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EXPOSURE TO SEWAGE SLUDGE – A NEW OCCUPATIONAL HAZARD

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ABSTRACT

A specific syndrome has been reported among sewage workers. It consists of acute attacks of fever, chills, diarrhoea and changes in biomedical parameters. Five different sewage water treatment plants were investigated. The number of airborne bacteria was determined at different working sites. All persons working in the plant were interviewed and clinical chemistry tests were performed. Workers from a drinking water plant served as a control group. The bacterial content of the air varied between the different parts of the plant. High numbers of airborne Gram-negative bacteria were found in connection with processes where the sewage water was agitated.

Few of the workers reported eye symptoms or fever. Diarrhoea was reported by 34% of the workers daily exposed to sewage sludge. Two per cent of the workers in the control group reported these symptoms. Increased levels of fibrinogen degeneration products (FDP) in urine were found in 27% of the exposed workers as compared to 14% in the control group. No significant differences were found in the number of white blood cells. A tendency to an increase in the IgG levels was found in the exposed group.

The occupational health risks of sewage workers have been investigated by several authors and reviews presented by Anders[1] and Clark and co-workers[5]. In previous investigations the emphasis has mainly been on the risk of infection either from microorganisms present in the sewage or from particular organisms in the sewage environment such as rats. An overall evaluation of additional environmental factors including sick absence, working conditons in general and satisfaction at work was presented in a Danish report[3].

In a previous study[6] a specific syndrom was reported among sewage workers in a plant where the sludge was heated and transformed into dust. After exposure to high concentrations of this dust, about 15% of the exposed workers suffered from inflammation in the eyes and acute episodes of fever and chills. A clinical examination demonstrated that the amount of serum immunoglobulins in the exposed persons was increased as compared to a non-exposed group. Antibodies to endotoxin showed slightly increased levels. The excretion of fibrinogen degradation products (FDP) in urine was increased as were also the C-reactive protein levels in serum. A higher dinitrophenylated human

serum albumin (DNP/HSA) activity was observed. An interpretation of these findings was that they were caused by exposure to high levels of endotoxins from Gram-negative bacteria present in the dust.

In order to assess whether the same symptoms were present also among sewage workers in other plants where the sludge was treated using conventional methods, a study was undertaken in five different sewage water treatment plants. Workers in three different drinking water treatment plants served as controls.

MATERIAL AND METHODS

All persons working in the installations including those engaged only in office work were interviewed with the aid of a standardized questionnaire. Questions were asked on the length of employment, previous working experience and the employee's health in general. Afterwards specific questions were asked about the presence of eye inflammation, attacks of fever, diarrhoea and skin disorders.

The interviewed persons were classified into three different groups with regard to their overall exposure in the sewage plant. Into the non-exposed group were classified office workers, laboratory supervisors, technical chiefs and other categories who only rarely came in contact with the sewage water or the contaminated plant environment. Into the low exposure group were classified those workers who regularly but not every day, came in contact with the sewage water, e.g. operators, laboratory personell and electricians. Into the high exposure group were classified those workers who regularly worked for several hours a day at the different installations in contact with sewage water.

The investigations were carried out among all personell working in the different plants who had been engaged for at least nine months. Practically all workers participated in the investigation – two refusals occurred. Persons temporarily absent due to sick leave, holiday or other reasons at the time of the investigation, were later contacted and interviewed either personally or by telephone.

In connection with the interview, blood samples were taken from most workers for the determination of the white blood cell count, thrombocytes and immunoglobulins. Urine samples were collected for the determination of FDP.

The bacterial exposure levels in the plants were determined by sampling the airborne bacteria at different locations. The number of airborne bacteria was determined using an Andersen sampler[2] with Drigalski agar, selective for the outgrowth of Gram-negative rods. The number of bacterial colonies was counted after incubation at 30 °C for 36 hours and the airborne bacteria expressed as colony forming units (cfu) per cubic meter of air. Dual samples or more were prepared at each location and the determinations were repeated on two or more separate days. The exposure was expressed as the average count obtained at one particular site and in certain cases during a particular working operation.

RESULTS

The study still continues and the results reported here are in certain cases incomplete and should be regarded as a preliminary. The results from the determinations of Gram-negative bacteria in the air are reported in Table 1. Particularly high numbers of airborne bacteria were recorded in connection with processes where the sewage water was agitated through pumping, sprinkling or aeration. In a drinking-water treatment plant the number of Gram-negative bacteria in air was 10^1 cfu/m^3.

TABLE 1

Average number of cfu (colony-forming units) Gram-negative bacteria per m^3 of air at various sites in the different sewage treatment plants ("–" indicates that values are not available). Plants No. I, II and III are indoor plants, whereas Nos. IV and V are outdoor plants.

	cfu/m^3 of air in plant No.				
	I	II	III	IV	V
Inlet, pump basin	10^4	10^3	–	–	10^4
Waste collection	–	10^3	10^3	–	10^1
Aerated basins including sprinkling	$>10^5$	–	–	10^4	–
Sedimentation basins	10^2	10^1	10^1	–	–
Sludge pressing	–	10^3	10^3	10^2	10^2

TABLE 2

Percentage of workers reporting clinical symptoms in drinking water treatment plants and in different exposure categories in sewage water treatment plants.

Exposure	N	Eye	Fever	Skin	Diarrhoea
Drinking water	41	2	0	2	2
Sewage – no exposure	14	0	0	21	7
Sewage – low exposure	72	3	1	7	38
Sewage – high exposure	102	2	1	9	31

Table 2 shows the number of persons examined in each exposure category and the results concerning the clinical symptoms revealed in the interviews. The majority of the persons examined belonged to the high exposure category. Very few of the workers reported symptoms from the eyes, and fever was only occasionally reported. The non-exposed workers from sewage plants reported a higher frequency of skin trouble (21%) than the exposed sewage workers (7–9%) and drinking water workers (2%). Diarrhoea was reported by a larger proportion of the workers in the low- and high-exposure groups. For the total material, 31% of the workers in the high-exposure group and 38% of the workers in the low-exposure group reported occasional or regular trouble with diarrhoea (34% of all exposed workers). The majority of the interviewed connected the appearance of these symptoms with particular working procedures such as descending into

the basins for cleaning and prolonged working at sites where the sewage water was aerated. Some of the workers reported that they had experienced intestinal troubles on one or two occasions when starting work at the plant or when they resumed work after the summer vacation.

TABLE 3

Per cent workers with increased FDP (fibrinogen degradation products) values (i.e. > 10 mg/l) in urine from drinking water treatment plants and from different exposure groups in sewage water treatment plants.

Exposure	N	% increased FDP
Drinking water	41	14
Sewage – low exposure	72	34
Sewage – high exposure	102	21

The results from the determinations of FDP in the urine is reported in Table 3. The proportion of workers having increased levels of FDP in their urine, i.e. FDP values of more than 10 mg/l urine, was slightly higher in the low-exposure group (34%) than in the high-exposure group (21%). Twenty-seven per cent of all the exposed workers had increased FDP levels as compared to 14% of the drinking-water workers.

TABLE 4

Blood cell elements and percentage of neutrophiles and lymphocytes in the blood of exposed sewage workers and workers from drinking water treatment plants (controls). The mean values ± standard deviation.

Exposure	N	Thrombocytes ($x10^3/mm^3$)	White blood-cells ($x10^3/mm^3$)	Neutrophiles (%)	Lymphocytes (%)
Drinking water	42	238 ± 47	7.4 ± 2.7	60	33
Sewage – high exposure	63	223 ± 65	6.1 ± 1.8	60	32
Sewage – low exposure	91	221 ± 72	6.6 ± 2.3	59	33

TABLE 5

Serum immunoglobulins (g/l) in workers from drinking water treatment plants and from different exposure groups in sewage water treatment plants. The values represent mean values and standard deviation.

Exposure	N	IgG	IgA	IgM
Drinking water	42	11.5 ± 2.6	2.0 ± 0.9	1.3 ± 0.6
Sewage – low exposure	63	12.9 ± 3.6*	2.4 ± 1.0*	1.8 ± 0.7**
Sewage – high exposure	91	12.5 ± 3.3	2.2 ± 1.0	1.6 ± 0.7*

*significant at the 5% level; **significant at the 0.1% level

Table 4 shows the results from determinations of thrombocytes, white-blood cells and proportions of neutrophiles and lymphocytes. As can be seen in the table, there was no difference between any of the groups. Table 5 shows the serum immunoglobulin levels in high- and low-exposure workers. It will be seen in the table that there was no clearcut difference as regards to the amount of immunoglobulins in the sera.

DISCUSSION

The results obtained so far from the present study indicate that the earlier observed reactions among workers exposed to dust from sewage sludge are not present to the same extent among workers exposed in sewage treatment plants employing traditional treatment procedures. In spite of this it is noticeable that a relatively high proportion of the workers experience occasional or regular intestinal troubles.

Whether the responsible exposure route is by inhalation or via contact with contaminated hands is still uncertain. It is appreciable that there exists a considerable airborne exposure in view of the relatively high levels of airborne Gram-negative bacteria observed in connection with working procedures where active aeration of the sewage water takes places. It cannot be ruled out that some of the symptoms may be caused by a direct activity of bacterial toxins. Such an exposure was probably responsible for the earlier reported syndrome among sewage workers exposed to dust and has also been reported in connection with cases of bathers' disease[4].

The biochemical data showed the amount of FDP excreted in the urine to be higher in the exposed group – a finding which is consistent with the previous study on sewage workers exposed to dust. As regards to immunoglobulins and blood cell elements, no clearcut differences were found between the low- and high-exposure groups.

The present findings indicate that basically the same biological effects that have previously been demonstrated for sewage workers in a particular plant are present among workers in conventional sewage water treatment plants. The extent of the symptoms among the workers is, however, lower. From the point of view of occupational health it is therefore important to clarify the exact mechanism underlying the investigated effects so that appropriate prevention measures may be enforced.

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