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PUBLIC HEALTH ADVISORY

PREVENTING LEAD POISONING IN NUNAVIK

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INTRODUCTION

Exposure to lead, both acute and chronic, has long been recognized as a threat to human health. First demonstrated in relation to the workplace, exposure to lead was consequently associated with environmental contamination in various forms: through the atmosphere (from leaded gasoline fumes), drinking water (antiquated distribution systems made of lead or welded with lead), contaminated soil (industrial waste), ingestion of fragments of paint containing lead, food (lead solder used to seal cans), etc.

First revealed by the *Health Québec Survey* (1994), the Nunavik population's exposure to lead was confirmed by the recent study on umbilical-cord blood samples (1993-1996). However, this recent study went further and led to the identification of the source of elevated blood lead content. From all the evidence, the ingestion of lead shot used in hunting constitutes a major source of human exposure to lead in Nunavik.

This discovery, associated with the upcoming application of a regulation banning lead shot for hunting migratory birds, is an ideal opportunity to reduce the Nunavik population's exposure to lead, through a reduction at the source of the problem. Thus, the Department of Public Health of the Nunavik Regional Board of Health and Social Services has prepared this public health advisory, essentially aimed at reducing the regional population's exposure to lead and, by the same stroke, preventing lead poisoning.

EFFECTS OF LEAD ON HEALTH

Appendix 1 presents the effects of lead on health. These vary according to type of exposure (acute or chronic), level of lead concentration attained in the blood and subject's age at the time of exposure.

TABLE 1: EFFECTS OF INORGANIC LEAD ON CHILDREN AND ADULTS (MINIMUM CONCENTRATION PRODUCING AN OBSERVED HARMFUL EFFECT¹)

Child	Blood Lead Content μmol/L (μg/dL)	Adult
	7.0 (140)	
Encephalopathy/nephropathy/obvious anemia⇒	5.0 (100)	⇐Encephalopathy
Colic⇒		⇐Obvious anemia
↓Hemoglobin synthesis⇒	2.5 (50)	⇐↓Hemoglobin synthesis
Metabolism of vitamin D ² (change)⇒	2.0 (40)	⇐Peripheral neuropathy/nephropathy
		⇐Effects on reproduction
↓Nerve conduction velocity⇒	1.5 (30)	⇐↑Erythrocytic protoporphyrin (men)
↑Erythrocytic protoporphyrin⇒	1.0 (20)	
Metabolism of vitamin D ² (change)⇒	0.75 (15)	⇐↑Erythrocytic protoporphyrin (women)
Toxicity related to development⇒	0.5 (10)	
↓I.Q. ²		⇐Hypertension ²

Source: Lévesque, B., M. Rhainds and H. Prud'Homme. *Protocole d'investigation et de suivi en regard de l'exposition au plomb au Nunavik*. Direction de la santé publique de Québec, March 1999.

Chronic poisoning is the most frequent type. Among adults, this may be manifested as an attack on the general state of health, hematopoietic system (anemia) or reproductive system, high blood pressure or an attack on the renal system or peripheral nervous system.

Besides the effects mentioned above, lead poisoning among children may be associated with learning difficulties and behaviour problems. For the most part, these effects occur insidiously and are difficult to detect clinically.

¹ Reproduction of the ATSDR adaptation, *Toxicological Profile for Lead* (1990), by the Federal-Provincial Committee on Environmental and Occupational Health, September 1994.

² No minimum value has been discovered yet.

Note that there is no level of blood lead content considered as safe (i.e., not having any effect on health). From the point of view of public health, it is therefore desirable to reduce lead exposure as much as possible among the population in general and among children and women of child-bearing age in particular.

EPIDEMIOLOGICAL DATA ON LEAD IN NUNAVIK

Appendix 1 presents all the epidemiological data currently available on exposure to lead in Nunavik. They essentially result from two large-scale studies: the *Health Québec Survey* and the study on umbilical-cord blood.

The *Health Québec Survey*, carried out among adults in Nunavik in 1993, revealed elevated lead presence in the blood. The average level was 0.49 $\mu\text{mol/L}$ and was influenced by zinc (higher among men), age (increases with age) and place of residence (higher on the Hudson coast). Worthy of note is that 26% of women between 18 and 44 years presented blood lead concentrations equal to or higher than 0.48 $\mu\text{mol/L}$.

The study on umbilical-cord blood, carried out between 1993 and 1996 among 475 Nunavik newborns, revealed an average blood lead content of 0.19 $\mu\text{mol/L}$. This level was higher in the Hudson subregion and in June and July. Blood lead content equal to or higher than 0.48 $\mu\text{mol/L}$ was observed in 6.9% of newborns.

The results of both studies indicate that the Nunavik population is significantly exposed to lead. However, the comparison of lead-content studies with other regions shows more or less significant results depending on the reference population chosen (Appendix 2). For example, blood lead content among Inuit newborns is approximately twice as high as that of newborns in the southern parts of Québec. The proportion of Nunavik newborns with blood lead concentrations equal to or higher than 0.48 $\mu\text{mol/L}$ was 7%, compared to less than 1% among newborns in the rest of the province. On the other hand, other comparisons reveal levels of blood lead concentration in Nunavik lower than those in other regions.

At any rate, because of the average lead concentrations identified among both adults and newborns in Nunavik and the proportion of these subjects presenting lead concentrations equal to or higher than 0.48 $\mu\text{mol/L}$, it is necessary to set up a public health program to reduce the regional sources of exposure.

SOURCES OF LEAD IN NUNAVIK

A review of recognized sources of exposure to lead appears in Appendix 1. In Nunavik, we can immediately eliminate atmospheric and soil contamination by industrial waste. As for drinking water, a review of the data provided by the ministère de l'Environnement et de la Faune du Québec concerning the analysis of drinking water in the various municipalities of Nunavik over the past few years allows us to eliminate drinking water as a significant source of exposure in the region (Appendix 3). The ingestion of paint dust and fragments containing lead can also be eliminated, as lead paint has been banned for several years now in Canada.

In addition, exposure to tobacco, both active and passive, constitutes a source of lead that is not inconsiderable. Smoking, being very prevalent in Nunavik (more than 70% of adults smoke), is, in a way, a source of population exposure to lead. The *Health Québec Survey* revealed average blood lead levels of 0.48 µmol/L among smokers and 0.38 µmol/L among non-smokers. Even though this difference cannot explain the scope of the problem of exposure to lead in Nunavik, it nevertheless deserves some attention, particularly among pregnant women.

The other possible source of exposure involves food. Consumption of traditional foods characterizes the Nunavik population. A review of the available data does not permit identifying traditional foods as a cause of elevated blood lead concentrations in the Nunavik population.

Two studies carried out in Nunavik have identified lead shot used for game-bird hunting as a major source of population exposure to lead in Nunavik. A recent study using 60 samples of umbilical-cord blood compared the lead contained in the blood with that used in manufacturing ammunition used by Nunavik hunters (isotope comparison). The study demonstrated that the two types of lead were very similar. A second study using the same technique was carried out with blood samples from the residents of a Nunavik village presenting an elevated blood lead content. As in the first study, the results revealed an obvious isotopic link between the lead in the blood and that in the shot used for hunting in the region.

Consequently, it is very plausible that the ingestion of lead shot or meat contaminated with lead shot constitutes the major source of elevated blood lead concentrations in Nunavik. The medical literature describes cases of elevated blood lead content related to ingestion of lead shot or other lead objects. It is not rare to observe the presence of lead in abdominal radiographs of Nunavik residents. This could also explain the increase in average blood

lead concentrations in June and July, as observed in the umbilical-cord blood study: the season on migratory game birds is usually from May to June.

PUBLIC HEALTH STRATEGIES TO REDUCE EXPOSURE TO LEAD IN NUNAVIK

1. INFORMATION

An information campaign with the primary objective of achieving regional consensus on completely banning the use of lead shot in Nunavik will be carried out. Three target groups will receive priority for the information activities: the general population, public decision-makers and hunter groups.

General Population

It is important to inform the population of the situation concerning the levels of blood lead content in Nunavik and the related causes, particularly lead shot. For this purpose, various communication methods will be used: local and regional radio, regional newspapers or newsletters and an open telephone line. The possibility of distributing an information pamphlet to Nunavik residents by post is being considered.

The notice is a very short one (during April 1999) because we wish to inform the population before the next hunting season.

Public Decision-Makers

Coordinators of Nunavik organizations associated with this problem will be informed through various means (newsletters, meetings, etc.). The objective is to create a regional coalition for the total ban on the use of lead shot in Nunavik. Among the organizations to be informed are the Nunavik RBHSS, Makivik Corporation, the Kativik Regional Government, the members of the municipal councils of the northern village corporations, the board of directors of the Tulattavik and Inuulitsivik Health Centres, the Avataq Cultural Institute, etc.

Hunter Groups

It is important for those most concerned--the users of lead shot--to be informed of the health risks related to the use of this type of ammunition. Information activities will be organized for this group through the Hunters and Fur Traders Association or the Kativik Regional Government and the

Hunter Support Program. It will be possible to organize information sessions on non-toxic shot for the hunters.

The deadline has been set with very short notice (April 1999), as we want the hunters to be aware of the problem before the next hunting season.

2. REDUCTION AT THE SOURCE

The strategy we believe to be the most appropriate and efficient is the reduction at the source of exposure to lead in Nunavik. This reduction at the source will be done through the total ban on the use of lead shot in Nunavik.

New Regulation Banning Use of Lead Shot throughout Canada (*Migratory Birds Regulation*)

A new regulation prohibiting the hunting of migratory game birds with shot other than non-toxic shot (lead shot is considered toxic) will come into effect everywhere in Canada on September 1, 1999. Hunters should be informed of this new regulation. The Nunavik Department of Public Health intends to do everything in its power to have this new regulation applied and respected.

Complete and Voluntary Elimination of the Use, Importation and Sale of Lead Shot Ammunition

The Department of Public Health intends to create a Nunavik coalition aimed at prohibiting the sale of lead shot ammunition. After verification, it seems this type of ammunition is no longer available in stores of the Federation of Cooperatives of New Québec, and this, for some two years now. We intend to arrive at the same result in the other points of ammunition sale in Nunavik. Through persuasive information activities, we would like to convince the user, that is, the hunter, to stop using lead shot and thus end its importation into Nunavik.

An important element in this intervention will be the possibility for hunters to have access to acceptable alternatives to lead shot ammunition at reasonable cost. To this end, we will meet with the coordinators of the Hunter Support Program to explore possible avenues (subsidies, group purchasing, etc.).

3. PALLIATIVE TRANSITIONAL MEASURES

Even though the measures for reduction at the source remain the most desirable, especially because of their permanent effect, it is also realistic to

expect the complete acceptance of such measures to take some time. We have therefore planned some palliative transitional measures that could reduce exposure to lead in the coming months or minimize the exposure's effects to health.

Remove Lead Shot or Fragments from Meat before Cooking and Eating

According to the data currently available, it seems exposure to lead results from ingesting lead shot or fragments of lead shot rather than ingesting the meat. It is therefore important to provide this information for the hunters and the population. This way, people can try to remove as many lead shot fragments as possible before consuming or, ideally, cooking the meat from an animal killed with lead shot ammunition.

Evaluation of Lead Content in the Various Culinary Methods Common in Nunavik

We are not aware of any study that has measured the liquefaction properties of the lead contained in lead shot during the preparation of food using the meat or carcass of migratory birds killed with shot (soup, stew, etc.). The Makivik Research Centre in Nunavik has agreed to carry out a study to measure the degree of lead dispersion within such culinary preparations. The results should be available shortly.

Use of the Protocol for Investigation and Follow-Up of Cases of Elevated Blood Lead Content

For cases of elevated blood lead content, a protocol concerning the appropriate management and follow-up depending on the level of lead in the blood was prepared for clinical personnel (Appendix 1). This protocol notably covers the individualized search for the cause of the elevated blood lead content, as much in the person in question as among his or her family members.

This protocol should be distributed shortly in all the points of service in the region after revision and acceptance by the CPDP's of Tulattavik and Inuulitsivik.

Optimal Application of Maternal and Child Health Programs

Intestinal absorption of lead is facilitated by certain nutritional deficiencies (involving iron and calcium in particular). It is important for these deficiencies to be detected, especially among pregnant women and young

children. This screening for anemia as well as the prescription of calcium and iron supplements are part of prenatal follow-up.

Workers in maternal and child health will be informed of the problem of elevated blood lead concentrations so they may rigorously apply the prenatal follow-up protocol.

Smoking and Pregnancy

As previously mentioned, even though smoking does not constitute the major source of lead in Nunavik, it nevertheless contributes to increasing average blood lead concentrations. Given its high prevalence in Nunavik, we believe it useful to recall its role as source of lead, especially among pregnant women.

Workers in maternal and child health will be informed of the link between smoking and high blood lead content.

4. EVALUATION OF THE EFFICIENCY OF INTERVENTION

It is important to measure the impact of proposed measures on the future evolution of blood lead concentrations in Nunavik. If the hypothesis establishing lead shot as the major source of exposure to lead in Nunavik proves founded, the application of the measures described above should rapidly result in a drop in average blood lead content.

The evaluation will cover the reduction of lead levels as well as the respect for proposed measures concerning the complete ban on the sale and use of lead shot in Nunavik.

Monitoring Lead Levels in Umbilical-Cord Blood of Newborns

An easy measure to apply, it will permit us to rapidly check the effect of measures for reducing average blood lead content at the source. By comparing the results with those obtained from 1993 to 1996, we will quickly have an idea if our intervention is effective.

Monitoring the Sale and Use of Lead Shot

We must gauge the respect for measures aimed at banning the sale and use of lead shot in Nunavik. With our partners' collaboration, we will check the respect for these measures within each of the 14 communities in Nunavik,

through either visits to potential points of sale or a survey among hunters and key informers.

Monitoring Blood Lead Content among Adults

It will be possible to check the impact of intervention on the average blood lead content among adults in Nunavik through blood samples taken for other tests. Once again, the collaboration of the health centre personnel will be necessary.

5. SYSTEMATIC SCREENING NOT REQUIRED

We considered the usefulness of systematic screening for blood lead content, among either the general population or certain specific groups such as pregnant women and young children. This possibility was not retained, as we found but few criteria justifying the application of a screening program. In general, very few cases of elevated blood lead concentration which could be identified would be subjected to specific measures. At the very least, these cases should be subject to evaluation to identify the source of exposure so it can be eliminated, which is what we are doing for the entire population when we ban the most probable source.

We therefore believe that systematic screening of blood lead content is not required and that the verification of elevated blood lead concentrations on the basis of individual clinical suspicion by the referring physician remains the most appropriate procedure.

CONCLUSION

The recent identification of the most probable source of exposure to lead constitutes a unique intervention opportunity. The upcoming application of a new regulation prohibiting the use of lead shot for hunting migratory birds, along with the voluntary ban on all sales and use of lead shot, if respected, could result in a rapid drop in blood lead concentrations in Nunavik.

For this purpose, the collaboration of several partners as well as the support of the population and hunters will be necessary. This way, the proposed measures could be applied very soon and become permanent.

APPENDIX 2: COMPARATIVE DATA ON BLOOD LEAD CONCENTRATIONS IN UMBILICAL-CORD BLOOD

Author	Country	Year of Study	n	GM ¹ ($\mu\text{mol/L}$)	Range ($\mu\text{mol/L}$)
Gershanik (1974)	USA	1972	218	0.453	--
Zetterlund (1977)	Sweden	1973-74	541	0.367	0.096-1.206
Winneke (1985)	FGR	1975-76	114	0.396	0.193-1.448
Tshuchiya (1984)	Japan	1974-78	95	0.405	0.050-2.504
Lauwerys (1978)	Belgium	1975-76	503	0.405	0.130-1.317
Rabinowitz (1982)	USA (Boston)	1979-81	11 837	0.318	0.000-1.785
McMichael (1986)	Australia	1979-82	500	0.487	0.469-0.506
Zaremski (1983)	England	1980-81	1 209	0.196	0.072-1.023
Ernhart (1985)	USA (Cleveland)	1981-82	178	0.275	0.125-0.709
Satin (1991)	USA (California)	1984	723	0.236	0.024-0.724
Declercq (1988)	France (Lille)	1986	144	0.230	0.000-1.340
Shucard (1988)	USA (Buffalo)	1987-88	802	0.183	0.072-0.965
Koren (1990)	Canada (Toronto)	1989	95	0.060	0.010-0.320
Our study	Canada (Québec)	1990	430	0.094	0.010-1.000

Source: Rhainds, M. and P. Levallois. "Umbilical Cord Blood Lead Levels in the Québec City Area." *Archives of Environmental Health*, Nov./Dec. 1993, Vol. 48 (No. 6).

APPENDIX 3: LEAD CONTENT IN DRINKING WATER DISTRIBUTED IN NUNAVIK

Village	Sample Date	Lead Concentration (mg/L)	Sample Site
Ivujivik	Mar. 26/97	0.0011	Untreated water
Salluit	July 15/97	0.0003	Residential reservoir
Kuujuuaq	Aug. 7/97	0.0005	Residential reservoir
Kuujuuaq	June 18/98	0.0120	Untreated water
Aupaluk	June 9/97	0.0024	Residential reservoir
Tasiujaq	May 22/97	0.0007	Water tank truck
Kuujuaraapik	Nov. 3/97	0.0150	Residential reservoir
Inukjuak	July 21/97	0.0003	Water tank truck
Inukjuak	May 12/98	0.0003	Water tank truck
Quaqtaq	June 4/97	0.0006	Residential reservoir
Kangirsuk	June 21/97	0.0003	Residential reservoir
Puvirnituq	Mar. 28/98	0.0012	Water tank truck

Source: Impact study on the drinking water modification project in Native communities, Direction générale de l'Environnement, Direction des politiques du secteur municipal, March 15, 1999.

¹ Geometric mean