VIA MEDICA
ORIGINAL ARTICLE
2019; 70, 4: 195–201
10.5603/IMH.2019.0031
www.intmarhealth.pl

ISSN 1641–9251

Exposure to fumigants in containers: a questionnaire assessment on 125 French dockers

David Lucas[1], Lygia T. Budnik[2], Xaver Baur[3]

[1]French Society of Maritime Medicine (Société Française de Médecine Maritime [SFMM]), Brest, France
[2]Translational Toxicology Unit, Institute for Occupational and Maritime Medicine, University Medical Centre Hamburg Eppendorf, Hamburg, Germany
[3]European Society for Environmental and Occupational Medicine, Berlin, Germany

ABSTRACT

Background: *Cases of intoxications to gas from container's atmosphere have been described. For diagnosis, Fum Ex 2 questionnaire has been developed by the European Society for Environmental and Occupational Medicine. The aim of this study was to enhance knowledge on health effects of toxic substances in containers and to validate this questionnaire in medical follow-up and diagnosis.*

Materials and methods: *In 2014, 125 French dockers answered the questionnaire in a face-to-face interview.*

Results: *83.5% declared no exposure to fumigants or pesticides. Most frequently declared symptoms were fatigue and neurological disorders for dockers and respiratory irritation for refrigeration technicians. Only 28 workers wore regularly individual protection equipment.*

Conclusions: *A "healthy worker" effect could explain low level of symptoms. Fum Ex 2 questionnaire is relevant for diagnosis. Workers in all steps of the logistic transport chain and consumers are exposed to containers' atmosphere.*

(Int Marit Health 2019; 70, 4: 195–201)

Key words: dockers, fumigants, container, occupational toxicology, maritime health

INTRODUCTION

The international transport of goods strongly evolved during the last decade. This part of maritime transport grew up from 6 to 9 billion tons between 2003 and 2014 where 42% was done by bulk carriers. Containerised harbour traffic rose to 5.6% in 2013 with a total of 651,1 million 20 foot equivalent units [1].

The multiplicity and high frequency of intercontinental maritime routes (South-East Asia — Europe and America essentially) exposes to the risks of pests scattering. Furthermore, to protect the quality of foodstuffs and other transported products, it is recommended by the Food and Agriculture Organisation of the United Nations Organisation to treated goods by fumigants [2]. However, those fumigants in containers could be responsible for acute or chronic occupational exposure for port staff, dockers, warehouse workers and employees of logistics platform to toxic, carcinogenic chemicals.

Baur et al. [3] published in 2015 a review on those health risks. Main cases were dockers and causative agents were, in order of frequency: formaldehyde, phosphine, methyl bromide, sulphuryl difluoride, ethylene dioxide, 1,2-dichloroethane (ethylene dichloride), dichloromethane and chloropicrine. These chemical products exhibit acute irritating effects: ocular, respirator and nasal, but also neurologic deaths were described further to acute exposures with high concentrations of some of the gases, in particular phosphine and bromomethane. Also solvents like dichloromethane (chloromethane), benzene and toluene are frequently noted in the atmosphere of containers and can come directly from goods or cleaning procedures. Studies performed in the harbours of Hamburg, Rotterdam and Gothenburg showed that exposure limits for such toxic industrial chemicals were exceeded in the atmosphere of a high percentage of the container units [4, 5].

Medium and long-term neuropsychological disorders have been described with all those volatile substances [3, 6].

Dr. David Lucas, French Society of Maritime Medicine (Société Française de Médecine Maritime [SFMM]), Brest, France, e-mail: d.lucas@metrabrest.com

Also respiratory symptoms are well documented. Since many of the substances found are carcinogenic to human (or probably carcinogenic), long term carcinogenic effects could also be expected [7].

The European Society for Environmental and Occupational Medicine (EOM) developed a questionnaire for clinical assessment of occupational exposure to these products [8]. The aim of this study was to enhance knowledge on health effects of toxic substances in container and to validate the aforementioned questionnaire in medical follow-up and diagnosis.

MATERIALS AND METHODS

We translated into French the Fum Ex2 questionnaire of the EOM and send it to Profs. Budnik and Baur for reappraisal. The French version of the questionnaire was applied by an occupational physician or an occupational nurse of Brest and Le Havre health centres, respectively, during a face-to-face interview. Before the study was done, all involved physicians and nurses had information on the aim, means and methods, volatile substances in container and their respective health impact. These physicians and nurses have been working in those centres for more than 3 years and have been trained in occupational health. During the interview of the workers, occupational staff was able to inform and explain the questionnaire and the asked occupational exposures.

Unlike for methyl bromide exposure, there is no known biomarker for phosphine exposure, so it wasn't possible to measure exposure with biomonitoring.

The study was performed in October and November 2014. Every docker who came for a routine medical (re-)examination into the occupational centre was asked to participate.

Inclusions criteria were: working as a docker or in a related occupation during the study period, agreement to fill in the questionnaire.

All questionnaires from Brest and Le Havre were collected by the Brest health centre and analysed with sphinx software. The frequency of symptoms was described for the whole group; frequencies were also compared between subgroups of workers.

RESULTS

One hundred and twenty-five dockers (100 from Le Havre and 25 from Brest) from a total of 130 (5 did not agree to participate) could be included in the study.

POPULATION CHARACTERISTICS

The study group included 124 men and 1 woman, median age was 33 years, and mean time at the workplace was 10 years. 46.24% of them were smokers.103 declared to work as a docker; the others include refrigeration technicians (5), managers (4), tank workers or port engine drivers (13).

83.5% declared that they had not been exposed to fumigants or pesticides. Only 5 workers declared still to be in contact with phosphine, 1 with methylene dichloride and 11 had been exposed in the past. For the 6 workers still being exposed, mean duration of exposure was 3.5 hours per week. In the majority of this group, exposure took place in container atmospheres.

Four of the refrigeration technicians (5 workers) answered that they were still exposed.

For individual protection equipment, 28 mentioned to have worn it regularly, 51 never, the others did not answer. Out of the personal protective devices, gloves were first with 75%, respiratory masks for dust (50%), respiratory mask for gas and solvents (43%) and clothes (32%).

Work-related symptoms, listed in Fum Ex2 questionnaire, reported by workers are in Table 1.

For the refrigeration technicians, most declared symptoms were fatigue (3, sometimes), irritation symptoms (airways 3, mucosa 2) and dyspnoea (3). In the population of dockers, the most common symptom was also fatigue (52%), followed by neurological symptoms (headache 44%) and irritation (airways 27%, ocular 15%) and dyspnoea (18%).

After including answers in two subgroups, namely "often-regularly-sometimes" and "rarely-never", we used a Chi-square test for statistical analysis. There was a significant relation between dyspnoea, headaches and the workplace of dockers. Refrigeration technicians reported less neuropsychological symptoms (depression, sleep disorders, headache, concentration disorders, emotional lability), but more irritating effects. The population is too small for statistical analyses of subgroups.

With the exception of mucosa irritation (p value = 9.4%), no significant association of symptoms was found for regular exposure to fumigants.

For the question: have you been exposed to fumigants in the past years, there was a significant relation with memory disorders ($p = 0.028$; with 3 workers out of 11 exposed, and 3 in the subgroup of 83 workers never exposed) and dyspnoea ($p = 0.098$; 4 workers out of 11 exposed, and 13 out of the 83 never exposed subgroup).

Refrigeration technicians declared significantly higher individual protection equipment wearing than the other workers ($p < 0.01$). In the subgroup of refrigeration technicians, there wasn't a significant relationship between exposure to fumigants and mean time working in the workplace on the one hand and one of the symptoms listed in the questionnaire on the other hand.

DISCUSSION

Our data on the exposure and symptoms of workers having been engaged in container traffic in two French ports add information on health risks to already published

Table 1. Frequencies (in %) of workers who reported work-related symptoms in the past 12 months

	No answer	Often	Regularly	Sometimes	Rarely	Never
Fatigue	0	3 (2.4)	9 (7.2)	52 (41.6)	11 (8.8)	50 (40)
Seizures	1	0	0	0	0	125
Concentration disorders	0	0	2 (1.6)	10 (8)	4 (3.2)	108 (86.4)
Emotional lability	0	0	5 (4)	6 (4.8)	5 (4)	109 (87.2)
Sadness, depression	0	0	4 (3.2)	7 (5.6)	3 (2.4)	111 (88.8)
Sleep disorders	0	5 (4)	15 (12)	22 (17.6)	4 (3.2)	78 (62.4)
Impaired balance	1	2 (1.6)	2 (1.6)	1 (0.8)	1 (0.8)	118 (94.4)
Tremor	1	0	4 (3.2)	3 (2.4)	2 (1.6)	115 (92)
Headache	0	0	14 (11.2)	38 (30.4)	23 (18.4)	50 (40)
Chest tightness, dyspnea	0	0	9 (7.2)	14 (11.2)	6 (4.8)	96 (76.8)
Airways irritation, cough	0	1 (0.8)	7 (5.6)	31 (24.8)	20 (16)	66 (52.8)
Mucosa irritation	0	3 (2.4)	6 (4.8)	18 (14.4)	13 (10.4)	85 (68)
Eye irritation	0	1 (0.8)	5 (4)	13 (10.4)	9 (7.2)	97 (77.6)
Nausea	0	0	0	6 (4.8)	2 (1.6)	117 (93.6)
Dizziness	0	0	0	5 (4)	6 (4.8)	114 (91.2)
Muscle cramps	1	2 (1.6)	6 (4.8)	38 (30.4)	6 (4.8)	72 (57.6)
Memory disorders	0	0	2 (1.6)	8 (6.4)	5 (4)	110 (88)
Dysgeusia	0	0	1 (0.8)	2 (1.6)	2 (1.6)	120 (96)
Numbness	0	0	2 (1.6)	13 (10.4)	4 (3.2)	106 (84.8)
Diarrhoea, abdominal pain	0	0	1 (0.8)	17 (13.6)	5 (4)	102 (81.6)

experiences from other ports. Lists of various chemical products, especially intendedly applied fumigants and volatile organic compounds from the industrial processes, including their concentrations in container atmosphere, were reported from ports in Netherlands, Germany, Sweden, Australia [5, 9, 10, 11]. The EU-OSHA reports on "Health risks and prevention practices during handling of fumigated containers in ports" summarised the literature data on fumigants and levels of exposure [12]. The high numbers of samples, the different locations in the world and type of goods transported in those studies give us information on a broad spectrum of endangering chemicals in container atmospheres. Due to the mainly international transport of goods we can assume that French dockers have the same level of exposure than their colleagues in other countries.

In our study, we are able to include 125 dockers working in two French ports, different in size and container traffic. Dockers in Le Havre only work for container traffic and in Brest, as typical of a medium size port, they work with container traffic as well as with cereal and hydrocarbon transport on bulkers. We used the Fum Ex2 questionnaire which was elaborated by the EOM. It was validated by experts in toxicology, occupational health and maritime medicine, especially from Germany and Netherlands with high experience in the subject.

The relatively high number of subjects and the use of this questionnaire increased the sensitivity of our study and allow us to analyse the results. Unfortunately, subgroups of agents and occupations are mostly too small for significant analysis. Physicians and nurses of the occupational centres had specific training before the study to learn and understand when and where dockers could be exposed to fumigants in containers' atmosphere. The questionnaire was filled in during face-to-face interviews or by debriefing the workers by an occupational physician or nurse of the occupational centre team; reading was done just after answering. In the second case, all answers were confirmed in face-to-face interview by an occupational physician or a nurse. Goals were to limit misunderstanding of questions and to increase exposure assessment relevance with information and explanation to workers. The high response rate (124/125) confirms efficiency of the method.

The first and pregnant result is the low percentage of workers who declared symptoms. We can explain this by a "healthy worker effect". We have a young population, median age at 33 years, and a mean time at workplace at 10 years. Maybe, workers left their job before our study

because of occurrence of symptoms, especially neuropsychological once which could occur after chronic exposure. With 80% of workers answering that they haven't been exposed to chemicals from containers, it's more probable that individual (low to medium level?) exposures were not recognised due to lack of knowledge to link unspecific symptoms to occupational hazards. This may also explain that we could not detect a relationship between declared symptoms and duration of working in the individual occupation.

Refrigeration technicians included in our study were only 4% of workers but 45% of the group with at least one clinical symptom. Nowadays, dockers have to handle containers but not to open and unload them. They only do it if containers are damaged or to assist custom officers. But, refrigeration technicians regularly wash containers after their maintenance. During washing, they can be exposed to residual fumigants (such as aluminium phosphide powder, methyl bromide from treated wood platelets, good stuffs still in containers). Another possible exposure source is natural degradation of container floors. Svedberg found one off-gassing from the container floor in an experimental study. Carbon monoxide (6 ppm.), methanol (8 pm.), and formaldehyde (1 ppm.) were found in container atmospheres [13].

Limitations of our study are: Not all study participants might have been aware of their exposure to fumigants, since it is well known that fumigated and otherwise contaminated containers and goods are not correspondingly labelled and declared in the documents of transport. Further, in our study, atmosphere measurements in workplaces and biomonitoring for assessment of exposure to fumigants or their metabolites in urine or blood were not performed. As mentioned, noticed symptoms might have been unspecific and falsely not related to occupational exposure.

Acute exposures to bromomethane have been observed at Rotterdam for 2 men unloading import containers and a truck driver [6]. Same conditions have been noted for 3 custom officers and a consignee's agent [14]. In October 2015, 4 workers were exposed to phosphine in Le Havre during unloading import containers in a warehouse. Also a mover described an acute exposure to phosphine when unloading furniture from South America [13]. Data published in previous studies and our results demonstrate that health risks due to fumigants and toxic chemicals from the production processes move along and beyond the maritime transport logistic chain and reach warehouses and even sellers and consumers. In 26 cases of fumigants exposure during unloading containers, majority worked in a warehouse and by laboratory analysis ethylene dichloride, methyl bromide, phosphine and methylene chloride were identified [15]. Also, Kloth et al. [16] published a paper on 6 storage room workers exposed to fumigants off gassing from shipped products. They worked in a medium sized European company, which received electronic production parts from south East Asia and South America. Following each incident, the workers noticed irritation symptoms and after second and third accident neurologic disorders. The 6 German workers, French mover and workers in Rotterdam described the same acute and chronic symptoms after exposure to fumigants. Besides important acute effects after exposure to high atmospheric concentration of toxicants (cardiac arrhythmia or failure, neurologic and pulmonary diseases and death), chronic effects have to be considered. Neuropsychological symptoms occurring several years after an accidental exposure (1 to 7 in Netherlands, 5 in French mover) are rarely linked to occupational exposure but they have high social and health impact for workers. Most of them have to move from their jobs, they have long sick leave period and high impact in non-occupational daily activities [6, 14, 17].

The type of volatile toxic agents differs between workplaces and tasks. Phosphine, bromomethane and 1.2 dichloroethane are the most frequently used fumigants in freight container transport. This is important especially for workers who open and enter first containers, i.e. dockers, custom officers, port authority people, consignee's agents, warehousemen, and movers. During goods unloading, gas trapping or activation of aluminium phosphide, bromomethane from wood pellets are still possible. For refrigeration technician the situation is the same. For warehouse and logistic workers who unload boxes from the container, methylene chloride and ethylene dichloride are frequently found. They are used as fumigants and also come directly from goods. Exposures to solvents like formaldehyde, benzene, toluene, and xylene have also been described in some studies [3, 18].

There's an urgent need for a systematic approach towards applied effective a preventive measures. Firstly, promotion of substitution or at least use of lower concentration of fumigants in container's atmosphere should be done. Actually, technical processes and equipment for chemical risk assessment in containers' atmosphere are developed in European countries. In polluted containers, different systems of active ventilation are tested in France and used in several ports and logistic warehouses. Nevertheless, at the individual level, awareness should be raised and rising education and training intensified. In our study, less than 20% of workers were aware of the problem and only 22% declared wearing individual protective equipment regularly. The lack of information and knowledge was also underlined by Petersen in 2014 and Jepsen before. Manual workers were less aware about toxic pollutants in containers than managers [19]. In France, dockers' and custom officers' trade unions already communicated on container's toxic atmosphere. However, such information should also reach

other workers such as movers, warehouse workers, truck drivers, sellers.

The EOM Fum Ex2 questionnaire was developed for diagnosis of occupational or environmental intoxications by fumigants. In the study of Budnik et al. published in 2013 [4], between 2006 and 2012, 164 subjects with presumed fumigant intoxication and 30 controls were recruited and the Fum Ex2 questionnaire was used to select exposed collectives. Exposure assessment was quantified with exposure biomonitoring and 86 patients (including the 26 from the preliminary study of Preisser et al. [15]) had confirmed exposure to fumigants. The effect biomonitoring was used to corroborate long term exposure. Results were used for classified long-term past exposure [4].

In our study, workers had some difficulty understanding the questionnaire. This questionnaire is at this time a part of diagnostic scheme of occupational or environmental intoxication to fumigants with clinical examination, biomonitoring and paraclinical exams. It has to be used in face-to-face interviews, as recommended by DiMoPEX Group [20]. For the daily routine use and screening of populations at risk, we developed a quicker questionnaire which can be easily filled in by the worker and a guide for paraclinical exams (Appendix 1). The latter will be evaluated and compared with the presented data obtained by Fum Ex2 questionnaire in a future study.

CONCLUSIONS

Long-term impact of exposure to fumigants and other toxic chemicals in container atmospheres and their contaminated goods is surely underestimated and often not link to them. People often do not refer to such exposure in cases where such exposure is a possible cause of clinical pictures. A specific study on long-term impact of exposure on workers but also on seller and consumer population is needed. The importance is underlined by a recent study with experimental outgassing performed on packaging materials and textiles with high level of ethylene dichloride out gassing from a doll 21 days after container unpacking [21].

We used Fum Ex2 questionnaire in a large population of dockers who could be exposed to fumigants and other toxic chemical in container atmosphere; however, few symptoms were declared by workers. A lack of knowledge on this risk and a "healthy worker" effect are likely. It is important that endangering exposures are now more frequent beyond the port traffic, i.e. in the following logistic transport chain. This refers to refrigeration technicians, manual workers in warehouses and logistic units, truck drivers, sellers and consumers.

Our study underlines the need of comprehensive information and education of workers about this occupational problem and the individual preventive measures. Actions of communication and technical guides made by the French National Institute of Security should improve the situation. We have now two different questionnaires on the subject, the Fum Ex2 questionnaire for diagnosis and the SFMM for screening. We propose the latter shorter one with guide for medical tests (Appendix 1); but evaluation of it still has to be done.

REFERENCES

1. The United Nations Conference on Trade and Development. Http: // unctad.org/fr/PublicationsLibrary/rmt2014_fr.pdf. Published September 2015 (Accessed March 3, 2019).
2. Food and Agriculture Organization of the United Nations. Http: // www.fao.org / docrep / x5042e / x5042e04.htm. Published 1980 (Accessed March 3, 2019).
3. Baur X, Budnik LT, Zhao Z, et al. Health risks in international container and bulk cargo transport due to volatile toxic compounds. J Occup Med Toxicol. 2015; 10: 19, doi: 10.1186/s12995-015-0059-4, indexed in Pubmed: 26075009.
4. Budnik LT, Kloth S, Baur X, et al. Circulating mitochondrial DNA as biomarker linking environmental chemical exposure to early preclinical lesions elevation of mtDNA in human serum after exposure to carcinogenic halo-alkane-based pesticides. PLoS One. 2013; 8(5): e64413, doi: 10.1371/journal.pone.0064413, indexed in Pubmed: 23741329.
5. Svedberg U, Johanson G. Work inside ocean freight containers–personal exposure to off-gassing chemicals. Ann Occup Hyg. 2013; 57(9): 1128–1137, doi: 10.1093/annhyg/met033, indexed in Pubmed: 23825354.
6. Baur X, Horneland AM, Fischer A, et al. How to handle import containers safely. Int Marit Health. 2014; 65(3): 142–157, doi: 10.5603/IMH.2014.0029, indexed in Pubmed: 25471164.
7. Budnik LT, Kloth S, Velasco-Garrido M, et al. Prostate cancer and toxicity from critical use exemptions of methyl bromide: environmental protection helps protect against human health risks. Environ Health. 2012; 11: 5, doi: 10.1186/1476-069X-11-5, indexed in Pubmed: 22284215.
8. The European Society for Environmental and Occupational Medicine (EOM). https://eomsociety my.sharepoint.com/personal/baur_eomsociety_org/_layouts/15/onedrive.aspx?id=%2Fpersonal%2Fbaur%5Feomsociety%5Forg%2FDocuments%2FWebsite%2FQUESTIONNAIRE%5FFUM%2DEX2%5FEOM%5F%20ENGLISHVERSION23%2D4%2Epdf&parent=%2Fpersonal%2Fbaur%5Feomsociety%5Forg%2FDocuments%2FWebsite&slrid=ceb3579e%2D5067%2D5000%2D2a08%2De69e5207c5ed. Published september 2013 (Accessed March 3,2019).
9. Knol-de Vos T. Measuring the amount of gas in import containers. Report No. 609021025/2003. Rijksinstituut voor Volksgezondheid en Milieu (RIVM). 2002. http://rivm.openrepository.com/rivm/bitstream/10029/9020/1/609021025.pdf (Published October 2002. Accessed March 3, 2019).
10. Baur X, Poschadel B, Budnik LT. High frequency of fumigants and other toxic gases in imported freight containers–an underestimated occupational and community health risk. Occup Environ Med. 2010; 67(3): 207–212, doi: 10.1136/oem.2008.043893, indexed in Pubmed: 19858536.
11. Safe Work Australia. Hazard surveillance: residual chemicals in shipping containers. Canberra, Australia: Safe Work Australia. 2012. http://www.safeworkaustralia.gov. au/sites/SWA/about/Publications/Documents/750/Hazard-Surveillance-Residual-Chemicals-Shipping-Containers.pdf (Published December 2012. Accessed March 3,2019).

12. Bråtveit M, Djurhuus R, Kirkeleit J, Hollund BE. Health risks and prevention practices during handling of fumigated containers in ports. EU-OSHA reports. 2018. https://osha.europa.eu/sites/default/files/publications/documents/OSH%20on%20fumigated%20containers%20in%20ports.pdf.
13. Svedberg U, Johanson G. Occurrence of fumigants and hazardous off-gassing chemicals in shipping containers arriving in Sweden. Ann Work Expo Health. 2017; 61(2): 195–206, doi: 10.1093/annweh/wxw022, indexed in Pubmed: 28395344.
14. Postel A. Le risque toxique des salariés exposés aux gaz de fumigation issus des containers. Mémoire de DES Faculté de médecine-Université de Rouen Avril 2017.
15. Preisser AM, Budnik LT, Hampel E, et al. Surprises perilous: toxic health hazards for employees unloading fumigated shipping containers. Sci Total Environ. 2011; 409(17): 3106–3113, doi: 10.1016/j.scitotenv.2011.04.053, indexed in Pubmed: 21636109.
16. Kloth S, Baur X, Göen T, et al. Accidental exposure to gas emissions from transit goods treated for pest control. Environ Health. 2014; 13: 110, doi: 10.1186/1476-069X-13-110, indexed in Pubmed: 25495528.
17. Loddé B, Lucas D, Letort JM, et al. Acute phosphine poisoning on board a bulk carrier: analysis of factors leading to a fatal case. J Occup Med Toxicol. 2015; 10: 10, doi: 10.1186/s12995-015-0050-0, indexed in Pubmed: 25763098.
18. Keller FX, Lucas D. Chemical risks and container transport. Risques chimiques à l'ouverture des conteneurs maritimes. RST. 2014; 139: 7–9.
19. Pedersen R, Jepsen J, Ádám B. Regulation and practice of workers' protection from chemical exposures during container handling. J Occup Med Toxicol. 2014; 9(1), doi: 10.1186/s12995-014-0033-6.
20. Budnik LT, Adam B, Albin M, et al. Diagnosis, monitoring and prevention of exposure-related non-communicable diseases in the living and working environment: DiMoPEx-project is designed to determine the impacts of environmental exposure on human health. J Occup Med Toxicol. 2018; 13: 6, doi: 10.1186/s12995-018-0186-9, indexed in Pubmed: 29441119.
21. Budnik LT, Austel N, Gadau S, et al. Experimental outgassing of toxic chemicals to simulate the characteristics of hazards tainting globally shipped products. PLoS One. 2017; 12(5): e0177363, doi: 10.1371/journal.pone.0177363, indexed in Pubmed: 28520742.

APPENDIX 1. Questionnaire: assessment of exposure to chemical toxins in containers' atmosphere SFMM

Administrative data:

First Name: Second name:

Age: Sex:

Occupational data:

Workplace:

Time at workplace:

Exposing tasks:

	Yes/no	Frequency	Gas and/or fumigants, if known
Opening containers			
Unloading containers			
Unloading bulk carrier			

Clinical signs:

Do you remember an exposure?

During those work tasks, have you experienced clinical signs like:

Respiratory	Wheezing	Yes/No
	Cough	Yes/No
Nasal	Nasal irritation	Yes/No
	Epistaxis	Yes/No
Digestive	Nausea/vomiting	Yes/No
	Diarrhoea	Yes/No
Neurological	Headaches	Yes/No
	Dizziness	Yes/No
	Consciousness disorders	Yes/No
	Muscular weakness	Yes/No

Chronic exposure:

Respiratory symptoms	Medication for asthma	Yes/No
	Wheezing	Yes/No
	COPD	Yes/No
Neurological symptoms	Concentration disorders	Yes/No
	Memory disorders	Yes/No
	Libido disorders	Yes/No
	Depression	Yes/No
	Smelling or gustative disorders	Yes/No
	Paraesthesia of lower limbs	Yes/No

Medical test:

Initial:

- ECG and cardiologic consultation
- blood: haemoglobin, renal function, liver enzymes
- spirometry
- ergovision and colour vision test

If acute exposure (in short-time):

- human biomonitoring in blood and urine (methyl bromide, ethylene oxide, ethylene dichloride, chloropicrin, methylene chloride)
- blood test with haemoglobin, ionogram, renal function, liver enzymes and muscle enzyme, troponin
- ECG
- spirometry ± methacholine test

Chronic exposure:

- spirometry and methacholine test
- neuro-psychological tests
- colour vision test
- cranial computed tomography