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Research and Development

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Project Summary

Biliary Excretion and Tissue Distribution of Cadmium-109 Administered to Rats

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This report is part of a series of investigations undertaken to establish the absorption/excretion characteristics of various metal pollutants in order to provide information for selection of relatively rapid mammalian tests for estimating exposure. This study was designed specifically to ascertain the role of bile in the excretion of cadmium following oral or intravenous administration of cadmium-109 to rats. Results of the study show that bile concentrates cadmium and transports it into the gastrointestinal tract where it may be either reabsorbed or excreted in the feces.

Tissue distribution of the cadmium was also determined in the study. Regardless of the route of administration, the liver retained the highest cadmium concentration, although kidney and bone also retained a large percentage of the administered radionuclide.

This publication is a summary of the complete report, which can be purchased from the National Technical Information Service.

Introduction

Cadmium is present as a trace metal in the earth's crust and as an impurity in ores of other metals. Concentration of ores and use of cadmium in industrial processes have caused cadmium to become an environmental pollutant producing a variety of toxic effects.

Because the body appears to lack an effective mechanism for eliminating cadmium, cadmium burden gradually increases with age. In addition, complex interactions that occur between cadmium and other divalent cations make predictions of intestinal absorption very difficult.

This study was undertaken to provide further information on the absorption, excretion, and tissue distribution of cadmium in the rat, in an effort to select universally available biological monitors, and to provide a reliable method for quickly estimating potential exposure of critical segments of a population to a potentially hazardous pollutant.

Results

The difference in the excretion of cadmium in urine and feces was measured in rats with either ligated or intact bile ducts. Three days following a single oral-administration of cadmium-109 plus stable cadmium chloride, 4×10^{-3} percent of the dose was excreted in the urine of rats with intact bile ducts, while 5×10^{-2} percent was excreted in urine of rats with ligated bile ducts. While 82 percent of the dose was excreted via the feces of intact rats, 71 percent was recovered in feces from rats with ligated bile ducts. The amount of the dose recovered in tissue was 13 percent for intact rats and 30 percent for ligated rats.

Following intravenous administration of cadmium, rats with intact bile ducts excreted about 5×10^{-1} percent of the dose in urine versus 2 percent for rats with

Table 1. *Average Percent of Cadmium Dose Recovered Per Tissue*

Tissue	Oral		Intravenous	
	Ligated	Non-Ligated	Ligated	Non-Ligated
Liver	1.86 ± 0.89	1.64 ± 0.67	39.3 ± 14.8	30.1 ± 10.4
Spleen	$4.65 \pm 0.79 \times 10^{-2}$	$4.49 \pm 0.81 \times 10^{-2}$	$4.37 \pm 3.51 \times 10^{-1}$	$4.60 \pm 0.98 \times 10^{-1}$
Kidney	0.21 ± 0.08	$6.88 \pm 3.58 \times 10^{-2}$	7.45 ± 1.95	7.36 ± 4.16
Heart	$3.20 \pm 0.27 \times 10^{-2}$	$3.05 \pm 0.40 \times 10^{-2}$	$2.96 \pm 0.57 \times 10^{-1}$	$2.30 \pm 1.52 \times 10^{-1}$
Brain	$2.20 \pm 0.24 \times 10^{-2}$	$2.01 \pm 0.35 \times 10^{-2}$	$2.85 \pm 0.76 \times 10^{-2}$	$2.19 \pm 1.50 \times 10^{-1}$
Skull	$4.36 \pm 0.93 \times 10^{-2}$	$3.02 \pm 1.01 \times 10^{-2}$	$4.20 \pm 1.13 \times 10^{-1}$	$2.09 \pm 1.72 \times 10^{-1}$
Bone*	$4.23 \pm 0.55 \times 10^{-2}$	$1.90 \pm 0.32 \times 10^{-2}$	2.82 ± 0.22	3.16 ± 0.12

**Estimation based on percentage of body weight assigned to the bone of adult rats as reported by Sikor and Mahlum.*

ligated bile ducts. About 8 percent of the dose was excreted via the feces of rats with intact bile ducts, compared to only about 6×10^{-1} percent by ligated rats. The amount of the dose recovered in the tissues was 91 and 96 percent respectively for intact and ligated rats.

As shown in Table 1, the liver, retaining the highest concentration, appears to be the organ of primary concern in this study, although cadmium was also retained in the kidneys and bone.

Conclusions

This investigation clearly demonstrated that bile plays and important role in the concentration and transport of cadmium for subsequent reabsorption or excretion. Collection of bile from animals endemic to a potentially polluted area would enable an investigator to easily determine an early increase in biologically available cadmium. However, caution must be exercised when attempting to correlate the amount of cadmium in the bile with the dose of cadmium received, as dose threshold effects and possible synergistic reactions with other pollutants may affect the kinetics of bile production.

Authors are EPA employees with the Environmental Monitoring Systems Laboratory, Las Vegas, NV (see below)

The complete report, entitled "Biliary Excretion and Tissue Distribution of Cadmium-109 Administered to Rats," (Order No. PB 80 217995; Cost: $5.00, subject to change) will be available from:

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