

THE HAEMOGLOBIN CONCENTRATION OF WORKERS CONNECTED WITH INTERNAL COMBUSTION ENGINES.

By C. E. JENKINS.

(From the Pathological Department, Salford Royal Hospital.)

THE present investigation was undertaken to test the American suggestion that the higher mean concentration of haemoglobin in males in America, compared to this country, is due to the chronic inhalation of carbon monoxide from the exhaust of closed motor cars (Price-Jones, 1931).

If this explanation is adequate, one would expect workers with I.C. engines to show a higher concentration than those not so employed.

In Salford the Hb concentration for normal males agrees closely with the American figures, being approximately 115 per cent. in Haldane's scale, as measured by the flicker haemoglobinometer calibrated to a standard determined by the Van Slyke method. The differences due to age periods also agree. These results were obtained from the examination of 53 males between the ages of 20 and 50, all of whom earned their living in the surrounding industrial area. Few of them owned cars, but more may have travelled to work in motor buses.

Through the interest of Dr Henry, Medical Inspector of Factories, and the courtesy of the Salford Corporation Transport Dept., I was afforded an opportunity of examining 58 men as they finished work for the day and who might therefore be expected to show CO in the blood if they had absorbed any. The test used for carboxyhaemoglobin was a simple one and shows the presence of the compound down to 4 per cent. when mixed with oxyhaemoglobin.

METHOD OF COLOUR CONTRAST TEST.

From the finger or ear 0.1 c.c. of blood is mixed with 9.9 c.c. of distilled water. At the same time a sample of blood from some individual presumed to be free from the risk of exposure to the gas is taken as a control and diluted to 1 in 50 with distilled water.

A rectangular glass cell, divided into two compartments, is taken and the blood under test placed in one compartment whilst the other is partially filled with the standard blood. The latter is then diluted with distilled water until it is an approximate colour match with the sample to be tested. An exact match is not necessary.

One drop of freshly prepared 5 per cent. potassium ferricyanide solution is placed in the suspected blood first, then another drop in the control compartment. It is done in this order to obviate any suggestion that the control has had a start in point of time.

Each solution is mixed at once with a pipette. The red colour fades immediately and is replaced by a clear yellow, but a CO sample has a slight but distinct orange tinge if the concentration is not below 4 per cent. The change is complete in three minutes and then remains stationary for at least an hour. Stronger concentrations show a correspondingly enhanced difference. The reliability of the contrast test was examined by showing the cell to unskilled strangers, such as nurses, and telling them that one compartment might or might not have an orange tinge compared to the other. In concentrations of 4 per cent. a mistake has never been made. Another test is for the observer to shut his eyes whilst the cell is rotated a number of times, then to judge the colour from a distance of 5 ft., the cell standing on a white tile. The observer should be able to pick out the correct compartment 10 times out of 10 without hesitation.

The least doubt should cause the test to be reported as negative.

The blood taken from the workers who volunteered were all examined for CO-Hb and the Hb concentration was estimated. Every man was asked if he suffered from headaches but no attempt at cross-examination on this point was made.

RESULTS.

Total Cases	58
Drivers	12
Garage workers	41
Conductors	5

No difference was found between these three classes by any tentative classification, so they were all placed in one large group.

Average Hb of all cases	115.9 %
Number complaining of headache	28
Hb of headache cases	114.8 %
Number not complaining of headache	30
Hb of those not complaining of headache	117.0 %
Cases showing CO in blood	13 (=23 %)
Hb of CO cases	122.6 %
Hb of cases not showing CO	114.0 %
CO positive complaining of headache	6
CO positive not complaining of headache	7
Cases of no headache or CO	25
Hb of above	110.3 %
Cases of either CO or headache	33
Hb of above	120.2 %
Highest Hb showing CO	138.0 %
Lowest Hb showing CO	109.0 %
Highest Hb not showing CO	138.0 %
Lowest Hb not showing CO	100.0 %
Average ages:	
Total	35 years
No headache or CO	36 "
Headache only	33 "
CO only	33 "

Headache was chosen as the best single symptom indicative of CO poisoning but the results show that it is of small value.

The CO cases are undoubtedly higher than the others and since the Hb

cannot be expected to rise within a few hours of the commencement of CO absorption one must assume that the high reading is the compensatory rise produced by previous absorptions or a mild continuous absorption. It is possible that the absence of a history of headache might indicate the latter. Absorption may be determined by the nature of the work, the mechanical condition of the vehicle, or by indifference to risk on the part of the workers.

The results of the colour contrast test indicates only the CO-Hb present at a given moment, and it is possible that small proportions disappear rapidly so that the classification of the individuals examined might be different after an interval of 24 hours, but hardly likely that the Hb would rise or fall much in the same period.

If the Hb of those showing neither headache nor CO be taken as the normal (110 per cent.), then to raise the Hb concentration to the American and Salford levels requires that not less than 23 per cent. of the total population must at any random moment show evidence of CO in the blood by the contrast test. This is an incredibly high proportion. The level of 110 per cent. is more probably due to slight anaemia from working in a fume laden atmosphere, for it should be realised that the exhaust fumes of i.c. engines are composed of CO, CO₂, soot and half-burnt lubricating oil, and if the carburettor mixture is rich, of unburnt petrol and benzol. The latter is more likely than the former to escape combustion, because it requires more air for complete combustion and it has a higher ignition temperature.

Finally it may be pointed out that Haden (1922) obtained 113 per cent. Hb as the normal male mean in America: at that date the open touring car was universal.

The complaint of "gassing" should be received with caution as many of the men did not distinguish between exhaust fumes and vapour from a large fuel storage tank. In fact one or two asserted that the latter fumes were much more poisonous than the former.

CONCLUSIONS.

Chronic or intermittent exposure to CO tends to raise the Hb concentration, but it is not adequate to explain the difference said to exist between America and Salford on the one hand and London on the other.

REFERENCES.

- PRICE-JONES, C. (1931). *J. Pathol. and Bact.* **34**, 779.
HADEN, R. L. (1922). *J. Amer. Med. Assoc.* **79**, 1496.

(*MS. received for publication 28. 1. 1932.—Ed.*)