

## CHAPTER 6

### LATIN AMERICA - ARGENTINA

#### ARSENIC AND CANCER INDUCTION IN CORDOBA EASTERN (ARGENTINA)

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#### **Abstract**

Arsenic and its compounds in water have repeatedly been observed worldwide. Arsenic may appear in water either due to natural causes or as a by product of human activities. Natural causes include: soil erosion, surface rocks and volcanic areas formed during the pre-Andes pre-Rocky Mountains period (as far as South and North America are concerned), a fact which explains why the same As-related problems have been detected in Argentina, Chile (Antofagasta) (1), Oregon (2), and Alaska (3).

Several areas of Argentina have had high exposures to arsenic from naturally contaminated drinking water, with well documented occurrence of typical skin alterations caused by arsenic, including skin cancer. Recent evidence indicates that consumption of water with elevated levels of In-As is also associated with increased rates of internal cancers, particularly lung, liver, bladder, prostate and kidney cancers (4-6). The eastern region of the province of Cordoba has been the most widely affected and in this chapter are summarized the studies in an endemic area of Argentina, where for over 70 years the population consumed artesian well water contaminated with arsenic, have shown a clear

dose-response relationship between arsenic and internal cancers.

The magnitude of these risks places In-As as one of the highest potential environmental risk factors, comparable to radon in homes and environmental tobacco smoke (7).

**Key words:** Argentina, arsenic, cytogenetic, bladder and prostate cancer, epidemiology, drinking water.

### **Introduction**

The evidence that arsenic in drinking water causes skin diseases including skin cancer has been extensively described in other populations. In Latin America, studies have found signs of chronic arsenicism in areas of Argentina (8-10), Mexico (11,12) and Chile (13,14). In Argentina, several provinces have been affected by natural arsenic contamination of their water including Córdoba, Salta, Tucumán, Santiago del Estero, Chaco and Santa Fe (15,16). However, the most studied and best described endemic area has been in the eastern region of Córdoba, located in the center of Argentina. High arsenic levels in drinking water have been repeatedly measured throughout this area, often above 100 ug/l and reaching levels above 2,000 ug/l (17,18).

As early as the beginning of the century, physicians noted an increased incidence of clinical skin alterations in patients from certain areas of Córdoba. The first observations were performed by Goyenechea (19) and Pusso (20). The high arsenic content of drinking water from wells in these regions was thought to be the cause (21). The term “Bell Ville disease” was coined because of the high frequency of arsenic-induced cutaneous manifestations among the population of the town of Bell Ville, near the center of the region (21). The high arsenic content in well water is due to the natural geological soil composition

of the area (14). Actually, the high concentration of arsenic was confined to the well water which served as main water supply to the region. On account of the deleterious effects on health caused by arsenic, aqueducts were made using river water of low arsenic content in order to replace well water for drinking. These aqueducts started operating in various villages from 1970 to 1980, however several communities are still exposed to arsenic contamination.

### **Reports**

Although most reports from Argentina have focused on pathological skin alterations caused by arsenic, one cytogenetic study was performed in an area next to the city of Bell Ville (22) and two investigations suggested increased bladder cancer and one investigation about prostate cancer mortality in Cordoba in the region of chronic arsenicism.

#### Cytogenetic study

The data regarding individuals that have been exposed to As in their drinking water for more than 20 years' time suggest that further assessments of the potential effect of As in drinking water on human health are in order, so that realistic standards can be set up. As regards the cytogenetic aspect, according to our findings, an increase in the incidence of genetic harm (as measured by SCE) can be observed. Sex and age did not affect the frequency of sister chromatid exchange (SCE). Petres et al. (23) and Nordenson et al.(24) have reported similar findings (measured as chromosomal aberrations) in exposed individuals. Thus there exists sufficient evidence that As at relatively higher doses favors both mutagenesis and carcinogenesis (25,26).

As regards the present study, besides findings related to a higher As concentration in water and urine, coupled to a SCE increase, emphasis should be placed on skin alterations that have

been detected among exposed subjects since evidence about As mutagenic action in humans includes: (a) observations on a higher frequency of some As-related clinical consequences, and (b) direct observations of abnormalities at the genetic material level. In summary, from studies performed in Taiwan, Germany, Chile and Argentina, it can safely be said that a regular consumption of drinking water with an As content higher than 0.1 ppm allows the development of cytogenetic injuries, and, in some cases, skin cancer, besides evidencing clear poisoning. In this research, a carcinogenic effect of ingested arsenic on lung and skin was suggested. Skin lesions, cytogenetic injuries, and cancer depend on: (a) arsenic concentration in drinking water; (b) subjects using exclusively water containing As; (c) duration of exposure (d) the susceptibility of the individual.

#### Bladder cancer study

One study examined the cancer deaths occurring between 1949 and 1959 in an area considered to be highly exposed, based both on the high frequency of skin disorders and on elevated measurements of arsenic in water (27).

It was reported that 24 % of deaths were due to cancer compared to 15 % for the entire Cordoba province, and that cancers of the urinary tract account for 11 % of the total cancer deaths. Another follow-up study of 116 patients diagnosed with arsenical skin disease between 1956 and 1960 found that 31 % died of cancer by 1970 (28). Urinary tract cancers constituted 13 % of all cancer deaths. For the purpose of comparison, an analysis of Argentina cancer mortality rates in 1980 showed that bladder cancer account for 2.9 % of all cancer deaths (averaged for men and women) (29). (Analysis of Argentina mortality data from a more recent time period indicates that bladder cancer accounts for roughly half of all

urinary tract cancers). Although the two studies mentioned above cannot be regarded as rigorous epidemiologic investigations providing conclusive evidence, they are consistent with findings from Taiwan showing increased bladder cancer risks associated with arsenic in drinking water.

#### Prostate cancer study

The prostate cancer mortality study was investigated in Cordoba for the years 1986 – 1998 (30). To assay exposure, arsenic content in drinking water was obtained from various sources, including some water sample studies (18,31) official records of water assay performed upon request (17), and water assays made by scientists deeply interested in the link between arsenic and human damage (32).

From the content of arsenic in water, as well as from the evident harm to skin, cancer and arsenic, it seems appropriate to use the department as the analysis unit and a group of departments grouped in three exposure levels: high, medium and low. The departments under study do not involve urban or industrial areas but are located in rural areas of the province thus limiting potential confounders effects. High exposure group has a high data record revealing high arsenic content in water (17,18). All research work on clinical symptoms observed among victims (18) occurred around Bell Ville. From 1934 to 1944 Bell Ville hospital admitted 525 subjects afflicted by arsenic (33) while the same finding was noticed with members of other communities within the department (27). A report from 1970 mentioned a brief summary of 53 medical appointments for arsenic poisoning (from 1917 to 1968) in various sites within this high exposure area (33) and a study carried out by Tello,E. (34) showed that from 39 patients suffering from skin injuries, 31 came from communities in

this high exposure groups. The medium exposure group was conformed the geographical area south east of Cordoba described as arsenic zone (27,35,36). The selection of this department for the medium exposure group was based on data from various sources (17,18,31,30) pointing out high levels of arsenic in water as well as skin damage and cancer. Arsenic level in water calculated as in the former group was 130.3 ug/l. In this group, unlike the former, data of arsenic content in water from each source were available. Marcos Juarez, the main city of the department of the same name, with the largest population group is the site where cytogenetic studies were performed on individuals who drank water with high arsenic content (130 ug/l), exposure level was confirmed by arsenic in urine 160 ug/l (30).

The low exposure group comprised two departments where only recent arsenic poisoning in water has been reported (30) although no data refer to skin damage and arsenic. Arsenic mean in water in both departments was 17.86 ug/l and 16.97 ug/l respectively. Analytical results for two of the three groups exposed to arsenic showed an increase trend for prostate cancer. The value of high exposure was 2.54 and medium exposure of 1.39, with a 0.39 value for the low exposure group. The mortality risk ratios estimated from Lewis et al. (37) by exposure groups (low, medium, and high) hinted at a dose relationship for prostate cancer.

### **Conclusions**

From studies performed in Argentina, it can safely be said that a regular consumption of drinking water with an arsenic content higher than 100 ug/l allows the development of cytogenetic injuries, and, in some cases, skin cancer, besides evidencing clear poisoning. Results of this study (bladder and prostate) in the south of Cordoba, Argentina revealed a close association between water intake with high arsenic content and bladder and prostate

cancer. In this connection, it is the author contention that every effort should be made to reduce the possibility of As-contaminated water being consumed.

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