Public Health Briefs

Abstinence from Smoking and Expired-Air Carbon Monoxide Levels: Lactose Intolerance as a Possible Source of Error

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Abstract: We investigated a possible source of contamination of expired-air carbon monoxide (CO) readings on CO monitors from raised expired-air hydrogen (H_2) levels, namely lactose intolerance, the norm in certain ethnic groups. A significant correlation between expired-air CO and H_2 readings was observed in four non-smoking lactose maldigesters. (*Am J Public Health* 1990; 80:1114–1115.)

Introduction

Expired-air carbon monoxide (CO) measurement is a simple and cheap method of validating non-smoking status in ex-smokers.[1] While falling short of the specificity and sensitivity of cotinine measures, it is the preferred method in a wide range of field settings.[2] Its application takes on particular value in the light of the increasing use of nicotine replacement strategies in smoking cessation. It is important that this test be valid if the success rates of smoking cessation interventions are to be correctly estimated and individuals spared needless embarrassment should they be suspected of not telling the truth about their smoking status.

We investigated a possible source of false positives in expired-air CO readings.

Method and Results

Bedfont EC50 and EC50 micro smokerlyzer portable CO monitors are the most popular means of measuring expired-air CO in smoking clinics in the United Kingdom[3] and are also used in the United States. The non-smoking/smoking cut-off CO value most commonly used is 10 ppm.[2] A non-smoking member of our staff was surprised to find a level of 36 ppm expired-air CO after routinely blowing into such a monitor as a demonstration of its use. This raised level was obtained with other Bedfont CO monitors and was not attributable to raised ambient CO.

Expired-air CO levels after 20 seconds breath-holding are in approximate equilibrium with the concentration of carboxyhaemoglobin in the blood.[1] However, in this case, carboxyhaemoglobin levels were normal (1.0 percent) indicating that expired-air CO levels were not raised and that the CO monitor must have been picking up another gas.

The instruction manual for these monitors indicated that they are specially constructed to be insensitive to interferences from hydrogen (H_2), alcohol, and other organic species.[4] As alcohol was eliminated as a possible source of interference, H_2 levels were investigated. The technical specification for the CO monitors indicates that 20 ppm H_2 would give less than a 4 ppm reading.[4]

Raised H_2 levels in humans can arise from several causes, such as lactose intolerance, excessive bacteria in the small intestine and variations in transit time through the small intestine.[5] Recent studies also indicate that breath H_2 excretion increases between three and seven hours after normal subjects have ingested flours derived from whole or refined wheat, oats, corn, potatoes or baked beans.[6]

Monitoring the subject's CO levels throughout the day revealed a strong diurnal pattern which was possibly related to food intake (breath hydrogen tends to be higher after waking).[6] Further investigation revealed that this subject was lactose intolerant. A Bedfont EC60 H_2 monitor which measures the H_2 content of expired air, confirmed that H_2 levels were raised and mirrored the apparent CO levels throughout a typical working day (see Figure 1). This suggested that the CO reading was being contaminated by raised H_2 levels.

The relation between expired-air CO and H_2 levels was further investigated using lactose tolerance tests.[7] A significant correlation between the expired-air CO and H_2 readings was observed in this subject and in an additional three

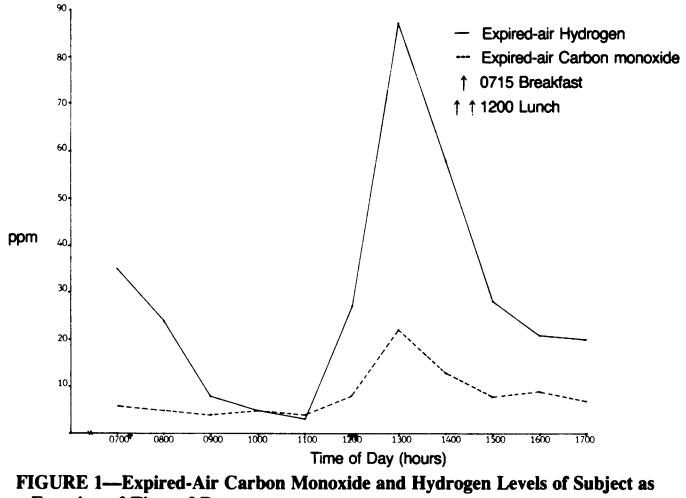

FIGURE 1—Expired-Air Carbon Monoxide and Hydrogen Levels of Subject as a Function of Time of Day

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non-smokers who were known to be lactose maldigesters ($r = 0.99$, $r = 0.95$, $r = 0.97$, and $r = 0.75$; $n = 6$ for each subject; range for CO values = 3 to 34 ppm; range for H_2 levels = 2 to 183 ppm). A regression analysis was carried out using the CO and H_2 values to estimate the level of hydrogen at which a CO reading of 10 ppm would be obtained. A linear trend was fitted across time and yielded a non-significant time-subject interaction and between-subject effect. An expired-air H_2 level of 38.91 ppm would be sufficient to register 10 ppm on a CO monitor (2.5 percent of individuals with levels of 42.07 would register less than 10 ppm, 2.5 percent of individuals with levels of 35.75 would register above 10 ppm). In lactose maldigesters a CO level of 10 ppm would therefore be achieved by consuming, for example, 350 ml or approximately two small glasses of milk.

Discussion

Despite the methodological limitations imposed by the small sample size, the strong patterns observed indicate that there may be cases where individuals classified as smokers on the basis of CO validation have a condition which results in raised expired-air H_2 levels. The proportion of the population who would fall into this category is unknown. As stated earlier, one of the causes of raised H_2 levels is lactose intolerance, which is thought to have a strong hereditary component: a recent estimate of primary lactose intolerance in the UK is given as 6 percent.[8] However, it can also be acquired following diseases which damage the small intestinal villi, for example, giardiasis, coeliac disease, tropical sprue, chronic alcoholism, rotavirus infections in children, and cholera.[7,8] Furthermore, not all lactose intolerant individuals are aware of their condition[9] and some can tolerate moderate quantities of milk, possibly as a result of acquired tolerance to the symptoms.[7]

The likelihood of middle-class Caucasians having raised H_2 levels due to lactose intolerance which could contaminate CO levels may be minimal. However, in certain ethnic groups the prevalence of lactose intolerance is much higher, for example, Jews,[9] American Blacks (among whom the figure is 75 percent), and certain African and Oriental races where it approaches 100 percent.[8] It would be counter-productive if a greater proportion of minority groups, when attempting smoking cessation, were to be wrongly labeled. Among such groups, CO validation may need to be supplemented by cotinine, or if nicotine replacement is being used, by carboxyhaemoglobin analysis. It would not be sufficient when performing the expired-air CO test to ask when the subject last consumed a dairy product as there are considerable inter and intraindividual differences in rates of absorption.[6]

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