SESSION V

LEAD AND WOMEN, A UNIQUE PROBLEM?

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REVIEW OF LEAD TOXICITY

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ABSTRACT

This paper presents a general review of lead toxicity considering exposure to lead in the workplace as well as in the general environment. Persons who are exposed to lead on the job are in double jeopardy since the lead exposure while working must be added to the lead entering their bodies from general environmental exposure, which in certain instances may already be excessive. In this regard women workers of childbearing age must be considered to be at triple risk. Among the effects of lead which have been of growing concern to health scientists is its ability to harm a number of organ systems in the body and in particular the central nervous system, the kidneys, and the blood-forming elements. Any recommended standard for lead either in the general environment or in the workplace should consider the special susceptibility of women of childbearing age and particularly the fetus to lead.

I welcome the opportunity to participate in this conference and to present a general review of lead toxicity at this particular session. My experience within government has been such that I have had an opportunity to view the lead problem both from the perspective of protecting the worker, and from the perspective of protecting the general population, especially young children, from the adverse effects of lead. In this regard I believe that a number of concerns expressed about lead exposure in the working population are now impacting our consideration of the situation involving the general population.

The toxicity of lead has been known to man for approximately two thousand years. Pliny the Elder, a Roman senator, warned against the toxicity of lead in the first century, A.D. I am sure that many of you are aware of the speculative opinion that excess exposure to lead may have been a contributing factor in the fall of the Roman Empire. I am obviously not in a position to verify the possibility.

Lead may enter the body from a number of routes. For the general urban population with no unusual source of lead exposure, lead absorbed into the body comes primarily from the diet and from the ambient air. In urban areas approximately one-third of the lead absorbed into the body of an adult comes from inhalation of air contaminated with lead derived primarily from motor vehicles. The relative contribution of automotive-derived lead to lead absorption in children is somewhat less certain but for a number of reasons it is likely that this source contributes even more to lead absorption in children than adults. This is because children, particularly young children, ingest lead-contaminated dirt and dust contaminated in large part by lead fallout from the atmosphere originating from motor vehicle emissions. However, the single most important source of lead for young children is derived from lead paint. Any strategy to control lead in the general environment must consider all sources of exposure, including lead in the diet and in the ambient air.

Persons who are exposed to lead on the job are in double jeopardy, since the lead exposure while working must be added to the lead entering their bodies from general environmental exposure, which in certain instances may already be excessive. The most important route of lead intake for exposed workers is by inhaling air that frequently is contaminated with large quantities of lead often 100 to 1,000 times greater than that commonly found in the ambient atmosphere. In addition, workers may also ingest significant quantities of lead-contaminated dusts on fingers, lips, cigarettes, etc. Lead dust on the clothing of workers has also been reported to cause elevated blood lead levels in children, when contaminated clothing is brought into the home. One special form of lead, organo lead compounds, may also be absorbed into the body directly through skin contact. Organo lead compounds are most commonly used as lead additives in gasoline.

Among the effects of lead which have been of growing concern to health scientists is its ability to harm a number of organ systems in the body -- in particular the central nervous system, the kidneys, and the blood-forming elements. Perhaps most publicized in recent times have been the effects of lead upon the nervous system. The relatively poor capacity of the nervous system to repair itself means that once damage has occurred, as in the case of lead, there is a possibility that full recovery will not take place.

Lead is capable of damaging both the central and the peripheral nervous systems. If exposure to lead is sufficiently great, the central nervous system may be acutely and severely damaged, resulting at times in coma, convulsions, and even death. This condition, often referred to as acute encephalopathy, is most commonly observed in young children. Studies in children have shown that once acute encephalopathy has occurred, there is a high probability of permanent, irreversible damage to the nervous

system. In lead poisoned workers a manifestation of injury to the nervous system, this time to the peripheral nervous system, involves damage to the extensor muscles in the forearm, a condition more commonly known as wrist drop. A common manifestation of lead poisoning in workers is severe abdominal pain, a condition known as lead colic.

In recent years, a great deal of concern has been expressed about the so-called subclinical effects of lead involving the nervous system. A number of studies strongly suggest that permanent damage to the nervous system may have occurred in children who have been only moderately exposed to lead, and in whom no overt symptoms of lead toxicity had appeared. These effects include behavioral problems such as hyperactivity, difficulty in task performance, deficiency in IQ, and nerve conduction deficits. These same concerns are now also beginning to be expressed in the case of workers excessively exposed to lead, who have deficits in nerve conduction, and who may also have decrements in task performance, or increased hostility and aggressiveness, as a result of exposure to lead. These areas of concern are admittedly on the fringes of scientific knowledge, and one can expect considerable new information in this regard in the next several years.

A well-documented effect of lead involves its ability to adversely affect the blood-forming elements. Clinically, this may be expressed as anemia if exposure has been sufficient. It is not uncommon, for example, to have decreases in hemoglobin concentrations among workers exposed to lead. These deficits may not be strikingly evident on an individual basis where blood counts may still, in general, be within or close to accepted limits of normal. However, on a group basis these changes become significant. In general, clinical anemia does not occur until blood lead levels exceed 80 ug/100g although recent studies suggest that mild anemia may occur at blood lead levels in the range of 60 to 80 ug/100g. The effects of lead upon the blood-forming elements may also be detected by biochemical tests. Biochemical abnormalities associated with effects of lead upon hemoglobin synthesis begin to occur at blood lead levels in the range of 30 to 40 ug/100g. The significance of these early biochemical changes has been a point of contention in the setting of standards of lead exposure for the general as well as the occupational population. In my personal view, these biochemical changes are important and should be considered in the standard-setting process.

An important concern involves the ability of lead to adversely affect the kidneys. A number of studies have demonstrated the toxic effects of lead upon this organ. Among exposed workers, lead is known to increase the risk of death from end stage renal disease. Recent studies suggest that adverse effects of lead as measured by biochemical tests may be affecting the kidneys of lead workers. Much more work needs to be directed at this problem, including the development of tests to indicate early kidney

damage before irreversible changes have occurred. In this regard, kidney damage has also been observed among children excessively exposed to lead paint. Finally, studies in experimental animals have shown lead causes kidney cancer, although confirmatory evidence of this in man is, to date, lacking.

The theme of this conference is women and the workplace. So I would certainly be remiss if I failed to voice my very real concern about the effects of lead upon the reproductive process. If workers exposed to lead on the job and in the general environment are at double jeopardy, then women workers of child-bearing age must be considered to be at triple risk.

Among the problems associated with exposure of pregnant women to lead are abortion and injury to the fetus, including damage to the nervous system. This problem has a long history. For example, at the turn of the century women workers in the lead industries were known to have decreased fertility and an increased abortion rate. Ingestion of lead-contaminated whiskey during the first trimester of pregnancy has been observed to cause fetal injury, and increased exposure to lead during pregnancy has been associated with neurologic damage in children born to these mothers. For example, a recent study from England associated an increased rate of mental retardation in children whose mothers during the time of their pregnancy lived in homes containing elevated concentrations of lead in the drinking water.

Numerous studies have shown that the concentration of lead in the mother's blood correlates with the concentration of lead in the blood of her child at birth. This means that lead, a known toxic material, is present in the tissues of the child before birth. Experiments in animals also demonstrate that lead crosses the placenta to reach the unborn infant. Consequently, exposure of the unborn child to lead will reflect the degree of exposure experienced by its mother by all exposure routes.

These facts are important for both women of childbearing age exposed to lead while on the job and to the larger number of women exposed to lesser amounts of lead through the diet and the ambient air. These facts have been of increasing concern to those Federal agencies charged with responsibilities for protecting workers. In a recent proposal to reduce the Federal standard for occupational lead exposure the Occupational Safety and Health Administration cited the problem of lead exposure among pregnant women as one of the reasons for the need to reduce exposure to airborne lead in American industries by a factor of two. The National Institute for Occupational Safety and Health is also concerned about lead exposure among women workers, and is planning additional studies of this problem.

Special risks to the fetus from exposure of women workers to lead, as for example in industries such as smelting and battery

manufacture, have also been of concern to the lead industries. A number of industries have, in fact, refused to place women in jobs where excessive exposure to lead may occur.

In all likelihood these same concerns about lead exposure among women in the lead industry will also impact recommended standards for lead exposure through the diet and the ambient air. As noted above, adults with no occupational lead exposure receive approximately one-third of the lead absorbed into the body from the ambient air and about two-thirds from the diet. In the case of women who reside near heavily traveled roads, or who spend a good deal of time driving in heavy traffic, the contribution of airborne lead to the total amount of lead absorbed into the body may be even greater. This means that women of childbearing age may already be entering the lead industry with blood levels of lead close to or above a level of concern with respect to an unborn fetus. Any recommended standard for lead either in the general environment or in the workplace should consider the special susceptibility of women of childbearing age and particularly the fetus to lead.

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