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SKIN CONDITIONS RESULTING FROM EXPOSURE TO CERTAIN CHLORINATED HYDROCARBONS*

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FOR a number of years there has been sporadic interest in the occurrence of a rather characteristic acneform eruption in workers handling the chlorinated naphthalenes† and diphenyls. Manufacturers of these substances recognized this condition among workers in their factories years ago, and found that the cases could be materially reduced or even completely eliminated by the introduction of adequate ventilation and by the practice of good personal hygiene on the part of their employees.

During the World War when perchloronaphthalene suddenly began to be used in quantity in Germany under the name of "Perna" as a substitute for resin and rubber, large numbers of workers contracted this

type of skin eruption. It was again found that improvement in hygienic conditions in the factory immediately reflected itself in a reduction in the incidence of this disease. German experience along these lines was, however, interrupted when the war came to a close. Since that time, however, there has been a growing demand in industry for the chlorinated naphthalenes and diphenyls wherever resistance to heat and moisture are essential, as for example in the insulation of wire or the manufacture of electrical condensers. The heat and moisture-resisting properties together with the fact that they are non-inflammable, appear to give these materials a unique place among the substances now available for such purposes.

In New York State a number of cases of skin eruptions occurring in workers engaged in the manufacture of electrical condensers have from time to time come to the attention of the Department of Labor, either as sporadic reports or because the workers applied for compensation. In following up these cases it was found that while many of the eruptions

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† The chlorinated naphthalenes are sometimes referred to as "Halowax" by purchasers and users. While the Halowax Corporation manufactures these substances, it also manufactures many others. The term "halowax" is merely a trade name for substances manufactured by this company and should not be used indiscriminately. In all instances substances should be designated by their chemical names only.

appeared to be very mild, causing no disability or serious discomfort, others were very severe--in one such case even involving the deeper layers of the skin and causing permanent facial disfigurement as a result of scar tissue formation. Superimposed infection was also encountered as a serious complication. The investigation further revealed the fact that relatively few physicians appeared to be sufficiently, if at all, familiar with this disease entity, and as a consequence the condition was apparently not always recognized when patients applied to their physicians for treatment. Not only is treatment apt to be misdirected and inadequate under these conditions, but patients are permitted to go on working with these substances even when further exposure is definitely contraindicated because of hypersusceptibility on their part.

It was for these reasons that the present study was undertaken. Here was an occupational exposure believed to be potentially hazardous, concerning which relatively little was known medically. Nevertheless there was reason to believe that it might be satisfactorily controlled by the introduction of proper hygienic measures. It was decided to make the use of these materials safe in the State of New York. To this end a survey was made of the twenty-two plants employing these materials in their manufacturing processes. Three of these plants made insulated wire and the remainder made electrical condensers. Their methods of operation, and their ventilation were carefully appraised and the skin of all workers inspected as they sat at their

work benches. In the case of each factory careful instructions were given as to the safe handling of these substances.

Since all skin eruptions which were reported to the Department of Labor emanated from plants manufacturing electrical condensers, two of these were selected for special study, attention being directed to an examination of the lesions found among the workers and the causative factors involved. On the basis of this it was hoped that an adequate program could be formulated for health maintenance in the industry.

Because the skin condition found among workers in this industry is not sufficiently familiar to the medical profession, special pains were taken to describe it with care, and to point out elements in the picture that would assist in making a differential diagnosis from other skin conditions presenting a similar clinical picture. The differential diagnosis from the acne of adolescence, known as acne vulgaris, was particularly considered because the two conditions resemble one another in many ways. As a background for this study the literature was reviewed and a bibliography compiled.

REVIEW OF LITERATURE

The literature was reviewed principally for information as to previous experience with the use of these materials in industry in relation to the skin eruptions which they produce. In 1934, in an article by Sulzberger, Rostenberg and Sher (1), three cases of severe acneform eruptions due to exposure to certain "waxes" were presented and discussed

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in some detail. These waxes, it was learned by personal communication with the authors were chlorinated naphthalenes.* The fact that one of us (M.G.S.) had the opportunity to examine these cases at the time proved an added stimulus to the present investigation.

Another illuminating contribution along these lines was a bulletin from the Pennsylvania Department of Industry and Labor in 1936, in which Fulton and Matthews (2) presented the results of a study of 101 cases of dermatitis which occurred in a wire insulating plant in their State. In addition to describing the lesions as they found them, they showed that it is possible for a worker suffering from this type of dermatitis to transfer the skin disease to other members of his family through intimate contact with the clothing worn in the factory. Through the courtesy of Dr. Fulton, the authors had the opportunity to see one such worker, his wife and two children, one a young baby, who were all affected by contact with him and his clothes when he came home from work.

As long ago as 1899 Herxheimer (3) accused the halogen, chlorine, of being the direct cause of acne, coining the word "chloracne." Considerable attention was thereafter concentrated on chlorinated substances as the cause of acne. However, it gradually came to be felt that it was not the chlorine that was responsible but that a chlorinated hydrocarbon was to blame in most cases. Tar, mineral oil, vaseline, paraffin and similar hydrocarbons have long been recognized as causative

agents in follicular and acneform eruptions.

The use of a chlorinated naphthalene known in Germany as "Perna" has already been mentioned. When this material came into use again after the war, Teleky (4) described the many cases of skin eruptions that he observed during the years 1926-7. Improvement in hygienic conditions in the factory appeared to be useful in controlling this disease. It was Teleky's final conclusion that the deciding factor as to the potency of any particular chlorinated wax in causing acneform dermatoses depended not so much on its chlorine content as upon the amount of unbound or loosely bound chlorine that it contained. A method was subsequently introduced and patented for so treating the chlorinated naphthalene as to remove all loosely bound chlorine, and it was believed that the incidence of acne in workers exposed to the material was greatly reduced thereby.

Courtois-Suffit, Touraine and Ménétrel (5) in 1934 drew attention to this condition in France in an admirable paper in which they pointed out that the coal products that are most apt to give rise to lesions of the pilo-sebaceous apparatus are those of the second distillation fraction. These writers noted erythematous and vesiculo-edematous symptoms in the workers as well as the acneform type. They believed that seborrhea was a predisposing factor and reported that patch tests with the chlorinated waxes were negative in all cases.

In 1935, Jones and Alden (6) in Atlanta, reported their observations concerning industrial skin eruptions of an acneform type in workers

* Personal communication from Dr. M. Sulzberger.

gaged in the manufacture of chlorinated diphenyls. It was their belief that the eruptions were perhaps due to impurities rather than to the chemicals themselves.

Schwartz (7) in a report on "Dermatitis from Synthetic Resins and Waxes" in 1936 confirmed the reports of other investigators that patch tests with these substances regularly give negative results.

The literature with reference to possible systemic effects from exposure to these chemicals is not considered sufficiently pertinent to the present investigation to be discussed here.

CHEMISTRY AND TOXICOLOGY

Chlorinated naphthalene is a naphthalene in which one or more of the hydrogen atoms has been replaced by chlorine. Thus, there are many chlorinated naphthalenes beginning with the monochloronaphthalene and going up to the octochlor derivative. The chlorinated naphthalenes as used commercially, however, are usually mixtures, each of which contains more than one of the chlorine derivatives. The so-called trichloronaphthalene, for example, which is most commonly used for the impregnation of condensers, in reality contains both the tri and tetra derivatives. Similarly the higher chloronaphthalenes may be used in various combinations. The tetra, penta, and hexachloronaphthalenes are sometimes used in combination with chlorinated diphenyls.

Generally speaking the higher the chlorination, the higher is the melting point of the wax and the more water-proof it becomes. Since resistance to heat and moisture are the outstanding

characteristics of these materials, the higher chlorinations are in great demand commercially. Unfortunately, however, the higher the chlorination of the naphthalene, the more toxic does it become. That is the dilemma which manufacturers of these products are working hard to solve.

Diphenyls are manufactured by passing benzene through molten lead so that C_6H_6 is converted into $C_{12}H_{10}$. Chlorine is then bubbled through, displacing one or more of the hydrogen atoms and forming substitution products ranging from the monochlor diphenyl to the decachlor diphenyl, all of the hydrogen atoms having finally been displaced ($C_{12}Cl_{10}$).

THE PROCESS OF MANUFACTURE

The manufacture of electrical condensers is not carried out in exactly the same way in all factories, but it usually follows the same general lines, depending upon whether the condensers manufactured are of the so-called "Inductive" or "Non-inductive" types.

Winding and soldering.—In making inductive condensers, long ribbons of paper alternating with tinfoil (three sheets of paper with two of tinfoil) are rolled on small spools by winding machines. When the winding is completed the paper is seen to extend out beyond the tinfoil. In this type of condenser ingoing and outgoing metal leads are introduced at right angles to the direction of the winding and the condenser is then impregnated. In finishing condensers of this type, a wire is soldered to each lead by means of a soldering iron.

In winding non-inductive condensers, the tinfoil strips are wider

than the strips of paper, so that when the winding on the spool is completed, the tinfoil extends beyond the paper. Sometimes aluminum foil is used instead of tinfoil. No leads are introduced after impregnation. The soldering of these condensers is done by passing the tin or aluminum foil portions over a hot plate, using a stick of solder to solder on the wires. This process gives off far more fumes than does the soldering of the inductive condensers above described.

Impregnation—After the spools are wound they are placed in wire baskets, several dozen to the basket, which are subsequently put into an enclosed oven in which they are impregnated with one of the chlorinated hydrocarbons. The one most commonly used for this purpose is a combination of trichlor and tetrachlor-naphthalene, a wax-like material heated to a temperature of 248–258° F. After impregnation, the oven is opened, the basket of condensers is removed and immersed in an open vat usually containing mineral oil.

Finishing operation—The basket of condensers is then transferred to a so-called finishing department where workers, mostly young girls, sit at long tables and perform various finishing operations, including what are known as sealing operations and the soldering of metal parts to the condensers.

The sealing of condensers may be done either by dipping them into a small pot containing a molten sealing compound, or by pouring such a molten compound into them. In many plants, including the two which were selected for special study, a pitch preparation was poured into the

condensers to seal them. This did not contain any chlorinated naphthalene. Since this latter material is difficult to pour in the ordinary way because of the ease with which it solidifies on cooling, it is more customary in using this wax to dip the condensers into a pot in which the chlorinated naphthalene is kept at a proper temperature. When it is desired, however, to pour molten chlorinated naphthalene into condensers, an especially designed small closed tank is used, in which the chlorinated naphthalene is kept at a proper temperature. When a key is pressed, the molten wax drops from the tank into the condenser. The higher chlorinated naphthalenes are used in these operations.

The soldering operations have already been mentioned.

In handling the condensers in the finishing rooms, there is constant contact of the hands with the chlorinated naphthalene in its cold wax state, usually somewhat moistened with mineral oil.

All workers engaged in testing finished condensers or employed in any other processes carried on in the "finishing room" are apt to be directly exposed to the vapors of the chlorinated naphthalenes given off in the soldering and sealing operations unless the ventilation of the room as a whole is adequate.

EXAMINATION OF WORKERS

In the present investigation, 13 plants in which a mixture of tri- and tetra-chloronaphthalene was employed in impregnating condensers were studied, and 31 workers examined. 12 of these workers were employed in

so-called "finishing departments" where exposure to the material resulted from flaming the impregnated condensers or otherwise causing a volatilization of the wax.

Ages and duration of employment—The ages of the workers and the length of time that they had been employed in the same plant at the same process are presented in the following tables:

	<i>Number of workers</i>
18-25 years	26
26-30	4
31-40	1
Over 40	0
	31
<i>Duration of Employment:</i>	
Less than 6 months	11
6-11 months	4
1-4 years	15
5 years and over	1
	31

History—In examining the workers the history taken in each case included (1) age, (2) sex, (3) process at which worker was engaged, (4) duration of employment before rash appeared, (5) duration of rash, (6) total employment, (7) family history of acne vulgaris, (8) personal history of acne vulgaris, (9) family history of dermatitis venenata, and other allergic manifestations, (10) whether work with chlorinated naphthalene was resumed, continued without interruption or permanently discontinued after the onset of the skin eruption.

Patch tests—The skin of the workers was carefully examined and finally patch tests were applied with the following substances: (1) potassium iodide 25% in anhydrous lanolin, (2)

potassium bromide 25% in anhydrous lanolin, (3) sodium chloride 25% and 50% in anhydrous lanolin, (4) naphthalene, and (5) mineral oil in use in the factories, with (6) anhydrous lanolin and (7) ammoniated mercury ointment 5%, as controls.

Dermatological Observations

From an analysis of the observations made, the skin conditions appeared to fall into three main categories, as follows:

1. Acneform eruptions with pustules, papules and large comedones.
2. Vesiculo-erythematous eruptions usually observed in dermatitis venenata.
3. Simple erythematous eruptions with pruritis.

In addition, localized dry scaling patches of dermatitis were observed in cases presenting any of the three types of eruptions listed. These patches were never a prominent part of the picture, and were never seen in the absence of one or another type of eruption mentioned. They were less than 5 cm. in diameter, and occurred on the face, neck or arms. Such scaling patches are often associated in the lay mind with eczema, and are frequently seen in all types of patients who complain of any of the longstanding itching dermatoses. They are sometimes at least secondary to friction applied for relief of the itching.

I. Acneform Eruptions.

To the uninitiated the acne which is seen among workers in this industry, and acne vulgaris look very much alike. Their clinical differentiation will be considered later.

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The high incidence of skin eruptions in workers engaged in the manufacture of electrical condensers has not escaped the attention either of employers or of those engaged in the manufacture of the chemicals used in this industry. Consequently there has for years been a concerted effort on the part of all concerned to remedy this situation, and to a large extent this has been accomplished by the introduction of better ventilation into the workrooms. In addition the practice has been followed, particularly in the larger plants, of examining all applicants for employment for any abnormalities of the skin, including the acne of adolescence. Only those with clear skins are ordinarily employed.*

It is not surprising, therefore, when walking casually through plants engaged in the manufacture of electrical condensers, and observing the skin of young men and women sitting at their work benches as carefully as one can under those conditions, to note that the incidence of acne vulgaris appeared to be definitely lower among these young people than what one ordinarily finds in an average unselected group of workers of the same age.

Severe cases—Among the 31 workers whose skins were carefully examined in the present series, there were six (4 females and 2 males) with marked acneform eruptions, showing pustules, papules and large comedones. One had a coexistent dermatitis venenata and was suffering from paronychia, involving the index fingers especially.

* There is an unconfirmed belief among employees in this industry that blondes are more susceptible to skin irritation than brunettes, so that the latter are usually selected for employment whenever possible.

In the case of one young girl examined, the acneform eruption was so severe and had persisted for so long a time that the deep layers of the skin had become involved; and though she was receiving excellent treatment there was marked scarring of the face with resulting permanent facial disfigurement.

An investigation in the case of one girl who contracted a severe acneform eruption in one of the plants studied, but who was not present when the plant examinations were made and so is not one of the series now being reported, revealed the fact that at the site of an itching acneform eruption on the cheek, a furunculosis of the inner aspect of the cheek had developed which, probably due to secondary infection from scratching, went on to septicemia and resulted in her death. The tendency for this type of acneform eruption to develop pustules and even go on to abscess formation has been recognized and reported in the literature.

Mild cases—In four cases the acneform eruption was discernible but was so slight that its presence was noted but not regarded as significant. Along with a few pinpoint papules or scattered comedones on the face there were found a few pinpoint papules surrounding hair follicles around the elbows or on the extensor surfaces of the arms. In none of these cases was there any pruritus. In some instances there was an apparent aggravation of a pre-existing very mild acne vulgaris. The eruption was so mild in these cases that one hesitated to make a definite diagnosis. The distribution of the lesions, however, more than anything else, tended to

suggest a differentiation of these skin findings from a true acne vulgaris.

Distribution of the eruption—The eruption appeared principally on the face and neck and the extensor surfaces of the arms. Sometimes the elbows were also involved, and very occasionally the chest, back and extensor surfaces of the legs. The forehead, cheeks and chin were most often involved, the line along the mandible being a site of special predilection. The eruption appeared there more often than elsewhere, and showed a marked tendency to persist there after it had cleared up elsewhere. It was striking that the nose was almost always spared. The importance of the distribution of the eruption as a means of differentiating it from acne vulgaris will be subsequently discussed.

Description of the lesions—Six of the 31 workers examined suffered from a very severe acneform eruption. In these cases the lesions were mostly pinpoint to pea size, yellow-white or slightly pinkish papules, often distinctly perifollicular and surrounding large comedones. Sometimes an area of closely packed large comedones could be seen without any surrounding reaction. This gave the skin a black spotty appearance. Although pustulation occurred, it was not a prominent feature in these cases. Occasionally there were also some small blotchy areas of erythema present or scaly itching patches.

The workers themselves were especially impressed with the comedones and the itching, so that the rash was rather aptly characterized by them as the "blackhead itch"—a term which they seem to have coined. The itchy character of the eruption was

mentioned by Fulton, but has not been greatly stressed in the literature as a whole. Though not a constant finding it is an important diagnostic sign when present because acneform eruptions as a group are not usually associated with pruritus. Acne vulgaris seldom itches. Four of the workers in this group complained of intense itching.

In one very severe case, the acneform eruption was associated with a dermatitis venenata, and a paronychia which persisted long after the eruption had disappeared. This case will be mentioned later.

Period of exposure preceding eruption—The period of employment before the acneform rash appeared varied from a few weeks to a little less than 1½ years. On the whole cases tended to be more numerous in the summer. On removal from exposure the rash tended to disappear in 2 or 3 months, though in very severe cases it apparently may persist for a much longer period of time.

Family predisposition—Though the cases were few, it was noted with some interest that there appeared to be a family predisposition to exposure to the chlorinated naphthalenes which was not apparently based on a susceptibility to acne vulgaris. For example, three of the workers who were suffering from severe acneform eruptions had sisters or brothers who had had to give up that type of work because of serious skin eruptions. Two of these workers, both girls from two different families, each had two brothers so affected. One of these families was using iodized salt at home because the mother was suffering from goitre. This may have supple-

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chest, though in one case it could also be seen on the extremities. There was no typical acneform eruption in these cases.

In one of the cases the eruption appeared twice—once 6 months and again 1 year after beginning employment—each time clearing up in 2 or 3 weeks. In the second case, the eruption made its appearance 3 months after beginning employment and had a duration of about 1 week.

In both cases the erythema involved the face, neck and extensor surfaces of the arms; and was associated with a severe pruritus. Both workers complained not only of itching at the time of the eruption, but also of intermittent attacks of itching even after the eruption was no longer visible.

Patch tests—As was anticipated in the acneform cases, all of the patch tests performed with the chlorinated naphthalenes in this series gave essentially negative results. This was in accord with the experience of previous workers including that of Dr. Louis Schwartz of the United States Public Health Service.

In the case which was associated with a dermatitis venenata the patch test with the tri and tetrachloronaphthalene (to which the worker was exposed) was positive, as were also the patch tests with the 25% potassium iodide, 25% potassium bromide and the 5% ammoniated mercury. In other words, this worker when seen apparently had a polyvalent sensitivity. The substance with which she had worked was thus only one of many substances to which she was hypersensitive.

Of the two workers who had a

simple erythematous eruption, one refused to be patch tested, and the other was negative.

Mechanism of acne production—Because of the resemblance between the acneform lesions found among these workers and acne vulgaris, the question arose as to whether the same mechanism might not be operative in both conditions. If this were so, one might expect the sporadic cases to break out in those individuals who had already suffered from attacks of acne vulgaris or in whose families there was a predisposition to such a condition. A careful examination of the evidence in this series of cases did not, however, appear to support this conclusion although a more extensive series might throw additional light on the question.

The further question suggested itself as to whether or not a relationship might exist between hypersusceptibility to the chlorinated naphthalenes and a general hypersensitivity to members of the halogen group generally, such as, for example, the iodides, or the bromides. That these latter substances are frequent causes of acneform eruption is well known. The relation of chlorides to the other halogens in these conditions is not entirely clear. It is of interest to note, in this connection, that the chlorides are at present being prescribed by ingestion and injection in cases of iodide or bromide poisoning with a view to mobilizing the other halogens.

Sulzberger, Rostenberg and Sher, as well as other writers, have felt that acne vulgaris may occur as a result of a hypersusceptibility of the pilo-sebaceous system to stimuli ema-

nating from specific circulating endocrine substances. A hypersusceptibility to potassium iodide, if clearly demonstrated by patch tests, might indicate that such individuals had an especially labile pilo-sebaceous system, easily responsive to a number of common insults to the pilo-sebaceous apparatus. It might on the other hand indicate a specific response to insults from members of the halogen family.

Because of these theoretical considerations, all cases studied were patch-tested with an ointment of potassium iodide, and an ointment of potassium bromide. Though the patch tests seemed to indicate a slight increase in susceptibility to these substances among the workers with the acneform eruptions, unfortunately, none of the reactions were sufficiently strong to warrant any definite conclusions on this point.

There is still a question whether the eruption here discussed is due to mechanical plugging of the sebaceous glands in the skin, or whether the sebaceous glands are overstimulated either when end products are circulating in the blood or are being excreted by the skin after absorption of the waxes by the body. That these substances are not excreted unchanged by the skin has recently been demonstrated by feeding experiments conducted by Dr. Cecil Drinker.* He found no increase in the chlorine content of the skin of rats who had been fed toxic amounts of the higher chlorinated naphthalenes. As a final point in relation to the skin lesions, it may be pointed out that no correla-

tion existed between these lesions and systemic effects of any sort. This failure to connect skin and possible liver lesions corroborates the experience of others.

PREVENTION

The process of impregnating electrical condensers has always presented so obvious a health hazard that all effort in the past to protect workers in this industry from injurious exposure to fumes and vapors of the chlorinated naphthalenes has been concentrated at this point. In the early days, condensers were impregnated in the general workroom. Uncovered pots were sometimes used for this purpose and everyone in the plant was more or less exposed to what vapors were given off. The incidence of skin eruptions was high. Nowadays, the impregnating rooms in most plants are completely separated from all other workrooms; the ovens used are, with few exceptions, tightly constructed and well covered; and the incidence of skin eruptions has dropped so low that one rarely sees a case in this department.

It is the very innocuous looking finishing departments which are responsible for most of the cases of skin eruptions one sees. In the dipping, pouring and soldering operations, the chlorinated naphthalenes are volatilized by heating or flaming. Because the fumes are given off in relatively small amounts from a great many different points in the workroom, their importance as a health hazard is apt to escape the attention of the casual observer. Consequently no concerted effort is usually made to correct this situation.

* Private communication.

While each plant has its own special ventilating problems which require special study, the following general principles are applicable to all, and should be carefully adhered to.

Impregnation of Condensers

All impregnating ovens should be enclosed and tightly constructed so that no vapors may escape as a result of leakage.

Each oven should be provided with a hood and equipped with lateral exhaust ventilation so disposed that when the door is opened, the vapors may be immediately exhausted at their source. A velocity of 1000 f.p.m. is recommended.

This process should be conducted in a room which is isolated from other portions of the plant.

Dipping

When the chlorinated naphthalenes are used for sealing condensers, all trays or pots into which such condensers are dipped should be equipped with lateral exhaust ventilation having a velocity of 1000 f.p.m. The higher chlorinations are employed in these sealing compounds, and these are more toxic than are the tri and tetrachloronaphthalene used for impregnation. A hood over the pot, together with upward exhaust ventilation as frequently employed at the present time, is inadequate for the purpose. There should instead be a duct completely surrounding the upper part of the pot through which the vapors are exhausted laterally.

Pouring

Where condensers are filled by pouring instead of dipping, various

pitch preparations are used more frequently than are the chlorinated naphthalenes. However, when these latter materials are employed for this purpose, the molten wax may be kept in a small tightly enclosed storage tank on the table. The condenser is placed under a slot beneath the tank, and when the operator presses a key the wax drops from the storage tank into the condenser. Such a tank should be supplied with lateral exhaust ventilation. The storage tank is refilled by dropping in lumps of the solid wax.

Soldering

Workers doing soldering should be similarly protected. Work benches at which this is done should be supplied with a series of small hoods, one for each worker, under which the soldering operations are carried out. Each hood should be equipped with lateral exhaust ventilation so disposed that the fumes given off are carried back and away from the workers' faces. An air velocity of 1000 f.p.m. is required.

Where soldering of tinfoil condensers is carried out by rubbing the end of the condenser on a hot plate, the hazard is greater than where wires are soldered on to leads. All such hot plates should be equipped with a hood having a slot at the end of the plate and supplied with lateral exhaust ventilation. An air velocity of 1000 f.p.m. is required.

General Ventilation

In addition to the local exhaust ventilation above outlined, careful attention should be directed to adequate ventilation of the room as a

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mented the occupational hazard in that family, but the fact remained that no member of the family had ever suffered from acne vulgaris, as far as could be determined, and that all three who began working in the condenser plant developed a very severe type of skin eruption—so severe in the case of two of them that they had to go into some other type of work. Both recovered satisfactorily after exposure ceased. In the other family there was no history of the ingestion of iodides or bromides and yet three members in turn were forced to discontinue work in the plant because of severe acneform eruptions. Here again, there was no history of acne vulgaris in the family. The family where iodized salt was being used appeared to have a very poor standard of personal cleanliness, but in the other family a high standard of personal cleanliness was observed.

Differential diagnosis from acne vulgaris—In the severe cases, there is usually little or no difficulty in differentiating these conditions. In the milder ones, however, the diagnosis is apt to be more difficult. Certain points of differentiation are helpful, however. When present, the intense pruritus, for example, is of great importance, since this is seldom found in cases of true acne vulgaris. The prominence of comedones in workers exposed to the chlorinated naphthalenes, and the frequency with which these comedones may be seen crowded together, is so striking as to suggest definitely this type of acneform eruption rather than acne vulgaris.

The distribution of the lesions tends to throw further light on the differential diagnosis. The distribution

along the extensor surfaces of the arms, and particularly around the elbows; and its predilection for the area along the whole length of the mandible is not characteristic of acne vulgaris. Furthermore, the back, which is an important site of predilection for acne vulgaris, was less often involved in the workers examined. Lesions may also be observed on the legs and abdomen, along the belt line, or other areas where there is friction from clothing, sites not usually involved in acne vulgaris.

II. Vesiculo-Erythematous Eruptions

One worker, in addition to having a severe acneform eruption, suffered from a weeping vesiculo-erythematous eruption of the dermatitis venenata type. The eruption had a widespread distribution on the face, neck, arms and trunk. It began about 6 months after starting work with the chlorinated naphthalenes and cleared up within a month after exposure was permanently discontinued. The girl returned to work in the same plant and was given a job in a department where she would not come into further contact with the substances to which she was sensitive. Nevertheless, she continued to complain of recurrent attacks of moderately severe itching. This case, among others, showed a chronic paronychia involving both index fingers which was extremely persistent.

III. Simple Erythematous Reactions

Two of the workers examined were found to be suffering from what appeared to be a simple erythematous eruption with severe itching. This appeared mainly on the face and

whole wherever any worker is exposed directly or indirectly to fumes or vapors of the chlorinated naphthalenes or diphenyls.

Personal Hygiene

This may be briefly summarized as follows:

1. Employers should supply workers with highly starched uniforms, underwear, caps and gloves; these clothes should be laundered every day.

2. Two lockers should be provided, one for street clothes and the other for uniforms.

3. Employers should provide workers with sanitary eating facilities, removed from their workroom.

4. Wash periods should be scheduled on company time, and washing up before lunch and before leaving work at night should be done under factory supervision.

5. Cold cream, plenty of hot water, soap and individual towels, together with a protective lotion for the skin should be supplied by the management.

Since the chlorinated naphthalenes are not soluble in water, the wax-like film which is deposited on the skin should first be removed with cold cream in which it dissolves. Workers should then wash thoroughly with plenty of warm water and a mild soap. This ritual should be carried out conscientiously before lunch, and again before leaving the factory in the evening. A shower before leaving work is desirable.

All workers should apply a protective lotion to all exposed parts of the body before starting work in the morning and before starting work again after lunch. A lotion which

has been recommended for this purpose is the following:*

Zinc oxide	1/2 oz.
Calomine lotion	1/2 oz.
Salicylic acid	20 grams
Adeps Lan. Hyd.	4 fluid oz.

Medical Supervision

1. All workers should be instructed as to the hazardous nature of their work and the rules to be followed in order to keep well. They should be encouraged to report promptly any evidence of a skin eruption or of general ill health.

2. Young workers suffering from acne vulgaris should not be employed in this industry.

3. Because of the possibility of severe scarring of the face following a severe acneform eruption, it would seem particularly desirable not to employ young girls.

4. Workers developing skin eruptions of any severity should be immediately removed from further exposure to the chlorinated naphthalenes. In rare cases the skin eruptions may be a forerunner of systemic poisoning, such as acute yellow atrophy of the liver.

5. All workers developing skin eruptions, particularly of the itchy variety, should be carefully watched so as to guard against infection.

6. Workers should be given periodic physical examinations.

SUMMARY

1. Exposure to the chlorinated naphthalenes in the manufacture of electrical condensers may result in

* Recommended by the Halowax Corporation.

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acneform eruptions, characterized by pustules, papules and comedones. The association of comedones in large numbers, with a severe pruritus (itching) has given it the name "blackhead itch" among the workers.

2. The 31 workers examined in two plants using a combination of tri and tetrachloronaphthalene in the manufacture of condensers were all employed in the finishing departments, doing soldering or testing of condensers which had already been impregnated.

3. The eruption observed fell into three main types, which have been discussed.

4. The eruption may or may not become disabling.

5. It usually occurs within the first few months of employment, though there are exceptions to this rule.

6. There appears to be great difference in the susceptibility of individuals to these substances. Some workers are never affected.

7. The incidence of the acneform eruption appears to be higher in the summer than in winter.

8. The acneform eruption differs from the acne commonly found among adolescents in the following important respects:

a. Severe pruritus, which very seldom accompanies vulgaris.

b. Association of acne with a dermatitis venenata or a paronychia of the fingers, especially of index fingers.

c. Comedones are far more numerous, more closely crowded together to form patches.

d. Distribution along the exterior surfaces of the arms and especially around the elbows, an

area almost never affected by acne vulgaris. The back, so often affected in acne vulgaris is not commonly affected here except in very severe cases. The legs and abdomen may be affected. The line of the mandible is an area of predilection.

e. The condition may be transferred to other members of the family by contact with the skin and clothing, when these have a coating of the chlornaphthalene on them.

10. The mechanism for these acneform skin eruptions is not clearly understood.

11. The eruption may in severe cases involve the deeper layers of the skin and result in permanent scarring. One case of permanent facial disfigurement in a young girl was observed in the course of the present study.

12. In severe cases, there is a tendency to secondary infection, especially when there is a coexisting pruritus and the worker scratches the lesions. In the present investigation a furunculosis of the cheek superimposed on a severe acneform eruption resulted in death from septicemia.

13. There is every reason to believe that attention to adequate local and general ventilation, good personal hygiene on the part of the workers and adequate intelligent medical supervision will effectively eliminate the hazard.

14. Fumes and vapors should be exhausted laterally at their source, the velocity of air being maintained at 1000 f.p.m.

15. General ventilation for the room as a whole should be introduced when necessary.

16. Principles of personal hygiene and medical supervision have been briefly outlined.

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