81%) were personally surveyed with a short set of questions. The questions sought out information on complaints of bowling-related medical problems and skin problems in the previous year. In addition, two patrons not bowling on these days were also surveyed. Of this group of bowlers (132), 11 people (8%) described having a skin rash that they felt was bowling-related.

Phase Two

A. Questionnaire

The questionnaire was completed by 24 of 26 employees (92%). This group included the full range of job descriptions at Beacon Bowl and included 14 females and 10 males in the age range of 20 to 50 years (mean age 34). Of the 24 participants, 17 (71%) were league bowlers. Sixteen individuals (66%) experienced symptoms during the period January 1, 1989 to January 22, 1990, that they felt were work-related. These symptoms included: headache (11 people); eye irritation (10); joint pains (8); skin rash (6); nose irritation (5); abdominal discomfort (5); hives (3); breathing difficulties (3); and wheezing (2). Four complaints of a skin rash, three of joint pains, one each of headache and abdominal discomfort occurred on a daily basis. The other symptoms were described as occurring intermittently in the workplace. Six individuals experienced their symptoms only in the workplace and did not have the symptoms while at home after work, during the weekends, or during vacations. The rest (10) also experienced their symptoms during time periods away from work.

Six individuals complained of a work-related skin rash. The rash was described as red and itchy, sometimes with scaling and bleeding, sometimes with bumps and sores. The location of the rash varied, but common sites included: face, neck, chest, arms, palms, and fingers. In three individuals who had participated in Phase One, the rash had been a problem since 1988. The other three employees were hired after Phase One was completed. Two of these three had similar skin complaints prior to being hired at Beacon Bowl. Four of the six individuals had a history of previous allergies.

Of the 24 participants in Phase Two, 10 had also participated in the questionnaire portion of Phase One. Of the four who participated in Phase One but did not participate in Phase Two, two had left the workplace (none of these for work-related medical complaints), one only worked intermittently and was unavailable at the time of Phase Two, and one was still employed but did not participate in Phase Two. A comparison of the ten individuals who had taken part in both phases of the investigation showed that in Phase One, eight had skin complaints that they associated with work and/or bowling. In Phase Two, three continued to complain of skin problems.

B. Physical exams

Of the six individuals who had skin complaints, four felt they had current skin problems. These individuals underwent a more thorough medical history and a skin exam. The findings included:

1) fine follicular (associated with hairs) rash on extensor surfaces of both forearms and on dorsum (back) of both hands;
2) scattered fissures near the nailbeds of the fingers;
3) erythematous macules (flat red areas) on forearms and buttocks; and
4) mild erythema of dorsum of hands.

In the opinion of the consulting dermatologist, none of the observed conditions were consistent with contact dermatitis.

C. Skin patch tests

Of the 24 individuals who had undergone skin patch testing, none had shown any reaction to the three concentrations of Uvitex-P. One individual developed slight erythema (graded as '?') to both lane oils (one containing Uvitex, the other without Uvitex). One individual, with a prior history of urticaria (hives), developed generalized urticaria approximately 30 minutes after skin patch placement. However, this was not related to the patch test and the patch test was negative.

VI. DISCUSSION

According to the manufacturer, the fluorescent whitening agent (FWA) Uvitex-OB is an odorless crystalline powder sold primarily for use in plastic products as an optical brightener. It has been reviewed by the Food and Drug Administration (FDA) and is regulated in several plastics which can be used as food packaging. During FDA's safety assessment, it was determined that the dietary intake from these uses would be about 0.15 mg/day/person, mainly from Uvitex-OB migrating into the food. FDA does permit use of this chemical as an "indirect food additive", as a component of adhesives (Title 21 Code of Federal Regulations (CFR) Section

175.105), and as a colorant for polymers (21 CFR 178.3297) under certain specific conditions of use. It is also used as a quality control agent in pesticide formulations and can be applied to growing crops at no more than 10 ppm (21 CFR 182.99). The recent use of the chemical in the bowling industry does not fall under the regulatory jurisdiction of the FDA.

Uvitex-OB is not considered to be a hazardous chemical under the Federal Occupational Safety and Health Administration (OSHA) Hazard Communication Standard. Under this standard, a concentration of 0.03% (333 ppm) would not require that this component be listed on material safety data sheets (MSDSs) of premixed bowling oils.

A warning on the MSDS distributed by the manufacturer (Ciba-Geigy) for pure Uvitex, notes that:

"This material will not be sold for use in products for which prolonged contact with mucous membranes or abraded skin, or implantation within the human body, is specifically intended. Because of the wide range of such potential uses, Ciba-Geigy Corporation is not able to recommend this material as safe and effective for such uses and assumes no liability for any such uses."
The MSDS also recommends the use of protective clothing while handling this chemical, but this recommendation is based upon cosmetic concerns (i.e. the strong fluorescence under ultra-violet light) rather than perceived health concerns.

The toxicity of Uvitex-OB was reviewed by the State of California, Department of Health Services, Community Toxicology Unit, at the request of the Orange County Health Department in August and October of 1986. Their review of studies done with this material concluded that Uvitex-OB has very low acute and chronic toxicity, is not teratogenic (the potential of causing birth abnormalities as a result of an effect on the fetus), is not a skin or eye irritant, is not a skin sensitizer or photosensitizer, and is not carcinogenic at the dose levels administered to two species of rodents. They asserted that the product is lipophilic (settling in fatty tissue), as evident in the physical/chemical data and the presence of fluorescent deposits in body fat and eyes of treated laboratory animals. They also calculated that if a 40-kg person were to absorb 100% of two daily applications of Uvitex applied onto one bowling lane every day, the dose would be 65.3 mg, or 1.6 mg/kg/day, assuming the use of 4 ounces of brightener per application.

Testing done by Ciba-Geigy showed that at doses of 50 mg/kg/day, in the one-year feeding study of mice, there were no differences from control animals. In the two-year feeding study of rats, there was slight liver enlargement noted without any change in liver histology. In skin irritation and skin sensitization studies carried out in laboratory animals at a 0.1% suspension in saline, no effects were seen. No evidence of irritation or sensitization was observed in 102 human subjects who were skin patch tested for 48 hours with 0.5 and 1% Uvitex-OB in white soft paraffin, and challenged with another patch application 2 or 3 weeks later.[1]

The toxicity of other FWAs has been well-studied, since these chemicals are widely used in the soap and detergent industry and in textile finishing. In these uses, skin compatibility is of practical interest. A variety of 11 FWAs were tested in a group of six volunteers, using a 1% preparation and a contact period of 24 hours. Of this group, one person had a positive reaction to one of the FWAs. In another study, eight different compounds were tested in a group of 70 volunteers in 0.5 and 1% preparations for contact periods of 24 and 48 hours. A positive reaction was observed in only a single case. Also, the FWA preparations were applied to the same area of skin (20 volunteers) on seven consecutive days, and no skin reaction was observed. Four other compounds were studied in a similar manner, using a 2% preparation in paraffin, applied in a patch test in 200 people. There were no positive skin

reactions observed. Another study had tested 2000 persons for hypersensitivity to FWAs. A very small number of cases had hypersensitivity, but no symptoms of manifest allergic or eczematous reactions were observed.[2]

VII. CONCLUSIONS

Of the variety of work-related symptoms experienced by the employees at Beacon Bowl, most were also experienced away from the workplace. Therefore, it is unlikely that all of these symptoms were related to the workplace. Headache, nose and eye irritation, breathing difficulties, and wheezing may have been related to the cigarette smoke-filled environment observed at Beacon Bowl. The other symptoms of joint pains and abdominal discomforts are more difficult to explain as being work-related.

In terms of exposure to Uvitex, we conclude that, at present, there is no evidence that Uvitex poses an acute health threat to workers employed in bowling establishments. Although other investigations[2] have shown that certain individuals may be susceptible and develop skin sensitization to FWAs such as Uvitex, we had no evidence of such reactions occurring during our investigation. A prior positive skin patch test, conducted by a local physician, did not follow the protocol of the International Contact Dermatitis Research Group and therefore is difficult to interpret.

At present there is no evidence of any long-term health effects from Uvitex. However, there is insufficient data regarding the toxicologic properties of Uvitex used in this unique application as an additive in lane dressing oils. This investigation did not resolve the issue of health effects of chronic exposure to this FWA. But, laboratory animal studies with FWAs have shown no chronic health effects from similar FWAs.

VIII. RECOMMENDATIONS

1. Certain individuals may be susceptible to Uvitex and could conceivably develop an allergic dermatitis. For such employees, and for employees working directly with the Uvitex/lane oils, we recommend the use of protective gloves that will prevent direct contact.

2. Several employees complained that they were experiencing a variety of irritative effects (eye irritation, nose irritation, and throat irritation) as a result of the cigarette smoke-filled atmosphere. Exposure to second-hand smoke has been documented to adversely affect the health of those exposed. We believe that all workers are entitled to a smoke-free workplace.

3. The use of the additive Uvitex-OB in bowling establishments has become a matter of concern to many employees. Although we have not found that Uvitex is an acute health hazard, many questions regarding chronic effects cannot be adequately addressed. This concern over safety in the workplace is detrimental to a comfortable work environment. If this concern is widespread throughout the industry, a program of employee education regarding Uvitex, the use of a less controversial substitute for Uvitex, or a change in the system of verification of lane oil conditions should be discussed among bowling lane proprietors and the sanctioning bodies (ABC and WIBC).

IX. REFERENCES

1. Ciba-Geigy Toxicology Data, Department of Product Safety, Ardsley, New York, June 1980.

2. Gloxhuber-C, Toxicologic Properties of Fluorescent Whitening Agents, Toxicology Annual, Vol 3, Winek, C.L. (editor), pgs 171-203, 1979.

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are temporarily available upon request from NIOSH, Hazard Evaluation and Technical Assistance Branch, 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 Publication Office at the Cincinnati address. Copies of this report have been sent to:

1. Beacon Bowl, Barstow, California
2. Bowling Headquarters (ABC and WIBC), Greendale, Wisconsin
3. OSHA, Region X

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.