

ROUTINE MEDICAL INSPECTIONS IN THE CARE OF THE HEALTH OF THE LEAD WORKER

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ABSTRACT

The organisation, conduct and record keeping for routine medical inspections carried out by Chloride Industrial Batteries Limited in the care of health of lead workers in the lead-acid battery and secondary lead smelter industry is described.

Operational experience and results for haemoglobin, blood lead, zinc protoporphyrin, ALA in urine, ALA-creatinine ratio in urine, coproporphyrin in urine and nerve conduction velocity are presented and discussed.

Lead poisoning became a notifiable disease in the United Kingdom in 1899. In 1925 the Electric Accumulator Lead Regulations instituted minimum standards for occupational hygiene. Pre-employment medical examinations and monthly medical inspections were introduced and responsibility was put on the worker for his own personal hygiene. It was as recently as 1964 that quarterly haemoglobin estimations became statutory and it was not until 1973 that the Code of Practice was introduced.

Chloride Industrial Batteries Limited have always recognized that the Statutory Regulations were not sufficient and have continued to be involved in a progressive programme of biological monitoring. Co-operation and trust between management, trade unions, employees and the Occupational Health Department has been earned and established.

ORGANISATION AND RECORDS

This is a mammoth task on a site employing approximately 2 000 industrial workers. Departments are divided into high and low risk areas. All areas are covered each quarter and the volume of work is evenly distributed each month. Every worker has his own individual biological monitoring record card. Cards are kept in departmental order, records can be moved to another department should a man change his occupation. Records are strictly confidential to the Occupational Health Department. Honesty has always been the policy of the department and an employee's own results are divulged to him alone if they exceed the acceptable limits or should he enquire.

BIOLOGICAL MONITORING

High risk areas

Each man has a statutory haemoglobin estimation done every three months and a lead-in-blood test twice yearly. Alternating with the lead-in-blood analysis each man has urinary ALA determined twice yearly and is screened at 1.1 mg/100 ml urine. Those exceeding 1.1 mg have a lead-in-blood analysis done.

Any employee who has blood lead, confirmed by a second specimen, at 75 $\mu\text{g}/100$ ml blood and over is seen by the medical officer and suspended from lead work until the blood lead returns to around 60 $\mu\text{g}/100$ ml. During an employee's suspension, monthly estimations are carried out and men are seen by the medical officer when results are known. Note: Suspensions at 100 μg are Government recommendations.

Low risk areas

Each man has a statutory haemoglobin estimation done every three months. Until the end of 1977 urinary coproporphyrins were estimated twice yearly. This test has now been replaced by a yearly blood lead test as recommended by the Code of Practice.

TYPES OF BIOLOGICAL EXAMINATIONS

Haemoglobin

This is a test of effect. Only capillary blood from the ear is used. The test is not of great value if done alone and results must be assessed in conjunction with blood lead, ALAU and a past medical history. Accurate estimations of haemoglobin can be difficult. Inaccurate results can be obtained if a man is a slow bleeder when more red cells are squeezed from the ear lobe. The ear lobe, in preference to the thumb or finger, is chosen because the sample is easier to obtain and less painful. The blood flows more easily, not much pressure is required and therefore, more red cells are not squeezed out. There is also less risk of infection in an industrial environment. Differing results have been obtained when haemoglobin was estimated in samples of venous blood. We have found venous blood haemoglobin to be 5% lower than capillary blood haemoglobin. Current legislation takes the two types of blood to be interchangeable when cases of lead poisoning are reported. Differing results have been reported when blood has been tested by ourselves, an independent laboratory and a hospital. This is probably due to an error of technique. Haemoglobin is estimated with a haemoglobin meter. Haemoglobin estimation does not give enough early warning of increased lead absorption for steps to be taken to avoid clinical lead poisoning.

Lead-in-blood

Lead-in-blood is a test of absorption. Only venous blood is used. Blood samples are taken in de-lead heparinised syringes because of the lesser risk of contamination. The degree of contamination is greatly increased when capillary blood is used. Capillary blood is easily contaminated from lead dust in the hair

and on the skin no matter how carefully the hair is covered up and the skin cleaned. Control checks are taken periodically. Two samples of blood are taken from the same man and sent to the same laboratory, one of the samples bearing a fictitious name. Samples of blood are also sent to two or more laboratories and the results are compared. Differing results have been obtained both from the one laboratory and the control laboratory. Blood lead values are normally estimated by atomic absorption spectrophotometry and occasionally by the dithizone method. Lead-in-blood is considered to be a reliable test of absorption but from experience of differing results it is questionable whether the test should be relied on when it is done only in conjunction with haemoglobin.

Aminolaevulinic acid-in-urine (ALAU)

This test of effect measures changes in body chemistry following the absorption of lead. It can be carried out much easily and cheaply by non-medical personnel than blood lead tests. The giving of a sample of urine is more acceptable than venepuncture to the majority of workers. Increased ALA has been detected in urine before the blood lead has risen. Urine samples are not used where the specific gravity is below 1.016. For this reason mid-morning specimens are used before there has been too much fluid intake. Certain medications have been found to affect the ALAU result. High doses of aspirin are known to cause an increase in ALAU and normal doses of diuretics a decrease in ALAU.

Lead-in-urine

This test of absorption is carried out only occasionally by Chloride Industrial Batteries Limited, usually if an employee refuses venepuncture. Urine specimens must be collected in lead-free containers. The urine samples are easily contaminated by lead from the employee's clothing and body. There is no guarantee that the worker has removed his clothing and washed his hands before passing the urine specimen. Too much reliance is placed on the employee to avoid contamination.

Zinc protoporphyrin-in-blood (ZPP)

This is a test of effect. A haematofluorometer, equipment used to estimate ZPP in the red cells, has been acquired recently in order to screen lead workers more quickly, easily and cheaply. We needed to know if this test was a more reliable screening method than our existing tests. Two instruments were used simultaneously after they had been standardised and calibrated by the manufacturers. ZPP was measured in both capillary and venous blood samples. It was found that instrument "two" consistently read higher than instrument "one". No explanation can be offered for the difference between the instruments. The ZPP measurements in capillary blood samples were compared with those taken in venous blood and there was found to be a consistent difference between the "two" types of blood. Capillary blood ZPP was consistently higher than venous blood ZPP. We have previously noted a consistent difference between the two

types of blood when estimating haemoglobin level i.e. capillary haemoglobin is 5% higher than venous haemoglobin. The cause of this difference cannot be explained:

- a) As our blood lead measurements are taken in venous blood; we compared venous ZPP with venous blood lead. The correlation was 0.397 indicating a poor relationship.
- b) As capillary blood is easier to obtain, we compared capillary ZPP with venous blood lead and found the correlation coefficient (0.34) to be lower than between venous ZPP and venous blood lead (0.397).
- c) The venous ZPP values were compared with ALAU and a poor correlation coefficient (0.57) was determined.
- d) We tried to use the ZPP measurement as a screening indicator for ALAU. It is possible to use a ZPP level of 100 as an indicator to test for ALAU but this is not practical as few people have a ZPP less than 100.
- e) Haemoglobin values were compared with venous ZPP values. The correlation coefficient (-0.01) indicated no relationship at all.
- f) Blood lead values were compared with those of haemoglobin. A poor relationship was indicated (correlation coefficient 0.18).
- g) ALAU and haemoglobin values were compared. There was no relationship between the results (correlation coefficient 0.06).

ZPP estimations as a screening method for blood lead have not been instituted in the factory.

Motor nerve conduction velocity

It is thought that motor nerve conduction velocity will improve if the lead worker is removed from lead exposure. We attempted to prove that nerve conduction velocity will slow down when the worker is exposed to lead. An opportunity to carry out a survey was taken following workers' return to work after nine weeks of industrial dispute. A random sample of lead workers (i.e. every ninth employee), a total of 40 employees, and a control group of 40 non-lead workers were tested on a monthly basis for 5 consecutive months. Only male employees were included in the survey. During the survey blood lead, zinc protoporphyrin and haemoglobin tests were also carried out. The results confirmed a poor relationship between zinc protoporphyrin and blood lead values. This survey showed that blood lead rose over the 5 months following the 9-week period of non-exposure. Lead-in-blood rose considerably over the first month and then more slowly over the following 4 months. To test motor nerve conduction velocity a prototype battery operated machine was loaned to us and tests were carried out on the left median nerve. We found that motor nerve conduction velocity decreased over the five-month period. It was not so pronounced in the first month but there was a considerable drop over the 5-month period and variation increased dramatically. There was no correlation between lead-in-blood and nerve conduction velocity.