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Analysis of pilot survey of Metal content in samples of hair collected in December 2009 in Gaza.

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Introduction

Metal contamination is one of the collateral effects of war. The pathologic and potentially toxic effects of chronic metal contamination, even at low levels, only presently start to be understood and its full potential pathogenic effects to be studied (1).
In Gaza after "Cast Lead" there is a reasonable concern to understand if there is contamination by metals that might cause health problems and that interfere with future well being of the population, with most concern for children.
In order to develop modalities to support the people in post-war areas is relevant to have a realistic factual knowledge of the real situation.

In absence of initiatives to undertake soil surveys and considering the importance to begin to collect information directly concerning the state of contamination of the population, we have conducted a pilot study in which we determined the actual metal burden in the hair of young inhabitants, the focus of this survey, in distinct areas in the Gaza strip. The Protection Agency (EPA), and the International Atomic Energy Agency (IAEA) have recommended the use of hair as an important biological material for worldwide environmental monitoring (2).
Hair has the potential of being an excellent bio-monitor due to its historical representation of intake over prior weeks to years and can be utilized for investigating the exposure of individuals or populations to toxins and pollutants, such as heavy metals. The analysis of hair for metal content reveals environmental exposure (3,4) and is informative of the environmental contamination since it was shown in many cases a positive relationship between soil/water and air content and the internal content of many metals in the hair of exposed populations (5-7).
For most metals their accumulation in hair reflects the accumulation in the whole body(7-9). There are exceptions like Cu and Zn, whose accumulation in hair may be regulated by the organism and are not therefore indicators of environmental exposure (7).
Many studies have shown a correlation between heavy metals concentration in hair and blood (3, 6,8,10). Most trace elements (Cd, Cr, Ni and Pb) have higher concentration in hair than other body compartment, which helps in the analytic process (6).
Hair sampling is a not invasive procedure and allows to collect high number of samples that can be stored easily.
The multi-elemental analysis by ICP/MS, in appropriate methodological conditions, allows for the determination of internal metal content in the hair (11,12).

Metals can enter the human body because of dispersion on the soil, directly through inhalation and contact, through drinking of contaminated water and, via assumption of vegetables themselves with high metal burden.

Methods

The sampling of hair was done on the nape of the neck including the nearest 2-3 cm from the skin, and considering an average growth rate of the hair between 0,6 and 3,6 cm/month, we measured the amount of metals incorporated during the previous 3, maximum 4, months, thus from middle august August to middle December 2009, date of the sampling.

We collected the 95 samples in the areas illustrated in the right side of Fig 1, which shows the number of samples taken at each location. For comparison is presented the UNEP map derived from satellite recording of bombings and attacks during "cast Lead" (13), on the left side.

We have utilized standard methodologies for hair treatment and preparation for ICP/MS (11,12) and analyzed the hair samples for their content in 33 metals.

We have used as reference value to evaluate the results one sample of hair from an area outside war zone, and the published values of certified standards, when available.

Results

The 95 samples of hair were collected mostly from young and very young inhabitants, in distinct areas in the Gaza strip.
We also examined hair of 7 pregnant women in the same families. We have now news that 2 of them delivered healthy children.
We examined also hair samples from 4 people who were injured (two with amputations and one by WP in 2009, and one wounded in 2006).
All the people were consenting and informed and can be eventually reached.
Our criteria for sampling hair from these individuals were:

- We selected areas where documented and frequent bombing and other attacks (UNEP reporting the satellite data for attacks (Fig1, left)) had taken place in winter 2008-09 by IDF;
- We selected places where the living conditions of the people are at ground level and in reduced spaces, which also induces children to play in the street.

In the conditions of the survey the sources of intake of metals by the people are by ingestion of water and food (e.g. vegetables cultivated in the strip), and inhalation of particles directly from the contaminated soil facilitated by the life conditions at ground level since December 2008.

Table I-A shows the absolute levels in parts x million (ppm) of metals for all hair samples analyzed and includes a reference sample from China and a control hair sample from Italy. A color code indicates graphically the windows of quantities of metals detected in the hair of different subjects. Location and sex are also shown.
We have omitted from the table the listing of some of the metals analyzed (Cs, Ca and Fe that were similar in all the samples and controls, and Al, K, Na and Mg that were for all, including control, on the higher level of the scale of detection, Li, Ga, Sb, In,Hg and Tl that were undetectable in all samples). We have left Cu and Zn in this Table, similar in amounts in all samples and control, in agreement with the report that the accumulation in hair of these metals is "regulated" by the organism; these are thus are considered unsuitable to detect environmental metal contamination.
Many individuals had higher metal burden than controls.
No sex related regularity was detected.

Controls and reference values for metals in hair are shown in **Table I-B.** This Table also shows the average values of each metal in hair in each location where there was an adequate number of samples collected (Beit Hanun, Gaza-Zeitun and Beith Lalya).
The average content of metal contaminants varied among the 3 locations considered. The more potentially dangerous contaminants detected in hair of people are shown in blue.

The differences the relative amount of metals accumulated in hair of people in the different areas considered are summarized in **Table II**. Here we also indicate the metals that have values above the control and above standard hair references (*). The metals in blue are carcinogens.

In summary, there is an overall higher content of many metals in the population analyzed, including presence of toxic/carcinogenic metals.
Although the amounts are not often higher than 2-3 fold the control hair metal burden, these data suggest that further monitoring of some of the individuals to confirm continuing higher than standard metal burden, is necessary.

We have selected and listed in **Table III** 60 individuals either with two or more metals at level at least 2 fold above the internal control and above the standard and above the average level of the area of residence, or individuals that have carcinogenic metals detectable at in their hair, and one individual who was injured in 2009 and has high level of Pb in his hair. Among these individuals there is a woman, pregnant in December, that gave birth to a healthy baby.

In this table we omitted listing Cu and Zn, and Cs.
The individual sex, date of birth and residence are indicated on the left.

Taking in consideration both the kind and toxicological potential of the metal accumulated (e.g. the people with carcinogenic or reproductive system toxicants) and the composite metal load in people, we have done a further selection of individuals recommended for investigation, indicated in the right side of Table III as:
(*) 23 people that could be monitored in late spring 2010 to test if they continue to have an high level of the metals in hair, thus show chronic accumulation, and pregnant women or women just after delivery and breast feeding, which we suggest to further monitor for precautionary reasons.
(**) 16 people have higher that control levels of metals carcinogenic/possible carcinogenic (Cd, U, W, Co) or toxic for reproductive organs (Mo) or combinations of these, that could be tested immediately again for metal content in hair if confirmed for their content in hair and in Urine, and for blood creatinine in the case of high Cd.

Conclusions

The further step, following a pilot survey of the kind reported here should be to define the health risk ensuing from metal accumulation in hair. This step cannot be yet considered as established in the common scientific – medical knowledge.
Even so, the indication of high metal content in hair in a population is often being utilized presently and was recommended by environmental agencies, with the purpose of selecting subpopulations for more detailed tests to confirm if the metal accumulation has occurred in other body compartments (urine) and is accompanied by functional changes (e.g. in blood proteinuria), and individuals with highest metal content should be monitored in time for their general health, and, if they are children, during their growth.
Eventually the identification of subjects confirmed to have a high burden requires the removal of the individual from the exposure, the therapeutic approach most favored in view of the lack of evidence on the efficacy and safety of chelation treatment manly in children with low to- moderate metal exposures. This will present serious problems in the present situation of Gaza where construction and removal of damaged structures is made difficult or impossible, and certainly it represent serious responsibility for those that should remediate damage to the civil population, according to international laws.

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biofluids and tissues: sample preparation methods for atomic spectroscopic techniques. Spectrochimica Acta Part B 51, 291-319, 1996) consists of five successive washes, namely,acetone-water-water-acetone, each for 10 min in 25 mL of solvent. After the washing about 50 mg of samples have been digested with about 1 mL of HNO3 (ultrapure) in small test tubes pressurized. The resulting HNO3 digests have been diluted to 50 mL with ultrapure water and analyzed by ICPMS, along with reference standards.
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