Paternal exposure to mercury and spontaneous abortions

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Abstract

The potential reproductive toxicity of mercury vapour was investigated by comparing the rate of spontaneous abortions among the wives of 152 workers occupationally exposed to mercury vapour with the rate among the wives of 374 controls in the same plant. The results indicate an increase in the rate of spontaneous abortions with an increasing concentration of mercury in the fathers' urine before pregnancy. At concentrations above 50 µg/l the risk of spontaneous abortion doubles (odds ratio (OR)=2.26; 95% confidence interval (95% CI)=0.99-5.23). Special care was taken to avoid bias in reporting abortions and known risk factors of spontaneous abortions do not seem to explain the results. Several biological mechanisms might account for them including, in particular, direct action of mercury on the paternal reproductive system and indirect toxicity to the mother or embryo through transport of mercury from the father. These indications could be of practical importance and should therefore be further documented.

Mercury in its elemental form is used industrially for various purposes, including the production of electrical apparatus, catalysts, thermometers, paints, amalgams, and chlorine.

Its toxicological effects come from its high vapour pressure, monoatomic nature, and high lipid solubility. The vapour is easily formed at room temperature and inhaled, and the proportion deposited and retained in man is about 80%.¹ Elemental mercury is rapidly transferred from the blood to the brain and moves readily across the placenta into fetal tissues.

Historical case reports indicate that toxic exposure of the mother to mercury at a relatively early gestational age has an abortifacient effect.² The effect of exposure to mercury vapour on the reproductive health of exposed workers, however, is not clear.

Increased frequency of spontaneous abortions among workers exposed to mercury has been reported in one study on female dental workers,³ but three other studies, one in a lamp factory⁴ and two among female dentists or wives of male dentists^{5,6} failed to show such an association. Some reports of menstrual disorders related to exposure to mercury have also been published.⁴ In a study of the fertility of male workers, no statistical difference was found between the number of children in the group exposed to mercury and the number expected based on the reproductive experience of a matched control group.⁷ A study in Denmark on the causes of infertility suggested that women exposed to lead, mercury, or cadmium might be at higher risk.⁸

Experimentally, inhalation of mercury vapour at 0.3 ppm has been shown to lengthen the estrous cycle of rats and to increase the mortality of offspring after preconceptional exposure.⁹ Inorganic mercury can affect endocrine and gonadal function in both male¹⁰ and female rodents,¹¹ considerably reducing fertility. It appears, however, that mercury compounds are not potent inducers of dominant lethal mutations.¹² A study of the toxicity of these compounds on preimplantation mouse embryos, however, shows that these embryos are highly sensitive to mercury toxicity *in vivo*, especially in the early preimplantation period.¹³

Production of C-mitosis in plant material is the most noticeable genetic effect of mercury compounds.¹⁴ They appear to alter the normal segregation of chromosomes during cell division by interacting with the spindle tubulins,¹⁴ but the results of studies of chromosomal aberrations in peripheral blood lymphocytes of mercury exposed workers are contradictory.¹⁵⁻¹⁷

It therefore seems clear that exposure to mercury vapour may be a reproductive hazard. The present epidemiological investigation is aimed at studying the effects of such exposure, testing the specific hypothesis of an association between paternal exposure to mercury and spontaneous abortions.

Methods

Production of chlorine by electrolysis of sodium chloride results in exposure to mercury vapour, as mercury acts as a cathode in the electrolytic process.

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In the chloralkali plant where the study was conducted, up to 1300 workers were at one time employed to produce some 230 000 tonnes of chlorine per year. The decision to conduct the study in this plant was not motivated by a report of a cluster of spontaneous abortions among employees' wives.

The study was conducted in 1984 among all married male workers aged 45 or less. They were asked to fill in an anonymous questionnaire. The questionnaire included two parts: one concerned the worker himself, requesting a description of his complete occupational history outside the plant, as well as details regarding his alcohol and tobacco consumption. The other part had to be filled in by the workers' wife, and included questions about her history of infertility, spontaneous abortions, and pregnancies. Women were specifically asked not to mention induced abortions. The wife also had to answer questions about her occupational history and her alcohol and tobacco consumption.

The questionnaire was distributed individually during the medical examination periodically conducted by the occupational health physician, who presented the questionnaire as part of a national study on the association between environmental exposure and health. The questionnaires, which were anonymous, were numbered and returned to the physician in a sealed envelope, and then sent to us.

REPRODUCTIVE HISTORY

Each workers' wife had to answer several questions about her reproductive history, problems of infertility, spontaneous abortions, and births.

Each abortion was characterised by the way the pregnancy was diagnosed (laboratory test, pregnancy testing kit, consultation of a physician without test, or late menstrual period), the need for hospital care and curetage, the number of weeks of pregnancy, and the date of the abortion and its medical cause if known. A spontaneous abortion was defined as a pregnancy which ended before 28 weeks of gestation. An abortion was considered doubtful if it occurred before 12 weeks of gestation, when the pregnancy had not been confirmed by a biological test, and if it did not necessitate a stay in hospital.

For each birth, information was given on the state of the baby at birth (any major anomaly), its sex and weight, the number of weeks of pregnancy, and the date of birth.

EXPOSURE OF THE FATHER

The plant health physician provided an individual occupational history inside the plant for each worker. Each job was characterised by the degree of exposure to mercury, which was graded as none, low, or moderate, and by the presence of any other types of chemical exposure. A worker was classified as

"exposed" if he had ever been assigned a job with potential exposure to mercury.

For most of the potentially exposed workers, the concentrations of mercury in their urine had been monitored at least once a year since 1968. For monitoring, specimens were collected from a miction passed during a day's work and stabilised with a drop of toluene. They were then mineralised overnight with sulphuric acid and potassium permanganate. Mercury concentrations were measured by atomic absorption.

EXPOSURE BEFORE PREGNANCY

For each pregnancy reported by the wife of an exposed worker, an index of exposure was computed from the average mercury concentration in the urine of the father throughout the period preceding conception. The duration of exposure before each pregnancy was defined as the total number of months when the father had worked in an exposed job. Such a pregnancy will be referred to below as an "exposed pregnancy".

OTHER TYPES OF EXPOSURE

Up to 75 types of exposure other than mercury were identified in the plant, including exposure to chemicals, magnetic fields, and heat. These types of exposure were only considered if they concerned at least 20 pregnancies, and consequently, only 21 of them were included in our analysis. A pregnancy was considered exposed to a specific agent if the father worked in a potentially exposed job at any time before conception.

STATISTICAL ANALYSIS

We considered different pregnancies of the same woman independently, both in statistical and biological terms, although this distinction is not entirely valid. Analysis was also restricted to first pregnancies to avoid this problem. The stability of the results was evaluated after the exclusion of doubtful abortions, and of women who had had two or more abortions. Statistical methods included stratified analysis using the Mantel-Haenszel procedure, and multiple logistic regression.

Results

Of the 565 workers included in the study, 434 returned an informative questionnaire (10 returned a blank questionnaire), which constituted an overall reply rate of 76.8% (75.7% in the non-exposed group, and 77.6% in the exposed group).

One hundred and eighteen workers were considered as potentially exposed to mercury vapour and 283 were never exposed to it, 27 had uncertain exposure and for six workers, no information was available. At least one determination of mercury

Table 1 Characteristics of workers exposed to mercury vapour and of those not so exposed

	Non-exposed workers	Exposed workers
No of subjects	374	152
No of replies to the questionnaire	283	118
% Of replies	75.7	77.6
Age (y mean $\pm$ SE)	37.3 $\pm$ 0.3 (281)	37.0 $\pm$ 0.5 (117)
No of years in the plant (mean $\pm$ SE)	6.8 $\pm$ 0.4 (277)	7.1 $\pm$ 0.4 (116)
Age of wife (mean $\pm$ SE)	34.7 $\pm$ 0.4 (267)	35.0 $\pm$ 0.5 (113)
% Aged > 30 years	74.5 (267)	77.0 (113)
No of pregnancies reported	544	239
No of spontaneous abortions	52	18
Average No of pregnancies	1.9 $\pm$ 0.1	2.0 $\pm$ 0.1
Average No of children	1.7 $\pm$ 0.1	1.9 $\pm$ 0.1
% Smokers	38.5 (278)	37.1 (116)
% Smokers among wives	20.2 (267)	21.2 (113)

No of subjects for whom information was available, if different from the total sample, are given in parentheses. SE = Standard error.

concentration in urine was available for 96 of the 118 workers in the exposed group.

Table 1 gives the characteristics of the exposed and non-exposed groups. The two groups did not differ significantly as regards the ages of the workers and their wives, the number of years spent in the plant, the number of pregnancies, number of births, and percentage of smokers. With respect to the characteristics of exposed *v* non-exposed pregnancies, it appears that exposed pregnancies seemed to occur when the mother was older (26.1 *v* 25.2 years), but were more recent in relation to the year of the study (8.4 years ago on average *v* 11.3 years) than non-exposed pregnancies. These factors were taken into account in our analysis of pregnancy outcome. In all, 70 spontaneous abortions were reported for a total of 783 pregnancies—that is, 8.9 spontaneous abortions per 100 pregnancies.

Table 2 gives the variations in the average mercury concentrations in the fathers' urine from 1968 to 1984. Assuming that these concentrations are a good indicator of exposure, this table shows that exposure to mercury has increased since 1968. It reached a

Table 2 Average mercury concentrations in workers' urine between 1968 and 1984

Year	No of workers monitored	No of measurements performed	Mercury concentrations (μ g/l) Mean (SD)
1968	20	58	26.9 (24.8)
1969	27	67	41.5 (37.4)
1970	34	68	38.7 (46.7)
1971	40	112	59.9 (61.0)
1972	48	127	74.3 (68.8)
1973	56	180	78.5 (78.7)
1974	68	243	51.3 (46.1)
1975	72	249	54.7 (50.7)
1976	75	158	68.5 (66.6)
1977	88	193	95.9 (91.4)
1978	78	207	81.8 (66.9)
1979	60	172	66.2 (52.9)
1980	88	258	93.8 (72.3)
1981	91	245	63.4 (56.6)
1982	96	228	55.2 (51.0)
1983	50	130	50.3 (31.1)
1984	91	212	50.9 (38.7)

peak in the years 1977–80 and has since declined. Individual concentrations ranged from 1 to 450 μ g/l with a median value of 45 μ g/l.

The periods of interest for exposure assessment differ according to the hypothesis on the mechanism concerned: exposure during the three months before conception may result in an alteration of spermatozoa themselves, exposure at any time before conception may alter paternal reproductive capacity, and both of these periods of exposure may also imply indirect exposure of the mother to mercury. Unfortunately, measurements available did not allow precise estimates of exposure during these different periods. For short periods, many measurements were missing (42/98 were available during the three months before pregnancy, 79/98 during the year before), and when estimates were available at different periods they were strongly correlated so that the different hypotheses could hardly be discriminated. For greater precision the average concentrations during the entire period preceding pregnancy were used as an index of exposure.

Table 3, which gives the variations in the rate of spontaneous abortion according to the average concentration of mercury in the urine of the father during the months preceding pregnancy shows that

Table 3 Rate of spontaneous abortion according to the average mercury concentration in the urine of the father before pregnancy

	Exposure unknown	Exposed but no measurement	Not exposed	Average mercury concentration (μ g/l)			χ^2 * linear trend
				1–19	20–49	≥ 50	
Rate of spontaneous abortion (per 100 pregnancies)	11.5	2.3	8.6	4.5	13.2	18.4	p < 0.05
No of pregnancies	26	43	616	22	38	38	

*Using four classes (not exposed, 1–19, 20–49, ≥ 50 μ g/l).

Table 4 Rates of spontaneous abortion (per 100 pregnancies) according to mercury concentration in fathers' urine and known maternal risk factors

	Spontaneous abortions per 100 pregnancies					Significance	
	Average mercury concentration ($\mu\text{g/l}$)					Stratum* specific	Overall†
	0	1-19	20-49	≥ 50	Total		
Maternal age (y):							
< 30	8.5 (515)	0.0 (12)	12.5 (32)	21.9 (32)	9.3 (591)	$p < 0.05$	$p < 0.05$
≥ 30	9.4 (96)	11.1 (9)	16.7 (6)	0.0 (6)	9.4 (117)	NS	
Unknown	(5)	(1)	—	—			
Gravidity:							
1	6.7 (284)	0.0 (10)	15.4 (13)	15.4 (13)	7.2 (320)	NS	
2	7.3 (206)	12.5 (8)	10.5 (19)	12.5 (16)	8.0 (249)	NS	$p < 0.05$
≥ 3	15.1 (126)	0.0 (4)	16.7 (6)	33.3 (9)	15.9 (145)	NS	
Tobacco consumption:							
No	9.5 (398)	0.0 (12)	15.0 (20)	16.0 (25)	9.9 (455)	NS	$p < 0.02$
Yes	6.2 (160)	12.5 (8)	20.0 (10)	25.0 (12)	8.4 (190)	$p < 0.01$	
Unknown	(58)	(2)	(8)	(1)			
Alcohol consumption:							
No	13.3 (145)	0.0 (4)	0.0 (7)	12.5 (8)	9.1 (164)	NS	
Low (< one drink/day)	8.2 (400)	0.0 (16)	18.5 (27)	20.7 (29)	9.3 (472)	$p < 0.02$	$p < 0.05$
Regular ($\geq$ one drink/day)	8.9 (56)	50.0 (2)	0.0 (4)	0.0 (1)	9.5 (63)	NS	
Unknown	(15)	—	—	—			
Time since pregnancy (y):							
< 10	10.5 (237)	7.7 (13)	14.3 (21)	23.3 (30)	12.0 (301)	NS ($p = 0.06$)	
≥ 10	7.5 (375)	0.0 (9)	11.8 (17)	0.0 (8)	7.3 (409)	NS	NS ($p = 0.13$)
Unknown	(4)	—	—	—			

*Each stratum was tested using the χ^2 test for trends.†Overall significance was determined with the extended Mantel-Haenszel χ^2 test.

Numbers in parentheses indicate the No of pregnancies.

the risk of spontaneous abortion rises significantly with the mercury concentration ($p < 0.05$).

The possible confounding or modifying effect of risk factors of spontaneous abortion such as maternal age, gravidity, and tobacco and alcohol consumption, and the possible bias in reporting past pregnancies were also considered (table 4). The rate of spontaneous abortion increased with gravidity and was higher for recent pregnancies, but in the stratified analysis there was no evidence that these factors explain the relation seen between spontaneous abortion and the mercury concentration in urine.

In a multiple logistic regression model including maternal age (in years), gravidity (1,2, ≥ 3), maternal tobacco consumption (yes, no), time since pregnancy (< 10 years, ≥ 10), duration of exposure, and the mercury concentration in the fathers' urine (4 classes), only three variables helped to explain the occurrence of abortion at the 10% level: gravidity ($p = 0.05$), time since pregnancy ($p = 0.10$), and the concentration of mercury ($p = 0.07$) (table 5).

Table 6 presents the other exposures considered inside the same plant and the correlation with mercury exposure for each specific exposure. No significant difference was found between the rate of spontaneous abortions in the exposed and non-exposed pregnancy groups, neither among those never exposed to mercury, nor after adjustment on

mercury exposure for those chemicals associated with mercury. Exposures such as chlorine, heat, electromagnetic fields, hydrogen, soda, and sulphuric acid were almost always present when exposure to mercury occurred, but no specific effect of these compounds on spontaneous abortions could be seen in this study.

Eight spontaneous abortions were considered doubtful (seven non-exposed and one exposed) and were excluded from the analysis, but this did not alter the final trend. Neither did the exclusion of women reporting two abortions or more change this trend significantly.

No differences were found between exposed and non-exposed pregnancies for other parameters such as birth weight or the presence of defects at birth but this survey was not specifically designed for the study of these pregnancy outcomes.

Discussion

The present results suggest that there might be a dose related connection between exposure of the father to mercury before the mother's pregnancy and the incidence of spontaneous abortion.

Retrospective studies in which questionnaires are used to assess the relation between spontaneous abortion and occupational exposure are subject to

Table 5 Results of the multiple logistic regression between the risk of spontaneous abortion and several maternal and exposure characteristics

Variables	Coeff $\pm$ SE	p Value	OR	(95% CI)
Gravidity:		0.05		
0 = Reference				
1	-0.15 $\pm$ 0.34		0.86	(0.44-1.76)
≥ 2	0.66 $\pm$ 0.33		1.93	(1.01-3.69)
Time since pregnancy (y):		0.10		
< 10 = Reference				
≥ 10	-0.47 $\pm$ 0.28		0.63	(0.36-1.08)
Mercury concentration: (four levels):		0.07		
0 = Reference				
1 = 1-19 μ g/l	0.27 $\pm$ 0.14		Level 1 1.31	(0.99-1.74)
2 = 20-49 μ g/l			Level 2 1.72	(0.99-3.01)
3 = ≥ 50 μ g/l			Level 3 2.26	(0.99-5.23)
Maternal age (y)		0.71		
Maternal tobacco consumption (yes-no)	Removed from the model	0.60		
Duration of exposure (y)		0.60		

Coeff = Estimated regression coefficient. SE = Standard error of the estimate. OR = Odds ratio. CI = Confidence interval of the odds ratio.

several methodological flaws, which we tried to take into account.

The cross sectional selection of the population is certainly less of a problem for inclusion in a study on men at work than in a study of the occupational exposure of women,¹⁸ as a woman's experience of miscarriage is unlikely to affect the working activity of her husband. Furthermore, a study confined to one plant ensures good social homogeneity of the group examined.

The rate of participation in our study was good (around 77%) and was not influenced by exposure state. Information available on non-responders show that they are slightly younger than responders (35.8 years on average *v* 37.3 years; $p < 0.02$) and that, consequently, their average number of children at the time of the study is smaller (1.5 *v* 1.8; $p < 0.05$). Those differences, however, are not dependent on exposure state. No other information concerning the obstetric histories of their wives could be obtained.

Special care was taken to preserve the confidentiality of the answers to the questionnaire, the questions were very simple, and there was no evidence of misunderstanding. Before the study, an attempt was made to validate the questionnaire in a maternity hospital; 224 women having delivered at this hospital were asked to fill in the questionnaire and their answers were compared with the obstetric information recorded in the medical chart. Subsequent to this test, modifications were made in the questionnaire, especially in the wording of some questions, to better differentiate between spontaneous abortions and induced or therapeutic abortions.

The study was presented to the participants as part of a national survey on occupation and reproductive health, no special attention was focused on mercury, and possible exposure to mercury was assessed from urine measurements and independently of reproductive outcome.

The overall spontaneous abortion rate found here was around nine per 100 pregnancies. This rate is of the order of magnitude of the rates found in surveys of different communities based on questionnaire data.¹⁹

Known risk factors for spontaneous abortions such as maternal age, gravidity, and tobacco and alcohol consumption do not explain the relation found. In our study, gravidity was related to the risk of spontaneous abortions. No type of exposure other than mercury was statistically associated with an increased risk.

Possible bias in reporting past pregnancies did not seem to play a part since the same trend persisted when analysis was restricted to pregnancies which had occurred during the past 10 years.

The relation between mercury concentration and the abortion rate did not alter when doubtful abortions were discarded, or when chronic abortions were taken into account by excluding from the analysis women who reported two or more abortions.

The availability of measurements of mercury concentration in urine allowed precise analysis of the association between paternal excretion of mercury before pregnancy and the risk of spontaneous abortions. It was not possible, however, to study the timing of exposure more precisely or to explore, for instance, the actual role of exposure during the three

Table 6 List of exposures other than mercury present in the plant and their correlation with exposure to mercury

Exposures	No of pregnancies exposed	% Pregnancies exposed		Significance
		Among pregnancies also exposed to mercury*	Among pregnancies not exposed† to mercury	
Acetylene	36	9.5 (74)	5.2 (557)	NS
Alumina	54	8.2 (73)	8.9 (538)	NS
Antimony trichloride	32	2.7 (74)	5.4 (554)	NS
Benzene	63	6.8 (73)	9.4 (616)	NS
Barium carbonate	47	55.6 (72)	1.3 (556)	p < 0.001
Carbon monoxide	67	2.7 (74)	11.7 (555)	p < 0.02
Chlorine	225	100 (74)	28.0 (540)	p < 0.001
Chlorobenzenes	44	2.7 (74)	7.6 (552)	NS
Dichloroethane	80	2.7 (75)	14.1 (554)	p < 0.01
Ethylene and ammonia	67	2.7 (75)	11.8 (553)	p < 0.02
Heat and electromagnetic fields	77	84.9 (73)	2.7 (556)	p < 0.001
Hydrazine	114	57.5 (73)	12.9 (556)	p < 0.001
Hydrochloric acid (solution)	112	2.7 (75)	19.9 (553)	p < 0.001
Hydrochloric acid (gas)	113	5.3 (75)	19.7 (554)	p < 0.01
Hydrogen	107	84.9 (73)	8.1 (555)	p < 0.001
Hydrogen peroxide	30	0 (74)	5.4 (554)	p < 0.05
Soda	163	100 (74)	16.4 (542)	p < 0.001
Sodium hypochloride	94	18.9 (74)	14.4 (556)	NS
Sulphur dioxide	49	5.4 (74)	8.2 (551)	NS
Sulphuric acid	101	89.0 (73)	6.5 (552)	p < 0.001
Vinyl chloride	74	2.7 (75)	11.3 (636)	p < 0.05

*Exposed to mercury = average exposure $\geq 20 \mu\text{g/l}$.

†Not exposed to mercury = in a job not exposed to mercury or dosage $< 20 \mu\text{g/l}$.

No of pregnancies with simultaneous information on mercury exposure and other types of exposure are shown in parentheses.

months preceding conception (the period of spermatogenesis) as paternal exposures at different points in time were closely correlated.

Several biological mechanisms might account for such a finding: they include mutagenesis or male germ cell damage, paternal reproductive toxicity leading to problems of fertility but without genetic damage, germ cell damage from the mother, and maternal toxicity or embryo toxicity through indirect exposure to mercury from the father. Such exposure may indeed exist, because there is evidence that the children of workers exposed to mercury have significantly higher concentrations of mercury in their urine than control children, and that the concentration of mercury in their urine is correlated to the concentration in the parents' urine.²⁰

Lauwerys *et al.*,⁷ who studied the effects of a range of exposure comparable with ours, did not show any difference between an observed and an expected number of children among male workers exposed to mercury vapour compared with non-exposed workers, but they did not look specifically at spontaneous abortions. In a study of women occupationally exposed to mercury vapour, de Rosi *et al.*⁴ did not find any relation between such exposure and spontaneous abortions, but did find a slight overall increase in "adverse pregnancy outcomes" including threatened abortion, spontaneous abortion, and threat of premature or pre-term delivery. The range of exposure reported, however ($< 10 \mu\text{g/m}^3$ atmospheric since 1976), was much lower than ours (between 40 and 90 $\mu\text{g/m}^3$ since 1984). Brodsky *et al.*⁵

reported on the reproductive history of male and female dentists or dental assistants using a mailed questionnaire to assess the type of work, health, and pregnancy history. Dentists were classified into low and high exposure groups depending on the number of amalgams prepared per week. For the pregnancies of these men or women exposed to high mercury concentrations, the spontaneous abortion rate was no higher than for the pregnancies of those exposed to low concentrations. The authors themselves agree that their classification of exposure was crude and that they lacked a truly non-exposed group. A study on the pregnancy outcome of women dentists in Sweden showed no increase in the rate of hospitalised spontaneous abortions compared with other gainfully employed Swedish women.⁶ Several possible explanations were given for these negative findings: firstly, early abortions were underestimated as only hospitalised abortions were included in the study; secondly, work practices in Sweden are especially good, including the use of special equipment for handling amalgams, and actual exposure to mercury may be low. On the other hand, a study in Poland of women dental workers⁸ showed an increased risk of spontaneous abortions and the concentrations of mercury reported were high (0.38 $\mu\text{g/g}$ in pubic hair in the exposed group compared with 0.06 $\mu\text{g/g}$ in the control group).

Most animal experiments failed to show that mercury compounds have a dominant lethal effect but this effect seems to be species dependent. On the other hand, the evidence that mercury does affect

fertility of male rodents and is toxic for early rodent embryos is convincing.^{10,13}

The strength of the present study compared with others might come partly from the fact that it was specifically designed for spontaneous abortions, with a precise questionnaire describing the way the pregnancy was diagnosed, the need for hospital care and the number of weeks of pregnancy, and taking into account known risk factors for spontaneous abortions. The major point is probably the fact that individual urinary measurements were available allowing precise exposure assessments before pregnancy and this made possible the study of a dose response relation.

In a future study one way to help identify the mechanism responsible for these effects in man would be to measure the mercury concentrations in the urine of workers' wives.

The present results give indications that paternal exposure to mercury might increase the risk of spontaneous abortion, a conclusion that could be of practical importance and should therefore be further documented.

This work was financed in part by the Caisse Nationale d'Assurance Maladie des Travailleurs Salariés (collaboration INSERM-CNAMTS). We wish to thank E Przybilski and M Dreyfus for skillful assistance in editing and revising the manuscript.

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Accepted 12 November 1990

Destruction of manuscripts

From 1 July 1985 articles submitted for publication will not be returned. Authors whose papers are rejected will be advised of the decision and the manuscripts will be kept under security for three months to deal with any inquiries and then destroyed.