EXPERIMENTAL INVESTIGATIONS ON THE QUANTITATIVE ESTIMATION OF ANILINE ABSORPTION IN MAN

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This paper was based on two reports, the aim of which was:

1. The elaboration of a quantitative total aniline absorption index on the basis of the determination of \( p \)-aminophenol excretion in urine;

2. The evaluation of different absorption routes in the experimental conditions.

THE QUANTITATIVE INDEX OF TOTAL ANILINE ABSORPTION

This index was worked out in two separate experiments on men. Piotrowski applied liquid aniline on the skin of the forearm by means of a gauze layer. The amount of aniline absorbed was determined from the difference between the dose applied and the amount of aniline left on the gauze and the skin at the end of the experiment. Dutkiewicz carried out investigations on the absorption of the aniline vapours in the respiratory tract in men. He used a technique which is routine for experiments of this kind. Both authors determined \( p \)-aminophenol in urine by the colorimetric method which is based on the indophenol reaction. However, each of them used a different variant of this method.

From the above experiments two variants of the absorption index were obtained. In the first one the aniline absorption is evaluated on the basis of \( p \)-aminophenol excretion in the urine collected during 24 hours (Figure 1).

![Figure 1](image-url)
Figure 2 represents a typical curve on the $p$-aminophenol excretion in urine, in mg/h, after a 5-hour exposure. The excretion rate between the sixth and eighth hours from the beginning of the exposure is a function of the amount absorbed (Figure 3). The second variant of the exposure test is based on this relation. It is especially valuable, because the collection of the 2-hour urine sample after the exposure is all that is required. The test can, therefore, be carried out during the routine prophylactic examinations.

![Figure 2](image_url)

The results of the investigation of the $p$-aminophenol excretion after absorption of aniline through the skin and respiratory tract are shown together in Figures 1 and 3. In spite of the different absorption routes through the skin and the lungs, and of the different methods of investigations used.

![Figure 3](image_url)
INVESTIGATIONS ON ANILINE ABSORPTION IN MAN

in both experiments, the results show an extremely close agreement. This justifies the claim that the problem of providing a total absorption index of aniline in man has been solved.

The absorption rate obtained by either of the above methods relates to the day in which the test was carried out. The aniline absorption in the preceding period can be neglected, because there is no appreciable accumulation of \( p \)-aminophenol in the body.

The method for the evaluation of exposure to aniline can be used under field conditions, and full details are given in a paper by Piotrowski (1957).

THE ABSORPTION ROUTES OF ANILINE

Dutkiewicz investigated the absorption of aniline vapour in the respiratory tract in man. For this purpose he used a special chamber in which constant conditions of temperature, humidity, and aniline vapour concentration were maintained. The person under examination was stationed outside the chamber and inhaled the air from the chamber. The concentrations of aniline vapour in inhaled and expired air were determined and the volume of respired air was measured. From these results the quantity of the absorbed aniline was calculated. The retention of aniline vapour was constant and very high, approaching 90 per cent.

Liquid aniline as well as aniline vapour is absorbed through the skin very easily. The absorption rate of liquid aniline from layers of gauze, containing 10 mg/cm² (practically saturated with aniline), is very high. It increases with the temperature of the skin and ranges from 0.2 to 0.7 mg cm\(^{-2}\).h\(^{-1}\). The data given represent the maximum values, simulating a situation in which the workers’ skin or clothes are splashed with a large amount of aniline. The absorption rate increases rapidly when the skin is moistened, reaching 3.8 mg cm\(^{-2}\).h\(^{-1}\).

The absorption of aniline vapour through the skin has been rather questionable in the toxicological literature, especially because of the negative results obtained by Schuetze. The absorption of aniline vapour through the skin was systematically investigated in our laboratory in experiments in which absorption via the respiratory tract was excluded.

From Dutkiewicz’s results the following conclusions may be drawn:

(i) In aniline vapour concentrations ranging from 5–20 \( \mu \)g/l, with a temperature of 25°C (or higher) and a humidity of 35 per cent (or higher), a resting, fully relaxed person absorbs through the skin amounts comparable with those absorbed simultaneously through the respiratory tract. The part played by the respiratory tract in the total aniline absorption was estimated to be 36–53 per cent.

(ii) The rate of absorption of aniline vapour through the skin ranges from 0.2–0.4 \( \mu \)g. cm\(^{-2}\).h\(^{-1}\), and is approximately 1,000 times lower than that of liquid aniline. The rate of absorption increases with the concentration of aniline vapour in the air (Figure 4).

(iii) The absorption of aniline vapour through the skin increases with the temperature and humidity of the air. A rise in temperature from 25° to
30°C, and of humidity from 35 to 75 per cent, leads to an increase in the rate of absorption of approximately 30 per cent.

(iv) The use of a simple overall protects a person, to some extent, against aniline vapour, his absorption being reduced by approximately 40 per cent.

(v) The adsorption of aniline vapour on the skin of the exposed person ranged from 1-3 μg/dm². These results are of some importance for the explanation of the mechanism of aniline vapour absorption through the skin.

CONCLUSIONS

(1) In consequence of the considerable absorption through the skin, the exposure of workers cannot be assessed merely by determining the concentration of aniline in the air.

(2) The total amount of absorbed aniline can be evaluated on the basis of the p-aminophenol excretion in the urine. The accuracy of this evaluation is sufficient for prophylactic purposes.

(3) We suggest that, for aniline, the absorption of which has now been sufficiently studied, the principle of estimating the maximum allowable absorbed amount should be introduced. We suggest 35 mg of aniline daily as the maximum allowable dose. This amount was calculated on the basis of the value of 5 μg/l. for the maximum allowable concentration of the aniline vapour in air which is accepted in the U.S.S.R. Only the vapour absorption was taken into consideration in arriving at the following values:

(a) absorption by the respiratory tract, during a 6-hour working day, when approximately 5 m³ of air will be inhaled, equals 25 mg;

(b) absorption through the skin, when the worker uses a normal overall, approximately equals 10 mg.

The proposed amount of 35 mg of aniline corresponds to a maximum amount of 15 mg of p-aminophenol in 24 hours urine, or to a rate of p-aminophenol excretion not exceeding 1·5 mg/h in a 2-hour urine sample collected after the end of the work.
Bibliography


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