

UNCLASSIFIED

AD NUMBER
AD862165
NEW LIMITATION CHANGE
TO Approved for public release, distribution unlimited
FROM Distribution authorized to DoD only; Administrative/Operational Use; JUN 1960. Other requests shall be referred to Army Edgewood Arsenal, MD 21010.
AUTHORITY
USAEA ltr, 1 Mar 1972

THIS PAGE IS UNCLASSIFIED

CWL Tech. Memo. 24-50,
Copy 7

AD-8621651

CWL TECHNICAL MEMORANDUM 24-50

INTERIM REPORT OF CS EXPOSURES IN PLANT WORKERS

by

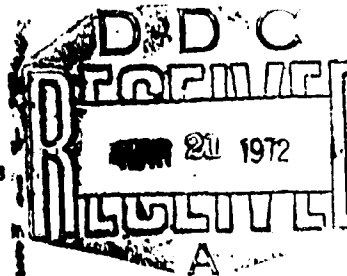
Malcolm B. Bowers, Capt, MC
Edmund J. Owens
Charles L. Punte

June 1960

REVIEWED FOR CLASSIFICATION
AUG 29 1960 *R-*
(Date) (Initials)

"The information in this memorandum is issued for temporary or limited use only, and it may be superseded".

Directorate of Medical Research
U. S. Army Chemical Warfare Laboratories
Army Chemical Center, Maryland



APPROVED:

David B. Lindsey
DOUGLAS LINDSEY, Lt Col, MC
Director of Medical Research

PROPERTY OF U. S. ARMY
CHEMICAL RESEARCH AND
DEVELOPMENT LABORATORIES
TECHNICAL LIBRARY
ARMY CHEMICAL CENTER
MARYLAND

BUILDING 355

STATEMENT #4 UNCLASSIFIED
Each transmittal of this document outside the Department of
Defense must have prior approval of _____
CO Army Edgewood Arsenal
attn: SMITH - TST1
Edgewood Arsenal, Md. 21010

INTERIM REPORT OF CS EXPOSURES IN PLANT WORKERS

INTRODUCTION

The Toxicology Division has been asked to investigate reported dermatological complications suffered by workers manufacturing and processing CS. The following remarks concern the results of this investigation.

METHODS AND SOURCES OF INFORMATION

Three sources of information were available to those who looked into this problem.

(1) Fourteen (14) forms, DA-1051 (Employees Notice of Injury or Occupational Disease) were filed by workers handling CS in Buildings 503, 605, and 58 at Edgewood Arsenal from April 1959 through February 1960. Each of these workers was interviewed by a medical officer and detailed notes were taken regarding number of reactions to CS, type and severity of reactions, time from actual exposure to onset of reactions, protective devices used*, specific type of employment engaged in when the reaction was noted, therapy given, and past history of dermatologic and/or allergic disease.

(2) A tour of the three buildings was made by the Authors. The various processes in use in manufacturing and preparing CS munitions were seen first hand. Changes that had been made to protect the workers since the onset of dermatologic reactions were pointed out by the foreman of the buildings.

* A list of the official names of the clothing items worn by workers is included in the Appendix.

(3) A report¹ previously submitted by Dr. Van Sim concerning reactions to CS suffered by workers in Chemical Warfare Laboratories and at Edgewood Arsenal was reviewed and the findings of this investigation were discussed with Dr. Sim.

The findings from the above three sources will be discussed in order.

A. Interview with Workers Submitting Forms DA-1051

1. C.H. is a 45-year old negro male. He submitted three accident claims while working with CS. In April of 1959 he was employed mixing CS and pyrotechnic ingredients. The process involved unavoidable exposure to CS dust. Clothing consisted only of fatigue clothes, protective mask, boots, and cotton gloves. He noted a pruritic papular rash about the wrists and neck after about two weeks of working in this capacity. He was treated at the Station Dispensary with antihistaminic cream and experienced minimal further discomfort.

In May of 1959, the worker returned to the above task. After 2 days he noted a papular rash as before. This rapidly progressed to become a process of extensive vesiculation over the wrists, neck, face, arms, and anterior thorax and abdomen. He spent three weeks in the U. S. Public Health Service Hospital recovering from this episode.

In October 1959, this man was again exposed to CS while loading bursting grenades. After one day in this capacity he developed a papular vesicular eruption about the wrists and neck. He was treated at the Post Dispensary as previously and convalescence was approximately one week.

In February, 1960, he was employed sifting dry CS in an air-supplied suit. He encountered no difficulty until he returned to shut

down some machinery in street clothes. This one-half hour exposure resulted in blisters about the face and neck with swelling of the eye-lids. This man had no past allergic history and had no dermatologic complications in previous work with mustard.

NOTE: This case represents progressive sensitization to a primary skin irritant. His tasks necessitated unavoidable exposure to powdered agent. He was well protected from the agent when the air-supplied suit was used, but the severe degree of prior sensitization resulted in blisters after one-half hour exposure to an atmosphere contaminated with dry agent when he was unprotected.

2. P.S. is a 49 year-old white man. In April, 1959, while working in the manufacturing plant at the centrifuge and drying ovens, he noted a vesicular eruption about the face, neck, wrists, and thorax after three weeks exposure to the agent. The lesions were intensely pruritic. His job at the drying ovens caused constant exposure to dry, powdered CS. He was treated at the Station Dispensary with ointment. The lesions healed after forming large eschars.

In September, 1959, while working at the hydraulic press packing burning-type grenades, he developed a generalized papular rash after two day's exposure. The rash persisted despite local treatment and was intensely pruritic. He later developed vesicles and several wheals. He was treated with oral antihistamines and local care to the blisters. He may have had a low grade fever. Protective clothing used was only as mentioned above. Since this time he has not worked in a CS environment. He filed a single accident report.

NOTE: This case also represents a case of sensitization to a primary irritant. The second episode seems to have had some characteristic of a serum sickness-type reaction. The jobs mentioned provided unavoidable contact with powdered CS when minimal protective clothing was worn.

3. W.B. is a 45-year old white male who was first exposed to CS in April, 1959. He was grinding and blending the agent at this time. After two weeks at this task he developed a vesicular dermatitis of the wrists. Protective clothing used was identical to that mentioned in the previous cases. He was treated with ointment, and the blisters healed in about one week.

In September, 1959, while employed in the same processes, this man developed hugh blebs over the wrists and anterior thorax and thighs after two days exposure to the agent. Convalescence was three weeks. There was no allergic history.

NOTE: This case seems to represent the same process of initial exposure; sensitization, and a generalized, severe reaction on re-exposure. The hugh blebs that were produced are remarkable. The worker again was involved in a task in which protection was ill-afforded by the clothing worn. Two accident reports were filed by this man.

4. R.S. is a 42-year old white male who noted his first reaction to CS two days after beginning work on the hydraulic press. He felt that increased sweating at this task was contributory to the development of his dermatitis which manifested itself initially as an erythema with vesicles about the wrists. Three months later, having been removed from the CS buildings in the interim, he developed a pruritic rash on his hands while taping and cleaning grenades. This reaction began after one day at the new

job. Again two months later, while working with the micro-pulverized CS, this man developed a bilateral erythematous vesicular eruption of the wrists. Since this time even brief exposure to CS dust causes an exacerbation of a chronic dermatitis of the neck and wrists. He has filed a total of three injury reports.

NOTE: This worker is exquisitely sensitive to CS at present. However, he has never developed a generalized-type reaction manifested by others who are hypersensitive to CS.

5. C.L. is a 53-year old white male who bagged micro-pulverized CS for one month before developing a typical rash with blisters over the face, anterior thorax, and neck. He felt increased sweating pre-disposed to the development of his initial lesion. He wore the usual work uniform including rubber gloves. The critical lesions were treated with an antihistaminic cream and cleared up in one week. After a respite from CS for four months, he was put to work filling bursting grenades. He promptly developed an eruption of the face and neck on the second day. He filed two accident reports.

NOTE: This case again illustrates the process of hypersensitization after an initial contact dermatitis. The tasks in which this worker was engaged were those in which the atmosphere was constantly filled with CS dust.

6. H. F. is a 45-year old white man who developed the usual erythematous vesicular dermatitis after one month's work at the hydraulic press. He also noted that the rash was worse when he perspired. He received the usual treatment, and his lesions resolved uneventfully. Recently he has returned to work with CS in the drying ovens and has had no recurrences of his dermatitis.

NOTE: This man's history illustrates the case of the worker who receives an initial contact burn but who, on re-exposure, doesn't develop a hypersensitive response. This can be explained by a job change with less CS contamination of the atmosphere, improved clothing, individual variation, or a combination of all three.

7. L. N. is a 64-year old white male who developed a local dermatitis of the wrists after two month's work loading CS capsules. He was unable to wear gloves at this job. Since this time he has worked almost constantly with CS in various tasks and has had no recurrences. He has never had to handle dry agent with his bare hands again, however.

NOTE: This man is another example of an individual who has suffered an initial dermatitis from a contact irritant but who has had no recurrences even after extensive re-exposure.

8. J. C. is a 38-year old white man who first developed extensive CS burns after two days of blending the agent while wearing the heretofore usual clothing. These burns were localized to the face, neck, and wrists. Treatment and recovery were as mentioned previously. Four months later this worker again developed localized burns while working at the hydraulic press. He felt that increased perspiration was again contributory to his second episode of dermatitis. The latent period in the second episode was two days. Recently this man has worked for eight weeks manufacturing CS. He handles primarily the reacting precursors and has had no further dermatitis.

NOTE: This man's state of sensitivity is debatable. At least he is very prone to develop the primary localized dermatitis. However, he has been able to continue working in the manufacturing plant due to minimal exposure to dry CS. This man has worked extensively with H and feels that

precautions in working with CS must be at least as rigid if protection is to be assured.

9. and 10. C. B. and O. M. are two further examples of individuals who have a history of one fairly severe localized dermatitis due to CS.—Repeated re-exposures have caused no exacerbations. C. B. reports the only episode in all individuals questioned which could be construed as a generalized reaction of a non-hypersensitivity type. He had headaches and dyspnea for 24 hours after working with very finely ground CS ($5\ \mu$ range). This reaction was quite distressing. Though a single case is difficult to evaluate, the possibility remains that very finely divided agent might pass swiftly through alveolar membranes and lead to the development of a certain blood level of CS and generalized toxic symptoms. Certainly all possible precautions should be taken in working with the finely divided agent.

11. B. O. is the single active case of CS burns seen and treated by one of the authors. A photograph was obtained of his lesions. They were confined to the dorsum of his hands and wrists and to the lateral margins of his nose and adjacent cheek. These seemed to represent areas of contact of rubber gloves and the nose-piece of the gas mask. The eruption was an indurated weeping erythema with several areas of denudation and secondary infection. Pruritus was marked. Treatment was with Burrow's Soaks, antihistamine cream, steroid cream (after closing of the denuded areas), and oral antihistamines. It is too early to evaluate the results of this therapy. The case represents a typical initial contact dermatitis involving a primary irritant.

B. Previous Report of CS Burns

Talking with Dr. Sim, considering his report¹, lead the above case histories to the conclusions that:

- (1) CS is a severe primary irritant
- (2) excessive perspiration at areas of clothing contact predispose areas as sites for the contact lesions
- (3) some individuals develop a hypersensitivity after an initial localized dermatitis and tend to react more rapidly and over a wider area on subsequent exposures.

DISCUSSION OF MEDICAL ASPECTS

In the extensive study by Gutentag, et al.,² it was adequately shown in volunteers that a single application of CS in powdered form or solution to normal skin caused erythema and vesiculation. It was further shown that any type of covering over the area of application made the resultant lesion worse, an air-tight compress being worse than a gauze bandage. Thus, CS is a primary irritant chemical. This is not surprising since many of the toxic gases are primary irritants as mentioned by Schwartz, et al.³ In discussion contact dermatitis Andrews⁴ notes that rarely can circulating antibodies be demonstrated. The process is akin to allergic eczema immunologically and to be differentiated from such processes as asthma, hay-fever, and other wheal-reacting allergies. In susceptible people eruptions may become manifest after periods of protracted exposure. One attack seems to predispose the involved areas so that subsequent outbreaks may be the result of extremely slight exposures. The sensitized area may be localized or generalized, according to Andrews⁴. Some substances known to cause dermatitis among war gas workers are brombenzylcyanide, chloroacetophenone, chlorpicrin, trichloromethane (lacrimators); adamsite (sternutator); chlorine, phosgene (lung irritants); and mustard, lewisite, ethyldichlorarsine (vesicants).

The volunteers in these tests were handled in accordance with the principles, policies, and rules analogous to those established in AR 70-25.

Thus this term "sensitized" is used a bit loosely in discussing these patients. Obviously the shortened latent period prior to developing lesions after each re-exposure is the basis of such a term. However, some individuals seem to continue to manifest only the local response whereas others demonstrate a generalized reaction. Presumably some additional mechanism is at work in the latter case. Examples of both types of reactions plus instances of a single contact episode are illustrated by the case histories.

Heat and humidity at the surfaces of contact are known to increase the likelihood of a contact eruption. Susceptibility of skin to mustard is known to increase under these conditions. This factor was suspected by nearly all workers interviewed.

Negroes are reportedly less susceptible to the dermatotoxic effects of war gases than whites. There was only one negro among our cases whereas there are more negro workers than white at the plant.

Thus, it seems that several factors are involved in any one man's getting a CS dermatitis and in attempting to predict just who will develop a reaction.

The most important factor, as obvious as it seems, is exposure to CS. This means that nearly anyone exposed long enough to this irritant will get a rash. Thus, protective clothing must be optimal especially in areas where the fine dust is a constant threat. CS should not be handled with the bare hands. Supplied/suits are being employed satisfactorily at present. Any process in the working and packaging of CS which can be enclosed would be much less hazardous. An adequate hand cream should be employed. Any process in which a worker has developed an eruption of the hands and neck while wearing

fatigue clothing should be attended by personnel in Supplied Air suits.

Exposure to CS, humidity, and friction seem to aid in development of a dermatitis. Clothing should fit loosely (including gloves and shirt collar). Unless a filtered air, constant temperature-humidity environment can be obtained, supplied-air suits seem to be the next logical step. However, if such suits are ineffective in an operation where there is no temperature and humidity control, it would seem wise to inclose the equipment. In other words, if the agent contaminates the skin trouble will result under certain circumstances. If these circumstances cannot be eliminated, it would seem wise to take further steps to lessen contamination.

Some individuals develop a single local reaction and seem to have no recurrence under conditions of reduced exposure. Others seem to develop repeated local responses with increasingly shorter latent periods between exposure and eruption. A third group seems to develop a more generalized-type eruption, again with progressively shortened latent periods. A priori, it is impossible to detect the two latter groups. Therefore, any persons who have had two local reactions should work at tasks where re-exposure is minimal and protective devices optimal. Indeed, it is recommended that anyone who has had a generalized reaction (classically as in Cases 1 and 3, above) not be allowed to return to work in CS contaminated atmospheres.

Treatment of these lesions is not specific. Astringent, drying soaks should be used during the acute weeping phase. Bacitracin ointment can be used if there is secondary infection. Antihistamine cream can be used, in the acute phases, in between soaks. Oral antihistamine therapy can be added if pruritus is a problem. When vesicles occur, local treatment should be

protective and aseptic. When vesicles dry and induration occurs, hydrocortisone ointment is effective. In the generalized reaction, hospitalization may be necessary to treat adequately all involved areas and properly guard against secondary infection.

TOUR OF THE CS PLANTS

The tour of Buildings 503, 605, and 58 was enlightening in that it was possible to see first hand which processes made the workers more liable to excessive exposure to CS. These processes will be described briefly.

In Building 58, the reactants are mixed and the wet cakes of CS placed into trays to dry. The only liability in this plant is at the drying ovens. Rubber suits with constant air circulation have been provided those men working at the ovens and loading dried CS into drums. At Building 503, CS is sifted and blended with potassium chlorate, thiourea, and magnesium carbonate. In the past, the blending and sifting procedures were particularly hazardous because of the constant contamination of the atmosphere with CS dust. However, air suits have been introduced for these steps and the hazard considerably reduced. In Building 605, several processes are carried out. By far, the most hazardous is the pressing of powdered CS mixture into burning type grenades. The impact of the hydraulic hammer unavoidably dispersed a constant cloud of CS. Supplied air suits have been furnished the four men who work in rotation at this task, with considerable lessening of the hazard. However, Case 11 developed burns while wearing such a suit. He attributed his burns to excessive sweating in the suit when the alternate worker rests for thirty minutes during a shift. Thus, it seems that this operation continues to produce a CS atmosphere which is threatening to workers even

in supplied air suits. At the hoods where starter mix is added to the filled grenades, there have been no problems, evidently because there is no exposure to fine powdered agent. Similarly double-seaming the lids and wiping, taping, and plugging the grenades have caused little trouble except for those who are hypersensitive as described above. The micro-pulverizer is not in use at present but presents a potentially severe hazard for the future. Certainly, supplied air suits should be used in this operation. Finally, the filling of the M-25-A2 bursting grenades has presented little problem. It should be mentioned that in addition to supplied air suits, two other innovations have lessened the possibility of excessive contamination since the majority of the above described cases were reported. First, more adequate hoods with higher air flows have been provided at sites such as in the hydraulic press room and at the starter mixture hood. Also, a double locker room system has been devised at all three buildings. The worker showers in his air suit (if used) and removes the suit in one area. Next, he showers himself after removing contaminated fatigues and underclothes. He then enters a locker room, which is essentially clear of CS, to dress. He wears a clean set of underclothes and a clean fatigue uniform each day.

Some of the workers use West Protective Cream No. 211 (see Appendix) which is antiseptic containing hexachlorophene cream. The workers feel that it washes off easily with minimal perspiration. A tenacious silicone cream has been recommended by Schwartz, et al.³

Building 605 - Cake Pressing - This operation seems to produce more agent dusting than any other production step. The agent blend must be measured and pressed into grenade size cakes, a procedure which requires measuring out quantities of the light powder and hydraulically pressing out

a cake. Although the entire operation is carried out in a fume hood, a considerable amount of material escapes into the room. It is recommended that the present hoods be replaced with a dry-box type hood provided with air-lock feed and exit doors. The operators would work through glove ports to eliminate any personal contact with the agent (and prevent the escape of particles) during the measuring and pressing operations. Production set-ups of this type have proven very successful in the pharmaceutical industry and are designed to permit the operation of heavy machinery through the gloves.

If the operations carried out in Buildings 58, 503, and 605 were consolidated under one roof (Building 503 has an adequate design and sufficient floor space) it is very likely that the CS contamination could be sufficiently limited by employing closed conveyer lines and dry-box work hoods. This would reduce the hazard of agent contact considerably.

Since this report has been written, it has come to our attention that similar dermatological cases have been reported by British workers manufacturing and processing CS.

The exact cause of this dermatitis is to be investigated by both the UK and US on a cooperative basis.

REFERENCES CITED

1. Sim, Van, Unpublished report.
2. Gutentag, Philip J., Joseph Hart, Edmund J. Owens, and Charles L. Punte, The Evaluation of CS Aerosols as a Riot Control Agent in Man, CWLR 2365, April 1960.
3. Schwartz, Louis, et al., Occupational Diseases of Skin, W.B. Saunders, Publishers, Philadelphia and London, 1954.
4. Andrews, G.C., Diseases of the Skin, Lea and Febiger, Publishers, Philadelphia, Pa., 3rd Edition, 1957.

APPENDIX

STANDARD ITEMS OF CLOTHING

FATIGUE UNIFORM (Treated for flame proofing)

Jacket - mens, cotton, herring bone twill, olive green, shade 7,
MIL Spec J-3001A

Cap - field, cotton, olive green MIL Spec C-300A

Trousers - mens, cotton, sateen, 8.5 ounce, olive green, Shade 107,
MIL Spec T-838B

Socks - mens, wool, olive drab, Shade No. 9, with cushion sole,
MIL Spec S-48C

Shoes - safety, low quarter, non-conductor, composition rubber, sweat resistant insole, bonded lining treated against athletes foot, full grain leather under safety toe cap, dacron laces and stitched, plastic heel cups.

GLOVES - rubber, lightweight, industrial, Goodrich 526

GLOVES - cloth, work type, mens, cotton, natural MIL Spec G-1057A

UNDERSHIRT - Cotton, full length sleeves, white, special MIL Spec 2526

SUIT - protective, with air supply connected and built in air circulation system, one piece, detachable gloves, boots and hood permanently sealed, 0.020 vinyl filament. Air supply 5/16 inch diameter plastic tubing, directed to feet, hands, hood; air outlets at legs, chest, back. Corresponds to protective suit No. 2-P, manufactured by Snyder Manufacturing Co., Inc. 1458 5th St., New York, Philadelphia, Ohio.

CREAM - antiseptic by West Chemical Products Inc., US Patent 2535077, West Protective Cream No. 211; contains butylene glycol, zinc stearate, methyl cellulose, hexachloropheno.

MASK - Protective, M9A1.