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Biological monitoring of MDA

Sir,—4,4'-methylenedianiline (MDA) is a primary aromatic amine usually made via the reaction of aniline and formaldehyde. It is used as a hardener in epoxy resin systems. The product produces cholestasis and hepatic necrosis in many animals and caused the so called Epping jaundice when 84 persons ate bread contaminated with it. In industry hepatitis developed in 12 young male workers exposed to MDA.[1] Studies from the National Toxicology programme (NTP)[2] showed that the dihydrochloride salt of MDA is carcinogenic in both sexes of rats and mice, and found cancer of the liver, the thyroid gland, and the haematopoietic system; MDA is structurally similar to benzidine, a known human bladder carcinogen.

The objective of the current study was to measure free and conjugated MDA in the urine of workers as an assessment of exposure.

Method

Urine was collected at the end of a workshift. Until June 1989 MDA was measured in hydrolysed urine with a liquid chromatographic method and UV detection (210 nm). The detection level was 100 ppb (100 μg/l). In May 1990 the method was changed. After reaction with hydrochloric acid, MDA was measured by high performance, liquid chromatography with electrochemical detection using ethylenedianiline as an internal standard. The detection limit was 2ppb (2 μg/l).

The concentration of urinary creatinine was photometrically estimated with a commercial kit (creatinine—Boehringer Mannheim).

Results below the detection limit were handled as the half of the detection limit.[3]

Results

These are presented in the table.

Discussion

Measurements of MDA were carried out at five different times. With many results below the detection limit it is a problem to calculate an average. Here I used the detection limit/2, a method described by Horning and Reed for use when data are highly skewed and with non-detectable values of more than 30%.[3] The real average must be somewhere between the two results given in parentheses (see table footnote).

After August 1988 working conditions were changed: masks, gauntlets, and disposable paper overalls became obligatory. Results for October 1988 showed a distinct improvement. Nevertheless the management took the decision to totally rebuild the unit. In June 1989 a survey without production was done in the new installation. This showed that 19 of 20 results were below the detection limit. One person had a value of 50 μg/g creatinine. The reason for this was not clear.

At the same time a new method using a liquid chromatographic technique with electrochemical detection of MDA in urine was developed in the medical laboratory of BASF Ludwigshafen with a considerably lower detection limit of 2 ppb. In the workshop the "dirty area" was separated from the "clean area" by a sluice. Additional personal protection equipment was used—namely, total protective PVC suits with uncontaminated air supply from outside. After these modifications had been implemented, biological monitoring was repeated. Results at least the same as in June 1989 were expected but they were disappointing. How was it that with the special dress and supply of air from outside, absorption was still possible? Analysis of the work process step by step showed that by changing protective clothing the outside of the dress contaminated the inside. After better cleaning of the protective clothing and improvements in the procedure for changing clothes, the results for June 1990 showed considerable improvement.

Time of measurement	*No of subjects*	*Median*	*Maximum*	*Average*	*Below DL (%)*
August 1988	91	<DL	4110	236 (215–274)	59*
October 1988	87	<DL	550	98 (63–133)	70*
June 1989	20	<DL	50	50 (2–98)	95*
May 1990	107	71	1416	202 (201–202)	4·5†
June 1990	43	11	366	43 (43–43)	0†

Median, maximum, and average are expressed in μg/g creatinine. DL = detection limit. *Detection limit = 100 ppb; †detection limit = 2 ppb. For the average, the results below the detection limit were handled as DL/2. Between parentheses the first value indicates the average if the results below the detection limit were handled as zero, the second value indicates the average if the results below the detection limit were handled as the value of the detection limit.

Conclusion

Even with extreme individual protection, monitoring of urine for the presence of MDA is recommended as a tool for detecting absorption from all sources. The method can also be used for checking work practices and assessing performance of personal protective equipment.

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