OSHA® BRIEF

Medical Evaluation of Renal Effects of Cadmium Exposures

This Brief will help physicians understand the medical surveillance provisions of the Cadmium standard (29 CFR 1910.1027 for general industry; 29 CFR 1926.1127 for the construction industry; 29 CFR 1915.1027 for the shipyard industry; and 29 CFR 1928.1027 for the agriculture industry), especially those provisions that address the renal effects of cadmium, and supplements the Cadmium Biological Monitoring Advisor eTool. General background information on cadmium (Cd) is available on the Health and Safety Topics page at OSHA's web site (www.osha.gov/SLTC/cadmium/index.html).

Occupational Exposure to Cadmium Can Result in Possible Kidney Damage

Occupational exposure to cadmium can result in serious kidney damage (renal tubular proteinuria). All workers who are working in conditions that may place them at high risk of elevated cadmium exposure, including levels at or above the current action level of 2.5 µg/m^3, must be evaluated under a medical surveillance program.

The Importance of Medical Surveillance

The medical surveillance provisions of the Cadmium standard (i.e., paragraph (l)) aim to accomplish three main interrelated purposes: (1) identifying workers who may be at increased risk of adverse renal effects from chronic exposure to cadmium; (2) preventing cadmium-induced renal disease; and (3) detecting and minimizing existing cadmium-induced disease. To accomplish these goals, periodic biologic monitoring of three key biological indicators (cadmium in blood – CdB, cadmium in urine – CdU, and beta-2-microglobulin in urine – β_2MU) is included in the medical surveillance provisions. If the employee's biological monitoring results are above normal levels, the employer must take additional actions, which may include, but are not limited to, more frequent medical surveillance.

Each biological measurement provides distinct information about hazardous exposures:

- Levels of cadmium in the blood are associated with recent exposures to Cd. They are measured as micrograms of Cd per liter of whole blood (CdB µg per lwb; reported as units of CdB);
- Cadmium body burden in the kidney is associated with long-term elevated exposures to cadmium in the air. It is measured as micrograms of Cd per gram of creatinine in urine (CdU µg per grCr; reported as units of CdU); and
- Potential and actual kidney damage is identified using elevated beta-2-microglobulin levels in urine. It is measured as micrograms of beta-2-microglobulin (β_2M) per gram of creatinine in urine (β_2M µg per grCrU; reported as units of β_2MU). β_2M is a small molecular weight protein in urine.

Using Biological Measurements during Medical Surveillance

The levels of biological measurements noted above indicate greater and lesser risk of contracting cadmium-induced renal disease (renal tubular proteinuria), and provide triggers for appropriate medical responses. The medical surveillance section (29 CFR 1910.1027(l)) of the Cadmium standard identifies elevated levels of these measurements that will alert the physician and the employee that the employee is at increased risk of kidney dysfunction. The medical surveillance section specifies clear triggers for non-mandatory and mandatory medical actions regarding the disposition of workers with elevated measurement levels. Table 1 of this Brief, below, describes the initial non-mandatory and mandatory actions with regarding to various elevated levels of these measurements.

Table 1. Medical Removal Actions Triggered by Initial Medical Surveillance (1910.1027(l))[1]

Biological Measurement	Normal Levels	Elevated Levels, Non-Mandatory Removal	Highly Elevated Levels, Non-Mandatory Removal	Highly Elevated Levels, Mandatory Removal
Cadmium in urine (CdU)[2]	≤ 3	> 3 and ≤ 7	> 7	> 7
Cadmium in blood (CdB)[3]	≤ 5	> 5 and ≤ 10	> 10	> 10
Beta-2 (β_2MU)[4]	≤ 300	> 300 and ≤ 750	> 750	> 750
Trigger level	All three measurements at normal levels.	Any one measurement at an elevated level.	Any one measurement at a highly elevated level.	After confirmed follow-up testing within 90 days, either CdU or CdB remain at a highly elevated level, or β_2MU remains at a highly elevated level and either CdU or CdB is at an elevated level.
Risk at this level	Negligible or relatively low risk of renal tubular proteinuria (i.e., consistent with the background rate among the general population).	Elevated risk of renal tubular proteinuria (i.e., above the background level experienced by the general population).	Elevated, and perhaps highly elevated, risk of renal tubular proteinuria (i.e., above the background level experienced by the general population). Risk may not be abnormal if β_2MU is highly elevated and CdU and CdB are at normal levels.[5]	Highly elevated risk of renal tubular proteinuria.
Actions	Provide annual biological monitoring and biennial medical examinations.	Provide semi-annual biological monitoring and annual medical examinations until all measurements return to normal levels.	If medically removed from job: Provide quarterly biological monitoring and semiannual medical examinations until physician decides to return employee to job or permanently remove the employee from job. If not medically removed from job: Provide quarterly biological monitoring and semiannual medical examinations until all measurements return to normal levels.	Mandatory medical removal required. Provide quarterly biological monitoring and semiannual medical examinations until physician decides to return employee to job or permanently remove the employee from job.

[1] This table addresses only medical removal actions specified by the Cadmium standard; other requirements may apply based on the results of the other medical examinations.

[2] CdU = CdU µg per grCr

[3] β_2MU = β_2MU µg per grCrU

[4] CdB = CdB µg per lwb

[5] In cases in which the β_2MU is highly elevated and CdU and CdB are at normal levels, the physician should check to determine that the β_2MU levels accurately reflect the true β_2MU levels. If they do, then the physician must determine the cause of the highly elevated levels of proteins in urine (e.g., presence of end-stage renal disease or immune-deficiency diseases).

OSHA uses the biological measurements to determine whether mandatory medical removal is necessary. However, any one measurement for β_2MU, CdU, or CdB at highly elevated levels may trigger action by physicians. There are several potential scenarios. For example, one potential scenario is indicated in Table 1, column 4 (non-mandatory removal). In this example, if the physician does not medically remove the worker from the job, then the worker must receive quarterly biological monitoring and semiannual medical examinations until all parameters are within normal levels. If the physician decides to remove the employee from the job, the employer must provide quarterly biological monitoring and semiannual medical examinations until the physician decides to return the employee to the job or to permanently remove the employee from the job.

Another scenario is indicated in Table 1, column 5 (mandatory removal). In this scenario, OSHA requires mandatory medical removal when either CdU or CdB remains at highly elevated levels, or β_2MU remains at a highly elevated level and either CdU or CdB is at an elevated level, after follow-up testing at 90 days after initial testing. Additionally, employers are required to provide quarterly biological monitoring and semiannual medical examinations until the physician decides to return the worker to the job or to permanently remove the worker from the job.

Cadmium Biological Monitoring Advisor eTool

OSHA developed an eTool that allows physicians to input test results to aid them in deciding what course of action is best for the worker. The Advisor presents questions and relies on data from the biological monitoring tests to determine the appropriate course of action. It determines the biological monitoring and medical surveillance requirements of the General Industry Cadmium standard applicable to those results, and cites the applicable provisions of the Cadmium standard. The physician also may print the determinations and other information for future reference.

All the industry Cadmium standards use the same criteria to make determinations based on biological monitoring test results. However, the Advisor **does not** reference or cite the applicable provisions of the Construction Industry Cadmium standard, which is the only standard with different citations. Consequently, a physician using the Advisor in association with the Construction Industry Cadmium standard must find the corresponding provisions manually.

The Advisor also provides direct links to relevant provisions of the Cadmium standard in the Code of Federal Regulations, including the appendices. Links to requirements for periodic monitoring, reassessments, biological monitoring, definitions of terms, and a table comparing the General Industry and Construction Industry standards are also provided.

The link to the eTool is: http://webapps.dol.gov/elaws/osha/cadmium/1.aspx

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