

parked MVs, 2) drivers should look carefully for children before and while backing up, and 3) MVs should be locked in garages or driveways with keys kept out of reach of children (6,8). Potential environmental modifications include fenced driveways, fenced play areas away from driveways and streets, and circular driveway designs that eliminate the need to back out. Potential automobile modifications include back-up warning alarms when vehicles are placed in reverse or mirrors, sensing devices, or cameras to alert drivers to out-of-sight objects, such as small children (1). Research is needed to determine the effectiveness of such approaches.

Data from injury surveillance systems such as NEISS-AIP highlight the preventable morbidity and mortality resulting from MV-related backover injuries in children. Effective engineering and environmental approaches to prevent MV-related backover injuries need to be identified, evaluated, and disseminated to public health and transportation officials and policy makers for implementation nationwide. Meanwhile, drivers and caregivers can take simple precautions to prevent these injuries. To this end, child MV safety programs and health professionals should ensure that parents, caregivers, and the public are aware of the risks for injury associated with MV backovers and appropriate prevention measures.

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Measuring Exposure to an Elemental Mercury Spill — Dakota County, Minnesota, 2004

Elemental mercury spills can cause contamination of neighborhoods and homes and result in neurologic and kidney disorders in exposed persons who inhale mercury vapors. Often, however, difficulties exist in determining the magnitude of exposure and effectiveness of decontamination or in recognizing that reexposure has occurred. This report summarizes the response to an elemental mercury exposure that resulted in the decontamination of 48 persons and the subsequent analysis of blood and urine samples from 14 exposed youths aged 6–16 years. Data from these analyses suggest that 1) blood samples are more sufficiently acquired and can be used to evaluate recent acute exposure and 2) use of a real-time mercury vapor analyzer can help public health officials determine the magnitude of exposures and help prevent reexposures. In addition, demolition and waste-disposal firms and government agencies must take actions to ensure that elemental mercury is adequately secured before disposal.

Case Report

In preparation for demolition of a factory in Dakota County, Minnesota, hazardous waste from the factory was temporarily stored in a shed, which was not effectively secured. During a late afternoon in September 2004, two teenagers entered the shed and found two canning jars containing approximately 21 pounds of elemental mercury. The teenagers brought the mercury back to their neighborhood, where they and approximately 12 other youths played with it, throwing handfuls of mercury at each other and splashing in a large puddle of mercury on an outdoor basketball court. This initial exposure was limited to <2 hours because of rapid response by a parent who saw what the youths were doing, told them to go home and shower, and contacted the police. Subsequently, 48 persons, including 18 youths, were decontaminated with water and detergent by the Dakota County Special Operations Team between 10 p.m. and 2 a.m. Beginning at 9 p.m., homes were scanned for contamination by using a real-time mercury vapor analyzer (RA-915+; Ohio Lumex Company; Twinsburg, Ohio). On the recommendation of Minnesota Department of Health (MDH) staff, residents of 12 contaminated homes* were sheltered in a motel by the American Red Cross.

* In this incident, MDH recommended evacuation of homes with a maximum mercury vapor concentration >1,000 ng/m³ and recommended cleanup of all homes with a maximum concentration (unventilated) >500 ng/m³, as measured by a mercury vapor analyzer. Cleanup or disposal of vehicles was recommended at concentrations >1,000 ng/m³. These cleanup/clearance criteria were intended to limit exposures to no more than the Environmental Protection Agency chronic reference concentration of 300 ng/m³ or the acute California reference effects level of 1,800 ng/m³.

As part of its epidemiologic investigation, MDH staff interviewed some of the youths the morning after the event and learned that the teenagers had attempted to ignite the mercury and might have been exposed to fumes. Subsequent sampling with the mercury vapor analyzer in motel rooms of displaced families revealed mercury contamination, and high concentrations of mercury vapor found near the hair of three youths 24 hours after exposure (Table 1) suggested that exposures might have been more severe than initially indicated, that decontamination was incomplete, and that exposures were continuing. Consequently, 14 youths aged 6–16 years with known exposures were examined by physicians; 11 were evaluated at Regions Hospital in St. Paul, Minnesota.

Blood and/or urine samples were obtained from all 14 youths. However, although the youths were provided bottles for urine samples when their blood was drawn, the first samples were not provided until 3 days later, during the weekend. In addition, at Regions Hospital and at one extended-stay motel, mercury vapor concentrations were measured with a mercury vapor analyzer near the skin of the youths, and exhaled air mercury vapor concentrations were measured by analyzing air in plastic bags inflated by some of the youths. Contaminated hair and scalps of the youths were washed at the hospital with shampoo containing selenium sulfide and dried with terry-cloth towels, which were then discarded. Decontamination was verified with a mercury vapor analyzer. Follow-up samples were obtained for youths with elevated mercury levels.

Epidemiologic and Sampling Findings

All 14 patients had routine physical examinations. Two had new onset cough, and one complained of a poor appetite; these symptoms had resolved by a follow-up visit. Samples from four youths were taken at different times because not

every patient agreed to provide a blood sample on day 2. In addition, blood samples drawn from two youths on day 2 coagulated; one of these persons was retested on day 10. Elevated mercury ($\geq 8 \mu\text{g/L}$) was found in five of eight analyzed blood samples taken on day 2 (Table 2). Additionally, measurable amounts ($5 \mu\text{g/L}$ and $6 \mu\text{g/L}$, respectively) of mercury were found in samples collected from one child on day 4 and another child on day 10. Second blood samples collected during days 9–15 from the five youths with the initial elevated readings determined their blood mercury levels had declined below the laboratory reporting limit ($5 \mu\text{g/L}$). Second blood samples could not be obtained from two youths. Measurable mercury was found in the urine samples of five youths (Table 2). However, these urine sample results might be unreliable because of small sample volumes.

From hour 44 to hour 98, exhaled mercury decreased for three youths (patients 5, 6, and 7), whereas readings for two youths (patients 3 and 9) indicated increases (Table 1). The increases, along with high concentrations in a motel room, suggested reexposure; investigation identified the source as a contaminated motor vehicle. Patient 7, who had a longer half-life of exposure than patients 5 or 6, was determined to have been reexposed by the same contaminated motor vehicle (Table 1). Comparison of mercury vapor concentrations near the skin and hair at hours 42–44 and 98 confirmed the reexposures observed in exhaled mercury (Table 1) and the motel room. Mercury vapor concentrations in motel rooms decreased after isolation of the contaminated motor vehicle and disposal of contaminated personal items. The last blood mercury analyses for all youths, except patients 12 and 13, indicated concentrations below laboratory reporting limits ($4\text{--}5 \mu\text{g/L}$), suggesting cessation of the exposure. No further treatment was indicated for any patient. The correlation

TABLE 1. Mercury vapor concentrations (ng/m^3)* associated with nine patients after mercury exposure — Dakota County, Minnesota, 2004

Patient no.	Near hair				Near skin (chest)		Exhaled air		$t_{1/2}$ [§] (hrs)
	Hour 24	Hour 42	Hour 43 [†]	Hour 98	Hour 44	Hour 98	Hour 44	Hour 98	
1	635 [¶]	1,742		664 [¶]			571		
2		376		142 ^{**}	597	454 ^{**}	990		
3		430		327 ^{**}	546	1,662 ^{**}	575	1,890 ^{**}	††
4		381		38	128	48		66	
5		1,247		169		273	380	90	26
6	17,000 [¶]	4,812	2,690	94	1,634	62	442	101	25
7		9,681	873	3,926 ^{**}	1,384	1,163 ^{**}	1,446	616 ^{**}	44
9		283		106 ^{**}	424	254 ^{**}	239	379 ^{**}	††
12	35,000 [¶]		850 [¶]						

* Sampling volume ~20 L/min; sampling rate: mean of 3 x 10 second averages, by using a real-time mercury vapor analyzer.

† After shampooing at hospital.

§ Exhalation half-life: calculated from two exhaled mercury vapor data points.

¶ Data likely a maximum, by using a real-time mercury vapor analyzer at a 1-second sampling rate.

** Patient determined to be reexposed.

†† Sampling data indicated increase.

TABLE 2. Total mercury in whole blood and urine* of 14 patients after exposure to mercury — Dakota County, Minnesota, 2004

Patient no.	$\mu\text{g mercury/L blood}$						$\mu\text{g mercury/g creatinine (mL urine)}$			
	Day 2	Day 4	Day 7	Day 9	Day 10	Day 11	Day 15	Day 5	Day 7	Day 10
1	9						<5	3 (850)		
2	9				<5			7 (300)		
3	13				<5					6 (750)
4	<5		<5							
5	<5		<5							
6	†								6 [§]	
7	12				<5			5 (350)		
8				<5						
9	8			<5					<10 [§]	
10						<5				
11	<4									
12	†				6				<10 (450) no date	
13		5								
14							<4			

* 24-hour urine sample requested.

† Sample coagulated, not analyzed.

§ Small sample volume; presumed random.

between blood mercury and exhaled mercury for individual youths was low ($R^2 = 0.27$).

Testing in eight of the youths' residences indicated maximum mercury vapor concentrations ranging from <60 ng/m^3 to >50,000 ng/m^3 (Table 3). Three additional homes were found to be contaminated by adults tracking mercury. Cleanup in accordance with MDH criteria and reoccupancy of all contaminated homes was completed 22 days after the initial incident. The Minnesota Pollution Control Agency used a mercury-sniffing dog (*I*) to find the source of contamination in the last house cleared. Tracked mercury was located by using a mercury vapor analyzer. Three of four contaminated cars could not be cleaned to the MDH criterion for clearance and were scrapped. All visible traces of mercury were cleaned from the basketball court and other affected outdoor areas. Dakota County Public Health nurses tracked all of the youths, facilitating medical examinations and testing and providing support for families.

Reported by: BA Baker, MD, Regions Hospital Occupational Medicine Clinic, St. Paul; C Herbrandson, PhD, T Eshenaur, MPH, RB Messing, PhD, Minnesota Dept of Health.

Editorial Note: Exposure to elemental mercury occurs largely from inhaling mercury vapors; very little mercury is absorbed through the skin or by ingestion. Mercury spills pose a serious health hazard and are difficult to clean because most common methods (e.g., sweeping or vacuuming) disperse mercury, increasing the surface area of the mercury, increasing evaporation, and exacerbating the contamination. This report illustrates that use of real-time portable instruments such as mercury vapor analyzers can enable investigators to rapidly measure mercury vapor concentrations and determine the extent of an exposure incident.

Geometric mean and 95% total blood mercury concentrations in the 1999–2002 National Health and Nutrition Examination Surveys (NHANES) for women of childbearing age were 0.92 $\mu\text{g/L}$ and 6.04 $\mu\text{g/L}$, respectively, and for young children were 0.33 $\mu\text{g/L}$ and 2.21 $\mu\text{g/L}$, respectively (2). Almost all inorganic mercury blood concentrations in the

TABLE 3. Maximum mercury vapor concentrations (ng/m^3)* in eight households of 13 patients exposed to mercury — Dakota County, Minnesota, 2004

Patient no.	Mercury vapor	Location	Time (hrs)	Mercury vapor	Location	Time (hrs)
1	1,500	At front door	24	2,270	Shower	48
2, 3, 7	17,000	Dresser drawer	98	1,900	Ambient air	98
4, 5	17,000	Outdoor steps	114	>50,000	Floor by couch	114
6	<200	Throughout home	98			
8	<60	Throughout home	9	1,300	Bag of clothes	9
9	735	Bedroom, ambient	114	3,412	Closet in bedroom	114
10, 12	3,600	Backpack	20	765	Bedroom	20
13	1,900	Ambient in house	9	7,500	Living room chair	Unknown
14	<200	Ambient in house	9			

* Using a real-time mercury vapor analyzer.

NHANES study were below the detection level of 0.4 $\mu\text{g/L}$ (2). Geometric mean and 95% concentrations of urine mercury for women aged 16–49 years in the 1999–2000 NHANES data were 0.72 $\mu\text{g/L}$ and 5.00 $\mu\text{g/L}$, respectively (3). Normal exhaled air mercury concentrations are typically <50 ng/m^3 for persons without dental amalgams (Minnesota Department of Health and Minnesota Pollution Control Agency, unpublished data, 2004).

The half-life of total mercury in blood for persons exposed to mercury vapor is 2–5 days, reflecting distribution to tissues and elimination through exhalation (4,5), which corresponds to the results in this report; blood mercury levels were below the detection limit 7–13 days after initial positive measurement. Exhaled mercury concentrations have been found to decrease, with half-lives of 13–25 hours (6) and 1.6–2.3 days (7). These half-lives also are consistent with the results in this report. However, exhalation half-lives longer than 30 hours might indicate continuing exposure or reexposure to mercury. The patient with the calculated half-life of 44 hours had been reexposed on day 4. Exhaled vapor concentrations can also depend on proper exhalation by patients. To compare data between patients, investigators should instruct all patients to exhale in the same manner; however, mercury vapor half-lives are repeated measures and will not be as sensitive to individual differences. The lack of correlation between exhaled mercury and blood mercury is likely caused by measurement of different forms of mercury (i.e., total mercury for blood and mercury vapor for exhaled) and the small range of exposures.

Approximately 70%–80% of inhaled mercury enters the blood before distribution to tissues; the rest is immediately exhaled. An estimated 7% of retained mercury is exhaled in the first 3 days after exposure (8,9). Approximately 9.2% and 2.4% is excreted in feces and urine, respectively, within 7 days (4). Conversely, mercury concentrations in blood can increase rapidly after an acute exposure to mercury, providing timely indication of exposure. In addition, the short half-life of mercury in blood can enable confirmation of the cessation of exposure. However, investigators should be aware of potential confounders to measurements of mercury concentrations (e.g., fish consumption, dental amalgams, medicinal use, and ritualistic use of mercury such as sprinkling on a floor for good luck) (10).

In this report, the experiences of responders and investigators also underscore several recommendations for demolition and waste-disposal companies and government agencies. These include 1) securing elemental mercury at demolition sites, 2) confirming mercury decontamination by sampling, 3) providing sensitive field instruments and appropriate training for tracking mercury contamination and exposure, and 4) incorporating quality-assurance controls into all data collection activities.

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Tuberculosis Transmission in a Homeless Shelter Population — New York, 2000–2003

In 2003, the incidence of tuberculosis (TB) cases in the United States declined for the eleventh consecutive year to a record low of 5.1 cases per 100,000 population (1). In 2003, 6.3% of reported TB cases in the United States were among homeless persons (2). Compared with the general population, this group has a greater risk for latent TB infection (LTBI) and progression to active disease (3). This report summarizes a recent outbreak of TB and highlights the challenges of preventing TB among homeless persons, particularly when multiple chains of transmission are occurring and multiple



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Hepatitis A Vaccination Coverage Among Children Aged 24–35 Months — United States, 2003

Hepatitis A vaccine was first licensed in the United States in 1995. In 1996, the Advisory Committee on Immunization Practices (ACIP) recommended vaccination of children aged ≥ 24 months in populations with the highest incidence of hepatitis A (e.g., American Indian/Alaska Native [AI/AN], Asian/Pacific Islander, and selected Hispanic and religious communities) (1). In 1999, these guidelines were expanded to recommend routine vaccination for children residing in 11 states* where average annual hepatitis A incidence during 1987–1997 was at least 20 per 100,000 population (twice the national average) and to consider routine vaccination for children in six states[†] where average annual incidence was 10–20 per 100,000 population (2). This report is the first national analysis of hepatitis A vaccination coverage among children. The results indicate that, in 2003, vaccination coverage levels with at least 1 dose of hepatitis A vaccine for children aged 24–35 months varied from 6.4% to 72.7% in areas where routine vaccination is recommended (Table). In addition, hepatitis A vaccination coverage rates for children aged 24–35 months are lower than overall rates for other vaccines recommended for children (3). Sustaining and improving vaccination coverage among young children is needed to ensure continued declines in hepatitis A incidence in the United States.

The National Immunization Survey (NIS) provides annual estimates of vaccination coverage as of the time of household interview among children aged 19–35 months for the 50 states and 28 selected urban areas. In 2003, NIS began to collect data regarding hepatitis A vaccination coverage. Hepatitis A vaccine is a 2-dose regimen (administered at least 6 months apart) licensed for use in children aged ≥ 24 months. Hepatitis A vaccination coverage data were limited to children aged

24–35 months and calculated by considering children who had received at least 1 vaccine dose. To collect vaccination data for all age-eligible children, NIS uses a quarterly, random-digit-dialing sample of telephone numbers for each of the 78 survey areas and determines vaccination status from health-care provider records (4,5). During 2003, information on vaccination history was collected from telephone interviews for 19,979 children; provider verified vaccination records were available for 13,731 (68.7%).

Among children aged 24–35 months residing in the 11 states where routine hepatitis A vaccination is recommended, 50.9% (95% confidence interval [CI] = 47.6%–54.2%; range among states: 6.4%–72.7%) received at least 1 dose of hepatitis A vaccine. Among children aged 24–35 months residing in the six states where routine hepatitis A vaccination should be considered, 25.0% (CI = 21.8%–28.2%; range: 0.6%–32.3%) had received at least 1 dose of hepatitis A vaccine. Among children aged 24–35 months residing in the 33 states without a specific recommendation, 1.4% (CI = 1.0%–1.8%; range: 0.0%–4.3%) had received at least 1 dose of hepatitis A vaccine (Table). Two states (Alaska and Arizona) and four urban areas had coverage estimates $>60\%$. Hispanic and AI/AN children had higher coverage rates than non-Hispanic white or black children in areas where routine vaccination is recommended or should be considered (Figure).

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*Alaska, Arizona, California, Idaho, Nevada, New Mexico, Oklahoma, Oregon, South Dakota, Utah, and Washington.

[†]Arkansas, Colorado, Missouri, Montana, Texas, and Wyoming.