Into the Mouths of Babes

Bottle-fed Infants at Risk from Atrazine in Tap Water

Environmental Working Group

Jane Houlihan • Richard Wiles

Acknowledgments

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Foreword

What a mess the Novartis chemical company has made here in the United States. They'd never get away with it in Switzerland, where the company is headquartered.

Novartis makes the number one pesticide, by volume and acres sprayed, in the United States. It's the cancer-causing weed killer known as atrazine, and it earns Novartis tens of millions of dollars here every year.

First registered for use in the U.S. in the late 1950s, the pesticide is number one in another respect, too. Atrazine causes more public drinking water supplies to violate federal health standards each year than any other chemical pollutant in America.

No one is more acutely aware of the problem than water suppliers in the Midwest. They're the first to have to deal with Novartis' mess. Atrazine is sprayed on millions of cropland acres each spring to kill weeds before corn is planted. The bulk of the pesticide runs off with spring rains into rivers and lakes. During the flood of 1993, the U.S. Geological Survey estimated that 12,000 pounds of atrazine were flowing through the Mississippi River each day. It also seeps down into groundwater.

Conventional water treatment systems don't filter out atrazine. Under federal drinking water laws, the utilities have to test for atrazine because it is regulated as a contaminant. If it looks like atrazine will exceed the federal standard—which is the way it looks at intake pipes all over middle America come May and June each year—water utilities have to do something about it. So many water suppliers have adopted costly, additional treatment steps. The utilities pass the cost on to their customers. They pass on a little atrazine, too. In most cases the treatment lowers atrazine levels, but does not remove it altogether.

It's a sensitive issue for water companies and utilities, and we are sympathetic with many of them. They don't want anything impure in the water they deliver. Companies like St. Louis County Water, and its public counterpart in the City of St. Louis, among others, pioneered in identifying atrazine and other farm chemicals as pollutants, and in spending money to clean it up at the treatment plant. But if our government simply tightens standards for atrazine in tap water, but allows use of the chemical to continue, it will simply cost water suppliers more to clean up Novartis' mess. It isn't fair. Atrazine shouldn't be in that water to begin with.

That's why Germany, Italy and other European countries have banned it. The Swiss cracked down on atrazine in tap water 15 years ago—before our government even required water companies to test for the chemical. The drinking water standard for atrazine in Switzerland is 30 times more protective than ours.

Unbelievably, Novartis has lobbied hard in recent years to weaken the U.S. standard even more (so that it would be about 200 times less protective than it is back home in Switzerland). It could be that Novartis' corporate ethics are just *a bit* off. After all, this is the same pesticide company that, under an earlier name (Ciba-Geigy) sought to ease regulatory requirements by experimentally spraying a 10-year-old Egyptian boy and other children with pesticide, by crop duster, in the 1980s; and by asking some of its executives to "volunteer" to drink atrazine.

We're guessing Novartis won't be at all worried to learn that each spring, thousands of American babies are fed infant formula that has been reconstituted with tap water containing atrazine.

If anyone knows exactly how long this exposure may have been going on, it is Novartis. We are willing to bet the contamination has been happening for decades. The use of various carbon treatments by water systems to strip atrazine from water, however, is relatively new. So for much of that time, atrazine contamination was much more widespread, and at much higher levels, than we're reporting for the mid- to late 1990s.

That's quite a corporate legacy for Novartis. Its pesticide has exposed tens of thousands of American babies to excessive cancer risks in their very first months of life.

We wish we could say the U.S. government is going to do something about the problem anytime soon. But Novartis has done a far better job lobbying our regulators than the company has done in Switzerland and elsewhere in Europe.

Kenneth A. Cook
President
Environmental
Working Group

Executive Summary

In a little-noticed decision earlier this year, the EPA's top scientific committee on children's health declared that protections against the toxic weed killer atrazine in food and water should not be considered safe for infants and children. According to the Office of Children's Health Protection Advisory Committee:

> "When EPA established the tolerances and 1991 drinking water standards for atrazine, children's differential exposure was not considered and children's differential susceptibility was not fully evaluated" (Federal Register, Feb. 3 1999).

This conclusion directly contradicts EPA's public position that pesticide levels in food and tap water are safe for infants and children. Precisely because the current standards do not protect children, and because millions of children are exposed, atrazine standards were chosen as one of five high priority regulations for review under President Clinton's Executive Order 13045. This order directs EPA to ensure that all regulations issued by the agency protect the health of infants and children.

Atrazine, the most heavily used herbicide in the United States, is a cancer-causing weed killer applied to 50 million acres of corn each year. After it is applied each spring, it runs off cornfields and through drinking water plants into the tap water of millions of Midwestern homes. While many larger water utilities suppress atrazine levels through special treatments, toxic traces remain in finished water.

To better understand the risks resulting from the EPA's failure to protect infants and children from atrazine, we analyzed more than 127,000 tap water test results for the years 1993 through 1998, obtained from state health and environmental officials in seven Midwestern states: Ohio, Indiana, Illinois, Iowa, Missouri, Nebraska, and Kansas.

- We found that atrazine contaminates tap water delivered to 10.4 million people in 796 towns in these seven states. In some communities the lifetime cancer risk from average atrazine concentrations is more than 20 times the legal limit. Peak daily atrazine exposures in tap water have been mea-

The EPA's top scientific committee on children's health declared that protections against atrazine should not be considered safe for infants and children.

EPA safety standards assume that a bottle-feeding newborn drinks the same amount of tap water relative to its weight as an adult. This assumption is wrong.

For a mother to get the same dose of atrazine as her bottle-fed baby, she would have to drink three and a half gallons of tap water a day.

sured as high as 42 parts per billion, 14 times the legally allowed annual average amount.

The EPA Misses Statutory Deadline to Protect Children From Pesticides

In August 1996, Congress unanimously passed major revisions to the nation's pesticide law. These amendments, known as the Food Quality Protection Act (FQPA), require all pesticide exposures to be safe for infants and children. FQPA contains clear deadlines for revision of current standards, beginning with pesticides that the EPA identified in August 1997 as presenting the greatest risks to children's health, including the weed killer atrazine (Federal Register, August 4, 1997). By law, health standards for atrazine and other high-risk pesticides must be revised to protect infants and children by August 3, 1999.

With the deadline less than one week away as this report goes to press, there is no chance that the EPA will meet it. EPA announced this year that new regulatory limits for atrazine in tap water will not even be proposed until 2001 (Federal Register, February 3 1999). The agency has set no date for implementing these new rules.

This government failure to enforce the law puts more than eighteen thousand bottle-feeding infants at serious risk each year. In a letter to the EPA Administrator in June of this year, the chairman of the Office of Children's Health Protection Advisory Committee expressed grave concerns that the agency was about to proceed with yet another assessment of the risk of atrazine to infants and children without proper consideration of the special risks that atrazine present to the very young (Reigart 1999). EPA disregarded the Committee's recommendation that the atrazine assessment be delayed until these issues are resolved (EPA 1999a).

The Government Ignores Infant Risk

EPA safety standards assume that a bottle-feeding newborn drinks the same amount of tap water relative to its weight as an adult. This assumption is wrong. In fact, for a mother to get the same dose of atrazine as her bottle-fed baby, she would have to drink three and a half gallons of tap water a day.

It is this flaw in the EPA safety standard setting process that led the EPA's Children's Health Protection Advisory Committee to conclude that "children's differential exposure was not considered" in food and water safety standards for atrazine.

Prompted by the committee's decision, Environmental Working Group analyzed the method and the data used by EPA to determine how much the agency underestimates exposure and risk to infants.

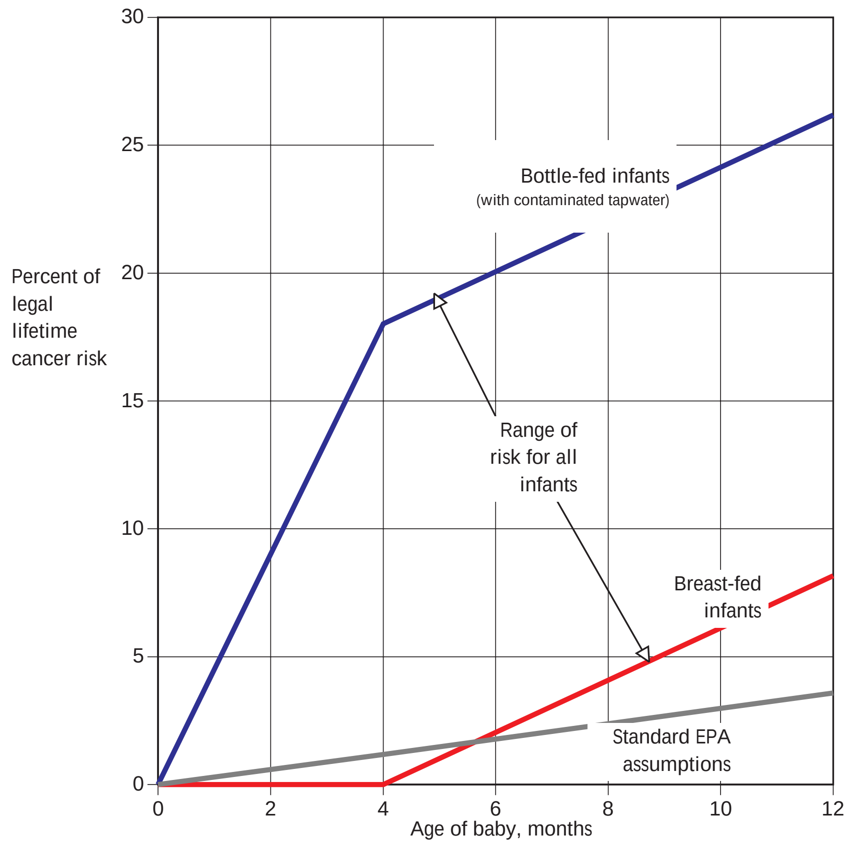
- EWG's analysis shows that the current EPA health standards understate bottle-fed infant exposure to atrazine and other tap water contaminants by a factor of 15 in the first four months of life (Figure 1).

This 15-fold underestimate of risk at this critical period of development is a huge omission on the part of the Agency, an omission that leaves infants in these nearly 800 towns unprotected from the serious potential health effects of atrazine, other weed killers and a host of other contaminants in tap water.

Using the actual amount of atrazine a bottle-fed infant receives, we estimated cancer risk accumulation during the first years of life. In the nearly 800 towns with atrazine in their tap water, we found that:

- In 138 communities, by age five children will exceed what federal law defines as their *lifetime* allowable dose of atrazine. In 40 towns bottle-fed infants exceed their legally allowable lifetime cancer risk from atrazine by their first birthday (Table 1). In Kansas City, Kansas, bottle-fed infants can get their legal lifetime dose by just over eight months of age (Figure 2) and in some other towns, babies get their lifetime dose by the time they are four months old (Table 1).

Figure 1. Some bottle-fed infants face a cancer risk from atrazine 15 times higher than EPA estimates.



Source: Atrazine exposure concentrations based on EWG analysis of State drinking water compliance testing results, 1993-1998. Exposure concentration represents population-weighted average for the 796 communities in seven Corn Belt states that find atrazine in their tap water.

The risks to children are surely greater than this because the toxicity studies used to estimate the cancer potency of atrazine have been performed on adult animals only, making them extremely suspect in predicting risk to the fetus, infant and child.

Industry Removes Atrazine from Ready-to-Feed Formula

The infant formula industry goes to great expense to remove atrazine and other pollutants from the water they use when they

Table 1. In 40 towns children exceed their legal lifetime dose of atrazine by their first birthday.

Community	State	Population, total	Months of age at which child exceeds legal lifetime cancer risk	Lifetime cancer risk as a multiple of legal standard
Louisville	Illinois	1,194	2.5 months	19.0
Hettick	Illinois	220	2.6 months	31.5
Sardinia	Ohio	940	2.9 months	16.8
Defiance	Ohio	17,000	3.3 months	14.4
Shipman	Illinois	675	3.5 months	25.9
Atchison	Kansas	10,660	3.5 months	13.0
Lake of the Woods, Granville	Ohio	412	3.5 months	19.5
Napoleon	Ohio	8,884	3.6 months	13.1
Gillespie	Illinois	3,900	3.6 months	17.9
Mount Orab	Ohio	3,450	3.7 months	17.4
Monroeville	Ohio	1,500	3.8 months	13.1
Keyesport	Illinois	500	3.8 months	16.7
Montezuma	Kansas	877	4.0 months	21.6
Williamsburg	Ohio	2,466	4.5 months	14.6
Osage City	Kansas	2,689	5.1 months	14.8
Delaware	Ohio	28,000	5.2 months	14.2
Clermont County Water, Batavia	Ohio	63,191	6.6 months	16.6
Blanchester	Ohio	4,450	7.2 months	13.6
West Salem	Illinois	1,058	7.3 months	15.3
Versailles	Indiana	2,000	7.4 months	10.8
SLM Water Commission, Mascoutah	Illinois	300	7.5 months	14.3
Ashley	Illinois	650	7.6 months	13.6
Sorento	Illinois	750	7.6 months	15.1
Farina	Illinois	600	7.8 months	18.3
Waterloo	Illinois	7,300	7.8 months	16.2
ADGPTV Water Commission, Girard	Illinois	1,257	7.8 months	13.7
Kansas City	Kansas	164,462	8.2 months	9.9
Palmyra	Illinois	70	8.5 months	14.5
Carlyle	Illinois	3,600	8.8 months	15.6
Alliance	Ohio	24,800	9.0 months	15.6
Upper Sandusky	Ohio	6,000	9.0 months	12.3
Greenfield	Illinois	1,200	9.4 months	14.1
Wilmington	Ohio	11,199	9.5 months	15.2
Smithville	Missouri	4,365	9.6 months	15.2
Illinois American Water Company, Camelot	Illinois	1,200	10.4 months	14.7
Olathe	Kansas	78,666	10.7 months	9.6
Evansville	Illinois	850	10.9 months	12.3
Logansport	Indiana	12,621	11.2 months	8.9
Milan	Indiana	1,750	11.7 months	10.2
Norwalk	Ohio	14,800	11.8 months	12.2

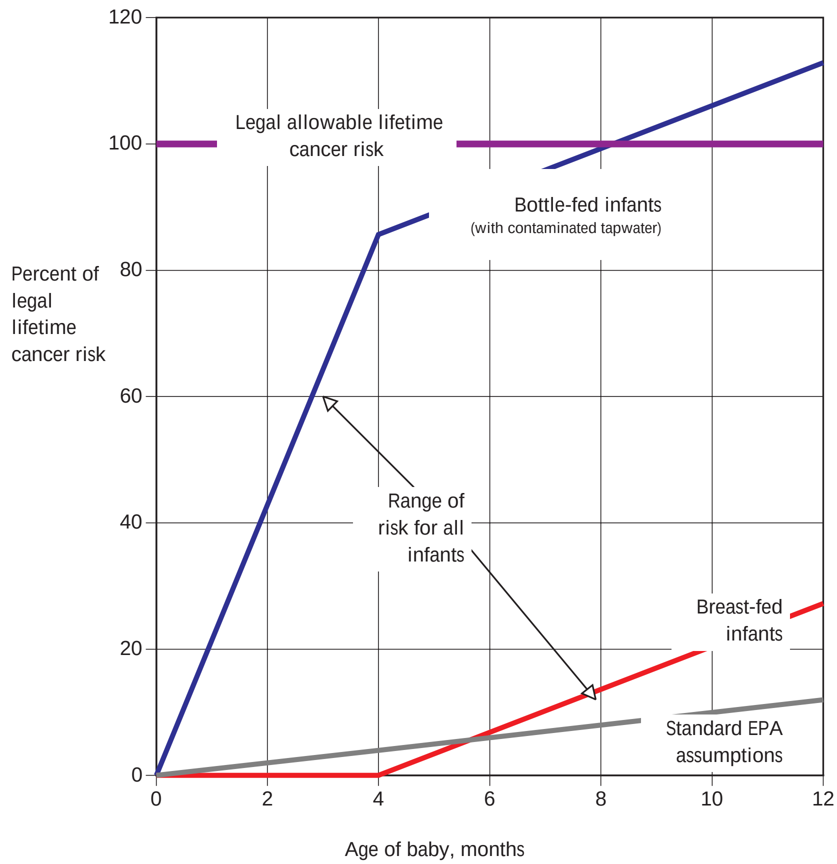
Source: EWG risk assessment based on analysis of electronic databases of State drinking water compliance testing results, 1993-1998.

make ready-to-feed, and liquid condensed infant formula. We contacted two of the three largest infant formula makers in the United States (Ross Labs and Nestle/Carnation), and found that both use some combination of advanced filtration and separation processes to purify the water used to make their ready-to-feed or concentrated products. Consequently, those products are far safer for infants than formula reconstituted with tap water from these 796 communities. Almost none of the communities with weed killers in their water can afford the treatment processes that the infant formula industry employs to render tap water safe for use in their products.

This irony is nowhere better illustrated than in Columbus Ohio, home of Ross Labs, the manufacturer of Similac, where the tap water is contaminated with atrazine and other weed killers. Before Ross uses Columbus city water in their infant formula products, they purify the water using advanced filtration and separation processes. This aggressive treatment scheme will remove most organic contaminants, including atrazine and other weed killers, from the water that Ross uses in its infant formula products.

Mothers and their babies in Columbus using tap water to reconstitute dehydrated Similac and other formulas are not so

Figure 2. In Kansas City, Kansas children get their entire lifetime dose of atrazine before they are weaned from infant formula.



Source: Atrazine exposure concentrations based on EWG analysis of Kansas City drinking water compliance testing results contained in electronic database supplied by the Kansas Department of Health and Environment (KDHE), and supplemented by 1997 and 1998 data contained in paper files at KDHE.

lucky. A bottle-fed child drinking Columbus city tap water from the Hap Cremean plant would reach his or her legal lifetime limit for cancer risk from atrazine in less than five years.

Profits at the Expense of Infants and Ratepayers: The Revolving Door

The EPA has not revised a single enforceable safeguard to protect infants and children from pesticides since the unanimous

The continued presence of atrazine in tap water is assured by the squadron of former top EPA pesticide regulators who now represent the pesticide industry in opposing the new children's health protections required under the FQPA.

congressional passage of tough children's health protections in August of 1996. As the EPA stalls, the pesticide industry pockets huge profits putting atrazine and other weed killers into the tap water fed to hundreds of thousands of Corn Belt babies and children. Recognizing the dangers of drinking weed killers, Midwestern water utilities and their ratepayers spend millions each year to keep contamination within insufficiently protective legal limits.

The continued presence of atrazine in tap water is assured by the squadron of former top EPA pesticide regulators who now represent the pesticide industry in opposing the new children's health protections required under the FQPA.

Our analysis of the current employment of former EPA staff shows that two-thirds of the top EPA pesticide regulators since 1977 (Assistant Administrators of Pesticide Program Directors) now represent the pesticide industry in opposing new regulations to protect children.

Recommendations

Atrazine is made by the Swiss company Novartis, and is subject to much tougher regulation in Switzerland than it is in the United States. The U.S. allows atrazine in tap water if the average amount found in four quarterly samples collected over the course of a year is less than 3 parts per billion (ppb). In Switzerland the standard is more than 30 times tougher, allowing not even a single detection above 0.1 ppb.

It will be impossible to remove atrazine from the tap water consumed by formula-fed infants unless water treatment systems in 796 towns in the Midwest are outfitted with filtration and separation systems such as granular activated carbon and reverse osmosis, preferably at the expense of Novartis. Use restrictions that have been in effect since 1994 are not effective. Powdered activated carbon is insufficient. In spite of the efforts of Midwestern water suppliers, atrazine causes more public drinking water supplies to violate federal health standards each year than any other chemical pollutant in the country.

Unless Novartis moves to purchase and maintain these filtration and separation systems in all towns with atrazine contaminated water, EPA should follow the lead of many of our European neighbors and ban atrazine to protect children.

Introduction

In 1994 the Environmental Working Group first highlighted the risk to infants and children from weed killers in tap water across the Corn Belt. Based on an exhaustive review of all the publicly available data on source water and tap water contamination with herbicides, we identified a pattern of unsafe exposures for infants and children following the application and runoff of weed killers in spring and early summer. In communities using reservoirs, high levels of contamination often continued into the fall and sometimes persisted year-round. EWG tap water monitoring projects in succeeding years confirmed these exposures and risks.

Since the publication of *Tap Water Blues* in 1994, and *Weed Killers by the Glass* in 1995, many large municipal water utilities have begun using powdered activated carbon to reduce levels of weed killers in the water that they send to their customers. This practice is costly, and its effectiveness is not clearly demonstrated across a range of contaminant mixtures and water chemistries. Even so, cities like St. Louis and Kansas City, Missouri; Columbus, Ohio; Springfield, Illinois; and Indianapolis, Indiana are spending thousands of dollars a day, and often millions of dollars a year, removing weed killers from the source water that they use to produce potable public drinking water. In smaller communities atrazine levels are almost always higher than in these big cities, but resources to treat the water are fewer. Citizens in these towns, including bottle-fed infants, drink what is likely the highest levels of atrazine and other weed killers anywhere in the world.

Cities are spending thousands of dollars a day, and often millions of dollars a year, removing weed killers from the source water that they use to produce potable public drinking water.

In spite of the efforts of water suppliers, more public drinking water systems violate federal health standards for atrazine each year than for any other chemical pollutant. This fact is of concern given the relatively large amounts of atrazine that are legally allowed in finished tap water in the United States — a level 30 times higher than the amount allowed in the European countries where atrazine is not already banned. These high levels of atrazine are most worrisome, however, because in February, 1999, the EPA's Office of Children's Health Protection Advisory Committee concluded

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that the current legal limit for atrazine in tap water cannot be considered safe for infants and children. In the Committee's words:

> "When EPA established the tolerances and 1991 drinking water standards for atrazine, children's differential exposure was not considered and children's differential susceptibility was not fully evaluated."

Regulatory Pressure is Building

In *Tap Water Blues,* the Environmental Working Group presented five major criticisms of the EPA's tap water safeguards for atrazine and other weed killers. We concluded that drinking water standards:

- Do not account for simultaneous exposures to many different pesticides and other contaminants commonly found in tap water;
- Fail to account for the toxicity of metabolites and degradation products, even though some of these by-products are as toxic as the weed killers themselves;
- Ignore the significance of seasonal peak exposures during which people, including bottle-fed infants, are exposed to weed killers at levels well above the legal lifetime average dose, often for months at a time;
- Do not account for the special vulnerability and higher than average exposures of infants and children, and;
- Do not protect against exposure to the most sensitive human organ systems such as the endocrine system, the immune system, or the developing brain and nervous system.

In November 1994, the EPA put the triazine herbicides, including atrazine, into a special regulatory review, citing the potentially high cancer risks presented by these compounds. Since that time, however, the EPA has done nothing to reduce atrazine exposure, protect infants and children, account for exposure to chemical mixtures and peak doses, or protect the most sensitive organ systems.

The Special Review of atrazine has produced no health protections at all for the public. Instead, for five years EPA bureaucrats have debated various aspects of atrazine toxicity with scientists from the manufacturer, Novartis. Notably, the conversation has focused primarily on the precise manner in which atrazine causes cancer in experimental animals, not on whether or not atrazine causes cancer in the first place. Meanwhile, millions of Midwesterners and their children drink the compound largely unabated.

President Clinton's Executive Order to Protect Children's Health

On April 21, 1997, President Clinton issued Executive Order 13045, entitled "Protection of Children from Environmental Health Risks and Safety Risks." The order instructed the EPA and all other federal agencies to identify health risks to children and to ensure that all regulations specifically address these risks. In response, EPA Administrator Carol Browner established the Office of Children's Health Protection to coordinate children's health issues across EPA. She directed the Office to identify five existing regulations for review and revision as models for environmental standards that protect infants and children. In February, 1999, atrazine was selected as one of the five standards for review.

The Food Quality Protection Act

On August 3, 1996, President Clinton signed the Food Quality Protection Act (FQPA), which for the first time requires EPA to explicitly determine that all exposures to pesticides are safe for infants and children before a pesticide is allowed in the food supply. In addition, the law requires that all safety standards protect infants and children from exposure to groups of pesticides with a common toxic mechanism.

FQPA also required the EPA to list priority pesticides for regulation within one year of enactment. On August 3, 1997, the EPA officially listed the triazine herbicides (including atrazine) in the first tier of pesticides being evaluated for compliance with FQPA standards. By law, first tier pesticides must comply with the new infant health protection provisions of FQPA by August 3, 1999.

The EPA will plainly miss this deadline by a wide margin. According to its latest published schedule for regulating atrazine risks, the agency says that it will issue a revised risk assessment of atrazine that considers infants and children by December 1999, and a proposed new drinking water maximum contaminant limit by July 2001.

It appears, however, that the revised risk assessment for atrazine will be conducted using controversial proposed revisions to EPA's cancer risk assessments guidelines. As currently drafted, the guidelines fail to consider many of the important toxicity, exposure, and risk assessment issues relevant to infants and children. On May 12 of this year, the Children's Health Protection Advisory Committee requested that a list of nine specific issues be addressed in the revised guidelines before they are used to develop regulatory standards by the agency. This letter "strongly urged" the agency not to conduct a risk assessment of atrazine using the proposed guidelines until after the nine issues are addressed by a special

The EPA has done nothing to reduce atrazine exposure, protect infants and children, account for exposure to chemical mixtures and peak doses, or protect the most sensitive organ systems.

Pediatric Panel of the EPA Science Advisory Board (Reigart 1999). EPA failed to respond to this request in the answers they gave the Committee (EPA 1999a).

The Safe Drinking Water Act

The Safe Drinking Water Act amendments of 1996 require that drinking water regulations be reviewed (but not necessarily revised) for their adequacy in protecting children's health. Atrazine's maximum contaminant level (MCL) is currently under review. Notably, the Office of Pesticides Programs, acting under the tougher children's health standards of the FQPA, will recommend the revised safe level of atrazine in tap water, the MCL, by July 2001 (Federal Register, February 3 1999).

Atrazine in Corn Belt Tap Water

To better characterize atrazine risks to infants and children in the Corn Belt, we analyzed the weed killer's occurrence in the tap water of seven Midwestern states: Illinois, Indiana, Iowa, Kansas, Ohio, Missouri, and Nebraska. Data were supplied by state regulatory agencies in electronic format and included, at a minimum, herbicide testing results performed from 1995 through 1998 by water suppliers, to satisfy monitoring requirements under the Safe Drinking Water Act. The number of atrazine test results available for the treated water from each town ranged from one to 129, and averaged about 11 for each testing compliance point in a water system. For the surface water systems of most concern, 20 to 30 results were typically available because of the more stringent monitoring requirements the State environmental agencies apply to contaminated water supplies.

We found atrazine in the treated water supplies of 796 towns serving water to 10.45 million people across the Corn Belt (Table 2). In the state of Ohio alone, as many as 2.6 million people drink atrazine in their tap water. Illinois water suppliers find atrazine in treated water going to as many as 2.2 million people, followed by Indiana water suppliers with 1.9 million people. Up to 1.0 million people in Iowa drink atrazine-contaminated tap water. In Kansas, 1.5 million people; in Nebraska, 950,000 people; and in Missouri, 350,000 people drink tap water from water suppliers who find atrazine in the water leaving the treatment plant.

Table 2. Atrazine contaminates the tap water of more than ten million Midwesterners in 796 communities.

State	Number of communities with atrazine in their tap water	Population affected
Illinois	210	2,160,000
Indiana	50	1,870,000
Iowa	111	1,000,000
Kansas	197	1,470,000
Missouri	71	350,000
Nebraska	87	950,000
Ohio	70	2,650,000
TOTAL	**796**	**10,450,000**

Source: EWG analysis of electronic databases of state drinking water compliance testing results, 1993-1998.

Single measurements of atrazine in treated water frequently exceed the drinking water standard.

Table 3. Atrazine has contaminated nearly an equal number of ground-water and surface-water supplied public water systems.

Source of water	Number of communities with atrazine	Population affected
Surface water	380	7,650,000
Groundwater	379	1,950,000
Mixed surface water and groundwater	27	830,000
Unknown	10	20,000
TOTAL	**796**	**10,450,000**

Source: EWG analysis of electronic databases of state drinking water compliance testing results, 1993-1998.

In Ohio, 42 percent of all towns with atrazine in their tap water had at least one sample with atrazine above the legal limit.

Of these 796 towns, about half receive tap water supplied exclusively or in part by surface water, such as a river, reservoir, lake or creek. In the remaining towns, tap water is supplied by wells that pump groundwater (Table 3). Almost without exception, the towns that drink surface water receive the highest levels of atrazine contamination. And the atrazine in these towns is typically at the highest levels during the post-planting season, when atrazine freshly applied to cornfields runs off the fields in the storms of spring and early summer. The highest seasonal average for the communities we considered was 2.4 times the drinking water standard of 3 ppb, and in Illinois and Kansas even the long-term atrazine concentration exceeded the drinking water standard in some communities (Table 4).

The average post-application seasonal concentration for these 796 towns is about twice the long-term average, and daily "spikes" that occur immediately after storms can be more than 15 times the long-term average and 14 times the federal drinking water standard. In at least 20 towns over the past five years, daily atrazine levels have been at least four times higher than the annual drinking water standard of 3 ppb (Table 5). And in Gillespie, Illinois, the long-term average of 2.5 ppb of atrazine is dwarfed by the 42 ppb measured in May 1996.

Single measurements of atrazine in treated water frequently exceed the drinking water standard. In Ohio, 21 percent of all samples exceeded the annual average legal limit, compared to nearly 17 percent in Illinois. Some states require more frequent sampling during the high concentration season, so these percentages can be skewed, but they do indicate that exceedances of the drinking water standard are fairly common (Table 6).

Table 4. In some communities seasonal and long-term average atrazine levels exceed the drinking water standard of 3 ppb.

State	Atrazine level in public water supplies statewide	
	Highest seasonal average and town	Highest long-term average and town
Illinois	7.16 ppb, Gillespie	4.39 ppb, Hettick
Indiana	3.96 ppb, Versailles	1.79 ppb, Batesville
Iowa	2.13 ppb, Mount Ayr	1.45 ppb, Mount Ayr
Kansas	5.20 ppb, Atchison	3.02 ppb, Montezuma
Missouri	3.16 ppb, Smithville	2.12 ppb, Smithville
Nebraska	3.01 ppb, Superior	1.71 ppb, Fremont
Ohio	6.24 ppb, Sardinia	2.69 ppb, Lake of the Woods in Granville

Source: EWG analysis of electronic databases of state drinking water compliance testing results, 1993-1998.

Table 5. Atrazine levels on a single day have been as much as fourteen times the drinking water standard.

Community	State	Population	Atrazine level, ppb	Date
Gillespie	Illinois	3,900	42.00	5/29/96
Sardinia	Ohio	940	38.73	6/25/96
Monroeville	Ohio	1,500	29.58	5/27/97
Newark	Ohio	46,000	20.75	5/27/97
Shipman	Illinois	675	19.00	9/16/96
Defiance	Ohio	17,000	17.60	5/28/97
Louisville	Illinois	1,194	17.00	6/13/96
Atchison	Kansas	10,660	16.00	6/3/96
Jamesport	Missouri	600	14.20	5/21/98
Springfield	Illinois	146,000	14.00	4/22/94
McClure	Ohio	850	14.00	6/22/98
Delaware	Ohio	28,000	13.76	6/9/97
Clay City	Illinois	1,033	13.00	6/6/94
Keyesport	Illinois	500	13.00	6/21/94
Lake of the Woods Water, Granville	Ohio	412	12.58	6/12/97
Napoleon	Ohio	8,884	12.47	6/9/97
Vermont	Illinois	806	12.00	6/8/94
Palmyra-Modesto Water Commission, Palmyra	Illinois	70	12.00	6/22/94
ADGPTV Water Commission, Girard	Illinois	1,257	12.00	6/21/93
Osawatomie	Kansas	4,514	12.00	5/30/96

Source: EWG analysis of electronic databases of state drinking water compliance testing results, 1993-1998.

Table 6. Peak atrazine levels routinely exceed the annual drinking water standard.

	Percent of detections over the drinking water standard	Number of detections over the standard versus total detections	Percent of communities with detections over the drinking water standard	Number of communities with detections over the standard versus total towns with detections
Illinois	16.6	303 / 1824	32.4	68 / 210
Indiana	9.3	35 / 377	40.0	20 / 50
Iowa	0.5	5 / 1026	3.6	4 / 111
Kansas	5.7	38 / 664	12.7	25 / 197
Missouri	10.8	7 / 620	3.4	3 / 87
Nebraska	1.1	46 / 427	39.4	28 / 71
Ohio	21.1	186 / 881	42.9	30 / 70

Source: EWG analysis of electronic databases of state drinking water compliance testing results, 1993-1998.

Exposed Population

Infants at Risk. U.S. Census Bureau data indicates that the exposed population of 10.45 million will include about 146,000 infants under the age of one. In our risk analyses we considered the group of infants who are born during the post-application season for atrazine, who are exclusively bottle-fed with powdered formula that has been reconstituted with tap water, who make up about five percent of all infants born in a given year. About 37.5 percent of all infants will drink some amount of formula reconstituted with tap water during the first four months of life.

For infants who receive tap water, EPA substantially underestimates cancer risk because their standard risk assessment methods fail to consider the high atrazine to body weight dose these infants receive relative to adults (Figure 3). The standard dose assumed by EPA is 15 times lower than the actual average dose these infants receive in their first four months of life (see Sidebar, p. 16).

The average bottle-fed infant in these 796 Corn Belt towns receives over 26 percent of his or her lifetime allowable dose of atrazine by age one (Figure 1, p. 3). EPA's standard methods would indicate only about 3.5 percent. Even children who are exclusively breast-fed from birth, and who in our analyses are considered to receive no exposure to atrazine in that period, would reach over eight percent of their allowable lifetime dose of atrazine by their first birthday, or more than twice what EPA would calculate.

In Kansas City, Kansas, bottle-fed infants can get their legal lifetime dose of atrazine by just over eight months of age. EPA methods would predict the lifetime dose would instead be exceeded at age 9 (Figure 2, p. 5).

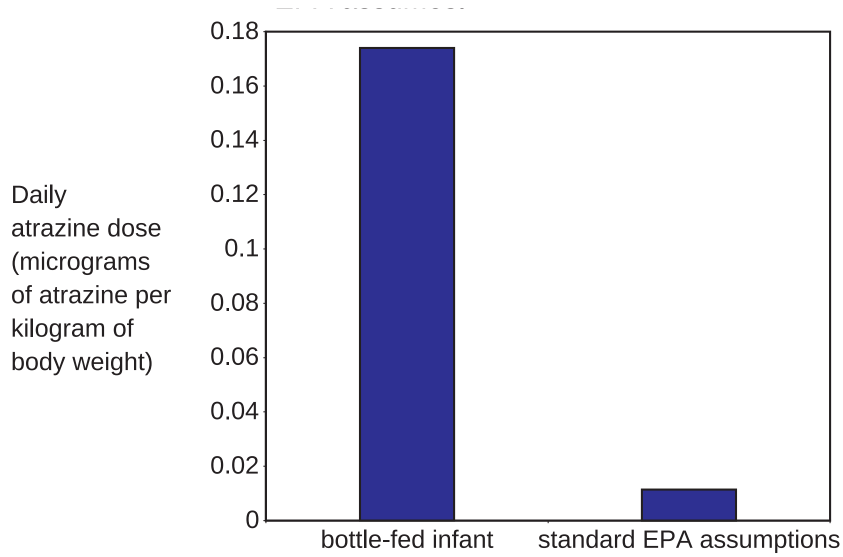
Children Overexposed by Age Five

In 138 communities in the Midwest, the population of children in this analysis exceed their allowable lifetime cancer risk by age five (Figure 4). Children can be overexposed by their first birthday in 40 communities, including 17 in Illinois, 14 in Ohio, five in Kansas, three in Indiana, and one in Missouri (Table 1, p. 4). In fact, in thirteen towns in Illinois, Ohio, and Kansas infants can exceed their allowable lifetime cancer risk in the first four months of their lives, when their only source of nutrition is formula.

Lifetime Cancer Risk

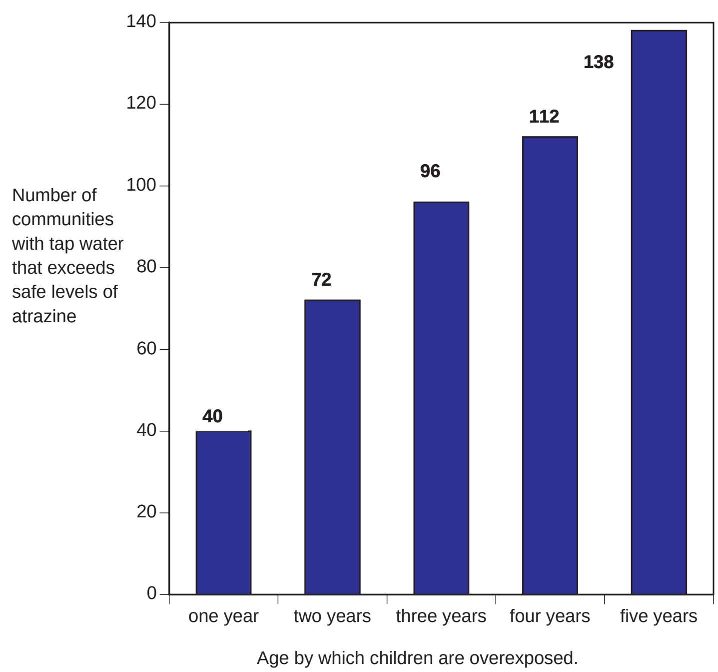
By failing to account for early childhood exposures, EPA's standard exposure assumptions also fail to correctly predict effects from a lifetime of low-dose exposures to atrazine. For instance, in Illinois the average person living in town with atrazine-contaminated tap water would exceed his or her allowable lifetime dose of atrazine by around 17 to 21 years of age. In contrast, EPA's calculation would overestimate this age by nearly 40 percent. In every state we studied, the average lifetime cancer risk from atrazine was higher than the legal limit, and on average EPA methods would over-

Figure 3. EPA underestimates by a factor of 15 the daily dose of atrazine a bottle-fed infant could get in the first four months of life.



Source: Atrazine exposure concentrations based on EWG analysis of electronic databases of State drinking water compliance testing results, 1994-1998. Exposure concentration represents population-weighted average for the 796 communities in seven Corn Belt states that find atrazine in their tap water.

Figure 4. Children in 138 communities across the Corn Belt can get their legal limit of atrazine in the first five years of their lives.



Source: EWG risk assessment based on analysis of State drinking water compliance testing results, 1993-1998.

EPA's Standard Exposure Assumptions Ignore Early Childhood Exposures

EPA's standard assumptions for calculating cancer risk ignore the impacts of high doses in early childhood. They typically assume a constant mg/kg dose over a lifetime instead of considering the high relative dose of an infant. Several pivotal EPA documents have endorsed using an adult dose to represent children's exposure. For example, according to EPA's Human Health Evaluation Manual (EPA 1989):

> "The value for body weight is the average body weight over the exposure period. … For pathways where contact rate to body weight ratios are fairly constant over a lifetime (e.g., drinking water ingestion), a body weight of 70 kg is used. … A constant body weight over the period of exposure is used primarily by convention (EPA, 1989)"

The fallacy in this statement is that for infants, the contact rate to body weight ratio can be far higher than that for adults. A comparison of representative consumption rates and body weights for infants under four months compared to adults is a clear example. The 90th percentile tap water consumption rate for formula-fed infants is 1.104 L/day, and these infants weight on average 5.2 kg (a derivation of these numbers is given in Chapter 4). Adults, on the other hand, have a 90th percentile consumption rate of about 2 L/day, and weigh on average 70 kg. These numbers show that relative to their weight, infants drink more than 7 times what an adult drinks.

EPA's Office of Drinking Water and Groundwater recently completed an assessment of the health risks to fetuses, infants, and children from disinfection byproducts. In this document, their first attempt to follow EPA's children's office guidance in assessing children's risk, they state:

> "The MCLG …. for drinking water is calculated … for a 70 kg adult consuming 2 L of water per day and also taking into consideration the relative contribution from drinking water. The Agency views the use of 2 L per day adult drinking water consumption to derive the MCLG from an RfD appropriate, because it represents the 84th percentile of adult drinking water consumption. … A conservative estimate is that children may be exposed about 3.5-fold more than adults relative to their water intake-body weight ratio (Draft Water Quality Criteria Methodology Revisions; Human Health, August 1998). *The Agency believes that the use of 2 L to calculate the MCLG provides sufficient protection to fetuses and children."(Emphasis added)*

Yet our analysis shows that infants under four months of age can get more than seven times the dose of tap water that adult gets, relative to their weight. Under any of their standard scenarios, EPA fails to consider the true risk to infants under one year of age.

We have further considered infants born during the post-application period for atrazine, when atrazine concentrations in tap water are highest. For the seven states and 796 towns we studied, the average post-application atrazine level is 0.82 ppb. This is an average concentration to which a formula-fed infant in these seven states might be exposed during the first four months of life. EPA's standard method would ignore this seasonal concentration and instead apply a lifetime average atrazine level for an infant, which for the seven states we studied in 0.40 ppb. When this concentration difference is taken into account, EPA methods can underestimate risk to formula-fed infants by an average of 15.3 times.

predict the age to exceedance by 37 percent.

Multiple Weed Killers are Common in Midwestern Tap Water

Tap water across the Midwest is routinely contaminated with multiple weed killers. Although we focus on atrazine in this analysis, at least five other carcinogenic weed killers have been found in Corn Belt tap water over the past five years: simazine, propazine, cyanazine, alachlor, and acetochlor. Three other weed killers which are not considered carcinogenic are also found, each of which is associated with a number of chronic health effects: metribuzin, metolachlor, and propachlor.

Our analysis included 127,197 tests from seven states, with test results from four to nine weed killers for each state. All told, tests have been conducted in 6,100 communities, and weed killers have been detected in 830 of these (Table 7). Of the 127,197 tests for which we have results, weed killers have been detected 9,345 times (Table 8).

Of the nine weed killers we analyzed, only three are regulated in tap water: atrazine, simazine, and alachlor. The other seven, unregulated weed killers included in our analysis are metolachlor, metribuzin, cyanazine, methoxychlor, acetochlor, propachlor, and propazine.

Regular testing is required under the Safe Drinking Water Act for the three regulated pesticides. Of the three, atrazine is by far found the most frequently. Of the 26,889 test results we obtained for atrazine, the compound was found 5,818 times (a 22 percent detection rate) in 796 towns and in all seven states. In contrast, alachlor is found in most states only about one to three percent of the time, and simazine is found from less than one to a maximum (in Ohio) of about 12 percent of the time.

Of the unregulated weed killers, metolachlor, cyanazine, and acetochlor are found frequently in tap water from the seven Corn Belt states. Any amount of these weed killers in tap water, no matter how high, is legal. Metolachlor is present in 21 percent of the samples from Indiana, ranging down to about two percent in Missouri.

Cyanazine is found in tap water in most states as frequently as atrazine, and in Iowa it is nearly two and a half times more common than atrazine. Cyanazine is unregulated in tap water, and as a carcinogen is five times more potent than atrazine. It was found in 24 percent of the samples from Ohio, and 60 percent of the samples from Iowa. Kansas may also have a high occurrence of cyanazine, where it was found in 14 of the 16 tests for which we received results. Although this weed killer is scheduled for a voluntary ban by its maker, DuPont, in 2002, EPA has lifted its use restriction rates in the meantime so farmers can use their surplus.

Acetochlor is another unregulated pesticide that appears to have a high occurrence, although testing has been limited as it is not required under the Safe Drinking Water Act. Ohio is the only state from which we received a large database of acetochlor results. In 62 towns tested, it was found in 27, or over one-third. It was detected in 139 of 735 samples, or 19 percent of the time. Limited data also show that Kansas may have a high occurrence, where acetochlor was found in the tap water from 6 of 7 towns tested and in 10 of 11 tests. This weed killer has been on the market only since 1993, and already may be pervasive in tap water.

EPA does not consider the effects of exposure to these multiple pesticides in tap water, even though almost never is only a single pesticide found in a glass of contaminated water.

Table 7. Weed killers have been found in 830 communities in seven states.

Chemical	Illinois 1993-1998	Indiana 1994-1998	Iowa 1994-1998	Kansas 1995-1998	Missouri 1995-1998	Nebraska 1995-1998	Ohio 1994-1998
Atrazine	210 (1319)	50 (408)	111 (984)	197 (622)	71 (1009)	87 (553)	70 (1173)
Simazine	117 (1319)	20 (374)	6 (983)	4 (358)	9 (1010)	4 (553)	45 (1173)
Cyanazine	67 (1277)		32 (37)	7 (8)	42 (1009)	5 (553)	32 (202)
Propazine				3 (4)			
Metribuzin	10 (1319)	1 (83)	3 (682)	5 (358)	3 (1009)	1 (553)	9 (1172)
Alachlor		10 (394)	13 (984)	18 (359)	2 (1009)	8 (553)	22 (1173)
Metolachlor		13 (88)	57 (692)	52 (358)	35 (1009)	22 (553)	43 (1172)
Acetochlor				6 (7)			27 (62)
Propachlor				2 (358)	2 (1008)		0 (828)

Note: Numbers indicate the number of communities where the weed killer has been detected versus total number of communities tested. Total number of communities tested is shown in parentheses.

Source: EWG risk assessment based on analysis of State drinking water compliance testing results, 1993-1998.

Table 8. Results of analysis of 127,197 compliance tests from seven states show that atrazine is commonly found and that multiple weed killers are often present in a glass of tap water.

Chemical	Illinois 1993-1998	Indiana 1994-1998	Iowa 1994-1998	Kansas 1995-1998	Missouri 1995-1998	Nebraska 1995-1998	Ohio 1994-1998
Atrazine	1824 (10094)	377 (1626)	1025 (4158)	664 (2159)	427 (3159)	620 (2016)	881 (3677)
Simazine	377 (10002)	67 (1254)	35 (2865)	6 (819)	41 (3158)	9 (2016)	425 (3623)
Cyanazine	342 (9327)		305 (509)	14 (16)	121 (2945)	17 (2016)	275 (1145)
Propazine				7 (10)			
Metribuzin	12 (9911)	1 (176)	11 (1248)	9 (820)	3 (3160)	1 (2016)	22 (3619)
Alachlor		16 (1304)	30 (3237)	30 (1156)	2 (3160)	22 (2016)	88 (3658)
Metolachlor		23 (226)	331 (1582)	114 (853)	77 (3160)	62 (2016)	476 (3638)
Acetochlor				10 (11)			139 (735)
Propachlor				2 (818)	2 (3162)		0 (1701)

Note: Numbers indicate detections versus total number of tests conducted. Total tests conducted are shown in parentheses.

Source: EWG risk assessment based on analysis of State drinking water compliance testing results, 1993-1998.

Health Effects of Atrazine

Perpetual Analysis Puts Children at Risk

The U.S. Environmental Protection Agency, the World Health Organization (WHO), and the maker of atrazine, Novartis, all agree that atrazine causes cancer in experimental animals and that it causes this cancer through interference with the normal functioning of the hormone (endocrine) system. Beyond these basic conclusions, however, there is little agreement on the scientific questions related to atrazine toxicity.

For the past four years Novartis has tried to convince the EPA that atrazine produces cancer in just one type of rat, and that the way that it produces this cancer is irrelevant to humans. Specifically, Novartis has argued that there is a safe threshold below which atrazine does not cause cancer and that exposure below this dose presents no risk to the human population. The EPA has not yet accepted this view.

The World Health Organization classified atrazine as possibly carcinogenic in humans based on a study in a different species of rat than the test evaluated by the U.S. EPA. The WHO-sponsored study found more cancers of more organs than the study relied on by the EPA, which was commissioned by atrazine's manufacturer, Novartis. Notably, the EPA has failed to obtain the raw data from the WHO sponsored study and is proceeding with its regulatory review without including this information in the analysis, an omission that creates a strong unfounded bias in favor of atrazine's safety.

When considered together these two studies show that atrazine causes an increase in cancer of the female mammary gland, combined lymphomas and leukemias, cancers of female reproductive tissue, and rare tumors of the male breast. In addition, the female mammary tumors in the Novartis/EPA study, and the male breast tumors in the WHO sponsored study both occur significantly earlier in life than is normal, an important condition called early onset.

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Failure of EPA Safety Standards

Gaps in Cancer Risk Assessment Methods. EPA's cur-

EPA's current cancer risk assessment models put infants and children in double jeopardy: they do not account for high exposure early in life and they do not account for the potential increased vulnerability of the fetus, infant, and young child to carcinogens.

rent cancer risk assessment models put infants and children in double jeopardy: they do not account for high exposure early in life and they do not account for the potential increased vulnerability of the fetus, infant, and young child to carcinogens (NAS 1993, Buffler and Kyle 1999). To make matters worse, all of EPA's cancer data is from studies conducted on adult (sexually mature) animals, in spite of volumes of data showing that fetal and early childhood exposure can dramatically affect cancer outcome. This flaw may significantly understate the potency of many currently identified carcinogens.

For atrazine, however, the situation may be even worse than this. Since the Bush Administration, the EPA has been working on revisions to its cancer risk assessment guidelines. In 1996, the agency issued a final draft of these new guidelines that for all practical purposes contains no specific provisions relevant to the unique risks and vulnerability of the fetus, infant and child. Worse, the EPA proposal actually weakens protections in current adult-based models by encouraging the use of new methods of risk assessment which assume that a safe dose of a cancer causing substance can be found from existing animal studies. This is a radical departure from current methods which assume that even small doses of carcinogenic substances present some small risk. While the agency has not finalized these proposals, they have recommended that the revised atrazine drinking water standard be conducted using these new methods. This decision was questioned by the Children's Health Protection Advisory Committee, which strongly supported a review of the guidelines by children's cancer experts to address a series of fundamental issues of fetal and childhood carcinogenesis not covered by the EPA in the proposed new guidelines (Reigart 1999). EPA failed to respond to this request in their answers (EPA 1999a).

A recent review of proposed revisions to the federal cancer risk assessment guidelines, published in the National Institute's of Health, Environmental Health Perspectives, characterized the flaws in the current cancer risk assessment methods this way:

> "Risk assessment methods for carcinogens have not considered the timing of doses of carcinogens during a human lifetime. Models used to estimate dose and response do not consider the age at which doses are applied. A given dose of a carcinogen counts the same at 70 years of age as it does at five. Because there is considerable evidence that doses received earlier in life are more likely to result in development of cancer than doses received late in life, this approach would be expected to

underestimate risks of doses received during childhood. Moreover, recent evidence suggests that cancers experienced early in life are associated with adult medical problems in a large percentage of cases. Effects of treatments typically used for cancer can include second malignancies, organ toxicity, effects on growth, endocrine effects, and reproductive effects. The new guidelines should give serious attention to doses received earlier in life, which can be expected to pose greater risks during the lifetime as a whole."

The authors add:

"We have no evidence to suggest that exposure standards based on assumptions about adult toxicity, susceptibility, and exposure will adequately protect infants and children. Quite the contrary, there is sufficient evidence for some agents to believe they may not. The proposed carcinogen risk assessment guidelines should incorporate language that will provide infants and children with needed protection." (Buffler and Kyle, 1999)

No Consideration of Endocrine Effects

It is well established that atrazine induces hormonal imbalances in test animals and that at experimental doses these exposures ultimately produce cancers. It is also true, however, that current testing protocols don't measure many of the critical toxic endpoints needed to understand atrazine's endocrine toxicity, and that according to the EPA's top advisory committee on children's health, the current safeguards for atrazine in food and water cannot be considered protective of children's health.

In fact, the EPA has no test protocols and science policies to guide the regulation of endocrine disrupting compounds. Although a broad screening program has been initiated, there is no consensus on how to measure endocrine toxicity for regulatory purposes, and even less agreement on how to determine a "safe" dose. This is a very significant gap in federal health protections for infants and children, because the fetus and neonate are more susceptible than any other sector of the population to the toxic effects of endocrine disrupting compounds.

Recently the European Economic Commission recommended a 0.01 parts per million pesticide residue limit for all pesticides in manufactured foods intended for children over 16 weeks of age. In supporting these recommendations the Commission noted that for compounds exhibiting endocrine toxicity, like atrazine, information on their precise hazards to infants and children is sorely lacking.
To quote the Commission:

Current testing protocols don't measure many of the critical toxic endpoints needed to understand atrazine's endocrine toxicity.

In fact, the EPA has no test protocols and science policies to guide the regulation of endocrine disrupting compounds.

"An area of particular concern is the possibility that interactions of chemicals with specific endocrine receptors during foetal life and infancy may have profound effects on morphological and functional properties of these systems after maturation. This raises the question whether the current toxicological database for pesticides is sufficient to fully assess potential developmental adverse effects. This may not always be the case, as for instance impairment of the central nervous system, leading to behavioral, memory and learning deficits are rarely examined in conventional studies, and delayed toxicity resulting from exposure to low levels of a toxicant during a particularly sensitive developmental period may not always be adequately addressed by current testing procedures.

"For example, while multigeneration studies conducted according to current EEC or OECD guidelines should identify endocrine disrupters acting in developing animals in qualitative terms (e.g. by gross effects on fertility), unless they are conducted to an enhanced protocol which examines a wider range of parameters, they will not be adequate to identify any lower no effect levels for the more subtle expressions of endocrine disruption (e.g. reduced sperm production, underdevelopment of the epididymis and reduced ano-genital distance in male offspring). Similarly, the ability of developmental toxicity studies to pick up certain endocrine disrupters affecting male offspring requires extending the duration of treatment beyond the end of the conventional treatment period (day 6-16) to day 20-21 of pregnancy in the rat. This is because the vulnerable period for affecting male testis and accessory sex organs and characteristics occurs late in gestation through to the early postnatal period." (EC 1997).

Notably, the EC has adopted a 0.1 parts per billion standard for individual pesticides in tap water, a limit 30 times more protective of the public health than the U.S. atrazine standard of 3 parts per billion. In regards to the effect of these standards and the current state of the science in protecting bottle-fed infants from chemical pollutants in tap water used to reconstitute infant formula, the Commission observed:

"None of the present standard toxicological tests mimic the situation where a human infant is exposed to chemicals via infant formulae. Therefore special considerations are needed for pesticides likely to be found in infant formulas for infants below the age of 16 weeks."

While the Commission was reasonably confident that atrazine at 0.1 parts per billion in tap water would not cause formula to exceed the new total pesticide residue limit of 0.01 parts per million, the Commission went to great lengths to make clear that this level should not be construed safe for infants under 16 weeks of age, and that all pesticides should be reviewed individually to ensure that the 0.01 parts per million residue limit was indeed safe.

Endocrine Disrupters are Toxic at Very Low Doses

A rapidly growing body of research strongly supports the theory that low doses of endocrine disrupting chemicals can be more potent, and cause more long term health damage than higher doses of these same substances. These findings depart radically from the core concepts of conventional toxicity testing where high doses are explicitly used to produce more crude and easily measured outcomes such as tumor formation, gross birth defects and overt illness. In spite of this very different rationale, the toxic effects of low doses of hormonally active chemicals is logical considering that human hormones can affect the fetus at doses in the parts per quadrillion range, an amount equal to one drop of hormone in 6,000 train cars of water.

A series of studies over the past decade have shown that at higher doses, hormone receptor sites on human cells can become saturated and block out increasing amounts of an endocrine disrupting compound, essentially protecting the cell from these higher doses. As a result, specially designed low-dose endocrine studies often identify toxic effects that only occur *below* a threshold dose, above which the incidence of the effect declines to normal levels. Notably, the high dose that produces no effect in these special studies is often well *below* the low dose administered in conventional toxicity tests, such as those require for pesticide registration by the EPA.

The low doses in specially designed endocrine studies are often equivalent to the doses at which human hormones are active in the human body, an amount that is thousands of times lower than the lowest doses used in standard toxicity tests required by regulatory agencies like the EPA. A recent study of the low dose toxicity of DES, bisphenol A, and the pesticide methoxychlor shows how current EPA testing protocols would easily miss the low dose endocrine toxicity of these substances.

In tests with all three compounds, low dose fetal exposure

A rapidly growing body of research strongly supports the theory that low doses of endocrine disrupting chemicals can be more potent, and cause more long term health damage than higher doses of these same substances.

Atrazine in tap water is almost always accompanied by other weed killers, metabolites, and nitrate from fertilizer applications and animal manure.

produced significantly increased prostate weight in adulthood, whereas high doses "within a toxicological dose range" (those typically used in EPA required toxicity studies), produced no effect or even a decrease in prostate weight in adulthood (Welshons et al. 1999). The doses of DES that caused a significant increase in the adult prostate weight after fetal administration were thousands of times lower than the doses used in studies of DES and reproductive cancers. Similarly, the amount of bisphenol A that caused significant increases in adult prostate weight were thousands of times lower than the so-called "no effect level" reported by the Society of the Plastics Industry that was used to set an acceptable daily dose of the compound for humans.

The study authors concluded that "It may be impossible to assess endocrine disrupting activities in response to low doses with a physiological range of activity by using high, toxic doses of xenoestrogens in testing procedures" (Welshons et al. 1999). In other words, current high dose toxicity tests used by the U.S. EPA and other regulatory agencies will almost always fail to identify these effects.

Low dose chemical mixtures

Atrazine in tap water is almost always accompanied by other weed killers, metabolites, and nitrate from fertilizer applications and animal manure. The toxic effects of these chemical mixtures are virtually unstudied and at the present time chemical mixtures are completely unregulated (although the FQPA mandates health standards that consider groups of chemicals with common toxic mechanisms).

A handful of peer-reviewed studies have looked at the immune and endocrine effects of a set of common chemical mixtures, including atrazine, at doses very similar to those that occur in tap water throughout the Corn Belt. In particular, researchers at the University of Wisconsin have examined the effects of atrazine in combination with nitrate and the insecticide aldicarb on thyroid and immune system function.

In the most recent of these studies, the immune system showed the most consistent and significant reaction to eight possible low dose mixtures of atrazine, the insecticide aldicarb and nitrate. The atrazine/nitrate mixture produced the most statistically significant and consistent responses across all mixtures tested, producing "particularly striking" results, according to the authors (Porter et al. 1999). Atrazine in combination with nitrate also produced increased scores on aggression tests conducted in the same experiment.

Conclusions

As researchers ask more refined questions and design more sensitive and elaborate experiments that more closely resemble real world fetal and infant exposure to pesticides like atrazine, more evidence emerges about the hazards of these exposures.

There are serious reasons to be concerned about the health risks of atrazine when it is fed to infants in formula, but no one really knows the full magnitude of these risks. Not the manufacturer, not the EPA, not the World Health Organization, not anyone. Given the evidence that atrazine disrupts the hormone system, causes several types of cancers in two species of test animals, and is widespread in tap water throughout the Midwest, the Environmental Working Group feels strongly that atrazine and all triazine herbicides should be banned.

Cancer Risk Assessment Methodology

Cancer Potency Estimates

The cancer potency estimate used in this study is the most recent available from the EPA Office of Prevention, Pesticides, and Toxic Substances (Burnam, 1998). In EPA's pesticide office, cancer potency estimates are commonly referred to as Q* ("Q Star") values. Q* represents the slope of the dose response curve from animal tests, where the slope measures the change in tumor incidence over the change in dose. The EPA calculates a Q* using a risk averse methodology that represents the 95 percent upper confidence limit of tumor induction likely to occur from a given dose. The Q* for atrazine is 0.22 milligrams (mg) of atrazine ingested each day for every kilogram (kg) of body weight.

Tap Water Consumption

In our analyses, tap water consumption was based on an analysis performed by the EPA Office of Water on USDA's 1994-1996 Continuing Survey of Food Intakes by Individuals (EPA 1999b). This assessment, mandated by the Safe Drinking Water Act Amendments of 1996, presents detailed, recent information on tap water consumption for many age categories extending from birth into old age, whereas previously, EPA recommendations were based on data that is now 20 years old, presented in a National Cancer Institute report on USDA's 1977-1978 consumption data (Ershow and Cantor, 1989.)

The EPA, many other federal agencies, and the World Health Organization support the use of a default adult exposure water consumption of 2 liters per day, which is about the 90th percentile dose. Consistent with this convention, we have used EPA's updated 90th percentile consumption rates found in EPA (1999b) for all age categories we consider in this report. An important difference in our method, however, is that we consider bottle-fed infants under four months of age as a separate age group from all children age zero to one. Where the available data spanned different age ranges for body weight and tap water consumption, we used time-weighted average values across age categories. Tap water consumption rates used in our analyses are shown on Table 9.

An important difference in our method, however, is that we consider bottle-fed infants under four months of age as a separate age group from all children age zero to one.

Table 9. Beyond the first four months of life EPA's standard tap water consumption and body weight data formed the basis for risk assessments in this report.

Infant source of nutrition*	Age, years	Tap water consumption (liters/day)	Body weight, (kg)
bottle-fed	0-0.33 (0-4 months)	1.104	5.2
breast-fed	0-0.33 (0-4 months)	0.000	not used
	0.33-1 (4-12 months)	0.884	9.1
	1-2	0.695	12.3
	2-3	0.695	14.3
	3-4	0.695	16.3
	4-5	0.919	18.6
	5-6	0.919	21.2
	6-7	0.919	23.8
	7-8	0.986	26.5
	8-9	0.986	29.8
	9-10	0.986	33.9
	10-11	0.986	38.7
	11-12	1.365	43.2
	12-13	1.365	47.9
	13-14	1.365	53.2
	14-15	1.365	57.1
	15-16	1.623	60.4
	16-17	1.623	62.9
	17-18	1.623	64.2
	18-70	2.095	71.8

Source: USDA Continuing Survey of Food Intake by Individuals, 1994-1996; and EPA Standard Exposure Factors (EPA, 1996).

Note: "Bottle-fed" refers to infants whose only source of nutrition is powdered formula reconstituted with tap water. "Breast-fed" refers to infants who are assumed to get no pesticide exposure in the first four months of their lives, but which could include exclusively breast-fed infants as well as infants fed formula free of pesticides.

Also consistent with previous EPA recommendations, we have used consumption data that represent total tap water intake, including both direct and indirect intake. EPA defines direct water as plain water consumed directly as a beverage, and indirect water as water added to foods and beverages during final preparation (EPA 1999b).

Bottle-fed infants are not specifically addressed in EPA's new water consumption estimates. The population of infants we study in this report are those infants who are exclusively bottle-fed from birth and who receive powdered formula reconstituted with tap water. Further, we considered those infants not yet receiving solid food, which we assumed were infants under four months of age. To calculate tapwater consumption for this group of infants, we used data on formula consumption from USDA's Continuing Survey of Food Intake by Individuals, 1994-1996, and an average infant body weight based on a University of Iowa study on growth rates of formula and breast-fed infants (Nelson et al. 1989).

USDA data contains 145 eating days for infants under four months of age who receive no breast milk. The 90th percentile consumption based on these data is 1255 grams of formula. This was corrected by the percent solids in formula (12 percent, USDA 1996), to give a total daily water intake of 1.104 L.

To characterize the full range of infant exposures, we also considered a group of infants we refer to as breast-fed infants in this report, and which represent infants who are assumed to get no exposure to pesticides in the first four months of their lives. Data are not yet available to indicate what amount of a mother's intake of the triazine pesticides or their metabolites may be passed to infants through breast milk. For the purposes of this report, we assumed that exclusively breast-fed babies would receive none of these pesticides, regardless of the quality of their mother's drinking water source. The group of infants who get essentially no exposure to pesticides would also include formula-fed babies who are given pesticide-free, ready-to-feed formula, or whose formula is reconstituted with tap water or bottled water that is free of pesticides.

Body Weight

Body weights used in calculations for this report are values recommended by EPA (EPA 1996), and represent gender-averaged mean body weights for the age categories considered in our report (Table 9). Since our cancer estimates included assessments of when in childhood various risk thresholds would be reached, after year one we used one-year age categories in our assessments through the age of 18. Adults were considered in a single category ranging from 18 to 70 years of age.

For our age group representing infants four to 12 months of age we used an average weight for 6 to 12 months of age presented in EPA (1996), which would give a slight underestimate of cancer risk. For formula-fed infants from birth to four months we used the time-weighted average of the detailed body weight data for formula-fed infants over the first four months of life presented in Nelson et al (1989).

Exposure Concentration

Numerous researchers have identified a clear seasonal pattern of atrazine contamination in rivers and streams. During the months immediately after pesticide application, from May through August, herbicides are washed into rivers and streams by spring rains and summer storms (Thurman, et al. 1991, Goolsby, et al. 1993, EWG 1994, EWG 1995, EWG 1997). By the end of the summer, due to many factors including microbial degradation, adsorption by soil organic matter, volatilization, and leaching, atrazine concentrations in soil decline fairly rapidly, and atrazine concentrations in field runoff are generally significantly lower. This leads to a pattern where, for a four month period, average atrazine levels in water are significantly elevated compared to the rest of the year.

Reservoirs used for water supply can show a different pattern of contamination. Because of the time it takes for a reservoir to fill with runoff from storms, the pattern of concentrations in reservoirs can lag behind those in rivers and streams. Sometimes peak atrazine concentrations in reservoirs are not seen until late summer or fall.

In response to seasonal contamination "spikes," more testing

In order to ensure that oversampling during periods of high exposure does not skew average exposure estimates upwards, we have used only seasonally adjusted average atrazine concentrations in our assessment of exposure and risk.

is generally done during the period of elevated contamination levels. Thus, in many cases where data are available, the number of samples is not spaced evenly over the year – more data are available for the period of high exposure than for lower exposure periods. In order to ensure that oversampling during periods of high exposure does not skew average exposure estimates upwards, we have used only seasonally adjusted average atrazine concentrations in our assessment of exposure and risk.

Seasonally adjusted averages were calculated by breaking the year into three periods – a pre-plant period from January to April, a post-plant period from May to August, and a harvest season from September to December. An average concentration of atrazine, for each community water supply, was calculated for each of these three periods. For a given water supplier in a given year, if data were available only for the post-plant period, concentrations in pre-plant and harvest periods were assumed to be zero. If data were available only for the pre-plant or harvest periods, the highest average concentration for each of these periods was also taken as the post-plant average concentration.

The high-risk group of infants we considered in our analyses were those born in the post-application season, exclusively formula-fed for the first four months of their lives with powdered formula reconstituted with tap water. For this group of infants, we assumed an exposure concentration representing a characteristic post-application seasonal concentration. We calculated this concentration as the average of the high seasonal concentration over all the years for which data were available for a particular water supplier. For most water supplies, this concentration corresponded to the post-application period, but for some reservoir-supplied systems the high seasonal concentration occurred during the harvest season.

For all other age groups considered in our risk analyses, from 4 months to 70 years of age, we used an exposure concentration that represented a lifetime average concentration. We calculated this as the seasonally-adjusted average for that water supply, which was the average of the pre-plant, post-plant, and harvest season averages for all years of data available.

Many water suppliers test water quality at multiple locations in the system. These locations could be, for instance, just after the water leaves the treatment plant, with additional test locations at individual groundwater pumping wells that supplement the main water supply. For water supplies with multiple test locations, we conservatively chose exposure concentrations that represented maximum averages. This approach ensures appropriate representation of risk for surface-water supplied systems that may use supplemental groundwater wells, perhaps free of atrazine, to serve only a small portion of the population.

All Non-Detects are Treated as Zero

In addition, we made the assumption in our calculations that herbicide concentrations are zero when tests were conducted and no herbicides were found above the detection limit. This approach underestimates risk. In general, EPA and other researchers use a different method, assuming that herbicides are present at half the detection limit in systems where they are found for at least part of the year.

Metabolites

Metabolites – breakdown products of the original compound – are nearly always present when herbicide parent compounds are detected in water. Water suppliers are not required to test for metabolites, even though their toxicity can be similar to that of the parent compound. Ciba (now Novartis), the maker of atrazine, concluded that certain atrazine metabolites are toxicologically similar to the parent compound (Ciba 1993). The state agencies from which we obtained compliance testing data each indicated that no metabolite data were available for their public water systems. In our risk analyses, cancer risk posed by metabolites was not considered.

Final Calculation of Cancer Risk

For each age category, we calculated the cancer risk from atrazine based on its Q* ("Q-Star"), the exposure concentration calculated from the water supplier's testing data, and consumption values described above. The cumulative lifetime risk at any point in a person's life was calculated by adding the cancer risks from all previous age categories considered.

For instance, for the period of life from birth to four months, the cancer risk was calculated as follows:

Risk from birth to four months = [water consumption of 1.104 L / 5.2 kg / day] x [herbicide concentration, mg/L] x [body weight of 5.2 kg] x [exposure time of 4 months, converted to days] x [Q* of 0.22 day-kg/mg] / [70 year lifespan, converted to days]

For each age category considered, a separate risk was calculated, with each risk normalized by an assumed 70-year lifespan to find the incremental cancer risk for that age range. This calculation makes no correction for the fact that young children may be more sensitive than adults to the effects of some carcinogens.

Two different scenarios were considered to represent the range of possible infant risks. In the first scenario, called "Bottle-fed infants" in Figure 1 (page 3), we

Water suppliers are not required to test for metabolites, even though their toxicity can be similar to that of the parent compound.

assumed the infant would be exposed to an average post-application seasonal concentration for the first four months of life. After four months, we used a long-term average atrazine concentration for the duration of a 70-year lifetime. A second scenario we considered, called "Breast-fed infants" in Figure 1 (page 3), assumes an infant would get no exposure to atrazine in the first four months of life, either because breast milk may be free of atrazine or because the infant's formula is reconstituted with water free of atrazine. After four months, we assumed this infant would be exposed to a long-term average atrazine concentration for the duration of a 70-year lifetime. Under a standard EPA scenario, a person is assumed to be exposed to a long-term average atrazine concentration over an entire lifetime.

To find cumulative cancer risk for any point in a lifetime, we added together the individual cancer risks up to the age of interest. Our simple approach of calculating only cancer risk from atrazine does not account for additive or potential synergistic effects from exposure to multiple herbicides.

Risk from Exposure to Multiple Carcinogens

In this study we present cancer risk from exposure to atrazine only. This represents an underestimate of risk, as cancer risks can be considered additive across the entire group of triazine weed killers. This additive approach to assessing the risk from low level exposures to environmental carcinogens has been recommended by three National Academy of Sciences (NAS) committees: the Safe Drinking Water Committee, Subcommittee on Mixtures, the Committee on Methods for the In Vivo Testing of Complex Mixtures and most recently, the Committee on Pesticides in the Diets of Infants and Children (NRC 1988, NRC 1989, NRC 1993).

Commenting on risk assessment improvements needed to protect infants and children from pesticides, the latter committee concluded that, "Estimates of total dietary exposure should be refined to consider intake of multiple pesticides with a common toxic effect" (NRC 1993).

This approach to risk assessment was mandated in the 1996 Food Quality Protection Act, which requires EPA to consider risk not only from all chemicals with a common mechanism of toxicity, but also from all possible routes of exposure, including drinking water, food, and pesticides used in the home, school, or workplace. In our analyses, we consider only the cancer risk from exposure to atrazine in drinking water.

Number of children exposed

Of the 1.4% of the general population under one year of age (U.S. Census Bureau 1999), about one-third of those children would potentially be born during the approximately four-month period of high pesticide concentrations in tap water.

Of these, data indicate that between 37.6 and 62 percent are fed formula exclusive of breast milk. For 1997, national statistics compiled by the makers of Similac infant formula show that 62.4 percent of infants are breastfed at birth, falling to 26 percent when infants are six months of age (Ross Products Division, 1997). Based on this data, for the four-month period we considered, 37.6 percent of infants would be exclusively formula-fed at birth, corresponding to the 62.4 percent of infants breastfed at birth. By the end of four months, we calculate the number of formula-fed infants to be 62 percent, if the trend is linear.

Of these infants, some are given ready-to-feed formula which does not require the addition of tap water. These infants would have lower exposures to tap water than infants fed solely with powdered or concentrated formula. The use of powdered formula in the U.S. has historically differed from that in Europe, Australia, and Japan, where powdered formula is used almost exclusively. In 1970 powdered formula accounted for only 6 percent of formula feeding in the U.S. By 1991 one formula manufacturer reported that powdered formula accounted for 28 percent of formula sold to individuals, and that 84 percent of formula sold is either concentrated or powdered requiring the addition of water. The dramatic increase in the use of powdered formula in the U.S. throughout the 1980s and 1990s is expected to continue (Fomon 1993). Data from Mead Johnson further demonstrates an increased use in powdered formula, as about half of the babies born in the U.S. are enrolled in the federal Women, Infants, and Children (WIC) program, which chiefly distributes powdered formula (Mead Johnson, 1999). Based on these data, we estimate that about half of all bottle-fed infants receive powdered formula as their primary source of nutrition, and that about 84 percent receive some form of formula that requires the addition of water.

Data show that some formula is reconstituted with tap water, and some with bottled water. EPA analyses show that among infants from birth to six months of age, tap water accounts for 72 percent of water use, considering direct and indirect consumption of both bottled and tap water (EPA 1999b). Although some infants may receive some tap and some bottled water throughout the day, for the purposes of these calculations, we have assumed that the percent use of tap water as a primary water source roughly corresponds to the percent of bottle-fed infants whose formula is reconstituted with tap water.

These factors indicate that about 5 percent of babies born would be in the high exposure group we considered, which is infants from birth to four months of age, exclusively bottle fed with powdered formula that has been reconstituted with tap water during the post-application season. About 37.5 percent of all infants receive some tap water during the first four months of life.

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