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Research Article

Evaluation of the Level of Exposure to Benzene and the State of Health of the Workers of "ORYX-BENIN SA"

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Abstract

Aim: To evaluate the level of exposure to benzene and the state of health of the workers of "ORYX-BENIN SA". It is a descriptive and analytical cross-sectional study aimed at evaluating the level of exposure to benzene in 18 workers of '' ORYX- BENIN SA ".

Materials and Methods: It was carried out with their informed consent and after they had completed a questionnaire. The data collection was carried out by questionnaire, a direct observation grid, a summary clinical examination of the workers and a composite biological assessment: Blood count and leucocyte count by the Culter method and the determination of urinary phenol by the nitro-4-aniline spectrophotometric method.

Results: 55.55% of the workers are between 26 and 40 years old. They are all male. 61.11% of the workers have less than one year of experience and 22.22% have at least three years of experience. All the workers, grouped in three shifts, work 8 hours a day. None of the workers wear a mask while working. The only means of protection used by all workers are gloves, gowns and safety shoes. No agent of this company works with his back to the wind. The clinical manifestations recorded during the survey are 50% nausea, 38.89% asthenia and 16.16% eye irritation. A total of three chargers show hematological signs of benzene intoxication. The rate of urinary phenol is largely higher than 250 mg/g. of creatinine at the end of the shift.

Conclusion: It is observed that the inversion of the leucocyte formula is moderate in only one charger while it is severe in five and very severe in six. All of the loaders involved in this study were exposed to benzene at more than 25 ppm per working day.

Keywords: benzene; urinary phenol; exposure level; loading activity

Introduction

The first known occupational intoxications were the sartunism of lead miners in the time of Hippocrates. The chemicals responsible for occupational intoxication are numerous and include various sub-categories. Benzene is one of these dangerous and toxic chemicals [1, 2]. Benzene C_6H_6, is a colorless, volatile liquid with a characteristic odor (aromatic). It is highly flammable and its vapors are explosive. It is sparingly soluble in water, but miscible with most organic solvents and mineral, vegetable or animal oils [2]. The main sources of exposure are the petroleum, chemical and petrochemical industries [3]. Also the perfume industry, the manufacture and use of synthetic glues in footwear, leather and rubber goods and furniture. It is also found in laboratories using benzene as an organic synthesis material or as a chromatography solvent [4, 5]. It is found in the transport, distribution and use of fuels (gasoline generally contains 1 to 5% benzene). Benzene is also present in cigarette smoke, which partly explains its presence in the exhaled air of non-occupationally exposed smokers. In an occupational setting, benzene is mainly absorbed through the respiratory tract and to a lesser degree through the skin. The digestive tract is accidental [5]. After inhalation, the quantity absorbed represents 40 to 60% of the quantity inhaled [2]. The fate of benzene in the body has been the subject of numerous investigations. After absorption, it is partly eliminated unchanged in the urine (less than 1%) and in the exhaled air (10 to 50% depending on physical activity and the amount of fat tissue); the rest is bio-transformed. The first step in the oxidation of benzene is the formation of benzene epoxide under the action of mixed- function oxidases in the liver. The main final metabolite is phenol, which is excreted in the urine, either conjugated with sulfuric or glucuronic acid or in free form. A small amount is metabolized to catechol, hydroquinol and then hydroquinone, trans- muconic acid and carbon dioxide. These main metabolites of benzene (benzene epoxide, catechol, hydroquinol, hydroquinone) are considered responsible for its myelotoxic action with a particular emphasis on hydroquinone which has been shown to be the most inhibitory of DNA synthesis [2, 5]. When one visits the workplaces of '' ORYX-BENIN SA'' agents, one wonders if this benzene does not have an adverse effect on their health. It is to answer this question that we have chosen this subject to evaluate the level of exposure to benzene of these workers. The results obtained allowed us to draw conclusions and to suggest practical conditions for a better monitoring of the health of these workers.

Patients and Methods

Our study took place in the company ''ORYX-BENIN SA'' It is a subsidiary of the ADDAX ORYX Group (ADDAX ORYX GROUP: AOG) established in several countries around the world. It should be noted that the activities of ORYX BENIN SA are mainly focused on the import and distribution of hydrocarbons and domestic gas (butane). This is a descriptive and analytical cross-sectional study from January to July 2018, aimed at assessing the level of exposure to benzene among the workers of '' ORYX-BENIN SA ''. It covers 18 (eighteen) workers working at the loading station.

In order to assess the level of benzene exposure of the workers involved in this study, a questionnaire survey was carried out which included closed and open questions; a direct observation grid through workplace visits; a summary clinical examination of the workers; and a composite biological assessment :

- Blood count and white blood cell count by the Culter method;
- Determination of urinary phenol by the spectrophotometric method with nitro- 4-aniline.

In this study we also used acute and chronic toxicity data to assess the level of benzene exposure of workers.

Acute toxicity is observed following short-term inhalation exposure and is responsible for central nervous system depression with clinical manifestations such as drowsiness, dizziness, vertigo, excitement and benzene intoxication, headache, nausea, asthenia, loss of coordination, confusion and even loss of consciousness. These symptoms are reported for exposures greater than 5ppm. Exposure to a concentration of 20,000 ppm is rapidly fatal according to the results of International Labour Office experts [6, 2]. Benzene is a moderate irritant, but it is not a skin sensitizer [2]. Benzene vapors are responsible for eye irritation, but no permanent injury is documented. In case of accidental ingestion, pneumopathic lesions may be observed. The lethal oral dose is estimated at 15mL of pure benzene for

adults [5] No effects on the blood and immune system are observed with short-term exposure. In this case, the central nervous system (CNS) is the primary target.

Chronic toxicity, given the degreasing action of benzene, repeated contact can cause redness, dryness and cracking of the skin. In fact we have an irritation of the skin and mucous membranes. The most notable toxic effect of long-term exposure to benzene is an insidious and often irreversible alteration of the bone marrow via its metabolites [2]. Individual susceptibility and hematological findings vary widely.

Thrombocytopenia, leukopenia or anemia, or one of these disorders (pancytopenia) are classic symptoms. These disorders can occur within a period of 3 months to 17 years [5]. The prognosis for pancytopenia is favourable in the majority of workers if they are removed from exposure, although some changes in blood counts may last for several years.

In practice, the following hematological signs must be recognized as evidence of intoxication and not only of benzene impregnation [5]:

- Red blood cell: less than 3.900.000 GR/ml in men and less than 3.700.000 GR/ml in women ;
- Hematocrit: less than 35% in men and less than 33% in women;
- White blood cells: less than 3500GB/ml ;
- Neutrophils: less than 1200/ml ;
- Platelets: less than 150000/ml.

This benign disorder characterized by a decrease in the number of blood cells that make up benzenism has become exceptional in developed countries due to reduced levels of exposure; in fact, it is a reversal of the blood count, which may go unnoticed if anemia were not present. When exposure persists, benzene causes leukemia, which can occur even years after exposure has stopped.

But according to more recent studies, it is the inversion of the leucocyte formula that is much more indicative of benzene intoxication.

The EPA (Environmental Protection Agency) estimates that a lifetime exposure to 1ppm benzene can lead to a further increase in leukemia mortality of 22/1000 [5].

Statistical analysis

Values are averages ± sd. Statistical analysis of the data is performed using STATISTICA (version 4.1; Stat-Soft, Paris, France). The data were evaluated by analysis of variance. Differences were considered significant when $P<0.05$.

Results

Characteristics of surveyed workers

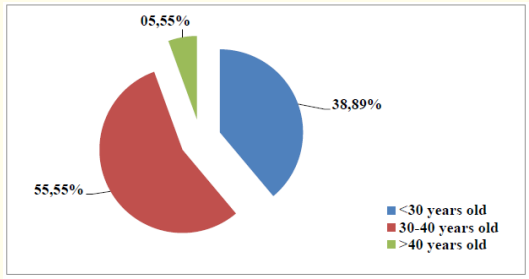


Figure 1: Distribution of Workers by Age.

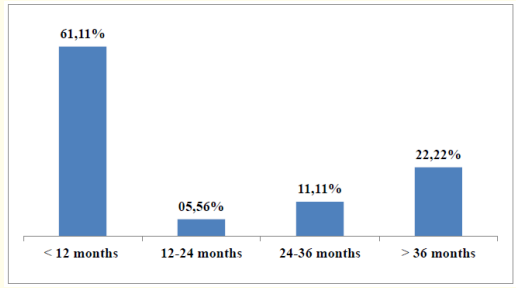


Figure 2: Distribution of workers by seniority in the loader position.

Protective measures

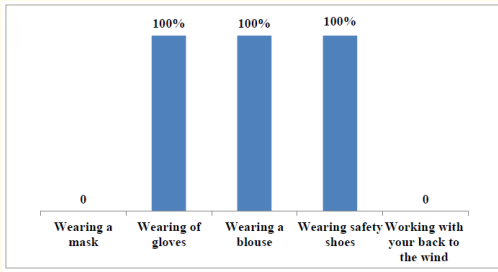
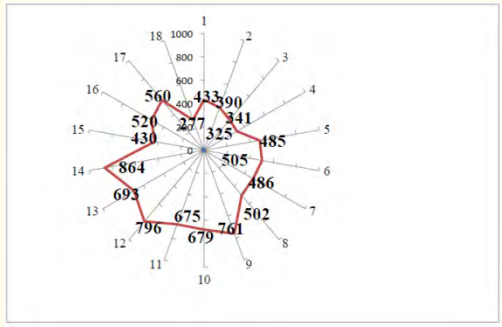


Figure 3: Distribution of Workers by Protective Measures.



Curve 1: results of the urinary phenol test in mg/g. creatinine at the end of the shift.

Clinical manifestations according to seniority.

Seniority	*< 12 months (11)*	*12-24 Months (1)*	*24-36 months (2)*	*> 36 months (4)*
Nausea	6 (54, 54%)	0	1 (50%)	2 (50%)
Vertigo	0	1 (100%)	2 (100%)	1 (25%)
Asthenia	5 (45,45%)	1 (100%)	0	1 (25%)
Dyspnea at work	0	0	1(50%)	0
Irritation of the respiratory tract	3 (27, 27%)	0	0	0
Eye irritation	2 (18, 18%)	0	0	0

Table 1: Clinical manifestations according to seniority.

Results of the bioassessment

Subject Normal				*Subject intoxicated with benzene*			
		Values	*%*			*Values*	*%*
Granulocytes:	Neutrophils	45000	65	Granulocytes:	Neutrophils	125 (5%)	65
	Basophils	280	4		Basophils	75 (3%)	4
	Eosinophil	70	1		Eosinophil	180 (7%)	1
Monocytes:		700	10	Monocytes		700 (30%)	10
Lymphocytes:		1400	20	Lymphocytes		1400 (55%)	20
Total:		7000		Total		2480	

Table 2: comparison of an intoxicated individual to a normal individual.

Charger No.	*GB/ml*	*Hematocrit (%)*	*Neutrophils/ml and %*		*Brochures/ml*	*GRx103/ml*
1	6300	39	1890	30%	191000	4300
2	6800	38	3672	54%	199000	4200
3	9200	41	6164	67%	270000	4550
4	4700	47	1974	42%	249000	5200
5	4000	43	1640	41%	288000	5200
6	3800	48	1520	40%	246000	5300
7	4400	44	2552	58%	219000	4800
8	12900	43	7740	60%	320000	4650
9	5300	43	2438	46%	310000	4700
10	3800	24	2280	60%	345000	2600
11	5200	41	2392	46%	396000	5000
12	4200	39	2268	54%	400000	4200
13	10400	40	6448	62%	292000	4400
14	11800	44	4485	38%	260000	4800
15	4400	35	2112	48%	130000	3800
16	5200	41	3016	58%	250000	4600
17	8100	38	5022	62%	132000	4200
18	7200	44	4608	64%	222000	4900

Table 3: blood count results.

Discussion

The majority of the workers in our study (55.55%) are between 30 and 40 years of age. NISSE and collaborator [7] in a cross-sectional study conducted among fuel transporters in the Nord-Pas de Calais region in 1996 found an average age of 39 years. More than half of the workers (61.11%) have less than one year's experience, while 22.22% have at least three years' experience, compared with 10.7 years in the NISSE and collaborators study [7].

None of the workers wear a mask during their activity, whereas in the workplace, benzene is essentially absorbed through the respiratory tract. The only means of protection used by all workers are gloves, gowns and safety shoes, and skin absorption is therefore very low. Working conditions do not allow any loader in this company to work with his back to the wind. All these considerations are factors that justify how often these workers are exposed to the risks associated with benzene.

The clinical manifestations found in our survey (Table I: Clinical manifestations according to seniority) are mainly nausea, asthenia, dizziness, respiratory tract irritation and eye irritation. Subjects with <12 months seniority; 24-36 months seniority and ≥36mois complained mostly of nausea. Vertigo is only reported after 12 months of seniority. Asthenia already appears at 45.45% in subjects with <12 months seniority. Dyspnea at work was found to be 50% at 24-36 months and respiratory tract irritation at 27.27% at <12 months seniority; as well as eye irritation at 18.18%. For the INRS [8], these symptoms appear at varying concentrations depending on the individual: no effect at 25 ppm, headache and asthenia from 50 to 100 ppm, symptoms more accentuated at 500 ppm, tolerance only for 30 to 60 minutes at 3000 ppm, death in 5 to 15 minutes at 20,000 ppm [9,10].

The results of the blood count (Table III) reveal that the No. 10 loader has a Red Blood Cell count of 2600x103/ml and a Hematocrit of 24% are very low. Chargers No. 15 and No. 17 have very low platelet levels at 130G/L and 132G/L respectively. So three chargers, i.e. 16.66%, have hematological signs of benzene intoxication. The absence of certain assessments such as the medullogram and the short seniority at work do not allow us to highlight cases of leukemia.

The standard of urinary phenol = 250mg/g. of creatinine at the end of the post on the http://www.inrs.fr site is used as a reference [11, 12]. The results of the urinary phenol mg/g balance sheet (Curve1), show that all chargers have a very high urinary elimination reflecting an exposure of more than 25 ppm. The standard is 5 ppm per working day [13, 14].

In the French literature, an excess of leukemia and myeloma is only observed for old exposures occurring 20 years after the first exposure according to IRELAND and al [15, 16] in 1997 or is significant only in workers with 15 years of seniority or more in the company and in those with 30 years of working life according to CONSONNI and al [17, 18] in 1999. Opinion shared by the International Agency for Research on Cancer (IARC) which certifies the leucomogenicity of benzene is for exposures above 100 ppm [19, 20].

On the other hand, RAABE and WONG [21, 22], in 1996 in the oil industry of the United States and the United Kingdom and in 1997 did not find an increase in leukemia of any type. These results were confirmed by the same authors in 1997 not in this industry but also in the oil industry of Canada and Australia [23]. SCHNATTER in 1996, RUSHTON and ROMANIUK in 1997 and WONG in 1999 found no relationship between the occurrence of leukemia and chronic exposure to low levels of benzene in gasoline distribution employees. This finding was contradicted by WESTLEY-WISE et al. in 1999 [24], who found an outbreak of leukemia at very low levels of benzene in the WARRAWONG region of Australia [25].

Conclusion

Symptoms of acute benzene intoxication alone or in combination reported by workers are nausea, dizziness, and tingling in the eyes during or immediately after loading. A total of 12 of the 18 respondents reported burns. It was observed that all the loaders involved in this study had very high levels of urinary phenol at the end of the working day, reflecting an exposure of more than 25 ppm. The standard is 5 ppm per working day. The inversion of the leucocyte formula is moderate in one charger, while it is severe in five and very severe in six.

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Contribution of the Authors

All the authors contributed favorably to the realization of this study. Each of us played his or her score until the manuscript was written. After the first manuscript, they all worked for; the completion of the final version. They even remain ready in case of eventual corrections to work towards a successful publication of our original research article.

Conflict of Interest

There are no conflicts of interest of any kind. We have all worked in a cordial and collegial manner.

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