Safer Chemicals Healthy Families

WASHINGTON TOXICS COALITION

On The Money

BPA in Dollar Bills and Receipts

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Safer Chemicals, Healthy Families
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The Safer Chemicals, Healthy Families coalition represents more than 11 million parents, health professionals, advocates for people with learning and developmental disabilities, reproductive health advocates, environmentalists, and businesses from across the nation who are united by our common concern about toxic chemicals in our homes, places of work, and products we use every day.

Washington Toxics Coalition
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Washington Toxics Coalition protects public health and the environment by eliminating toxic pollution. WTC promotes alternatives, advocates policies, empowers communities, and educates people to create a healthy environment.

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Editorial Review

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Design & Layout: Josh Schramm, Washington Toxics Coalition

Executive Summary

A hormone-disrupting chemical, linked to serious health problems such as cancer, infertility, and early puberty, has invaded something we use every day. The chemical is bisphenol A (BPA), and that something is money. The Safer Chemicals, Healthy Families Coalition and Washington Toxics Coalition set out to track down the trail of BPA in our bodies and lives by testing cash register receipts (already shown to commonly contain BPA) and the money in our wallets.

We collected receipts and dollar bills from a total of 20 states and Washington, D.C. and tested them for BPA. The results demonstrate that BPA, shown to raise hormonal havoc in both laboratory and human studies, has escaped from other products, most likely receipts, to contaminate our money supply. We also tested whether the BPA that coats receipts transfers to skin.

Findings

1. **About half of thermal paper receipts are made with large quantities of unbound BPA.** We collected receipts made with thermal paper from 22 retailers in 10 states and Washington, D.C. Laboratory tests found BPA in very large quantities—up to 2.2% of the total weight—in 11 of the 22 receipts. Since BPA used in thermal paper is not chemically bound, it is free and able to come off onto skin, money, and other objects.

2. **BPA transfers easily from thermal paper receipts to human skin.** In tests mimicking typical handling of receipts, BPA transferred from receipts to fingers. Just ten seconds of holding a receipt transferred up to 2.5 micrograms. Testers transferred much higher amounts, about 15 times as much, by rubbing receipts.

3. **Unregulated use of hormone-disrupting BPA has contaminated our money supply.** Since the BPA in thermal paper receipts is present in a powdery film, we suspected it could easily travel from those receipts to other objects. We tested 22 dollar bills and found BPA in 21 of 22 dollars tested. Because of its unregulated use, BPA now contaminates something virtually all of us use every day: paper currency. It is very likely that BPA contaminates many other objects we use regularly. To the best of our knowledge, this is the first-ever test conducted to measure how much our paper currency is contaminated with BPA.

Conclusions

The BPA in receipts and on the money in our wallets is a direct result of the absurdly lax controls on chemicals in the United States. Half a century ago, paper makers found that they could make cheap paper that essentially contained its own ink, using a chemical already produced in large amounts. Thermal paper was born, and the chemical was BPA. Today, paper companies produce massive quantities of thermal paper for uses from gas station and grocery store receipts to medical papers and lottery tickets. That this paper contains—and releases—BPA has come as a surprise to most people who use receipts and medical papers. No label states the presence of BPA on thermal paper, and few would anticipate the chemical on paper currency.

Continual surprises regarding where chemicals are used constitute just one of many problems with the federal law regulating chemicals, the Toxic Substances Control Act (TSCA), passed in 1976. TSCA gives the U.S. Environmental Protection Agency (EPA) very limited authority to require safety testing of chemicals, and the agency has required testing of only a few hundred of the approximately 80,000 chemicals in commerce since 1976. Of that large number of chemicals, 62,000 were grandfathered under the law with no requirement for testing or safety assessment. Manufacturers introducing new chemicals after TSCA's passage must notify EPA of the new chemical, but don't have to test it for health and safety. Perhaps most importantly, nothing in the law ensures that chemicals in products are safe or that the safest alternatives are used.

Recommendations

More than thirty years after TSCA's passage, both the U.S. Senate and the U.S. House of Representatives have introduced bills to update this failing policy. With this legislation, we now have an opportunity to make sure that manufacturers use only the safest chemicals, keeping hormone-disruptors and cancer-causers out of our products, homes, and bodies.

The 112th Congress should make reform of TSCA a top legislative priority, ensuring that new federal law contains the following provisions for safer chemicals:

Act fast to eliminate the worst chemicals. Chemicals that can cause cancer, disrupt hormones, cause reproductive harm and infertility, or cause learning disabilities have no place in the products we bring into our homes. New law must reduce or eliminate the use of known toxics on a strict timeline.

Chemical manufacturers must provide robust health and safety information. EPA should have the authority to require companies to provide thorough health and safety information for their chemicals. Such health and safety information would have revealed, for example, that BPA is absorbed through skin.

Consider impacts from multiple exposures and multiple chemicals. Traditional risk assessment that evaluates risk from single sources of chemical exposure just doesn't work in a world where people are exposed to BPA from food cans, water bottles, receipts, and even money. EPA's assessments must use the best scientific methods and protect the most vulnerable among us, such as pregnant cashiers facing high BPA exposure on the job.

Reward innovation that leads to new, safer chemicals. New law should expedite the approval of new chemicals that are inherently low-hazard and/or would serve as safer alternatives for problematic uses of existing chemicals such as BPA. Innovative companies could use this expedited approval to meet the growing global market for safer chemicals.

Section 1: Introduction

Used to be, thermal paper was that shiny, thin paper that faxes came on. It wasn't as sturdy as regular paper, and its print faded over time. Many breathed a sigh of relief when plain-paper fax machines appeared.

But while it seemed that thermal paper had exited our lives, it was instead busy becoming the darling of retailers and taking over the receipt paper industry. Retailers of all kinds love it that with thermal paper, printers don't have to apply any ink—it's already in the paper, a sort of invisible ink that becomes visible with heat. That makes for printers that are cheaper to operate because they fail less often and don't need any ink refills, and that's why most receipts today from grocery stores, gas stations, and other retailers are printed on thermal paper.

Thermal papers do their job via a special coating made of a mixture of a color former, a developer, and a sensitizer to control temperature. Heat from the printer essentially melts the mixture; this allows the color former to contact the developer and form a visible color.

Several chemicals can function as the developer in thermal paper, but many paper manufacturers choose bisphenol A (BPA), a chemical most associate with the clear, hard plastic typical of baby bottles and sports bottles. But BPA is a chemical of many uses, which include those bottles but also medical devices, optical media like CDs, epoxy linings in food cans, and flame retardants.

No estimates are available for BPA's use in thermal paper in the United States, but in Europe it amounts to about 3.7 million pounds of BPA per year[1]. Given the magnitude of other uses, thermal paper is unlikely to represent a large percentage of BPA use in the United States or worldwide. What sets this use apart, however, is that BPA on thermal paper isn't chemically transformed or bound in any way: it's free BPA. And as our data indicate, there's a lot of it, and it doesn't stay on the paper.

BPA: Hazard in a Bottle

Produced in quantities of about six billion pounds each year worldwide, BPA is one of the most popular chemicals of all time[2]. Though it's used in dozens of products that are part of our daily lives, it remained fairly unknown among the general public until this past decade. Public concern soared in 2008, when the Canadian government declared it toxic and moved to ban BPA-containing baby bottles[3]. Seven U.S. states and the city of Chicago have since followed suit with similar bans. This year, two U.S. agencies, the Food and Drug Administration (FDA) and the U.S. Environmental Protection Agency (EPA), announced that they are concerned about the health impacts of BPA[4, 5]. These announcements followed earlier conclusions by the National Toxicology Program, which determined in 2008 that it had some concern about the effect of BPA on brain development and its role in prostate cancer[6].

Their concern echoes that of numerous scientists, including 38 who signed a consensus statement in 2007 after a meeting to discuss the effects of BPA[7]. They met to explore the connection between BPA exposure and troubling trends in human health: early puberty, rising rates of obesity and diabetes, decreases in sperm count, increases in breast and prostate cancers, more ADHD and autism, and higher rates of abnormal reproductive development in boys.

Could a single chemical influence all of these problems? Perhaps. BPA is a hormone-disrupting chemical, and hormones are key operators in our bodies, important for the development and function of multiple systems.

During the past decade, an explosion of research has explored the connections between BPA exposure—particularly before birth and in early childhood—and the health problems that are increasingly afflicting U.S. residents.

"Could a single chemical influence all of these problems? Perhaps. BPA is a hormone-disrupting chemical, and hormones are key operators in our bodies, important for the development and function of multiple systems. "

Cancer: In laboratory animals, exposure to BPA before birth leads to changes in prostate and mammary development that raise the risk for cancer. Neonatal rats exposed to BPA developed pre-cancerous prostate lesions[8]. Animals exposed to BPA while in the womb had altered mammary gland development, and greater sensitivity to estrogen, and at puberty, the animals had higher levels of cancer precursors[9, 10]. Exposure to estrogen and related chemicals is known to increase the chance of developing breast cancer, and among other effects, BPA acts as an estrogen in the body.

Developing brains: Laboratory studies have found that prenatal exposure to BPA can change brain development, affecting a wide range of behaviors[8]. In some cases, this means that animals exposed to BPA don't show the typical differences expected between sexes. They also show more anxiety, hyperactivity, and aggression, and females lack normal maternal behavior, spending less time nursing their young[8, 11, 12].

Reproductive effects: BPA is an estrogen mimic, so it is not surprising that it affects reproductive development in both males and females. In laboratory studies, female animals exposed in the womb showed signs of early puberty[13]. Male animals exposed in the womb produced less testosterone, had larger prostate glands, and made fewer sperm than unexposed animals[8].

Diabetes and obesity: Two human studies have found a correlation between exposure to BPA and obesity. In one investigation of 26 normal and obese women, the obese women had significantly higher levels of BPA in their bodies[14]. In 2008, the Journal of the American Medical Association published a study of 1,455 individuals, finding that adults with greater exposure to BPA were more likely to have diabetes and cardiovascular problems[15].

Laboratory research backs up these findings on diabetes and obesity. Some laboratory studies have found that, particularly in female animals, BPA exposure can lead to higher weight gain and greatly increased fat deposits [8, 16, 17]. Exposed animals ate no more food, but gained more weight than unexposed animals. In addition, cell-culture studies show that BPA can suppress hormones that protect from insulin resistance and even trigger other types of cells to become fat cells[18, 19]. More research is needed to better understand the effects of BPA on metabolism.

For a number of reasons, scientists can't prove conclusively that increases in cancer, early puberty, obesity, learning disabilities, and infertility are due even in part to exposure to BPA or other toxic chemicals. But according to the 38 experts who met in 2007, BPA levels in people today are higher than levels that show effects in laboratory studies[7].

New studies continue to sound the alarm over BPA. For example, research published earlier this year suggests that human exposure might be much greater than previously thought[21]. By comparing the fate of BPA in monkeys and mice, researchers concluded that studies in mice are indeed relevant for humans because monkeys and mice cleared the chemical at similar rates. They also found that in the monkeys, the oral exposure level needed to achieve blood levels similar to those typical in U.S. residents was much higher than the typical human exposure level previously estimated. Thus, they concluded that human exposure may be significantly higher than formerly believed.

Study co-author Patricia Hunt of Washington State University said, "We've assumed we're getting BPA from the ingestion of contaminated food and beverages. This indicates there must be a lot of other ways in which we're exposed to this chemical and we're probably exposed to much higher levels than we have assumed."

Section 2: About this study

To investigate the extent to which thermal paper containing BPA has permeated the market, and whether BPA is escaping onto our skin and other items, we tested receipt paper and dollar bills for BPA. We also tested how much BPA transfers to skin after normal handling of receipts.

Working with partner organizations, we collected receipts from ten states and Washington, D.C. Receipts were minimally handled and placed in aluminum foil packets for shipment to the laboratory. Analytical Sciences, Inc. of Petaluma, CA, analyzed the receipts for total BPA content.

Also together with our partners, we collected dollar bills from individuals and one retailer in 18 states and Washington, D.C. As with the receipts, bills were minimally handled and placed in aluminum foil packets for shipment to the laboratory. Analytical Sciences analyzed the dollar bills for total BPA content.

For exposure testing, we selected four receipts that had tested positive for BPA. Laboratory personnel handled the receipts by holding firmly between a finger and a thumb for 10 seconds, or by rubbing five times between two fingers and a thumb.

Please see Appendix 1 for detailed methods.

Section 3: BPA Everywhere: Receipts, Money, and Us

The results of our tests suggest that not only is BPA commonly used in receipt paper, but its use is resulting in widespread exposure to people and contamination of other items.

BPA in Receipts

We detected large amounts—up to 2.2% total weight—of BPA in store receipts. Half of the receipts tested contained BPA, indicating that its use in receipt paper is very common. Unlike in most other known uses of BPA, such as to make water bottles and can linings, BPA on receipt paper is free, unbound chemical, making the levels we found very significant[22]. At the same time, our results show that alternatives are widely available, with half of the receipts testing BPA-free.

Table 1 details the results.

Receipts from major retailers contained BPA. Retailers with BPA-containing receipts included Safeway, Shaw's, Meijer, Cub Foods, Sunoco, Kroger, Giant Eagle, H-E-B, Randalls, and Fred Meyer. A receipt from the Rayburn Café in the U.S. House of Representatives also contained BPA. The Safeway receipt contained the highest concentration of BPA: 2.2%.

On the other hand, many major retailers (at least in some locations and some of the time) use BPA-free receipts, including Trader Joe's, Hannaford, Home Depot, Albertson's, Ace Hardware, Wal-Mart, Sears,

Table 1: BPA in Receipt Paper

State	Retailer	BPA Level
CA	Safeway	22,000 ppm (2.20%)
CA	Trader Joe's	ND
DC	Hart American Grill (U.S. Senate cafeteria)	ND
DC	Rayburn Café (U.S. House of Representatives cafeteria)	8,900 ppm (0.89%)
ME	Hannaford	ND
ME	Shaw's	17,000 ppm (1.70%)
MI	Meijer	19,000 ppm (1.90%)
MI	Home Depot	ND
MN	Target	ND
MN	Cub Foods	16,000 ppm (1.60%)
MT	Albertson's	ND
MT	Ace Hardware	ND
NY	Price Chopper	ND
NY	Sunoco	16,000 ppm (1.60%)
OH	Wal-Mart	ND
OH	Kroger	12,000 ppm (1.20%)
PA	Giant Eagle	15,000 ppm (1.50%)
PA	Sears	ND
TX	H-E-B	16,000 ppm (1.60%)
TX	Randalls	18,000 ppm (1.80%)
WA	Fred Meyer	18,000 ppm (1.80%)
WA	Costco	ND

ND=not detected above 50 ppm

and Costco. The Hart American Grill, serving the U.S. Senate, also provided a BPA-free receipt.

Other studies have found similar results in testing receipts for BPA both in terms of levels of BPA and in percentage of receipts containing BPA. The first data came from tests commissioned by Swiss Public Radio and reported on air in January 2010, then published in a peer-reviewed journal in July, and measured BPA in receipts and laboratory paper from Zurich [23]. Also in July 2010, the Environmental Working Group (EWG) published the results of tests on 36 receipts from supermarkets, gas stations, pharmacies, restaurants, and other retailers in the U.S. and Japan [24]. Their testing found substantial levels of BPA in 16 of the 36 receipts, with levels ranging from 0.8 to 2.8%. Interestingly, the EWG research found that several retailers issued BPA-containing receipts in some but not all locations tested. For example, they found BPA in one of three receipts from Wal-Mart, whose receipt tested negative in our study.

Green chemist John Warner also published the results of his tests of cash register receipts this year[22]. Warner's researchers found BPA in eight of ten receipts from suburban Boston businesses, with levels ranging from 0.3% to 1.54%, similar to the results of other studies.

Receipts are just one example of BPA-containing thermal paper. According to estimates in Europe, about half of thermal paper is used in point-of-sale receipts and nearly a third for self-adhesive labels used for things like deli trays, shipping labels, and luggage tags[1]. The European Thermal Paper Association has indicated the remainder is used for lottery tickets and FAX paper. The Association estimates that about 30% of thermal paper enters recycling streams.

BPA Exposure From Receipts

Clearly, BPA is present on receipts in large quantities, but how much of it actually gets onto skin when receipts are handled? To answer this question, we selected four receipts that had tested positive for BPA for exposure testing. We used two different protocols to measure exposure, mimicking typical handling of receipts. In the first, the receipt was held with medium pressure for 10 seconds—about as long as someone would generally hold a receipt before placing it in a wallet, shopping bag, or trash can. In the second, the receipt was rubbed between two fingers and the thumb five times—simulating crumpling or other handling of the receipt.

We found that both ways of handling receipts resulted in significant skin exposure, with much higher levels resulting from rubbing than from simple pressure. Results are presented in Table 2. Simply holding the receipt transferred from 0.97 to 2.5 micrograms (µg) from the receipt to human skin, and rubbing the receipt transferred 27 to 31 µg to skin. Both protocols were conducted by laboratory staff at Analytical Sciences, Inc.

These results are in the same range as those reported by the Grob lab in Switzerland, which has conducted the most extensive tests of how easily and how much BPA comes off of thermal paper onto skin [23]. Using laboratory recorder paper and receipts, they developed a standard exposure test, consisting of holding the paper five seconds with hands made slightly greasy from an oily tissue or forehead. They then dipped an exposed finger in ethanol and measured the quantity of BPA in the ethanol. They found that variable amounts, averaging 1.13 µg (micrograms), transferred from the paper to the finger. Much higher amounts—up to 41 µg—transferred to damp, wet, or oily skin.

Table 2: BPA Transfer to Skin From Receipts

Retailer	State	Handling Method	Amount of BPA Transferred to Skin
Cub Foods	Minnesota	medium pressure	2.5 µg
Fred Meyer	Washington	medium pressure	0.97 µg
Safeway	California	rubbing	27 µg
Kroger	Ohio	rubbing	31 µg

The results from our tests using the rubbing protocol are nearly as high as the Grob lab's results using wet fingers, in which a visible white stain was left on the finger after contact. They are higher than the Grob results using their standard exposure test. Our results indicate that ordinary handling of receipts could result in higher BPA exposure levels than previously estimated.

Recently published research indicates that BPA travels easily through the skin under experimental conditions. Researchers applied BPA to pig and human skin explants, and found that that only about 2% of the chemical stayed on the skin surface. Nearly half of the BPA passed completely through the skin, and the rest remained in the skin itself after 72 hours. Some of the BPA that passed through the skin had been metabolically inactivated but some was still in the biologically active form. The authors point out that even the inactive form can be reactivated by enzymes that are present in many body tissues[25].

BPA in Money

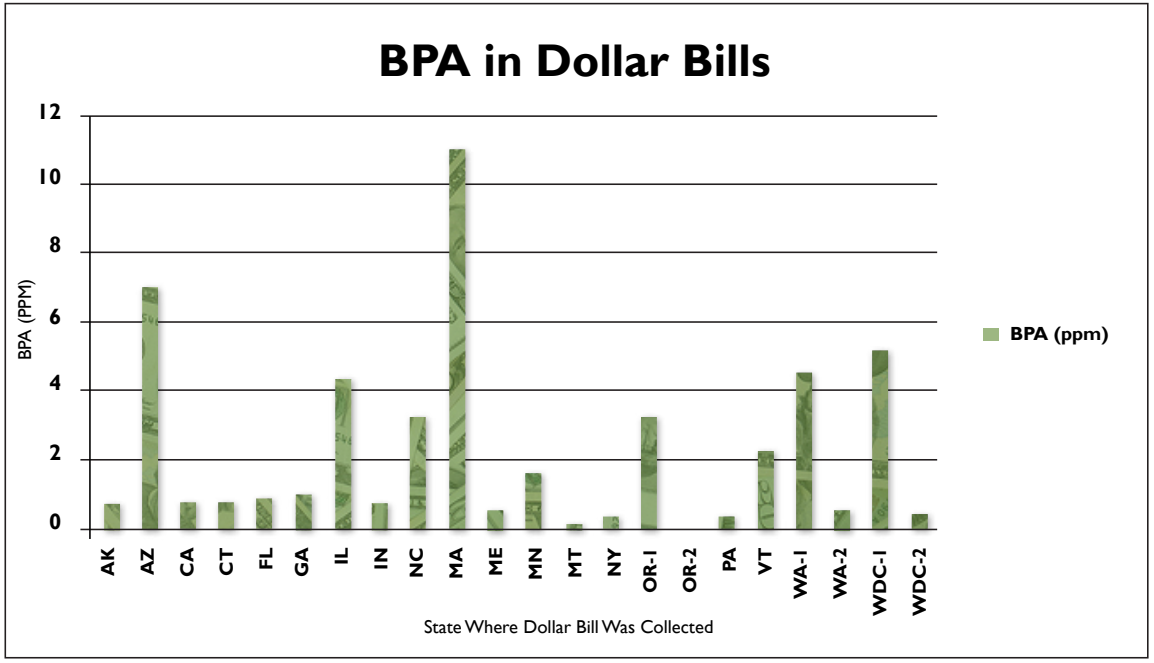
Money isn't known for being the cleanest item we use, but we don't expect an encounter with toxic chemicals when we pay for our morning coffee. On the other hand, the close association of money with paper receipts—in our wallets and in the hands of cashiers—creates a short pathway for BPA to move from those receipts to contaminate money. We tested 22 dollar bills to find out whether BPA could be migrating from paper receipt to paper money, and found that it does appear to make the trip. Twenty-one of twenty-two dollar bills tested positive for BPA, at levels ranging from 0.12 up to 11 parts per million (ppm).

We can't be sure that the BPA found on the bills came from receipt paper. Other studies have found BPA in house dust, which could be another source of BPA to money[26]. Since the levels detected in dust are comparable to those we detected in the entire bills, it is likely that a more direct source is responsible for the bulk of the BPA on money. But BPA is used in so many products, without notice to consumers or regulatory agencies, that it is impossible to pinpoint the source. Money may well just be one type of BPA-contaminated object that people handle regularly.

The money we tested, with one exception, came from personal wallets. The condition and apparent time in circulation varied. The one bill that tested free of BPA appeared quite new. Thus, though it is conceivable that BPA is actually used somehow in the production of paper money, it appears more likely that BPA is accumulating on the surface of the bill.

Figure 1 shows levels of BPA (in parts per million, or ppm) in dollar bills from 18 states and Washington, D.C.

Figure 1: BPA in Dollar Bills



Section 4: Implications and Options for BPA in Paper

Exposure to BPA From Money and Thermal Paper

Once BPA gets onto skin from handling items made with BPA (such as cash register receipts) and items contaminated with BPA (such as paper money), it can take one of two major pathways to get inside our bodies. First, it can travel through the skin. The data on how much and how quickly BPA can get under our skin are just starting to come in, and much remains to be learned. For example, to our knowledge, no one has compared absorption rates through skin at different parts of the body. However, available information indicates that skin absorption could be a significant route of exposure.

The Grob lab in Switzerland estimated that skin exposure from all-day handling of receipts, such as by a cashier, could reach about 70 µg per day, which is similar to estimated high-end dietary exposures from canned food[6, 23, 27]. Actual amounts would vary depending on how thermal paper was handled, hand washing practices, use of hand sanitizers or hand creams that could facilitate uptake, and other factors.

Our results lead to a similar rough estimate, but for an average shopper rather than a cashier. In our tests, rubbing a receipt resulted in a transfer of about 30 µg. We developed an estimate of exposure assuming that half of that amount crossed the skin. If five receipts were handled in a day, and 15 µg per receipt actually crossed the skin, exposure would total 75 µg per day. This estimate assumes that although nearly all of the BPA could cross the skin over a prolonged period, hand-washing or contact with other objects would remove enough that about half the transferred BPA would cross the skin.

Another major pathway to exposure is hand-to-mouth contact. Dr. Heather Stapleton of Duke University estimated exposure to the toxic flame retardants PBDEs via this route after measuring their levels on skin[28]. She noted that activities that involve hand-to-mouth contact such as eating finger foods, smoking, and nail biting would increase exposure. For PBDEs, her estimated exposure levels were higher for hand-to-mouth contact than for intake through food. A similar study measuring typical BPA levels on hands would need to be conducted to evaluate this pathway for BPA, but it could well constitute a significant exposure route.

Cashiers, handling both receipts and money all day long, would be expected to be among the most exposed to BPA from these items. Disturbing data published in October back up that supposition. In a study of 389 pregnant women in the Cincinnati area, cashiers had the highest concentrations of BPA in their bodies, an average of 55% higher than teachers[29]. EWG also analyzed data from the Centers for Disease Control and Prevention (CDC), which tested BPA levels in urine and collected occupation information[24]. EWG found that people working in retail had above-average BPA levels in their bodies: 28% higher than other adults generally, and 34% higher than members of other professions.

The levels of BPA we detected on money are much lower than those on receipt paper, so BPA transfer from money to people is likely a less significant, if more frequent, source of exposure. The near-ubiquitous presence of BPA on dollar bills, however, highlights the fact that BPA is escaping from products to contaminate other materials in unexpected ways. Even a well-informed consumer can't avoid exposure when contamination is so pervasive and constant.

Alternatives to BPA in Thermal Paper

According to a history prepared by an employee of Nashua Corporation, BPA got into the thermal paper business in the 1960s because it worked as a developer, was already widely available, and was believed to be safe[30]. As thermal paper became more established, industry found other chemicals that also worked. In fact, for some uses, they were better suited than BPA, which never got a toehold in higher-end applications but remained the go-to chemical for lower-end applications.

Even for the lower-end applications, such as supermarket and gas station receipts, companies are currently using a number of other chemicals. EPA's Design for the Environment program has identified at least thirteen chemicals, aside from BPA, currently in use to form thermal paper in the U.S., Europe, and Japan[31]. The program is now in the process of evaluating the suitability and toxicity of the alternatives, some of which are quite similar in structure to BPA. Appleton Paper, which produces much of the country's thermal paper, is one company that has publicized its elimination of BPA. The company has, however, moved to using bisphenol sulfonate, or BPS, a close chemical relative of BPA[32]. BPS has not been studied nearly as extensively as BPA, but in vitro studies indicate it may also disrupt hormones, with studies indicating it has some estrogenic and anti-androgenic properties[33-35].

"Savvy consumers, smart retailers, and innovative manufacturers have led the stampede away from BPA in products like baby bottles. These players are now faced with piecing together the puzzle of how to get away from BPA in thermal paper."

Section 5: BPA In Receipts and Money: A Symptom of a Disease In Need of a Cure

Most Americans became aware of the dangers of BPA in the context of it leaching from baby bottles and potentially harming our youngest children. Parents were shocked that such a basic tool of parenting was delivering a toxic chemical to babies. And manufacturers responded to their outrage. Once the problem was widely recognized, all of the major baby bottle companies moved quickly to replace BPA-containing polycarbonate bottles with alternatives, and major retailers removed bottles and sippy cups with BPA from their shelves. Seven states and a number of other governments have now acted to make sure all baby bottles sold within their borders are free of BPA.

But while attention was focused on addressing the problem of BPA leaching from plastic, companies were slathering it on an item we handle every day—cash register receipts. And unlike its use in baby bottles, the BPA on receipt paper isn't chemically bound in any way: it's free BPA and as our results show, it moves easily from paper to people. Apparently, it also moves from receipts to other items we use every day, like money.

Out of Thermal Paper, Into the Rest of Our Lives

Over the last decade, researchers have discovered BPA in some strange places. When Danish and German scientists tested recycled paper for contaminants in 2000, they discovered that extracts of seven out of nine recycled paper towels created a marked estrogenic response [36]. That means that some component or contaminant in the paper towel was mimicking estrogen. In fact, they found BPA (among other chemicals) in all nine recycled paper towels.

BPA gets into recycled paper products when thermal paper from receipts and/or fax paper is mixed into paper for recycling. According to EU estimates, about 30% of thermal paper winds up in the mixed paper recycling stream, meaning more than a million pounds of BPA go into recycled paper each year in Europe alone[1].

Of course, paper towels aren't the only place recycled paper is used. A Japanese group tested 21 paper and cardboard items intended for food contact to see if BPA could actually migrate from the paper into food [37]. No BPA migrated from virgin paper, with no recycled content, but BPA came out of the recycled paper food boxes.

In Germany, researchers found BPA in every toilet paper sample they tested[38]. They also sampled paper destined for recycling, and found BPA in all seven samples. Based on their tests, they estimated that 16.6 metric tons of BPA are emitted to wastewater in Germany every year because of contaminated toilet paper.

Paper recycling involving thermal paper also appears to constitute a significant source of BPA pollution in water. Tests of effluent from eight paper manufacturing plants in Japan found that the plants were polluting waters with BPA as well as chlorinated BPA, which is much more resistant to breakdown in the environment [39].

Studies began appearing only in the last five years or so finding BPA in recycled paper products like toilet paper, raising the question of the source of the BPA in the paper stream. The presence of large quantities of BPA in thermal paper became widely known only after Janet Raloff, writing for *Science News*, broke the story in October 2009, learning about it from John Warner[40]. Warner knew about the practice from the 1990s, when he worked for Polaroid Corporation and the toxicity of BPA was more poorly understood. He had tested receipts at various points in time, often working with his students at the University of Massachusetts, but never published the data until this year.

Not surprisingly, Raloff's article about her interview with Warner and his industry-insider knowledge of this use of BPA met with considerable dismay. An online commenter wrote, "it is amazing to hear about it in this haphazard way! What other common sources of endocrine mimicking monomers are out there?" Indeed. The tale of BPA in shopping receipts exposes a huge hole in the way we manage chemicals in this country: companies don't have to report on what chemicals they're using to the federal government, to manufacturers that use their products, or to the public.

Nobody Knows

This gap in information makes it difficult to impossible for companies down the supply chain, known as downstream users, to make smart decisions about what to use as components in their finished products. And government agencies can't effectively prioritize action or assess overall safety when they don't even know how a chemical is used.

Unfortunately, lack of information on chemical uses isn't the only problem with the current law of the land on chemicals, the Toxic Substances Control Act (TSCA), passed in 1976. Under the current law, the EPA has very limited ability to require safety testing of chemicals before they're used in commerce. The agency has required testing of only a few hundred of the approximately 80,000 chemicals in commerce since 1976. Of that large number of chemicals, 62,000 were actually grandfathered under the law without any requirement that they be tested or their safety assessed. Manufacturers introducing chemicals after TSCA's passage must notify EPA of the new chemical, but don't have to test it for health and safety.

Perhaps most importantly, nothing in the law ensures that chemicals in products are safe or that the safest chemicals are used. This flaw became maddeningly apparent to American parents in 2007, when the widespread presence of lead and other toxic chemicals in children's toys became widely known. More recently, BP poured millions of gallons of Corexit® dispersant into the Gulf of Mexico while EPA struggled to figure out, after the fact, what chemicals were in the dispersant and if a safer alternative was available.

EPA's investigation of the use of BPA in thermal paper and whether there are safer alternatives comes as part of the agency's new action plan on BPA, announced in March of 2010[22]. These efforts to address BPA and other priority chemicals are laudable, but the reality is they will fall short of what we need because EPA is hamstrung by TSCA's severe limitations. Under the law, EPA lacks the authority to require chemical makers to submit needed information on chemical use and toxicity, and it lacks legal authority to take swift action to restrict production or use of a chemical.

Time for a Stronger Chemicals Law

Savvy consumers, smart retailers, and innovative manufacturers have led the stampede away from BPA in products like baby bottles. These players are now faced with piecing together the puzzle of how to get away from BPA in thermal paper. Clearly, the "flavor-of-the-month" approach to making sure chemicals are safe isn't working for them or any other U.S. residents.

On April 15, 2010, Senator Frank Lautenberg introduced the Safe Chemicals Act (S. 3209), a bill designed to update the sadly lacking TSCA. On July 22, 2010, Representatives Bobby Rush and Henry Waxman introduced a companion bill, the Toxic Chemicals Safety Act (H.R. 5820), which would go even further to protect Americans from toxic chemicals.

The 112th Congress should make passage of these bills a top priority, and ensure that final legislation includes the following elements:

Act fast to eliminate the worst chemicals. Chemicals that can cause cancer, disrupt hormones, cause reproductive harm and infertility, or cause learning disabilities have no place in the products we bring into our homes. New law must reduce or eliminate the use of known toxics on a strict timeline. In addition, persistent bioaccumulative toxics, like lead, mercury, and toxic flame retardants, are widely acknowledged to pose an unacceptable threat to health and the environment. New law must ensure these chemicals are phased out of use within five years, with time-limited exceptions allowed only for critical uses for which there are no alternatives.

Chemical manufacturers must provide robust health and safety information. The EPA should have the authority to require companies to provide thorough health and safety information for their chemicals, the kind of testing that would have discovered the importance of skin exposure to BPA. That information should be sufficient to determine whether the chemical causes cancer, birth defects, and other health problems, and whether it is persistent or builds up in our bodies. EPA also needs a full picture of all uses of the chemical. Finally, chemical makers must provide information on the chemicals they supply to product manufacturers so they can make informed decisions about which chemicals they want to use, and which they want to avoid.

Consider impacts from multiple exposures and multiple chemicals. Traditional risk assessment that evaluates risk from single sources of chemical exposure just doesn't work in a world where people are exposed to BPA from food cans, water bottles, receipts, and even money. EPA's assessments must use the best scientific methods, protecting the most vulnerable among us, such as pregnant cashiers who face high BPA exposure on the job. EPA should consider the full universe of exposures, as well as exposures to multiple chemicals with similar toxic effects, before making a determination of safety.

Reward innovation that leads to new, safer chemicals. New law should expedite the approval of new chemicals that are inherently low-hazard and/or would serve as safer alternatives for problematic uses of existing chemicals such as BPA. Innovative companies could use this expedited approval to meet the growing global market for safer chemicals.

Appendices

Appendix 1: Detailed Methods

To investigate the extent to which thermal paper containing BPA has permeated the market, and whether that BPA is escaping onto our skin and other items, we tested receipt paper and dollar bills for BPA content. We also tested how much BPA transfers to skin after normal handling of receipts.

We collected receipts from ten states and Washington, D.C. Receipts were minimally handled and placed in aluminum foil packets for shipment to the laboratory. Analytical Sciences, Inc. of Petaluma, CA, analyzed the receipts for total BPA content. The laboratory also analyzed the foil for BPA and did not detect any.

We collected dollar bills from individuals and one retailer in 18 states and Washington, D.C. As with the receipts, bills were minimally handled and placed in aluminum foil packets for shipment to the laboratory. Analytical Sciences analyzed the dollar bills for total BPA content.

Receipts were extracted and analyzed as follows:

A piece of thermal receipt paper (approximately 0.1 gram) was weighed carefully to the nearest tenth of a milligram and placed into a 40 milliliter vial. Twenty milliliters of a 1:1 mixture of methylene chloride and acetone were added to the vial, completely covering the thermal paper. The vial was sealed and placed into a sonication bath where continuous sonication occurred for 30 minutes. The solvent from the vial was reduced in volume and exchanged to isopropyl alcohol using a Buchi NVAP concentrator. The final volume of the isopropyl alcohol extract was about 1 milliliter. Thirty milliliters of distilled water were added to the isopropyl alcohol extract. Because isopropyl alcohol mixes well with water, the bisphenol A (BPA) uniformly spread throughout the water volume. 0.5 grams of potassium carbonate were added to the vial and allowed to mix and dissolve. The potassium carbonate makes the water basic (c.a. pH=11). After the potassium carbonate was dissolved 1 milliliter of acetic anhydride was added to the vial to act as a derivatizing agent. The acetic anhydride derivatizes the hydroxide groups on the bisphenol A molecule, converting them to acetate esters. After a few minutes, exactly 2 milliliters of hexane were added to the sample vial containing the derivatized bisphenol A. The derivatized Bisphenol A readily extracted into the 2 milliliters of hexane floating on top of the water. After mixing and equilibrating the hexane layer was removed and analyzed for the acetate ester of bisphenol A using a gas chromatograph attached to a sensitive mass spectrometer (GC/MS). Water standards of bisphenol A were derivatized with acetic anhydride and extracted into hexane to be used as standards to calibrate the GC/MS instrument. Dilutions of the extracts and reanalysis were performed in cases where receipts contained high levels of bisphenol A which exceeded the calibration range of the instrument. Blanks were also analyzed, using all reagents, and found to contain no detectable bisphenol A.

Dollar bills were extracted and analyzed as follows:

Approximately 0.05 grams of paper was accurately weighed to the nearest 0.1 milligram. The paper was weighed directly into a 40 milliliter extraction vial. Once all samples were weighed out, 20 milliliters of a 50/50 mixture of acetone and methylene chloride was added to the sample vials. The vials were sealed, vortexed and vigorously sonicated for 30 minutes. The bisphenol A extracted into the organic solvent was concentrated and exchanged to 1-2 milliliters of reagent grade isopropyl alcohol. Ten milliliters of reagent grade deionized water was added to the isopropyl alcohol extract. A one centimeter magnetic "twister" extraction bar (Gerstel Instruments) was added to the vials along with 0.50 grams of potassium carbonate to bring the pH to approximately 10. After gentle mixing 1 milliliter of the derivatizing agent acetic anhydride was added to the vials. The vials were then placed on a stir plate for two hours to allow for complete derivatization of the bisphenol A and the subsequent extraction into the twister extraction bar.

Once extraction was complete, the twister bar was rinsed and carefully placed into a sealed exchangeable gas chromatographic injection liner (Gerstel Instruments). The extracted sample in the injection liner was placed in the instrument autosampler. Each extracted sample was thermally desorbed from the twister extraction bar directly into a liquid nitrogen cooled trap. Once the thermal desorption was complete, the liquid nitrogen trap was rapidly heated and the sample was introduced into an Agilent 7890A gas chromatograph equipped with a very sensitive mass spectrometer, which was

simultaneously operating in full scan and selective ion monitoring modes (Agilent 5975C). Purified bisphenol A was purchased from Aldrich Chemical Company. The instrument was calibrated with bisphenol A standards extracted and derivatized using the procedure described above. Only the fully esterified (i.e. derivatized) bisphenol A was observed under the derivatization conditions utilized. Mass ion 213 of the derivatized bisphenol A was utilized to quantitate the bisphenol A. Results were reported in units of micrograms per kilogram (parts per billion). A blank containing all reagents was analyzed and found to contain no detectable bisphenol A.

We selected four receipts that had tested positive for BPA for exposure testing. Laboratory personnel handled the receipts by holding firmly between two fingers and a thumb for 10 seconds, or by holding the receipt for ten seconds, then rubbing five times between two fingers and a thumb. The entire hand surface was then wiped with a gauze pad (previously tested and found free of BPA) soaked in isopropyl alcohol. The laboratory analyzed the isopropyl alcohol from the pad for BPA. A blank containing a gauze pad saturated with isopropyl alcohol was analyzed and found to contain no detectable bisphenol A.

The Western Institutional Review Board approved the exposure testing protocol and consent.

Participating Organizations

The following organizations obtained receipt samples or provided money samples:

Air Alliance Houston
Alaska Community Action on Toxics
Breast Cancer Fund
Center for Environmental Health
Clean New York
Connecticut Coalition for Environmental Justice
Ecology Center
Environmental Community Action
Environmental Health Fund
Environmental Health Strategy Center
Florida Physicians for Social Responsibility
Healthy Legacy
Illinois PIRG
Indiana Toxics Action
Learning Disabilities Association
Ohioans for Health and Environmental Justice
Oregon Environmental Council
Safer Chemicals, Healthy Families
The Alliance for a Healthy Tomorrow
Toxic Free North Carolina
Washington Toxics Coalition
Women's Voices for the Earth

Appendix 2: H.R. 5820 Bill Description

H.R. 5820 requires that all chemicals be proven safe

The chemical industry must prove that their chemicals are safe. Both existing and new chemicals must meet a health-based safety standard in order to stay on or enter the market — just as we already require for pharmaceuticals and pesticides under other laws. The U.S. Environmental Protection Agency (EPA) will make an independent safety determination to ensure that the industry has proven safety.

Immediate action on the worst chemicals. EPA must immediately act to reduce exposure to PBTs (chemicals that are persistent, bioaccumulative, and toxic) to the greatest practicable extent. PBTs, including lead, mercury, and many halogenated compounds, persist in the environment and build up in the food chain. Nineteen other high priority chemicals are identified in the legislation and targeted for immediate safety decisions; these include bisphenol A, phthalates, TCE, formaldehyde, and hexavalent chromium. EPA is to add to this list of priority chemicals, identifying 300 within the first year.

H.R. 5820 protects our health using the best science

The safety standard must protect the most vulnerable among us. Toxic chemicals especially threaten

the health of the developing fetus, babies, young children, and teens. Other uniquely vulnerable groups include the elderly, people with preexisting medical conditions, workers, and low-income communities—predominantly people of color—located near chemical hot spots.

The safety standard must account for chemical exposures from all sources. Exposures to a chemical aggregated across all sources—reflecting how people are exposed in the real world—must be quantified and shown to be safe.

When determining chemical safety, EPA must use the best available science. EPA must follow the recommendations of the National Academy of Sciences, the nation's top scientific experts, when assessing chemical safety.

H.R. 5820 informs the market, consumers, and the public

Safer Chemicals, Healthy FamiliesChemical manufacturers must provide essential health and safety information for all chemicals. Chemical producers must provide EPA with all of the data on chemical hazards, uses, and exposures it to needs to determine safety. Honoring the public's right to know, basic safety data are to be provided by the EPA to the public through an Internet-accessible database. Chemical makers must also provide information on the chemicals they supply to product manufacturers, so manufacturers can make informed decisions about which chemicals they want to use, and which they want to avoid.

The bill makes it harder to keep chemical information secret. The bill ensures that information about health hazards and the presence of chemicals in children's products is made public – it can't be kept 'secret' except in narrow circumstances. All claims of confidential business information (CBI) have to be justified up front and will expire after five years unless rejustified. EPA will be required to review a sufficient number of CBI claims to ensure they are valid.

H.R. 5820 promotes environmental justice

EPA must identify environmental 'hot spots' and take prompt action to reduce chemical exposures in those communities. Many local geographic areas, often home to people of color and low-income residents, face greater exposure to toxic chemicals than the national average. EPA must name at least 20 'hot spots' and develop chemical action plans to significantly reduce such exposures.

EPA must consider cumulative impact and exposure across all stages of a chemical's life cycle, when making safety determinations. EPA must take into account multiple exposures to different chemicals with the same adverse effects, such as cancer or learning disabilities, when determining safety. All sources of exposure to a chemical must be factored in, including those from industrial facilities, consumer products, and waste disposal.

H.R. 5820 boosts innovation, development of safer chemicals and jobs

The bill rewards innovation that leads to new, safer chemicals, enhancing the competitive strength of the American chemical industry. The bill allows new chemicals to enter the market without a safety determination whenever they: (1) are inherently low-hazard, (2) offer safer alternatives to specific uses of existing chemicals, or (3) serve critical uses.

The bill levels the playing field between new and existing chemicals. In order to remain on the market, existing chemicals must, for the first time, be assessed and shown to be safe. By also ensuring the safety of new chemicals, the bill positions innovative companies to gain advantage by meeting the growing global market demand for safer chemicals and products.

Investment in green chemistry research will boost American business. The bill establishes and funds a network of regional green chemistry research centers to speed the adoption of safer alternatives and create new green business development opportunities.

Investment in workforce development will spur new American jobs. The bill creates an education and training program to develop the green chemistry skills of industrial and scientific workers, enabling workers to produce safer alternatives, and creating new and safer jobs.

H.R. 5820 supports the states and tribes

The new bill supports state-level and tribal chemical programs. To ensure chemical safety, EPA must provide grants to and coordinate and share data with existing state and tribal government agencies. The bill will not preempt stricter state and tribal rules.

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