

Occupationally related respiratory symptoms in trout-processing workers

D. SHERSON, I. HANSEN & T. SIGSGAARD

Department of Occupational Medicine, Vejle County Hospital, Denmark

All eight production workers from a small trout-processing factory were studied because of respiratory or rhinitis symptoms when working next to the automatic gutting machine. Seven of the eight had positive histamine provocation tests. Four patients had elevated total IgE levels while one had a slightly elevated eosinophil count. All workers had either weakly or moderately positive RAST against contaminated water from the outlet drain of the gutting machine. This water contained 1 µg endotoxin/ml. We concluded that five of the workers had probably developed occupationally related asthma from inhalation of contaminated aerosol from the gutting machine. Inhalation of endotoxin from gram-negative bacteria may be the cause of this disorder. An alternative explanation is a Type I allergy caused by fish or bacterial protein with or without a simultaneous effect of endotoxin.

Key words: asthma; bronchial; hyperreactivity; endotoxin; fish-processing; rhinitis; trout-processing.

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CLINICAL ASPECTS

Occupationally related bronchial asthma was diagnosed in five of the eight production workers at a small trout-processing factory. Inhalation of contaminated aerosol from the automatic gutting machine was probably the cause. The specific etiology may be endotoxin content in this aerosol, or Type I allergy.

Bronchial asthma has been described after ingesting fish (23) or in association with fish products: larvae of *Calliphora erythrocephala* (24) or *Daphnia* (14). Allergy has also been described among fish meal factory workers (8). Recent reviews of occupational asthma (1, 11, 18) have not described this problem in the fish-processing industry, and no mention of respiratory problems was made in a review of health problems among fish-processing workers (15). Dyspnea and rhinitis have been described among clam- and oyster-processing workers (13), and occupational asthma in association with snow crab-processing (4). Due to repeated respiratory complaints from workers at a rainbow trout-processing factory, the following study was undertaken in the fall of 1986.

MATERIAL AND METHODS

Patients and work process

All eight of the production workers at a small rainbow trout-processing factory were interviewed and examined in a standardized manner by the same physician at the Department of Occupational Medicine, Vejle County Hospital. All workers stood in a 80 m² production hall with ceiling ventilation. The rainbow trout come from fish farms, are stored in tanks and transported alive in bins to the production hall. Each fish is placed back down on a hook on a conveyor belt which transports the fish through

Table 1
Employment histories and work-related symptoms among eight female fish-processing workers

Patient	Age	Total years employed	Latency before symptoms	Cough	Dyspnea	Wheezing	Rhinitis
1	37	1	1 week	+	+	+	-
2	25	6	few months ¹	+	+	-	-
3	41	7	few weeks ¹	+	+	+	-
4	54	13	11 years	+	-	-	+
5	42	7	1 year ¹	+	+	-	-
6	29	12	10 years	+	+	-	+
7	52	3	2 weeks ¹	+	+	+	-
8 ²	42	1	few weeks	?	?	?	+

¹These workers were employed on several occasions separated by long intervals. Latency from the onset of the last employment is shown.

²Pt. 8 complained of exercise-induced dyspnea with wheezing for 2 years, in addition to work-related rhinitis.

the automatic gutting machine where the intestines are removed. Thereafter, the fish are washed manually, weighed and packed. Respiratory complaints were most intense when workers stood next to the gutting mashine.

Laboratory tests

Blood samples were taken and lung function tests performed with a portable Vitalograph® spirometer at the factory. Normal values were based on those of the Danish population (7). Histamine provocation testing adapted from standard methods (6, 10) was done at the Department of Pulmonary Medicine, Vejle County Hospital. No subjects had taken asthma medicine on the day of examination. The highest of three peak flow measurements was chosen as the reference value (100%). Peak flow was again measured 2 min after the completed inhalation using tidal volume breathing of 1.5 ml physiologic saline solution from a Pari nebulizer. Thereafter, the patient completely inhaled 1.5 ml of the test solution starting with a concentration of 0.03 mg/ml histamine. Peak flow was again measured after 2 min. The concen-

tration was increased stepwise until maximum concentration of 8 mg/ml. The histamine concentration at a 20% fall in peak flow (PC₂₀) was calculated. Asthma was defined as a sudden attack of breathlessness with fully or partially reversible airway obstruction (20). A positive histamine provocation test with a PC₂₀ < 8 mg/ml histamine, or a diurnal peak flow variation > 20% was considered as sufficient evidence of reversibility.

Aluminium radio-allergosorbent-test (RAST) was carried out using Weeke's method (21) with the following allergy classes: Negative (0-1 sorbent units, SU), doubtful (2-3 SU), weak (4-19 SU), moderate (20-99 SU) and marked (≥ 100 SU). All RAST extracts were negative when tested against a control donor pool from 1000 individuals (Diagnoselaboratoriet ALK, Post Box 408, 2970 Hørsholm, Denmark).

Endotoxin content was measured in the contaminated water collected from the outlet drain of the gutting machine (3). Anti-lipopolysaccharide, IgG and IgM (anti-LPS) in serum was also measured with the following antigens: *E. coli*, Salmonella and Serratia species (12). Bacteriological studies were conducted by the Department of Microbiology, Vejle County Hos-

Table 2
Pulmonary function studies among female fish-processing workers

Patient	Smoking history in pack-years (P-y)	FVC		FEV ₁ /FVC %	Histamine provocation (PC ₂₀ : mg/ml)	Work-related maximum diurnal peak flow variation (%)	Asthma
		Fev ₁	(% pred.)				
1	0	124	123	83	+ (6.4)	10	?
2	ex-smoker	112	108	85	+ (7.2)	22	+
3	12 P-y	108	89	98	+ (0.55)	ND	+
4	ex-smoker	118	104	88	normal	8	-
5	ex-smoker	93	89	86	+ (0.20)	31	+
6	5 P-y	99	102	80	+ (7.00)	33	+
7	16 P-y	74	90	67	+ (1.15)	29	+
8	7 P-y	116	136	70	+ (1.70)	ND	+ ¹

¹Pt. 8 had exercise-induced asthma and work-related rhinitis
ND = not done

pital, using standard substrates (blood agar and selective substrate plates). Serum samples for RAST and endotoxin determinations as well as water and aerosol samples, apart from the supplementary water samples described in the next section, were taken at the work place on the same day (Sept. 17, 1986). Standard prick tests were carried out using the following extracts: cod, birch, *Phleum pratense*, *Artemisia vulgaris*, cat hair, dog hair, horse dander, *Alternaria*, *Aspergillus fumigatus*, *Cladosporium herbarium* and *Derma-*
tophagoides pteronyssinus.

RESULTS

The onset and type of symptoms in the eight production workers are described in Table 1. Four patients developed symptoms when they returned to work after some years absence (patients 2, 3, 5, 7). Respiratory symptoms of seven of the workers were definitely work-related with marked improvement during vacation. Spirometry was normal with the exception of patient 7 who had a mild obstructive reduction (Table 2). Seven of the eight workers had a

Table 3
Laboratory studies among female fish-processing workers

Patient	Total IgE (KU/l)	Total eosinophil count (10 ⁹ /l)	Prick test	RAST in sorbent units (SU)				Asthma
				Trout intestines	Trout skin scraping	Contaminated water from gutting machine	Salmon	
1	413	0.456	-	3	5	20	6	?
2	11	0.250	-	0	2	3	6	+
3	96	0.288	-	1	28	11	2	+
4	148	0.200	-	1	2	6	4	-
5	2	0.231	-	1	1	5	8	+
6	30	0.338	-	0	4	9	9	+
7	61	0.125	-	0	8	13	6	+
8	290	0.063	-	1	2	20	7	+

RAST: Negative (0-1 SU); doubtful (2-3 SU); weakly positive (4-19 SU); moderately positive (20-99 SU) and markedly positive (≥ 100 SU).

Table 4

Anti-lipopolysaccharide antibodies (anti-LPS) measured in serum from eight fish-processing workers. All measurements in mg/l

Patient	IgG anti-LPS	IgM anti-LPS
1	18	74
2	24	48
3	10	55
4	8	61
5	33	97
6	29	53
7	43	37
8	17	105
$\bar{x}$ = 22,75 (SD = 11.13) 66.25 (SD = 22.43)		
Normal values (ref. 21)		
	9 mg/l.	28 mg/l.

positive histamine provocation test, although three had weakly positive tests (patients 1, 2, 7). Patient 2 had a delayed peak flow fall of 22% 5 min after completion of the final histamine inhalation. Four patients (1, 3, 4, 8) had elevated total serum IgE levels (Table 3). Only one patient (No. 1) had a slightly elevated total eosinophil count. Six patients had weakly positive RAST tests against the contaminated water from the gutting machine, while two were moderately positive.

Endotoxin analysis demonstrated 1µg endotoxin/ml contaminated water from the gutting machine. Anti-lipopolysaccharide antibodies (anti-LPS) are described in Table 4. The mean concentrations were more than double the values found in a normal Danish population (presented in parentheses): IgG anti-LPS = 22.75 mg/l (9 mg/l) and IgM anti-LPS = 66.25 mg/l

Table 5

Bacteriological growth from contaminated air above the fish gutting machine (No. of colonies)

Proteus/Providencia species (10)
Citrobacter freundii (11)
Flavobacterium species (25)
Pseudomonas species (50)
Klebsiella pneumoniae (50)
Aeromonas hydrofila 2 types (80)
Coagulase negative Staphylococcus and Staphylococcus epidermis (300)

(28 mg/l). However, only 1 IgG anti-LPS (pt. 7) and 1 IgM anti-LPS (pt. 8) are significantly elevated (12, 19).

Bacteriological growth in water from a randomly selected fish tank from a transport truck (fish farm water) showed pure growth of Klebsiella pneumoniae (10⁶ colonies/ml). Because of this finding a supplementary systematic bacteriologic analysis was undertaken 7 weeks later. Klebsiella pneumoniae together with many other species was found in a fish farm tank that supplied fish to the factory. Water from one of the factory's own fish tanks had 4 × 10³ colonies/ml of Klebsiella pneumoniae and Pseudomonas fluorescens. The fresh water tank which supplied the gutting machine had 0.7 colonies/ml of Aeromonas hydrofila, Enterobacter agglomerans and Hafnia alvei without Klebsiella. Contaminated water from the gutting machine grew 3 × 10⁹ colonies/ml of Aeromonas hydrofila, Klebsiella pneumoniae and Pseudomonas species. Growth from three standard-sized plates placed on top of the gutting machine for 1.5 h is described in Table 5.

DISCUSSION

Occupationally related rhinitis occurred in three workers, while six workers complained of work-related dyspnea. Symptoms were strongly associated with the fish gutting machine and absent when this machine was not in use. Occupational asthma was demonstrated in four workers (pts. 2, 5, 6 and 7) who had positive histamine provocation tests as well as work-related dyspnea with a fall in peak flow of at least 20%. Pt. 3, who also complained of work-related dyspnea, and with a moderately positive histamine provocation test, probably had occupational asthma. Peak flow monitoring was unfortunately not done in this case. A sixth patient (pt. 1) possibly had occupational asthma, but a significant fall in peak flow was not demonstrated. Pt. 7 had non-work-related exercise-induced asthma as well as occupationally related rhinitis.

We were surprised to find a pure culture of Klebsiella pneumoniae in water from a truck fish tank. This organism, which was not found in

the stream supplying the fish farm, could be traced from the fish farm directly to the gutting machine. The presence of antibiotics in fish farm water, which may be periodically added, could make it possible for selective growth of *Klebsiella pneumoniae*. However, this finding cannot directly explain the workers' symptoms.

The cause of asthma is most likely a component in the aerosol which surrounds the gutting machine. This aerosol may cause an irritation leading to hyperreactive airways as described in a painter and a welder (2). A more plausible explanation could be inhalation of bacterial endotoxin in the aerosol. The large amount of endotoxin that was measured in the contaminated drain water (1 µg/ml) is probably reflected in a relatively large concentration in the aerosol, which unfortunately was not measured. The average endotoxin antibody levels (anti-LPS) in our study population was approximately twice that of a normal population (12, 19), which suggests occupational exposure. However, it is difficult to attribute etiological significance to this observation. Endotoxin has been closely correlated with acute reduction in FEV₁ after exposure to cotton dust (5). Respiratory problems associated with the grain industry (9), poultry-processing (17) and silo unloading (22) may also be caused by inhaled endotoxin.

Another possible etiology is a Type I allergy caused by fish or bacterial (e.g. *Klebsiella pneumoniae*) protein, which is supported by the presence of a latency period. Only one of our patients had a slightly elevated eosinophil count and three had definitely elevated total IgE levels. Five patients had moderately positive RAST against the contaminated water from the gutting machine. This suggests that there may be a protein component in the contaminated water that could cause an allergic reaction. A third possible explanation is that endotoxin exposure could act synergistically with a protein allergen to cause our patients' symptoms (16). Regardless of the etiology it should be possible to reduce symptoms by reducing the quantity of aerosol associated with gutting of fish.

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David Sherson, M.D.

Department of Occupational Medicine
Vejle County Hospital
7100 Vejle
Denmark

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