One Century of the Discovery of Arsenicosis in Latin America (1914–2014) – Litter, Nicolli, Meichtry, Quici, Bundschuh, Bhattacharya & Naidu (Eds)
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From the presence of arsenic in natural waters to HACRE

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ABSTRACT: An update on a proposal put forward by the authors, which up to date has not been discussed in depth, is provided. The problem of the different arsenic tolerance thresholds in drinking water and their validity is analyzed in the face of the uncertainty as to the concentrations above which chronic endemic regional hydroarsenicism (known as 'HACRE' by its initials in Spanish) is present. Once the current situation and the changes in the standards have been discussed, the focus is shifted to the need for local regulation with ecotoxicological criteria and the provision of truly viable treatments for water conditioning.

1 INTRODUCTION

Ever since 1913/1914, when the health problems caused by the intake of water with high arsenic content (Litter, 2010; Auge, 2013) were disseminated, the regulations on drinking water quality for Argentina have evolved as the guidelines of the World Health Organization (WHO) were incorporated, as well as the consequent standards of the Código Alimentario Argentino (CAA). As Argentina is a federal state, the CAA can only be enforced in the provinces that have adopted the regulations, many of which have standards of their own, causing a considerable diversity in guideline values, as this is the case of arsenic. A previous contribution of the authors (Hernández *et al.*, 2005a) proposes a series of criteria to set standards, which in general have not been taken into consideration up to date. Subsequently, the current situation and the perspectives are reviewed, as well as the lack of a clear limit between the presence of arsenic in water and the conditions in which HACRE develops, against the backdrop of the persistent absence of ecotoxicological studies in Argentina. Finally, the problems deriving from the possible need for the treatment of water, to conform the potability standards, are discussed. The contribution focuses on natural occurrence, not on high values caused by environmental disasters and/or anthropogenic presence.

2 DISCUSSION

In 2007, by means of a joint resolution (No. 68 and 196/2007), the 982 and 983 articles of the CAA were modified, decreasing the arsenic standard in water for human consumption from 0.05 to 0.01 mg L^{-1}, and setting a 5-year period—whose deadline was in June 2012—to adapt to the new values. Subsequently, the Comisión Nacional de Alimentos (CONAL; National Food Commission) (2011), decided to extend the original deadline until the results of the study "Hidroarsenicismo y Saneamiento Básico en la República Argentina. Estudios básicos para el establecimiento de criterios y prioridades sanitarias en cobertura y calidad de aguas" ("Hydroarsenicism and Basic Sanitation in Argentina. Basic studies to establish guidelines and sanitary priorities in water coverage and quality"), whose terms were set by the Subsecretaría de Recursos Hídricos de la Nación (National Undersecretariat of Water Resources). Neither task had set a deadline, nor does the validity of the mentioned standard. However, an interesting prospect has emerged in line with the above-mentioned proposal of the authors, if the principles formulated are taken into consideration.

2.1 *Arsenic concentrations and HACRE*

In Argentina, arsenic concentrations in groundwater vary "between 4 and 5,300 μg L^{-1}, and an extreme value of 14,969 μg L^{-1} was measured in Santiago del Estero," according to Litter (2010). Nevertheless, there is uncertainty regarding the value over which the symptoms make it possible to identify the incidence of HACRE; in certain cases, it has been determined as being above 10 μg L^{-1} (Litter, 2010). However, the context of certain conditioning factors remains to be studied, such as the

ethnobiological factors, the volume of daily intake, the local climate (in relation to the previous factor), whether the population lives in an open or closed community, time of exposure, age of the individual, body weight, time of residence in the locality and other related factors. The lack of more precise etiological knowledge of HACRE in general leads to the common tendency towards asserting its existence when the arsenic content in natural water is at a minimum and there is no medical evidence, as it happens in a large section of the humid Pampas in the Province of Buenos Aires (Pelusso *et al.*, 2007). No cases that can be attributed to HACRE were reported until occasionally public concern was aroused for different reasons; it was combined with poor social communication with the population, as was the case in Junín (Buenos Aires) due to legal action, which was then dismissed (Hernández *et al.*, 2005b). In such cases, the situation has reached an extreme situation: the population has the habit of replacing the consumption of supply network water by bottled water coming from the same aquifer and the same location. If the validity of the 10 $\mu g\ L^{-1}$ limit for arsenic were enforced today in the Province of Buenos Aires—which adheres to the CAA—and considering the map of arsenic distribution (Auge, 2013), it would be easy to confirm that most of the territory with groundwater supply would be unfit for domestic use.

2.2 *Treatment*

Considering such a possible alternative, the need arises for a treatment that would make the water of the supply network to meet the standard, and it would require the distinction between rural localities and middle to large cities. In the first case, methods of abatement of the arsenic concentrations have been developed, ranging from small gadgets of individual use to water treatment microplants, all of which are generally based on the fixation of arsenic by means of sorption. The use of treatment units of reverse osmosis with energy supplied by solar panels, which was implemented several years ago in educational institutions, has the same disadvantages that will be discussed below at a different scale. When the urban areas are of a certain size, from small to large cities, the problem mainly becomes more complicated due to two factors, depending on the volumes to be treated: the essentially economic aspect and the environmental one. If sequestration treatments are chosen, such as reverse osmosis, economic drawbacks arise, deriving from the considerable cost of energy at present and of the replacement of osmotic membranes when dealing with such large volumes. Regarding the environmental aspect, a safe destination should be found for solid wastes, not so much due to its quantity as to its hazardous quality, which requires that they be disposed in high security repositories with the consequent special transportation and cost of disposal. On the positive side, it should be mentioned that these techniques would bring about other improvements in water quality, due to the decrease of other inconvenient solutes.

2.3 *Need for ecotoxicological studies*

Apart from the modification and/or adoption of new standards, it is essential to perform the test for arsenic content on the main parts of the body that accumulate it (i.e., skin, hair and nails) in a population that has continuously inhabited each area for over thirty years, as already proposed by the authors (Hernández *et al.*, 2005a). It would be advisable for the universe sampled to be supplied both from the water supply network and from individual sources, and for a regional target area with little or no arsenic content to be available. In the studies, public and private healthcare providers, professional associations of physicians and biochemists, the university and other research centers should participate in order to compile an etiological record of disorders derived from the consumption of water with arsenic and other related pollutants. A recommendation in this sense was aptly put forward by Vazquez *et al.* (1999), when they state, "The adoption of standards in water quality regulations for parameters that have an impact on health, on the basis of the guideline values proposed by the WHO whenever there is a certain measure of uncertainty and difficulty to reach them, must be preceded by local epidemiological studies. These studies will allow the authorities and monitoring bodies to support the revision, update and adoption of standards for drinking water, taking acceptable risks depending on the different exposure times compatible with the hydrogeological, social and economic reality of the region...". The suspension implemented by the CONAL (Comisión Nacional de Alimentos, 2011) and its intervention in the letter of the CAA regulations are excellent opportunities to carry out such studies.

3 CONCLUSIONS

In Argentina, there are still problems regarding the acceptable limits of arsenic in groundwater for human consumption, even though the national regulations (CAA) have extended the current threshold, while a basic study supporting the new standard is awaited. Should a limit such as the one previously set by the CAA be adopted, vast regions would have As concentrations above the threshold, which is why water treatment would be required

In this respect, the case of the rural localities (where small units or individual low-tech solutions would be suitable) should be differentiated from the case of the supply networks of middle to large cities, which require large volumes to provide their service. Regardless of the decision, the new value should arise from ecotoxicological studies based on determinations performed on individuals meeting certain characteristics, such as residence in the locality and source of supply. The participation of healthcare providers, public health authorities, professional associations and researchers from different fields of knowledge is necessary.

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