CANNED MILK

BY KEVIN P. SHEA

RECENT REPORTS of significant amounts of lead in canned evaporated milk products have compounded the already serious problem of childhood lead poisoning. These reports have revealed that small children, previously thought to be safe from dietary lead exposures, may be receiving lead in milk in amounts large enough to predispose them to lead poisoning when they reach the age at which eating bits of paint and plaster in older, dilapidated housing becomes the major source of the poison. There is fragmentary evidence that lead contamination of milk has worsened in recent years. Canned milk has also been reported to contain disturbingly high levels of tin and cadmium. The lead in canned milk is apparently from the solder and flux used to seal the cans; tin, cadmium, and perhaps other metals are dissolved into the milk from the can’s tin plating.

In a report published in July 1971,1 two U.S. Food and Drug Administration (FDA) scientists noted lead concentrations in canned evaporated milk ranging from 0.74 to 0.87 parts per million (ppm) for four different brands of canned evaporated milk (the brands were not named). In the same series of tests it was found that four different canned prepared formulas contained lead from 0.34 to 0.54 ppm; 22 samples of human milk averaged only 0.012 ppm.

More recently, Environment has obtained data on lead in evaporated milk from two other sources. Dr. Steven Lamm of the Bronx, New York, Municipal Hospital told us of measurements he made of lead in samples from various canned milk products. In canned evaporated skim milk he found lead concentrations from 0.3 to 2.3 ppm; in evaporated whole milk lead ranged from 0.3 to 0.8 ppm. Powdered milk, not packaged in cans, was found to have no more lead than fresh whole milk; Dr. Vincent Guinee of the Bureau of Lead Poisoning Control, New York City Health Department, also informed Environment of the presence of elevated lead levels in canned milk products. Dr. Guinee detected levels from 0.5 to 3.2 ppm in canned evaporated whole milk and 0.52 to 1.5 ppm in canned evaporated skim milk.2 For comparison, one should note that the World Health Organization (WHO) has set a standard of 0.05 ppm for lead in drinking water. The measurements reported by Drs. Lamm and Guinee have since been confirmed by surveys undertaken by the Evaporated Milk Association and the FDA.

In a telephone interview, an official of the FDA, who asked not to be quoted by name, told us the results of a survey conducted by the FDA early in 1972, apparently in response to the earlier reports of lead in canned milk. In the survey, conducted over a “number of months,” measurements were made of lead in canned milk taken from grocery shelves throughout the country. In evaporated whole milk, lead concentrations ranged from 0.23 to 1.0 ppm, with a mean of about 0.5 ppm; raw whole milk was found to contain no more than 0.28 ppm lead in the highest sample tested. The FDA official felt that the slightly higher measurements reported by Lamm and others were due to a difference in measurement technique and that the FDA measurements were likely to be more accurate.

The trade association of canned milk producers, the Evaporated Milk Association (EMA), has also conducted a survey of its products, in conjunction with the FDA; another official, who also asked not to be named, told us the results of this program. The EMA sampled 191 cans taken at random from store shelves throughout the country and found a maximum level of 0.79 ppm lead; 12.6 percent of the sample tested at concentrations higher than 0.5 ppm, while 26 percent had no more than 0.2 ppm. The official was not able to tell us what the mean value of all measurements was. He claimed that the sample size was much higher than had been used by the FDA and the EMA, atomic absorption spectroscopy, but had no explanation for the slightly higher values found by the FDA in its survey.

In general, both these surveys seem to confirm the findings of Lamm and Guinee, although yielding slightly lower average values of lead. All investigators agreed that lead levels were higher in canned milk than in either fresh or powdered milk and that much canned milk contained 0.5 ppm lead in 1972.

Interest in lead contamination in evaporated milk is by no means new. In 1957, L. H. Fairhall conducted an extensive survey3 using canned milk from 22 cities representing every part of the U.S. Using two different methods of analysis, he found values averaging 0.076 ppm and 0.11 ppm. Although methods of analysis were not as refined as those used today, these values may have been reasonably accurate. From the observed values in evaporated milk Fairhall calculated the amounts that might be found in whole milk from which the canned milk was prepared. The calculated values were 0.034 by one method and 0.004 by the other. These are close to the actual measurements of raw milk samples made by R. U. Harwood and R. M. Tulley in the 1930s (0.035 ppm).4 They are also within the range of lead levels found more recently in raw milk by Dr. Lamm (0.03 to 0.05 ppm) and in other samples of raw milk (0.02 ppm),5 and presumably indicate lead from natural sources and auto exhausts. In another survey, published in 1954,6 a mean value for lead in 35 samples of evaporated milk was observed to be 0.35 ppm with a range of 0.09 to 0.72 ppm.

Because of the difference in methods of analysis it is difficult to compare analytical results obtained in 1971 with results obtained in 1937 and 1954. Similar readings from whole milk samples, however, are evidence that lead contamination of canned milk has worsened since the earliest measurements were made. Other factors could affect the results of analysis: a high lead content in soil, the presence of lead smelters or lead mining activities, industrial lead emissions, and auto exhausts from a nearby highway all might contaminate fodder and result in higher lead readings in both raw and canned milk.

Dangers to Children

Whether or not the recently observed levels of lead in canned milk pose a hazard to children is not certain. Canned evaporated milk is widely used in the home preparation of formulas, which are the sole source of nourishment for many children from birth up to four months of age. There is, however, a complete lack of data on children under one year old in terms of intake, excretion, and storage rates of lead, and it is these infants who are most endangered by this form of lead contamination. Since canned evaporated milk is used most frequently by the poor, it is also those infants exposed to the more serious hazard of lead in peeling paint and plaster who receive the additional burden of lead from canned milk. Although no data are available on the sales patterns of canned milk intended for use in infant formulas, the U.S. Department of Agriculture notes that the distribution of canned evaporated milk as a part of a food supplement program. For example, in September

Small children may be receiving lead in their milk in hazardous amounts.

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TABLE 1

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<thead>
<tr>
<th>Exposure to Lead and Estimated Levels in Blood</th>
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<tr>
<td>Last Present in Milk</td>
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</tr>
<tr>
<td>0.5</td>
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*Based on four, eight-ounce feedings in 24 hours.
**Widespread use of lead in ammunition and gasoline.


1972, 2,453 children under two years of age, in the city of St. Louis, received some into milk (thirteen fluid ounces) each day. Another 2,761 children two to five years old received an average of twenty pints per month. More important, however, is the fact that the two communities where the distribution took place only one is designated outside the "lead belt" - that area of the city where childhood lead poisoning from stilpiloted housing is most prevalent.

In spite of the fact that almost nothing is known about very early lead poisoning (under one year of age), some observations have been made on children gathered on other age groups. It should be emphasized that such a comparison may be deceptive. To begin with, the functional nature and the ability to excrete lead in newborn infants may not compare with that in children of one year of age. Furthermore, a child over one year of age generally weighs several times more than an infant under four months. These are important considerations in toxicological evaluations of potential lead poisoning.

Since children one to three years of age are most susceptible to poisoning through the ingestion of paint, plaster, pottery, and lead-bearing house dust, an ad hoc committee appointed by the Department of Health, Education, and Welfare (HEW) was convened in 1970 for the purpose of establishing the daily age-specific safe intake level (DPI) for children over the age of one year.5

The recommendation of the committee is that children one year or older should receive no more than 500 micrograms of lead daily, from all sources. This advice is based on the fact that the blood of exposed and non-exposed children, the results of experimental lead ingestion and the present knowledge of fetal output of lead in exposed and non-exposed children, the rate of increase in levels of lead in the blood of exposed children, and the appearance of symptoms of lead poisoning.

Using such data the committee estimated that any intake of lead in blood below 0.5 ppm would result in elevated levels of lead in blood. Blood levels of 40 or more micrograms of lead per 100 milliliters of blood are considered to be an indication of undue accumulation of lead. Normal blood concentrations, derived from the diet and the presence of lead in the adipose tissue, range from 25 micrograms per 100 milliliters of blood in urban children to 12 micrograms per 100 milliliters of blood in children in rural areas.

Using the value of lead in canned milk as determined by Drs. Lann and Guillet and assuming four, eight-ounce feedings per 24 hours (sixteen ounces of the total is evaporated milk), daily exposures and estimated blood levels are shown in Table 1.

It can be seen from these calculations that a child consuming canned milk containing 0.5 ppm, or less, will have no adverse effects on its health. The amount of lead in canned milk can be measured directly close to the estimated daily permissible dose proposed by the HEW ad hoc committee. These calculations do not include lead taken into the body by inhaling contaminated air, which is contained in milk, and by absorbing it through the placenta so that newborn infants may have slightly elevated levels at birth if their mothers are unexposed to lead during pregnancy. Fortunately, powdery milk provides an inexhaustible microparticle substitute for canned milk and does not have elevated lead concentrations.

An Old Problem

The recent attention to contamination of canned milk with lead, as an example, is serious, as a problem in itself, because the amount of lead in canned milk will soon be in the public domain. The regulations will limit the concentration of lead in canned milk products to 0.5 ppm. As we noted earlier, the standard for lead in drinking water already established by WHO is 0.05 ppm, and Table 1 indicates that 0.5 ppm might expose children to hazardous quantities of lead. An FDA official, in a telephone interview, agreed that 0.5 ppm was undesirable for all canned milk but argued that most milk would be well below the legal maximum. The EMA has already taken action to control contamination and the FDA has been asked to improve the techniques used to sell canned milk. EMA data indicate this has already brought the average concentration of lead in milk to levels well below the permissible 0.5 ppm.

It has also been known for some time that other metals may be dissolved in evaporated milk. A study cited earlier showed that tin, copper, and other metals were found in canned milk and that the concentration increased in the concentration of the can was stored. The metals are presumably dissolved slowly from the metal of the can. After approximately six months of storage, the tin plating from the inside of tested cans had been all but completely dissolved by the milk. When stored at room temperature for 340 days, the milk contained from 102 to 123 micrograms of lead per 100 milliliters of milk and 66 micrograms of lead per 100 milliliters of milk, respectively.

In a later study cadmium was found to be more than 250 micrograms of lead per 100 milliliters of milk, concentrations of 0.055 to 0.042 ppm (maximum permissible level for drinking water) are 0.01 ppm, copper 0.17 to 0.14 ppm, and zinc 7.75 to 8.60 ppm.

The tinplate can was patented by Peter Durand in 1810 and the first such can was sold commercially the following year. It was a four-pound object, soldered together by skilled craftsmen. It was not until the 1850s that canned food products became widely popular in the U.S., however, and not until the 1860s, when patentization was introduced, that canned foods became important in the wide areas where other means of food preservation were not available. During this time, canned condensed milk, popularized by Gall Borde, who had invented the product in 1853, was responsible for the wide acceptance of cans as food containers. Canned condensed milk is credited with a significant lowering of infant mortality rates at this time.

Up to the end of the nineteenth century, there was little change in the technology of can manufacture. Essentially all cans were made of tin-plated iron or steel, which meant that the can had to be cut to form a cylinder, and soldered along the side seam. Circles of tinplate were then soldered to the ends of the cylinder to form a complete can. To fill the can, a small hole was punched in one end, through which the contents were poured, and then the hole was closed with a drop of solder. While the same basic process was used by all manufacturers, each made its own process, and produced its own cans, which came in a correspondingly great variety of forms.

In the 1890s can-making was improved by the introduction of automatic machinery, but the can itself remained unchanged until the 1900s, at which time an advance in the technology gained acceptance. This was the "sanitary" can, so called because solder was applied only to the outside of the side seam, and not to the inside. The cylindrical metal liner formed by connecting the edges of a rectangular sheet of tinplate in such a way that a seam was forced to form one part of the can, the other part being simply bent by overlapping the edges of the end flaps and the body cylinder twice, and then sealing them together with soldering "flat." A sealing compound is put within the fold to make an airtight seal.

The new process evidently reduced the amount of solder needed to make the can, and thereby reduced the amount of solder in contact with the food. However, the new process also increased the amount of lead from the lining, since the only solder used in the lead-containing compounds, and one of the advantages of the sanitary can was its wide use.

The sanitary can, as made by large companies, the country's most widely used food container.

More recently, there have been further advances in can technology, although the sanitary can, as introduced early in the century, remains the basic food package. In the 1930s, electroplating steel became the universal method of making tins, replacing the earlier technique of dipping steel sheets into molten tin. During the Second World War, efforts were begun to reduce the amount of relatively expensive tin needed to protect the steel from corrosion. Oceans were used to coat the interior of cans, allowing thinner tin plating to be used. Aside from protecting the steel from corrosion, however, the tin plating also facilitates the soldering process and makes it easier to open the can.

The sanitary can, as modified for use on the battlefield, is the most common type of food container used today.