

Health Consultation

THE POTENTIAL FOR INGESTION EXPOSURE
TO LEAD FRAGMENTS IN VENISON IN WISCONSIN

NOVEMBER 4, 2008

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

You May Contact ATSDR TOLL FREE at
1-800-CDC-INFO

or

Visit our Home Page at: <http://www.atsdr.cdc.gov>

HEALTH CONSULTATION

THE POTENTIAL FOR INGESTION EXPOSURE
TO LEAD FRAGMENTS IN VENISON IN WISCONSIN

Prepared By:

Wisconsin Department of Health and Family Services
Under cooperative agreement with the
Agency for Toxic Substances and Disease Registry

Table of Contents

Summary and Statement of Issues	1
Background.....	1
Discussion.....	3
Child Health Considerations.....	7
Conclusions.....	7
Recommendations.....	7
Public Health Action Plan.....	8
References.....	9
Appendix 1. Venison and lead information distributed to local health officers and posted to the Wisconsin Health Alert [Internet] Network.....	11
Appendix 2. DHFS letter to food pantry managers	12
Appendix 3. DHFS/DNR letter to Wisconsin Veterinarians.	14
Appendix 4. Blood Lead Concentrations Corresponding to Adverse Health Effects.....	17
Appendix 5. How can lead affect children?.....	19

Summary and Statement of Issues

Bullet fragments in rifle-killed deer have led to concerns about risks of lead exposure associated with human consumption of venison. The presence of lead bullet fragments in venison intended for human consumption has been confirmed, and indicates a completed exposure pathway for the ingestion of lead-contaminated meat. A modeled exposure estimate, based on currently available field data, suggests a significant risk of elevated lead levels in blood among children consuming venison shot with lead ammunition. Because elevated blood lead has not been confirmed among consumers of venison, and because the measured lead content in venison varies greatly, there is an *indeterminate public health hazard* among those consumers. The Wisconsin Department of Health Services (DHS) recommends the use of non-lead ammunition as the simplest and most effective solution to lead poisoning, in both humans and wildlife, arising from the consumption of deer killed with lead ammunition. In addition, food pantries and their clients should be made aware of possible lead fragments in venison; processors of deer should use best practices to avoid lead exposure from venison.

The presence of lead in venison is a topic that has implications for deer hunters and their families, food pantries and their clients, meat processors, and others with a public or private interest in hunting. The purpose of this report is to determine the health implications of eating lead-contaminated venison, based upon laboratory analysis of venison samples and a modeled exposure assessment.

Background

Wisconsin ranks near the top of all states in the popularity and economic importance of White-tailed deer hunting (WDNR 1998, 2007). Deer hunting is an important part of Wisconsin recreation and tourism, and is a long-held tradition in many families. In addition, the large size of the state's deer population has effects such as crop damage and road vehicle accidents that demand population management. Most of that management is conducted via hunting, traditionally with rifle and shotgun using lead ammunition, as well as bow and arrow.

The issue of human exposure to lead ammunition fragments in venison came to the attention of Public Health indirectly. Hunt *et al.* (2006), concerned about reports of lead poisoned avian scavengers, investigated hunter-shot deer for the presence of lead, hypothesizing that eagles and other birds consumed lead from deer killed but unrecovered, or from discarded entrails. They reported that tiny metal fragments were prevalent in the wounds of these deer, particularly those shot with copper-jacketed and hollow point bullets. Subsequently, concerns were raised in North Dakota, South Dakota, Iowa, Minnesota, and Wisconsin about the potential for human exposure to lead among those consuming venison. North Dakota was the state taking the earliest public health position (NDDOH 2008):

“Earlier this year, Dr. William Cornatzer, a Bismarck physician and hunter, contacted the Department of Health with concerns about the potential of lead fragments from bullets in ground venison. Dr. Cornatzer collected 95 packages of ground venison donated for food pantries. Of those, X-rays detected the presence

of metal in 53 packages. The Department of Health recently took five samples targeting the metal pieces, all five of which tested strongly positive for lead....The Department of Agriculture sent a letter to all state- and federal-inspected meat processing plants in North Dakota informing them about the situation, and the Department of Health sent a letter to food pantries with recommendations for disposing of the meat. Additional studies concerning lead in wild game and lead levels in children are being planned by the Department of Health. In addition, the Game and Fish, Health, and Agriculture departments are working to develop guidance about how to properly clean and dress wild game to reduce the chances of lead in meat.”

Venison donated to charity food pantries is a particular concern, as this program is an important outlet for harvested deer while also serving a population having a greater than average exposure to lead in the home. In Wisconsin, food pantry venison is not regulated, unlike commercial and retail meats, which must be inspected before and after processing. The 2006 Wisconsin deer harvest was approximately 500,000 deer (WDNR 2007). From these, about 400,000 pounds of venison were donated to food pantries via 126 meat processors participating in the Department of Natural Resources (WDNR) program.

The Wisconsin Department of Health Services (DHS, formerly Dept. Health and Family Services) has a comprehensive *Childhood Lead Poisoning Prevention Program* devoted to identifying those at risk and interrupting all sources of lead exposure (DHFS 2008). Metallic lead in food is not a new issue. Lead solder in canned foods and lead leachate from ceramic and glass vessels were important sources that were addressed starting in the 1970s. Consumers of wild game are familiar with lead pellets, bullets, and slugs to be avoided in meat. However, the presence of nearly invisible lead fragments in wild game, to our knowledge, had not been widely considered.

Because this issue has implications for an important food distribution program, on April 11, 2008 the DHS asked food pantries to hold venison pending the analysis of venison samples from food pantries (Appendix 1). As the analysis proceeded (see below), DHS concluded that due to the prevalence and concentration of lead seen in venison samples, the frozen venison held in food pantries and other facilities should not be released without further screening. This was conveyed in a second letter to food pantries (Appendix 2). In cooperation with the WDNR, an appeal was made to local veterinarians throughout the state (Appendix 3) for their assistance in screening the venison using their X-ray facilities.

Venison sampling. In Wisconsin, the Departments of Natural Resources and Health Services cooperated to sample and analyze lead in venison from around the state. One hundred eighty three (183) nominal one-pound ground venison samples were collected from freezer stocks of 5 food pantries and 6 meat processors located around the state (“pantry samples”). The samples were screened radiographically by WDNR staff. Of these, 46 samples with radiopaque fragments were submitted to the Wisconsin State Laboratory of Hygiene (WSLH) for lead analysis. Each of the 46 packages was subdivided into nominal ¼ lb “portions” for chemical analysis. Each ¼ lb sample (approx. 0.113 kilograms) was digested in KOH. Any metal fragments recovered following digestion were dissolved in acid and analyzed for Pb (See USDA

2004 for method). The lab reported lead concentration as milligrams Pb per kilogram fresh meat (mg/kg). Means \pm standard deviation are reported in terms of the ¼ pound samples. Reported prevalence was calculated from ¼ pound samples normalized to the 1 pound x-ray screened package size.

One hundred fourteen (114) additional samples of ground and whole cut venison were solicited from WDNR employees in order to more directly sample the hunter population (“hunter samples”). These were screened and analyzed as above. Sixteen of the 114 hunter samples were identified by the submitter as “commercially processed.” Therefore, for the purpose of calculating averages, these sixteen were grouped with the pantry samples, for an adjusted total of 199 pantry (or commercially processed) samples and 98 self-processed samples (from hunters).

Results. Lead was ultimately detected in 30 of 199 commercially processed samples, a prevalence of 15% (Table 1). The mean lead concentration found among those pantry samples positive for lead was 15.9 mg/kg \pm 32.5 std. dev. The mean lead concentration found among *all* pantry samples was 2.4 mg/kg \pm 13.8 std. dev.

Lead was detected in 8 of 98 hunter samples, a prevalence of 8%. Seven of the eight positives were from ground meat; one was from a whole cut. The mean lead concentration found among those hunter samples positive for lead was 21.8 mg/kg \pm 67.1 std. dev. The mean lead concentration found among *all* hunter samples was 1.8 mg/kg \pm 19.8 std. dev.

Table 1. Summary of lead content analysis in Wisconsin hunter-killed deer.

<i>Sample group</i>	<i>Number of samples*</i>	<i>Mean lead conc., lead-positive samples mg/kg \pmstd. dev.</i>	<i>Mean lead conc., all samples mg/kg \pmstd. dev.</i>	<i>Prevalence of lead-positive samples</i>
<i>Commercial processor</i>	199	15.9 \pm 32.5	2.4 mg/kg \pm 13.8	15%
<i>Hunter processed</i>	98	21.8 \pm 67.1	1.8 mg/kg \pm 19.8	8%

*Each sample represents a nominal 1 pound package.

Discussion

Venison sampling. The presence of quantified lead bullet fragments in venison intended for human consumption indicates that a completed exposure pathway exists for the ingestion of lead-contaminated meat. To date, there has been no corresponding sampling of blood lead among consumers of venison in Wisconsin. This work represents an initial assessment of the risks of lead in venison.

This health consultation emphasizes the implications of lead found in donated venison. However, it is noteworthy that donated venison represents approximately 2% of the total deer harvest in Wisconsin. The potential exposed population extends well beyond clients of food pantries. Changes in practices that result in lower lead concentrations in venison will have positive effects in the broader population.

The analytical results of lead in venison conducted to date in Wisconsin are characterized by high variability. Each hunter-killed deer is a unique interaction of the anatomical placement of the shot, the type of ammunition used, the ballistics of the individual shot, and details of the processing method. Each of these variables affects the passage of the bullet through the wound, the degree of fragmentation, and ultimately the concentration of lead. As more data is gathered from deer carcasses and processed meat, it may later be possible to state the prevalence of lead in venison killed in a particular way, and to predict whether there are exposure risks to a processed lot of meat based upon samples taken from that lot. Despite these limitations, it is clear that many venison samples contained unhealthy levels of lead.

U.S. Food and Drug Administration regulatory position. There is no single standard for permissible amounts of lead in food. Furthermore, FDA regulatory standards and guidelines for lead in food are complicated by the relatively recent recognition (ATSDR 2007, EPA 2008) of lead as a probable human carcinogen.

Health and environmental agencies rely on several standards and guidelines, including FDA guidelines for tolerable levels of daily dietary lead intake, and FDA guidance suggesting specific limits for lead in certain foods such as shellfish and candy (ATSDR 2007, FDA 2007).

For meat and fat products, an international consensus standard of 0.05 mg/kg is under discussion (FDA 2000). While there is no known endogenous role for lead, and no known level of exposure that is without effect, the variety of standards and guidelines acknowledges that some exposure to lead is unavoidable. The FDA's *provisional total tolerable intake levels* provide the following limits on daily lead intake: for adults, 75 µg/day; for pregnant women, 25 µg/day; and for children age five and under, 6 µg/day (FDA 1998).

Exposure analysis. Blood lead levels that could result from ingesting Pb-contaminated venison were predicted using the U.S. EPA *Integrated Exposure Uptake Biokinetic Model* (IEUBK, EPA 2007). The model has 100 input parameters that account for the various sources of ingested and inhaled lead in the environment. Default inputs and assumptions were used for all parameters save dietary consumption of Pb-contaminated game meats as a percentage of total meat consumption. The model was run using inputs for game meats at the mean concentrations observed in Wisconsin (Table 1), at an ingestion frequency of either once (3.5%) or twice (7.0%) per month. The ingestion frequency assumes one meat meal per day. The model was also run using the maximum concentrations found in venison (Table 2). Running the model at these maximum concentrations and at the once- or twice-per-month consumption frequency resulted in a model error, and were therefore calculated using a lower exposure frequency.

Table 2. Childhood blood lead concentrations predicted from consuming venison containing lead fragments at concentrations found in Wisconsin.¹

<i>Exposure scenario</i>	<i>Pb conc. in venison mg/kg</i>	<i>Consumption frequency (meals/month)</i>	<i>% children with blood Pb above 10 µg/dL</i>	<i>Average blood lead (geometric mean, µg/dL)</i>
<i>maximum</i>	265 ³	<i>1 per 2 months</i>	100%	34 ²
<i>maximum</i>	265	<i>1 per 4 months</i>	96%	23
<i>maximum</i>	169 ⁴	<i>1 per 2 months</i>	98%	27
<i>medium</i>	21.8 ⁵	<i>2 per month</i>	90%	18
<i>medium</i>	21.8	<i>1 per month</i>	65%	12
<i>medium</i>	15.9 ⁶	<i>2 per month</i>	81%	15
<i>medium</i>	15.9	<i>1 per month</i>	50%	10
<i>low</i>	2.4 ⁷	<i>2 per month</i>	11%	6
<i>low</i>	2.4	<i>1 per month</i>	5%	5
<i>low</i>	1.8 ⁸	<i>2 per month</i>	8%	5
<i>low</i>	1.8	<i>1 per month</i>	4%	4
<i>standard</i>	0.05 ⁹	<i>2 per month</i>	1%	3.5

Shaded area is “medium” exposure scenario. See uncertainty discussion.

mg/kg: milligram lead per kilogram fresh venison. µg/dL: micrograms lead per deciliter of blood.

¹*Predictions modeled using U.S. EPA Integrated Exposure Uptake Biokinetic Model (EPA 2007).*

²*Exposures associated with blood lead levels above 30 µg/dL are above the range of values calibrated and validated for the model.*

³*Maximum lead concentration found in hunter samples.*

⁴*Maximum lead concentration found in pantry samples.*

⁵*Average lead concentration among hunter samples that were positive for lead, n=8.*

⁶*Average lead concentration among pantry samples that were positive for lead, n=30.*

⁷*Average lead concentration among all pantry samples, n=199.*

⁸*Average lead concentration among all hunter samples, n=98.*

⁹*International consensus standard for lead in meat (FDA 2000).*

Results. As shown in Table 2., the model predicts that consuming venison with 21.8 mg/kg (hunter samples) lead every 15 days will result in 90 % of children less than 7 years old having blood lead greater than the 10 µg/dL level of concern. If the ingestion frequency is reduced to once every 30 days, the predicted percentage of children with blood lead >10 µg/dL is 65%. A comparable statement for adult blood lead is not included, as the model is designed only for the pharmacokinetic fate of lead in children.

At the mean lead concentration found in pantry samples, the model predicts that consuming venison with 6.2 mg/kg lead every 15 days will result in 80 % of children less than 7 years old having blood lead greater than 10 µg/dL level of concern. If the ingestion frequency is reduced to once every 30 days, the predicted percentage of children with blood lead >10 µg/dL is 50%.

Uncertainty. The conditions used in the modeled predictions (Table 2) were chosen to reflect a range of risk levels among the wide variation in prevalence and concentration of lead in venison samples. The assumed ingestion frequency may over- or underestimate any particular child. The overall means would tend to underestimate exposures to those consuming venison from pantries and processors having a high prevalence of lead in meat samples. The venison Pb concentrations used in the model are means of only those samples that were positive for lead and are not overall means. However, these averages were 10-42 fold lower than the maximum concentrations of lead seen in some samples (maximum 169 mg/kg in pantry samples; 265 mg/kg in hunter samples). Calculated lead exposure to those children consuming venison with the highest levels of lead measured was at or near 100%, even with a lower frequency of consumption (Table 2). At the lowest calculated lead levels, using the same 15 and 30 day exposure frequencies, the model predicts that most children would have measurable increases in blood lead that are *below* 10 µg/dL. However, this lower estimate is skewed away from the possibility of ingesting venison having very high lead levels. For the purpose of this exposure estimate, it is assumed that a realistic exposure, or the calculated averages of 21.8 and 15.9 mg/kg Pb in venison, lies somewhere between the minimum and the maximum permitted by our data.

Toxicological effects expected from lead fragments in venison. Lead is a well-established developmental neurotoxin, and also affects the kidneys, blood formation, reproduction, humoral immunity, and the peripheral nervous system. Due to variation in lead uptake among individuals and among the various chemical forms of lead, the toxicity of lead exposure is usually expressed in terms of its resulting concentration in blood (PbB), and the toxic endpoints corresponding to those blood concentrations. Ten micrograms per deciliter of blood (10µg/dL) is commonly cited as the level of concern in children (CDC 1991). However, numerous studies (*e.g.* Finkelstein *et al.* 1998; Fels *et al.* 1994) report subtle biochemical, nephric, neuromotor, and cognitive effects in children (and in some studies, adults) chronically exposed to lead corresponding to blood lead levels as low as 2 µg/dL.

Although we know of no formal studies of lead poisoning resulting from ingestion of lead bullet fragments in large game animals, the presence of lead in game birds is well established (Tsuji *et al.* 1999) and some studies (*e.g.* Johansen *et al.* 2006) have measured elevated blood lead (>10 µg/dL in adults) among subsistence hunters who regularly consume waterfowl shot with lead pellets. Several reports have demonstrated clinical lead poisoning among adults retaining two or more lead shot in the appendix (Madsen *et al.* 1988, Hilman 1967). Other reports (*e.g.* Mowad *et al.* 1998) have documented cases in which medical intervention was required for children who intentionally ingested lead fishing sinkers or other metallic lead objects. A recent Minnesota case resulted in a fatality (CDC 2006).

A variety of effects of lead in children and adults correspond to various blood lead levels (see Appendix 4, from ATSDR 2006). Within the limitations of modeled blood lead predictions presented here, some of these effects can be reasonably expected among children and adults consuming venison contaminated with lead fragments.

Child Health Considerations

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health.

Developing fetuses and young children are particularly vulnerable to the effects of lead (ATSDR 2006). Children are more sensitive to the effects of lead than adults, have absorb more ingested lead into the body than adults, and no safe blood lead level in children has been determined (see Appendix 5, for a child-specific public health statement).

Conclusions

- The quantified presence of lead bullet fragments in venison intended for human consumption indicates that a completed exposure pathway exists for the ingestion of lead-contaminated meat.
- The modeled exposure estimates, based on currently available field data, indicate that even at the lowest exposure scenario, there is predicted risk of elevated lead levels in blood among children consuming venison shot with lead ammunition.
- Because elevated blood lead has not been confirmed among consumers of venison, and because the measured lead content in venison varies greatly, there is an *indeterminate public health hazard* among those consumers.

Recommendations

- Food pantries and their clients should be made aware of possible lead fragments in venison, to include consumption recommendations to protect young children and fetuses from lead exposure.
- Identifying and discarding those portions of the deer carcass most likely to contain bullet fragments is one way to avoid lead exposure from venison. Best practices for butchering deer should be provided to commercial processors and to hunters.
- Future venison donations to charity food pantries should be from processors using methods shown to minimize bullet fragments in meat.
- DHS recommends the use of non-lead ammunition as the simplest and most effective solution to lead poisoning, in both humans and wildlife, arising from the consumption of deer killed with lead ammunition. To address this issue, DHFS recommends the eventual transition to non-lead ammunition.

Public Health Action Plan

- Advice to hunters for minimizing the amount of lead in venison has been included in the WDNR 2008 Deer Regulations.
- To verify the effect of revised meat processing recommendations, DHS, in cooperation with WDNR, DATCP, and local and state health agencies, will analyze ground venison samples for the presence of lead following the 2008 deer hunting season.
- DHS will continue to work with state and local health and environmental agencies, with the hunting community, and with food relief programs in providing education on this topic.
- DHS will work with state agencies to encourage the public's awareness of and availability to non-lead hunting ammunition.

Consultation author

Robert Thiboldeaux, Ph.D.
Toxicologist
Health Hazard Evaluation Unit
Bureau of Environmental and Occupational Health
Division of Public Health
Wisconsin Department of Health Services

Technical team

Sean M. Strom, Wildlife Toxicologist
Julie Langenberg, DVM
Wisconsin Department of Natural Resources

Noel V. Stanton
DeWayne Kennedy-Parker
Toxicology/Environmental Sciences Section
Wisconsin State Laboratory of Hygiene

Rossana Perez-Freytes
University of Wisconsin
College of Veterinary Medicine
DVM/MPH Candidate

Chuck Warzecha, Director
Bureau of Environmental and Occupational Health
Division of Public Health
Wisconsin Department of Health Services

References

ATSDR. 2006. Agency for Toxic Substances and Disease Registry/Division of Toxicology and Environmental Medicine. Lead ToxFAQs: /Chemical Agent Briefing Sheet. Internet: http://www.atsdr.cdc.gov/cabs/lead/lead_cabs.pdf

ATSDR. 2007. *ch. 8 in Toxicological Profile for Lead*. Agency for Toxic Substances and Disease Registry, Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. <http://www.atsdr.cdc.gov/toxprofiles/tp13.pdf>

CDC. 1991. *Preventing Lead Poisoning in Young Children*. U. S. Department of Health and Human Services, Centers for Disease Control. Internet: <http://www.cdc.gov/nceh/lead/publications/books/plpyc/contents.htm>

CDC. 2006. Death of a child after ingestion of a metallic charm – Minnesota, 2006. U. S. Department of Health and Human Services, Centers for Disease Control. *Morb. Mortal. Wkly. Rept.* 55:340-341.

DHFS. 2008. *The legacy of lead: the report on childhood lead poisoning in Wisconsin*. Wisconsin Dept. Health Family Services. Internet: <http://dhs.wisconsin.gov/lead/LegacyofLead/index.HTM>

EPA. 2007. *Integrated Exposure Uptake Biokinetic Model (IEUBK) for lead in children, ver. 1.0*. Internet: www.epa.gov/superfund/lead.

FDA. 1998. Dangers of Lead Still Linger, FDA Consumer:Jan.-Feb. 1998. reprinted by: U.S. Food and Drug Administration, Center for Food Safety and Applied Nutrition. Internet: www.cfsan.fda.gov/~dms/fdalead.html

FDA. 2000. Emerging international contaminant issues: Development of Codex alimentarius standards to address the issues. Food Safety Magazine, Feb. 2000. reprinted by: U.S. Food and Drug Administration, Center for Food Safety and Applied Nutrition. Internet: <http://www.cfsan.fda.gov/~cjm/codexfa2.html>

FDA. 2007. Pesticides, Metals, Chemical Contaminants & Natural Toxins. U.S. Food and Drug Administration, Center for food safety and applied nutrition. Internet: <http://www.cfsan.fda.gov/~lrd/pestadd.html>

Fels LM, Herbort C, Pergande M, Jung K, Hotter g, Rosello J, Gelpi E, Mutti A, De Broe M, Stolte H. 1994. Nephron target sites in chronic exposure to lead. *Nephrol. Dial. Transplant.* 9: 1740-6.

Finkelstein Y, Markowitz ME, Rosen JF. 1998. Low-level lead-induced neurotoxicity in children: an update on central nervous system effects. *Brain Res. Brain Res. Rev.* 27: 168-76.

Johansen P, Pedersen HS, Asmund G, Riget F. 2006. Lead shot from hunting as a source of lead in human blood. *Environ. Poll.* 142: 93-97

Hilman FE. 1967. A rare case of chronic lead poisoning: polyneuropathy traced to lead shot in the appendix. *Industrial Med. Surg.* 488-92.

Hunt GW, Burnham W, Parish CN, Burnham KK, Mutch B, Oaks JL. 2006. Bullet Fragments in Deer Remains: Implications for Lead Exposure in Avian Scavengers. *Wildlife Soc. Bull.* 34(1): 167-70.

Madsen HHT, Skjødt T, Jørgensen PJ, Granjean P. 1988. Blood lead levels in patients with lead shot retained in the appendix. *Acta Radiologica* 29: 745-6.

Mowad E, Haddad I, Gemmel DJ. 1998. Management of Lead Poisoning from ingested fishing sinkers. *Arch. Pediatr. Adolesc. Med.* 152:485-488.

NDDOH. 2008. Food Pantries Notified About Lead Fragments Discovered in Donated Ground Venison. North Dakota Department of Health. March 26, 2008 News Release. Internet: <http://www.ndhan.gov/media/news/>.

Tsuji LJS, Nieboer E, Karagatzides JD, Hanning RM, Katapatuk B. 1999. Lead shot contamination in edible portions of game birds and its dietary implications. *Ecosystem Health* 5: 183-92.

USDA. 2004. Detection and Identification of Extraneous Material in Meat and Poultry Products. United States Department of Agriculture, USDA SOP MLG 32.01 rev.1 12/3/04 (part C). Internet: <http://www.fsis.usda.gov/Ophs/Microlab/MLg32.01.pdf>

WDNR 1998. *Wisconsin's Deer Management Program: The Issues Involved in Decision-Making, 2nd Edition*. Wisconsin Department of Natural Resources. Internet: <http://www.dnr.state.wi.us/org/land/wildlife/hunt/deer/Deerbook.pdf>

WDNR. 2007. Deer Season Forecast. Wisconsin Department of Natural Resources. Internet: http://www.dnr.state.wi.us/org/caer/ce/news/specialedition/2007_Fall_Hunting_Forecast.html

Appendix 1. Venison and lead information distributed to local health officers and posted to the Wisconsin Health Alert [Internet] Network

TO: Local and Tribal Health Officers, DPH Regional Office Directors

FROM: Chuck Warzecha, Bureau of Environmental and Occupational Health

RE: Possible lead contamination in processed venison at food pantries.

DATE: April 11, 2008

Please forward this alert to food pantries in your jurisdictions.

By now you may have heard or seen news out of North Dakota or Minnesota related to lead contamination in venison donated to food pantries in those states. Wisconsin has been in contact with those states and we are also conducting sampling of venison from processors in this state. We are taking the reports from the other states seriously. There have been no reports of illness associated with lead in venison. But, as a precaution we have advised that food pantries with donated venison on their shelves hold any remaining product until we have more information.

The concern stems from studies that show bullet fragments (particularly from high velocity rifles) dispersing widely in the meat, and then incorporated into the ground meat from processors. We are working with the DNR and DATCP to better understand the issue and formulate clearer advice for the public. We are testing venison to determine if bullet particles in wild game pose a health issue. If we get similar results to what Minnesota has received, it is possible we will recommend disposal of the remaining venison at food pantries.

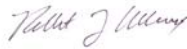
Because of the extensive blood lead surveillance we have done, we are confident that the primary source of lead poisoning in the state comes from chipping and peeling lead paint. Eating venison has not been identified as a concern from this surveillance. However, we are unable to rule this issue out as a possible source of unsafe lead exposure.

We have sent messages to the food pantries in the TEFAP program (The Emergency Food Assistance Program). However, that does not include all food pantries. Please pass this advisory on to other food pantries in your area.

Please address any questions on this matter to Chuck Warzecha (608/264-9880) in the Bureau of Environmental and Occupational Health. Thank you.

Appendix 2. DHS (formerly DHFS) letter to food pantry managers.

TO: Food Pantry Managers
Local and Tribal Health Officers
DPH Regional Office Directors
Please forward this alert to food pantries in your jurisdictions.

FROM: Chuck Warzecha, Rob Thiboldeaux, 
Bureau of Environmental and Occupational Health

SUBJECT: Health Concerns about Lead in Venison

June 20, 2008

Thank you for your patience while the Department of Health and Family Services works with the Department of Natural Resources, the Department of Agriculture, Trade, and Consumer Protection, and neighboring states to develop recommendations regarding lead in venison.

At this time, processing guidelines are being established so that food pantries and meat processors can continue their involvement in venison donation programs when hunting season opens again in the fall.

In addition, based on what we currently know about the health implications of eating venison containing lead, we recommend that remaining venison from food pantries not be consumed or distributed unless the meat has been tested. If it is not possible to test the meat, pantries have the discretion to discard it.

Using X-ray equipment and lab tests, we have analyzed more than 200 venison samples from food pantries and meat processors throughout the state. The number of samples with lead present was fairly low, about 4%, but not low enough to eliminate the potential for exposure under the right set of circumstances.

Resources are not available for screening all remaining venison stocks. If a food pantry has access to X-ray equipment through a local veterinarian, it may be possible for them to screen their remaining venison and still release uncontaminated meat. A plan to offer this screening is underway, but may take several months to implement.

Although lead in venison does not rival lead paint in older homes as a health risk for Wisconsin children, the risk is not low enough to ignore. Wisconsin's health and environmental agencies continue to study this concern to determine the actual risk.

We do know that pregnant women and children less than six years old are most at risk. These two groups in particular should avoid consuming venison shot with lead bullets or slugs, or

venison from an unknown source. Lead poisoning can cause health symptoms that may not immediately be noticed by a casual observer. Lead exposure in young children is known to affect brain development and cause reduced IQ and attention span, impaired growth, reading and learning disabilities, hearing loss, and a range of other health and behavioral effects.

We again thank you for patience while DHFS, DNR, and DATCP work to understand this issue. If you have questions please call Chuck Warzecha 608/264-9880 or Rob Thiboldeaux 608/267-6844.

Appendix 3. DHS (formerly DHFS)/DNR letter to Wisconsin Veterinarians.

TO: Wisconsin Veterinarians
FROM: Department of Health and Family Services
SUBJECT: Radiographic Screening for Lead in Food Pantry Venison

July 1, 2008

Dear Wisconsin Veterinarian,

The Wisconsin Division of Public Health (DHFS) and the Department of Natural Resources (DNR) request your assistance with an issue of public health concern. Recent studies have shown a prevalence of tiny lead fragments in venison shot with lead ammunition. These are typically too small to be seen or removed during meat processing, and can disperse far from the wound channel. This first came to light from studies investigating the potential for eagles to be poisoned by feeding on deer carcasses.¹ More recently, preliminary investigations in Minnesota and Wisconsin, using X-ray screening followed by chemical analysis, have found lead in processed venison stored at charity food pantries and from hunter's home freezers.

Venison to be distributed from charity food pantries is of particular concern to state health and environmental agencies. Based on what we currently know about the health implications of eating venison containing lead, we recommend that venison currently remaining in food pantries not be consumed or distributed *unless the meat has been screened radiographically*. DHFS and DNR do not currently have the resources to screen all the venison remaining at state food pantries from the last season. In order to allow food pantries to confidently release donated venison to the needy, *we seek to enlist the voluntary services of local vets willing to offer their X-ray services to screen packaged meat*.

The lead fragments occur with relatively low incidence (4-20% of 1 lb. meat samples in preliminary work), but often at a high concentration (up to 169 milligrams per kilogram, compared to a FDA-recommended 0.05 mg/kg in meat products). Because this source of lead exposure has not been considered until recently, we do not understand all of its health implications. Most current examples of human lead poisoning involve exposure to lead paint. We do know that subsistence hunters that regularly consume waterfowl from areas where lead shot is used are at high risk lead poisoning, both from ingestion of lead pellets and from meat tainted by pellets in the gizzard.² We have little information about the effects of infrequent lead

1 Hunt GW, Burnham W, Parish CN, Burnham KK, Mutch B, Oaks JL. 2006. Bullet Fragments in Deer Remains: Implications for Lead Exposure in Avian Scavengers. *Wildlife Soc. Bull.* 34(1): 167-70.

2 Johansen P, Pedersen HS, Asmund G, Riget F. 2006. Lead shot from hunting as a source of lead in human blood. *Environ. Pollution* 142: 93-97.

Madsen, *et al.* 1988. Blood lead levels in patients with lead shot retained in the appendix. *Acta Radiologica* 29: 745-46.

exposure at the concentrations we see in venison, but our best information is that there is a level of concern, and that the exposure is to be avoided, especially by those most sensitive.

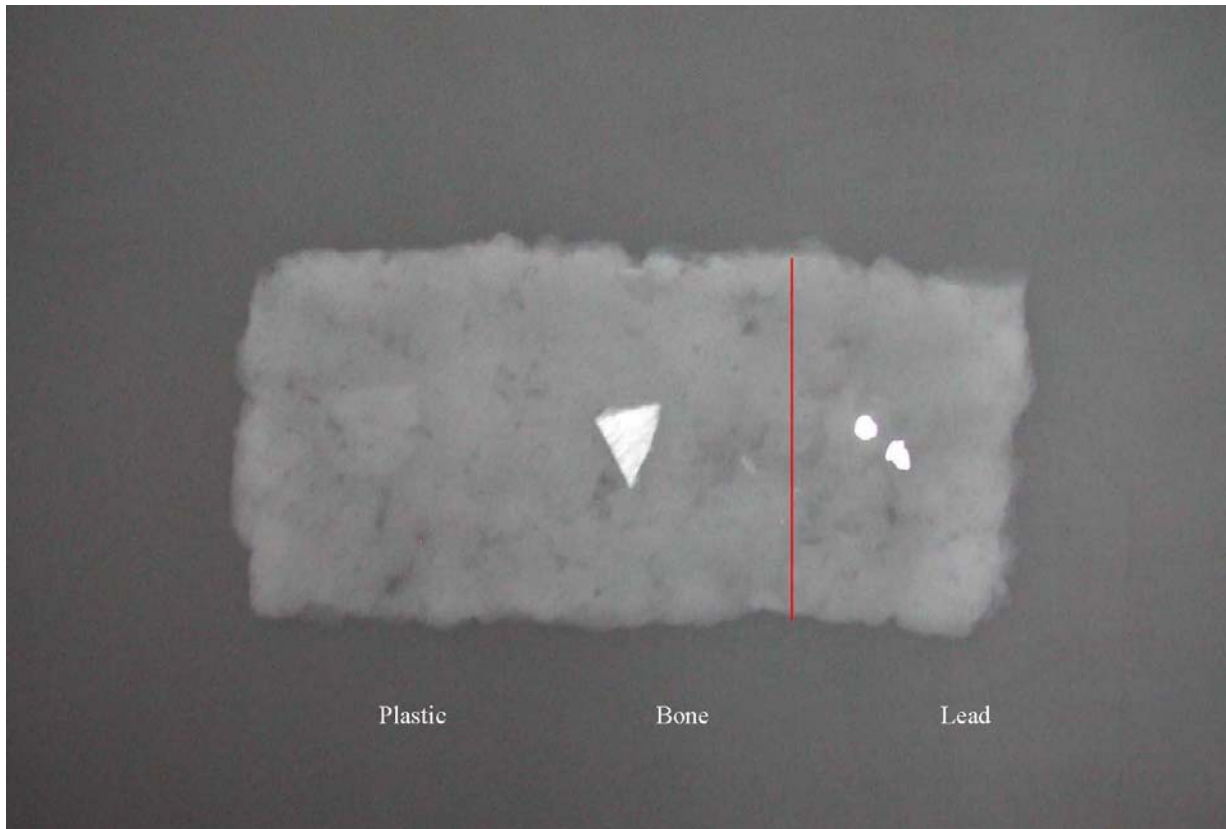
In order to prevent this source of lead exposure, DHFS is working with the DNR, the Department of Agriculture, Trade, and Consumer Protection (DATCP), and neighboring states to develop recommendations regarding lead in venison. Processing guidelines are being established so that food pantries and meat processors can continue with the venison program when hunting season opens in the fall. New processing guidelines should avoid the need for future X-ray screening.

We hope that food pantries who are interested in having their current stores of venison screened for lead will be able to find a veterinary clinic in the community that is willing to provide radiography services. This request for assistance would apply only to the period prior to the 2008 deer season. For the upcoming season, we are working on a separate plan that will include recommendations to meat processors, along with spot checks by the state lab of hygiene to see how well processing techniques are able to eliminate lead from venison.

Screening guidelines. Based on preliminary work by the DNR, radiography of the wrapped frozen packages of venison is a simple process. Lining up several packages on a large cassette works well, as long as identification of the individual packages is recorded on the film, so that those containing fragments can be later identified. The exposure technique will vary with different equipment, but since the goal is to differentiate metal from soft tissue, details of the exposure technique are not critical. As an aid to interpreting X-ray images, this letter includes a “radiographic scale” demonstrating the appearance of small fragments of plastic, bone, and lead-containing bullets on a background of ground venison.

The goal of the venison radiography is to identify those packages with ANY fragments compatible with lead. These packages should be separated and identified as possibly containing lead when results are communicated to the food pantry. Using this information, *it will be the pantry’s responsibility to decide which packages are distributed for consumption and which are discarded.* DHFS recommends that all packages possibly containing lead be discarded.

Thank you for considering helping your local food pantry and your community by participating in this program. In closing, please note that DHFS and DNR make no presumption of commitment from individual veterinarians. The choice is yours, as you will not be reimbursed for your donated time and resources. Nonetheless, if you do choose to provide this support to local food pantries, we are very interested in learning the results of your screening. There is still much to learn on this issue, and your experience will add to our understanding. If you have questions about the program or your clinic’s role, please contact Robert Thiboldeaux, PhD, Department of Health and Family Services (Robert.Thiboldeaux@wi.gov; 608-267-6844). If you have questions about the radiographic screening techniques, please contact Julie Langenberg, VMD, Department of Natural Resources (Julia.Langenberg@wisconsin.gov; 608-266-3143).



Radiography scale illustrating opacities of plastic, bone, and lead fragments in ground venison. Venison containing any objects with an opacity similar to that of lead (to the right of the red line) should be discarded.

Appendix 4. Blood Lead Concentrations Corresponding to Adverse Health Effects

From: Agency for Toxic Substances and Disease Registry/Division of Toxicology and Environmental Medicine. 2006. Lead ToxFAQs: /Chemical Agent Briefing Sheet.

Blood Lead Concentrations Corresponding to Adverse Health Effects		
Life Stage	Effect	Blood lead (µg/dL)
Children	Depressed ALAD* activity	< 5
	Neurodevelopmental effects	<10
	Sexual maturation	<10
	Depressed vitamin D	>15
	Elevated EP**	>15
	Depressed NCV***	>30
	Depressed hemoglobin	>40
	Colic	>60
Adult	Depressed ALAD*	< 5
	Depressed GFR****	<10
	Elevated blood pressure	<10
	Elevated EP (females)	>20
	Enzymuria/proteinuria	>30
	Peripheral neuropathy	>40
	Neurobehavioral effects	>40
	Altered thyroid hormone	>40

	Reduced fertility	>40
	Depressed hemoglobin	>50
Elderly Adult	Neurobehavioral effects	> 4

*aminolevulinic acid dehydratase (ALAD)

**erythrocyte porphyrin (EP)

***nerve conduction velocity (NCV)

****glomerular filtration rate (GFR)

Source: ATSDR Toxicological Profile for Lead (Draft for Public Comment), 2005.

Appendix 5. How can lead affect children?

A public health statement from the Agency for Toxic Substances and Disease Registry's *Toxicological Profile for Lead* (ATSDR 2007).

1.6 HOW CAN LEAD AFFECT CHILDREN?

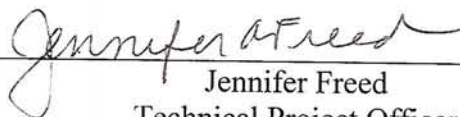
This section discusses potential health effects in humans from exposures during the period from conception to maturity at 18 years of age. Studies carried out by the Centers for Disease Control and Prevention (CDC) show that the levels of lead in the blood of U.S. children have been getting lower and lower. This result is because lead is banned from gasoline, residential paint, and solder used for food cans and water pipes. However, about 310,000 U.S. children between the ages of 1 and 5 years are believed to have blood lead levels equal or greater than 10 µg/dL, the level targeted for elimination among young children in the United States by 2010.

Children are more vulnerable to lead poisoning than adults. Children are exposed to lead all through their lives. They can be exposed to lead in the womb if their mothers have lead in their bodies. Babies can swallow lead when they breast feed, or eat other foods, and drink water that contains lead. Babies and children can swallow and breathe lead in dirt, dust, or sand while they play on the floor or ground. These activities make it easier for children to be exposed to lead than adults. The dirt or dust on their hands, toys, and other items may have lead particles in it. In some cases, children swallow nonfood items such as paint chips; these may contain very large amounts of lead, particularly in and around older houses that were painted with lead-based paint. The paint in these houses often chips off and mixes with dust and dirt. Some old paint contains as much as 50% lead. Also, compared with adults, a bigger proportion of the amount of lead swallowed will enter the blood in children.

Children are more sensitive to the health effects of lead than adults. No safe blood lead level in children has been determined. Lead affects children in different ways depending on how much lead a child swallows. A child who swallows large amounts of lead may develop anemia, kidney damage, colic (severe "stomach ache"), muscle weakness, and brain damage, which ultimately can kill the child. In some cases, the amount of lead in the child's body can be lowered by giving the child certain drugs that help eliminate lead from the body. If a child swallows smaller amounts of lead, such as dust containing lead from paint, much less severe but still important effects on blood, development, and behavior may occur. In this case, recovery is likely once the child is removed from the source of lead exposure, but there is no guarantee that the child will completely avoid all long-term consequences of lead exposure. At still lower levels of exposure, lead can affect a child's mental and physical growth. Fetuses exposed to lead in the womb, because their mothers had a lot of lead in their bodies, may be born prematurely and have lower weights at birth. Exposure in the womb, in infancy, or in early childhood also may slow mental development and cause lower intelligence later in childhood. There is evidence that these effects may persist beyond childhood. Children with high blood lead levels do not have specific symptoms. However, health workers can find out whether a child may have been exposed to harmful levels of lead by taking a blood sample. They can also find out how much lead is in a child's bones by taking a special type of x-ray of the finger, knee, or elbow. This type of test, however, is not routine.

CERTIFICATION

This Health Consultation was prepared by the Wisconsin Department of Health Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun. Editorial review was completed by the Cooperative Agreement partner.



Jennifer Freed
Technical Project Officer
CAT, CAPEB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation and concurs with its findings.



Alan Yarbrough
Team Lead
CAT, CAPEB, DHAC, ATSDR