A Contaminant Candidate List

Prioritizing Drinking Water Contaminants

By Kelly A. Reynolds, MSPH, Ph.D.

In 1996, the Safe Drinking Water Act (SDWA) was amended requiring that the U.S. Environmental Protection Agency (USEPA) establish a list of contaminants of potential public concern that weren't currently regulated. This list is known as the Drinking Water Contaminant Candidate List (CCL)[1]—see http://www.epa.gov/safewater/ccl/cclfs.html—and identifies priority contaminants for drinking water research, occurrence monitoring and guidance development, including health advisories. The initial criteria for identifying contaminants for the CCL were based on whether or not the contaminant adversely affected public health and whether it's known or suspected to occur in public water systems at exposures potentially harmful to public health. Initially 391 contaminants, including 25 microorganisms, were listed as potential drinking water concerns. Limited resources and practical evaluation required that this list be reduced to more manageable numbers. Even when contaminants are recognized as waterborne and a public health threat, they may be difficult to regulate due to the lack of sensitive methods for their detection, information as to their harmful dose levels, and many other factors.

The first CCL

More than 80 inorganic and organic chemicals, radionuclides and microbes are regulated under the SDWA, originally enacted in 1974 and amended in 1984 and 1996. The 1996 amendments require that at least five contaminants be chosen from the CCL every five years for regulatory consideration. Currently, 10 microbes and 50 chemicals or classes of chemicals are listed on the CCL.

Among this list, contaminants are classified as "Regulatory," "Research" and "Occurrence Priorities" (see *Table* 2). More data are needed for contaminants listed in the occurrence and research priorities before regulatory decisions can be made. Information on health impact, treatment options and analytical methods are needed for those listed under "Research Priorities," while occurrence data are lacking for those on the "Occurrence" list.

Although Table 1 lists all of the 1998 Candidate Contaminant List items, the USEPA recently proposed to eliminate nine items from regulatory consideration (see bolded text in column one of Table 1). Current data indicates that these nine items do not meet the requirements for contaminant regulation under the SDWA. The agency is soliciting public comment now on this decision (see www.epa.gov/safewater/ccl/pdf/prelimreg_fr.pdf).[2]

The first CCL—a first draft of which was released in 1997—was an unranked list. With tens of thousands of potential candidates, choosing which contaminants of drinking water should be top priority for regulatory consideration isn't a simple process. In addition, the regulatory process isn't rapid, in part because a cost/benefit and risk management analysis must be performed so that the practicality, and relative need, of a new regulation can be assessed. In 1998, at the request of the USEPA Office of Ground Water and Drinking Water, the National Research Council's (NRC) Water Science and Technology Board and Board on Environmental Studies and Toxicology oversaw the formation of the Committee on Drinking Water Contaminants. The NRC committee's primary function was to provide advice on setting priorities for drinking water contaminants that would identify contaminants posing the greatest threat to public health.

Guidance from the NRC

Last year, the NRC published its third report aimed at providing guidance and recommendations for identifying and prioritizing drinking water contaminants.[3] The first report, completed in July 1999, examined past approaches used to establish a priority among drinking water pollutants. This report, titled "Setting Priorities for Drinking Water Contaminants," recommended that the USEPA establish a phased decision making process, timeline and related criteria for priority setting and categorizing CCL contaminants.[4] The committee outlined past procedures for setting priorities among drinking water contaminants and stressed the continued need for expert judgment and conservative approaches while erring on the side of human safety. Also in 1999, the committee conducted a workshop on emerging drinking water contaminants and published these proceedings in a second report, titled "Identifying Future Drinking Water Contaminants." This second report suggested a new type of screening process be used to identify and evaluate a broader, more objective, group of drinking water contaminants.

Building on the first two reports, the third NRC report recommends a two-step process for developing future CCLs. In this process, a "universe" of drinking water contaminants is established including naturally occurring substances, water-associated microbes, chemicals, products of environmentally transformed chemicals, reaction by-products, metabolites in the environment, radionuclides, biological toxins and fibers. This broad list of contaminants is then reduced to a preliminary CCL (PCCL) based on whether they are known or thought to be a health risk, and are known or thought to occur in drinking water. Each PCCL is then assessed using a classification tool and expert judgment to create the CCL. The expert judgment is important because occurrence and health effects data may not be known, even for some of the most harmful contaminants. These contaminants shouldn't be overlooked due to a lack of information. The CCL selection process should be repeated for each list development cycle to consider any new information that may have become available since the last CCL was finalized.

Problems with the 1998 CCL

Time constraints of the SDWA's 1996 amendments forced the USEPA to quickly form the 1998 CCL. The Committee on Drinking Water Contaminants commented in their third report that these time constraints resulted in a lack of sufficient explanation and justification for the contents of the list. Some of the specific concerns of the committee were:

- The establishment of varying methods for assessment of chemical and microbial contaminants. The committee suggested a concentration limit for individual microbes, as with chemicals, rather than the "zero-tolerance" approach that has been used. The past policy has forced reliance on microbial indicators (i.e., fecal and total coliforms) that are known to be inadequate determinants of many waterborne pathogens. In addition, use of bacterial indicators to monitor water quality has led to an insufficient occurrence database for specific pathogens.

- Chemicals on the CCL were taken from previously established databases and lists, ignoring the tens of thousands of chemicals not yet identified. While these previously recognized contaminants are of concern, questions remain as to whether they merit highest priority status.

- The formation of the 1998 CCL of contaminants excluded contaminants that lacked occurrence data. Therefore, relevant contaminants were overlooked due to missing or inadequate occurrence information.

- The 1998 process to develop the CCL eliminated contaminants determined to be endocrine disrupters or pesticides based on the assumption their evaluation could be deferred to other USEPA programs (i.e., The Endocrine Disrupter Screening and Testing Advisory Committee, The Office of Pesticide Programs, etc.).

- The lack of explanation for the USEPA's decision to limit the CCL to only 60 contaminants, and for the decision to include or exclude specific contaminants, and limited opportunity for public participation (a two-month comment period) were also criticized.

The USEPA was forthright in admitting there was a need to improve the process for the development of the next CCL in 2003.[6]

Suggested improvements

The NRC committee recommended, as a starting point, five attributes that could be numerically valued and used to score specific contaminants. Scores are based on an assessment of the severity (what are the health effects?), potency (what is the dose response relationship?), prevalence (how often does it occur in drinking water?), magnitude (is the level high enough to be harmful?), and persistence-mobility (solubility, stability, chance of growth or amplification in water) of each contaminant. Using a complex classification modeling process, attribute scores can be used—allowing for predicted values where data gaps occur—to prioritize PCCL contaminants toward a working CCL. This approach allows for a more objective, consistent approach to evaluate all potential drinking water pollutants.

New approaches are needed to evaluate the harmful potential of microbes. The NRC committee suggested a method similar to that used for evaluation of chemicals. Quantitative structure activity relationships (QSARs) have been used for chemicals where the structures of new chemicals are compared to known chemical toxins, in an attempt to predict the new chemical's toxicity factor. Similarly, the virulence factor activity relationship (VFAR)—the relationship between a known or potential microorganism and its real or potential ability to cause adverse health effects—is suggested as a means of identifying microbial contaminants of drinking water.

The increasing advances in molecular methodologies have aided in the development of a genetic database of microbial pathogens. Genetic detection methods can help to identify the potential threat of a microbe since specific structural and biochemical characteristics (i.e., lipid structures, toxin production, surface proteins, attachment and invasion structures, etc.) are more likely associated with the ability of the organism to be harmful.

Other improvements suggested by the NRC committee to the USEPA included the need to recognize sensitive populations relative to drinking water contaminants. In the past, regulators have recognized that they must consider all consumers, including susceptible populations that are most affected by drinking water pollutants. Highly vulnerable populations include the very young, the elderly, the immunocompromised, the chronically ill, etc. Up to 20 percent of the U.S. population, a significant portion, is considered immunocompromised. The current SDWA legally mandates consideration of vulnerable subpopulations; however, the Committee on Drinking Water Contaminants recommends the category of susceptible populations be expanded to include women of child-bearing age, unborn fetuses, persons genetically predisposed to adverse reactions, the malnourished, and persons with individual sensitivities to specific contaminants.

Conclusion

Ultimately, it's the responsibility and task of the USEPA to decide which contaminants should be included on the 2003 CCL. The USEPA has called on the experience and knowledge of many experts to help formulate a better process, than were available in the past, to accomplish this goal. Recognizing that no single list will include all contaminants in need of regulation and/or research, and experts will never completely agree on what contaminants should be included or how they should be prioritized, the effort to improve drinking water quality is continuing in a forward direction.

References

1. EPA, "Announcement of the Drinking Water Contaminant Candidate List; Notices," *Federal Register,* 63(40):10273-10287, 1998a.

2. EPA, "Announcement of Preliminary Regulatory Determinations for Priority Contaminants on the Drinking Water Contaminant Candidate List," Washington, D.C., Office of Groundwater and Drinking Water, *Federal Register,* Vol. 67, No. 106, June 3, 2002.

3. NRC*, "Classifying Drinking Water Contaminants," Washington, D.C., National Academy Press, 2001.

4. NRC*, "Setting Priorities for Drinking Water Contaminants," Washington, D.C., National Academy Press, 1999a.

5. NRC*, "Identifying Future Drinking Water Contaminants," Washington, D.C., National Academy Press, 1999b.

6. EPA, "U.S. EPA Response to Comment Document: Draft Drinking Water Contaminant Candidate List," Washington, D.C., Office of Groundwater and Drinking Water, 1998b.

* All three NRC reports are available to purchase or read online at www.nap.edu

About the author

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Table 1. 1998 contaminant candidate list

Regulatory Determination		Research Priorities		
Priorities	**Health Effects**	**Treatment**	**Analytical Methods**	**Occurrence Priorities**
Acanthamoeba (guidance)	Adenoviruses	Adenoviruses	Adenoviruses	Adenoviruses
Sodium (guidance)	*Aeromonas hydrophila*	*Aeromonas hydrophila*	*Aeromonas hydrophila*	*Aeromonas hydrophila*
1,3-dichloropropene*	Caliciviruses	Caliciviruses	Caliciviruses	Cyanobacteria (blue-green
Aldrin*	Coxsackieviruses	Coxsackieviruses	Coxsackieviruses	algae)""
Boron	Cyanobacteria (blue-green	Cyanobacteria (blue-green	Cyanobacteria (blue-green	Caliciviruses**
Dieldrin*	algae)	algae)	algae)	Coxsackieviruses**
Hexachlorobutadiene	Echoviruses	Echoviruses !	Echoviruses	Echoviruses"*
Manganese	*Helicobacter pylori*	*Helicobacter pylori*	*Helicobacter pylori*	*Helicobacter pylori*"*
Metolachlor*	Microsporia	Microsporidia	Microsporidia	Microsporidia**
Metribuzin*	*Mycobacterium avium*	*Mycobacterium avium*	*Mycobacterium avium*	*Mycobacterium avium*
Naphthalene	*intercellulare*	*Intercellulare*	*Intercellulare*	*intercellulare*
Sulfate	1,1,2,2-tetrachloroethane	1,1,2,2-tetrachloroethane	1,2-diphenylhydrazine	1,2-diphenylhydrazine
	1,2,4-trimethylbenzene	1,2,4-trimethylbenzene	2,4,6-trichlorophenol	2,4,6-trichlorophenol**
	1,1-dichloroethane	1,1-dichloroethane	2,4-dichlorophenol	2,4-dichlorophenol**
	1,1-dichloropropene	1.1-dichloropropene	2,4-dinitrophenol	2,4-dinitrophenol**
	1,2-diphenylhydrazine	1,2-diphenylhydrazine	2-methyl phenol (o-cresol)	2,4-dinitrotoluene
	1,3-dichloropropane	1,3-dichloropropane	Acetochlor	2,6-dinitrotoluene
	2,4,6-trichlorophenol	2,4,6-trichlorophenol	Alachlor ESA	2-methyl phenol (o-
	2,2-dichloropropane	2,2-dichloropropane	Diazinon	cresol)**
	2,4-dinitrophenol	2,4-dichlorophenol	Disulfoton	Acetochlor**
	2,4-dinitrotoluene	2,4-dinitrophenol	Diuron	Alachlor ESA**
	2,6-dinitrotoluene	2,4-dinitrotoluene	Fonofos	DCPA mono-acid degradate
	2-methylphenol (o-cresol)	2,6-dinitrotoluene	Linuron	DCPA di-acid degradate
	Aluminum	2-methyl phenol (o-cresol)	Perchlorate	DDE
	Bromobenzene	Acetochlor	Prometon	Diazinon**
	DCPA mono-acid degradate	Alachlor ESA	RDX	Disulfoton"*
	[OPP]	Aluminum	Terbufos	Diuron**
	DCPA di-acid degradate	Bromobenzene	Triazines & Degradation	EPTC (s-ethyl-dipropyl
	[OPP]	DCPA mono-acid degradate	products (incl., but not	thiocarbamate)
	p-isopropyltoluene	DCPA di-acid degradate	limited to Cyanazine and	Fonofos**
	(p-cymene)	DDE	atrazine-desethyl)*	Linuron**
	Methyl bromide [OPP]	Diazinon	Organotins	Methyl-tertiary-butyl ether
	Methyl-t-butyl ether (MTBE)	Disulfoton		(MTBE)
	Nitrobenzene	Diuron		Molinate
	Organotins***	EPTC (s-ethyl-dipropyl		Nitrobenzene
	Perchlorate	thiocarbamate)		Perchlorate**
	RDX	Fonofos		Prometon**
	Vanadium	p-isopropyltoluene		RDX**
	Triazines & degradation	(p- cymene)		Terbacil
	products (incL but not	Linuron		Terbufos**
	limited to Cyanazine and	Methylbromide		Organotins
	atrazine-desethyl)*	Methyl-t-butyl ether (MTBE)		Triazines & degradation
		Molinate		products (incl., but not
		Nitrobenzene		limited to Cyanazine and
		Organotins***		atrazine-desethyl)*
		Perchlorate		
		Prometon		
		RDX		
		Terbacil		
		Terbufos		

Bolded items hi column 1 - EPA is making preliminary regulatory determinations not to regulate these contaminants.[2]

* OPP = Chemicals deferred to the EPA Office of Pesticide Programs for health research and assessments.

** Suitable analytical methods must be developed prior to obtaining occurrence data.

*** Organotins include Monobutyl tin trichloride, Dibutyl tin dichloride, Monomethyl tin trichloride, and Dimethyl tin trichloride.