Info-MADO

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Management of reports of *MADO*s of chemical origin identified during the *Qanuilirpitaa?* 2017 Inuit Health Survey

Mercury – Lead – Cadmium

Drafted by Sylvie Ricard,
Advisor, Environmental Health, NRBHSS[1]

Jointly with Dr. Mario Brisson, Medical Advisor, NRBHSS,
Suzanne Côté, Clinical Research Coordinator, CRCHUQ[2],
Dr. Mélanie Lemire, Researcher, Laval University,
Dr. Pierre Ayotte and Dr. Benoît Lévesque, Researchers, *INSPQ*[3]

Note : To streamline the text, references are not cited in the text body but may be found in the list of documents consulted at the end of the newsletter.

This *Info-MADO*[4] newsletter is intended to inform Nunavik health professionals of reports of *MADO*s of chemical origin identified during the *Qanuilirpitaa?* ("How are we now?) 2017 Inuit Health Survey. Its goal is to guide health professionals in managing the results of blood levels of **mercury (Hg)**, **lead (Pb)** and **cadmium (Cd)** in participants, which, beyond a given threshold, constitute a *MADO*.

What Is the *Qanuilirpitaa? 2017* Health Survey?

Qanuilirpitaa? 2017 is a vast survey on the physical and mental condition of residents of all the Nunavik communities. It was launched to obtain reliable and up-to-date data on the Inuit population's current state of health. In effect, two regional health surveys were conducted in the past among the Inuit of Nunavik: the *Santé Québec* Survey in 1992 and the *Qanuippitaa?* ("How are we?") Health Survey in 2004. An update of information on the Nunavik population's state of health was therefore due.

More than 1,300 participants aged 16 years and older voluntarily accepted to participate in the *Qanuilirpitaa ?* 2017 Survey. Data were gathered using the Canadian Coast Guard vessel *Amundsen*, which sailed along the region's coasts, stopping at each of the 14 Nunavik communities from August to October 2017. The participants filled out questionnaires that enabled documenting issues such as food security, mental health, addictions, violence and so forth. They also underwent clinical tests and provided blood, stool and urine specimens as well as oropharyngeal and vaginal swabs for laboratory analysis.

What Tests are Performed?

Clinical tests and laboratory analyses include complete blood count, nutritional status and anemia, investigation of sexually transmitted infections (STIs) and zoonotic infections, documentation of gastrointestinal health, including markers for infection with *Helicobacter pylori*, markers for inflammation, indicators for kidney health, respiratory health, cardiovascular health (pulse, blood pressure), diabetes and liver health, markers for allergies, screening for colorectal cancer

P.O. Box 900
Kuujjuaq, Québec J0M 1C0
Tel.: 819 964-2222/1 844 964-2244
Conf. fax: 1 866 867-8026

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RÉGIE RÉGIONALE DE LA SANTÉ ET DES SERVICES SOCIAUX DU NUNAVIK
NUNAVIK REGIONAL BOARD OF HEALTH AND SOCIAL SERVICES

1. Nunavik Regional Board of Health and Social Services (NRBHSS).
2. Research Centre, University of Québec Hospital Centre (CRCHUQ).
3. Institut national de santé publique du Québec (INSPQ).
4. A *MADO (Maladie À Déclaration Obligatoire)* is a mandatory reportable disease, infection or intoxication.

(among those aged 50 years and older) and an oral examination. Laboratory analyses are also performed on blood specimens to ascertain whether participants had been exposed to metals (Hg, Pb, Cd) and other contaminants (polychlorinated biphenyls or PCBs, organochlorine pesticides, flame retardants, biphenyl A and its congeners, etc.). Levels of nutrients such as selenium and polyunsaturated fatty acids (e.g., omega-3) from the consumption of traditional foods are also tested.

Certain tests and analyses, for which clinical follow-up are likely to be indicated, are performed as priorities. Blood levels of Hg, Pb and Cd are among the tests identified as priorities, as a *MADO* reporting threshold exists for those substances. Also covered were STIs (chlamydia, gonorrhea, syphilis) that had already been reported as *MADO*s and which were all taken under clinical management in January 2018.

How Will the Results of Blood Levels of Metals Be Communicated?

WHETHER OR NOT the **participants** and the **health professionals will RECEIVE** the results from the *Institut national de santé publique du Québec* (*INSPQ*) depends on the type of consent provided by the participant:

A. If the participant **provided consent**, the results will be sent individually by mail to **each participant** and his[5] home community's CLSC for inclusion in his medical record. If a result requires clinical follow-up, the participant will be notified in his letter to consult at his CLSC and may thus consult for medical reasons with his letter in hand.

B. If the participant **did not provide consent**, the results will NOT be communicated to him and will NOT be sent to his home community's CLSC.

However, in accordance with the *Public Health Act*, **blood levels of Hg, Pb or Cd which exceed the *MADO* threshold** must be reported by the laboratory of the *Centre de toxicologie du Québec* (*CTQ*) to the Nunavik Public Health Department (PHD).

For the *Qanuilirpitaa?* 2017 participants, such is the case when:

⇒ **Hg blood level ≥ 60 nmol/L;**

⇒ **Pb blood level ≥ 0.5 µmol/L (for individuals aged 12 years and older);**

⇒ **Cd blood level ≥ 45 nmol/L.**

As applicable, a participant's results **must** therefore be communicated to the Nunavik PHD (even if the participant did not provide consent), which, when follow-up is required, will forward them to:

⇒ **The IHC or UTHC's Director of Nursing. They will be responsible for sending the results to the CLSC and for coordinating actions with the health profesionnals, and;**

⇒ **The CLSC will then ensure clinical follow-up of the participant.**

Note that under *Qanuilirpitaa?* 2017, the report sent by the *CTQ* to the Nunavik PHD will not indicate the name of the family physician (or other health professional), but, rather the name of the principal researcher (i.e., Pierre Ayotte in the case of *Qanuilirpitaa?* 2017).

How Are the Results of Blood Levels of Metals Normally Communicated when the Test Is Requested by a Family Physician or Other Health Professional of Nunavik?

Transmission of results of blood tests is somewhat different when the test is requested by a family physician or other health professional. In that case:

◊ the patient does NOT receive the result DIRECTLY;

◊ the result is sent directly to the family physician or health professional who requested the test;

◊ however, the transmission details remain similar when a result exceeds the *MADO* threshold: it is then reported by the *CTQ* to the PHD, which in turn will forward the information to the CLSC. The latter ensures clinical follow-up for the patient.

[5] In the interest of simplicity, the masculine or feminine form is used in this text to denote either sex.

What Are the Recommendations of the Public Health Dept. (PHD) for Results Exceeding the *MADO* Threshold?

The results are sent to the CLSC along with recommendations for clinical follow-up in accordance with the guidelines developed for Hg and Pb. As the foetus is most at risk of suffering harmful effects pursuant to exposure (see Appendices A and B), the recommendations particularly target pregnant women even though other recommendations are also provided for the rest of the population.

Guidelines for Cd have not yet been developed. However, it is known that blood levels of Cd are highly influenced by smoking (see Appendix C). No recommendations for Cd reports will be issued by the PHD.

All the recommendations take into account the fact that traditional foods are an important element of Inuit culture and contribute to efforts to prevent food insecurity. These foods are also among the healthiest foods available; they are an important source of several nutrients essential to good health, particularly during pregnancy (omega-3 fatty acids, vitamin D, iron, etc.). In the vast majority of cases, the advantages of consuming traditional foods outweigh the risks of exposure to contaminants. **Avoiding consumption of traditional foods and increasing consumption of certain store-bought foods often entail a greater risk linked to chronic diseases such as diabetes, osteoporosis and cardiovascular diseases.**

*MADO*s of Chemical Origin (Chemical *MADO*s)

The complete list of mandatory reportable diseases (*MADO*s) intended for physicians, other health professionals and laboratories is available online at:

www.msss.gouv.qc.ca/professionnels/maladies-a-declaration-obligatoire/mado/declarer-une-mado/

Further, laboratory updates to the reporting thresholds, in effect since January 1, 2017, may be found at:

www.inspq.qc.ca/sites/default/files/publications/2151_maladies_declaration_obligatoire_chimique.pdf

For any questions concerning clinical follow-up, you may contact:

Sylvie Ricard – Advisor, Environmental Health
Public Health Dept. (PHD)
Nunavik Regional Board of Health and Social Services (NRBHSS)
E-mail: sylvie.ricard2.ciussscn@ssss.gouv.qc.ca
Tel.: 418 666-7000 ext. 436
Conf. Fax: 1 866 867-8026

Dr Mario Brisson – Medical Advisor, Environmental Health
Public Health Dept. (PHD)
Nunavik Regional Board of Health and Social Services (NRBHSS)
E-mail: mario.brisson.ciussscn@ssss.gouv.qc.ca
Tel. : 418 666-7000 ext. 335
Conf. Fax: 1 866 867-8026

APPENDIX A : MERCURY (Hg)

Note: For further information on mercury, you may request consultation of the reference document by Lemire et al. 2014 (under revision). Guidelines taking into account the complex balance between mercury exposure and country foods benefits – Reference document for health professionals in Nunavik. Nunavik Public Health Dept.

MADO Reporting Threshold

The threshold for reporting to the Nunavik PHD by laboratories for blood Hg is 60 nmol/L.

Prevalence Data for Nunavik

The *Qanuippitaa?* 2004 Survey revealed an average Hg level of 51.2 nmol/L among adults (see Table 1). That represents a significant drop ($p < 0.001$) compared to the average level observed during the *Santé Québec* Survey of 1992 (average of 74.8 nmol/L), perhaps reflecting a reduction in the consumption of traditional foods.

Table 1: Average levels of blood mercury, population aged 18 to 74 years, Nunavik, 1992 and 2004

	Santé Québec Survey 1992			*Qanuippitaa?* 2004 Health Survey among Nunavik Inuit				
	n	Ave.*	CI 95%**	n	Ave.*	CI 95%**	Min.	Max.
Mercury (nmol/L)	492	74.8	69.2-80.9	917	51.2	47.9-54.7	0.4	1,200.0

* Geometric average.

** The confidence interval (CI) at 95% is a value interval that has a 95% chance of including the true value of the estimated parameter

Health effects

An individual's exposure to Hg may be acute or chronic. Two major episodes of acute exposure are identified in the literature, the first in rural zones of Iraq and, more recently, in Japan's Minimata Bay. The symptoms that occurred during those situations were generally linked to blood levels higher than 1,000 nmol/L.

Chronic exposure to Hg, with considerably lower blood levels, is the form that has been encountered to date in Nunavik. Young children and foetuses are particularly sensitive to Hg. Exposure during the prenatal period, often at levels without clinical consequences for the mother, is linked to subtle effects that appear later during childhood.

Studies conducted in Nunavik and among other populations subsisting on fish reveal that several subtle neurobehavioral effects (such as disorders involving attention, memory, intellectual performance, equilibrium and motor skills) have been linked to chronic, prenatal exposure to low doses of Hg. In adults, studies in Nunavik and elsewhere have observed significant links between increasing exposure to Hg and higher blood pressure as well as with decreased heart rate variability. These two effects are risk factors for cardiovascular diseases later in life.

Among other populations that consume large quantities of fish, studies suggest a link between exposure to Hg in children and effects on the immune system. Other studies also suggest links between exposure to Hg in adults and effects on the immune system and several early effects on neurological functions such as disorders with fine motor coordination as well as difficulties with colour and peripheral vision, sensitivity to visual contrasts and near-field visual acuity. It is pertinent to note that, until present, the effects of chronic exposure to Hg on the immune system during childhood as well as on the immune system and neurological functions during adulthood have not been studied in Nunavik.

The effects of exposure in children and adults specifically documented in Nunavik are presented in Table 2.

Table 2: Effects linked to chronic exposure identified in Nunavik studies

Children/prenatal exposure	⇒ Shortened pregnancy, premature birth ⇒ Later during childhood: ♦ subtle difficulties in attention, memory, language, intellectual and visual/spatial performances, processing of sensorial information, equilibrium and motor skills ♦ heightened risk of hyperactivity and attention problems
Children/postnatal exposure	⇒ Delay in development of fine motor skills ⇒ Decreased heart rate variability
Adults	⇒ Higher blood pressure and decreased heart rate variability ⇒ Low paraxonase 1 (PON 1) activity[6]

Probable Sources of Mercury in Nunavik

Hg exists in more than one form. One, inorganic Hg, can be modified naturally by microorganisms into an organic form called methylmercury (MeHg). MeHg can accumulate in considerable quantities in animals of higher trophic levels (predatory fish and certain marine mammals) and in older specimens of animals in the aquatic food chain. MeHg can then be absorbed in the digestive tract of individuals who consume those animals.

It is very important to note that most traditional foods in Nunavik contain low levels of Hg. Research suggests that it is essentially beluga *nikku* (dry meat) and beluga meat (raw, cooked) that contribute most to blood Hg among *Nunavimmiut*, particularly in the Hudson Strait subregion, where it is consumed most frequently. Lake trout, which are predatory and relatively long-lived, also show high levels of Hg, particularly older specimens (larger ones).

On the other hand, beluga *mattaq* (skin and blubber) on average contain significantly lower amounts of Hg than does beluga meat. Moreover, practically all fish species, fish eggs, mussels and other seafood, wild berries and plants as well as meat from walrus, caribou, muskox, hare, polar bears, seals, geese and ptarmigan, are among the traditional foods shown to contain low to medium levels of mercury. These foods thus constitute alternatives that may be consumed more safely by individuals with high blood mercury.

6. Enzyme involved in detoxification of oxidized LDL (low-density lipids) cholesterol, which causes atherosclerosis.

Appendix B: Lead (Pb)

Note: For more information on lead, you may request consultation of the reference document by Lemire et al. 2014 (under revision). Guidelines taking into account the complex balance between mercury exposure and country foods benefits – Reference document for health professionals in Nunavik. Nunavik Public Health Dept.

MADO Reporting Threshold

The threshold for reporting to the Nunavik PHD by laboratories for blood Pb is 0.25 µmol/L for children aged 0 to 11 years and 0.5 µmol/L for individuals aged 12 years and older.

Données de prévalence au Nunavik

Blood levels of lead measured during the *Qanuippitaa?* 2004 Health Survey averaged 0.19 µmol/L (Table 3). A significant drop ($p < 0.001$) was noted compared to the values measured in 1992 (average of 0.42 µmol/L). However, nearly 10% of the values among adults and 2% among women of childbearing age remained above the threshold of 0.5 µmol/L.

Table 3: Average levels of blood lead, population aged 18 to 74 years, Nunavik, 1992 and 2004

	Santé Québec 1992 Survey			*Qanuippitaa ?* 2004 Health Survey among Nunavik Inuit				
	n	Moy.*	IC 95 %**	n	Moy.*	IC 95 %**	Min.	Max.
Lead (µmol/L)	493	0.42	0.40-0.44	917	0.19	0.18-0.20	0.028	2.40

* Geometric average.
** The confidence interval (CI) at 95% is a value interval that has a 95% chance of including the true value of the estimated parameter.

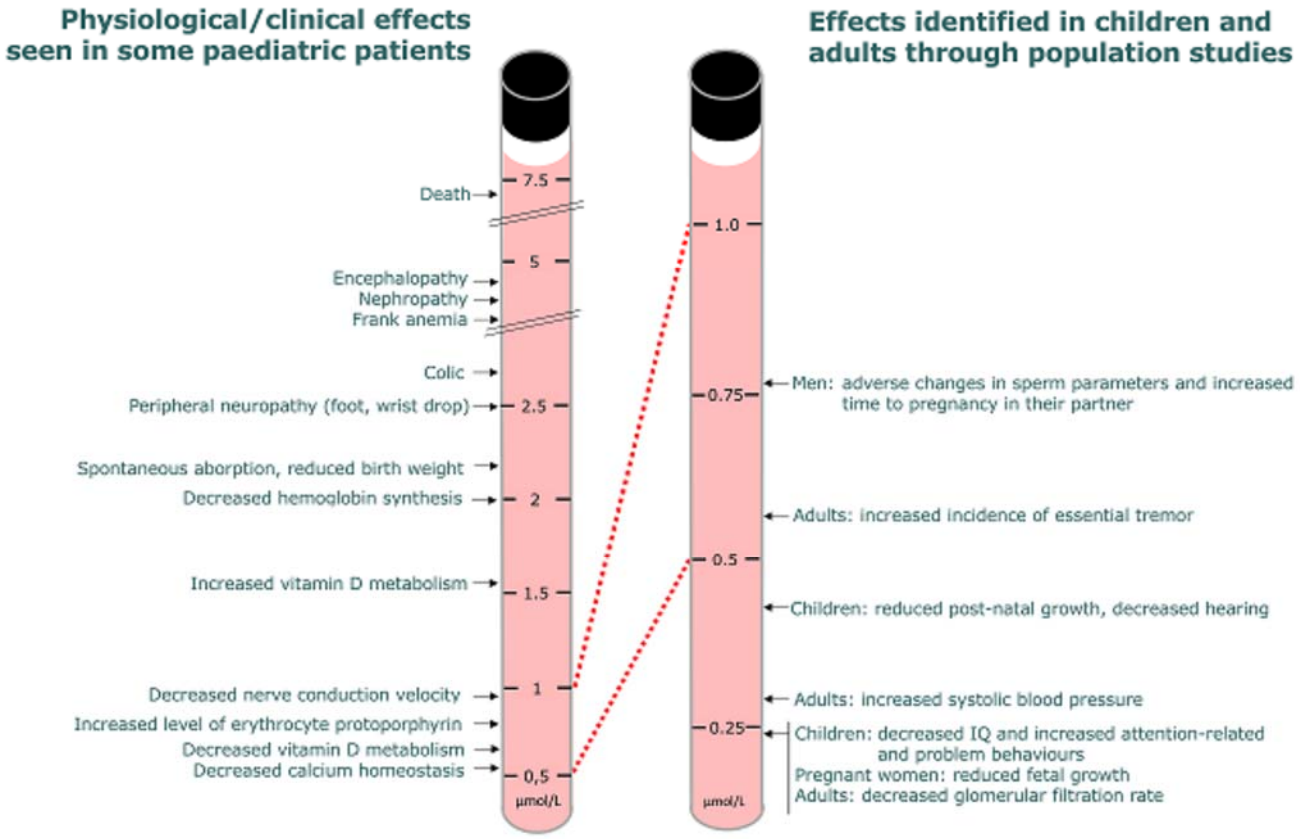
Health Effects

Manifestations of acute Pb poisoning are practically no longer encountered in developed countries, where health measures are in effect.

Chronic exposure to Pb, with considerably lower blood levels, is the form that has been encountered to date in Nunavik. This type of exposure can lead to negative physiological effects in children and adults (Figure 1). Although the effects of exposure to low doses of Pb are not clinically detectable at the individual level, statistically significant population effects at the population level have nevertheless been observed in epidemiological studies (Figure 1). Studies conducted in Nunavik since the 1990s have, moreover, demonstrated a link between prenatal exposure to Pb and neurobehavioural effects in children (reduced speed in processing information, increased inattention, reduced working memory, neuromotor changes, hyperactivity, etc.).

An increasing body of scientific evidence supports a relationship, without a threshold, between exposure in foetuses and young children and neurological effects. All recent information therefore indicates prudence, and the objective of public-health authorities is to reduce, as much as possible, exposure to Pb, particularly during pregnancy and in young children.

Figure 1: Summary of physiological, clinical and population effects observed in children and adults



Probable Sources of Lead in Nunavik

In Nunavik, environmental analysis of probable sources of Pb and isotope identification of blood Pb, performed between 1996 and 1998, revealed that the principal source of exposure among *Nunavimmiut* was Pb contained in the shot[7] used in hunting.

Since 1999 in Canada, the *Migratory Birds Regulations* have forbidden the use of Pb shot for hunting migratory birds, which include snow geese, Canada geese and ducks. During the 1990s and 2000s, Nunavik organizations including the NRBHSS and the HFTA (Hunters, Fishermen and Trappers Association) decided to launch an awareness campaign and to promote a voluntary ban on Pb shot on the territory. That measure was followed by a marked drop in blood lead in adults and newborns. However, an internship project carried out in the summer 2016 revealed that certain hunters still use Pb shot for hunting and that that type of ammunition is still available in the majority of the Nunavik communities.

Further, the Fachehoun study in 2015 suggests that consumers of game harvested with bullet ammunition could also be exposed to Pb. In effect, fragments of Pb bullets, sometimes microscopic in size, can remain in the meat if it is not properly cleaned before consumption (i.e., by removing roughly 10 cm around the projectile's penetration canal). Hunters who use Pb-based ammunition can also be exposed through inhalation of Pb smoke or dust when cleaning, firing or reloading a firearm. Cleaning firearms at home and handling Pb cartridges can also be sources of exposure for hunters' family members.

The use of Pb-free ammunition (e.g., steel shot, copper bullets) constitutes the most effective measure for protecting *Nunavimmiut* against exposure, particularly young children, who are more vulnerable to Pb neurotoxicity.

7. It is important to distinguish between two principal types of projectile: shot and bullets.

Appendix C: Cadmium (Cd)

Note: For more information on cadmium, see the list of documents consulted at the end of this newsletter, principally Dewailly *et al*. (2007) and Charania *et al*. (2014).

MADO reporting threshold

The threshold for reporting to the Nunavik PHD by laboratories for blood Cd is 45 nmol/L.

Prevalence data for Nunavik

The *Qanuippitaa?* 2004 Health Survey revealed that the average Cd level was 36.6 nmol/L among adults. That represents a significant drop ($p < 0.001$) compared to the average observed in the *Santé Québec* 1992 Survey (see Table 4). In 2004, the average dose of Cd measured in 663 smokers was 45.1 nmol/L (maximum measured was 130 nmol/L) and in 76 non-smokers, 5.9 nmol/L (maximum of 22 nmol/L).

Table 4: Average levels of blood cadmium, population aged 18 to 74 years, Nunavik, 1992 and 2004

	Santé Québec 1992 Survey			*Qanuippitaa ?* 2004 Health Survey among Nunavik Inuit				
	n	Moy.*	IC 95 %**	n	Moy.*	IC 95 %**	Min.	Max.
Cadmium (nmol/L)	493	45.1	42.5-47.6	917	36.6	35.1-38.1	1.4	130.0

* Arithmetic average.
** The confidence interval (CI) at 95% is a value interval that has a 95% chance of including the true value of the estimated parameter.

Health Effects

The most important health risk linked to exposure to Cd is nephrotoxicity. Cd can aggravate a preexisting kidney problem, particularly in case of diabetes. Chronic exposure can also cause anemia, interference with the metabolism of calcium and vitamin D, bone loss and may constitute a potential risk factor for diabetes and cardiovascular diseases.

Probable Sources of Cadmium in Nunavik

Cd found naturally in the environment (rocks, sediments, soils, etc.) is taken up by plants (lichen, cereal grains, vegetables, tobacco, etc.) and become concentrated in herbivorous mammals such as caribou, particularly in their kidneys and livers. Consumption of those organs could lead to a small increase in blood levels of Cd in *Nunavimmiut*. Consuming market foods like vegetables can also result in human exposure. However, it has been ascertained that levels measured in blood can primarily be attributed to smoking habits. A study in *Eeyou Istchee* (Quebec) revealed NO association between consumption of traditional foods (specifically wild game organ meats) and blood Cd concentrations. However, a significant positive association was observed with the number of cigarettes smoked per day.

Exposure to Cd present in tobacco smoke is considered as being much higher than exposure due to consumption of traditional foods. To reduce exposure to Cd, the recommendation is to stop smoking and to avoid exposure to second-hand smoke.

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