

## Using the current Brazilian value for the biological exposure limit applied to blood lead level as a lead poisoning diagnostic criterion

A utilização do atual limite brasileiro de tolerância biológica da plumbemia como elemento diagnóstico no saturnismo

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**Abstract** *In general, biological exposure limits are only used for the promotion and preservation of workers' health and are not applied for diagnostic purposes. However, the issue is controversial for certain types of occupational poisoning. This paper proposes the utilization of biological exposure limits currently applied to blood lead levels in Brazil as an important criterion for diagnosing occupational lead poisoning. The author argues that contrary to the traditional clinical criterion, one should deal with the diagnostic problem of lead poisoning from an epidemiological perspective, using the current Brazilian value for the biological exposure limit applied to blood lead level as an indicator of high relative risk.*

**Key words** *Lead; Lead Poisoning; Risk; Biological Exposure Limit; Occupational Health*

**Resumo** *Tradicionalmente, os limites de tolerância biológica são utilizados exclusivamente para a promoção e a preservação da saúde dos trabalhadores, não sendo aplicados com fins diagnósticos. Entretanto, com relação a algumas intoxicações profissionais, o assunto é polêmico. Neste artigo, defende-se a utilização do limite de tolerância aplicado atualmente no Brasil à plumbemia como um critério importante para a realização do diagnóstico da intoxicação profissional pelo chumbo. Argumenta-se que, em oposição ao tradicional critério clínico, deve-se abordar o problema do diagnóstico da intoxicação pelo chumbo sob um ponto de vista epidemiológico, utilizando-se o atual valor do limite de tolerância para a plumbemia como um marcador de risco relativo significativamente aumentado.*

**Palavras-chave** *Chumbo; Saturnismo; Risco; Limite de Tolerância Biológica; Saúde Ocupacional*

## Introduction

Since the consolidation of Internal Medicine as the medical practice devoted to curing individuals, establishing diagnostic criteria has always been a controversial issue. Public Health – and particularly Epidemiology – by taking the clinical definition of a case and extending it to the collective level, have introduced greater complexity into the issue. In the field of Occupational Health, this difficulty is further aggravated by the fact that the discussion of relationships between work and health are more permeable to economic interests and the political game.

There is a current debate over the convenience of using the biological exposure limit (BEL) as an important diagnostic element for some types of occupational poisoning, including occupational lead poisoning or plumbism. This discussion is particularly relevant in view of the magnitude in the distribution of such diseases in Brazil and the implications of incorporating BEL into the diagnosis of occupational poisoning for preventive and even curative measures.

In a recent literature review, Cordeiro & Lima Filho (1995) analyzed a large number of independent international studies pointing to the occurrence of central and peripheral neurological disorders in workers exposed to lead, with biological exposure and effect indices well below the biological exposure limits adopted by the Brazilian Ministry of Labor. Later, Cordeiro et al. (in press) demonstrated the occurrence of peripheral neurological disorders in workers at a battery factory in Brazil, whose blood lead levels during the two years prior to the study had consistently been below the safe limits established by the Ministry of Labor. Such studies have reignited the controversy over diagnostic criteria used for characterizing occupational lead poisoning in Brazil.

The purpose of this study is to contribute to this discussion by defending the validity of using the current BEL applied to occupational lead poisoning as one of the relevant diagnostic elements for lead poisoning in Brazil.

## The basis for biological exposure limits

The American Conference of Governmental Industrial Hygienists (1959) defined occupational hygiene as “the science and art devoted to the recognition, assessment, and control of ambient risks and stress originating from or in the workplace, which can cause disease, dam-

age to health and well-being, and significant discomfort and inefficiency among workers or members of a community”. Della Rosa & Colaccioppo (1994) underscore that the term occupational hygiene, as compared to industrial hygiene or labor hygiene, better reflects the content and objectives of preventing work-related injury and is currently recommended by various organizations in the European Community and the World Health Organization.

Included in the range of occupational hygiene is ambient monitoring, which was defined by the joint committee set up by the European Community Commission (ECC), Occupational Safety and Health Administration (OSHA), and National Institute for Occupational Safety and Health (NIOSH) as the “measurement and assessment of agents in the environment in order to estimate ambient exposure and risk to health by comparison of results to appropriate references” (Berlin et al., 1982).

In addition to ambient monitoring, biological monitoring is recommended. The latter is defined by the joint CCE/NIOSH/OSHA committee as “the measurement and assessment of chemical agents or their biological by-products in tissues, secretions, excretions, exhaled air, or some combination thereof, to estimate the exposure or health risk as compared to an appropriate reference” (Berlin et al., 1982). Biological monitoring aims to estimate the bioavailable amount of the chemical agent, complementing ambient assessment and providing a more solid basis for developing allowable limits related to environmental pollution, in addition to establishing normal reference value intervals for the biological exposure indices (Della Rosa et al., 1991).

Biological monitoring measures and accompanies biological indices, defined in Appendix II to Regulatory Directive No 7 of the Brazilian Ministry of Labor as “any and all endogenous or exogenous substance in the body, the measurement of which in bodily fluids, tissues, and/or exhaled air assesses the intensity of occupational exposure to chemical agents” (MT, 1988).

Based on knowledge of the relationship between exposure, internal dose, and effect, biological exposure limits (BEL) are proposed, the concept of which was introduced into Brazil's Consolidated Labor Legislation (*Consolidação das Leis de Trabalho – CLT*), Articles 189 and 192 (Brasil, 1978), and which appears in detail in Appendix II to Regulatory Directive No 7 as “an alteration and/or maximum concentration of an endogenous substance in the body which must not be surpassed...” (MT, 1988).

Thus, keeping the lead-sensitive biological indices below the established BEL would ensure preservation of the health of the exposed individual (Siqueira, 1992).

In Brazil, the established BEL for various injuries, including exposure to lead, have constituted a legal norm since 1983 (MT, 1988), recently extended (in 1994) under Directive 24/94, also pertaining to the Ministry of Labor (MT, 1994).

### The controversy

Utilization of biological exposure as a diagnostic element for lead poisoning is a controversial issue in the literature. Some authors stress that such limits cannot be taken as figures that clearly demarcate between safe and unsafe exposure; rather, they should be seen as warning levels proposed on the basis of current knowledge concerning the relationship between exposure and response (Della Rosa & Colaccioppo, 1994; Siqueira, 1992; Della Rosa et al., 1991; Della Rosa & Siqueira, 1989). To a greater or lesser degree, such authors play down the importance of BEL as a diagnostic aid for lead poisoning, which in their opinion should be established strictly on the basis of clinical parameters, i.e., based on observations of signs of the disease. Nevertheless, some authors (Buschinelli, 1987; Colombi et al., 1989; Buschinelli & Kato, 1989; Rigotto, 1989, 1994) highlight the utilization of BEL as a diagnostic resource, amongst other uses. Colombi et al. (1989) stress the use of BEL as a tool to detect early biological effects. Rigotto (1989, 1994) reports that among the diagnostic criteria for lead poisoning is the presence of a dose and/or effect index above the BEL, stressing that *clinical signs and symptoms characteristic of plumbism may or may not be present*. Buschinelli (1987) and Buschinelli & Kato (1989) state that blood lead levels and/or ALAU for a worker exposed to lead and higher than the currently established BEL indicate that the worker is sick and that measures should be taken to remove him/her from exposure, in addition to providing treatment and assessment of possible sequelae. In practice, this is the conduct officially recommended by government-run workers' health services (INAMPS, 1986; INSS, 1993).

### Discussion

I agree with the first group of authors, who maintain that the BEL do not have the power to dichotomously classify exposure as safe or unsafe. I also agree when they highlight that a biological index just below or above the respective BEL does not, per se, rule out a diagnosis of lead poisoning, because the kidneys, bone marrow, and neurological circuits are unaware of the values established for them. From a clinical point of view, i.e., approaching an individual case, the disease should be diagnosed on the basis of clearly established signs and symptoms. Human bodies are not standardized machines responding in standard fashion to standard exposures.

Nevertheless, the clinical approach to both lead poisoning and diseases as a whole is insufficient to control them. Occupational disease only rarely occurs as an isolated case.

One must seek a diagnostic criterion that instrumentalizes public health measures to control occupational poisoning. In this sense, I find the point of view defended by the second group of authors quite appealing, valuing BEL as one of the diagnostic criteria for lead poisoning.

By presupposing the validity of generalizing the analysis by Cordeiro et al. (in press) for Brazilian workers as a whole, the predictive value of a blood lead level equal to 60 µg/dl is some 37% in Brazil. That is, given that an exposed worker has a blood lead level equal to 60 µg/dl, the probability that he or she is sick is some 0.37, with the clinical diagnosis based only on the peripheral neurological damage caused by lead. Knowing that damage to higher neurological functions begins at an exposure threshold well below that at which the first peripheral manifestations begin to be detected (Baker et al., 1984; Baker et al., 1985), it would be consistent to suppose that this predictive value is underestimated.

This underestimation is further aggravated by the fact that the predictive value has been calculated on the basis of an exposed group of workers limited to those who do not consume (and have never consumed) alcohol, have never been exposed to organic solvents or pesticides, and have no clinical history of neurological disease or repercussions, all of which are known to be synergistic factors with lead in affecting the nervous system.

That is, the probability that a *generic* worker reaching the Brazilian BEL for blood lead level is sick is even greater than 37%. In other

words (and taking what I believe is a conservative stance), every second worker with a blood lead level equal to the biological exposure limit is sick and the first is about to become sick.

*In a situation like this*, to require that lead poisoning be diagnosed exclusively on the basis of documented biological alterations is a kind of strictness that would be laudable if it did not cause a brutal underreporting of lead poisoning, as unfortunately it does in our country. After all, what Brazilian company now allows its workers access to periodic electroneurographic and neurobehavioral testing to rule out the possibility of poisoning?

Thus, I find it quite appealing to use the *current* BEL for blood lead level in an epidemiological approach as an important criterion for establishing the diagnosis of lead poisoning. In essence, such a procedure is routine for innumerable other diseases. As examples I would cite two of the greatest public health problems in the field of chronic/degenerative diseases: systemic arterial hypertension and diabetes mellitus.

The Fifth Report of the Joint National Committee on the Detection, Evaluation, and Treatment of High Blood Pressure defines systemic arterial hypertension in adults over 18 years of age as diastolic arterial pressure greater than or equal to 90mmHg and/or systolic arterial pressure greater than or equal to 140mmHg (The Joint National Committee, 1993), regardless of renal, retinal, cerebral, cardiovascular, or any other alterations in a specific individual. This does not mean that the latter should not be exhaustively investigated and controlled in the clinical approach to the case. What makes clinical practice a fervent challenge is that in spite of the above, a diastolic arterial pressure stabilized at 85mmHg does not in itself rule out arterial hypertension. For example, such a level may be sufficient to set off vascular and renal alterations in an adult that previously had a baseline diastolic pressure of 60mmHg.

Qualitatively, the situation is the same for diabetes mellitus, the diagnosis of which is easily established in the presence of an asymptomatic individual with persistently high fasting blood sugar levels (Foster, 1983).

Establishing such "cutoff points" separating diseased from healthy individuals has been and will continue to be a complex and controversial issue, as well as an intrinsically arbitrary one, i.e., arbitrated by the professionals involved in the issue, a limitation which there is no getting around. Let us return to the issue of hypertension, which has been delineated through three approximations (Rose, 1985),

which can be termed statistical, epidemiological, and clinical. The first, essentially statistical, is based on the distribution of the frequency of arterial pressure in a given study population, establishing as hypertensive those individuals with arterial pressure higher than something close to the mean plus two standard deviations. The second approximation, valuing epidemiological aspects, is based on the concept of relative risk to define the limits of arterial hypertension. According to this approximation, one can define as the cutoff in a given population the pressure values where there begins to be a significant increase in the risk of appearing signs and symptoms of the disease (Cordeiro, 1991; Cordeiro et al., 1993), i.e., when the relative risk for the disease begins. Finally, the third way of conceptualizing arterial hypertension emphasizes clinical aspects by valuing the cost/benefit weight of pharmacological treatment for the hypertensive individual. That is, it attempts to establish as limits for hypertension the pressure values at which the benefit to the hypertensive individual provided by treatment outweighs the side effects of the drugs used. Following such reasoning, Evans & Rose (1971) defined systemic arterial hypertension as "a level of arterial pressure above which the diagnosis and treatment are more favorable than dangerous".

If BEL signals a level of exposure above which the risk for lead poisoning increases, as seen previously, its use as a diagnostic criterion is essentially the same as the second diagnostic criterion described above for arterial hypertension.

The NIOSH itself understood the need for such a diagnostic approach when it recently defined lead poisoning simply as "a concentration of lead in whole blood exceeding 50 µg/dl" (National Institute for Occupational Safety and Health, 1992).

In this sense, the diagnostic use of BEL in the context described above is logically defensible and widely used in other areas of medicine; in my opinion, its consolidation as routine practice in occupational health is an important policy issue. Through its use, the scope of preventive measures for occupational diseases will certainly be broadened, based on an understanding between industry and workers at a more favorable threshold for promoting the latter's health.

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